Original Research Article

Recent links between zoonosis and a catastrophic global climate change

ABSTRACT

COVID-19 has caused widespread fear, a global health catastrophe, and a fall in the global economy. There has been a conflict over COVID-19 cases over the last couple of years. Daily incidents prompted previously unheard-of preventative measures, incarcerating a considerable percentage of the world's population and establishing "social distance" as the newly accepted standard of behavior. All recent outbreaks within the past few decades share a common characteristic: they are zoonotic viruses that spread through human contact and wreak havoc on mankind. COVID-19, EBOLA, Zika virus, avian flu, the West Nile virus, SARS, and MERS all exhibit this characteristic. In essence, zoonotic viruses that spread from animals to humans cause 70% of all infectious diseases worldwide. COVID-19 has taught humanity how terrible life can be. Its link to climate change is likewise not obscured from humans. As zoonotic diseases become more common, humans must consider the larger picture, including their connection to climate change. We can learn how to limit climate change by addressing pandemics and the reasons behind those triggers.

This paper aims to analyses recent zoonotic virus outbreaks linked to climate change over the past few decades and ponders the possible consequences for humanity and its future. The paper also discusses potential causes of epidemics that happened in the past linked with the climate crisis as well as mitigation strategies for the climate crisis to prevent them from disrupting our daily lives.

KEYWORDS

Zoonosis
Mosquito born zoonosis
Ebola
COVID-19
Zika virus
avian flu
West Nile virus

1. INTRODUCTION

Humanity has been working ceaselessly since the dawn of time to discover a solution to eliminating the menace of contagious illnesses. Over the last four decades, humanity has witnessed the birth and re-emergence of viral outbreaks [1] .COVID-19, EBOLA, Zika virus, avian flu, West Nile virus, SARS, or MERS are all zoonotic viruses that spread through human contact and cause havoc on humanity. Basically, zoonotic viruses that transfer from animals to people account for 70% of all infectious illnesses worldwide. Given the many parallels between the COVID-19 issue and subsequent breakouts and the approaching global climate emergency, this crisis gives previously unattainable insights into how to control the worldwide climate disaster

Based on one 2020 research, our planet's temperature will rise faster in the next 50 years as a result of many factors than what it did in the previous 6,000 years [2]. “The average surface temperature has increased by at least 1.1° Celsius (1.9° Fahrenheit) since 1880, as per NASA's Goddard Institute for Space Studies. Since 1975, the substantial fraction of temperature increase has been between 0.15 and 0.20 degrees Celsius every decade” [3]. Temperature fluctuations over time can be detrimental to human health. While the significant health implications of climate change have gained greater attention, the collateral health effects have received relatively little attention, in part because they're more difficult to establish and model [4] .

Recent epidemics, pandemics, and smaller communicable diseases have revealed how close mankind is to self-destruction. As the growing frequency of heat waves, floods, droughts, water shortages, polar cap melting, and species extinction is getting more common than before mankind is already in middle of a massive climatic crisis. This crisis, however, will have an impact on more than just the climate of our surroundings; it will also cause new outbreaks to be more frequent than ever before by making viruses and bacteria more resilient to warmer temperatures, as well as by increasing the number of asymptomatic host populations for zoonotic viruses by providing them with a suitable environment, such as mosquitos. We have increased our demands on nature over the last century to the point that we are presently eliminating species at a rate not seen since the dinosaurs, half of all life on Earth was wiped It was roughly 65 million centuries earlier. Climate change is a key cause of species extinction, and it has the ability to disrupt plants and animals' habitats as well as cause the outbreak of infection. “As the earth heats, animals of all sizes, both on land and on water, are flocking to the polar regions to avoid the heat. As a result, diseases have a chance to infect new hosts since animals have contact with other creatures that they would not normally associate with” [5].

“Pathogens can spread as a result of a variety of factors, such as bush or wild meat hunting and consumption, excessive livestock grazing, and ineffective antibiotic and vaccination treatment. Temperature, weather, and pathogenic environmental survival, dispersion, and preservation all influence pathogenic environmental survival, transmission, and survival” [6]. “Deforestation, largely for agricultural purposes, is the leading cause of global habitat loss. Due to habitat loss, animals are forced to move, where they may come into contact with humans or other animals and transfer illnesses. Large livestock farms can potentially be a source of animal-to-human illness transmission” [5]. This has the potential to trigger future epidemics and was also the cause of previous outbreaks.

