ANALYSIS AND COMPARISON OF THE SCOPE, IMPACTS, AND RESPONSES TO THE COVID-19 PANDEMIC AND CLIMATE CHANGE AS MAJOR CRISES IN THE UNITED STATES

by
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Executive Summary

The COVID-19 pandemic has become the global crisis of 2020 and the focal point of much public attention. Climate change is the ongoing crisis of the industrial and post-industrial ages. The United States and the rest of the world are attempting to navigate both crises. This study researched and analyzed the COVID-19 pandemic and climate change as the major crises affecting the United States of America in terms of the scope of both crises, their impacts, and national responses. This project draws on the knowledge learned throughout the Energy Policy and Climate Change program such as the principles of climate change, its effects, and challenges with regards to implementing effective adaptation and mitigation measures. To the best of this researcher's knowledge, this project is the first attempt to analyze both COVID-19 and climate change as contemporaneous crises occurring within the United States. As the pandemic continues to evolve, every passing month has offered new information relevant to this project, highlighting both this project's novelty and the dynamism of the crisis. The research needed to complete this project drew initially from over two-hundred resources, from the Intergovernmental Panel on Climate Change Assessment Reports to newspaper articles. Additionally, it forced "deep-dives" into the impacts of climate change, challenging preconceived notions, and brought to light the reality that the people most likely to suffer from one crisis are most likely to suffer both. Looking beyond this project, a next step beyond comparing and contrasting will be to splice the two crises to learn their independent effects and how overlapping impacts interact with each other. This would allow a cumulative analysis of the impacts on shared, vulnerable demographics in order to understand how crises in the U.S. continue the oppression of certain demographics of American society. This project should be considered a first step toward better understanding COVID-19, climate change, and the way in which crises are processed in 21st century American society.

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1. Introduction

A national crisis may be defined as an event, or time, consisting of “intense difficulty, uncertainty, danger or serious threat to people and national systems” (IGI Global, 2020). The 2019 novel coronavirus (COVID-19) and climate change present themselves as the major crises of the current year and current century, respectively. By studying and comparing the two crises and the resultant policy responses, it may be possible to understand how the two interact and the significance of that interaction for society.

Climate change is a function of global warming, which the Intergovernmental Panel on Climate Change (IPCC) defined as “a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or variability of its properties and that persists for an extended period, typically decades or longer” (IPCC Glossary, 2018, 544). This warming is due to a net imbalance of energy receipt from the sun and energy loss through infrared radiation, caused by anthropogenic emissions of greenhouse gases (GHGs). As a global crisis, climate change will have multiple consequences in tandem with increasing temperature: extreme weather events (tropical storms, heat waves, drought), ocean acidification from increased carbon absorption, and sea level rise (Allen et al., 2018).

The mechanisms of climate change were first theorized in the 1800’s, by scientists such as Svante Arrhennius and John Tyndall, who wrote on the principle of heat absorption and radiation in 1861 (Tyndall, 1861). Climate change became an issue of concern in the United States after Dr. James Hansen’s 1988 Congressional testimony of demonstrable global warming due to the atmospheric accumulation of carbon dioxide (Shabecoff, 1988). Since that testimony, the United States has been inconsistent in addressing climate change, where the nation was a signing party to the United Nations Framework on Climate Change (UNFCCC) but refused to ratify the Kyoto Protocol due to the perceived price of compliance (Peterson, 2004). The furthest any national climate legislation reached in Congress was the American Clean Energy and Security (ACES) Act which narrowly passed in the House of

Representatives but was never subsequently voted on by the U.S. Senate (Congress, 2010). In the absence of federal intervention, multiple states, coalitions of states, municipalities, cities, and corporations have taken actions to mitigate their contributions to climate change. Microsoft's recent corporative initiative pledged net negative carbon emissions by 2030 (Smith, B., 2020). While these individual, sub-national efforts are being made, the crisis of climate change has made its impacts felt across the country. Temperatures across the contiguous United States have risen between by 1.2°F between 1986 and 2016, and the number of coastal flooding events has risen fivefold in many areas (Hayhoe, K. et al., 2018). Echoing these findings, the IPCC determined that human-induced warming of 1°C already occurred by 2017, demonstrating that the crisis predicted in the late 20th century is well underway in the early 21st century (Allen et al., 2018).

The newer crisis of the 21st century, COVID-19 has negatively impacted nearly every country across the world, causing millions of infections and hundreds of thousands of deaths worldwide (Johns Hopkins University (JHU), 2020). Many nations have taken strong policy measures to bar entry of the virus, contain its spread, and mitigate economic damages while containment measures persist. Because the virus is easily transmissible and highly infectious, these policies were by design abrupt, stringent, and disruptive. Travel bans to halt the international spread of the virus, affecting the transportation sector and those relying on it, had at one point grounded greater than 60% of commercial aircraft (Albers and Rundshagen, 2020). Further, these policies have to economic shrinkages in the advanced economies (Europe, Japan, United States), where the United States' Gross Domestic Product (GDP) is expected to shrink by approximately 6% (World Bank, 2020).

In contrast to climate change, the first U.S. case of COVID-19 occurred on January 20, 2020, giving the country nine months to adapt to and learn from the crisis and writing this paper (Holshue et al., 2020). However, in this short period of time, Congress authorized a $2 trillion financial aid package to mitigate the economic collapse (World Bank, 2020). This decisive action demonstrated that the federal government could mobilize a massive amount of spending to deal with a crisis, just as requested in the 116th Congress' House Resolution 109, the Green New Deal (H. Resolution 109, 2020). In contrast, spending at this scale was never allocated for the Green New Deal or any other previous proposal to combat climate change at a federal level. Although COVID-19 and climate change are different types of crises, operating on dissimilar timescales, this action maintains the possibility for a similar agreement to fund climate change mitigation and adaptation strategies.

Given how quickly the pandemic matured from initial notification to full global responsiveness to de-escalation of those responses, it is possible that COVID-19 could be used as an example of how governments can manage crises in the 21st century. Compared to previous crises of the 20th century, COVID-19 allows such a study to occur in the environment of today's dynamics of economic interdependency, shifting demographics, and the intersections of social media, politics, and communication. Responses to COVID-19 may have lessons that are applicable to climate change, such as how to achieve political alignment on policy response, precedence for budgetary spending to meet a global challenge, and how society responds to shifting economic signals. However, the usefulness of COVID-19 as a crisis management learning tool that can be related to climate change is not yet clear. This study provides an in-depth comparison and analysis of climate change and COVID-19 as major crises in the United States. This paper will analyze the two crises in terms of their scope, their impacts, and the U.S. responses to these crises and will focus specifically on those elements directly affecting human society. An additional historical perspective will be provided to understand the crises and their impacts better.

2. Crisis Histories

2.1 History of Climate Change

Climate variability has occurred through the planet's history. According to the IPCC, a key indication of climate change includes the relative concentrations of atmospheric GHGs, such as methane and fluorinated gases, with carbon dioxide (CO_2) as the gas of most concern because it is generated by human activity (Cubasch et al., 2020). Prior to the Industrial Revolution, atmospheric CO_2 cycled between approximately 170 parts-per-million (ppm) to 300 ppm (Lüthi et al., 2008). Because of the accelerated rate of fossil fuel use during the Industrial Revolution, studies of GHG-driven radiative forcing imbalances have sometimes used 1750 as the unofficial "start" of anthropogenic climate change. Some impacts of climate change include warming oceans, changes in ocean acidity, increased number of warm days throughout the year, decreasing snow cover and Arctic sea ice extent, and changes in precipitation (Cubasch et al., 2013). Since Dr. James Hansen's 1988 testimony, measured atmospheric CO_2 has steadily increased (Figure 1), exceeding 400 ppm (Jacobson et al., 2018). Following his testimony, the political attitude towards climate change has not resulted in a comprehensive federal policy.

The U.S. initially embraced international efforts to address climate change in the 1990's, signing the UNFCCC in 1992. However, the politics of the mid-1990's viewed both national environmental regulations and international climate agreements as detrimental to U.S. economic competitiveness, resulting in the U.S. choosing not to ratify the Kyoto Protocol and the subsequent growth of state and municipal government efforts to mitigate carbon emissions (Peterson, 2004). Significantly, the 2007 Supreme Court ruled in *Massachusetts v. EPA* that the Clean Air Act (CAA) authorizes the Environmental Protection Agency (EPA) to regulate CO_2 as an air pollutant, to include vehicle emissions (Meltz, 2007). This ruling allowed for the EPA's Clean Power Plan (CPP), a comprehensive federal plan that was announced in August 2015 with the overall goal of reducing carbon emissions from electrical generating stations by 32% below 2005 levels by 2030 (EPA, 2017). The U.S. Supreme Court stayed its implementation due to states' challenges to the rule, preventing its implementation prior to a new administration and EPA Administrator. Under the new administration, the CPP was repealed in June 2019 and replaced by the Affordable Clean Energy Rule, marking the most recent federal policy to reduce carbon emissions (EPA, 2019). The EPA estimates this rule will reduce carbon emissions from electrical generating stations by 35% below 2005 levels by 2030 (EPA, 2019).

Evidence of climate change has been documented in U.S. waters and lands during the intervening decades. For example, the northern California Current System has reached detrimental acidic conditions in previous summers due to the combination of increased dissolved CO_2 and upwelling of dissolved organic carbon to the ocean surface (Fennel et al., 2018). Similarly, shelled marine life off coastal California and Alaska have been impacted by the reduced concentrations of free aragonite, negatively affecting their ability to form critical body structures (Fennel, et al, 2018). Naturally occurring droughts in the Southwest have been exacerbated by increasing temperatures and changes in seasonal snowpack timing and volume, and climate change is believed to have significantly increased the total area vulnerable to naturally occurring wildfires (Gonzalez et al., 2018). In the Northeast, coastal temperatures rose an average of 0.06°F per year from 1982-2016, with this increase accelerating within the last decade (Dupigny-Giroux et al., 2018). Sea level rise in the Mid-Atlantic region has occurred approximately three times faster than the global average due to the additive of land subsidence, contributing to the increased frequency of high tide flooding, which has grown tenfold in Northeast (Dupigny-Giroux et al., 2018). Climate change can elevate the costs of natural disasters, such as the compounded damage costs of fires and flooding affecting Fort Collins in 2013 which amounted to approximately $2 billion (Dupigny-Giroux et al., 2018). Rising temperatures caused by imbalanced global radiative forcing, due to annual increases in atmospheric CO_2 concentration, is expected to grow in magnitude in the absence of significant action to stop emissions (Figure 2).

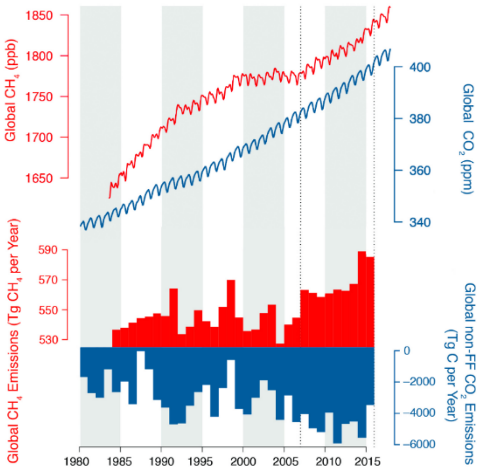

Figure 1. Change in global methane and carbon dioxide concentrations between 1960-2015. From Second State of the Carbon Cycle Report, Chapter 8 (Jacobson et al., 2018).

