

# Entering the Era of Pandemics or Climate Change as a Risk Factor for Global Zoonotic Diseases

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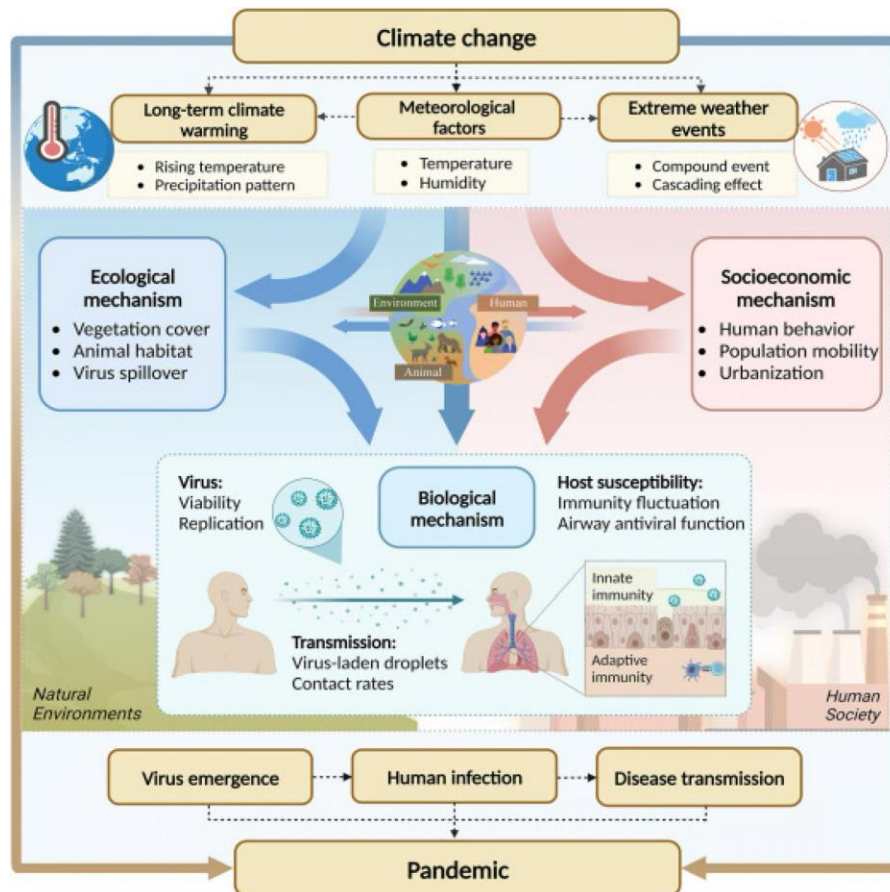
## Abstract

The Earth's climate is experiencing significant warming, and this ongoing change, coupled with human-driven environmental disruptions, presents an increasing risk of global pandemics. The COVID-19 pandemic may represent just the beginning of such threats, with factors like **human activity**, **environmental manipulation**, **urbanization**, **wildlife biodiversity exposure**, and the operation of **wet markets** playing pivotal roles in facilitating the emergence and spread of infectious diseases (Climate change and COVID-19: Does global warming fuel pandemics?).

Pandemics, such as COVID-19, are not novel phenomena for humanity. Historical pandemics, including the **plague**, **influenza**, and **cholera**, have caused millions of deaths over centuries, profoundly shaping human history and altering societal trajectories (Xu et al., 2011), (Morens and Fauci, 2020).

The intensification of anthropogenic impacts on ecosystems is exacerbating the risks to human health associated with **zoonotic diseases**—those transmitted from animals to humans. The frequency and severity of these diseases are increasing, raising concerns over the emergence of new infectious diseases with potentially high morbidity and mortality rates (Daszak, Cunningham and Hyatt, 2001).