One of the most challenging parts of the COVID-19 outbreak, or any other outbreak issue, is how tough it is to manage the virus after it has reached a particular level of abundance in a community. The community's continued expansion triggered a chain reaction of exponential growth. A change in climate seems to be quite likely to function similarly. Scientists are increasingly agreeing that once temperatures exceed certain crucial thresholds, rapid and irreversible changes may occur [7].

Changes in large-scale climatic trends may also put in motion unexpected and everlasting systems with unanticipated repercussions. Changes in the polar jet stream [8,9], ocean salinity [9,10], and pH [11], for example, are anticipated to have large-scale and irreversible consequences on the global climate that will echo for decades or centuries. As a result, it is vital to comprehend the relationship between zoonotic diseases and climate change, as well as to define and forecast the patterns of these illnesses under various climate change scenarios.

2. METHOD

2.1 Strategies Used

This paper seeks to bridge the gap between climate change and epidemics. This research article is made up of full-text English-language publications from 2000 to 2022. Keywords were utilized to find data for this research study, with ScienceDirect serving as the primary search engine. Key phrases were also utilized to search for papers in Springer, ScienceDirect, Web articles, and PubMed.

3. IMPACT OF CLIMATE CHANGE TRIGGERING ZOONSES OUTBREAK

“Geoclimatic fluctuations can be caused by shifts in land and ocean temperatures, sea level and acidity, precipitation and wind patterns, land use and landforms, soil conditions, and extreme weather events. The term "global warming" refers to the alarming rise in average global temperature over the last century, which has been mostly triggered by greenhouse gas emissions from human activity" [1], Extreme weather can have an impact on water accessibility, quality, or availability, posing a significant risk to human populations. Throughout the twentieth century, there has been a 0.5-1 percent higher in precipitation and a rise in the frequency of heavy precipitation episodes across the rest of the northern hemisphere's mid- and high-latitude continents [2].

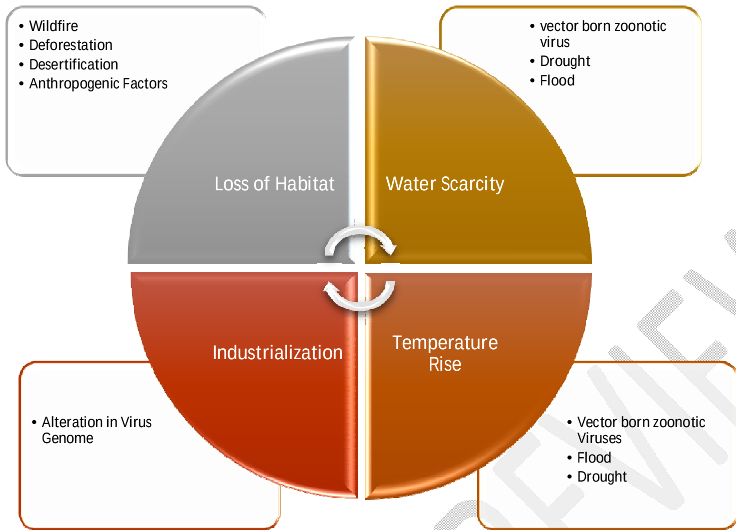

Fig 1. Impact of Climate Change

3.1) Loss of Habitat

"As the global wildlife trade continues and human activities expand into tropical forests, living beings become more vulnerable to wild animals and the illnesses they may transmit. Animals are compelled to shift to new or smaller regions as mining and logging damage or destroy their natural habitats, exposing them to stress or illness in particular. They are also more likely to come into touch with humans and domestic animals, speeding disease transmission from wildlife to humans" [4]. "One way that biodiversity loss endangers human health is through increased disease risk and incidence. The West Nile virus (WNV) illness and Lyme disease (LD) are two zoonotic diseases where a diverse community of vertebrate hosts for arthropod vectors significantly lowers human risk" [1,2]. "The risk of human exposure to emerging and established zoonotic pathogens appears to be increased by biodiversity loss. Future research should concentrate on gathering and examining information regarding the variety, abundance, and transmission potential of the taxa that actually share these pathogens with us" [29,30]. SARS, avian flu, and other illnesses that spread from animals to humans are believed to have grown when people migrate to less developed areas. "Mammals and birds are estimated to host 850,000 undiscovered viruses, which scientists believe have the potential to infect people. With deforestation and habitat loss, animals are more likely to move into new areas and come into contact with people. When these diseases jump from animals to humans, human to human transmission in rural areas can, in turn, lead to more widespread transmission in urban settings" [8].

