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Climate Change as a Hazard in Emergency Management

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Abstract

This project will provide a basic overview of hazards, a scientific overview of climate change, examine evidence used to document climate change, investigate how the public and private sectors are impacted by climate change, and determine if states are preparing for this hazard. Sources such as the National Oceanic and Atmospheric Administration (NOAA), the National Weather Service (NWS), and Climate Impact Lab will be consulted to determine if it would be beneficial to implement changes to prepare for the worsening effects of climate change. The methodology for this project will include quantitative climate data for temperature extremes and trends, hurricanes, and droughts. In order to further these findings to tie into why climate change should be considered in preparedness planning for both the public and private sector, additional quantification of factors regarding agricultural impacts, threats to public health, and direct effects on the military related to economic loss will be further explained. This project will provide an opportunity to investigate more of what can be done to prepare and combat climate change to lessen the effects on industry in the future if preparedness plans are indeed adopted for climate change as a hazard.

Hazards

Gilbert F. White, founder of the Natural Hazards Center based in Colorado, explains that:

> Hazard always arises from the interplay of social and biological and physical systems; disasters are generated as much or more by human actions as by physical events; the present forms of government intervention in both traditional and industrial societies often exacerbate the social disruptions from extreme events; if we go on with the present public policy emphasis in many regions upon technical and narrow adjustments, society will

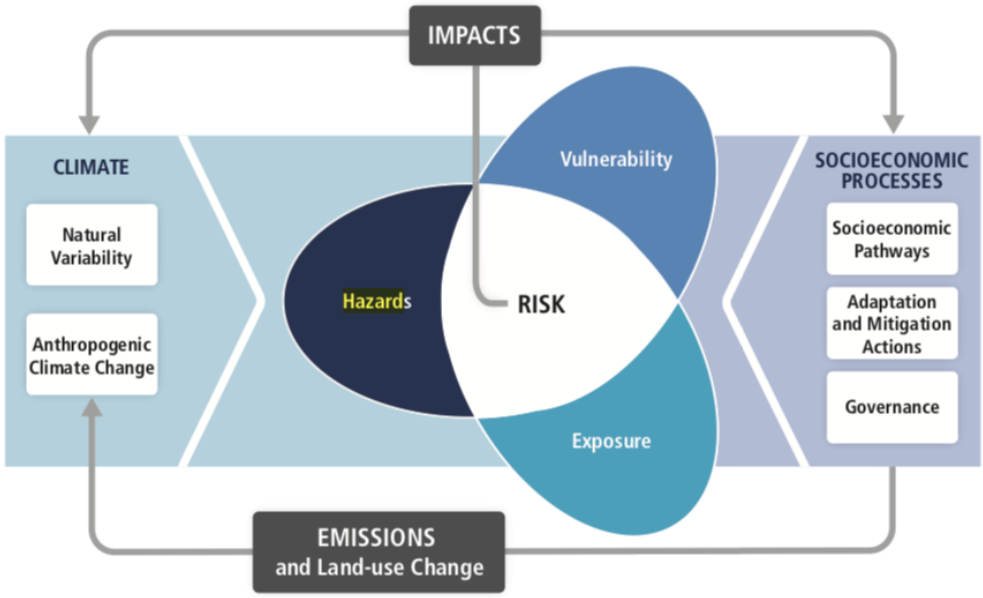
become still less resilient and still more susceptible to catastrophes like the Sahelian drought. (Selected Quotations of Gilbert White para. 73).

It is important to understand what hazards are and how the two concepts of climate change and hazards relate.

Climate Change

Climate change is best categorized as a natural hazard, and there are several reasons that can be cited to back this up (AR5 Climate Change 2014: Impacts, Adaptation, and Vulnerability). Climate change is prevalent in regard to hazards due to the fact that the hazards that relate to this phenomenon add to the stressors that already exist, which is particularly true in urban areas (AR5 Climate Change 2014: Impacts, Adaptation, and Vulnerability). This will be discussed further in the following sections of this paper.