***A visual representation of the impact of climate change on human health and pandemics. As global temperatures rise, human activity, urbanization, and the degradation of ecosystems contribute to the increasing emergence of zoonotic diseases.***



Source: [eBioMedicine, Volume 93, July 2023, **Authors:** He Y., Liu W.J., Jia N., Richardson S., Huang C.]

This study provides a comprehensive review of various human behaviors, the extent of human exposure to animal habitats, and the connections between anthropogenic environmental changes and public health outcomes. Through a critical examination of the available literature, I have classified and traced the climatic, demographic, and environmental drivers of zoonotic diseases and pandemics.

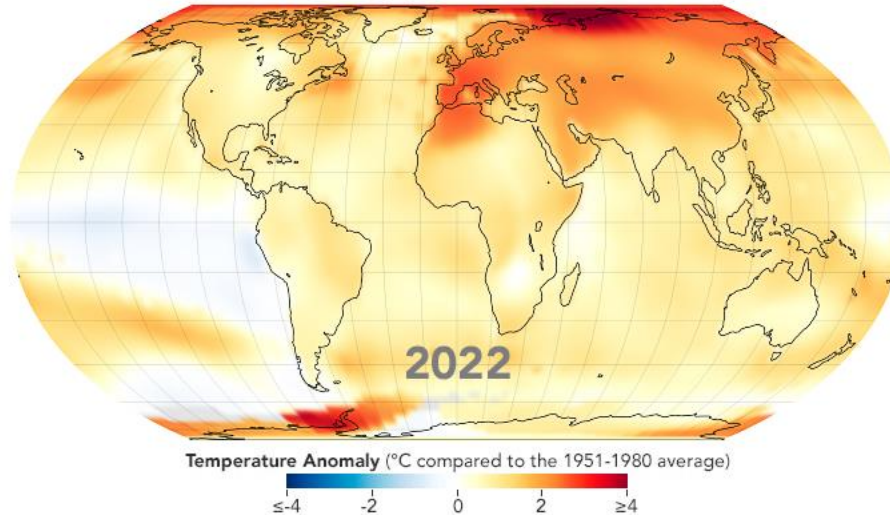
The findings underscore that humanity is at considerable risk due to the accelerating pace of climate change and the rising incidence of zoonotic diseases. These threats are intensifying as a result of widespread environmental degradation and disruptions to ecological systems.

While future advances in science and public health may enable better preparedness and response to pandemics like COVID-19, it is clear that we are currently navigating a steep learning curve. As noted by Boni et al. (Boni et al., 2020), the unpredictable nature of emerging infectious diseases means that we will likely continue to encounter new and unexpected challenges as we attempt to control one of the deadliest pandemics of the past century.

## Introduction

Our climate is changing. Earth's temperature has been rising at an unprecedented rate of 0.18° C per decade since 1981 (Climate Change: Global Temperature | NOAA Climate.gov) with a forecasted average temperature increase ranging between 1.8°C and 4°C by the end of the century. While our planet is heating up, many infectious diseases that were previously specific exclusively for warmer environmental conditions, are gradually enlarging their range. In fact, zoonotic diseases – which the World Health Organization (WHO) defines as any virus that is spontaneously transmissible from vertebrate animals to humans (Zoonoses), or simply saying: diseases that circulate from non-human animals to humans—are taking advantage of the expanded areas made available by climate change to pose an escalated danger to human health. (Bartlow et al., 2019).

***The image below shows global temperature anomalies in 2022, which tied for the fifth warmest year on record. The past nine years have been the warmest years since modern recordkeeping began in 1880.***



Source: [earthobservatory.nasa.gov]

The COVID-19 pandemic, which is now terrorizing the world, will serve as a shining indicator of climatic changes leading to the emergence of infectious diseases and the spread of pandemics. COVID-19 has been classified as a zoonotic disease, (Haider et al., 2020), which was linked to direct exposure to the Huanan Seafood Wholesale Market of Wuhan, and the animal-to-human transmission was presumed as the main exposure mechanism (Cascella et al., 2020).

