

COVID-19 Pandemic and its Impacts on the Global Environment, Ozone Layer and Greenhouse Gas Emissions

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ABSTRACT

COVID-19 pandemic has raised many questions about the interactions between new infections, the global environment, climate, and health. The European Union has asked for the H2020 HERA project, which aims to establish environmental, climate, and health research priorities to identify the research needs related to Covid19. The outbreak of this virus appears to be related to urbanization, habitat destruction, trade in live animals, intensive livestock farming, and global travel. The present study compared the impacts and consequences of COVID19 regarding several environmental indicators. To this end, previous studies on the global consequences of the prevalence of COVID-19 infection and the environmental effects of this phenomenon (renewables, climate change, ozone layer, and solid waste) were reviewed. Data collection was done through reviewing various published studies in prestigious international journals and conferences and reports of official organizations. Although the literature on the prevalence and spread of the COVID19 virus is limited, this article predetermined the impact of COVID19 and investigated various aspects of its impact on the environment. The obtained results indicated the impact of COVID-19 on various environmental areas. In general, this phenomenon has had a positive impact on the environment (such as reducing fossil fuel consumption and reducing CO₂ production). Therefore, sustainable methods have been proposed to maintain the existing conditions.

Keywords: COVID-19 outbreak, global environment, solid waste, greenhouse gas emissions, renewable energy.

Introduction

Pandemic

A pandemic is a disease outbreak that spreads across countries or continents. It affects more people and takes more lives than an epidemic. The World Health Organization (WHO) declared COVID-19 to be a pandemic when it became clear that the illness was severe and spread quickly over a wide area. (Lone and Ahmad, 2020).

The number of lives lost in a pandemic depends on:

- How many people are infected
- How severe of an illness the virus causes (its virulence)
- How vulnerable certain groups of people are
- Prevention efforts and how effective they are

Disease caused by COVID-19 infection

The new coronavirus infection, COVID-19, was initiated from the Hunan seafood market in Wuhan city of China in December 2019, and within a couple of months, it has turned out to be a global health emergency. Live animals like bat, frog, snake, bird, marmot, and rabbit are frequently sold at the Hunan seafood market. Genomic analysis revealed that SARS-CoV-2 is phylogenetically related to severe acute respiratory syndrome-like (SARS-like) bat viruses; bats could be the possible primary source (Bar-On, Flamholz, et al., 2020). ; Mehta, Mytton, et al., 2020). Daily infection of COVID-19 has been steadily rising worldwide (Fig. 1). (Figure 1)

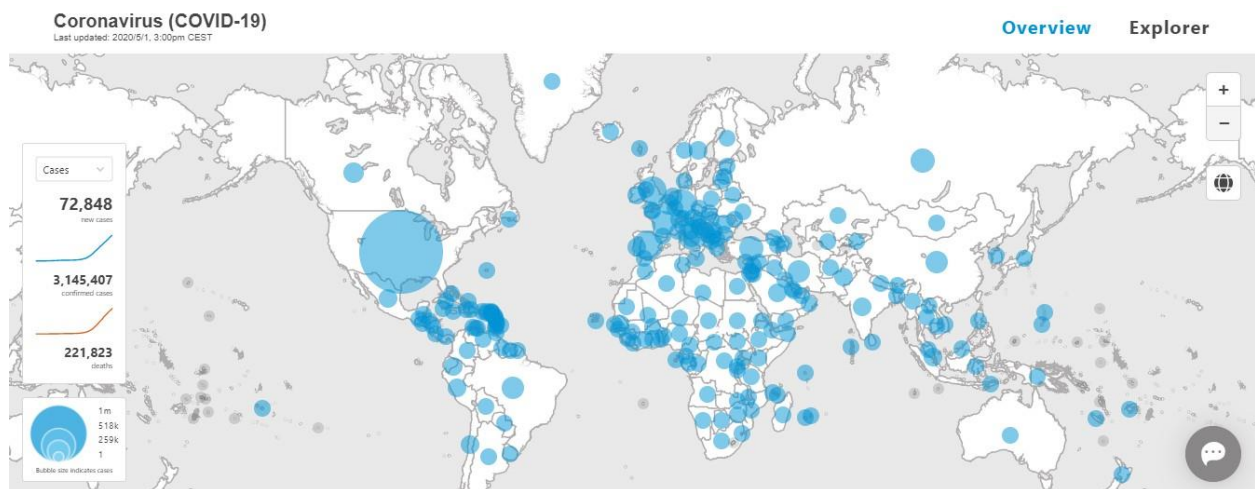


Figure 1: Configuration of confirmed cases of deaths due to coronavirus (Ogen, 2020).