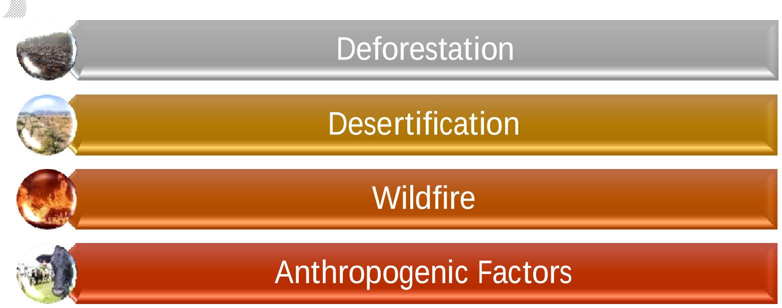

Fig 2. Major Cause of Habitat Loss

3.1.1 Deforestation

“Habitat destruction is a key contributor to biodiversity loss, with significant ramifications for human health. Deforestation plays a significant role majorly to climate change, both directly and indirectly, by releasing carbon dioxide and other greenhouse gases into the atmosphere and destroying environments that are no longer viable for various species” [6].

Rainfall in the Midwest of the United States and Central Africa has been shown to be influenced by forests in some regions of the world. Deforestation leads to more human-wildlife interactions as there is less undeveloped forest available and more human presence in areas where animals once lived.

Conflict is more likely as a result, particularly where there is hunting. Animals may try to cross roads and be hit by cars, or they may get loose and wander onto farms or into cities. It also gives hunters access to areas of the landscape that were previously inaccessible. Wildlife can typically avoid direct contact with humans while there are still healthy patches of forest present, though it gets more challenging.

In contrast, human activity has brought people closer together than ever before. “After accounting for human population expansion, we discovered that increases in zoonotic and vector-borne disease outbreaks from 1990 to 2016 are associated to deforestation, notably in tropical nations, and reforestation, mostly in temperate countries. Because of changes in the natural landscape and more contacts with animals, these interactions are becoming more common on the frontier of human expansion” [5].

“A study published in April found that deforestation and habitat fragmentation in Uganda increased direct encounters between primates and people” [5,11]. “While some creatures may be able to survive and even thrive in manmade surroundings, the vast majority are experiencing huge population declines, pushing our planet into its sixth mass extinction” [19-22]. “Some species are going extinct, but those that tend to survive like bats or rats and thrive are more likely to host potentially harmful pathogens that can spread to humans” [11].

The only flying mammals are bats, and their immune systems have undergone genetic changes to accommodate this function. Bats have a higher metabolic rate than other animals and exhibit a special interferon system (IFN), which may be the reason they can coexist with pathogens. The variety of viruses found in the enteric samples from bats may aid in boosting immunity through their microbiome [7].

Bat and rodent encounters are becoming more frequent as habitat loss becomes an increasingly serious problem, as was the case with the NIV or Ebola. Although the normal body temperature of bats is between 103- 104-degrees Fahrenheit, the microbiome is destructive to humans because our normal body temperature range between 98-98.6 degrees Fahrenheit. Being in close proximity with these species could increase chances for future outbreaks.

“Since ancient times, the Amazon jungle has threatened locals with diseases spread by wild animals. The Amazon Forest is home to about 12% of the world's 1400 bat species, which are known to host a dizzying array of viruses. Numerous potential threats are also carried by its monkeys and rodents” [23-25].

Animals are "relocating " due to deforestation. And the virus or pathogen is looking for hosts [9]. The risk of interacting with animals in Brazil's Amazon region is rising as a result of urbanisation, highway expansion, and hydroelectric dam construction.

3.1.2) Desertification

The capacity of the environment to provide resources like water and wood is being strained more and more by population growth. When trees are removed from the land, the soil is more prone to erosion because the roots no longer stabilise the soil. The ability of the environment to supply commodities such as wood and water is being strained as a result of rapid population growth. “By altering the vegetation cover, creating sand and dust aerosols, and increasing greenhouse gas fluxes, desertification exacerbates climate change. Between 1948 and 2012, the area where dryness, rather than temperature, governs CO_2 exchange increased by 6%, and if the expansion keeps up at this rate, it will have increased by at least another 8% by 2050" [14].

. Drought and desertification will raise a population's dependency on bush meat, raising the possibility of zoonotic infections spreading to mankind. Indirect relationships have been discovered between the incidence of vector-borne infectious illnesses and the incidence of floods caused by unpredictably severe rainfall.

