THE COVID-19 PANDEMIC AS A CATALYST FOR THE DEVELOPMENT OF SUSTAINABLE ENVIRONMENTAL PRACTICES AND THEIR IMPACT ON QUALITY OF LIFE

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Abstract

The COVID-19 pandemic has been an important catalyst for the adoption of sustainable environmental practices. Restrictive measures such as quarantines and curtailment of international travel have reduced greenhouse gas emissions and improved air quality in cities. This has provided an opportunity to rethink consumption and resource use patterns and accelerate the transition to greener and more sustainable approaches across sectors including transport, energy and manufacturing. The pandemic has also highlighted the relationship between environmental health and human quality of life, spurring the development of green economy, renewable energy and circular economy initiatives. In the long term, the adoption of sustainable practices can not only mitigate the impact of climate change but also improve public health and well-being. COVID-19 pandemic, sustainable environmental practices, climate change, air quality, renewable energy, circular economy, quality of life, green economy.

Keywords: sustainable environmental practices, climate change, air quality, renewable energy, circular economy, quality of life, green economy

I. Introduction

The COVID-19 pandemic triggered extensive global measures aimed at curbing its spread, resulting in unexpected consequences for both the environment and the economy. These unforeseen effects have shed new light on how pandemic control strategies influence environmental health and economic systems, thereby affecting global sustainability efforts. This detailed narrative review thoroughly explores the complex relationship between COVID-19 control measures and environmental well-being (fig.1). Our study examines critical ecological factors such as air and water quality, noise pollution, soil quality, and energy consumption, analyzing how these aspects changed during lockdown periods. We also investigate the pandemic's unexpected economic implications, especially the rapid shift toward digitization and e-commerce. Our research methodology relies on a comprehensive literature review, utilizing meticulous comparisons between conditions during lockdown and those prior to it. Our results indicate a significant improvement in environmental quality indicators during peak lockdown phases, exceeding pre-pandemic levels. This change highlights the possibility of integrating sustainable behaviors into everyday life. The pandemic has acted as both an awakening and a catalyst for sustainable practices. This review emphasizes the unprecedented positive environmental and economic insights revealed by the COVID-19 crisis. As the global community prepares to enhance health and economic resilience for future challenges, the critical lessons

learned from the pandemic's benefits should inform the development of future environmental policies and goals. This interplay among health, economy, and environment offers a unique chance to move closer to our collective sustainable development objectives. The COVID-19 outbreak in 2020 prompted the World Health Organization (WHO) to declare a global public health emergency. As of May 2023, COVID-19 had resulted in over 750 million cases and nearly 7 million deaths worldwide. In response to the virus's severity and rapid spread, governments implemented various measures such as lockdowns, restrictions on social interaction, and limitations on movement and economic activities. Among the most affected sectors were transportation, with air travel plummeting by 96%, and the industrial sector, as global oil consumption and prices dropped sharply.