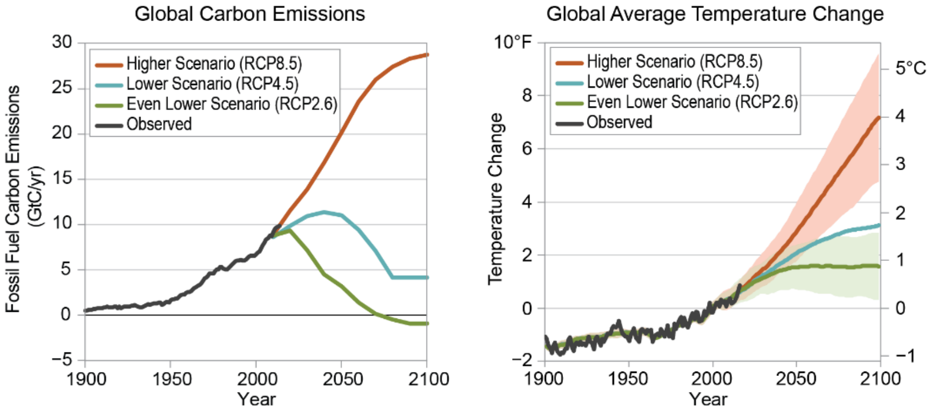

Figure 2. Left, change in fossil fuel carbon emissions from 1900 to 2100, comparing observed emissions with three modeled Representative Concentration Pathways (RCPs). Right, change in temperature over the same time span, also comparing observed temperature changes with RCPs. Emissions rate tends to follow the higher emissions, higher temperature RCP 8.5. From NCA4, Volume II, Chapter 2 (Hayhoe et al., 2018).

2.2 COVID-19 Pandemic History

The first COVID-19 cases, initially diagnosed as pneumonias, were identified in Wuhan, China, on December 31, 2019, but by January 7, 2020, these pneumonias were diagnosed as COVID-19 (Holshue et al., 2020). By January 30th, COVID-19 infected 9,976 people in twenty-one countries, with the first U.S. case documented on January 20th (Holshue et al, 2020). On January 24, the publicly stated risk from COVID-19 was described as “low” (Hauck et al., 2020). The World Health Organization (WHO) issued a public health emergency on January 31st, followed by the United States on February 3rd (American

Journal of Managed Care (AJMC), 2020). The first U.S. death attributed to COVID-19 occurred on February 12, and on February 26, the Centers for Disease Control and Prevention (CDC) confirmed the first infection of a U.S. citizen lacking international travel (Hauck et al., 2020). Between late February and early March, *USA Today* reported problems with CDC-issued COVID-19 test kits sent to state and local health departments and subsequent delays in testing (Alltucker, K., 2020 and Wagner, D., 2020). A national emergency was declared on March 13 which provided authority to increase spending, and a limited travel ban was declared to prevent U.S. entry from a selected list of European countries (AJMC, 2020). By the time these measures were in place, approximately 2,200 Americans were infected (JHU, 2020). In response to the economic effects of containment measures, the Coronavirus Aid, Relief, and Economic Securities (CARES) Act was signed into law on March 27. During this period, California became the first state to issue a stay-at-home order, and, by the end of March, all fifty state governments issued state of emergency orders (Newsom, 2020 and National Governors Association, 2020). However, in March alone, COVID-19 created a net loss of 8.9 million jobs (layoffs, discharges, and other separations) and approximately 192,000 confirmed infections in the United States, a nearly eighty-seven-fold increase (Bureau of Labor Statistics (BLS), 2020, JHU, 2020). Because of the pandemic's rapid spread, the United States would have the highest number of cases in the world by April, surpassing both Italy and even China (Hauck et al., 2020, and Chakraborty and Maity, 2020). By May 28, the CDC reported 100,000 deaths related to COVID-19 (CDC Website 1, 2020). In April and May, examples of shortages in testing supplies continued, as reported by CNN and NPR (Ellis et al., 2020 and Pfeiffer et al., 2020). Through the summer (June, July, August), infections rose sharply (Figure 3) to reach two-million confirmed cases, the record for highest single-day infections was set (July 10), and the United States notified the WHO of its intention to withdraw (July 6) (Hauck et al., 2020, and Taylor, 2020). As of September, 200,000 deaths were attributed to the virus in the United States, approximately 12.7 million citizens received unemployment insurance, and a 31% depreciation in real GDP between second and first quarters

(Johnson, C., 2020, BLS, Oct. 2020, Bureau of Economic Analysis, 2020).

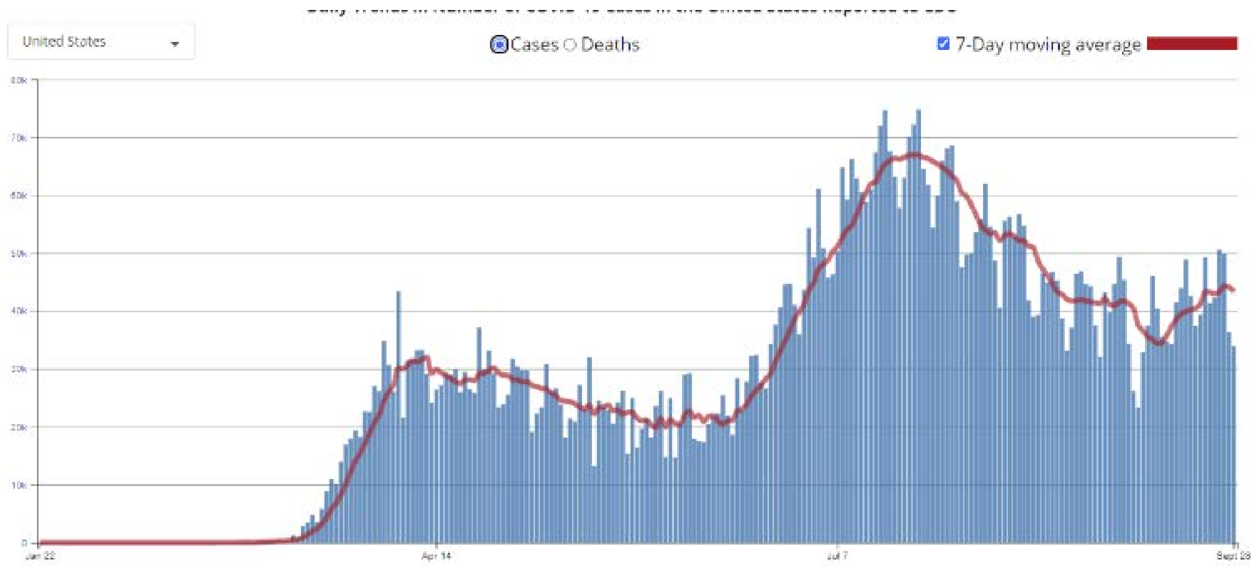

Figure 3. Trend in daily number of COVID-19 cases reported to the CDC as of September 28, 2020. Image retrieved from the CDC "Trends in Number of COVID-19 Cases and Deaths in the US Reported to CDC by State/Territory" (CDC Website 7, 2020).

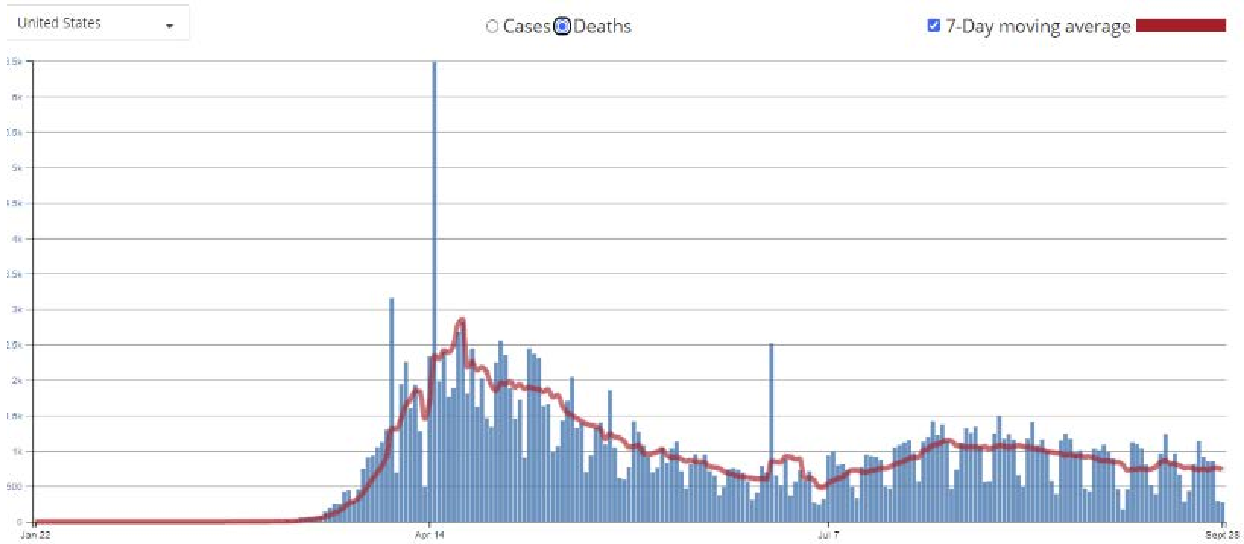

Figure 4. Trend in daily number of deaths attributed to COVID-19, reported to the CDC as of September 28, 2020. Image retrieved from the CDC "Trends in Number of COVID-19 Cases and Deaths in the US Reported to CDC by State/Territory" (CDC Website 7, 2020).

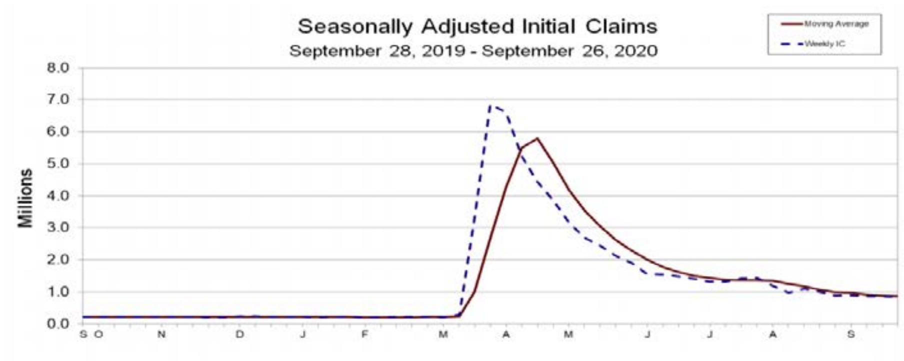

Figure 5. Seasonally adjusted initial unemployment insurance claims from September 2019 to September 2020. Unemployment claims rose quickly in March 2020 and peaked in mid-April. Image retrieved from the Bureau of Labor Statistics' September News Release (BLS, Sep. 2020).

3. Methods

Document analyses were conducted to identify the characteristics, scopes, and impacts of climate change and COVID-19. Documents selected for analysis included the *Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (AR5), the U.S. Global Change Research Program's (USGCRP) *Fourth National Climate Assessment* (NCA4), as well as publications by federal agencies, including the Environmental Protection Agency (EPA), Bureau of Labor Statistics (BLS), CDC, and U.S. Census Bureau. Additionally, selected documents included peer-reviewed journal articles, editorials, and newspaper articles. Research articles were screened for the following attributes: research was specific to the United States, had quantifiable results to facilitate crisis comparison, and reported results in national or regional perspectives. News media was considered for COVID-19 information due to the nascent stage of research, continuous availability of new information, and to support historical facts. This resulted in 190 cited resources to support this paper. The results of the document analyses were organized to describe the crises in terms of their characteristics, impacts to the United States, and responses to the crises. Drawing comparisons of the two crises was confounded by the variety in which impacts of climate change are researched, the much smaller body of COVID-19 research relatable to climate change research, and the on-going nature of the pandemic which prohibited both a clear historical perspective and altered the magnitudes of impacts and policy responses as the paper was written.

4. Results and Discussion

Potential impacts of both climate change and COVID-19 were identified using existing literature to analyze both crises. These impacts were then organized to describe their characteristics, impacts, and responses to those crises. The impacts analyzed are summarized in Table 1.