The pandemic has had devastating and negative effects on air pollution, global community health, health, the environment, greenhouse gas emissions, and even the ozone layer (Le Quéré et al., 2020; Muhammad et al., 2020). The World Health Organization (WHO) advises using masks as a precaution and gloves and hand sanitizers daily, which results in the production of large amounts of medical waste in the environment. Medical organizations of waste management companies have already taken steps to disinfect the coronavirus; governments need to find solutions as soon as possible (Singh, Tang, et al., 2020).

Masks are made from plastic materials that are liquids-resistant materials and have high durability after disposal and are eventually and end up in the ocean or landfill (Klemeš et al., 2020). Surgical masks should

not be used for more than one day. Empty bottles of hand sanitizer and solid tissue papers are ending up to a huge trail of medical waste in the environment. In addition, other global environmental changes such as soil degradation, ozone layer depletion, changing environment create an indisputable threat to our planet and human health. Global warming has its roots in industrial development, with the huge release of CO₂ during the industrial revolution and beyond, finally allowing the greenhouse effect to take place, to some extent COVID-19 outbreak may be considered as an indirect consequence of global environmental changes (Pakkattil et al., 2021). These substances are important for photochemical production and ozone layer depletion in the atmosphere. In clean air or with less pollution, reducing nitrogen oxides or VOCs reduces the photochemical production of ozone and consequently less ozone. In contrast, in highly polluted air, reducing nitrogen oxides can increase ozone concentrations because less nitrogen oxide is available to eliminate ozone (Roviello and Roviello, 2021).

This study presents a systematic literature review that provides scientific evidence on the impact of COVID - 19 on various environmental areas. This study examines the observed and predicted effects of changes in major variables on the environment, climate, ozone layer, and greenhouse gases. By discussing research advances and gaps in possible human society strategies for responding, adapting, and preparing for the impact of COVID - 19, this research sheds light on future studies (Lockhart et al., 2020).

The role of COVID-19 in Environment

Over the past few months, various areas have been affected by COVID-19. This is a major environmental concern due to increasing demand for and use of plastic products, protective gears, personal protective equipment (PPE), disposable support equipment, and general plastic accessories such as syringes, all of which are used to prevent and treatment of viruses. (Dargaville et al., 2020; Lockhart et al., 2020). Before the COVID - 19 pandemic, land, and marine environmental pollution had become a growing global issue due to increased waste generation and poor waste management. With the advent of the pandemic, these concerns have now spread. Numerous studies have assessed the effects of COVID - 19 on the environment, as summarized in Table 1 (Ockhart et al., 2020).

Table 1 - Review of the literature related to the effects of COVID-19 from various environmental aspects

Studied are	Author and year	Main findings
Climate quality	Ropkins and Tate 2021 Singh and Chauhan 2020	NO, NO ₂ , and NO _x (average) decreased by 32% to 50% on roads during the outbreak of COVID-19. O ₃ concentration increases by an average of 20% during lockdown A significant reduction of PM _{2.5} particulate matter and air quality index (AQI) was observed in the studied cities. A downward trend in tropospheric NO ₂ concentration was observed during the lockdown in 2020 compared to the same period in the year.
Global environmental pollution	Bashir, Jiang, et al. 2020 Venter, Aunan, et al. 2020	Environmental pollutants such as PM ₁₀ , PM _{2.5} , SO ₂ , NO ₂ , and CO are significantly associated with the COVID-19 epidemic in California. Decreased nitrogen dioxide concentrations (NO ₂ : 60% with 95% CI 48 to 72%) and fine particles (PM _{2.5} : 31%) were observed.

Renewable energy sources	Naderipour, Abdul-Malek et al. 2020	Emissions of greenhouse gases (GHG), equivalent to 8 tonnes of CO ₂ . is decreased from January 2020 to March 2020, to less than 1 ton of equivalent CO ₂ . Reducing emissions of greenhouse gases and pollutants allowed more sunlight to reach the photovoltaic panels, thus increasing renewable energy production.
Climate	Yang, Ren, et al. 2020	Global warming increases mainly in the Northern Hemisphere with increasing regional temperatures of 0.04-0.07 between 30 ° N and 50 ° N, while the North Pole, due to low surface area, cooling close to the surface. Furthermore, it reduces global warming. Emission reductions show an observed temperature increase of 20% to 40% over East China compared to 2019.
Reduced carbon dioxide levels	Mitra, Chaudhuri et al. 2020	The COVID-19 epidemic can evidence changes in CO ₂ levels between the years, but the apparent change at the sites is related to the vegetation on the site associated with human activities
Municipal solid waste	Ragazzi, Rada, et al. 2020	Disposable masks and gloves do not significantly impact waste management, hence <1% of the remaining municipal solid waste is collected annually. Scattering of masks and gloves outside the indoor environment can cause environmental problems.