"As a result of severe rain and flooding, there were greater outbreaks of Dengue viruses, WNV, and malaria in Romania (1996-1997), the Czech Republic (1997), Italy (1998), southern Africa (2000), and several parts of Southeast Asia (2011), to mention a few. The present worldwide pandemic issue is likely to coincide with an increase in the frequency of flood and drought catastrophes, that has exacerbated climate risk" [3,11] .

3.1.3) Wildfire

"Fire modifies the distribution, structure, and characteristics of ecosystems throughout the landscape. Forests and animal habitats, like other natural systems, fluctuate cyclically and react to disturbances in comparable ways. Following a fire, there may be a prolonged shortage of shelter and food. Animal populations may shift from cold, damp climes to warmer, drier ones. Herbivores and species that rely on herbaceous plants for cover prefer broad-leaved forests or grass/forb ecosystems that sprout up after a fire" [16].

Scavengers such as crows, ravens, bald and golden eagles, coyotes, grizzly and black bears, and wolves will consume animal corpses in the near future. Snags and fallen woody debris provide critical habitat for a range of species while also supporting cavity nesting places, reptiles, small mammals, and even huge animals such as bears. When there is a wildfire, wildlife will migrate to avoid the flames and find another habitat. Because of their mobility, animals may wander into areas with dense human populations and contact with humans they would normally avoid, perhaps contributing to the spread of contagious illnesses.

3.1.4) Anthropogenic factors

"The evolution and spread of zoonotic pathogens in the human population has also been influenced by anthropogenic factors such as intensive livestock production, extensive agricultural practises, globalisation, and pollution" [2,3]. Increased chicken production in Southeast Asia, as well as development of cattle husbandry on the "Eurasian ruminant street," led to the expansion of highly pathogenic seasonal flu in 2004 [27,28].

The rate of zoonotic disease introduction or re-emergence in the near future will be directly related to the growth of the agriculture-environment nexus [2,25]. Agri-chemical use in agriculture has resulted in changes to soil and water microbial ecosystems, increased desertification, and biodiversity loss [3,14]. The SARS-CoV-2 coronavirus shares 96.2 percent of its DNA with a bat coronavirus from Yunnan province in China. Pollutant exposure may result in selection pressure to affect genomic structure, providing resistance to antiviral medicines. Pollutants like nonylphenol, which can promote mutation in symbiotic organisms and harmful microbes, are also ingested by wild animals [11].

3.2) Water Scarcity

"Because of climate change and global water scarcity, people are migrating much more frequently than most folks understand. Desertification, sea level rise, and an increase in extreme weather events, according to the United Nations' 2016 World Water Development Report, may result in the relocation of 200 million people by 2050" [20]. Climate change is wreaking havoc on our planet and affecting everyone, but the consequences are always more severe for those who live in more vulnerable areas. Changing climate generally affects those who are in Africa and the Middle East who dwell in arid or semi-arid regions the most.

Many individuals are compelled to leave their houses year after year as a direct result of the difficulties in acquiring potable food and drinks as a result of climate change [26,27]. "The Middle East region has altered during the preceding few decades as a consequence of desertification, climate change, high temperatures, and water scarcity. As a result of the Middle East's favourable environment for diverse insect vectors, several arboviruses' illnesses commonly occur, jeopardising both human and animal health. Iran and Turkey are in an active seismic zone as a result of several natural catastrophes that produce humanitarian issues" [13].

3.3) Warmer temperature

"With both indirect and direct effects on physiology and life history traits, temperature is arguably the most significant abiotic factor that affects all organisms" [7]. "Temperature variations can influence the physiology of both the host and the parasite, resulting in complicated and unpredictable outcomes. Host shifts, in which a parasite from one host species invades and settles in the other, are a major source of newly emerging infectious diseases" [7-14].

"A host shift must go through several steps in order to be effective. Several human infectious disease epidemics, including those caused by the most fatal strains of the Ebola virus, HIV, and the SARS coronavirus, have been linked to host switch events" [10-16]. "Temperature changes may increase the likelihood of new host shifts owing to changes in host and/or parasite fitness, shifts in species distribution, or changes in species diversity [22]. Changes in distribution might lead to the formation of new species assemblages and novel interactions between potential hosts and parasites" [16-23].

