The Influence of Climate Change on Disease and Public Health

Natalie Petruzelli
St. John Fisher College, ngp01978@sjfc.edu

Follow this and additional works at: https://fisherpub.sjfc.edu/ur

Part of the Disorders of Environmental Origin Commons, Environmental Health Commons, Health and Medical Administration Commons, and the Immunology of Infectious Disease Commons

How has open access to Fisher Digital Publications benefited you?

Recommended Citation

This document is posted at https://fisherpub.sjfc.edu/ur/vol21/iss1/3 and is brought to you for free and open access by Fisher Digital Publications at St. John Fisher College. For more information, please contact fisherpub@sjfc.edu.
The Influence of Climate Change on Disease and Public Health

Abstract
This paper attempts to analyze the growing influence of climate change on the spread and development of diseases, as well as how this continues to affect public health and medical administrations around the world. The prevalence of airborne, waterborne, and vector-borne diseases have been found to be exacerbated as a result of climate change. In addition to this, the paper addresses the reemergence of eliminated diseases and ancient pathogens due to changing temperatures and weather patterns. Finally, the effect of these different conditions on national and international public health organizations and policies is analyzed, including projections on what can be done to resolve these issues in the future.

Cover Page Footnote
Thank you to Dr. Carolyn Vacca for the assistance in developing the focus of the paper and overseeing the writing of the research.
The Influence of Climate Change on Disease and Public Health

Natalie Petruzelli

Climate change has long since been a controversial issue on the worldwide stage, dominating political conversations and dividing countries and their populations alike. Commonly mistitled as global warming, climate change includes a variety of changing environmental conditions over extended periods of time, such as fluctuating temperature trends, extreme weather conditions, ice mass loss, and innumerable others. Despite being seemingly confined to environmental effects, climate change actually has great influence on every level of society, ranging from negative economic impacts to transforming political landscapes. However, one consequence of climate change that is often overlooked is the extensive effect on disease and public health. As long as the present day climate situation remains unchecked, already threatening diseases will become increasingly prevalent, new health issues and diseases will emerge, and unprepared populations around the world will be faced with an unprecedented public health disaster.

Climate Science Background

Climate change as a process is quite simple and has direct influence on the main passages of disease propagation in many regions. As defined by the Environmental Protection Agency, climate change is when there are significant variations in average weather, such as temperature, wind patterns, and precipitation, lasting for an extended period of time, usually decades. Climate change can be brought about by natural factors, like volcanic eruptions and differences in ocean current circulation, but the term “climate change” has most recently been used to describe when this process is caused by human factors (EPA). One of the primary human factors known to create climate change is the emission of greenhouse gases, where high concentrations of gases like methane and ozone are released into the atmosphere and remain there instead of being emitted (Shuman). These gases cannot be effectively disposed of due to a lack of flora to absorb it, and thus stay in the atmosphere and generate heat (Shuman). This relatively recent surge in greenhouse gases can be attributed to human activities like the burning of fossil fuels, agriculture, deforestation, urbanization, and many others (EPA). Since health officials first began to use statistics in the 1850s, global temperatures have risen at an unprecedented rate, and are expected to continue rising by a subsequent 1.8 to 5.8°C by the year 2100 (Shuman). Though this seems like a small change, it has and will continue to drastically affect the water cycle, which alters the amount of rainfall, drought, humidity, heat waves, storms, and severe weather events occurring (Shuman).

This transformation in weather patterns dramatically affects the propagation routes of infectious diseases. Alterations in the movement patterns of wind and precipitation allow for airborne diseases to spread over greater distances, and differences in the water cycle can create flooding or droughts that provide perfect conditions for the spread of waterborne illnesses (Wu, Xiaoxu, et al.). In addition to this, changes in temperature can lead to the geographic expansion of vector-borne diseases, which can prosper in warming temperatures (Wu, Xiaoxu, et al.). Therefore, climate change heavily impacts a multitude of currently existing diseases and health problems, including airborne, waterborne, and vector-borne maladies. The sobering effects of climate change have the potential to cripple public health systems and should be addressed before life as we know it is permanently altered by a global health crisis.