COVID-19 and The Global Environment

As an inevitable consequence, environmental pollution has become a big issue of the present day. However, due to the unusual outbreak of COVID-19, almost every big and small city and village in the affected countries like China, Taiwan, Italy, USA, France, Spain, Turkey, Iran, Germany, S Korea, U.K, India, Australia, and many more, is under partial or total lockdown for a long period ranging from a few weeks up to a few months. (Muhammad et al., 2020). Meanwhile, efforts to restrict the transmission of the SARS-CoV-2 by restricting the movement have had a tremendous environmental effect. Due to the non-functioning of industries, industrial waste emission has decreased to a large extent (Lalmuanawma et al., 2020; Li et al., 2020; Ni et al., 2020). Vehicles are hardly found on the roads resulting in almost zero emission of greenhouse gases and toxic tiny suspended particles. Due to the lesser demand for power in industries, the use of fossil fuels or conventional energy sources has been lowered considerably (Qiu et al., 2021). Ecosystems are being greatly recovered. In many big cities, the inhabitants are experiencing a clear sky for the first time in their lives. (Zand et al., 2021).

Environmental factors in COVID-19 susceptibility

Effect of COVID-19 on air quality

Beyond the effects of social distance, the COVID-19 pandemic shows a way to achieve positive environmental change. The greenhouse gas emission is also shrinking largely due to reduced industrial and refinery activities, and the use of vehicles and transportation systems has been significantly reduced. In Asia, Europe, and the United States, air pollution levels have been reported to decrease in several cities, in particular nitrogen dioxide (NO₂) concentrations, particulate matter less than 2.5 mm in diameter (PM_{2.5}), and carbon black (CN). A decrease in PM₁₀ of about 28 to 31.0% and an increase in ozone (O₃) concentration of about 50% were observed (Lian et al., 2020; Ogen, 2020). NASA satellites, the European Space Agency (ESA), and the Copernicus Atmosphere Monitoring Service have recorded significant reductions in air pollution in large cities (Elleby et al., 2020).

The global environmental pollution effects of covid-19

The COVID-19 pandemic highly affected the environment. One of these cases is medical lesions due to increased medical activity. A review article from 2020 stated that the city of Wuhan in China generated

nearly 247 tons of medical waste per day at the peak of the pandemic, nearly six times more than before the pandemic. (Feng et al., 2020). It has also been reported that there is still no evidence of transmission of the coronavirus through sewage or sewage workers or water purifiers, even if they were at risk of infection (De-la-Torre & Aragaw, 2021). Also, there is no evidence that the virus is transmitted through sanitary waste. Environmentally, corona outbreaks also have constructive effects (Chakraborty & Maity, 2020). In-house studies during the outbreak increased the Ministry of Interior's applications. Carbon dioxide emissions have also decreased by reducing people's movement in the external environment (Méndez-Arriaga, 2020).

Many countries around the world have turned to remote education because of the coronavirus. (Nakada et al., 2020). In most countries, people who cannot move have reduced their greenhouse gas emissions (Kulkarni & Anantharama, 2020). A recent study found that people whose social activities were limited during the coronavirus outbreak were aware of food wastage; they tried to reduce waste and showed behaviors to prevent food wastage. (Ju et al., 2021). According to another analysis conducted in the same study, avoiding food loss is the negative economic effects (food anxiety, limited movement, lack of income) of the coronavirus outbreak instead of environmental awareness. During this outbreak, strengthening educational and communication activities will be useful to enhance the people's positive environmental behavior.

Impact of COVID-19 on renewable energies

The COVID-19 pandemic has accelerated the lockdown of coal-fired power plants and reduced coal-based power generation. In recent years, Shares of renewables in electricity generation continued to rise in a global market driven mainly by ongoing cost reductions in some technologies. On average, new solar photovoltaic (PV) and onshore wind power cost less than many existing coal plants (Eroğlu, 2020; Hosseini, 2020).