"Climate change may influence the occurrence of VBZDs by affecting four important host and vector population features relevant to disease transmission to humans. Geographic distribution, population density, the frequency of zoonotic pathogen infection, and pathogen load in certain hosts and vectors are examples of these. These mechanisms may interact with one another and with other factors like as anthropogenic disturbance to have varying effects on disease transmission within host and vector populations as well as to humans. Because most VBZDs are influenced by climate change via animal hosts and vectors, interdisciplinary teams will be needed to conduct and assess ecosystem-based research in order to fully comprehend the repercussions" [17].

Arboviruses replicate in vertebrate hosts between 37 and 44 °C before switching to their ectotherm vectors, where temperatures can dip as low as 15 °C [24,26]. "The ability of arboviruses to withstand such extreme temperature variations raises several questions, including how temperature affects subspecies structures and dynamics, how temperature affects the selection of temperature-adapted variants, and how temperature affects virus transmission, expansion, and pathogenesis. Temperature is known to trigger molecular changes that impact the structures and functions of lipids, nucleic acids, and proteins" [15-18] .

"Temperature is thus very likely to alter the properties of viral particles and their interaction with cell functions during reproduction. According to research on the temperature-sensitive qualities of an enzyme's functional capabilities, the two key parameters to consider during temperature adaptation are putative binding affinity and catalytic rate. Linker affinity reduces during cold adaptation to allow for faster catalysis" [19].

"A new temperature-dependent method for alphavirus entrance into mammalian cells was also revealed. At temperatures that preclude virus receptor-mediated endocytosis, which is the conventional entrance mechanism for arboviruses, viral genomes were internalised directly at the plasma membrane. Furthermore, silent mutations, or mutants that do not modify the amino acid sequence, are considered to be important for the RNA virus's adaptability to high temperatures. Temperature may influence the frequency and intensity of outbreaks by altering the evolution, selection, and transmission of arboviruses" [20].

3.4) Industrialization

A rapid exchange of pathogens between continents is made possible by the development of global transportation for both tourism and the trade of goods with an animal origin. The majority of the time, the effects of those changes have been favourable, enabling the Human species to achieve unprecedented success. The "reverse of the coin" is inevitable, though, when we allow ourselves to become complacent in the face of a constantly changing environment. As a result of intensification and industrialization, the food chain is longer and more complicated than it was before, with many additives being used and raw materials coming from various sources.

“The expansion of habitats suitable for the development of some disease agents and the survival of insects and arthropods—the disease's vectors—was facilitated in some areas by global warming. Infection agents that could be used as biological weapons are easily manipulable thanks to current technological advancements. The Veterinary Faculty of Lisbon (FMV) creates research projects in a variety of fields, including animal health and veterinary public health. In an effort to assist in developing solutions for problems on a national and international scale, this Centre has developed research projects on some of the problems mentioned” [11].

4. CLIMATE CHANGE CONSEQUENCES ON ZOONOTIC DISEASES

4.1) Zoonosis transmitted via vectors

“Infectious diseases carried by infected arthropods such as mosquitoes, ticks, triatomine bugs, sand flies, and blackflies are examples of arthropod-borne disorders. The survival and reproduction of ectothermic arthropod vectors are affected by temperature. Following a heat wave, Aedes aegypti pupae were significantly less common in Choliambic, Western Kenya. Escobar predicted that by 2100, the geographic range of leishmaniasis and arbovirus vectors in Ecuador will have shrunk due to future climate circumstances” [2].

4.1.1) Zika Virus

“After being discovered in Brazil in 2015, the Zika virus (ZIKV) has rapidly spread across the Americas. Guillain-Barré syndrome and microcephaly both have been linked to it” [1]. According to ZIKV, a continual intensification of social and environmental elements has resulted in a new paradigm of arbovirus transmission [22]. The reported incidence of dengue virus more than quadrupled between the 1980s and the 2000s, and it now accounts for an average 96 million cases of pneumonia per year [23]. The chikungunya virus (CHIKV, genus alphavirus) first arrived in St. Martin in 2013, producing 1.8 million suspected and confirmed cases [4,24]. These re-emerging arboviruses are worldwide migration and change afflictions. “They are both primarily transmitted by the Aedes aegypti mosquito, which oviposits in household water bowls and feeds primarily on humans” [25].

