Forum:	World Health Organization
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I. Introduction

Climate change and its effect on the planet and on humanity is often portrayed through melting ice caps, rising sea levels, dwindling natural resources and increasing natural disasters. However, while these are all consequences of rapid climate change, one often overlooked repercussion is the increased spread of infectious diseases. The life-cycles and transmission of infectious diseases are closely linked to climate. Changes in temperature and humidity are some of the factors that affect the survival of pathogens, bacteria, viruses, or other microorganisms that can cause disease. This means that changes in climate can introduce infectious diseases to previously unaffected geographical areas, risking disease epidemics in areas that may not have the infrastructure, knowledge or funding to deal with them. Moreover, there could also a resurgence of diseases previously considered to be under control. The pathogens of these diseases evolve within an immunizing society, making them increasingly aggressive, especially for a population that has had no previous contact, and therefore, no natural coping mechanism.

II. Definition of Key Terms

a) Climate Change

Climate change is a general term used to indicate major changes in climatic properties, such as temperature, precipitation, extreme weather events or wind patterns that persist over a longer period of time, usually at least a decade. Climate change is a natural process which has always taken place. However, in recent years, the rate of this climatic change has increased rapidly, mostly due to human factors.

b) Climate Variability

One must differentiate between climate change and climate variability, which is a variation of the regular climate on all temporal and spatial scales beyond singular weather events. Climate variability is mostly due to the natural oscillations in the Earth systems and is not linked to human activity.

c) Pathogen

"Pathogen" is the scientific term referring to the cause of the disease, also called disease agent. Examples of disease pathogens include viruses, bacteria, parasite germs, and specific types of fungi.

d) Hosts and Vectors

The term "host" refers to a living animal or plant on/in which disease pathogens reside/live. "Vectors" (intermediate hosts) are organisms that do not cause the disease itself, but spread infection by carrying and transmitting pathogens to the organism that becomes the host. For example, mosquitos as a species serve as a vector for the deadly disease, malaria.

e) Infectious Diseases

Infectious diseases are medical conditions brought on by infectious agents, which are pathogenic microorganisms—bacteria, viruses, parasites or fungi. They can be transmitted either directly or indirectly.

i) **Vector-borne** diseases are human illnesses caused by parasites, viruses and bacteria that are transmitted by vectors, such as mosquitoes, blackflies, ticks, mites and lice.

ii) **Water-borne** diseases are caused by pathogenic micro-organisms that are transmitted in contaminated fresh water. Infection commonly results during bathing, washing, drinking or the preparation or consumption of food brought into contact with the contaminated water.

iii) **Air-borne** diseases are any diseases caused by pathogens that are transmitted or "travel" through the air.

iv) **Food-borne** diseases result from the spoilage of contaminated food through pathogenic bacteria, viruses or parasites**.**

f) Transmission (Direct or Indirect)

Disease "transmission" can be direct of indirect. "Direct transmission" refers to the transmission of a disease from one person to another through liquid droplet contact, direct physical contact, indirect physical contact, air-borne transmission, or faecal-oral transmission. Whereas, the transmission of a disease to humans via another organism, a vector, or an intermediate host is referred to as "indirect transmission".

g) Extrinsic Incubation Period (EIP)

EIP is the time between the introduction of the parasite into the human body and the development of the first symptoms.

III. General Overview

a) Climate Change and human infectious diseases

Climate changes can include variations of one or more climate variables such as temperature, precipitation (rainfall), wind and sunshine. In turn, these variations influence the survival, reproduction, or distribution of disease pathogens and hosts, as well as the availability and mean of transmission to humans. The following section will break down the influences of climate variables on the three aspects of disease: pathogens, hosts, and transmission.

i) Climate change and pathogens

Climate change impacts pathogens in two ways, directly or indirectly. It *directly* impacts pathogens when it influences their survival, reproduction and lifecycle. Whereas, it *indirectly* impacts pathogens by influencing their habitats, environments and competitors. As a result, the quantity of pathogens and the geographic and seasonal distributions may change.