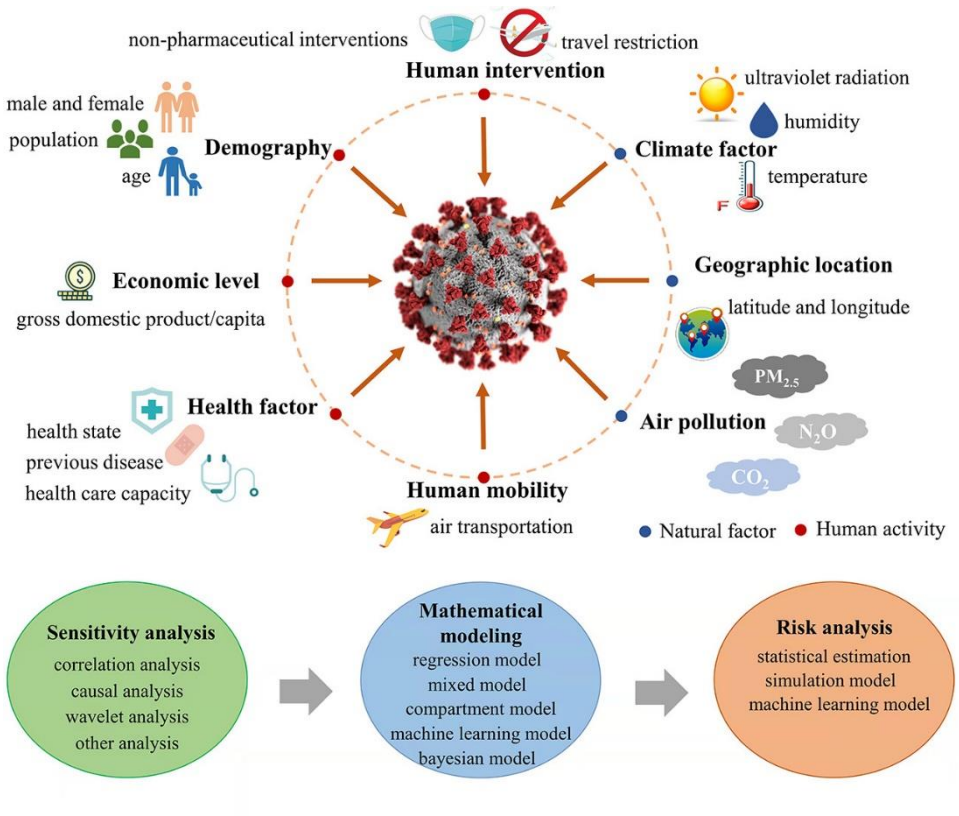

Figure 1: *Impact of main geo-environmental factors on global COVID-19 spread.*

Inger Andersen, Executive Director of the United Nations Environment Program, suggested that post-pandemic leadership in environmental sustainability would be crucial. While the pandemic shifted the global focus toward public health over environmental conservation, it also led to several positive environmental developments. For instance, reduced economic activity lowered pollution and industrial waste emissions, and ecosystems began to recover. Lockdowns helped mitigate environmental issues like climate change, ozone depletion, and air pollution. Silva et al. (2021) noted that COVID-19 indirectly supported several UN Sustainable Development Goals (SDGs) by reducing greenhouse gas emissions, air and noise pollution, and pressures on wildlife.

However, negative environmental impacts also emerged, such as the increased use of single-use plastics and worsening indoor air quality. The pandemic highlighted the intricate relationship between human health, economic stability, and environmental health. Drawing insights from this complex interplay is essential for fostering sustainable practices in the post-pandemic era.

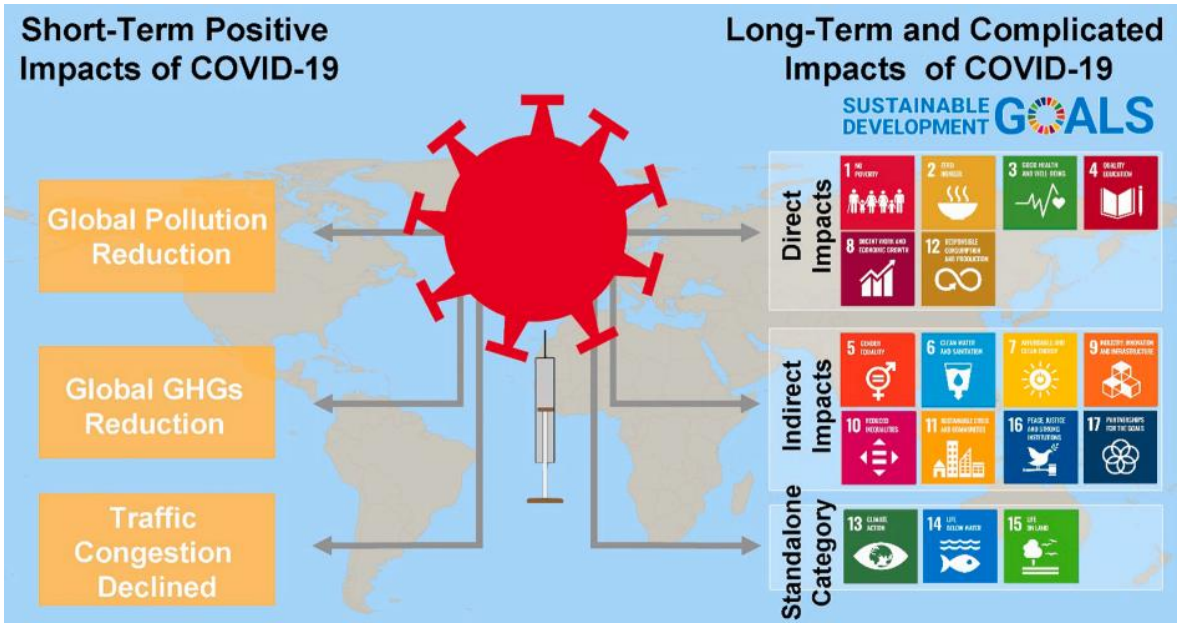

Figure 2: *Conceptualized diagram showing the 17 SDGs as impacted by the COVID-19 in three categories. SDGs-icons are reproduced from UN-website (UN-SDGs)*