“Mosquito geographical range, population density, longevity, and transmission capabilities are all influenced by climate and weather. Based on the nonlinear effects of temperature on virus incubation rate and rates of fecundity, development, survival, and biting for Aedes aegypti and Aedes albopictus, a recent study found that ZIKV transmission can occur between 18°C and 34°C, with a peak at 29°C” [4] . “ZIKV has largely been found in the Americas' tropical and subtropical regions, when summer temperatures are already perfect for Aedes aegypti” [9,15]. This provides support to the idea that ZIKV transmission is influenced by climate[26]. “Sanitation, water contamination and hygiene are the main effects that are evident. Deforestation and new habitation are two other environmental changes. As mosquitoes enter the deforested area, malaria is caused. They have seen an unanticipated population increase in their area. The third environmental change, agricultural intensification, has resulted in a rise in malaria cases. Crop pesticides and vector resistance are two instances of plainly observable impact paths. Over the last three decades, natural habitats and wildlife have entered closer touch with people, and as a result, only zoonotic illnesses account for 75% of all infectious diseases” [27].

4.1.2) Dengue Fever

The two main mosquito species that transmit dengue have an incubation period of 3 to 14 days: Aedes albopictus and Aedes aegypti. “Dengue fever can infect people of any age, including new-borns, with symptoms ranging from mild flu-like symptoms to severe or fatal haemorrhagic fever” [2,3]. Local human settlement has aided mosquito species adaptation, and they may now be found in both natural and artificial populations in urban and urban areas [13].

“Dengue fever is a major public health concern for more than half of the world's population because it is a primary cause of illness and mortality, particularly among children in endemic nations” [2,3]. The average world temperature has risen by 0.75°C in the last 100 years as a consequence of climate change [2]. Population expansion, urbanisation, inadequate sanitation, increasing human travel, inefficient mosquito control, and enhanced reporting ability are all key variables that may impact changes in dengue incidence and distribution across the world [28].

Dengue fever is turning into a national public health concern. Complex causes such as increasing urbanisation with poor living conditions, a lack of vector control, viral evolution, and worldwide travel are to blame for the recurrence of dengue in the tropics and subtropics [1]. Existing national public health monitoring systems might benefit from sentinel observation of travellers [51].

4.2) HIV

HIV transmission, health consequences, and climate change are all intertwined. Food insecurity has become a particularly key mediator through stimulating sexual risk-taking behaviour patterns, migration, and increase the susceptibility to illnesses that are widespread among HIV-positive persons.

"Sub-Saharan Africa and Southeast Asia have been heavily affected by both HIV and climate change." [29] . "Given the tight relationship between natural resource allocation and HIV/AIDS transmission and progression. HIV/AIDS can be viewed as an environmental justice problem" [1]. This is especially true in rural regions in SSA and SEA, where subsistence farming provides a living and food security for a considerable section of the population [15,30]. For example, the World Bank projects that droughts, floods, and variations in rainfall caused by 1.5-2 °C climate change will reduce food output in SSA by 40-80 percent [31]. This is critical since the WHO African Region now has 25.7 million HIV-positive persons [32], and 3.8 million more do so in the Southern and Eastern Asia region.[33]. Several studies have found a link between HIV morbidity and mortality and climatic change. According to a 2019 study, drought circumstances were significantly linked to the hazardous reproductive risk of the current HIV prevalence among rural females aged 15 to 19 in Lesotho [34]. A 2014 study of 19 SSA nations found that for each recent drought, the prevalence of HIV infection rose by about 11% in areas where the disease is endemic [35].

4.3) EBOLA

In the case of Ebola virus disease (EVD), a zoonosis caused by Ebolavirus spp. that can be fatal in humans, there is a clear association between forest loss and fragmentation and human disease outbreaks [36]. Although direct human actions such as hunting clearly have a negative impact on bat populations, a variety of environmental changes triggered by individuals have a favourable impact on tropical bat abundance and have expanded the range of species [37] .

Due to frequent direct and indirect human-bat contacts, such as while picking fruit and hunting for bush meat, there is a high potential for bat-to-human disease spill over effects in EVD sites [38]. "Pathogen dissemination can be facilitated by bush or wild meat hunting and eating, mass animal raising, and the use or abuse of antimicrobials and vaccinations" [1]. Climate, temperature, and ecological survival and transmission all have an impact on pathogen survival, proliferation, and preservation [39].

Since 2000, high-resolution forest data from satellites have been available. We take into account instances of the first human Ebolavirus infections that were reported after 2004 to evaluate changes in forest cover and forest fragmentation prior to each outbreak [40].