The climate variable of temperature affects the life-cycle of a pathogen because they can only survive in a certain temperature range. Excessive heat can increase mortality rates (number of deaths in a particular population) for some pathogens. For example, the development of a malaria parasite ceases when the temperature exceeds 33-39 degrees Celsius. Additionally, rising temperatures can influence the reproduction and extrinsic incubation period (EIP) of pathogens. Higher temperatures can decrease the time between the introduction of the parasite into the human body and the development of the first symptoms, while lower temperatures lengthen EIP. Lastly, extended periods of hot weather can raise the average temperature of water bodies and food environment, providing an agreeable environment for microorganism reproduction. For example, salmonella is a food-borne disease, and the reproduction of the bacteria that causes it, increases as temperature rises.

Shifts in the climate variable precipitation affect the spread of waterborne disease pathogens. For example, the rainy season is related to the increase of faecal pathogens (disease pathogens that come from human or animal bodily waste or dung), as heavy rain may stir up waste that has settled at the bottom of bodies of water, leading to the accumulation of faecal microorganisms. Furthermore, unusual precipitation after a long drought can result in an increase in pathogens, causing a disease outbreak.

The pathogens of air-borne, vector-borne, and water-borne diseases are sensitive to changes in the climate variable of humidity. The survival of water-borne viruses near the water surface, for example, is limited due to the drying effect of surface water. Sunshine is an additional important climate variable that may affect the pathogens of infectious diseases: sunshine hours and temperature act together during cholera periods to create favorable conditions for the multiplication and spread of the disease.

Wind is a key climate variable that affects the pathogens of air-borne diseases. The presence of desert dust in the atmosphere during Asian dust storms is reportedly associated with an increased concentration of different bacteria, fungi and fungal spores. One researcher found, that the concentration of influenza A virus was significantly higher during Asian dust storms than on an average day. Additionally, studies have also found that the viruses of infectious diseases can be transported across oceans by dust particles. Meaning, an increase in dust and wind through climate change may result in the transmission of viruses across very large distances to places currently not affected by the virus.

ii) Climate change and vectors/hosts

The geographical locations and population changes of vectors, for instance insects, are closely linked with the patterns and changes of climate. Thus, climate change may cause changes in the range, period and intensity of infectious diseases through its impact on disease vectors.

The rise in temperature will probably lead to insects in low-altitude regions relocating to colder areas in mid- or high altitude regions, leading to a geographical shift or expansion of diseases. Some vector-borne diseases, including malaria, lyme disease, yellow fever, plague and dengue have spread to a wider range in recent years. In addition, disease vectors may survive climate change by taking shelter in small-scale protective environments where temperature does not change as much. A particular type of mosquito (A. aegypti) was found to hide from high summer temperatures of around 40 degrees Celsius in the town of Jalore Rajasthan, India by using household pitchers or cement water tanks underground to survive.

Many vector-borne infectious disease are found to be positively associated with rainfall: the more precipitation, the larger the reproduction, survival and transmission rate of vectors. The larval development of some mosquito vectors escalates with increased rain and rising temperatures. In some rare cases, drought may limit the quantity and quality of breeding sites for mosquito vectors, resulting in a reduction in the vector population and disease transmission. Outbreaks of cocoliztli in Mexico proved that rainfall can also affect the outbreaks of rodent-borne diseases through its impact on rodent populations.

Many disease hosts respond strongly to changes in humidity. For example, it affects malaria transmission through changing the activity and survival of mosquitoes. When dry-spells intersect periods of wet and warm weather, the mosquito vectors carrying West Nile virus and Lyme disease may move into non-traditional areas such as Canada and Scandinavia.

The climate variable of wind has dual effects on disease vectors, affecting many cycles both positively and negatively depending on the specific situations. Sunshine, on the other hand, acts to amplify the effect of other climate variables on vectors. Specifically, high temperature and moderate sunshine combine to form good conditions for cholera outbreaks, and relatively low temperatures may still support cholera vectors if long-hour sunshine is available.

iii) Climate change and disease transmission

Scientific studies have shown that climate variables and weather conditions may change disease transmission, however, many of the specific details are still unclear. One of the ways in which changes in climate conditions may alter disease transmission is by directly influencing a pathogen's viability (its ability to survive or live successfully). Conversely, the alteration in transmission routes can be indirect if it results from how human and vectors respond to climate change. For example, wind and dust storms can directly affect the transmission of infectious diseases. Wind can act as a transportation means for pathogens of air-borne diseases. Pathogens can spread from regions where they are regularly found in new regions previously untouched by the disease through interregional dust storms. For instance, the human influenza virus could be transported from Asia to the Americas in the winter months through wind blowing across the Pacific Ocean.