	Climate Change	**COVID-19**
Characteristics		
Origin	Carbon emissions from fossil fuel energy use, land use and land use changes, and other human activities.	Novel corona virus, SARS-CoV-2, encountered in Wuhan, China.
Geographic scope	Evidence for present and expected future effects in all U.S. terrestrial and aquatic environments.	Documented infections and morbidities attributed to COVID-19 in all fifty states.
Temporal scope	Commenced with Industrial Revolution, active through present. Effects of climate change expected to persist for centuries.	Less than one year as of the writing of this paper. Infection lasts for approximately four weeks for cured individuals, approximately 4 ½ weeks for mortality.
Scope of affected populations	Disproportionate effects depending on type of impact and population distribution. Low-income, rural communities, people of color, are more vulnerable.	Infections more common in adults older than 30. Fatalities more common in the elderly. Low-income, rural communities, people of color, are more vulnerable.
Environmental scope	Precipitation changes and temperature increases will change ecosystems and reduce biodiversity.	No direct effect to the environment but may improve biodiversity.
Reproducibility	If GHG emissions cease, anthropogenic climate change not reproduceable.	Future respiratory syndrome pandemics are likely due to mutability of RNA viruses.
Impacts		
Economic	Expected effects of climate change dependent on future warming. In a BAU future, short-term national economic gains may be realized. Over the long-term, multi-sectoral impacts may slow GDP growth or cause contraction.	Decreases in GDP and high unemployment rates during first six months of pandemic followed by employment returns.
Health and welfare	Hospitalization rates increase from vector-borne diseases and heat-related illnesses. Increased mental health issues due to climate anxiety and extreme weather events. Mortality expected to increase over the course of the 21st century.	Hospitalization rates significantly increased in highly affected regions of the United States, in some cases reaching local capacity. Mortality rates increased as a function of the rate of infection. Increasing mental issues due to coronophobia.
Political	Climate change has exacerbated political instability in other countries, may negatively affect national security, and is associated with political partisanship.	Economic and social disruptions due to the pandemic have caused political instability. Pandemic perception associated with political partisanship.
Responses		
Policy	No national policy meant to directly mitigate climate change. Many sub-federal governments have climate action plans of	Has devoted Federal agencies responsible to contain pandemic. The CARES Act passed to mitigate economic consequences.

	varying scope. EPA required to regulate carbon emissions.	
Spending	Less than $200 billion spent to combat climate change.	CARES Act allocated over $2 trillion to support various programs covered by the Act.
Monitoring/Information	Climate change indicators monitored by various government and academic organizations.	COVID monitored by government and academic organizations. Information is often provided by hospitals not belonging to those organizations.

Table 1. Summary comparison table of characteristics, impacts, responses of climate change and COVID-19.

4.1 Characteristics

4.1.1. Origin.

This paper considers anthropogenic climate change to have "started" in 1750, consistent with the findings of the IPCC *Fifth Assessment Report*. Anthropogenic GHG emissions have exceeded historical natural trends, showing a substantial increase in the last two centuries. With "very high confidence", according to the IPCC, the sum of human activities, superimposed on natural drivers of climate variability, has resulted in the net effect of global warming (Cubasch et al. 2013). The United States is not a sole contributor to climate change but has been ranked as the second greatest contributor to total CO_2 emissions for the last several years, with most emissions coming from fossil fuel combustion (Boden and Andres, 2017, and World Resources Institute, 2020). For the U.S., the following can be said about the origin of climate change: it is multiple (several GHGs from various sectors, land use changes), artificial (anthropogenic), and shared by all GHG emitting nations (not unique to the United States). Additionally, climate change will likely impact the United States in the same manner without its continued contribution to climate change (not isolable to or from the United States), albeit delayed due to reduced annual carbon emissions. The origin of anthropogenic climate change *is cumulative GHG emissions from human activities in all nations, including the United States*.

The COVID-19 pandemic originated with the SARS-CoV-2 zoonotic RNA betacoronavirus, believed to have first appeared in November 2019 in Hubei, China, and was first recognized as a new disease the following December by Dr. Li Wenliang (Matricardi et al., 2020). As previously mentioned, this virus was introduced to the United States after an individual returned to Washington state on

January 15th after visiting family in Wuhan, China (Holshue et al., 2020). The pandemic's origin differs from that of climate change: it is singular (one viral strain), natural (not anthropogenic), and has affected every nation (not unique to the United States). The pandemic may not have impacted the United States in the same manner if the U.S. had zero documented cases of infection, since much of the resultant policies were designed to slow or stop the spread of the disease (is isolable to or from the United States). The origin of the pandemic *is a naturally occurring RNA betacoronavirus originating from outside the United States but transmitted by those within the U.S*.

4.1.2. Geographic Scope.

The geographic scope of climate change encompasses the contiguous United States, Alaska, and Hawai'i, since climate change affects the entire planet. The NCA4 divides climate change impacts occurring into the following regions: Northwest, Southwest, Northern Great Plains, Southern Great Plains, Midwest, Southeast, Northeast, Alaska, Hawai'i and Pacific Islands, and U.S. Caribbean (USGCRP, 2018, pp.5). According to Volume I, Chapter 6 of the NCA4, each of these listed regions had observable increases in annual average temperature, including increases in annual average maximum and minimum temperatures (Vose et al., 2017). The NCA4 does not provide resolution to the level of individual states, but the assessment is clear that nationwide climate change impacts are expected across the U.S. as demonstrated in the figure below (Figure 6). Therefore, the scope of this crisis is *nationwide*.

Like climate change, the geographic scope of the pandemic encompasses the entirety of the United States. The Centers for Disease Control and Prevention (CDC) and Johns Hopkins University (JHU) are two organizations monitoring infections and mortality due to COVID-19. Both organizations provide interactive maps on their respective websites that detail infections and deaths. The CDC interactive map provides both state and county-level resolution using data from January 21, 2020 onward, reporting infections and deaths related to COVID-19 in every state, with Maine having the least infections at approximately 5,000 and California at approximately 875,000 infections in October, 2020 (CDC Website

2, 2020). The JHU interactive map (COVID-19 United States Cases by County) also utilized county-level resolution, reports the top fifty counties by confirmed cases, and provides demographics information and perspective of a county's contribution to total state confirmed cases (JHU Website, 2020). The JHU "Cases by County" map agreed with the CDC that each of the fifty states reported cases of COVID-19. However, county-level resolution showed counties that did not report has confirmed cases of COVID-19 infection or mortality. Examples included several Utah counties (ex. Piute, Garfield, Beaver), Esmerelda County (Nevada), Duke County (Massachusetts), and Hoonah-Angoon County (Alaska) (JHU Website, 2020). Additionally, there was no correlation between COVID-free counties with state performance. Utah had the highest number of COVID-free counties but also a higher cumulative confirmed case count than neighboring Idaho, Colorado, and New Mexico (JHU Website, 2020). Additionally, many counties throughout the United States had fewer than fifty confirmed cases since the start of the pandemic. For example, Washington County, Maine, had 21 confirmed cases and zero deaths reported to JHU, with only one case newly reported within the last 14 days as of the date the map was accessed (Oct. 21, 2020) (JHU Website, 2020). Counties and smaller municipalities displaying zero to low confirmed cases may not find their healthcare systems in extremis and may not perceive the pandemic as a crisis. Because of these instances, the pandemic's geographic scope as a crisis may not incorporate every U.S. county. However, confirmed cases have been identified in every state on the orders of thousands to hundred-thousands, so from a state-to-national crisis resolution, the scope of the COVID-19 crisis is considered *nationwide*.

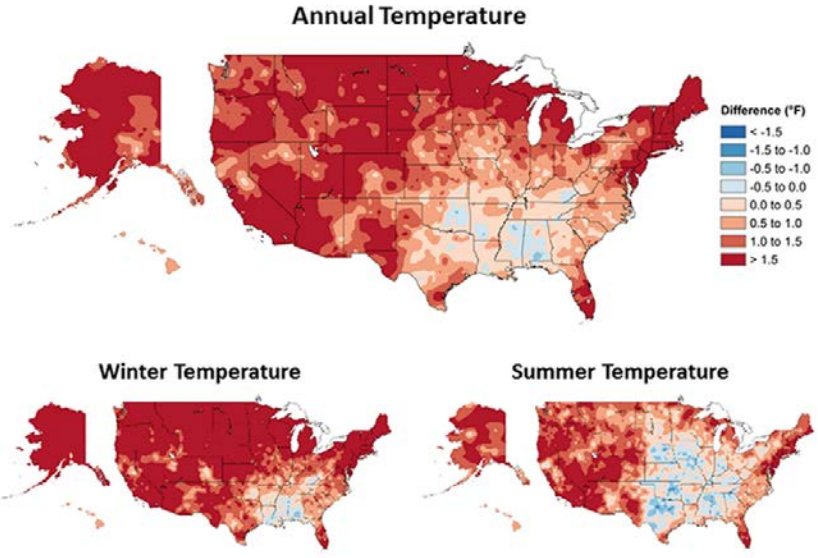

Figure 6. Observed changes in annual, winter, and summer temperature. Changes are measured as the difference between the average temperature from 1986-2016 and the average from 1901-1960 for the continental U.S. (1925-1960 for Alaska and Hawai'i). Image taken from NCA4, Volume 1, Chapter 6 (Vose et al., 2016).

4.1.3. Temporal Scope.

Climate change and COVID-19 operate at significantly different temporal scopes, requiring a clear definition of the extent of climate change to draw a comparison. They are also distinct from each other in that the pandemic may have a distinct limitation, but the effects of climate change will become integrated with what eventually becomes a way of life. The IPCC's AR5 defines climate change commitment as "the future change to which the climate system is committed by virtue of past or current forcings" (Cubasch et al., 2013, pp. 128). Many climate change studies and models view climate change in the timeframe of the ongoing present to the year 2100, such as the Representative Concentration Pathways (RCP) cited in the IPCC's AR5 (IPCC Annex III, 2013). Various drivers of climate change differ in their effective timelines, such as the presence of atmospheric water vapor, the atmospheric half-lives of GHGs, or the rate of air to ocean CO_2 exchange. As the AR5 asserts, even the immediate cessation of GHGs would require centuries for all radiative forcings to return to equilibrium and that global temperatures would remain relatively unaffected by that cessation for centuries

(Cubasch et al., 2013 and Collins et al., 2013). To compare the two crises as events that may be actionable, restricting the temporal scope of climate change requires constraining it to a timescale relevant to the consequences or after-effects of human action. In this case, the timescale for climate change as a crisis should be constrained to the half-lives of anthropogenic GHGs since humanity has direct control over their production and emission, despite understanding the long-term effects of climate change will continue. This evaluation could be performed based on the atmospheric lifetime of the most long-lived GHG, the most abundant, or the weighted average of all GHGs. The atmospheric lifetime of CO_2 is chosen because it is the most abundant GHG based on annual emissions. Specifically, CO_2 is emitted at an annual rate three orders of magnitude greater than the next most abundant GHGs, methane and nitrous oxide, and six orders of magnitude greater than other GHGs of concern, such as fluorinated halogens (EPA, 2020). Additionally, CO_2 is the central GHG of most climate change studies policies, and other GHG emissions are often measured in million metric tons of CO_2 equivalent, highlighting the gas's relevance as a functional unit of climate change. However, CO_2 has a complex atmospheric lifetime due to its marine, terrestrial, and biosphere interactions, making it more complicated than methane, with an established 9 to 10-year lifetime estimate (Bruhwiler et al., 2018, Collins et al. 2013). Archer et al. (2009) determined that the mean lifetime of fossil-fuel derived CO_2 was in the range of 12,000 to 14,000 years, under an assumption that 10% remained to be taken up through terrestrial interactions (Archer et al. 2009). Unfortunately, use of this timescale limits understanding climate change as a crisis in the perspective of human civilization. For consistency then, the assumptions used in the IPCC discussions of Global Warming Potential (GWP) and Global Temperature change Potential (GTP) will be used, making the effective climate change temporal scope 100 years (Stocker et al., 2013). It's acknowledged that a 100-year timeframe ignores the many long-term implications of climate change, but the benefits of relatability to GWP and GTP and to a timeframe reconcilable with human historical terms makes it a more useful measure. Thus, the temporal scope of climate change is *100 years from origin cessation*.