4.4) Respiratory Zoonoses

The coronavirus, which caused SARS, MERS, and COVID-19, is the most recent member of a virus family that affects both animals and people. According to early research, the new virus is less likely to cause severe symptoms but more contagious than the one that causes SARS. "Although the new coronavirus is more infectious than the one that caused SARS, it is less likely to cause serious sickness. The unique SARS-CoV-2 virus is most closely related to a group of coronaviruses seen in humans, bats, pangolins, and civets" [7]. According to preliminary analyses, the new COVID-19 may not be as dangerous as SARS, but it may spread differently from person to person [41].

COVID-19's worldwide repercussions have touched over 200 nations, resulting in over a million deaths. "Throughout the winter, zoonotic spill overs with pulmonary modes of transmission are predominantly concentrated in the northern hemisphere, notably in and around China and neighbouring countries. Particular attention should be paid to a region surrounding South China, where yearly seasonal influenza infections have caused a rise in respiratory illnesses" [40]. "The significance of "cold dry" weather in the development of respiratory infections appears to be critical and irrespective of the site of the spill over, an essential component that is sometimes overlooked. SARS and numerous imported MERS epidemics were all linked to cold seasons and propagated in northern hemisphere countries rather than tropical ones" [6].

"The present coronavirus was discovered to be a reservoir in bats, and it is believed that ingestion of these Chiropterans caused the virus to spread to people. Over the course of around 64 million years of evolutionary change, bats have developed specific immune defences that allow them to escape infection with a range of different viral illnesses. Some of these are capable of infecting people and causing sickness and even death. Bats also have significant quantities of heat shock proteins, which defend them against high temperatures and oxidative stress by chaperoning viral proteins and giving the ability to cause virus mutations. Another noteworthy anti-microbial function is mediated by their gut flora, which produces compounds that aid in the formation of their immunological defences" [2,42].

Changes in human leisure activities or cultural practises, such as consuming new foods at stores that sell foreign goods, could be factors in growing human engagement with these bats. The "dilution effect," which happens when a niche has a varied host species and lowers infection persistence, has historically been linked to decreased disease transmission [7].

"Climate change may have increased the number of aerosols and particles in the atmosphere that might have functioned as effective carriers of SARS-CoV-2 and coronaviruses. The rise in temperature and relative humidity may be one of the more harmful consequences of climate change on transmission effectiveness. Higher temperatures have been proven in experimental animal investigations to alter viral reproduction and transmission in both in vitro and in vivo situations" [2].

A variety of meteorological conditions may have contributed to the propagation of the virus during the COVID-19 pandemic, but more study is needed to understand how these processes function [42].

4.5) Frozen Danger

The glacier has held a collection of frozen viruses for the past 15,000 years, many of which are unknown to scientists today. In the ice cores, the research revealed 33 groupings of viral genera, including 28 previously unknown virus groups. A group of experts studied ice samples from China's Tibetan Plateau in 2015 to learn more about the ice core microbial populations [43].

Climate science glacier collapse will result in the discharge of germs and viruses. Precautions are difficult to plan since scientists have not fully recognised all of the possible dangers associated with the freshly reported viruses. The necessity to preserve the glaciers and snow cover remains the most proactive and realistic option [44].

Some academics have investigated the relationship between the consequences of global warming and the threat of infectious disease transmission in Arctic regions. The abundance and distribution of animal reservoirs and arthropod vectors will shift in the polar regions [1], where increasing temperatures will have a greater influence on ecosystems [6]. Trajectories or reservoirs can be distributed by commerce, migration, or human interaction, allowing illnesses to spread to new locations where climate change may have previously offered favourable conditions [11] .

Anthrax killed thousands of reindeer and infected hundreds of people on the Yamal peninsula of Northwest Siberia in 2016. The epidemic was sparked by permafrost melt-induced spore activation, which was worsened by the summer heat wave. Extremely warm years were followed by cold years with heavy snow cover from 2011 to 2016, avoiding soil freezing [45] .