Climate variation plays an important role in shaping the patterns of human and other host activities and behaviours. These include seasonal occupation, migration, winter-summer lifestyles, and physical exercises. For example, a person would likely not play a game of soccer in -30 degrees Celsius weather on icy ground. These behavioural patterns also significantly influence the patterns of disease transmission. A global cross-sectional study of diarrhea occurrences in children under the age of 5 found a negative association between rainfall and diarrhea rates. This means that an increase in rainfall lowers the rate of diarrhea. The opposite is also true: an lack of clean and abundant water sources leads to reduced hygiene practices and more diarrhea outbreaks. With global warming, water scarcity will become a broader and more severe issue, and may lead to more diarrhea cases worldwide.

Another way in which climate change indirectly affects disease transmission is through harming human immunity (the body's ability to resist a particular infection) and susceptibility (how likely it is the person will be infected) to disease. Climate change will probably lead to the partial collapse of many ecosystems, which will harm agricultural productivity, causing issues such as malnutrition, starvation, increased population displacement and resource conflicts. Even the early malaria-predicting models in the 1920s, found that food shortages, rising wheat prices, crop failure, and malnutrition harmed human immunity. Furthermore, the territorial expansion of the risk for malaria and other tropical diseases has great potential to reach southern Europe due to rising temperatures. Therefore, in the nearby future, larger and larger populations will be exposed to the disease, putting more lives in danger—especially in the new areas that have no structure in place to deal with it.

b) Extreme weather event and infectious diseases

Extreme weather events refer to weather which equals or exceeds the extremes of historical distribution (the range that has been seen in the past), including unexpected, unusual, unpredicted, severe or unseasonal weather. Types of extreme weather events include heat waves, winter freezes, tropical cyclones, tornadoes, hurricanes, wildfires and floods. Climate change is expected to worsen the frequency, intensity and impacts of extreme weather events. These events are commonly accompanied by dramatic changes in one or more climate variables, and can therefore change the dynamics of human infectious diseases by impacting pathogens, vectors/hosts, or transmission. Additionally, these extreme weather events can easily damage health infrastructure, for example hospitals. These do not directly spread the infectious diseases; however destroyed health infrastructure means that infectious diseases are harder or near impossible to treat, making it easier for them to spread and cause serious harm to a population. The scientific knowledge in this area is still lacking. There is a need to fully understand the changing patterns and magnitude of climate variables and the combined weather effects during extreme weather events, resulting in the fact that our ability to currently correctly predict the health impacts of infectious disease is rather limited.

c) The Human Factor and Responses

It is essential to recognise the significant role social and economic factors play in predicting the changing risk for infectious diseases by climate change. Some populations and regions are simply more vulnerable due to their lack of ability to effectively respond to the stresses and challenges imposed by climate change. It depends on the programs and measures that are in place to reduce the burdens of climate sensitive health risks, such as infectious diseases. The presence of regular health infrastructure and public health practices—including access to safe water and good sanitation—and biosurveillance programs to identify and respond to infectious disease outbreaks can aid in mitigating the effects of infectious diseases. For instance, in India, badly planned urbanization has contributed to the spread of malaria and dengue.

On the other hand, societies and countries that have advanced technologies and abundant financial resources to eliminate or lessen the impacts of water shortages often are exempt from problems like diarrhea as water becomes scarce. With the result that infectious disease outbreaks, made more frequent and severe by climate change, will still disproportionately affect Less Economically Developed Countries (LEDCs).

