

Systematic Review



A Systematic Review on the Climate and Ecosystem Change Associated With the COVID-19 Epidemic: Global Challenges

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Abstract

The most serious current challenge in the world is COVID-19 disease incidence. With the spread of COVID-19, in addition to widespread human and economic damages, concerns have increased about the world's climate and ecosystem change. This change alters the genetic structure of viruses, leading to newer strains. This study addressed global challenges regarding the COVID-19 epidemic effects and possible two-way changes in climate and ecosystems. Studies conducted from 2019 to 2022 were reviewed in this systematic review. Articles on climate and ecosystem change related to the COVID-19 epidemic were searched in the Scopus, Web of Science, and PubMed databases in accordance with the MeSH search strategy using keywords such as "Climate Change" and "Ecosystem" or "COVID-19". In this research, the coding method based on the PRISMA chart was used, and 13 related articles were included in the study after qualitative evaluation. The COVID-19 epidemic is likely to have significant implications for progress in climate and ecosystem change. The phenomenon of climate change and its interaction with the COVID-19 epidemic is not limited to natural issues. One of the most important consequences is its impact on the social and economic issues of human societies, the most important of which are air pollution and environmental degradation. An increase in normal and special wastes, water consumption and wastewater production, air pollution after the start of the global economy, damage to forests and animals, and tendencies to use fossil fuels are only a part of the direct and indirect negative effects of COVID-19 on climate and ecosystem change. Epidemics directly threaten people and the health system, while climate and ecosystem change more broadly weakens natural and human systems. The COVID-19 crisis requires solutions within weeks and months, whereas responses to the climate and ecosystem change crisis seem less acute. However, the effects of climate and ecosystem change worsen with further procrastination. Thus, such crises with overlapping conditions and interactions require more attention and immediate public mobilization. Thus, the necessary planning should be implemented to moderate and reduce its effects.

Keywords: COVID-19, Global warming, Climate change



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1. Introduction

The emergence and spread of COVID-19 have caused widespread human and economic harm throughout the world (1, 2). The World Health Organization (WHO) named the COVID-19 global disease in a global statement, announcing the state of emergency on February 11,

2020. COVID-19, unlike the other similar viruses found in China in 2002 (3), has an extremely high rate of replication, mutation, and spread. The emergence of new diseases is strongly influenced by various factors, and the COVID-19 epidemic is the most critical global challenge of the present era (4). The COVID-19 pandemic has



undermined many of our day-to-day certainties to such an extent that we must expect significant changes in the functioning of our communities in the future (5).

In recent years, climate and ecosystem change has had an increasing trend and adverse effects on many countries worldwide (6). Climate change refers to directional changes in the mean of climate parameters over a long period. Therefore, a change in limit values and averages of climate parameters is an important consequence of climate change (7). According to the United Nations Framework Convention on Climate Change, climate change is defined as weather change that is directly or indirectly related to human activities and changes the composition of the Earth's atmosphere and enhances natural weather change (8). Concerns about global climate change and ecological conditions have increased since the advent of COVID-19. Environmental conditions have been an integral part of the evolution of COVID-19 outbreaks in response to rapid global climate and ecosystem change.

Current trends in the present climate and ecosystem change and the dramatic impact of human interventions in nature (9) are now influenced by the increasing and unstable changes in greenhouse gas (GHG) emissions from human activities (e.g., fossil fuel combustion) during the COVID-19 epidemic. Factors affected by human intervention in nature have led to rapid changes in climate at much higher levels in terms of average, frequency, and severity than before COVID-19. These changes provide the conditions for rapid and abrupt climate dynamics, some of which are already observed in many ecosystems around the world and are expected to intensify as global warming continues. New conditions have been created, and the results obtained from economic, social, environmental, and political issues are under study and can undergo an investigation. Talking about the association between climate and COVID-19 is primarily about minimizing the resulting economic damage, which has overshadowed the interests of all countries worldwide (10-12). The approach to globalization, the value-oriented approach, and the approach of governments to crisis management have been selected as the axes of scenario development (13).