The temporal scope of the COVID-19 pandemic, on the other hand, is much easier to define and to understand. Current experience with the pandemic is less than one year, and as of the writing of this paper has not abated. At present, the United States is seeing a second wave of confirmed infections, which was suggested as likely to occur (Maragakis, 2020). Like climate change, the impacts of the pandemic are expected to have varying recovery times. For example, the periods of time for national unemployment to return to pre-pandemic levels and for GDP to return to expected growth may be different. To make an understandable comparison, the pandemic's temporal scope is treated similarly to climate change, where a case infection is the functional unit of the pandemic. The temporal scope of climate change was taken in perspective of a complete cessation of emission. The parallel to this for COVID-19 is a complete cessation of transmission by an ideal state where all potentially and confirmed infected persons were properly isolated and treated. The average COVID-19 incubation period is approximately 5 days with 97.5% of symptomatic patients displaying those symptoms within 11.5 days, which aligns with CDC guidance of a fourteen-day quarantine (Lauer et al., 2020). However, the median time that the virus is detectable in survivors after becoming symptomatic is typically about 20 days, although up to 37 days has been observed (Matricardi et al., 2020). Pandemic propagation is considered here to be a function of the period from a person’s infection until the end of the virus’s lifecycle in the host. If all potentially infected persons were isolated for the cumulative 14-day quarantine period plus maximum expected time for viral detectability, the conservatively estimated temporal scope for the pandemic is an approximate 60 days, or two months. Thus, the temporal scope of climate change is *two months from original cessation*.

4.1.4. Scope of Affected Populations.

Due to the nationwide geographical scope, all populations of the United States will be impacted by climate change. Using USGCRP's *Climate and Health Assessment* definition of vulnerability, a population's vulnerability to climate change is related to its exposure to the risks of climate change, its sensitivity to those risks, and ability to respond or cope with climate change (Gamble et al. 2016). Depending on a population's location, the strength of local adaptation efforts, and the potential for adaptive resilience, climate change risks can vary. The USGCRP lists the following as vulnerable populations: low income, communities of color, immigrants, Indigenous peoples, children, the elderly, pregnant women, those with medical conditions, the disabled, and those working in occupations more likely to expose them to risk (Gamble et al., 2016). Additional populations vulnerable to combined climate and non-climate stressors include those living in geographically at-risk regions, such as floodplains, coastlines, and isolated rural areas (Gamble et al., 2016). The scope of populations is not just a function of those impacted by weather events or changes in subsistence due to climate change effects on agriculture and local biota. Climate change has a health aspect to it as well. According to the NCA4, populations at greater health risk include children, elderly, low-income populations, and some communities of color (Ebi et al., 2018). The populations of most concern then are the most vulnerable to multiple effects of climate change, i.e., children, the elderly, low-income populations, and communities of color. The following are examples of the risks faced by these populations:

a. Rural communities typically exhibit higher poverty levels than urban areas, are less likely to have enforced building codes, limited infrastructure and resources, and a greater economic dependence on local natural resources (Gowda et al. 2018).

b. Residents of New Orleans, Louisiana, are vulnerable since the city is in a geographically at-risk region due to its coastal, low-altitude topography. The 2005 Hurricane Katrina damaged hundreds of thousands of homes, displaced over a million individuals, and resulted in over one thousand deaths (Cannon et al., 2020).

c. Rural, coastal African American communities perceived a limited adaptive capacity for climate change (Jurjonas et al., 2020).

d. Climate change will drive increased death tolls from vector-borne diseases among the elderly (Hernandez-Delgado, 2015).

e. Those with outdoor occupations in urban and rural areas will be at-risk of mortality during periods of extreme heat exacerbated by climate change (IPCC, 2014).

Thus, the scope of affected populations with regard to climate change includes *low income, communities of color, the elderly, children, those with pre-existing medical conditions (to include disabilities and pregnancy), and populations whose livelihoods rely on land at risk to climate change or occupations that increase risk exposure*.

The population scope of the COVID-19 pandemic overlaps with climate change. For this section, the scope is limited to those confirmed cases of the virus and not any derivative effect of policy responding to the virus. The following table summarizes demographic information of infected individuals available from the CDC and was accessed November 1, 2020:

	Hispanic /Latino	Indigenous American	Asian	Black, Non-Hispanic	Hawaiian, other Pacific Islander	White, Non-Hispanic	Male	Female	
Cases	27.1%	1.2%	3.1%	16.4%	0.4%	47.3%	48.1%	51.9%	
Deaths	16%	0.8%	4.6%	20%	0.2%	54.3%	53.8%	46.2%	
	0-4 yrs.	5-17 yrs.	18-29 yrs.	30-39 yrs.	40-49 yrs.	50-64 yrs.	65-74 yrs.	75-84 yrs.	>85 yrs.
Cases	1.7%	7.3%	23.9%	16.5%	15.2%	20.5%	7.6%	4.3%	2.9%
Deaths	<0.1%	<0.1%	0.5%	1.3%	3.1%	15.3%	21%	26.6%	32.2%

Table 2: Summary of confirmed cases and deaths attributable to COVID-19. Taken from the CDC's website "Demographic Trends of COVID-19 cases and deaths in the US reported to CDC", accessed November 1, 2020 (CDC Website 3, 2020).

	Hispanic /Latino (Not as only race)	Indigenous American alone	Asian alone	Black, Non-Hispanic	Hawaiian, other Pacific Islander alone	White, Non-Hispanic	Other race alone	Two or more races
% U.S. Population	18.4	0.9	5.7	12.8	0.2	72.0	5.0	3.4
	Under 5 years old	>18 years old	>65 years old	Median Age (years)				
% U.S. Population	5.9	77.8	16.5	38.5				

Table 3: Demographic statistics for the United States. Information taken from The United States Census Bureau (U.S. Census Bureau, 2019).

Hispanic/Latino and Non-Hispanic Whites were the two predominant groups of confirmed cases for all age groups younger than 65 to 74 years. Only the 0 to 4-year age group of Hispanic/Latinos has the highest proportion of confirmed cases (39.7% compared to 31.7% Non-Hispanic White) (CDC Website 3, Demographics, 2020). In every subsequent age group, Non-Hispanic Whites were the majority of confirmed cases. In the 65 to 74-year age group, Non-Hispanic Whites comprised 58.1% of confirmed cases, with Non-Hispanic Blacks the second largest group at 17.7% and Hispanic/Latino at 15.6% (CDC Website 3, Demographics, 2020). The trend of confirmed cases skewed toward Non-Hispanic Whites being the majority group, with 64.7% of cases in the 75 to 84-year age group and 72.6% of the greater than 85-year group (CDC Website 3, Demographics, 2020). The percentage of confirmed infected individuals in ages older than the 50-64 age group lowers dramatically, but the percentage of deaths greatly increases (Table 2). Hispanics/Latinos and Non-Hispanic Blacks comprised a greater proportion of confirmed cases than their proportion of the U.S. total population (Table 3). The Non-Hispanic Whites proportion of total cases is less than their proportion of the total population for all age groups except for those 75 years and older (CDC Website 3, Demographics, 2020). Supporting the CDC, a study of ethnic disparities in the burden of COVID-19, focusing on U.S. veterans as the study group, determined Hispanics and Blacks were more likely to test positive than Whites (Rentsch et al., 2020).

The only workplace-related statistics reported by the CDC involved healthcare, of which there were 201,037 confirmed cases among 1,602,298 healthcare professionals (updated November 1, 2020), or about 12.5% (CDC Website 3, Healthcare Personnel, 2020). Regarding urban and rural populations, urban areas (defined as large central and fringe metro, medium metro, small metro, and micropolitan) averaged the most new cases per 100,000 people from April through September, while rural areas superseded urban areas starting in October (CDC Website 3, Trends by Population Factors, 2020). Comparing counties with low poverty rates (0-12.3% of population) versus high poverty rates (>17.3% of population), high poverty counties had higher seven-day average confirmed cases per 100,000 than low income counties (CDC Website 3, Percentage of County in Poverty, 2020). Compounding negative effects, low income persons lacking health insurance may lack the same care as those who can afford to do so. The pandemic's scope of affected populations includes all nationalities in urban and rural communities, with the following being especially vulnerable: *low income, communities of color, adults, the elderly, and those with pre-existing medical conditions*.

4.1.5. Environmental Scope.

The environmental scope of climate change extends to all terrestrial and aquatic environments contained within the borders of the United States. The AR4 includes the following examples of climate change's all-environment reach: observed increases in ocean surface temperature, ocean acidification along American coastlines, reduced snow pack in the Western U.S., reduced Arctic sea ice and thawing Alaskan permafrost (Hayhoe et al., 2018). Flora, such as those in forests, which provide sustenance and habitats for many animal species are undergoing changes, including changes in seasonal leaf production and flowering, elevation shifts in plant species, and some evidence suggesting northern migration of some boreal tree species (Vose et al., 2018). In the Midwest, there is evidence that forest understory plant species have migrated approximately thirty miles northwest between the 1950s and 2000s (Angel et al., 2018). In addition to the marine impacts mentioned in the introduction, regional warming has been attributed to lengthier temperature stratification periods in Lake Superior, affecting oxygen and nutrient availability which could lead to aquatic population declines (Angel et al., 2018). In the Great Plains, depreciations in snowpack have led to reduced stream flows, higher stream temperatures, and have negatively affected riparian ecosystems (Conant et al., 2018). Given the evidence of climate change affecting various environments across the United States, the environmental scope for climate change is *nationwide*, or *all environments*.

Since the COVID-19 pandemic is driven by a virus, SARS-CoV-2, it does not directly impact the physical environment. However, the pandemic has had the indirect environmental effect of improved air quality in urban areas. For example, reductions of nitrous oxide (NO_2) and particulate matter ($PM_{2.5}$) and corresponding increases in ozone were attributed to lockdown measures in Europe, the United Kingdom, and Wuhan, China (Ching and Kajino, 2020). In contrast, a preliminary study indicated that air quality in the United States with regards to $PM_{2.5}$ and ozone did not significantly improve due to post-COVID restrictions, although there was a significant reduction in NO_2 (Bekbulat et al., 2020). An additional indirect effect was a reduction in CO_2 emissions relative to 2019 (Ching and Kajino, 2020). Separately, the pandemic's effects on biodiversity are not well understood, although a study of Italian wildlife indicated both native and invasive species benefited from reduced human activity (Manenti et al., 2020). For this comparison, since the indirect effects of climate change were not considered (i.e., ecosystem changes due to agricultural migration), the direct effects of COVID-19 only will be considered. The environmental scope of COVID-19 is *none*.

4.1.6. Reproducibility.

The scope of reproducibility considers whether a specific event or category of events has the potential to be repeated even after specific policies or safeguards to prevent such a reoccurrence are put in place. For example, increased flooding may be a specific event that is just one of many effects due to climate change. Because it causes a variety of detrimental impacts, climate change is considered a category of events. The COVID-19 pandemic is driven by SARS-CoV-2, a specific virus within the category of coronaviruses. For a given crisis, it is assumed that responsible parties will take some action, of any degree of adequacy, to combat that crisis. In this case, the scope of reproducibility for the crises of climate change and COVID-19 is taken in the perspective of whether each crisis, as a category, may reoccur after policies or actions are taken to eliminate the crisis's origin, i.e., to cease GHG emissions and to prevent the transmission of SARS-CoV-19 among individuals.