Figure 1:



Source: PreventionWeb

Scientifically, climate change has the potential to have widespread effects environmentally and economically. Specifically, there are many impacts that the public and private sectors are likely to face as a result of climate change as alluded to in Figure 1. Although effects of climate change such as drought, increased wildfires, and intensifying storms vary by geographic location, there is evidence to show that climate change is a hazard to the public and private sectors.

Hazards and Climate Change

The main types of hazards in the field of emergency management include: natural, anthropogenic intentional, and anthropogenic non-intentional which is important for the understanding of how hazards, climate change, and emergency management are related. There are several ways in which climate change can be considered a hazard, but this particular research seeks to illustrate how the phenomena of climate change is a hazard itself in addition to the hazards that manifest as a result of the changing climate. Ultimately, climate change is creating instability and danger around the world as a result of lack of preparedness for such significant changes. In order to more clearly address these concerns, historic climatological data will be analyzed to better understand the severity of these changes and how emergency management framework can be implemented to better prepare for climate change as a hazard.

The Four Phases of Emergency Management

The concept of emergency management is built on an interrelated framework of four principles including: mitigation, preparedness, response, and recovery (Federal Emergency Management Agency). This principle encapsulates the understanding that disasters are ongoing and are not simply forgotten once they occur (Federal Emergency Management Agency). In general, emergency management mitigation occurs prior to a disaster which involves working to

lessen the effects of a hazardous event before it happens (Federal Emergency Management Agency). Similarly, preparedness measures are also taken prior to a disastrous event, which can include exercising plans for response and recovery measures, acquiring supplies to ensure more effective response, Community Emergency Response Training, and purchasing additional personal protective equipment for responders (Federal Emergency Management Agency). Figure 2 provided by the Federal Emergency Management, below, illustrates the continuous cycle of the four phases of emergency management.

Figure 2:

Source: The Federal Emergency Management Agency

In this research regarding climate change, preparedness will be the primary phase addressed so that protective measures can be adopted as the effects of climate change become more prevalent throughout the public and private sectors. Empirical evidence will be provided to illustrate the impacts of climate change in the following sections. First, the impacts of drought in regard to climate change will be addressed.

Droughts

It is important to understand that NASA has projected intensifying droughts and heat waves in the Southwest, and in turn, cold waves are expected to become less intense in all locations (Global Climate Change: Effects, 2019). Similarly, it is expected that summer

temperatures will continue to increase, which heavily impacts the amount of moisture in soil (Global Climate Change: Effects, 2019). According to an information statement of the American Meteorological Society, global surface temperatures have increased an average rate of "0.8°C (1.4° F) per century over the period of 1901-2017 and 1.9° (3.4° F) per century from 1979-2017" (AMS, 2019, para. 5). This evidence supports the speculation that the western and central United States can expect intensifying heat waves in coming years. In general, heat waves are defined as "a period of two or more consecutive days where the daily minimum apparent temperature (actual temperature adjusted for humidity) in a particular city exceeds the 85th percentile of historical July and August temperatures (1981–2010) for that city" (USGCRP Indicator Details, para. 5). In the 1960s, major cities typically experienced two heat waves per year; however, in the 2010s, data through 2017 supports that major cities are experiencing nearly six heat waves per year (Global Change).

Figure 3a (Top)

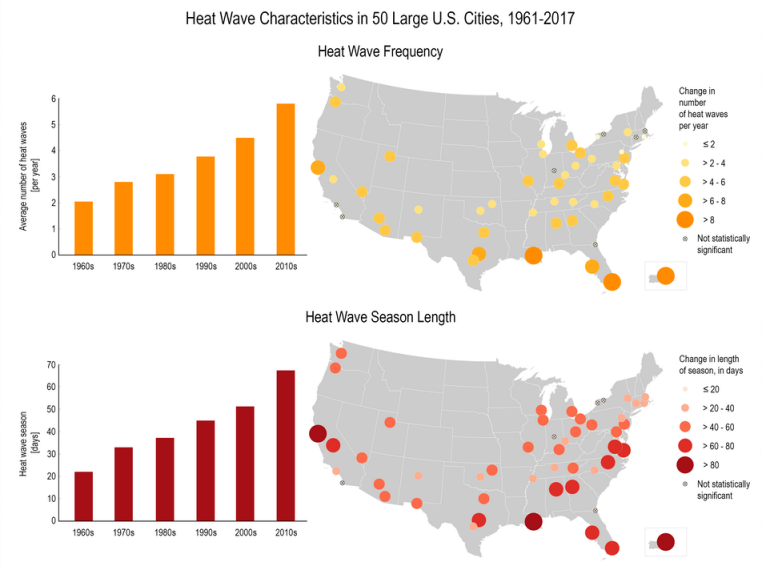


Figure 3b (Bottom)

