Global climate change is a threat to U.S. national security

Emilio Morales, Jr.

University of Texas at El Paso

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Almost every day, news reports from across the United States have announced that current temperatures are at a record high or low from the previous year. The main cause of global climate change is the large amount of carbon dioxide and various other greenhouse gases that have been released into the atmosphere, creating a barrier around the Earth, and responsible for increasing the Earth's average temperature by 1.4 degrees Fahrenheit over the past century. (EPA, 2014). This temperature increase has resulted in floods, droughts, extreme temperatures, and other weather changes that were not present a century ago (Jansen, 2007). In addition to the alarming implications of global climate change for the environment, it may have negative implications for the security of the world's states. This research study is guided by the following question: Does global climate change pose a threat to the United States' national security enterprise?

In a survey conducted in 2014, American citizens rated the economy as an area of greatest concern and climate change as second to last on a list of 15 issues. The survey showed that 51% of Americans had little to no concern about climate change (Riffkin, 2014). The results of this survey of American perceptions of climate change is problematic, considering that climate change affects every citizen, individually, and the country, as a whole. Despite the lack of concern about climate change among American citizens and policymakers, 28 U.S. senators and the Obama administration have begun to recognize its potential negative consequences (White House, 2013).

Threats to national security from global climate change: A framework

This research proposes that global climate change indirectly weakens U.S. national security through its effects on critical infrastructure, public health, the economy, and conflicts over new or diminishing resources. Figure 1 demonstrates these proposed relationships.

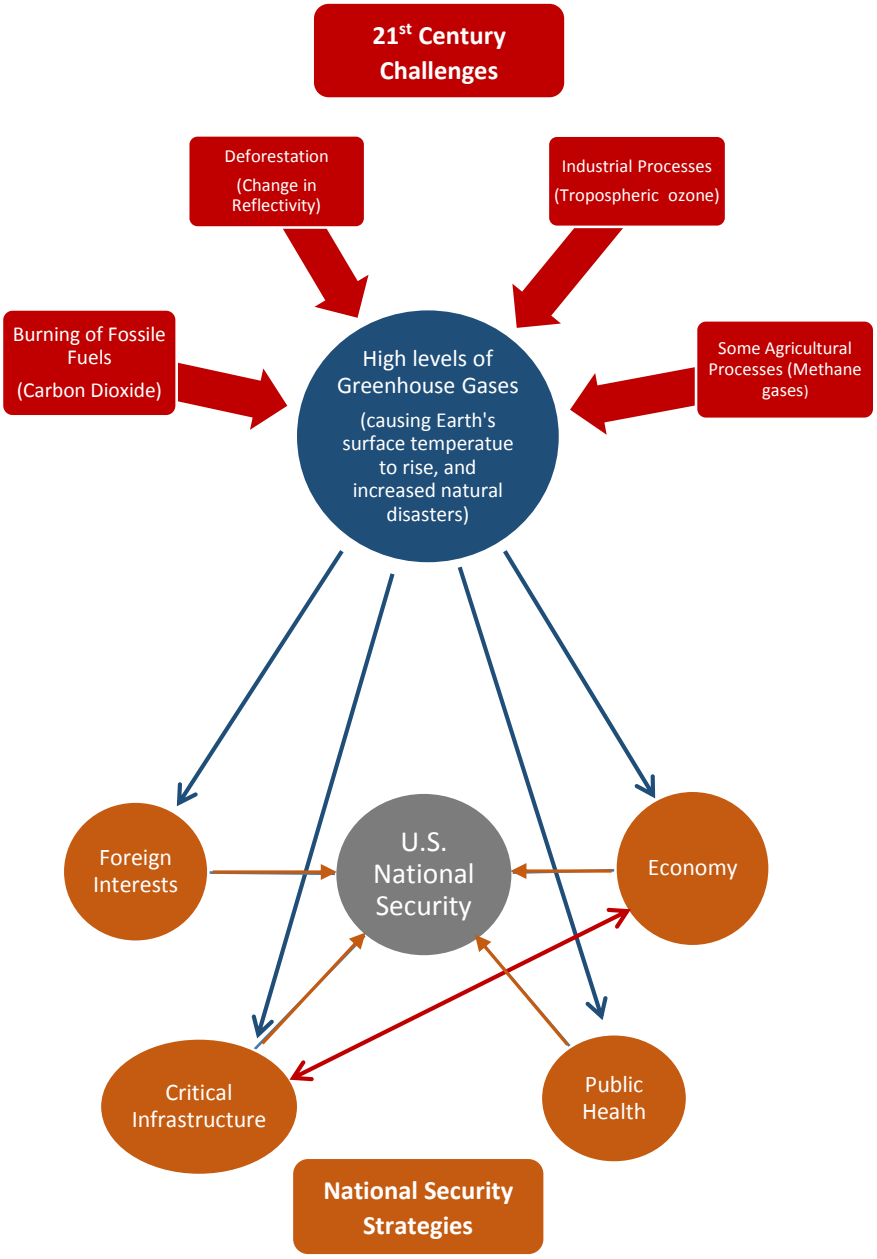

Figure 1. Model of global climate change indirectly affecting U.S. national security

The United States National Security Strategy of 2010 (NSS) defines national security as a set of specific strategies outlining the goals, objectives, and foreign interests necessary to build a stronger and more secure America (White House, 2010). Four areas of interest from the 2010 NSS specifically related to global climate change are depicted in Figure 1. These strategies are as

follows: ‘Strengthen Security and Resilience at Home’, improve the public health of the American people and counter public health threats, ensure a strong U.S. economy, and ‘Sustain Broad Cooperation on Key Global Challenges’ (White House, 2010).