Since anthropogenic GHG emissions are the source of anthropogenic climate change, if policies were implemented to limit GHG emissions to zero (or to a rate less than what could be removed through technological or terrestrial sinks), then *anthropogenic climate change is not reproducible*. The scope of climate change's reproducibility does not omit any other potential anthropogenic environmental changes not presently considered.

New Zealand demonstrated the COVID-19 pandemic may be ended after the implementation and adherence to stringent lockdown measures isolating infected individuals long enough for the virus to complete its lifecycle without further transmission. However, the SARS-CoV-2 virus is similar to the severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV) (Ding et al., 2020). Variations in the SARS-CoV-2 receptor-binding domain (the "spike" that allows it cellular entry) indicate mutation due to natural selection (Tang et al., 2020). While the specific strain may be rendered non-existent, the potential for mutation allows for reproducibility of another, similar coronavirus outbreak. The measures and policies used in New Zealand, for example, did not prevent initial entry of the virus and were retroactive in nature. A general, worldwide return to international travel and cessation of isolation measures leaves any one country, including the United States, vulnerable to a new viral strain for which there is neither vaccination nor natural immunity. Thus, the *COVID-19 pandemic, within the context of it being a coronavirus pandemic, is reproducible.*

4.2 Impacts

4.2.1. Economic.

There is much research about the global economic impact of climate change, but little research quantifies the effects of climate change on corporations, trade effects, and adaptation benefits (Smith et al., 2018). The progressive effects of climate change are expected to allow economic growth with small, but not negligible, reductions in growth potential. The IPCC's AR5 estimated (medium evidence, high agreement) that non-climatic influences on the economy, such as technology, lifestyle, and regulation, will have a larger relative impact to most economic sectors than climate change (IPCC, 2014). GDP was used as the primary measure of economic impact since it correlates well with other measures of prosperity (UN Human Development Index, education, life expectancy) and is simple to measure (Lomborg, 2020). According to Lomborg, a continued positive increase in global GDP per capita (median 2.03%) over the course of 2010-2100 is expected, which closely matches the projections of the business-as-usual Shared Socioeconomic Pathway, SSP2, which uses a business-as-usual scenario that correlates with the year 2060 U.S. population projected by the U.S. Census (Lomborg, 2020, Avery et al., 2018). Using 2100 as an end date, climate change will reduce the net positive gain in GDP per capita over the 21st century, where an assumed 4.5-fold increase in GDP per capita (under an SSP2 scenario) will be reduced to 4.3-fold increase (Lomborg, 2020). The global net reduction in GDP per capita by 2100 is estimated be in the range of 2.5% for a 3.24°C warming (SSP1) to 5.7% for a 4.86°C warming (SSP5). Consistent in this range of global economic impact, a 1.3% reduction in GDP per capita is expected for a 2.5°C warming, based on the averaged estimate of 11 economic projections (Tol, 2018). Tol estimated that continued growth will occur until approximately 1.1°C, and climate change will not negatively impact growth until a 1.7°C warming (Tol, 2018). The global economic impacts of climate change are expected to reduce positive long-term economic growth.

Economic impacts to the U.S. are consistent with expected global trends. Figure 7, utilizing information from the International Monetary Fund (IMF), shows the following trends in the United

States from 1980 through 2020: GDP per capita, change in real GDP, inflation, unemployment rate, and population (IMF, 2020). Annual real GDP growth since 1980 was positive with notable instances of negative growth (contraction) occurring in the early 1980s, 2009, and 2020. Quarterly reports of real GDP have all been positive between 2016 and 4th quarter 2019, with both 1st and 2nd quarters of 2020 reporting negative percent changes concurrent with the pandemic (Bureau of Economic Analysis (BEA), 2020). A study using county-level information reported inflation-adjusted GDP per capita increased between 1960 and 2009 from $12,322 to $33,431 in 2008 dollars (Preston, 2013). More rapid increases in the rural Southeast and the Dakotas and slower increases on the West Coast and the “Rust Belt” and projected GDP per capita growth of $33,431 to $73,011 between 2009 and 2050 (Preston, 2013).

Regions experiencing high rates of economic growth and wealth concentration may be disproportionately vulnerable to the damages of future extreme weather events. Losses from extreme weather events in 2050 may result in GDP per capita losses increasing by a factor of 1.8 to 3.9 times their 2009 values, even without accounting for climate change (Preston, 2013). For example, if the annualized impact of natural disasters calculated by GDP per capita in 2009 was $12 billion, that cost in 2050 could be some value between $21.6 billion to $46.8 billion (Preston, 2013). Of the five selected natural disasters in this study, hurricanes and tornadoes were the most influential in causing the rate of loss increase to outpace predicted increases in capital (Preston, 2013). Since this study did not evaluate the additive effects of climate change, the financial damages could grow further if natural disasters' frequency or strength increases due to further warming.

Between the first and second decades of the 21st century, the U.S. government spent approximately $300 billion due to extreme weather and fire events, issuing payments due to disaster relief, flood and crop insurance, and fire management (Government Accountability Office (GAO), 2015). Future costs are expected to rise for multiple reasons. For example, a study assessing the effects of extreme weather events on air quality estimated annual costs between $54 billion and $153 billion

(2017$) in the 2046-2055 timeframe caused by combined mortalities from increased ozone and particulate matter (Zhang et al., 2020). In a business-as-usual scenario, water availability reductions due to climate change could lead to annual damages of $1.5 billion for agriculture, $1.9 billion in environmental flow penalties, and $697 million for the hydropower industry, with all potential consequences totaling approximately $4 billion per year (Henderson et al., 2013). For perspective, the sum of the above costs in 2050 alone could be approximately $200 billion per year based on the socioeconomic costs of extreme weather events and air quality changes alone, equivalent to approximately 1% of present day GDP (0.94% of $21.16 trillion 3rd QTR 2020) (BEA, 2020). These costs would be representatively smaller in proportion based on continued, positive economic growth, but these examples are not comprehensive for all possible costs of climate change. Separately, as shown in Figure 7, unemployment rates did not show a progressive increase over recent decades commensurate with climate change. Instead, peaks in unemployment follow the housing market crash of 2008 and lockdown measures due to COVID-19. The economic impact of climate change can be summarized as having *a repressive effect on, but not inhibiting, continued positive economic growth in the temporal scope of the next 100 years*.

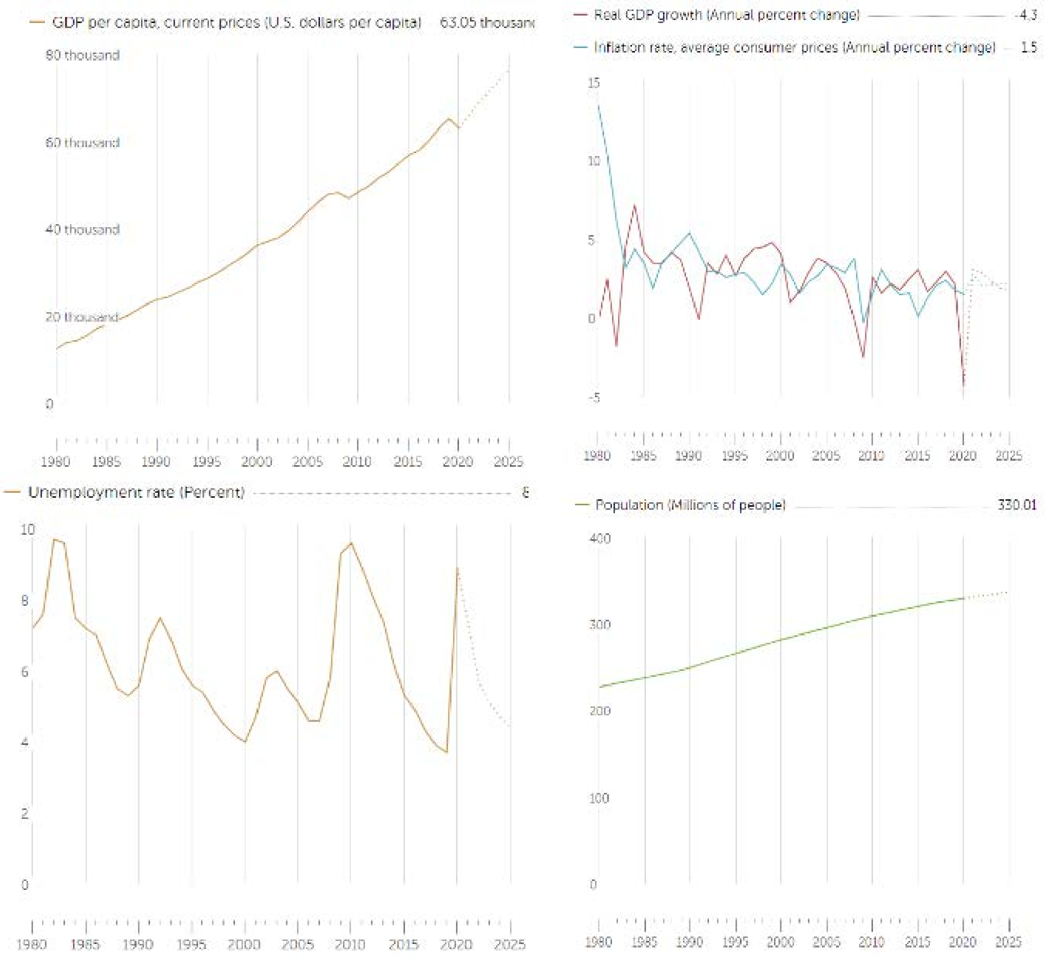

Figure 7. U.S. economic indicators from 1980 to 2020, with projections through 2025. Information accessed from https://www.imf.org/en/Countries/USA#, selecting for following indicators – Top left: GDP per capita, current prices. Top right: Default displayed graph, displaying Real GDP growth and inflation rate, average consumer prices. Bottom left: People – Unemployment rate. Bottom right: People – Population. (IMF, 2020).

The COVID-19 pandemic had a more acute impact on the economy. As discussed above, real GDP grew from 2016 through the 4th quarter of 2019, after which the real GDP change in 1st quarter 2020 (compared to 4th quarter 2019) was -5% and lowered further to a -31.7% change in the 2nd quarter (Figure 8) (BEA, 2020). The cause of the steep depreciation was not attributed to the direct consequences of infection but instead was a consequence of "stay-at-home" orders, affecting spending and increasing remote work and schooling (BEA, 2020). In USD, the net GDP change from 4th quarter 2019 to 2nd quarter 2020 was $2,227.3 billion, a 10% decrease from the reported 4th quarter GDP of $21,747.4 billion (BEA, 2020). Reductions in personal consumption expenditures contributed the greater losses ($1,661.9 billion), with a $200.9 billion dollar decline in durable and non-durable goods and a $1,461 billion decline in services, most notably household consumption expenditures, transportation services, food services and accommodations, with a gain in housing and utilities (BEA, 2020).

Figure 7 above shows that unemployment increased from approximately 4% in 2019 to 8% in 2020 and real GDP had a net negative change for the first time since the housing market crisis of 2008. However, the BLS reported a peak unemployment of 14.7% in its May 2020 Economic News Release, with that rate falling to 10.2% in July and to 7.9% in September (BLS May, August, and October 2020).

One direct comparison between the pandemic and an extreme weather event comes from Louisiana, where the total unemployment insurance weekly claims due to the pandemic exceeded claims following Hurricane Katrina by the tens of thousands (Habans, 2020). Given the magnitude of the pandemic's economic impacts in the shorter period of time, the pandemic has a *much greater repressive effect on the economy, can inhibit positive growth, and can promote economic contraction* more severely than climate change.