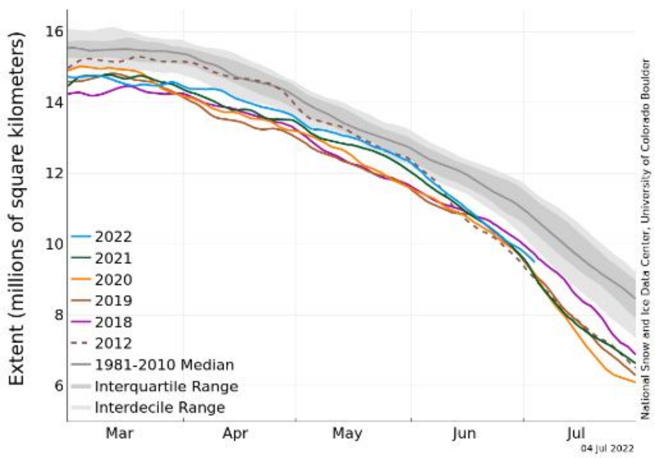

Fig 3: Arctic Sea Ice Extent (Area of ocean with at least 15% sea ice) [8]

"The graph above depicts the amount of Arctic Sea ice on July 4, 2022, as well as daily ice extent data for the previous four years and the previous record-low year. The year 2022 is displayed in blue, the year 2021 in green, the year 2020 in orange, the year 2019 in brown, the year 2018 in magenta, and the year 2012 in dashed brown. From 1981 to 2010, the median is shown in dark grey. The data's interquartile and interreducible ranges are shown in the grey regions surrounding the median line. data from the Sea Ice Index" [46] .

5. HOW TO TACKLE THESE ISSUES

- Monitoring the local animal population and medical patients will help researchers prevent the spread of zoonoses [37]. Additionally, it could direct hospital-based surveillance for novel and uncommon diseases, allowing medical personnel to react quickly [8]. To prevent the spread or containment of highly contagious diseases like COVID-19, forecasting and preparation for extreme weather events like floods, cyclones, and droughts are crucial [11]. To predict, prevent, and respond to pandemic zoonoses in a timely and efficient manner, a global strategy to coordinate pandemic preparedness and response is required.
- "Global leaders must stop removing legal safeguards for protected areas because doing so could hasten climate change, cause biodiversity loss, and contribute to deforestation. Even during the COVID-19 pandemic, governments in nations where illegal mining, poaching, and deforestation are on the rise urgently need to keep up enforcement efforts. Governments and development financing organisations should give priority to stimulus programmes that have large economic multiplier effects and lower carbon emissions after restrictions are lifted" [1,3].
- "To predict, prevent, and respond to pandemic zoonoses in a timely and efficient manner, a global strategy to coordinate pandemic preparedness and response is required. To lower the risk of disease emergence, One Health's strategy involves cross-sectoral work by public, animal, and environmental health agencies. This should be a top priority, as the emergence of pathogens is becoming more frequent" [1].
- "Since adopting cross-sectoral approaches is constantly difficult, cross-sectoral approaches are necessary to gain enough momentum in controlling emerging disease. The One Health vision must be realized through the establishment of systems, which require careful planning, money, and time to implement" [1].
- Building trust, coming up with new ideas, learning from mistakes, and establishing sustainable working relationships are all important during the implementation of these programs. As part of the tripartite agreement, the OIE, FAO, and WHO as well as the World Bank have assisted nations in collaborating across sectors [24] to create robust and resilient systems [6,24]Specifically, because of their limited access to health services, rural and indigenous communities are the most exposed to risks and the most susceptible to infectious diseases.

- By looking past, the dichotomy between public health and economic concerns, make stopping deforestation a top priority in tropical areas. In tropical regions, expect an increase in forest fires before the dry season. Support the supply chains and markets for legal wood.
- “According to the majority of available data, mosquito born zoonoses transmission is sensitive to both climate variability and change. We think it is critical to create, use, and integrate various quantitative modelling strategies that are compatible with long-term data on climatic and other socio-ecological changes to predict how the disease will affect us in the future. Existing national public health surveillance systems might be improved with sentinel surveillance of travellers” [2].

6. CONCLUSION

The rise of respiratory and cardiovascular diseases is only one example of how climate change has a substantial impact on human health. Zoonoses are becoming a big hazard as a result of rapid environmental changes and humans' great proximity to other animals. “Monitoring variations in weather systems over short, medium, and extended time periods is a helpful tool for public health. It can aid in the early detection of disease breakout pandemic precursors and act as an early warning system for reducing risk. Global warming has already been acknowledged by regional and worldwide governments as having a significant impact on human health” [11].

In 2015, the World Health Organization (WHO) Executive Board authorised a work plan on climate change and health [6,7]. It advocates for collaboration, education efforts, and the usage of The World Health Organization (WHO) Executive Board encourages the implementation of public health solutions to climate change through collaborations, education campaigns, the use of research and data, and other ways. Future study is thus required to cover the information gaps indicated above, which will help us plan and implement control programmes for a healthy world in order to better prepare for coming zoonotic dangers.

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