The four bottom circles in Fig.1 are a shorthand version of the 2010 NSS. *Foreign interests* is consistent with the “Sustain Broad Cooperation on Key Global challenges” strategy, *Economy* falls under the “Ensure a strong U.S. economy” strategy, *critical infrastructure* is consistent with the “Strengthening security and resilience at home” strategy, and *public health* is in line with the “Improve the public health of the American people and counter public health threats” strategy. *Foreign interests* is linked to U.S. national security because it is important for the U.S. to actively participate in the international community; in turn, global climate change affects the international community’s ability to respond to the challenges it presents. The *economy* relates to U.S. national security because, without a strong economic structure to rely upon, the U.S. government would be unable to fund and maintain the multiple departments and agencies that are integral to ensuring the nation is safe. *Critical infrastructure*, as the name suggests, is critical to the survivability of the U.S., as a nation; if the U.S. critical infrastructure were to be damaged or fail in any of its 16 sectors, then the critical resources necessary to carry out national security operations would be disrupted. *Public health* is important to U.S. national security because any type of public health problem (e.g., viral disease outbreaks, endemics, pandemics, common flu, and common cold) severely diminishes the ability of the national security enterprise workforce to carry out their duties and, ultimately, weakens U.S. national security. A large number of people in the U.S. workforce suffering from illness would be unable to staff essential positions within the national security enterprise, essentially leaving the nation defenseless. Each of the four strategies directly affect U.S. national security and problems within

any of these four important areas of interest may weaken U.S. national security through diminishing, delaying or completely degrading the U.S. ability to respond to 21st century challenges presented by global climate change. (White House, 2010, p. 1). The remainder of this paper will elaborate on the mechanisms through which each of these areas impacts specific aspects of national security.

Global climate change effects on critical infrastructure

The critical infrastructure (CI) of the United States has been defined by the Department of Homeland Security (DHS) as "…the assets, systems, and networks, whether physical or virtual, so vital to the United States that their incapacitation or destruction would have a debilitating effect on security, national economic security, national public health or safety…"(DHS, 2006). The importance of a safe and robust CI is so vital to the United States that a number of Presidential Decision Directives (PDD) have been passed in order to ensure the safety of the nation's domestic assets and to address any vulnerabilities that can become exploited by man-made threats, such as terrorist organizations, and natural threats, like hurricanes and tornadoes. PDDs intended to protect the CI from any attack have led to the development of federal organizations and information-sharing centers and have directed the private sector, which currently owns 85% of the CI, to assume responsibility over its protection (Sauter & Carafano, 2012).

Protection of the CI falls within the NSS 2010 'Strengthen Security and Resilience at Home' strategy. This strategy is focused on keeping Americans safe and secure through preventing dangers caused by terrorism, natural disasters, cyber-attacks, and pandemics. Key to accomplishing these goals is protection of the nation's CI because it is comprised of all resources necessary for ensuring national security and continuity of government (White House, 2010).

Without a secure infrastructure, all functions at all levels of government would cease, leaving the nation vulnerable to domestic and foreign threats. Figure1 shows an interrelation between critical infrastructure and the U.S. economy because critical infrastructure allows the free flow of interstate and international trade (i.e., well maintained roads and industrial sectors boost production, as well as trade). Additionally, if U.S. critical infrastructure deteriorates further it will cause a disruption in the free flow of trade and the cost of repair may increase to a point where the U.S. economy will be unable to fund necessary repairs, thus directly disrupting the 2010 NSS of ensuring a strong U.S. economy. Despite the importance of CI to national security, American CI in its current state is frail and susceptible to damage. The American Society of Civil Engineers (ASCE), which conducted a full investigation into the health of American CI, determined that the cost to upgrade and modernize it would require $3.6 trillion. The ASCE, which investigated the CI's current condition, capacity, and maintenance, granted a 'Report Card' grade average of a D+ to U.S. CI (ASCE, 2013).

Global climate change impacts the quality of CI in two ways. First, climate change causes degradation in CI over time. For example, Eckelman (2014) found that the reinforced concrete currently being used in CI has become victim to the increased atmospheric carbon and higher temperatures caused by global climate change. This study indicated that climate change has slowly rendered rebar brittle, corroded, and expanded, decreasing the life of the concrete from the expected 75 years to a shorter lifespan of 50 years.