According to previous research, there is a significant association between epidemic effects, improvement of air quality, clean beaches, and reduction in environmental noise. On the other hand, there are secondary negative aspects such as a reduction in recycling rates, an increase in waste, and problems in the renewable energy sector (14). The spread of COVID-19 disease threatens human health worldwide. These changes have an effect on various aspects of life, including the impact on human health and changes in disease patterns. Climate and ecosystem changes alter the genetic structure of viruses, leading to newer strains (15). In addition, convergent evidence suggests that relationships between changes in the virus genotype, climate, and ecosystems have evolved extensively (16). It is now well known that climate and ecosystem change may adversely affect several physiological systems and

the functioning of various organs of the body at different ages, and may be involved in perinatal, respiratory, and cardiovascular disorders, allergies, cancers, and neurological and psychiatric disorders.

Researchers' findings over the past few decades demonstrate that the prevalence of viral diseases from animals to humans (17) has been increasing due to inadequate geographical distribution and the habitat climate of different animals (18). Human health is inextricably linked with animal life and the environment, but this phenomenon has increased with growing environmental degradation (19). However, governments, politicians, decision-makers, and experts need to ensure that epidemic prevention is properly planned and invested in (20). Despite scientific and medical advances, factors such as climate and ecosystem change, population growth, human migration, urbanization, severe climate change-related events, forest fires, and rising sea levels can all lead to the spread of emerging diseases (21). The challenge posed in recent decades as climate and ecosystem change is highly different from the climate change of recent decades because human intervention in nature has increased and the accelerating trend of climate and ecosystem change has made the process of adaptation difficult. As a result, understanding adaptation to climate and ecosystem change has become a major concern to facilitate adaptation measures and improve adaptation capacities (22).

Climate and ecosystem change in recent years has led to warmer temperatures, affected rainfall, and reduced air quality, especially in densely populated and developing countries. These climate changes have caused severe storms, floods, drought and dust, and the scattering of fine dust in the air. The pattern of diseases changes under the influence of these conditions, and the incidence and prevalence of some diseases have represented an increase. The present study cautiously presented a set of global challenges regarding the effects of the disruption of the natural order during the COVID-19 epidemic and the two-way changes which may affect climate and the ecosystem. However, it should be noted that drawing a complete picture of the effects and breakdowns requires the passage of time and the stability of other effects and consequences of the COVID-19 virus epidemic. Although the association between climate change and health dates back centuries, rigorous and coherent studies on this topic have been performed only in the last few decades. Therefore, more research should be conducted to clarify the role of climate in the epidemic and treatment of diseases. Therefore, this systematic review aimed to investigate climate change and the ecosystem associated with the COVID-19 outbreak as world challenges.

2. Materials and Methods

The research conducted from 2019 to 2022 was reviewed in this systematic review. Articles on climate and ecosystem change related to the COVID-19 epidemic were searched in

the Scopus, Web of Science, and PubMed databases. MeSH search keywords included the terms “Climate Change” and “Ecosystem” or “COVID-19”, which were examined in the search strategy. The inclusion criteria were all research articles extracted from the mentioned databases, including studies on climate and ecosystem change. On the other hand, the exclusion criteria included conference papers, abstracts, and letters to the editor which were excluded from the review process. First, a list of abstracts was prepared by the researcher. It should be noted that in this study, the coding method was used based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) chart, and the initial findings were recorded in these forms (23). The PRISMA method is a well-known method for conducting systematic reviews, which determines the process of selecting and reviewing previous studies on a specific topic using a methodology. Subsequently, duplicate articles and ones with irrelevant titles were removed, and then articles that had only related titles and their abstracts were irrelevant, were excluded as

well. Finally, the full text of the articles was reviewed based on the aim of the study. Then, a checklist of necessary research information, including the researcher’s name, the title of the article, completion year, location, method, and effects of climate and ecosystem change, was reviewed and entered into the final checklist for the final review.

3. Results and Discussion

In the present systematic review, 431 articles were found in the mentioned databases. After deleting 22 articles due to duplication and 338 articles due to the irrelevance of their titles and the content of their abstracts, 71 articles were reviewed according to the PRISMA protocol. Eventually, 13 articles were recognized by the qualified researchers and met the inclusion criteria. Fig. 1 depicts the article search chart, and Table 1 presents the search strategy in databases.