Effects on Airborne Disease

Climate change fundamentally affects air-related illnesses in two ways: increasing allergens and increasing air pollution. Each brings with them a
new wave of health problems as they decrease the general quality of air. While allergies may seem like an unimportant health issue, they can be incredibly dangerous to one’s health, causing death in some extreme cases. Most dramatically, climate change influences the level of production and the composition of allergenic spores in plants, and also impacts the rate of emission and dispersion of such allergens (AAAAI). This can cause higher pollen concentrations and longer pollen seasons in the environment, only further propagated by changing rainfall and winds, which alter how far allergens will travel and how densely they will spread (CDC). This is particularly dangerous to those with allergic and restrictive pulmonary disorders like asthma, as well as children, elderly, and those suffering from other diseases that may constrict their airways (AAAAI). Moreover, climate change can bring about the increased presence of windstorms through new wind patterns, which can unpredictably spread triggers for pulmonary disorders to new areas and threaten those afflicted by such illnesses (Wu, Xiaoxu, et.al). In addition to this, greenhouse gases are capable of causing respiratory issues within people suffering from asthma and lung disease and can contribute to increased decline in lung function over time and higher mortality rates (AAAAI). This presents a dangerous challenge to public health professionals, who must be prepared to provide adequate control and treatment for respiratory ailments that previously were not as difficult to treat.

Meanwhile, the exacerbation of air pollution is drastically becoming a larger issue in conjecture with the effects of climate change. Not only does air pollution caused by human industrialization accelerate the pace of climate change, it also increases the prevalence of pulmonary issues, which will only make the spread of airborne diseases expand. A study from The Lancet Commission on pollution and health found that diseases produced by pollution were estimated to be responsible for approximately nine million premature deaths in 2015, which represented about 16% of deaths worldwide that year, air pollution representing a great portion of this number (Griffin). The majority of this harmful pollution is from a rise in ground-level ozone, hailing from the burning of fossil fuels, which is a major cause of decreased lung function, asthma, and death (CDC). With greenhouse gas emissions remaining unchecked, ozone concentrations are only expected to grow in the coming years, increasing already high rates of heart disease, stroke, and lung cancer (Griffin). Coupled with the fact that these emissions will only worsen the effects of climate change and dramatically increase the danger associated with preexisting pulmonary conditions, airborne diseases could become an enormous issue in the very near future, given that their effects will only be amplified by the widespread weakening of immune systems caused by air pollution. Despite these alarming statistics, the rate of greenhouse gas emissions and fossil fuel usage remain at the same level, and issues with allergens and air pollution continue to become progressively worse.

Effects on Waterborne Diseases

As aforementioned, climate change has a remarkably strong effect on water and the water cycle itself. The impact of waterborne disease depends significantly on the weather-related events generated by climate change, including flooding, droughts, and rainfall. With fluctuating water temperatures and rising atmospheric temperatures, sea levels are expected to rise at an alarming rate, enough to flood some coastal cities like Miami and New York City (Hancock). This flooding brings a heavy concentration of waste and contaminants from already polluted water sources into other unpolluted sources of water, disrupting sewage systems and further worsening water quality. (Hancock). The most common waterborne illnesses that will result from the flooding caused by climate change are diarrheal diseases, which include salmonellosis and campylobacteriosis (CDC). The increased water flow into previously dry areas will bring fecal matter from the ground and chemicals from water pollution into contact with other bodies of water as well (Hancock). For communities with little access to water, this will be particularly dangerous, as their water sources can become unusable very quickly, and the population will
have no choice but to risk their health in order to survive (Hancock).

On the other side of the spectrum, droughts originating from climate change provide equally dangerous conditions for waterborne disease. When the level of water decreases, concentrations of sediments and minerals can be left behind and impact the quality of what little water is left (Hancock). Shallow waters produce perfect breeding conditions for mosquitoes and other insects as well, which can lead to an increase in vector-borne disease (Hancock). In addition to this, the rising humidity and surface level temperature of bodies of water create adequate conditions for the blooming of phytoplankton, of which certain types can directly lead to a resurgence of cholera (Kibria). This is particularly worrisome, as cholera has nearly been eliminated in many regions, and its reappearance presents deadly consequences. The expansion of cholera to relatively unaffected areas is only one example of the disastrous effects of climate change’s extreme weather conditions. Waterborne disease is a much more prominently seen consequence of climate change, as health conditions caused by air generally take time to come to fruition, while disease carried in the water can rapidly decimate the body as fast as it is introduced (Kibria). It is for that reason that an increase in waterborne maladies is so concerning. With over 3.4 million people already dying per year from waterborne illnesses, climate change only stands to exacerbate the situation, directly providing the conditions necessary for waterborne diseases to flourish and spread (Kibria).