Second, the natural disasters stemming from global climate change exploit the weaknesses of the aging CI (Eckelman, 2014). The inability of CI to adapt to these weather-related changes has been demonstrated over the past decade. For example, Hurricane Sandy, which hit the American northwest in 2012, was able to disrupt and cripple the critical

infrastructure in less than two days, resulting in 4.7 million people over a dozen states losing electricity, flooded streets, submerged subways, the flooding of five New York waste water plants that released waste onto city streets, and billions of dollars' worth of damage to businesses and homes (NYT, 2012). Other examples of the impact of natural disasters on CI include the collapse of Alaska's transportation sector and massive damage to water pipelines in Oklahoma, which will be discussed below.

Transportation sector's highway infrastructure. The transportation sector is an expansive, open, and accessible interconnected system of highways, roads, tracks, terminals, and pipelines that provide services that are essential to U.S. national security. This sector is depended on by U.S. government officials, agents, military, and civilians to rapidly and securely move tradable goods and personnel through the U.S. and overseas. Initially created in 1956, the Federal-Aid Highway Act of 1956 created a 41,000 mile national system of interstate and defense highways in order to allow for quick transcontinental travel and to permit quick evacuation of key target areas (e.g. major cities and military bases) (Congress, 1956). Since 1956, all critical infrastructure sectors and have become dependent on transportation services and this dependency is reciprocal; in other words, there is an interdependent relationship between the transportation sector and other critical infrastructure such that, if either were disabled by a natural disaster or terrorist attack, U.S. national security would be affected (DHS, 2010).

The highway system has been affected by global climate change. Transportation systems created in the United States are designed to withstand the local climate. When designing transportation systems, engineers have had to rely on historical records of temperature in order to build resilient structures to last extensive periods of time (TRB, 2008). However, climate change has made this historical data increasingly unreliable, causing uncertainty for transportation

planners regarding whether or not the design of structures can survive extreme storms (EPA, 2009).

Global climate change can cause structural damage to roads in three ways. First, the increase in temperatures and the intensity of extreme weather can create a climate which old roads and bridges were not built to withstand, causing the pavement from roads to soften and expand. This expansion of the road due to high temperatures creates depressions and potholes, which have become common in high-traffic areas around the country. Expansion of pavement can also cause significant structural damage to bridges (TRB, 2008).

Alaska's transportation sector suffered from the effects of climate change when a three degree increase in temperature over a 56 year time period, between 1949-2005, caused bridges to collapse, water pipes to burst, and roads to crumble (Larsen, 2007). The cost of the damage was assessed at between $5 and $10 billion and regular upkeep of the transportation sector until 2080 was estimated to cost Alaska between $32 and $56 billion. This demonstrates the interrelationship between national security strategies relating to critical infrastructure and to the U.S. economy (DHS, 2010): had there been regular maintenance to the Alaskan transportation sector, the state would have saved the $5 – $10 billion spent in repairs of damaged transportation systems.

A second way that global climate change can cause damage to roads is through climate change-related natural disasters, such as heavy rains that can cause flooding and wash away soil supporting the roads. Specifically, floods brought by hurricanes can cause catastrophic damage to roads and bridges not built to withstand such extreme weather (EPA, 2009). For example, tropical storm Isaac released an historic 15 inches of rain in just a few hours, causing a portion of the Florida state road in Fort Lauderdale to be washed away (Streeter, 2013).

A third way that global climate change can affect the transportation sector is through rising sea levels, resulting from thermal expansion of the world's oceans and the loss of land-based ice due to increased polar and glacial melting. The Intergovernmental Panel on Climate Change (IPCC), in a study of the consequences of climate change, found that sea levels are rising around twice the rate as that recorded in the 20th century (IPCC, 2014). These rising sea levels can affect the integrity of roadways and other structures. For example, an evaluation of the vulnerabilities Palm Beach County roadways estimated that a two-foot rise in sea level would affect 13 miles of roads, while a three-foot sea level rise would affected 41 miles of Florida's roadway. Furthermore, the rise in sea levels has threatened to flood the Virginia Military Institute and its naval base. Terry McAuliffe, the governor of Virginia, expressed concern for climate change by saying

> "…if it rained a day or two or three, there were roads that were shut down. They bring the cones out. That's just with rain. Now we know with these severe weather patterns, it's not just a question of IF, it's a question of WHEN…We need to prepare our coastal communities to deal with the growing threat of climate change and all related national disasters that the area is soon to become flooded." (Bedard, 2014, p. 1).

In summary, global climate change causes extensive damage to the transportation sector throughout the year and is affecting a broad spectrum of U.S. states from Alaska to Virginia. All critical infrastructure and the 2010 NSS depends on the transportation sector for secure travel and the efficient transport of goods. If this sector sustains further damage as a result of global climate change, it will weaken the U.S. ability to provide national security.

Transportation sector's pipeline systems. Climate change has affected the CI's transportation sector not only through its impact on roadways, but also through its impact on the pipelines that stretch across the United States and transport natural gas, water, and oil. The main issues facing all of types of pipelines stem from leaks and ruptures resulting from an aging infrastructure that was first built in the 1880's.