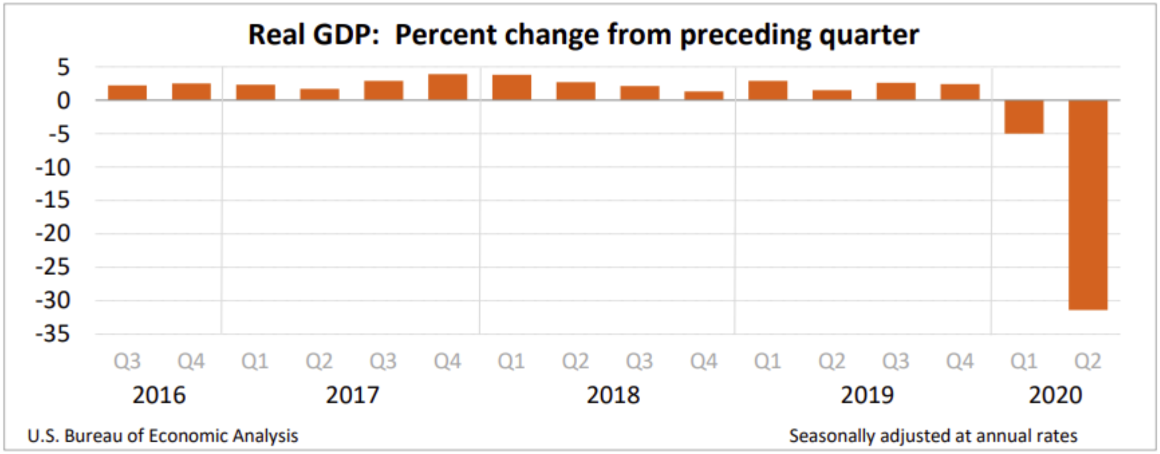

Figure 8. Percent change in real GDP from preceding quarter, third quarter 2016 through second quarter 2020 (BEA, 2020).

4.2.2. Health.

Climate change's influence on health is wide-ranging due to its effects on temperature, air quality, extreme weather events, vector-borne diseases, and mental health. Climate change can change the seasonal survivability rates, geographic ranges, and behavior of disease vectors (ticks, mosquitoes), by affecting food and water quality and availability and affecting mental health (Balbus et al., 2016). Demographics influences the interaction of climate change and health, including a growing population with an increasingly older median age, growing wealth disparities, and growing minority and immigrant populations (Balbut et al., 2016). A summary of climate change influence on health is as follows:

a. ***Temperature***. Heat related illnesses such as heat exhaustion and heat stroke occur due to prolonged exposure to extreme temperatures which can debilitate the body's internal temperature control, and hypothermia may occur during extreme cold temperatures (Sarofim et al., 2016). Between 2006 and 2010, 326,497 cases of heat-related illness hospitalizations were correlated with temperature extremes, and though there is uncertainty how non-fatal illnesses (e.g., respiratory admissions) will change through the 21st century, it is likely that increased hospitalizations will follow the same trends as mortality (Hess, Saha, and Luber, 2014 and Sarofim et al., 2016). Direct attribution studies (i.e., using medical records) indicated an averaged 1,970 deaths per year between 2006-2010 due to extreme weather (1,300 due to cold, 670 due to heat), but statistical studies (extrapolating reported mortality increases with temperature data) reporting 1,300 annual deaths from excess heat (Sarofim et al., 2016). In contrast, increasing adaptation and shifts in human tolerance to extreme heat has led to reductions in potential heat related mortality, which was confirmed for a select cluster of U.S. cities through a separate study using data from 1973 through 2006 (Sarofim et al., 2016 and Schwartz et al., 2015). Further, the effects of climate change depend on the magnitude of future warming, adaptation measures, and location. For example, according to the Schwartz et al., study, cities in historically colder regions will experience a relatively higher mortality rate per degree warming above average than cities in historically warmer regions (Schwartz et al., 2015). Compared to 1990 baseline data, projected increases in mortality from excessive heat will outpace the decreases in mortality from cold temperatures over the 21st century, resulting in an approximate six thousand net increase in mortality in 2050 and nearly 10,000 net increase by 2100 (Schwartz et al., 2015).

b. ***Air Quality***. Air pollution studies suggest that in the context of climate change, particulate matter ($PM_{2.5}$) and ozone will be the primary air pollutants causing health effects (Fann et al., 2016). Regulatory efforts by the EPA have decreased concentrations of both air pollutants since 1990 (EPA, 2019). Ozone concentration lowered from 23% above the present day National Ambient Air Quality Standards (NAAQS) (70 ppb, 8-hr exposure) to -1% below present NAAQS from 1990 to 2018, and $PM_{2.5}$ lowered from -1% to -34% below NAAQS (12.0 $\mu g/m^3$ annual average) from 2000 to 2018, while overall emissions of the six common air pollutants lowered by 74% since 1970 (EPA, 2019). In this context, long-term exposure of an increased 10 $\mu g/m^3$ concentration $PM_{2.5}$ resulted in increased mortality due to cardiopulmonary, cardiovascular, pneumonia, and lung cancer, with an all-cause hazard ratio of 1.12, and it was estimated that increased $PM_{2.5}$ concentrations, as would be expected due to climate change, would yield higher hazard ratios (Pope III et al., 2019). Exposure to lesser concentrations (i.e., >2.8 $\mu g/m^3$) was attributable to approximately 30,000 deaths associated with cardiorespiratory disease in 2015 when controlled for other mortality-influencing factors, which is lower than mortality rates in 1999 (income, race, education, smoking, mean temperature and humidity), and increased mortality was associated with rates less than that of EPA NAAQS (Bennett et al., 2019 and Schwartz et al., 2018). Long-term exposure to $PM_{2.5}$ was also associated with increased mortality from diabetes (HR of 1.19), while ozone had no effect (Lim et al., 2018). Increased ozone of 10 $\mu g/m^3$ was associated with increased mortality, with some studies suggesting a one day increase of 10 ppb may increase mortality anywhere between 0.78% to 1.28%, and increased incidents of asthma (Orellano et al., 2020, Goldberg, 2005, and Nassikas et al., 2020).

Ozone concentrations are expected to increase in the U.S. due to increased temperatures if ozone precursors are not abated, and increased temperatures exacerbate the health consequences of air pollution (Fann et al., 2016). By 2050, climate change is expected to increase $PM_{2.5}$ in the form of organic carbon and carbon aerosols due to increased wildfire frequency and duration and drought (Fann et al., 2016). Nassikas et al., determined in a business-as-usual, RCP 8.5 future, expected hospitalizations due to ozone-related asthma illness could increase by 3,100 annual visits between 2045-2055, while by 2030, Fann et al., estimated climate change may result in increased illness and premature deaths in the range of tens to thousands (Nassikas et al., 2020 and Fann et al., 2016).

c. ***Extreme Weather Events.*** Extreme weather events cause death, injury, and illness due to their hazardous nature and downstream effects of the disruption of essential services such as electricity and water (Bell et al., 2016). Mortality from extreme weather events declined globally over the course of the 20th century due to improvements in infrastructure and adaptation measures (Lomborg, 2020). Between 2004 and 2013, approximately 5,500 fatalities were due to extreme weather events, with over 3,000 of those deaths caused by heat waves, hurricanes, and tornadoes (Bell et al., 2016). Examples include Hurricane Katrina, causing 1,833 casualties and Hurricane Sandy, causing between 117 to 147 deaths, with drowning as a leading cause of death (Pugatch, 2019 and Bell et al., 2016). A cumulative 21,549 flash flood events from October 2006 through 2012 accounted for 224 injury reports and 326 deaths according to the National Weather Service's *Storm Data* database (Špitalar et al., 2014). Thunderstorms were attributed with an averaged 101 lightning-related deaths per year between 1956-2006, 26 wind-related deaths between 1977-2007, and 4,366 injuries between 1993-2003 (Bell et al., 2016). The short to long-term projected impacts of climate change on extreme weather event severity and frequency in the U.S. are uncertain as is the interaction of those changes, although it is expected that tropical storm intensity will increase due to warming (Kossin et al., 2017). Globally, tropical cyclone frequency is likely to lower or be unchanged and likely that mean maximum and precipitation will increase with regional uncertainties, but *extratropical* cyclones are very likely to result in more winter precipitation toward the end of the 21st century (Christensen et al., 2013). Wildfire hazards are not isolated to direct damages and air pollution but may also contaminate drinking water sources and affect flooding frequency due to post-fire erosion and runoff (Bell et al., 2016).

d. ***Vector-borne Disease***. There are 14 vector-borne diseases of concern in the United States, most of which are spread primarily by ticks and mosquitos (Beard et al., 2016). How climate change will interact with natural transmission cycles and the changing social and environmental effects on vectors is uncertain due to the complexity of modeling those dynamics (Beard, et al, 2016).

Lyme disease, spread by blacklegged ticks, is an example of how climate influences disease distribution. Lyme disease cases have increased since infection reporting started in 1991 (Beard et al., 2016). Its geographic distribution has expanded north into regions where historically low temperatures would have reduced tick survivability, and this distribution has been attributed to warming temperatures (Figure 9) (Beard et al., 2016). Similarly, continued tick redistribution is expected due to changes in precipitation since ticks prefer moister climates (Beard et al., 2016). Lyme disease is the most common U.S. vector-borne disease and comprised 36,307 of the total 51,258 reported vector-borne disease cases in 2013 (Beard et al., 2016). Reported vector-borne disease incidents in 2013 were higher than the 2004-2013 median numbers for 12 of the 13 diseases discussed in the USGRCP *Climate and Health Assessment* (Beard et al., 2016). According to the CDC, more than 640,000 illnesses were reported between 2004-2016, increasing steadily over this period such that disease cases in 2018 doubled those in 2004 (Figure 10) (CDC Website 5, 2020 and CDC Website 6, 2020). Table 4 uses 2016-2018 CDC data regarding reported mosquito and tick-borne diseases occurring in the continental United States, Alaska, and Hawai'i. If territories were included, 2016 mosquito-borne disease cases would have quadrupled due to the additional 36,512 cases of Zika (2016 Data, CDC Website 6, n.d.).

Year	Mosquito-borne	Tick-borne	Plague	Total	Lyme Disease (Case example)
2016	10,550	48,610	4	59,164	36,429
2017	6,072	59,349	5	65,426	42,743
2018	5,462	47,743	1	53,206	33,666

Table 4. Reported incidents of cumulative mosquito-borne, tick-borne, plague, and Lyme disease as reported to the CDC (2016 Data, 2017 Data, and 2018 Data, CDC Website 6, n.d.).

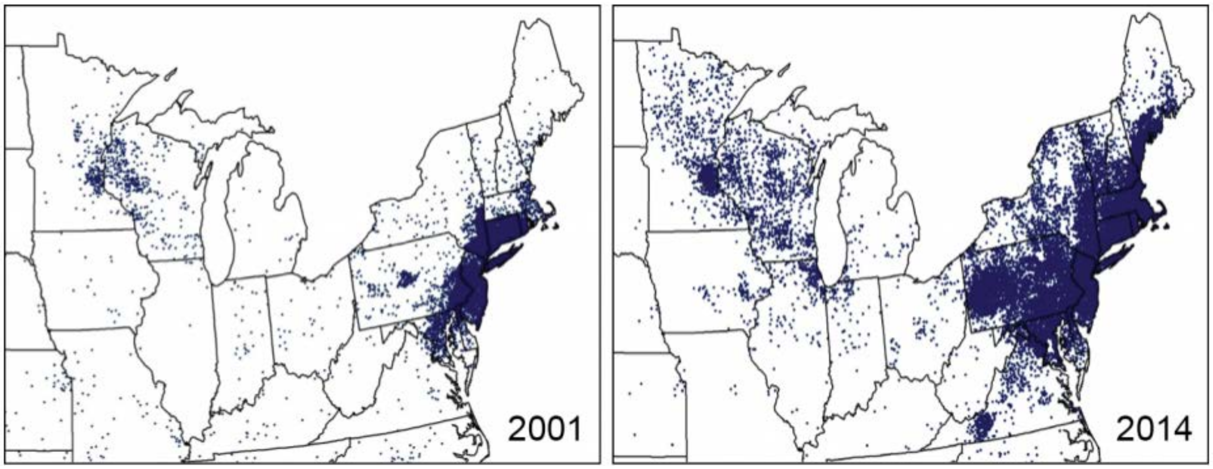

Figure 9. Left, cases of Lyme disease reported in 2001. Right, cases of Lyme disease reported in 2014. Image retrieved from USGCRP Climate and Health Assessment, Chapter 5 (Beard et al., 2016).