The global renewable and sustainable energy scenario, which has burgeoned in recent decades and enjoyed rapid growth, has encountered a serious challenge due to the coronavirus. The COVID-19 pandemic has struck the renewable energy manufacturing facilities, supply chains, and companies and slowed the transition to renewables. Even the well-established renewable energy policies are under question, particularly those that burden industries badly influenced by the crisis. Many countries' budgets will inevitably be tightened, and the implementation of new renewable energy projects will almost certainly be deferred. The development projects of manufacturers that make/install equipment for renewable energy technologies will be shelved amidst the adoption of austerity measures. As an example, the American-based Morgan Stanley company plans to decrease the installation of the US solar photovoltaics (PVs) in the second, third, and fourth quarters of 2020 by 48%, 28%, and 17%, respectively (Barbier and Burgess, 2020; Naderipour et al., 2020, Tsao et al., 2021).

The Impact of the COVID-19 outbreak on climate

Multiple studies have shown that climate-change prevention (mitigation) is also a far more economically efficient solution than adaptation, with alarming figures of the economic consequences of not implementing mitigation actions globally; past review articles on the COVID-19 pandemic to date suggests that countries that sent clear, consistent and serious messages to the public regarding the consequences and risks of the pandemic (e.g., Germany, New Zealand, South Korea) have more effectively contained the disease than those which denied or played down risks and sent inconsistent messages to the public (e.g., United Kingdom, USA). (Gupta et al., 2020; Sahoo et al., 2020). The management of climate change faces a similar challenge of communicating the need for early and strong action in the face of a distant threat, enhanced by the global nature of the challenge and the lack of counterexamples between countries to demonstrate success. Nevertheless, lessons from the COVID-19 crisis may be learned that may help in formulating successful communication strategies.

Reduced fossil fuel CO₂ emissions due to COVID-19

Tracking emissions of anthropogenic greenhouse gases by atmospheric observations is a major challenge for policymaking, such as the Paris Agreement. Huge atmospheric observation networks comprised of various platforms, including satellites, have been developed to monitor regional/country-scale changes in anthropogenic greenhouse gas emissions. The new coronavirus (COVID-19) outbreak has been affecting global socio-economic activity, leading to a significant reduction in fossil-fuel-derived CO₂ (FFCO₂) emissions and other anthropogenic air pollutants globally. This situation gave us a unique opportunity to assess our ability to quantify the changes in the regional FFCO₂ emissions using atmospheric observations. However, there are few reports of observational evidence for CO₂ emission reduction due to the COVID-19 lockdown, although a large number of publications have reported reductions in short-lived air pollutants from various parts of the world (See Figure 2) (Feng et al., 2019; Chevallier et al., 2020; Tohjima et al., 2020).

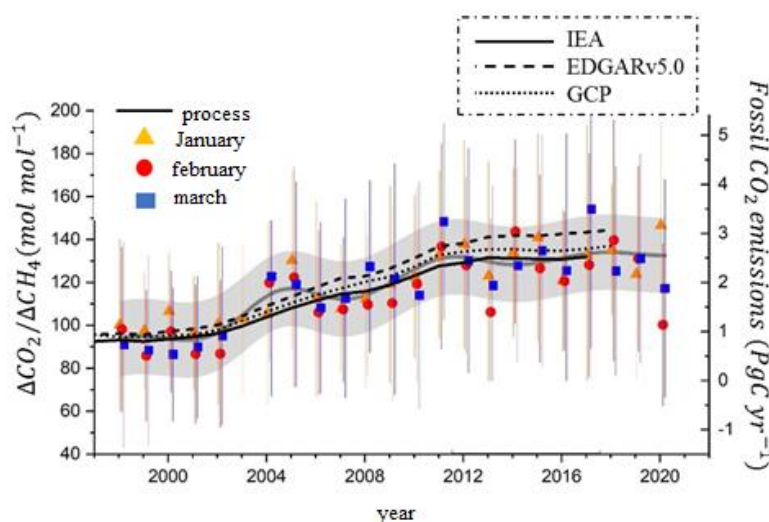


Figure 2: The impact of COVID-19 on reduction in fossil-fuel-derived CO₂ (FFCO₂) detected by atmospheric observations

Impacts of COVID-19 Outbreak on the Municipal Solid Waste

The COVID-19 pandemic has affected everyone's lifestyle, resulting in a change in the quantity and composition of municipal solid wastes (Kulkarni and Anantharama, 2020; Penteadó and de Castro, 2021). The spread of COVID-19 and its changes in people's lifestyles have impacted the quantity and composition of municipal solid waste. For example, in the study, the usual composition of municipal solid waste in Tehran (as shown in Figure 3) has been investigated (Zand and Heir, 2021). As shown in Figure 3, an increase in the number of wastes has been seen because of the possible risk of spreading the virus in recycling centers. Furthermore, since people use more disposable products such as face masks and gloves, many of them are littered in every part of cities. Therefore, it is highly expected that the quantity and components the municipal solid waste have dramatically changed. Nevertheless, in the municipal solid waste management services section, there has been no difference in the frequency of services and the level of activity of the responsible organizations before and during the epidemy.