The integrity of water pipelines within the country have been integral in ensuring public health and economic strength. Any disruption or damage to water pipelines can cause either denial-of-service or water contamination, which can affect every interdependent sector, such as the agriculture industry, or critical services, such as hospitals (DHS, 2014). There are at least 240,000 water main breaks per year (ASCE, 2013). Extreme temperatures have increasingly affected old water pipes, contributing to this high level of water main breakage. For example, during 2011, Oklahoma experienced record-high temperatures of over 100 degrees, which caused 685 water main breaks at four times the normal rate during a one-month period (Patterson, 2011).

The nation's pipeline system is important to national security, as the system contains hundreds of thousands of miles of pipelines that transport the majority of the country's natural gas and 65% of hazardous liquids (e.g. crude oil and refined petroleum), which is all consumed within the United States (DHS, 2010). Damage to this system can potentially release deadly hydrocarbons that have been known to cause deaths, damage the environment, and harm the economic health of the country. Increasingly colder temperatures threaten the integrity of gas pipes because pipelines exposed to cold temperatures can crack or bend when the moisture in the soil surrounding the pipe freezes, which causes the soil to expand, bending the pipe in an upward direction (Nixon, 1998). A study conducted by Rosenfeld (2012), found that cold weather caused

at least 85% of the gas pipeline accidents recorded by the Pipeline Hazardous Material Safety Administration (PHMSA). Rosenfeld also found that 77% of all recorded pipeline-related incidents occurred below ground and that pipes installed before 1950 were at significantly greater risk from cold temperatures than those installed after 1950 (Rosenfeld, 2012).

In summary, the aging U.S. pipeline system is deteriorating at a rapid rate and global climate change is accelerating this process. Compounding this problem, most of the oldest pipelines are located within difficult-to-access locations in very old urban areas, such as New York City or Boston. The dangers of aging pipelines are serious, as they are used to transport dangerous gases that can ignite or release toxins into public areas. For example, on March, 2014 a 127-year-old gas pipeline explosion in New York City killed eight, injured dozens, and resulted in the collapsing of two five-story buildings (Kiger, 2014). This sort of incident should cause great concern, as global climate change-related incidents will continue to pose a threat to the vulnerable CI, thereby weakening U.S. national security.

Global climate change effects on public health

Another major strategy outlined in the 2010 NSS concerns maintaining American citizens' health through countering public health threats, such as the current Ebola outbreak. According to the 2010 NSS, strong public health is achieved by improving medical capabilities, domestic and international disease surveillance, and rapid and reliable medical countermeasures to public health risks (White House, 2010).

Air pollution. Public health is weakened by global climate change through the creation of air pollution. Ozone pollutants such as those produced from vehicles, factories, and other factors increase temperatures by creating an atmospheric barrier that retains the sun's energy on the earth's surface for long periods of time (Natural Resources Defense Council, 2007). These

hotter weather patterns accelerate the creation of smog and unhealthy levels of ground-level ozone, which have been documented to last longer in urban areas than its surrounding rural areas, known as the 'heat island effect' (EPA, 2014).

One-hundred and forty-six million American citizens are now living in counties that do not meet air quality standards (Physicians for Social Responsibility, 2006) Although not all of those instances are related to global warming "… the emergence of the climate changing will play an increasing role in global emergence, resurgence, and redistribution of infectious diseases." (Physicians for Social Responsibility, 2006, p.3). Additionally, a study conducted at the Massachusetts Institute of Technology (MIT), estimated that about 200,000 Americans have died each year as a result of poor air quality caused by unhealthy levels of ozone that stem from road transportation emissions and electrical power generation (Barrett, 2013). Smog pollution is expected to worsen in the coming years (WHO, 2014), affecting the health of individuals with and without respiratory diseases, effectively doubling the amount of individuals affected by climate-related illnesses by the year 2030.

Heat waves. Heat waves are related to climate change and threaten public health because of the potential for death resulting from extreme temperatures. Heat waves have been defined by the CDC (2009, p.1) as "several days of temperatures greater than 90° F; warm, stagnant air masses; and consecutive nights with higher-than-usual minimum temperatures periods of excessive temperatures in a region." The EPA (2010) has identified those areas most likely affected by heath waves as northern large metropolitan areas where the majority of greenhouse gases are present, such as Manhattan.

According to the CDC (2009), heat waves are currently the deadliest of the 'weather-related exposures' and account for more annual deaths than hurricanes, floods, earthquakes, and

tornado disasters, combined. An average of 700 individuals die each year as a result of heat waves (CDC, 2009). This average number of mortality rates caused by heatwaves is expected to increase to 2,379 annually by 2057 if the current level of emissions continues (Environmental Health Perspectives, 2014). In fact, a recent study over two possible scenarios on the future production of greenhouse emissions in 12 American cities, one future scenario with a low emission production and another with a high emissions production route, estimated that there could be a minimum total of 188,000 heat-related deaths by the end of the 21st century even with a reduction in greenhouse emissions (Petkova, 2014). Furthermore, the researchers, utilizing 16 different global climate models, estimated that a considerable increase in heat-related deaths will occur in all 12 American cities until the 2080's, despite their best-case scenarios.

