

A comprehensive analysis assessing the impact of climate events on global citizens' health: From the aspect of disease and public health

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Abstract. The challenge posed by shifting climatic conditions has emerged as one of the most critical issues of our time, carrying significant implications for human well-being. This research seeks to investigate climate events' impact on individual health on a global scale. In order to achieve a comprehensive understanding of the intricate relationship between climate events and the health of global citizens, we analyze a diverse array of data sources, encompassing epidemiological studies, climate records, and health indicators. This study examines the direct and indirect effects of climate events, such as heat waves and extreme weather occurrences drawing upon authoritative epidemiological research. Furthermore, it explores the secondary repercussions of climate-induced disruptions, including alterations in the trend of cardiovascular diseases, which have been observed to heighten the overall health burden. The primary objective of this study is to advance our comprehension of the intricate interplay between climate change and global public health. The findings will underscore the pressing necessity to address climate-changing events as a paramount public health concern, emphasizing the importance of comprehensive, evidence-based policies that safeguard human well-being amidst an increasingly volatile climate. By combining empirical evidence with a broader understanding of social and environmental determinants of health, we aspire to assist decision-makers in implementing proactive measures to protect and promote the health of populations worldwide in the face of a changing climate.

Keywords: Global Citizens' Health, Disease And Public Health, Climate Events.

1. Introduction

This paper will address the research question "To what extent do climate events affect global citizens' health?" from the aspect of public health and diseases by analyzing the existing data that indicates the correlation between climate events, conditions, and the impact on humans.

Climate events play a significant role in shaping Earth's weather patterns and have wide-ranging consequences for different regions. A regional climate event refers to a notable and often abnormal deviation from the usual climate conditions in a specific geographic area over a relatively short timeframe. These events encompass extreme weather phenomena, such as heatwaves, droughts, floods, tropical cyclones, and severe storms, with the potential to disrupt ecosystems, economies, and, most critically, human health. The occurrence and impacts of regional climate events have drawn increasing attention in recent decades due to growing concerns about global climate change. The Intergovernmental

Panel on Climate Change a renowned authority on climate science, has emphasized the connections between climate change and the rising frequency and intensity of extreme weather events worldwide [1]. These events can further exacerbate vulnerabilities in susceptible populations, leading to adverse health consequences.

To address the impact of climate events on human health, the case study of El Niño - Southern Oscillation (ENSO) will be referenced in this paper.

ENSO holds a position of immense influence among climate phenomena, exerting a critical role in shaping global weather patterns and climate variability. This natural climate oscillation occurs within the tropical Pacific Ocean and involves intricate interactions between the atmosphere and ocean ENSO events are characterized by abnormal warming (El Niño) or cooling (La Niña) of sea surface temperatures in the central and eastern tropical Pacific, leading to significant shifts in atmospheric circulation patterns and weather systems. The oscillation period between El Niño and La Niña typically spans around 2 years [2].

El Niño and Rainfall

El Niño conditions in the tropical Pacific are known to shift rainfall patterns in many different parts of the world. Although they vary somewhat from one El Niño to the next, the strongest shifts remain fairly consistent in the regions and seasons shown on the map below.