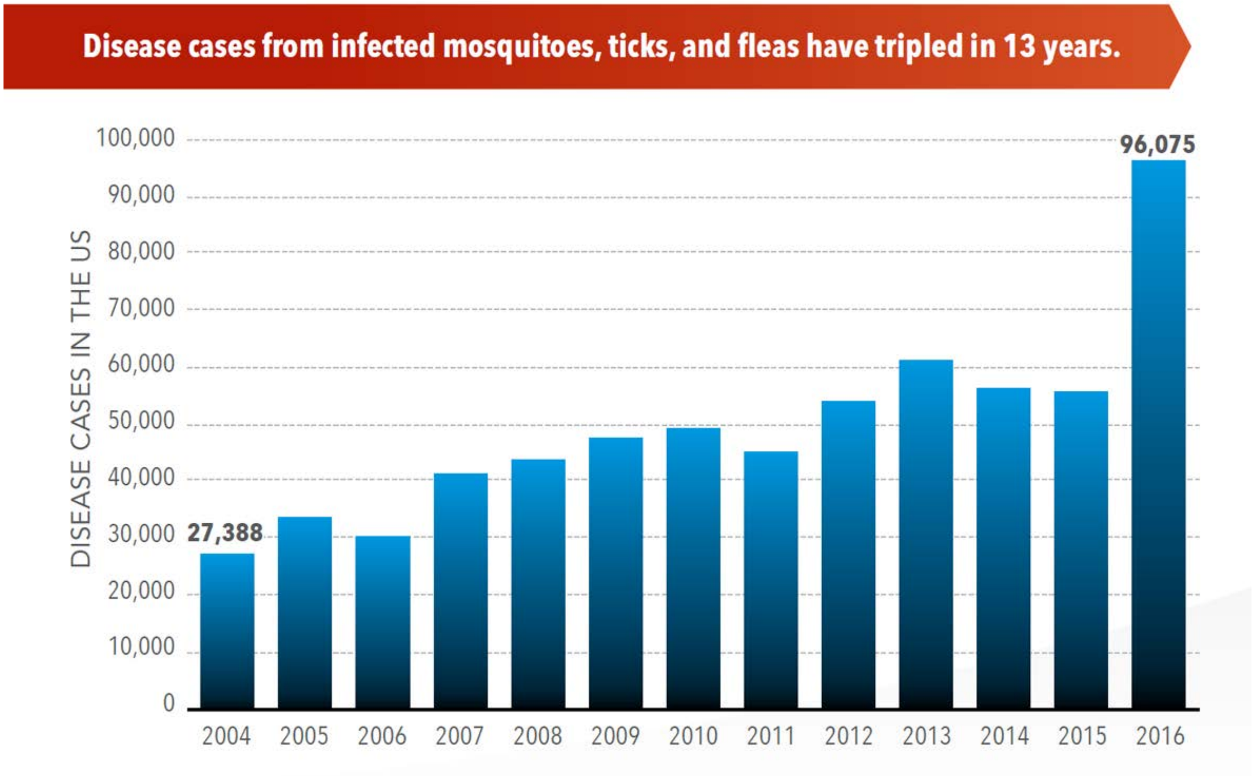

Figure 10. Graph of cumulative vector-borne diseases from 2004 through 2016 as reported to the CDC. (CDC Website 5, 2020)

e. ***Mental Health***. Mental health impacts of climate change vary and may be caused by past experiences with extreme weather events or the implicit knowledge and growing attention placed on climate change (Dodgen et al., 2016 and Clayton, 2020). Increased heat has been associated with increased suicide rates, mental health hospitalizations, aggression, and increased air pollution associated with behavioral and cognitive issues, both of which are expected to worsen in the future due to climate change (Clayton, 2020). Pre-existing mental health conditions are associated with an increased risk of death during heatwaves (Dodgen et al., 2016). Exposure to extreme weather events or natural disasters has led to increased rates of suicidal ideation and post-traumatic stress disorder, and in areas prone to disasters, such as the Gulf coast region, the negative mental health effects may be cumulative (Dodgen, et al, 2016). For example, suicides among women displaced by Hurricanes Katrina and Rita were 14.7 times the national average, and following Hurricane Andrew, homicide rates in Miami-Dade exceeded the previous five-year average (Dodgen, et al, 2016).

“Climate anxiety” refers to anxiety linked with the perception of climate change (Clayton, 2020). Citing Yale Program on Climate Change Communication 2018 surveys, Clayton wrote that 29% of Americans were “’very worried’” about climate change, almost half believed it will harm them, and half answered that it was a “’somewhat or significant source of stress’” (Clayton, pp.3, 2020). In contrast, a separate 2010 Yale survey showed that only 16% of respondents were “very worried” about climate change, but a November 2019 survey reported that 30% were “very worried”, consistent with the previous year’s responses (Leiserowitz et al., 2010 and Leiserowitz et al., 2019).

Demographically, children and women are at higher risk for negative health effects associated with natural disasters, extreme weather events, and climate anxiety (Dodgen et al., 2016, and Clayton, 2020). Additionally, individuals with pre-existing mental health conditions will be prone to the exacerbating effects of climate change, and those who have increased exposure or reduced capability to find and seek treatment are also at higher risk (i.e., first responders, elderly, homeless, low-income) (Dodgen et al., 2016).

To summarize the health impacts of climate change*, instances of illness, hospitalization, and deaths are expected to steadily increase over the course of this century, where annual deaths attributable to climate change may range in the thousands. Still, beyond the temporal scope, the accumulated deaths are inestimable in the confines of this paper. They may become socially perceived as normal as the experiential baseline shifts to higher mortality rates, short of novel adaptation measures*.

The physical health impacts of COVID-19 can be bounded by the disease symptoms and effects on the body to include mortality. The higher frequency symptoms of COVID-19 identified in the United States include fever, cough, shortness of breath, fatigue, and headaches (CDC Website 4, 2020 and Aggarwal et al., 2020). Using CDC data from January through May 2020, one study identified that 22% of reported cases had underlying health issues, such as cardiovascular disease, diabetes, and lung disease, and that frequency of death among those with underlying health issues was approximately 12 times greater than those without (Stokes et al., 2020). The most severe, survivable outcomes of the disease included respiratory distresses requiring mechanical ventilation, acute renal failure, and pneumonia (Aggarwal et al., 2020). Ultimately, the most severe physical health impact of COVID-19 is death. As stated previously, of the several million Americans infected by COVID-19 as of the writing of this paper, approximately 200,000 deaths were attributable to this virus (Johnson, 2020). Deaths associated with COVID-19 were exacerbated by the presence of air pollution. Nitrogen dioxide (NO_2) was associated with increased mortality and may have contributed to 14,000 of U.S. pandemic-related deaths through mid-July (Liang et al., 2020). A concurrent reduction of NO_2 (25.5%, 4.8 ppb absolute decrease compared to historical data) between March and April 2020 may have mitigated additional deaths (Berman and Ebisu, 2020). $PM_{2.5}$ exposure was also associated with elevated rates of COVID-19 mortality (Wu et al., 2020). In areas that closed non-essential businesses early in the pandemic, decreases in $PM_{2.5}$ (11.3%, 0.7 $\mu g/m^3$ absolute decrease compared to historical data) were also measured between March and April 2020, which may have led to a reduction in both COVID-19 and non-COVID related respiratory illnesses (Berman and Ebisu, 2020).

The pandemic is also responsible for afflicting a growing population with mental health issues due to the psychological traumas of unemployment and deaths, similar to the mental health consequence of climate change (Lee et al., 2020). New mental health terminology such as “COVID stress syndrome” and “coronaphobia” have been developed to encompass the changes in rates of depression and anxiety due to the pandemic (Lee et al., 2020). As an indicator, anti-anxiety medication demand increased substantially between February and March 2020 (Lee et al., 2020). A five factor "COVID Stress Scale" was developed to measure the mental health effects of COVID-19, measuring fear of danger from the virus, socioeconomic worries, xenophobia associated with viral spread, and traumatic stress syndromes (Taylor et al., April 2020). A study using the COVID Stress Scale confirmed the strong association of coronaphobia with depression, anxiety, and suicidal ideation and identified that the number of people feeling negative emotional effects from the pandemic exceeded the number of those actually infected (Taylor, et al, June 2020 and Lee et al., 2020). However, research in this area is nascent, and the papers cited here state that further studies are required to confirm and further develop this field (Taylor, et al, 2020 and Lee et al., 2020). In summary, the physical health impacts of the pandemic are less varied than those of climate change, but the number of illnesses, hospitalizations, and deaths due to the virus over the course of one year were much more significant than those attributable to climate change over the same period. Confined to the pandemic event, *the health impacts were more severe per unit time, as evidenced by the greater number of deaths in one year than those due to climate change and, thus, more impactful*.

4.2.3. Political.

Political ramifications of climate change are caused by the indirect exacerbations of underlying issues previously threatening political stability. Globally, increased warming limits the likelihood of achieving United Nations' Sustainable Development Goals, prolonging poverty, inequality, and food insecurity, which could lead to further conflict (Roy et al., 2018 and Smith et al., 2018). According to a 2007 national security report, climate change was projected to threaten U.S. national security, act as a destabilizing threat multiplier in vulnerable regions of the world, and even threaten stability in less vulnerable countries (CNA Corporation, 2007). Climate change could lead to increased migration from southern countries to the U.S., stress U.S. military readiness and operations, and further stress existing Naval forces due to a warming and increasingly traversable Arctic Ocean (CAN Corporation, 2007). In press releases, the United States Navy (USN) has discussed increasing naval presence in the Arctic due to its opening waterways (USN, 2015, 2017, 2019). The Department of Defense (DoD) has been impacted by infrastructure damages, causing further operational impacts and ultimately requiring more funds (Smith et al., 2018). While climate variability contributed to civil destabilization in Egypt, and later cascading Middle Eastern conflicts during the Arab Spring, the U.S. was not shielded from those conflicts and was drawn into continued military and political involvement in the Middle East (Smith et al., 2018). Additionally, climate change has become linked with growing political partisanship in the U.S., with primarily Democrats seeking policies to regulate climate change and Republicans opposed to such policies (Ferreira et al., 2012). Whether the topic of climate change exacerbated political partisanship or is a victim of such partisanship is beyond this paper to analyze, although research has demonstrated an inverse relationship between valuation of environmentalism and conservative principles (Mah et al., 2020). Ultimately, climate change has *impacted the American political structure due to its effects on the physical landscape and international and domestic politics*.