According to the obtained results, the proposed solutions to control climate change in the time of COVID-19 include investing in infrastructure projects and clean research, as

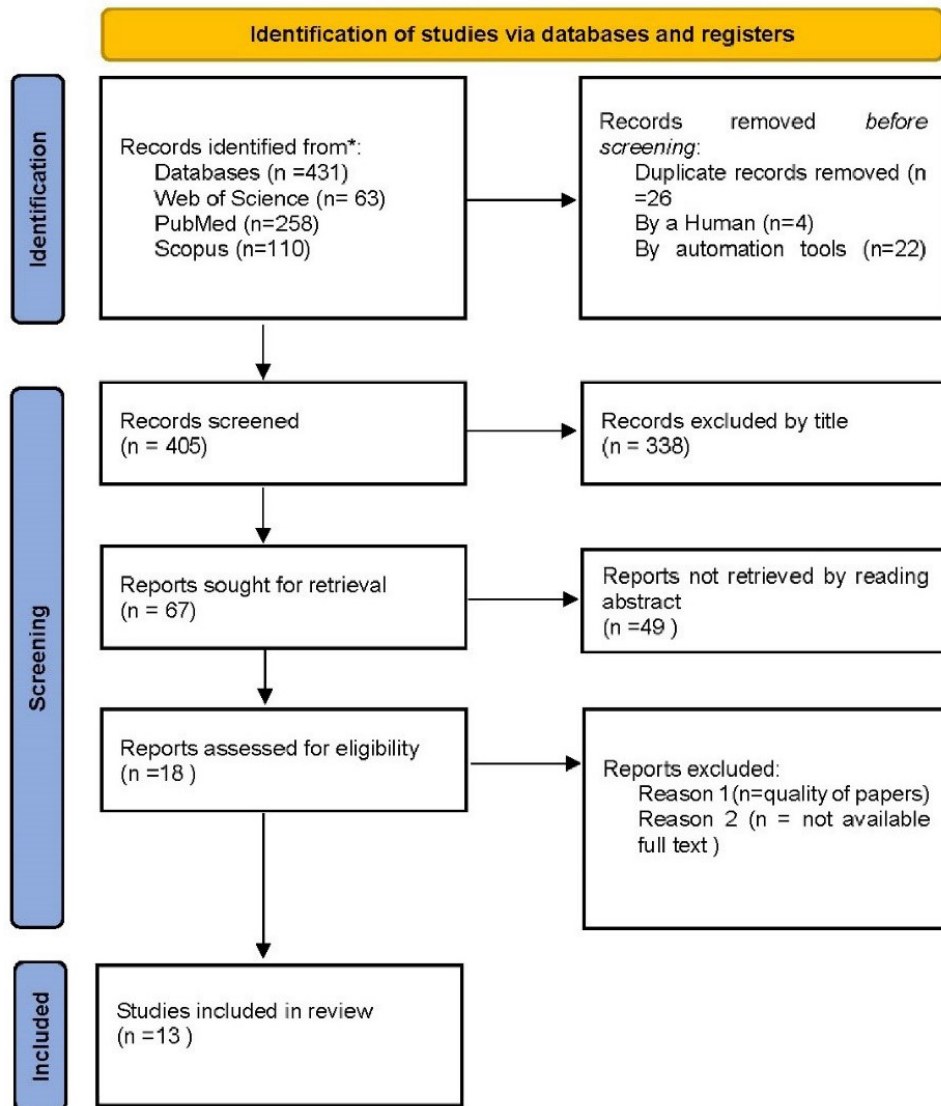


Fig. 1. Flowchart of the Strategy of Conducting a Systematic Review (PRISMA). Note. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Table 1. Search Terms and the Total Number of Publications From Each Database