This study aims to thoroughly examine both the positive and negative environmental consequences of the pandemic. It will assess immediate impacts, such as improvements in air and water quality, and explore how these changes align with specific SDGs. By linking these environmental shifts to broader global sustainability goals, the study underscores the need for interdisciplinary collaboration in addressing future sustainability challenges. It also calls for further research into the long-term environmental implications of the pandemic, advocating for the continued adoption of eco-friendly practices like digitization and reduced industrial activity. The study's hypotheses propose that COVID-19 lockdowns led to significant improvements in air and water quality, that these improvements contribute to the achievement of certain SDGs, and that the pandemic has revealed sustainable practices that could have lasting positive environmental impacts.

II. Methods

A comprehensive literature review was conducted to gather relevant scientific articles, governmental reports, and research studies examining the impact of COVID-19 on air, water, and soil pollution. Key databases such as PubMed, Google Scholar, and government websites were searched using keywords like "COVID-19," "air pollution," "water pollution," "soil pollution," "lockdown," and "pandemic." The search was restricted to publications from the past five years (2018–2022) to ensure the inclusion of recent and pertinent data.

To ensure rigor, specific inclusion criteria were set, focusing on studies published between 2018 and 2022 that addressed COVID-19's effects on air, water, or soil pollution. These studies needed to provide quantitative data on pollution indicators such as pollutant concentrations, emission levels, or water quality metrics, and compare pre-pandemic levels to those during the lockdown period. Only peer-reviewed articles, governmental reports, and reputable studies were considered. Exclusion criteria eliminated studies published before 2018, those lacking direct

relevance to pollution impacts of COVID-19, non-quantitative studies, and non-peer-reviewed materials like opinion pieces and editorials.

The data synthesis and analysis process involved extracting key data from the selected studies, focusing on changes in pollution indicators. This data was categorized by pollution type (air, water, or soil) and geographic region for structured analysis. Summary tables were compiled to compare data across studies, emphasizing significant trends. Descriptive statistical methods were employed to quantify changes in pollution levels during lockdowns relative to pre-pandemic baselines, while comparative analysis helped identify consistent trends across regions and pollution types. The results were also linked to specific United Nations Sustainable Development Goals (SDGs) to assess the broader sustainability implications.

Despite the thorough approach, the study had several limitations. It relied on existing data, which varied in measurement techniques, monitoring locations, and reporting formats, potentially affecting the comparability of findings. Additionally, the study primarily focused on short-term effects of the pandemic, with the acknowledgment that further research is needed to understand long-term impacts. Nevertheless, these methodological details enhance the transparency and reproducibility of the review, offering a solid foundation for evaluating the environmental consequences of COVID-19 lockdowns.

III. Results

The COVID-19 lockdown led to a significant reduction in industrial activities and a subsequent drop in air pollution from sources such as automobiles, power plants, and industrial sites across many urban areas worldwide. This improvement in air quality was confirmed by pollution-monitoring satellites from NASA and the European Space Agency, which reported sharp declines in air pollution, particularly in China and European cities. For example, air pollution in China dropped by 20–30%, and India experienced its lowest airborne particle concentrations in 20 years. Major European cities like Rome, Milan, Madrid, and Paris saw reductions in air pollution by up to 54%, while levels of nitrogen dioxide (NO2) in Eastern and Central China decreased by 10–30%. Similarly, the United States and the UK also recorded notable reductions in NO2 levels.

These findings are consistent with previous research linking industrialization and urbanization to environmental degradation. However, while the improvements in air quality during the lockdown were substantial, they are not enough to achieve the Paris Agreement's goal of limiting global warming to below 1.5°C. Air pollution, exacerbated by industrial and transportation emissions, poses a serious risk to human health, contributing to tens of thousands of premature deaths annually in the UK alone. Long-term exposure to air pollution has been linked to respiratory illnesses, heart disease, lung cancer, and asthma, all of which have been worsened by COVID-19. Yet, during the lockdown, improved air quality likely saved lives by reducing the harmful effects of pollution.