Two instances that illustrate the deadly results of heat waves were observed during the 1995 Chicago heat wave, which resulted in an estimated 750 deaths (Ostro, 2009), and the 2006 California heat waves that resulted in 333 deaths (Harris, 2012). The heat waves demonstrated the fact that extreme weather events such as these can cause severe damage to public health through an increase in air temperature and will continue to be an indirect national security threat as extreme temperatures continue to increase into the 21st century.

Animal-borne diseases. According to a study conducted by the Intergovernmental Panel on Climate Change (IPCC, 2007), air temperature is projected to increase between 1.8-6.4 degrees by the end of the 21st century as a result of climate change. Studies conducted by Epstein (2000) and the World Health Organization (WHO, 2003) have found that these rising temperatures and the resulting droughts have created the ideal breeding ground for mosquitos, ticks, and fleas to develop diseases such malaria, dengue fever, yellow fever, West Nile, and other viruses. The drought areas produced by climate change specifically create the ideal

environment for insects to breed in more numbers, thereby increasing the infectious disease insect-carrying population. Other studies have found that global climate change alters disease transmission patterns of such animal-borne pathogens, exhibiting a direct correlation to temperature and rainfall, and affecting the type of pathogens arthropods can transmit to humans (Physicians for Social Responsibility, 2006).

This correlation between air temperature and a pathogen's development specifically makes disease-carrying mosquitoes a further public health risk, as warmer air temperatures create malaria pathogens, accelerate their maturation, and extend the time in which their pathogens are spread. For example, Epstein (2000) concluded that at 68 degrees F, the pathogens in mosquitoes take 26 days to fully develop, while a temperature of 77 degrees F, produces a fully developed pathogen in mosquito in 13 days. More importantly, the temperature increase allows mosquitoes greater opportunities to successfully spread diseases to larger human populations because mosquitos can travel further to locations previously unavailable to them when the climate was colder.

All of this data indicates that animal-borne diseases are a threat to American citizens' public health as an indirect result of global climate change. For example, in 2012, the hottest year on record, a new form of the West Nile virus, a disease that is carried by mosquitoes, was discovered in cities across the United States. The spread of the West Nile was discovered to affect an estimated 5,600 people infected by the new virus, with Texas accounting for about 33% of the reported cases, accounting for the most West Niles virus transmission cases by mosquitos in 2012 (CDC, 2013). The new West Nile virus strand affects the spinal cord and brain, resulting in disturbance in speech, language, and other brain functions. No vaccine or medication is available to treat, or prevent, the virus (CDC, 2013; Vastag, 2012).

Global climate change will likely continue to contribute to death and illness through the mechanisms discussed above. Because the NSS 2010 specifies that national security encompasses the government's ability to protect the nation from public health threats, this research indicates that the government has not been successful in providing countermeasures to global climate change in such a way as to reduce these threats.

Global climate change effects on the economy

The United States economy has always been a symbol of American power because it has been instrumental for national growth, prosperity, and influence since the end of the Great Depression. According to the NSS 2010, national security depends on the maintenance of a strong economy through the reduction of the deficit and wasteful government spending (White House, 2010).

Loss of productivity. Global climate change has created a drain on the economy by decreasing productivity in a number of industries. The agriculture industry has been affected the most by climate change, as the industry relies on rain to grow produce to feed people and livestock. Global climate change reduces rainfall, which produces droughts that have led to farmers drastically reducing their crops and livestock, resulting in a potential loss of millions of dollars to the agriculture industry (Nagourney & Lovett, 2014). For example, a study conducted by the United States Department of Agriculture (USDA) identified that droughts from the past 25 years have severely reduced agricultural production. Most recently, a severe drought in 2012 affected about 80% of land devoted to the production of crops, such as corn, soybeans, and wheat, resulting in high grocery prices (Crutchfield, 2013).

As a result of this loss of production, a growing concern for 'Food Security' has emerged this year within the U.S. government. National Security Advisor Susan Rice spoke about the

need to address the effect of climate change on agriculture at the Chicago Council Global Food Security Conference (White House, 2014). According to Rice, the Obama administration is concerned about this causal chain from extreme weather to lower crop production to higher food prices. She stated:

> It's an outrage when children starve or when hard-working families can't afford to fill their most basic nutritional needs. We've seen what can happen when a spike in food prices plunges tens of millions of people into poverty—riots break out; conflicts for scarce resources cost lives; economies falter; instability increases (White House, 2014, p 1).

Other extreme weather resulting from climate change, such as heat waves, droughts, floods, cyclones, and wildfires affect food security, including food access, utilization, and food price stability (IPCC, 2014). In fact, a global temperature increase of only four degrees above late 20th century temperatures would have significant negative outcomes for those living in poverty across the globe as food becomes less available due to heightened prices (IPCC, 2014). In summary, a loss of agricultural production resulting from severe weather affects the NSS 2010 strategy of maintaining a strong economy and meeting the basic needs of American citizens, as agricultural losses negatively affect the economy and basic needs are not met when food is not affordable.