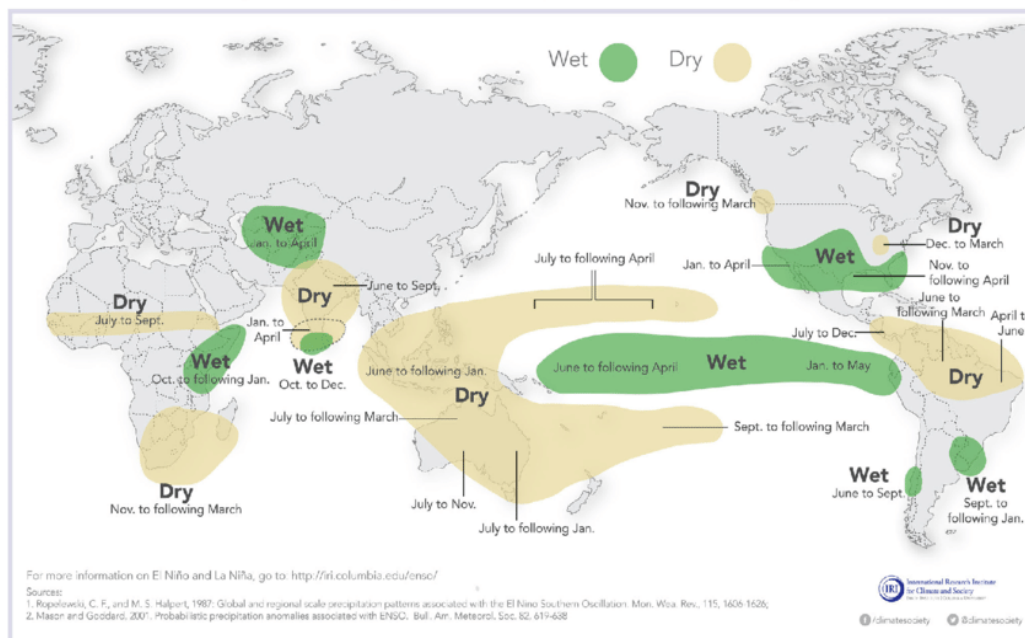


Figure 1. A map indicating regions on the Earth that are affected by ENSO [3].

The impacts of ENSO are vast and diverse, exerting profound effects on weather, agriculture, ecosystems, economies, and the health of humans. It is noteworthy that despite ENSO being a regional climate event in the southern Pacific Ocean, its effect is significant to all continents worldwide, just as shown in Figure 1. For example, El Niño events may result in severe droughts, intense rainfall, and extreme weather events in certain areas while causing arid conditions and wildfires in others. In contrast, La Niña events can bring about above-average precipitation and heightened flooding risk in specific regions, while alleviating drought conditions in others [4]. Those abnormal events are the predominant reasons for human health problems such as cardiovascular diseases and heat stroke.

2. Methodology

This paper will examine studies and data on the effect of ENSO events on global citizens' health. Studies from various databases, and environmental and medical journals will be analyzed as well as evaluated.

The conclusions made from these studies and data will then be analyzed and used to explore what are possible solutions for humans to mitigate or adapt to those climate events.

In my preliminary research, I found a substantive amount of research on the impact of ENSO on human health in regard to heat-related diseases such as cardiovascular diseases and heat stroke. However, there was little research comparing and contrasting the impact of ENSO on multiple regions. Therefore, I've decided to choose the United States of America as an entry point for my research topic which aims to explore the direct correlation between ENSO events and the incidences of cardiovascular diseases. Furthermore, the approaches I took allowed me to propose scientific methods to alleviate the impact of ENSO. The case study that is analyzed is the 2016 El Niño event.

3. El Niño

El Niño phenomenon is part of the larger El Niño-Southern Oscillation system, which includes its cooler counterpart, La Niña [5]. At the heart of an El Niño event lies a complex interplay between oceanic and atmospheric processes. During El Niño events, normal easterly trade winds that usually blow from east to west along the equator are weakened, weakening the upwelling of cold, nutrient-rich waters along the coasts of South America. As a result, warmer waters accumulate in the central and eastern equatorial Pacific, causing the rise of temperature in South American countries as well as part of a large region in North America including the United States of America [6]. Figure 2 below presents the principle of El Niño.

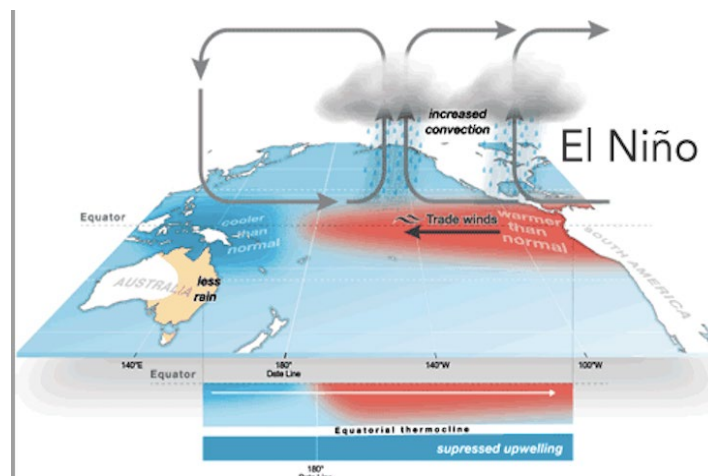


Figure 2. Annotated diagram presenting the principle of [7].