Effect on Vector Ecology and Vector-borne Disease

Vectors are organisms which carry and are capable of transmitting disease pathogens onto other organisms, including humans. The most common types of these vectors are fleas, ticks, and mosquitoes, which are all extremely common around the globe (CDC). Vector-borne diseases are some of the most well-known and dangerous illnesses, some examples including malaria, plague, typhus, and the Zika virus (WHO). These ailments already represent a formidable threat to the public health community as they struggle to help treat the many victims of them, with vector-borne diseases accounting for over 17% of all cases of infectious disease (WHO). Climate change only serves to heighten the gravity of this situation.

First, with the general warming of climates, insect vectors will become more active at the higher temperatures. It is estimated that mosquito abundance is amplified tenfold with the increase of every 0.1°F in temperature, which is especially shocking considering that the rise in global temperature is occurring at a much faster rate than this (Kibria). Different temperatures and weather patterns allow for both longer breeding seasons for vectors and extended geographic ranges for vector-borne illnesses (Cho). Areas which formerly were not considered in danger of vector-borne diseases will become viable locations for an epidemic. This process can already be seen in the highland areas of East Africa, where malaria has spread despite the fact that it previously did not exist there (Shuman). In the case of malaria and mosquitoes, the Plasmodium parasite that creates malaria reproduces faster under warmer conditions, and the mosquitoes that carry it will thus have to feed more often to survive, which in turn transmits the disease at a faster rate (Cho). Increased rain and humidity contribute as well, creating favorable habitats that allow for more young mosquitoes to be born and for more adult mosquitoes to survive (Cho). Unfortunately, malaria is only one of the vector-borne diseases that has increased in global prominence due to climate change.

Dengue fever, one of the primary causes of illness and death in tropical regions, is also carried by mosquito vectors, and climate change has already extended the reach of the disease (Cho). Studies project that expected increases in both temperature and population will put 5 to 6 billion people at risk of developing dengue fever in the 2080s, in comparison to the population of about 400 million people contracting it per year in the present day (Cho). With an expected population of about 11 billion in the 2080s, this means that almost 50% of the world will be in danger of dengue fever, as opposed to the 6%
currently experiencing it now (Cho). Dengue fever’s geographic range has also been broadened by the rapidly changing temperature, precipitation, and humidity, with the mosquito vectors carrying it appearing as far north as San Francisco (Cho). Further examples of this effect of climate change can be seen with the prevalence of West Nile Virus, which made its first appearance in the Western Hemisphere in New York in 1999 and has only expanded dramatically since then (Cho). The temperamental climate and resulting weather conditions as a result of this are expected to continue spreading dangerous vector-borne diseases to previously unaffected areas, exposing the world to infectious afflictions like Lyme disease, malaria, sleeping sickness, and Ebola (WHO). These vector-borne illnesses, which already ravage so many communities, could become an even more immense concern for health care systems around the world as they expand further and further due to climate change.

**Effect on Eliminated or Ancient Diseases**

Not only does climate change drastically alter environments and cause currently existing diseases to flourish, but it also can provide a possible pathway for the resurgence of ancient maladies from primordial permafrost to ravage humankind once more. There exists almost 9 million square miles of permafrost on the Earth, which is soil and ice that has remained frozen for over 35,000 years and only thaws slightly in the summers (Meyer). The permafrost is packed with extremely old organic contents, including dead plants, animals, and pathogens, all frozen and protected from decomposition (Meyer). As climate change affects these areas, summer seasons have lengthened and colder seasons have warmed, causing the deep active layer of the permafrost to thaw (Meyer). The active layer contains bacteria and viruses that have been immobilized by the frost, but still can survive even after tens of thousands of years and may reemerge to infect humanity once again (Meyer).

This permafrost has proven to have maintained both strains of old and dangerous viruses that previously decimated human populations, as well as new pathogens that have never been discovered before. Scientists Jean-Michel Claverie and Chantal Abergel of Aix-Marseille University have pioneered work on these unknown viruses, which are known as “monster viruses” because of their immense size, as they are able to be viewed under a microscope unlike contemporary viruses (Meyer). In a 30,000 year old core of ice from the permafrost, Clavarie and Abergel unearthed *Pithovirus sibericum*, one of the largest viruses ever found (Meyer). It was measured to be 10 times the size of the HIV virus, and upon thawing, was found to be active and still infectious (McKenna). Also discovered in the permafrost sample was another living monster virus, *Mollivirus sibericum*, which was found to still be infectious as well (Goudarzi). Recently, an increasing number of extremely old viruses have been located in the darkest corners of the world, including *Paenibacillus*, found in a cave in New Mexico that had been closed off for almost four million years (Meyer). The strain, like *Mollivirus* and *Pithovirus*, was seemingly harmless to humans, but was resistant to even the most technologically advanced and aggressive clinical treatments (Meyer). Despite the monster viruses found only being able to infect amoebas, their active existence within the permafrost serves as an indication of other potential ancient viruses contained within the ice that might actually be harmful to humans.