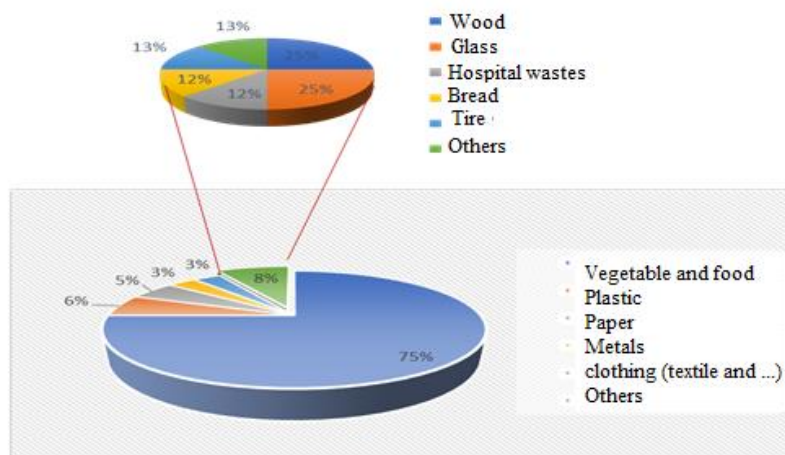


Figure 3: Combination of different wastes in municipal solid waste collected in Tehran

Discussions on COVID-19 pandemic and its environmental effects

The global spread of acute coronavirus syndrome (COVID-19) and the response of national authorities to the epidemic are unprecedented in speed and extent. This is why the current crisis has put information specialists at the center of this pandemic information. Because they are required to refer to scientific texts as sources to provide simple, informative, and accessible information to the public. In addition, academics have resorted to bibliographic reviews to facilitate navigation in scientific databases to analyze and simplify access to research findings on the coronavirus (Rupani et al., 2020).

Coronavirus outbreak and climate pollution

Environmental studies highlight a rapid decline in NO₂, CO₂, and PM air pollutants and the rise in O₃ during the outbreak of the Coronavirus. These studies also show that populations suffering from poor air quality are more susceptible to COVID-19 infections, hospitalization, and death. Water pollution has improved as the virus spreads, as evidenced by decreased metal concentrations in lakes and rivers (Sharma et al., 2020).

Coronavirus and meteorological factors

Environmental studies suggest that a significant relationship exists between wind speed, air pressure, humidity, ultraviolet rays, and the virus's prevalence. Despite specific findings suggesting an adverse effect on temperature and virus cases, little research confirms such a relationship (Lin et al., 2020).

The impacts of covid-19 on agriculture conservation

Environmental Sciences Knowledge Club have investigated coronavirus-induced changes in food supply chains and changes in waste habits during the pandemic that argue for its effect on biodiversity conservation (Jámbor et al. 2020)

Coronavirus and climatic measures

Environmentalists claim that this pandemic clearly shows dependence on natural and environmental resources to mitigate the effects of climate change. Cooperation of all spheres of society based on decisions obtained by scientific results and the creation of sustainable incentives can lead to the goals of Paris (2020) (Bostrom et al., 2020).

Conclusion

Environmental changes are arguably the most vital and severe challenge of the twenty-first century. Despite the continuous efforts by governmental and non-governmental organizations to restore and repair nature, humans can only move a few steps forward, yet there are enormous challenges. Nevertheless, the Covid-19 pandemic during the past few months has had a profound effect on various areas of the environment, and ignoring its effects can strain nature. However, the Covid-19 pandemic has improved the mutually useful link between nature and humans. At present, it is important to control the disease, reduce the transmission, and reduce the adverse effects of the disease on the environment. In this study, the relationship between the COVID-19 outbreak, various areas of the environment, climate change, the ozone layer, and the renewable energy sector was discussed, and a detailed literature review was done, which could be used to plan further research on this topic.

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