4. 2016 El Niño event

The 2016 El Niño event was a notable and impactful occurrence within the realm of climate variability and drew widespread attention due to its profound influence on global weather patterns and associated consequences. The 2016 El Niño stands as a significant event within this broader context, leaving a discernible mark on various ecological, societal, and medical dimensions.

Characterized by a substantial abnormal increase in sea surface temperatures across the equatorial Pacific, the 2016 El Niño event generated a cascade of effects that reverberated far beyond its geographical origin, resulting in causing significant impact on the human population in North America. This particular El Niño episode is notable for its intensity, with sea surface temperatures reaching levels that placed it among the strongest El Niño events recorded in recent decades [8].

The repercussions of the 2016 El Niño were diverse and impactful. Altered atmospheric circulation patterns led to anomalous weather conditions in numerous regions worldwide. Some regions experienced prolonged droughts, while others were confronted with enhanced precipitation and the risk of flooding. These conditions, in turn, had implications for agriculture, water resources, infrastructure, and public health, with many communities grappling with the challenges posed by these abnormal

weather patterns. The year 2016 was shockingly in turn of 0.2 degrees Celsius warmer than 2015 and about 1.3 degrees warmer than pre-industrial levels [9].

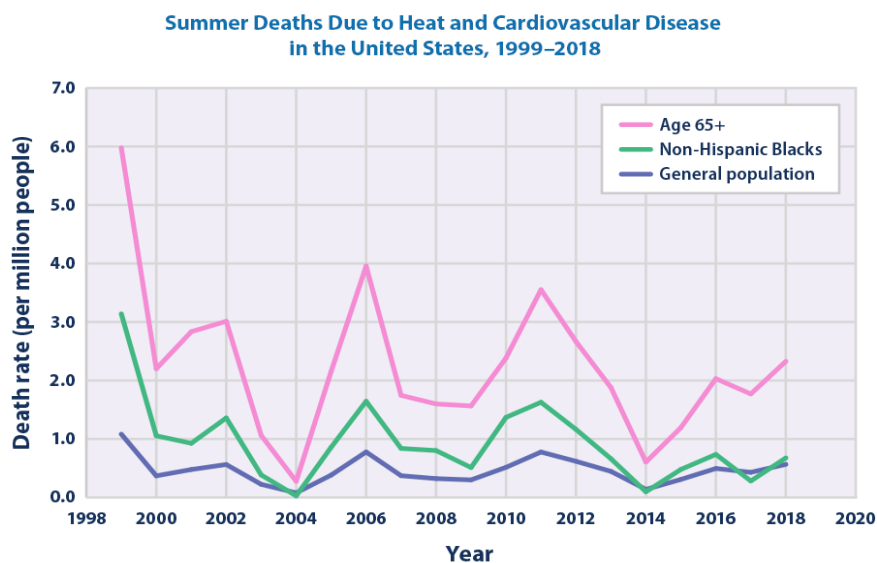
5. 2016 El Niño event impact on United States of America's temperature

During the winter of 2015 to early 2016, the United States encountered relatively moderate temperatures, especially in its northern and eastern regions. This warming was linked, to the impact of the 2016 El Niño.

While the 2016 El Niño contributed to warmer conditions overall, it is noteworthy that its effects were not the same across the entire United States. Some regions experienced more abnormal warming and significant weather changes than others. For instance, the northern Rockies experienced milder winters and fewer snowy days, while parts of the southern United States experienced more frequent and intense rainfall events due to the altered climate effect associated with El Niño. In 2016, the United States average temperature was 54.9°F which is 2.9°F above the 20th century average [10]. In addition, the year 2016 has been recorded to be the hottest year in the 137 years of record keeping in the country's history [11].

6. Correlation between abnormal warming and cardiovascular disease incidence

Cardiovascular disease (CVD) refers to various conditions that affect the heart and blood vessels, including coronary artery disease, heart attack, and stroke. Studies have shown a direct correlation between hot weather and cardiovascular issues.



Data source: CDC (U.S. Centers for Disease Control and Prevention). 2020. CDC WONDER database: Multiple cause of death file. Accessed June 2020. <https://wonder.cdc.gov/mcd-icd10.html>.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.