Databases	No.	Query	No. of Articles
Web of Science	1	Covid-19 (Topic) or "Covid 19" (Topic) or covid19 (Topic) or "SARS Virus" (Topic) or SARS-CoV-2 (Topic) or SARS-CoV2 (Topic) or "SARS-CoV 2" (Topic) or "SARS-CoV19" (Topic) or "SARS-CoV-19" (Topic) or "novel COVID 19" (Topic) or "novel COVID-19" (Topic) or "novel COVID19" (Topic) and 2023 or 2022 or 2021 or 2020 or 2019 (Publication Years) and Articles or Review Articles (Document Types) and 2023 or 2022 or 2021 or 2020 or 2019 (Publication Years) and Articles or Review Articles (Document Types) and English (Languages)	153759
	2	(TS=("Climate change")) OR TS=("Global Warming") and English (Languages) and Articles or Review Articles (Document Types)	297432
	3	TS=(Ecosystem) and English (Languages) and Articles or Review Articles (Document Types)	328287
	4	#3 AND #2 AND #1	63
PubMed		((((((((Covid-19[Title/Abstract]) OR ("Covid 19"[Title/Abstract])) OR (covid19 OR[Title/Abstract])) OR ("SARS Virus"[Title/Abstract])) OR (SARS-CoV-2[Title/Abstract])) OR (SARS-CoV2[Title/Abstract])) OR ("SARS-CoV 2"[Title/Abstract])) OR ("SARS-CoV19"[Title/Abstract])) OR ("SARS-CoV-19"[Title/Abstract])) OR ("novel COVID 19"[Title/Abstract])) OR ("novel COVID-19"[Title/Abstract])) OR ("novel COVID19"[Title/Abstract])) AND ("Climate change"[Title/Abstract]) OR ("Global Warming"[Title/Abstract]) AND (Ecosystem[Title/Abstract]) Filters: Full text, English, from 2019 - 2022	258
Scopus		(TITLE-ABS-KEY (covid-19) OR TITLE-ABS-KEY ("Covid 19") OR TITLE-ABS-KEY (covid19) OR TITLE-ABS-KEY ("SARS Virus") OR TITLE-ABS-KEY (sars-cov-2) OR TITLE-ABS-KEY (sars-cov2) OR TITLE-ABS-KEY ("SARS-CoV 2") OR TITLE-ABS-KEY ("SARS-CoV19") OR TITLE-ABS-KEY ("SARS-CoV-19") OR TITLE-ABS-KEY ("novel COVID 19") OR TITLE-ABS-KEY ("novel COVID-19") OR TITLE-ABS-KEY ("novel COVID19") AND TITLE-ABS-KEY ("Climate change") OR TITLE-ABS-KEY ("Global Warming") AND TITLE-ABS-KEY (ecosystem))	110

well as education and for the restoration and resilience of the ecosystem. Further, the results of the review of the articles represented that prioritizing the reduction in the effects due to the high cost of delayed measures, finding a solution to attract the participation of citizens, eliminating inequalities due to having adverse consequences, and considering the cooperation of all countries in the world should be regarded as an effective solution to solve this problem. Finally, the results revealed the design of the risk management strategy for COVID-19, the separation of managerial and executive needs in order to reduce the effects of this virus and other epidemics in different dimensions, and the adoption of integrated approaches for social development should be seriously taken into consideration.

The COVID-19 epidemic is likely to have significant implications for progress in climate and ecosystem change. Studies have shown that the effects of climate and ecosystem change on reducing aerosol and gaseous pollutant emissions during the COVID-19 global epidemic must continue undergoing investigation. On the other hand, climate and ecosystem change can moderate the spread of epidemics, and it can lead to the incidence of new infectious diseases. Reducing GHG emissions and decarbonization has been suggested by climate scientists and environmental activists as a solution to global climate change. Considering that the reduction in CO₂ emissions during the COVID-19 quarantine is global in scope, it can hypothetically provide clues about the effectiveness of GHGs and the reduction in PM_{2.5} resulting from global decarbonization.

An increase in normal and special wastes (24, 25), water consumption and wastewater production (26, 27), air pollution after the start of the global economy (28), damage to forests and animals (29), and tendencies to use fossil fuels (30) are only a part of the direct and indirect negative impacts of COVID-19 on climate and ecosystem changes.

Instead, reductions in air pollution, GHG emissions, noise pollution, and water pollution are some of the direct and indirect positive environmental aspects of COVID-19 (31). One of the achievements of the COVID-19 outbreak is the possibility of counteracting climate change from the viewpoint of governments' response to the spread of the disease. This is highlighted when comparing the responses to the COVID-19 epidemic with the ones to climatic crises (32).