At the same time, COVID-19 could only be the beginning of a feasible prospective scenario in which climate change and exposure to animal habitats would be critical factors in increasing the incidence of potential pandemics. (Climate change and COVID-19: Does global warming fuel pandemics?)

## Methods

In this literature review, I examined various human activities and their associated environmental and ecological impacts, particularly focusing on the exposure of humans to wildlife and the connections between anthropogenic environmental changes and public health outcomes. I traced the historical development of zoonotic diseases, with an emphasis on the biological, environmental, and ecological factors contributing to their emergence, as well as their potential to escalate into pandemics with catastrophic consequences for human populations (Jones et al., 2008).

To explore the relationship between climate change and zoonotic diseases, I reviewed sources from authoritative organizations such as the United Nations Climate Action rubric (Beyer, Manica and Mora, 2021). I also accessed scientific journals, including *The Lancet*, and conducted a comprehensive search of the PubMed database. Additionally, I reviewed open-access articles, reports from the World Health Organization (WHO), and documents from the Centers for Disease Control and Prevention (CDC) that address climate change and zoonotic disease dynamics.

Through this extensive review of literature, I critically analyzed available data to identify and track the climatic, biological, demographic, and environmental drivers of zoonotic disease emergence. This analysis aimed to better understand how environmental disruptions, exacerbated by human activities, contribute to the risk of pandemics.

## Results

The history of human-animal interaction goes back to the ancient times. Animals provide numerous benefits to human beings. Many people are connected with animals in their everyday lives, both in domestic and in external environment. Animals give shelter and income to people all around the world. Around the same time, animals can be a vector of infectious germs and viruses that can be transmitted to humans and cause infection, which is known as zoonotic diseases or zoonoses.

Zoonotic diseases are common all over the world. Scientific sources suggest that “*six out of every 10 infectious diseases in people are zoonotic*” (Zoonotic Diseases | One Health | CDC). These diseases are not new either. They can be traced throughout the history of human civilization making the great impact on its development. One of the most disastrous zoonotic diseases of all the time was the plague. The plague had several epidemics over the history, the greatest of which was called the Black Death, which killed 60% of the population of Europe. The plague is transmitted to humans through the bite of a flea, which is borne by mice, rats, and squirrels, which have been prevalent in human environments for centuries. The plague enormously effected human civilization, making its footprint on arts, literature, and culture (Zoonosis History), analogous to impact, which is being made by the COVID-19 on the normal life of people nowadays.

We also should not forget about the so-called “Spanish” influenza pandemic, which killed, according to various estimations, from 18 to 50-100 million people in 1918 - 1919, making this disease the most globalized pandemic in history until now. Recently, the laboratory studies indicated that it was caused by an “*H1N1 virus with genes of avian origin*” (Reid et al., 1999).

Other examples of the relatively recent zoonotic epidemics may include *severe acute respiratory syndrome (SARS)*, outbreak of which occurred in 2003 in more than 20 countries in North America, South America, Europe, and Asia. And the fact that SARS-like viruses were found in different animals supports the hypothesis that the virus was transmitted to humans from wild animals that were used for food, with the following human-to-human transmission (Guan et al., 2003). The same concerns the *Middle East respiratory syndrome coronavirus (MERS-CoV)*, viral respiratory illness that was first reported in Saudi Arabia in 2012 and spread to several other countries. This virus



has a zoonotic nature, it is thought it occurs from direct or indirect contact with dromedary camels (Alexandersen et al., 2014).



*People in a market in the Pudong district of Shanghai, China sell live birds such as chicken, geese and smaller birds. The global outbreak of H5N1 influenza in 1997 is thought to have originated in Chinese geese. Photo by Paul McKinnon via iStock*

These are just some examples demonstrating that the life on the earth and public health have been threatened over the humankind history by numerous diseases that had zoonotic origin. And the recent pandemic of COVID-19 is just another dramatic illustration of this fact.