Figure 3. Graph highlighting the death rate of cardiovascular disease and heat in the United States from 1999 to 2018 [12].

According to Figure 3 above, there is a significant increase in the death rate (per million people) of summer deaths due to heat and cardiovascular disease from about 0.7 to about 2.1 per one million during the 2014 to 2016 El Niño event. Notably, most earlier years that had a peak in death rates such as 2006, 2002, and 1998 were all El Niño years (El Nio). Therefore, it is reasonable to conclude that El Niño has a direct impact on human cardiovascular health.

There are several reasons why abnormal heat conditions impact human cardiovascular health [13].

Heat Stress and Cardiac Strain: Increased temperatures can induce heart and blood vessel pressure. The body's response involves increasing blood circulation to the skin, leading to an increase in heart

rate and the volume of blood pumped by the heart. This added strain on the heart can exacerbate the conditions of individuals with pre-existing heart issues, potentially resulting in negative cardiac events.

Vasodilation and Blood Pressure: High temperatures can cause the widening of blood vessels, causing a decrease in blood pressure. While this might seem advantageous for individuals with high blood pressure, prolonged exposure to heat can also cause dehydration and loss of salt, activating mechanisms that elevate blood pressure, potentially worsening hypertension.

Dehydration and Electrolyte Imbalance: Elevated temperatures can lead to excessive perspiration and dehydration, disrupting the equilibrium of electrolytes within the body. This imbalance of electrolytes can have adverse effects on the function of the heart.

Inflammation and Plaque Rupture: Certain research studies have proposed that heat stress could contribute to inflammation within the blood vessels and encourage the rupture of atherosclerotic plaques, which are accumulations of cholesterol and other substances on artery walls. The breaking of these plaques can trigger heart attacks and strokes.

Blood Clotting: Heat can impact the factors involved in blood clotting, potentially heightening the risk of forming blood clots. This circumstance is of particular concern for individuals with conditions such as deep vein thrombosis.

7. Potential Solution

It is noteworthy that despite the fact that scientific research has shown that humans would most likely be facing more extreme and abnormal climate conditions, such as stronger ENSO events, there are potential solutions that could help us relieve the threat of climate events to our health. Geo-engineering methods such as cloud seeding are currently being considered by multiple countries.

7.1. Cloud Seeding

Cloud seeding is a geoengineering weather modification technique that involves the introduction of various substances into clouds to encourage precipitation. Cloud seeding aims to enhance rainfall or snowfall in specific regions, often to increase water resources for agriculture, hydroelectric power generation, and water supply.

Cloud seeding typically involves dispersing materials into clouds that act as nuclei for the condensation of water vapor, which can then form into larger water droplets or ice crystals. One cloud seeding method is silver iodide seeding.

7.2. Silver Iodide Seeding

Silver iodide is a common substance used for cloud seeding. It has a crystalline structure similar to ice, making it an effective nucleus for ice crystal formation. Silver iodide particles are released into clouds from aircraft, ground-based generators, or other dispersal methods. When these particles come into contact with cooled water droplets in the clouds, they can initiate the freezing process, leading to the growth of ice crystals. Clouds will eventually increase the albedo of Earth, thereby, reducing global warming which may lead to more frequent extreme heat weather that causes health issues [14].

8. Conclusion

According to the referenced studies on ENSO, extreme climate, and cardiovascular public health, it is reasonable to draw the conclusion from this research that there is a direct correlation between climate events and the health status of humans. The strength of climate change has been proved as even a regional climate event such as ENSO could affect the health of people extending its region. Although geoengineering methods such as cloud seeding could mitigate the effects of global warming and abnormal climates to reduce their impact on human health, their efficiency and reliability are still under determination. Therefore, the impact of environmental change on human health is a global issue that cannot be ignored by global citizens.

Despite that, this study has proved the direct correlation between climate change and human health, but there are limitations as well. Firstly, since this El Niño event has an impact globally, just focusing

on one particular region (United States) could not allow people to realize the variety of effects of this specific climate event. Secondly, even though, there is evidence showing the relationship between cardiovascular diseases and rising temperatures caused by El Niño events, such data on cardiovascular diseases have all ignored other factors such as infectious diseases, epidemics, and medical improvements. Therefore, further research that could exclude those factors is required.

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