Social development can often determine a society's vulnerability to climate change induced health risks of infectious diseases. Infectious diseases often break out in developing countries after extreme weather events, such as tropical cyclones, however such outbreaks after Early Warning Systems (EWE) are rare in developed nations. There are many examples to support this: the outbreak of Balantidium on the Pacific Island of Turkey, typhoid fever in Mauritius, as well as cholera in Guatemala, Nicaragua and Belize. In contrast, a surveillance report of the post-hurricane infectious diseases in developing countries found no increase. Less effective means of communication and public health education, coupled with inadequate financial and medical resources in developing states, limit their ability to prepare for and respond to the changing landscape of infectious diseases.

The existing public health infrastructure also plays a large role in a country's ability to respond to disease outbreaks. Extreme weather events, natural disasters and political conflicts can have devastating effects on a member state's response capability. An already weak health system in Yemen has been pushed to near ruin after almost four years of war. Nearly half of all hospitals and health facilities have been destroyed due to the ongoing conflict, leaving thousands of citizens without sufficient care. In October 2016, an outbreak of cholera began that continues to this day. The disease has affected over 1 million people and caused more than 2,500 deaths; this outbreak is the worst epidemic of cholera since records began. With an increase in frequency and geographic locations of infectious diseases due to climate change, these severe epidemics will have a greater chance of affect areas of conflict.

IV. Major Parties Involved and their Views

a) **WHO (World Health Organization):** Approximately 250,000 additional deaths between 2030 and 2050 will be of malaria, diarrhoea, malnutrition and heat stress caused by climate change. This outlook is keeping countries on their toes in finding measures to deal with and prevent the spreading of the diseases. The World Health Organization has a general goal to attain the highest possible level of worldwide health. With this it has established functions to tackle individual cases in order to provide effective solutions. The first of the three main objectives to reach their goal is to increase awareness of the health consequences of climate change among financial, political and community leaders, health practitioners, non-governmental and other sectors, and the general public. Secondly, they aim to maximize the strength of health systems to be able to provide protection from climate-related risks and fundamentally reduce emissions of health systems' greenhouse gas (GHG). And lastly, they guarantee that health concerns are addressed when acting to decrease the risks from climate change.

b) **Indonesia** has taken a series of measures, bringing them closer to complete malaria eradication. The "National Malaria Eradication Unit" was established in 1952, but only put to intensive use in 2004. Derived from extracts of sweet wormwood, Artemisinin became the first-line treatment with its antimalarial effects. Along with functional medicine, insecticide bed nets began to be distributed in highly endemic districts. The country also has active monitoring of migratory fisherman. The coordination of the malaria response was led by the Ministry of Health with UNICEF, WHO, community organizations and private sectors. All of which listed above measures taken are still being strengthened to reach its goal of being malaria free by 2030. 72% of Indonesia in April 2018 was malaria free with a continuous increase.

c) **In Nepal,** cases of Rubella have been conquered and successfully dealt with through vaccination. In 2016 the Comprehensive Multi-Year Plan (cMYP) 2017-2021 decided to immunitize all children. A district immunization map was created with fully supplied hospitals provided each district. A vaccination schedule was established with specific days for parents to bring in their children. In order for this to take place, awareness for community participation has been spread and increased.

V. Timeline of Events

Date	**Event**
December 1997	Kyoto Treaty; United Nations works

	together to protect the climate. All major countries signed this treaty except the United States
January 2005	The European Union Trading Emission Scheme is launched, greatly limiting the emission of greenhouse gasses within the EU.
February 2014	Ebola epidemic in west Africa caused by the shift in landscape due to rising temperatures.
March 2014	Climate change allows malaria infected mosquitoes to spread rapidly throughout central Africa and parts of South America, causing the spread of the disease to become a global issue.
October 2014	IPCC (Intergovernmental Panel on Climate Change) releases fifth assessment report about the impact and danger of climate change

December 2015	The Paris Agreement: Member states of the United Nations agreed to take action against the imminent threat of climate change.
April 2016	The Zika virus epidemic began throughout South America and Mexico due to rising temperatures.
August 2016	Anthrax outbreak in Siberia due to thawed out bacteria that had been frozen in the permafrost for many years.
June-August 2018	Heat wave sweeps over Europe, causing wildfires in northern Sweden, droughts in Denmark and Austria, and heat records being reached all over europe.
October 2018	The IPCC releases special report stating the dangers of the 1.5 degrees celsius of global warming