The researchers from the University of Cambridge, the Potsdam Institute for the Study of Climate Change, and the University of Hawaii discovered significant changes in plant type in southern China's Yunnan province and neighboring areas of Myanmar and Laos over the last century. Climate change, which includes elevated temperature, sunshine, and ambient carbon dioxide, which impacts plant and tree formation, has altered natural ecosystems ranging from tropical shrubs to tropical savannas and deciduous forests. (Beyer, Manica and Mora, 2021). This has created a favorable habitat for many species of bats, which predominantly live in forests. The study found that another 40 species of bats moved to the southern Chinese province of Yunnan in the last century, along with about a hundred species of coronavirus carried by them.

### Discussion

This table summarizes the major factors involved in the relationship between human activity, climate change, and zoonotic diseases, and the actions needed to address these challenges for future public health protection.

| Aspect  | Description   |
|---|---|
| <b>Human Activities Impacting the Environment</b> | <ul style="list-style-type: none"> <li>- Population growth</li> <li>- Urbanization and crowding</li> <li>- Increased population mobility</li> <li>- Intensified trade in goods and services</li> <li>- Human-created ecological niches</li> </ul> |

| Aspect   | Description   |
|--|---|
|  | <ul style="list-style-type: none"> <li>- Deforestation and intensive planting</li> <li>- Wet markets and human-animal interactions</li> <li>- Changes in food procurement, preparation, and water sources</li> </ul>  |
| <p><b>Climate Change and Health</b></p>            | <ul style="list-style-type: none"> <li>- Changes in temperature, precipitation, and natural processes affecting public health</li> <li>- Extreme weather events (e.g., hurricanes, floods, droughts)</li> <li>- Increased mortality due to heatwaves and pollution</li> <li>- Rising sea levels and ice melt</li> </ul>   |
| <p><b>Public Health Risks</b></p>                  | <ul style="list-style-type: none"> <li>- 54% increase in heat-related mortality (last 20 years)</li> <li>- 7 million premature deaths annually linked to fossil fuel use and air pollution</li> <li>- Climate change contributes to the rise in zoonotic diseases by disrupting ecosystems and habitats</li> </ul>  |
| <p><b>Zoonotic Diseases and Climate Change</b></p> | <ul style="list-style-type: none"> <li>- Environmental shifts force wildlife and domestic animals into new habitats, increasing risk of zoonotic disease transmission</li> <li>- Climate change alters transmission patterns between animals and humans</li> <li>- Human-induced environmental changes disturb natural balance, leading to the spread of infectious diseases</li> </ul> |
| <p><b>Migration and Urbanization</b></p>           | <ul style="list-style-type: none"> <li>- Climate-induced migration and urbanization increase exposure to new pathogens</li> <li>- Travel, tourism, and trade impact the spread of zoonotic diseases</li> <li>- Global human mobility accelerates the emergence and spread of new diseases</li> </ul>  |
| <p><b>Epidemiological Challenges</b></p>           | <ul style="list-style-type: none"> <li>- Increased risk of disease outbreaks due to human-environment interaction</li> <li>- Need for effective epidemiological surveillance, especially in rapidly changing environments</li> <li>- Early detection and swift response are critical for disease control during emergencies</li> </ul>  |
| <p><b>Future Public Health Strategy</b></p>        | <ul style="list-style-type: none"> <li>- Strengthening surveillance and control of infectious diseases</li> <li>- Focus on prevention of future pandemics through cleaner environments and healthier habitats</li> <li>- Capacity building for quicker emergency responses</li> <li>- Addressing environmental risk factors for long-term health improvements</li> </ul>                |
| <p><b>Long-Term Solutions</b></p>                  | <ul style="list-style-type: none"> <li>- Protecting biodiversity and natural habitats to prevent zoonotic disease emergence</li> <li>- Sustainable development practices to mitigate climate change and reduce environmental risks</li> <li>- Focus on improving air quality, access to clean water, and food safety</li> </ul>   |

It is obvious that changes that occurred in the climate and atmosphere of the earth are associated with the activities of the human beings. Among disturbing human behaviors there can be named population growth, urbanization and crowding, increased population mobility, *“intensified trade in goods and services”* (Str, Seb and St.), human-created ecological niches, deforestation, intensive planting, activity of wet markets, contribution to wildlife habitats, and other

human-environment interactions, such as drinking water from different sources, food procurement, trading and processing, and food preparation practices.