Despite these positive outcomes, scientists caution that the temporary reduction in pollution during the pandemic is not a permanent solution to the broader climate and health challenges posed by air pollution.

IV. Discussion

The COVID-19 pandemic led to the largest annual decline in CO2 emissions ever recorded, exceeding reductions observed during any prior economic crisis or wartime period (Verma and Prakash, 2020). This unprecedented drop in global CO2 emissions was one of the major environmental benefits of the pandemic, primarily driven by a sharp decline in energy

consumption, which in turn reduced greenhouse gas (GHG) emissions worldwide (see fig. 3). The decrease is primarily attributed to the ground transportation sector (−18.6%), as well as domestic (−35.8%) and international aviation (−52.4%) (Figs. 3). Figure 3 illustrates the distribution of daily emissions changes across different sectors. The largest contributors to the global emissions reduction in 2020 were ground transportation (−613.3 Mt CO2, 40% of the total decrease; purple in Fig. 3a) and the power sector (−341.4 Mt CO2, 22% of the total decrease; orange in Fig. 3a), with smaller reductions in the industrial sector (−263.5 Mt CO2, 17% of the total decrease; warm orange in Fig. 3a) and the aviation sector (including both domestic and international aviation, −200.8 Mt CO2, 13% of the total decrease; yellow in Fig. 3a). Relatively minor decreases were seen in international shipping (−89.1 Mt CO2, 6% of the total decrease; blue in Fig. 2a) and emissions from the residential sector, which includes residential, public, and commercial buildings (−42.5 Mt CO2, 3% of the total decrease; green in Fig. 2a). The reduction in CO2 emissions during the pandemic was even greater than the combined decreases seen in the five previous economic recessions (IEA, 2020).

However, as economies recover, emissions tend to rise again, potentially masking the progress made during the pandemic unless there is a focused shift towards cleaner, more sustainable energy infrastructures (IEA, 2020). At the same time, some cities saw an increase in pollutants like sulfur dioxide (SO2) and carbon monoxide (CO), which is likely due to a rise in private vehicle use during the pandemic as people avoided public transport and carpooling (Orak and Ozdemir, 2021). These pollutants, which primarily come from the combustion of fossil fuels such as coal and oil, remained prevalent in areas heavily reliant on non-renewable energy sources, such as coal-fired power plants (Filonchyk et al., 2020).

In colder months, the increased demand for heating in residential areas, particularly those dependent on fossil fuels, is expected to further elevate emissions, counteracting some of the temporary reductions achieved during the lockdown. This underscores the need for a transition to cleaner energy sources to sustain the environmental benefits observed during the pandemic. The COVID-19 lockdown brought significant improvements in air quality, primarily due to reduced industrial activities and fewer vehicles on the road. However, maintaining these improvements requires a strategic and gradual shift towards cleaner energy and transportation systems. A key step is increasing the number of electric vehicle (EV) charging stations and encouraging the use of low-emission fuels. Cities need to reorganize by introducing measures like clean air zones or low-emission classifications to restrict polluting vehicles from entering congested urban areas (PHE, 2020).

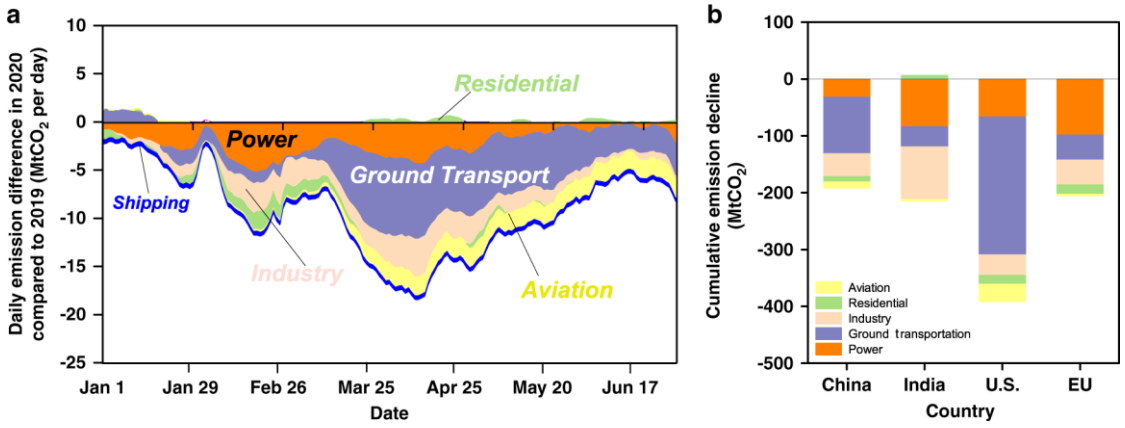

Figure 3: *Sectoral effects of COVID-19 on CO2 emissions*

A critical component of decarbonizing road transport and integrating renewable energy into power grids is the advancement of battery technology (World Economic Forum, 2019).