VI. Previous Attempts to Solve the Issue

Many simple measures have been used to decrease human vulnerability to infectious diseases changed by climate change. For instance, physical changes like better drainage systems, the building of sea walls, reforestation, and desalination have been used upon recommendation in various African countries already prone to disease outbreaks. As a response to epidemic malaria, diverse public health programs have been put in place in the majority of these nations to reduce the impacts. However they are still insufficient, due in part to a lack of funding, access to clean water and resources. The success of a proactive adaptation program depends heavily on correctly predicting the health risks of infectious diseases and at the moment the information available is still lacking.

Another previously successful attempt to solve the issue was the development of Early Warning Systems (EWS) for infectious diseases. Long-term collaboration between countries and scientific institutions is required to realize this. When implemented correctly, EWS can be very effective. They have successfully predicted the rising malaria risks in Botswana, enabling timely anticipatory measures to be taken to combat the impacts.

In terms of the direct implications of epidemic disease outbreaks, examining how the cholera outbreak is being handled in Yemen can give an insight into modern epidemic management. Various non-governmental organizations such as the WHO have helped contain the outbreak through strengthening of disease surveillance - including laboratory capacity, case management, and improving sanitation. Distribution and availability of medication and doctors is also of the utmost importance. Vaccine programmes for the vulnerable population in addition to quarantines can be implemented to protect people from infectious diseases.

VII. Questions to Consider

1. What are some measures that can be implemented to tackle this issue that are not directly linked to preventing climate change?
2. Is it easier to tackle the different stages of transmission separately or more effective to tackle the increased transmission as a whole?
3. How much should MEDCs, as the main polluters and contributors to climate change, contribute to helping LEDCs face the effects of climate change, specifically regarding the spread of infectious diseases?
4. To what extent can the increased spread of infectious diseases be tackled through medicine and research?
5. How should member nations balance the necessity for short term, as well as long term, solutions?
6. How can the main human factors contributing to the spread and transmission of infectious diseases be limited?

VIII. Possible Solutions

Through collaboration and effective preemptive measures, member states can make progress in controlling the negative effects of infectious diseases impacted by climate change. For example, better understanding of the patterns of climate change and its implications on infectious diseases will help. Additionally, effectively allocating technology and resources to promote healthy lifestyles and public awareness is also of extreme importance. Health education for the general population and especially for vulnerable populations can help increase awareness of preemptive measures that can be taken on an individual level.

In terms of adaptive measures, the following are recommended based on the scientific research currently available:

1. to go beyond empirical observation of the association between climate change and infectious diseases and develop more scientific explanations
2. to improve the prediction of spatial-temporal process of climate change and the associated shifts in infectious diseases at various spatial and temporal scales
3. to establish locally effective EWS for the health effects of predicted climate change.

The success of the methods above depends heavily on the scientific research available on this issue. Therefore, creating and investing in institutions that are able to help fill in the gaps in scientific knowledge would be a valuable asset. The presence of regular health infrastructure and public health practices, including access to safe water and good sanitation, and biosurveillance programs to identify and respond to infectious disease outbreaks, could also aid in mitigating the effects of infectious diseases.

X. Conclusion

Climate change and the increased spread of infectious diseases are inherently linked. This can be partly attributed to the fact that climate and a change in climate affects all three stages of disease transmission - the agent, the host and the environment. While this threat is currently affecting mostly countries with close proximity to the equator, the rise of global temperature is starting to enable diseases to also spread with increasing proximity towards the poles. However, the ability to cope with these infectious diseases differs strongly in LEDCs and MEDCs. This is due to factors such as general health infrastructure but also the access and quality of medicine and doctors. This inequality is further highlighted by the fact that the main polluters are not the countries most affected by this issue, and therefore these polluters do not directly feel the consequences of their actions.

This ever-evolving threat of the increased spread of infectious diseases has developed from a collective man-made cause – climate change - and as such, the primary way to effectively combat this global issue is through organized and thoughtful action.

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