Climate change also results in loss of production when it affects transportation (Climate Hot Maps, 2011). When citizens are unable to travel, they are unable to work. For example, in 2011 a winter storm hit Chicago, closing down streets and both Midway and O'Hare airports and forcing the city to spend $37.3 million dollars to reopen the streets in order to resume the operation of businesses and schools (Kwak, 2011). Instances when citizens are unable to travel to

work and remain at home, as a result of severe weather, reduce individual income, which negatively impacts the economy. This was recently seen in late November of 2014 when Buffalo and western New York experienced a snowstorm that closed down numerous businesses and other facilities around the region for over a week, preventing thousands of employees from working and causing a reduction in their income for the time they were unable to work (Tokasz, 2014).

Severe weather resulting from climate change can affect energy productivity. Severe weather is the leading cause of power outages within the United States (White House, 2013). Damage to the electrical grid from climate change-related incidents accounted for an estimated 679 widespread power outages across the country between 2003 through 2012 (White House, 2013). Power outages force the closure of schools, industries, and businesses that rely on power to operate (Kousky, 2012), compounding the loss in production. Weather-related power outages between 2003 through 2012 cost the nation's economy between $18 and $33 billion of dollars per year; this amount is higher (between $27 and $52 billion per year) for years during which there is a major storm or disaster, such as Superstorm Sandy.

The loss of productivity forms an interesting mediator between global climate change and national security, as proposed by Figure 1, because extreme weather, ranging from heat waves to winter storms, can disrupt services and food production, causing millions of dollars in lost revenue. As these climate change-related events increase in frequency, further disruption to the daily lives of individuals and to agriculture industry will cause an additional strain on citizens' income and the national economy. Additionally, the U.S. electricity grid will continue to be disrupted by severe weather and cost the nation an annual estimated $18 to $33 billion dollars further damaging the economy.

Cost of damage. In addition to negatively affecting production, global climate change can create a strain on the economy by engendering costs to the government and private sectors for repairing damage created by climate change-related natural disasters. Because these are unplanned costs many cities are forced to request assistance from the federal government to pay for recovery efforts.

In 2012 the United States experienced its warmest year on record, accounting for at least one-third of the U.S. population experiencing temperatures over 100 degrees for more than ten days, while also costing the American economy over $100 billion in natural disasters that occurred throughout the year (White House, 2013). What follows is the breakdown of damage costs created by global climate change as described by the White House report: 1) droughts and heat waves in 2012 caused over $30 billion in damage, 2) Super Storm Sandy resulted in an estimated $65 billion of damage to the Northeast coast, 3) the combined instances of severe weather events, such as winter storms and thunderstorms, was worth $11.1 billion, 4) California wildfires in the western United States caused $1 billion in damage, and 5) Hurricane Isaac caused an economic loss of $2.3 billion.

The Obama Administration has realized the effect of global climate change on the nation over the recent years, and has developed a national plan to reduce the amount of carbon produced by the country. However, the financial strains caused by disasters are still increasingly becoming a major strain as private organizations and government agencies are having to perform extensive repairs of essential infrastructure, such as homes, roads, bridges, railroad tracks, airport runways, power lines, dams, levees, and seawalls (Climate Hot Maps, 2011). Last year, Northern California wildfires cost an estimated $89 million to extinguish and an additional estimated costs

to repair damage caused to the environment were in the tens of millions of dollars (Guardian, 2013).

According to the NSS 2010, national security depends on the maintenance of a strong economy through the reduction of the deficit and wasteful government spending (White House, 2010). Global climate change, through its impact on production and natural disaster-related damage represents a challenge to the government for accomplishing the goals in this national security strategy.

Global climate change effects on foreign interests

Another of the NSS 2010 strategies, 'Advancing Our Interests', focuses on the security of the United States, the prosperity of the U.S. economy in the international economic system, universal values, and relationships with foreign states through international order. Specifically, the NSS 2010 addresses potential conflict over U.S. interests, indicating that, although diplomacy should be used to preserve peace, the United States reserves the right to defend its interests from foreign states (White House, 2010). Tension among countries over natural resources that are newly available or even diminishing, as a result of global climate change, can contribute to future conflicts between states which threaten national security. For example, the melting of the Arctic Circle has resulted in several states, such as Iceland, Norway, Canada, and Russia disputing the ownership of territory which is expected to be made available by the increasing temperatures in the Northern Hemisphere (Pittenger, 2003). This newly accessible territory, consisting of 33 geographical provinces, was determined by the U.S. Geographical Survey (USGS) to be rich in oil and mineral resources. The USGS (2008) estimated an average of 90 billion barrels of oil and 44 billion barrels of natural gas per province. Although the effect of global climate change on national security through its impact on foreign interests is introduced

here and in the framework specified in Figure 1, it will not specifically be addressed further in this research study due to limitations in the availability of data to evaluate a further proposed relationship.

Conclusion

This research has demonstrated how global climate change presents indirect threats to U.S. National Security through negative effects on critical infrastructure, public health, and the economy. Aging critical infrastructure has suffered extensive damage from natural disasters and will continue to deteriorate unless significant investment is made in repair and improvement. Extreme temperatures created by greenhouse gases result in natural disasters that place a strain on the American economy through loss of production and costs to repair damage. Increased temperatures create hotter and drier climates and increase smog production, infectious arthropods passing animal-borne diseases, and heat waves that all threaten public health. Although the Obama Administration has acknowledged the threats from global climate change to national security, these problems will continue to exist into the foreseeable future unless these threats are also acknowledged by the American citizens (White House, 2013).