Scientists have exercised extreme caution in reviving monster viruses and other pathogens within the ice in fear of finding one that might be fatal to humans, but industry has other plans. Many companies are interested in the opening of Greenland to commercial traffic and mining for oil and metals, which will not only excavate 16 million tons of undisturbed permafrost, but will also exacerbate climate change in itself by releasing fossil fuels and disordering the environment and its habitats (Meyer).

In spite of these concerns, diseases that are deadly to humans have already begun to be revived from the melting permafrost, even without the assistance of mining to bring them to the surface. There has already been an outbreak of anthrax in Siberia in 2012, which had not experienced an outbreak in 75 years (Goudarzi).
Anthrax is an extremely dangerous infectious disease, and the outbreak killed a 12-year-old boy, infected over twenty others, and killed over 2,300 reindeer in the area (Goudarzi). The cause of the outbreak was attributed to thawing permafrost, which held the carcass of a deer that had died from anthrax in 1941, perfectly preserved by the ice (McKenna). The spores were able to mobilize and release into nearby water and soil, spoiling the food supply (Goudarzi). It is suspected that anthrax will only be the first of these outbreaks. Extensive studies on the state of the permafrost have found enclaves of surviving smallpox in the tundra of Siberia, and Spanish flu was able to be revived from a frozen corpse in the ice of Alaska, both of which are credited with killing tens of millions of people over time (McKenna).

Furthermore, there are also unknown diseases under the permafrost. It is still a mystery as to why early human species like the Neanderthals and Denisovans died off, but the answer is thought by numerous scientists to be deadly diseases lying dormant under the permafrost (Meyer). A resurgence of these diseases would be a health catastrophe that would dwarf any concerns over airborne and waterborne diseases. With the world being more interconnected than ever before, the thawing of one small patch of permafrost could decimate communities all over the globe. Any disease that has previously threatened humans or species before humans in history has the ability to do so once more, and any new diseases from unknown viruses and bacteria pose an equally frightening threat.

**What Can Be Done to Reduce Climate Change?**

With diseases of all types flourishing under the conditions provided by climate change, and the political response to fix the situation being fractured depending on the region, the circumstances seem bleak. While global attempts have been made, like the Kyoto Protocol and the Paris Agreement, which both set goals for reducing greenhouse gas emissions and limiting the world temperature, these have only been somewhat successful (Shuman). This is mainly because of the notable withdrawal of the United States, the country that accounts for 15-25% of all global emissions, from both accords (C2ES). With no united front against climate change, and the issue being debated as a fallacy in the United States, the response to such an environmental catastrophe and its effects falls to the individual level.

In terms of the general community, the most effective solutions are already common knowledge. Some of these local level efforts are recycling, using public transport, switching to renewable energy, and cutting down on meat products (Griffin). Citizens of any country are also urged to present their concerns about climate change to their businesses, employers, and politicians in order to influence change in their respective institutions and societies (Griffin). Though these deeds are all small on the worldwide scale, one person’s endeavors can inspire a whole community, and begin the snowball effect towards effective public health legislation and legitimate environmental revolution. An example of this could be the communities of Greenland mobilizing and protesting in order to prevent the opening of the country to commercial interests. This force of public opinion could prevent mining operations from occurring and thus protect the world from the unknown dangers held within the permafrost. Thus far, much of the public has yet to acknowledge many of the effects of climate change that they are being faced with, but on a health front, the effects are becoming dangerous at an alarming rate. As more communities experience climates and weather conditions that are not common to their area, they will be exposed to diseases and health circumstances that, while perhaps being normal and treatable in other places, have never been faced by these groups ever before. These will leave entire populations of people exposed to such conditions, and local public health professionals unprepared and untrained for possible large-scale crises. Until any individual or group efforts take place, the public health community is faced with an impending disease catastrophe of unprecedented scale and can only put forth plans to adapt to the circumstances, not to fix them.
What Can Public Health Do?

Public health organizations and medical practitioners alike have long since been taking the steps to adapt to the alterations in levels of disease caused by climate change in an attempt to mitigate the impact on their communities. As aforementioned, there has been no global agreement that has experienced widespread success. These accords, like the Paris Agreement, serve to try and solve the main sources of climate change, and most do not even mention the effects of climate change on health and disease, so little worldwide action has been taken in this field. The closest example of global attention towards this public health crisis is by the United Nations, who works with countries in need by helping them build systems to adapt to climate change in whatever way it might affect the area in question (UN). This may include financial assistance, constructing new economic systems, or reducing emissions, but this effort mainly focuses on the environment and treats public health as an afterthought (UN).