The phenomenon of climate change and its interaction with the COVID-19 epidemic is not limited to natural issues. One of the most important consequences is its impact on the social and economic issues of human societies, the most essential of which are air pollution and environmental degradation. Therefore, having knowledge and learning about climate and ecosystem change and its effect on social and economic issues play a vital role in the emergence of protective and preventive behaviors against this phenomenon. One of the most important measures in this regard is to increase the interaction of countries concerning consensus on global issues. The increase in the world population and the expansion of human activities in various sectors have caused major problems, the most significant of which is global warming, which has a long-term impact on climate change. Based on the above-mentioned discussion, climate and ecosystem changes have negative effects on human health, and the necessary planning should be launched to moderate and reduce its effects. Table 2 provides the findings of studies in the field of climate and ecosystem changes during the COVID-19 epidemic.

After the spread of COVID-19 in the world, the life of people, as well as living organisms and their environment was affected in different ways. The virus spread brought many environmental opportunities and challenges to the world. In line with the results of the current study, Malekian performed a review study aiming at discovering

Table 2. Studies by Researchers on Climate and Ecosystem Change During the COVID-19 Epidemic

Names of Authors and Year of Publication	Objectives	Key Findings
Gholami et al, 2022 (33)	Analysis of the effects of biological environmental hazards on urban spaces with an emphasis on COVID-19 in Tabriz	-Separation of managerial and executive needs in order to reduce the effects of this virus and other epidemics in different dimensions
Lovejoy, 2021 (34)	Nature, COVID-19, Disease Prevention, and Climate Change	-The need to appropriately respond to emerging phenomena
Kunreuther and Slovic, 2021 (35)	Learning from the COVID-19 epidemic to tackle climate and ecosystem changes	- Design of a risk management strategy for COVID-19 - Granting short-term economic incentives - Prioritizing the mitigation of effects because of the cost of delay measures
Klenert et al, 2020 (36)	Providing lessons learned from COVID-19 to promote climate change mitigation	- Finding a solution to attract and involve citizens - Eliminating inequalities because of adverse consequences - Considering the cooperation of all countries in the world to solve problems - Valuing scientific policy advisors
Hosseini et al, 2020 (37)	Investigating the effect of COVID-19 virus on climate and citizens' health in urban planning	- Consideration of urban facilities and infrastructures in the master plans of urban planning in the case of pandemic diseases Learning from: - The process of moving forward
Manzanedo and Maning, 2020 (38)	Providing lessons for climate change emergency during COVID-19	- Irreversible changes - Social distances and inequalities - Weakening international solidarity - Prevention costs are less than treatment costs
Ching and Kajino, 2020 (39)	A review of air quality, as well as climate and ecosystem change after COVID-19	- An increase in disaster preparedness and how to deal with emerging crises such as the COVID-19 pandemic by asking fundamental questions and the importance of scientific research
Hepburn et al, 2020 (40)	Will COVID-19 fiscal recovery packages accelerate or retard progress on climate change?	- Investment in infrastructure projects and clean research - Investment in education - Investment in ecosystem reconstruction and resilience
Fuentes et al, 2020 (41)	Two global problems: Climate change and COVID-19	- Reductions in greenhouse gas emissions - Changes in the way we treat nature - Reorganization of the global economy
Newell and Dale, 2020 (42)	An integrated vision of climate change and COVID-19	- Adoption of integrated approaches to community development
Forester et al., 2020 (43)	Investigating the current and future effects of COVID-19 on global climate change	- Use of clean fuels and moving toward reductions in fossil fuels
Schwartz, 2020 (44)	Awareness, COVID-19, Climate Change and Immigration in the United States	- The entanglement of many components of human societies with each other
Schwartz, 2020 (45)	Awareness of and preparedness for climate change and COVID-19	- Consideration of researchers' experiences and scientific reserves valuable in the face of climate change and COVID-19