If we depart, for a moment, from emerging zoonotic diseases and their connection to the climate change, we can assert that changing climate, in general terms, impacts on social and environmental health factors - clean air, safe drinking water, adequate food and safe shelter. According to the Lancet's fifth annual report on the ties between healthcare and environment, the worst public health forecast in our generation's history is a dangerous combination of excessive temperatures, air pollution, and intensive land agriculture. (Climate change means future pandemics are more likely - TheJournal.ie).

According to environmental experts, global climate change includes an uptick in the annual temperature, which causes ice to melt and sea levels to rise. In addition to warming, all natural processes are becoming more imbalanced, resulting in changes in precipitation patterns, temperature anomalies, and a rise in the occurrence of adverse events such as hurricanes, flooding, and droughts. According to the Lancet Countdown survey, there has been a 54 percent increase in overheat-related mortality in the susceptible population over the last two decades, which is consistent with exposure to an additional number of days of heatwaves. Beginning in the early 2000s, several countries were also subjected to wildfires, which resulted in burns, heart and lung damage, and death. The 7 million premature deaths per year are linked to the use of fossil fuels and the deterioration of air quality (Watts et al., 2021).

Climate change as a result of human effects on natural environments is one of the factors that lead to deterioration of situation in disease epidemiology. (8 Zoonotic Diseases Shared Between Animals and People of Most Concern in the U.S. | CDC Online Newsroom | CDC). The delicate structure of the human-animal link is continuously affected by the impact of climate change and natural forces.

Human-caused environmental changes are disrupting plant and animal life and forcing them to leave their natural environments. (Half of All Species Are on the Move — And We're Feeling It). Environmental shifts, exposure of humans and domestic animals to the wildlife species, that represent reservoirs of zoonotic diseases, change the patterns of transmission amongst natural reservoir inhabitants, and alter the likelihood of animal-to-human disease transmission (Kulkarni et al., 2015).

In addition, climate change is driving massive migration and urban growth, which is also fueling re-emergence of zoonotic diseases and the spread of epidemics. Travel, tourism and trade are the major human factors impacting the epidemiology of zoonotic diseases.

In the conclusion, it can be stated that the dangers to human health, related with zoonotic diseases, are increasing due to developing anthropogenic impact on biological and environmental systems (Daszak, Cunningham and Hyatt, 2001).

Widespread exploitation of nature and the resultant anthropogenic environmental change may result in potential pandemics associated with the emergence of zoonotic infectious diseases with high morbidity and mortality.

In the future we will be definitely better equipped to combat infections like COVID-19 and other possibly emerging diseases and epidemics; however now we are only at the beginning of a steep learning curve that will undoubtedly continue to surprise us as we try to contain what is now one of the worst pandemics of the century. (Boni et al., 2020). And, as we recover from current crisis, we need to think about creation of healthier and cleaner environments to defend against future pandemics.

Great contribution to saving lives and protecting population can be brought by capacity building activities directed to quicker response to the arising emergency situations and Public Health problems. Also, it is necessary to mention that effective epidemiological surveillance and control will gain even greater importance in the context of rapidly occurring changes in the environment conditions and accelerated rate of movement of people, who are the vectors of diseases and infections. As well as, strengthening surveillance and control of infectious diseases can ensure public health protection both locally and globally.

In addition to that, it can be concluded that the fight against known environmental risk factors can significantly improve the condition of Public Health, while contributing to sustainable development of the world.

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