The primary political stressor of the COVID-19 pandemic is the strain between government policies to curb the pandemic and their effects on general welfare. Without pre-existing medical countermeasures such as effective treatments and vaccines, governments worldwide were required to pursue non-medical interventions to limit the spread of the disease (Sabat et al., 2020). The International Crisis Group (ICG) states on its website that COVID-19 could cause “damage in fragile states, trigger unrest and undermine international crisis management systems” and has already disrupted peace and humanitarian operations (ICG, “The Covid-19 Pandemic and Deadly Conflict”, 2020). To date, there are no known conflicts among any sovereign militaries, state-sponsored organizations, or other armed organizations that are either directly or indirectly attributed to the existence of the pandemic, although pre-existing conflicts have complicated control of the pandemic (Gordon and Carrot, 2020). In the U.S., government efficacy in controlling the pandemic was speculated as having an influence on the upcoming presidential election (Miller, 2020). An April 2020, Pew Research Center (PRC) survey found that 75% of surveyed 18-49 years old and 55% of those 50 years and older believed the President was too slow to act on the pandemic (PRC, April 2020). Like climate change, the perception of COVID-19 has either exacerbated, or been exacerbated by, political partisanship. In a series of PRC surveys from March through July 2020, the percentage of respondents believing the pandemic to be a major threat increased from 59% to 85% for Democrat or Democrat-leaning respondents and 33% to 46% for Republican or Republican-leaning respondents, and Democrats were more likely than Republicans to be concerned with infection (Tyson, 2020). Non-medical policies meant to constrain the pandemic in the U.S. have fomented public dissatisfaction, such as the required use of masks being viewed as oppressive (Van Kessel and Quinn, 2020). The most severe, and isolated, indication of political instability due to COVID-19 was an attempted kidnapping of the Governor of Michigan, which was partially motivated by lockdown measures instituted to slow the pandemic (Quinn, 2020 and Carrega et al., 2020). Two U.S.-internationally political effects included the U.S. funding withdrawal from the WHO and deteriorating relations with China (Samuels, 2020, Myre, 2020, and Nye, Jr., 2020). The pandemic then has *impacted the American political structure through the inserted stress of non-medical lockdown measures on a pre-existing domestic political divide and a deterioration in international relations*.

4.3 Responses

4.3.1. Policy.

Policy responses meant to curb climate change in the United States have been limited to subnational scales. Environmental legislation passed with the explicit purpose of protecting or preserving certain aspects of the U.S. natural environment and not originating from an intent to address climate change, such as the CAA, is not considered a policy response. Although such legislation has been used as legal authority to take mitigative action against climate change, the primary and most controversial example is the EPA regulation of carbon emissions via the CAA (Ferreira et al., 2012). Recent attempts at Federal law designed to limit carbon emissions have not resulted in passed legislation. As discussed previously, ACES was the furthest a domestic national policy proceeded through Congress, having been passed by the House of Representatives but was never voted on by the Senate (Congress, 2010). Similarly, the Green New Deal proposed by House Democrats has yet to be voted on despite it being effectively a non-binding pledge of actions rather than actionable legislation as was ACES (Congress, 2020). As mentioned in section 3.1 of this paper, the EPA announced the CPP in August 2015, which was a federal rule focusing on climate change mitigation by reducing GHG emissions from power generating stations and was projected to offer $20 billion in climate benefits and between $14-$34 billion in health benefits through avoided costs (EPA, 2017). The principal nature of the CPP was evident in its Executive Summary, stating that the rule would be “the foundation for longer term GHG emission reduction strategies necessary to address climate change,” and “confirms the international leadership of the U.S. in the global effort to address climate change (Carbon Pollution Emission Guidelines, 2015, 64663). In contrast, the Affordable Clean Energy mentions climate change only twice, as a footnote and in a statement that the regulatory impact assessment utilized in the rulemaking took into consideration the anticipated, “direct impacts of climate change” (Repeal of the Clean Power Plan, 2019, 32562). Despite climate change nearly disappearing between the two rules, the Affordable Clean Energy rule should still create a reduction in annual GHG emissions, but this rule has also met legal challenges and has not yet been formalized in the Code of Federal Regulations as an executable, national policy (Shouse, Ramseur, Tsang, 2020). Sub-nationally, climate change policy responses have been driven by state governments, regional cooperation, and nonprofit organizations, which have waged effective campaigns to enact climate legislation, such as in California (Hall and Taplin, 2009).

Municipality and state-level initiatives are believed to be important precursors to federal involvement and may signal decreasing resistance to climate change policy (Hall and Taplin, 2009). Hamstringing effective national response is uncertainty of what type of policy (i.e., carbon tax vs. cap-and-trade, methods of clean energy deployment), whether a policy is required (i.e., climate denialism, faith in market forces), whether it should be the federal government to make policy (Federalism and states' rights), and whether any policy would negatively impact U.S. economic performance (Peace and Juliani, 2009, Jenkins, 2014, Knuth, 2018). Political partisanship may have also stymied introduction of national legislation. For example, implementation of Democrat President Clinton's Climate Change Action Plan was limited through appropriations with a Republican Congress (Peterson, 2004 and Ferreira et al., 2012).

International involvement with United Nation efforts consisted of cooperative development and participation in the Kyoto Protocol to the UNFCCC, although the U.S. Senate did not ratify the agreement as a treaty, and more recent entry and subsequent withdrawal from the Paris Agreement (Peterson, 2004 and Cooper, 2020). However, opposition to climate change mitigation efforts has been facilitated by fossil fuel and other industrial lobbyist groups (Vesa et al., 2020). Policy responses to climate change should be expected to mirror the public perception towards the crisis in a representative democracy. Creation of a national policy may be complicated since perceived changes in the local environment does not always correlate with a belief in climate change (Cornell et al., 2019). Despite this, 22 states have climate action plans in effect, including nearly all Atlantic coastal states, Georgia excluded, the Great Lakes region, the Southwest, and West Coast (Center for Climate and Energy Solutions, 2020). From a policy response standpoint, *no substantive national policy has been set since the establishment of the UNFCCC, but state strategies have grown over the 21st century to include nearly half of the United States.*

Policy responses to COVID-19 have been implemented by at all levels of government. A national public health emergency was issued February 3, 2020, and by the following March 27th, the CARES Act was passed to provide economic relief exceeding $2 trillion (U.S. Department of the Treasury (DoT), 2020). The CARES Act provided direct funds to individuals through tax identification, a Paycheck Protection Program for small businesses, and assistance for state, local, and tribal governments (DoT, 2020). In contrast to the 22 states with climate action plans in effect, 42 states issued some combination of lockdown or stay-at-home orders to stop the initial spread of the pandemic, and of the seven that did not, some municipalities implemented lockdowns (Secon, 2020). Continued lockdowns could expect opposition as they and stay-at-home orders are perceived as infringements on Constitutional rights (Olson, 2020). Other non-medical federal measures were implemented to combat the pandemic. In one example, the Department of Health and Human Services (HHS), DoD, and Pfizer, Inc. entered a government-corporate agreement, dubbed Operation Warp Speed, to produce 100 million doses of a COVID-19 vaccine and granted the U.S. the rights to acquire an additional 500 million doses (HHS Press, 2020). Separately, the Defense Protection Act was utilized to boost production of, and facilitate access to, N95 masks, which have been recommended as effective in blocking viral particulate (Soucheray, 2020). Policy responses to COVID-19 involved both the *implementation of substantive national policies, the use of existing legislation, and meaningful action among the >80% majority of U.S. states*.

4.3.2. Spending.

Spending on both climate change and COVID-19 mitigation depends on the policies executed. As mentioned, no substantive, national policy has been drafted with the explicit purpose of combatting climate change, although costs associated with enforcement of the CAA and DoE grants for clean energy sources, such as the $125.5 million allocated for solar research by the Office of Energy Efficiency and Renewable Research, may be considered as indirectly supporting climate change mitigation (DoE, 2020). An accurate accounting of how much all levels of U.S. government have spent on climate change was not found, complicating a total assessment. The GAO reported in 2018 that $154 billion was spent directly on climate change activities since 1993, or roughly $5.7 billion per year from 1993 to 2018 (GAO, 2018). This does not account for state and local government spending or spending by private corporations and non-profit organizations. In contrast, the CARES Act alone authorized over $2 trillion in spending in one year, or 13 times the total spent on climate change over 25 years. An accurate assessment of the accumulated state spending related to combatting the pandemic is not presently known, similar to climate change. A direct comparison of the known federal spending would show that COVID-19 related spending greatly exceeded that spent on climate change, consistent with policy enactment, but the large, identified unknowns prohibit a useful comparison.

4.3.3. Monitoring and Information Collection.

The systems used to monitor and track the progressive stages of climate change are many, robust, and incorporate government-sponsored agencies such as the National Oceanic and Atmospheric Administration (NOAA), the National Aeronautics and Space Administration. For example, NOAA monitors sea level through its Global Sea Level Observing System, satellite monitoring, and buoys (NOAA, 2017, 2019). Additional monitoring and reporting resources include the USGCRP, responsible for publishing the National Climate Assessments, *The Climate Science Special Report*, and *Climate and Health Assessment*. In addition, non-governmental entities also monitor and report relevant information, including the Center for Climate and Energy Solutions and the Climate Action Tracker (CAT), which monitors world governments' adherence to the Paris Agreement (CAT, 2020). This does not include the breadth of research information accumulated over the last thirty years by researchers from the nation's different academic institutions and scientific organizations. Thus, the collection and reporting of information related to climate change is *robust due to the utilization of multiple, independent, and redundant monitoring capabilities by multiple organizations*.

Monitoring and tracking of COVID-19 matured quickly over the course of the year, from a state of non-existence to highly detailed programs such as those operated by JHU and the CDC. The Nationally

Notifiable Conditions List, established to ensure rapid tracking and communication of infectious diseases and utilized by approximately three thousand subnational public health departments, added COVID-19 in April 2020 (CDC Website 8, 2020). However, redundant, secondary sources of information relay data provided by a much smaller subset of originating agencies. For example, CNN's own COVID-19 tracking map relies on JHU for source information, and the website "covidusa.net" uses both JHU and the CDC for source data (Hernandez et al., 2020, covidUSA.net, 2020). Because of this, the American public has easy accessibility to information but is reliant on a few primary sources for accuracy. For COVID-19, the collection and reporting of information is *growing, reliant on a handful of primary data sources, lacking in the same redundancy inherent in monitoring climate change*.

5. Conclusion

Climate change and COVID-19 are distinct crises. However, as this paper demonstrates, both of these major crises affect all of the United States. As identified with reference to the scope and impacts, the crises overlap in terms of affected populations, health impacts, and economic impacts. Further studies are required to properly address the cumulative interaction of the two crises as the pandemic occurs in tandem with climate change. Two major distinctions between the two will challenge analyses of cumulative impacts. First, the magnitude of their impacts per unit time (i.e., per year) and how well their beginning and end may be defined. While the economic and physical health impacts of COVID-19 far exceeded their climate change parallels, the continued impacts of climate change throughout the future of the United States could allow for an accumulated dwarfing of the impacts of COVID-19. Second, there are significant differences in their temporal characteristics. One example includes the time delay between an additional "unit of crisis" (i.e., infection or one-ton emission of CO_2) and the effect that unit may have. Whereas COVID-19 takes effect within weeks of transmission, carbon emissions will affect humanity decades later. A second example is the U.S. experience of climate change, which is that of a steady progression along an expected trajectory, in contrast to the pandemic's rapid progression, stagnation, decline, and resurgence.

While this paper canvassed both crises for a comprehensive review, there are both analytical gaps and information that can be considered "hidden" by the metrics used. For example, the use of GDP for economic impacts is a broad metric that does not account for economic disparity among different groups and does not valuate negative consequences of climate change like biodiversity loss, changes in environmental scenery, and the sense of a lost, place-based heritages faced by Native Americans (Jantarasami et al., 2018). This could erroneously lead to a misperception that climate change may not be as damaging as anticipated if impacts are strictly seen through an economic lens. Such misperceptions, or discussion of climate change in the context of COVID-19, could lead to reduced support for combating climate change (Ullrich et al., 2020). Additionally, allocating relevant information in real-time as the pandemic unfolded revealed the knowledge gaps involving COVID-19. However, this paper is the first comprehensive comparison of climate change and the COVID-19 impact, and it may serve as a useful tool for future research regarding U.S. crisis management, understanding the effects of the pandemic, or as a basis to understand additive effects of concurrent crises.

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