References

ASCE. (2013). 2013 Report Card for America's Infrastructure. American Society of Civil Engineers, Retrieved from http://www.infrastructurereportcard.org/

Barrett. (2013). Air Pollution and Early Deaths in the United States. Part 1: Quantifying the Impact of Major Sectors in 2005. *Atmospheric Environment, 79*.

Bedard, P. (2014, April 11). Sunk: Climate change threatens to flood world's largest navy base, warns gov. terry mcauliffe. Washington Examiner, Retrieved from http://washingtonexaminer.com/sunk-climate-change-threatens-to-flood-worlds-largest-navy-base-warns-gov.-terry-mcauliffe/article/2547107

CDC. (2009). Heat Waves. Retrieved from http://www.cdc.gov/climateandhealth/effects/heat.htm

CDC. (2013). Continued Evolution of West Nile Virus, Houston, Texas, USA, 2002-2012. *Centers for Disease Control and Prevention, 19*(9).

Climate Hot Maps. (2011). Global warming effects on the economy. Retrieved from http://www.climatehotmap.org/global-warming-effects/economy.html

Crutchfield, S. (2013). U.S. Drought 2012: Farm and Food Impacts. United States Department of Agriculture, Retrieved from http://www.ers.usda.gov/topics/in-the-news/us-drought-2012-farm-and-food-impacts.aspx

DHS. (2006).What is critical infrastructure? U.S. Department of Homeland Security, Retrieved from http://www.dhs.gov/what-critical-infrastructure

DHS. (2010). Transportation Systems Sector-Specific Plan. *The Department of Homeland Security*. Retrieved from http://www.dhs.gov/xlibrary/assets/nipp-ssp-transportation-systems-2010.pdf

DHS. (2014). Water and Wastewater Systems Sector. *The Department of Homeland Security*. Retrieved from http://www.dhs.gov/xlibrary/assets/nipp-ssp-transportation-systems-2010.pdf

Eckelman, M. (2014). Urban Scale Mapping of Concrete Degradation from Projected Climate Change. *Urban Climate, 9*.

Environmental Health Perspectives. (2014). Estimation and Uncertainty Analysis of Impacts of Future Heat Waves on Mortality in the Eastern United States. *Environmental Health Perspectives, 122*(1).

EPA. (2009). Climate impacts on transportation. Environmental Protection Agency, Retrieved from http://www.epa.gov/climatechange/impacts-adaptation/transportation.html

EPA. (2010). Climate impacts on human health. Environment Protection Agency, Retrieved from http://www.epa.gov/climatechange/impacts-adaptation/health.html

EPA. (2014). Climate change: basic information. United States Environmental Protection Agency, Retrieved from http://www.epa.gov/climatechange/basics/

EPA. (2014). Heat Island Effect. *United States Environmental Protection Agency*. Retrieved from http://www.epa.gov/heatisland/

Epstein, P. R. (2000). Is global warming harmful to health. Scientific America. Retrieved from http://udy.vcharkarn.com/uploads/61/61083.pdf

Guardian (2013, September 08). U.S. scientists assessing damage from California wildfire as blaze rages on. The Guardian, Retrieved from http://www.theguardian.com/world/2013/sep/08/scientists-california-wildfire-damage

Harris, R. (2012, September 12). When heat kills: Global warming as public health threat. National Public Radio. Retrieved from http://www.npr.org/blogs/health/2012/09/10/160761974/when-heat-kills-global-warming-as-public-health-threat

IPCC. (2007). Climate Change 2007.The Physical Science Basis. *Intergovernmental Panel on Climate Change*. Retrieved from http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4_wg1_full_report.pdf

IPCC. (2014). Summary for policymakers. Climate Change 2014 impacts, adaptations, and vulnerability. *Intergovernmental Panel on Climate Change*. Retrieved from https://ipcc-wg2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf

Jansen, E., & Overpeck, J. (2007). Is the Current Climate Change Unusual Compared to Earlier Changes in Earth's History? *IPCC*. Retrieved from http://co2now.org/index2.php?option=com_content&do_pdf=1&id=75

Kiger, P. (2014, March). East harlem explosion highlights risk of natural gas leaks. National Geographic, Retrieved from

http://news.nationalgeographic.com/news/energy/2014/03/140312-east-harlem-explosion-natural-gas-leaks-risk/

Kousky. (2012). Information Climate Adaptation: A Review of the Economic Costs of Natural Disasters, Their Determinants, and Risk Reduction Options. *Resources of the Future*. Retrieved from http://www.rff.org/rff/Documents/RFF-DP-12-28.pdf

Kwak, S. (2011, March 05). Blizzard snow removal cost chicago $37.3 million Chicagoist, Retrieved http://chicagoist.com/2011/03/05/blizzard_snow_removal_cost_chicago.php