However, individual countries have endeavored to deal with these consequences by adapting and preparing for any possible health epidemics in an attempt to replace the lack of action on an international level to reduce climate change itself. For instance, the Smart Health Facilities Initiative and Smart Hospitals Toolkit by the Pan American Health Organization functions primarily within the Caribbean in order to assess health facilities and put programs into place to reduce their vulnerability to disease (UNFCCC). Another example of this is in France, where the Tiger Mosquito Surveillance Network detects fluctuations in the populations and movements of disease-carrying mosquitoes so that the threat of malaria is heavily monitored in case of any drastic increase in prevalence (UNFCCC). Some countries integrate rising health issues into their national adaptation plans for climate change, including Macedonia and Germany, who combine public health and disease matters caused by the climate into policy regarding the environment, nature conservation, and nuclear safety (UNFCCC). Mexico also features a policy that trains medical practitioners and spreads awareness to the community about possible shifts in disease patterns and presence (UNFCCC). The country’s National Institute of Public Health funds the Self-Learning Course on Climate Change and Health, which educates the public on the health effects from climate change (UNFCCC). Some countries have even banded together in lieu of a true international organization, like in the case of the Climate Adaptation Management and Innovation Initiative of the World Food Programme, which educates 16 countries across Asia, the Middle East, and Africa about climate induced issues and how to make decisions around them (UNFCCC).

Though a multitude of countries have created agencies like these in order to address rising health concerns triggered by climate change, the United States remains somewhat deadlocked by politicians believing the environmental phenomena are just fallacies. Despite this, several American government agencies have put forth plans to prepare for any health catastrophes if they cannot prevent them. One instance of this is the Climate and Health Program sponsored by the Center for Disease Control and Prevention, which is the only climate change adaptation program invested in by the U.S. Department of Health and Human Services (CDC). The program includes the Climate Ready States and Cities Initiative (CDSCI), which covers 16 coastal states and two cities using the BRACE framework, which stands for Building Resilience Against Climate Effects (CDC). The BRACE framework works to identify health-related impacts of climate change in communities across the country and provides help to at-risk areas and populations (CDC). The program helps states write and implement health adaptation plans for changing disease patterns and remedy gaps in critical services of public health organizations (CDC). This, like many other programs around the world, serves to project possible disease burdens and researches ways to intervene in these issues, as well as functions to build a proactive framework that will be prepared for any public health crisis in the future (CDC). The American Public Health Association has also formed a multiyear strategy in order to address climate change and health (APHA). The plan projects that it will develop
awareness of helpful practices, individual behavioral choices, and political policies that not only address climate change, but will improve the general health of the public in preparation for any problems (APHA). It aims to push towards science and policy resources in order to create action both in the community and within government (APHA). Though international plans are mostly lacking in progress, countries and their local communities and organizations have recognized the threat climate change poses to health and have responded as they see fit.

While public health organizations cannot necessarily stop climate change from happening, the best course of action that could be taken would be to learn and adapt to changing diseases in their communities. For diseases that are known, medical practitioners should be educated and trained to recognize the symptoms of diseases of other regions that could be expanding into their areas due to climate change, as well as be prepared to treat any such disease. For instance, if malaria has increasingly spread into subtropical zones, doctors and clinicians in the surrounding temperate zones should be ready to address any case of malaria if it continues to expand its range. Medical organizations should be aware of how their air and water conditions may be altered in the future and recognize the possible health risks that may arise because of this. More than anything, public health professionals must continue to interconnect with each other, both nationally and internationally, to create as much of a united front against climate-borne disease patterns as possible, with or without the support of their respective governments.

**Concluding Remarks**

Despite its surrounding controversy, climate change undoubtedly remains one of the most pressing issues currently on the world stage. The environmental effects engendered by climate change permeate every level of society, influencing great change in political, economic, and most of all, public health landscapes. Climate change can and will have catastrophic consequences in health, already being seen within airborne, waterborne, and vector-borne illnesses, as well as in ancient or unknown diseases hidden within the Earth’s permafrost. With varied international responses, the responsibility for preparing for these impending health crises falls to the public health and individual level. With proper attention, education, and adaptation, public health professionals can become ready to face the coming trials and tribulations already emerging from the rapidly accelerating course of disease caused by climate change.
References