Overcoming these challenges will require a circular value chain that includes designing products for extended life, implementing Vehicle-to-Grid (V2G) systems, and scaling up shared electric mobility solutions. Integrating the transportation and energy sectors is crucial for building a sustainable battery ecosystem (Masiero et al., 2017; PHE, 2020). Yet, simply replacing all vehicles with electric models won't solve traffic congestion or resource consumption issues. Instead, adopting circular value chains can help minimize these risks, enabling the development of a more sustainable battery industry by reducing emissions during production, ensuring ethical working conditions, and promoting reuse, recycling, and remanufacturing.

The assumption that industrialized economies inherently produce substantial pollution is essential, as air pollutants significantly impact COVID-19 death rates (Fofana et al., 2020). Studies have demonstrated that higher levels of air pollution contribute to increased fatalities. For example, Wu et al. (2020) found that a 1 μg/m³ increase in fine particulate matter (PM2.5) correlated with a 15% rise in COVID-19 mortality. These findings highlight the urgent need to prioritize air quality improvements, as poor air quality can exacerbate the spread and severity of airborne diseases like COVID-19. For instance, strong airflow in an air-conditioned restaurant in Guangzhou, China, facilitated viral transmission among diners (Liu et al., 2020).

Road traffic noise, a significant environmental issue in Europe, affects millions of people's health and well-being, contributing to a range of negative outcomes such as sleep disruption, anger, and serious impacts on metabolic and cardiovascular systems (EEA, 2020). The European Environment Agency (EEA) reported that approximately 20% of Europeans live in areas with noise levels that are harmful to their health. This chronic noise pollution leads to around 12,000 premature deaths and 48,000 new cases of ischemic heart disease annually. Additionally, about 22 million people experience chronic high irritability due to noise, and 6.5 million suffer from severe sleep disturbances (EEA, 2020).

Airplane noise has also been shown to impair cognitive abilities, particularly reading, in children. For example, one estimate suggests that airplane noise negatively impacts the reading abilities of 12,500 schoolchildren. While air pollution leads to more premature deaths, noise pollution has a broader impact on people's quality of life and mental health (EEA, 2020).

The COVID-19 pandemic, however, brought a drastic reduction in noise pollution due to a sharp decline in road traffic and industrial operations. Lockdowns reduced noise input into both the troposphere and stratosphere, as noted by Verma and Prakash (2020). Road traffic became rare during this period, contributing to an unprecedented quietness in urban environments (Nazir et al., 2021). This reduction in environmental noise created a conducive environment for outdoor activities, including exercise. A global study found that, during the lockdown, exercise rates increased dramatically. Average individuals experienced an 88% increase in their exercise rates, moderately active individuals saw a 38% rise, and sedentary individuals had a 156% increase (Snider-McGrath, 2020). These statistics reflect the broader positive influence of reduced noise and air pollution on physical well-being.

Marine life also benefited from the reduction in human activity during the lockdown. Noise pollution in the ocean, largely caused by shipping and seismic air cannon experiments for gas and oil exploration, can severely disrupt marine life. Sound travels much farther and faster in water than in air, making noise a significant threat to marine ecosystems (Duarte et al., 2021). One study on humpback whales and other marine animals found that elevated stress hormone levels in these species were linked to increased ocean noise, and prolonged stress can negatively impact reproductive success (Rolland et al., 2012). The temporary reduction in marine traffic during the pandemic likely provided some relief to marine life, although the long-term consequences of decreased ocean noise remain to be fully understood.

In summary, the COVID-19 lockdown led to significant reductions in both terrestrial and marine noise pollution, highlighting the deep connection between human activities and

environmental health. The data underscores the importance of addressing noise pollution not only for human well-being but also for the broader ecological health of both land and marine environments.

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