Larsen, P. (2007). Estimating Future Costs for Alaska Public Infrastructure at Risk from Climate Change. *Institute of Social and Economic Research University of Alaska Anchorage*. Retrieved from http://www.iser.uaa.alaska.edu/Publications/JuneICICLE.pdf

Nagourney, A., & Lovett, I. (2014, Feb 1). Severe drought has the U.S. think the worst. New York Times. Retrieved from http://www.nytimes.com/2014/02/02/us/severe-drought-has-us-west-fearing-worst.html?emc=eta1&_r=0

Natural Resources Defense Council. (2007). Air pollution: Smog, smoke and pollen. Retrieved from http://www.nrdc.org/health/climate/airpollution.asp

Nixon, J. (1998). Analytical Solutions for Peak and Residual Uplift Resistance of Pipelines. *Naviq Consulting Inc.* Retrieved from http://pubs.aina.ucalgary.ca/cpc/CPC6-570.pdf

NYT. (2012, October 29). Assessing the damage from hurricane sandy. New York Times, Retrieved from http://www.nytimes.com/interactive/2012/10/30/nyregion/hurricane-sandys-aftermath.html

Ostro, B. (2009). Estimating the Mortality Effect of the July 2006 California Heat Wave. *California Climate Change Center, 122*(1). Retrieved from http://www.energy.ca.gov/2009publications/CEC-500-2009-036/CEC-500-2009-036-D.PDF

Patterson, T. (2011). Heat Pops Pipes Nationwide; Brace for Higher Bills. *The Cable News Network*. Retrieved from http://www.cnn.com/2011/US/08/13/water.infrastructure/

Petkova, E. (2014). Heat-Related Mortality in a Warming Climate: Projections for 12 U.S. Cities. *International Journal of Environmental Research and Public Health*.

Physicians for Social Responsibility. (2006).The medical and public health impacts of global warming. Retrieved from http://www.psr.org/resources/the-medical-and-public-health-impacts-of-global-warming.pdf

Pittenger, R. (2003). Global Warming Could Have a Chilling Effect on the Military. *Center for Technology and National Security Policy*.

Riffkin, R. (2014, March 12). Climate change not a top worry in U.S. GALLUP, Retrieved from http://www.gallup.com/poll/167843/climate-change-not-top-worry.aspx

Rosenfeld, M. (2012). Distribution Pipeline System Integrity Threats Related to Cold Weather. *Kiefner and Associates*. Retrieved from http://www.kiefner.com/downloads/Gas Distribution System Integrity Threats Due to Cold Weather.pdf

Sauter, M., & Carafano, J. (2012). Homeland security. (pp. 404-405). New York: The McGraw-Hill Companies.

Streeter, A. (2013, April). South Florida assessing impact of climate change on roads, bridges, railroads, airports. Sun Sentinel, Retrieved from http://articles.sun-sentinel.com/2013-04-19/news/fl-climate-change-transportation-20130418_1_climate-change-tropical-storm-isaac-roads

TRB. (2008).The potential impacts of climate change on U.S. transportation. Transportation Research Board, Retrieved from http://onlinepubs.trb.org/onlinepubs/sr/sr290.pdf

Tokasz, J. (2014). Snowed-in workers wonder about employers' pay policies. *The Buffalo News*. Retrieved from http://www.buffalonews.com/city-region/weather/snowed-in-workers-wonder-about-employers-pay-policies-20141123

Vastag, B. (2012). Hints of a more virulent, mutating West Nile virus emerge. *Washington POst*. Retrieved from http://www.washingtonpost.com/national/health-science/hints-of-a-more-virulent-mutating-west-nile-virus-emerge/2012/11/08/75e37776-2523-11e2-9313-3c7f59038d93_story.html

USGS. (2008). Circum-Arctic Resources Appraisal: Estimates of Undiscovered Oil and Gas North of the Arctic Circle. *United States Geological Survey*. Retrieved from http://pubs.usgs.gov/fs/2008/3049/fs2008-3049.pdf

White House. (2010). National Security Strategy of 2010. *The White House*. Retrieved from http://www.whitehouse.gov/sites/default/files/rss_viewer/national_security_strategy.pdf

White House. (2013). Climate change and President Obama's action plan. Retrieved from website: http://www.whitehouse.gov/share/climate-action-plan

White House. (2013). Economic Benefits of Increasing Electrical Grid Resilience to Weather Outages. *Executive Office of the President*. Retrieved from http://energy.gov/sites/prod/files/2013/08/f2/Grid Resiliency Report_FINAL.pdf

White House. (2014). Remarks by National Security Advisor Susan E. Rice at the Chicago Council Global Food Security Conference. *The Office of the Press Secretary*. Retrieved from http://www.whitehouse.gov/the-press-office/2014/05/22/remarks-national-security-advisor-susan-e-rice-chicago-council-global-fo

WHO. (2003). Global Climate change and health: An old story writ large. *The World Health Organization*. Retrieved from http://www.who.int/globalchange/climate/en/chapter1.pdf

WHO. (2014). Climate Change and Health. *The World Health Organization.* Retrieved from http://www.who.int/mediacentre/factsheets/fs266/en/