the environmental opportunities and threats of the coronavirus. They found that the quarantine and the requirement for humans to stay at home in order to break the virus transmission chain caused animals to feel safe, leave their natural territory, and enter urban and rural areas. Reductions in noise pollution, air pollution and emission of GHGs due to the reduction in car traffic, and the temporary closure of factories were the other positive effects of the COVID-19 outbreak, which helped improve air quality and reduce the consequences of global warming. In addition to these positive effects, the reduction in conservation activities during the COVID-19 pandemic in some areas increased the destruction of habitats and illegal hunting. The increase in the production of household and hospital waste and consumption of plastic and disposable materials, as well as the decrease in waste recycling, were among the negative effects of the coronavirus epidemic, which caused pressure on the environment by destroying resources. Increasing the consumption of detergents and disinfectants has many harmful effects on the environment. In general, the positive effects of the coronavirus on the environment seem to be temporary, short-term, and small compared to long-term outcomes. Therefore, by overcoming Corona, we should focus on

rebuilding a healthy society and economy, and by fully understanding the opportunities and threats of this virus, we should consciously teach environmentally friendly behaviors (46).

Han et al focused on three main findings aiming at investigating the effect of the coronavirus outbreak on the environment. First, they evaluated the effect of individual environmental factors on the incidence of the coronavirus, and then they examined the mutual effects of environmental factors on the occurrence of the coronavirus. In particular, the interactions of natural factors can affect the coronavirus transmission in a micro and macro way by affecting the survival of SARS-CoV-2, and human mobility and behaviors. The third main finding was about the impact of the coronavirus spread on the environment in such a way that quarantines caused by the coronavirus pandemic improved air quality, changed wildlife, and developed socio-economic depression (47). These findings are in accordance with the results of the present study. The temporary decrease in the consumption of fossil fuels, which led to the reduction in air pollution and GHGs brought joy to many environmentalists. Wild animals found more freedom and the beaches were cleared of garbage. This caused some to look at the coronavirus

as a nature savior. The spread of the coronavirus could increase the production of waste, consumption of plastic and disposable goods, consumption of water and energy, and severe pollution of surface water with detergents and disinfectants which would have many consequences on the environment (48). To prevent the spread of pandemic viruses, we must address the threats to ecosystems and wildlife, which cause habitat loss, illegal trade, and pollution. Any manipulation on the ecosystem and natural habitats for development purposes should be based on the principle of sustainable development and take a sustainable path (47).

To achieve sustainable development, the economy should be considered, along with the environment. COVID-19 caused a heavy blow to the world economy and spread poverty. In such a situation, governments will move toward providing the basic needs of society and will not be strict on the industries, and as a result, the environment will be a victim. The coronavirus led to various social and economic disturbances, and in this situation, attention to the environment will not be a priority while the environment, society, and economy are three important sides for achieving sustainable development. In a world where the coronavirus is killing people and destroying the economy, the discourse on the environment failed to receive attention (49).

4. Conclusion

There are significant global challenges between climate and ecosystem change and COVID-19. The COVID-19 epidemic has affected all human societies and severely affected the economy and public health. The current epidemic shows that climate and ecosystem changes have undergone many changes in the decrease and increase of global warming. Delays in addressing the important issue of climate and ecosystem change can distract us from the investment needed in clean energy. In addition, the actual implementation of the policies of different governments takes a lot of time. Typically, the current crisis alerts decision-makers and countries to the enormous costs of delays in climate measures and increases their responsiveness to climate and ecosystem change. The lessons learned in this systematic review are broad enough to apply to many common global challenges which meet specific characteristics. If not receiving enough attention, the damage and costs of air pollution and fossil fuel consumption will increase over time. Additionally, there is a need to strengthen governmental and non-governmental structures and institutions in response to the COVID-19 epidemic and to raise public awareness to increase the adoption of long-term policies of climate and ecosystem change. The results of the review of the articles revealed that the design of risk management strategy for COVID-19, the separation of managerial and executive needs in order to reduce the effects of this virus and other epidemics in different dimensions, and the adoption of integrated approaches for the development of society

should be seriously taken into account. Epidemics directly threaten individuals and the health system, while climate and ecosystem change undermines broader natural and human systems. COVID-19 requires solutions within weeks and months, whereas responses to crises resulting from climate and ecosystem change seem less acute. However, research indicates that the longer we wait, the worse the effects of climate and ecosystem change. Therefore, we are facing overlapping crises which require immediate public mobilization.

Competing Interests

The authors declare that they have no conflict of interests.

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