Source: USGCRP Indicator Details

According to Figure 3 above, 50 metropolitan areas between 1961 and 2017 documents statistically significant increases in heat waves and provides that 45 metropolitan areas have experienced increases in season length during this time period (USGCRP Indicator Details). One area where heat waves have significantly increased over time can be best illustrated in North and South Carolina. In Figure 3a, data from the 1983 heat wave has been displayed where 100°F and 110°F were documented as all-time records for temperature. Trends gathered from the US Department of Commerce and NOAA (2017) indicate the following temperatures from a 1983 heat wave.

Asheville, NC	100*	Fayetteville, NC	110*	Columbia, SC	107
Hickory, NC	102	Wilmington, NC	100	Florence, SC	103
Charlotte, NC	103	New Bern, NC	100	Myrtle Beach, SC	100
Greensboro, NC	100	Hatteras, NC	90	Georgetown, SC	103
Raleigh, NC	101	Greenville-Spartanburg, SC	103	Charleston, SC	100

Similarly, in the Summer 1999 heat wave, an additional all-time record for a specific location was documented.

Asheville, NC	95	Fayetteville, NC	100	Columbia, SC	104
Hickory, NC	102	Wilmington, NC	103	Florence, SC	104
Charlotte, NC	100	New Bern, NC	100	Myrtle Beach, SC	99
Greensboro, NC	97	Hatteras, NC	93	Georgetown, SC	103
Raleigh, NC	104	Greenville-Spartanburg, SC	104	Charleston, SC	105*

Additional records continued to be made in the heat wave of 2007

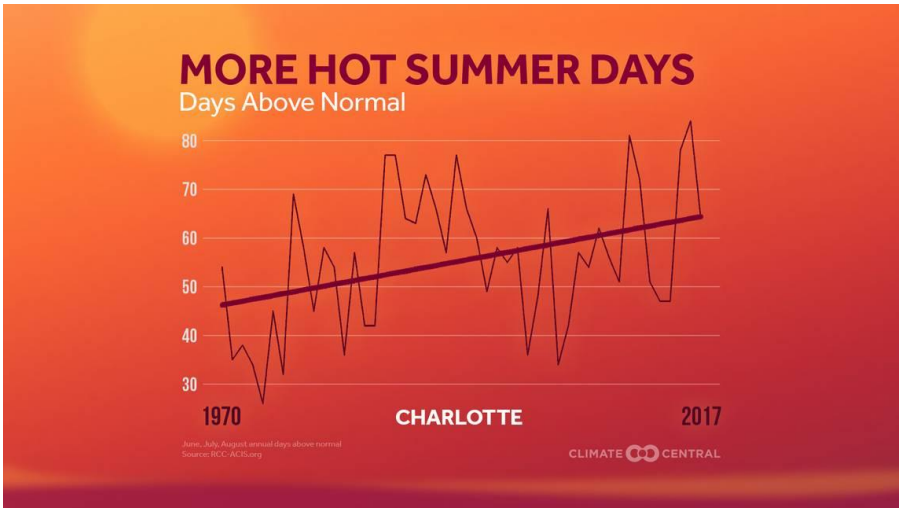
Asheville, NC	94	Fayetteville, NC	107	Columbia, SC	107
Hickory, NC	104	Wilmington, NC	98	Florence, SC	106
Charlotte, NC	104*	New Bern, NC	101	N. Myrtle Beach, SC	94
Greensboro, NC	101	Hatteras, NC	91	Georgetown, SC	101
Raleigh, NC	105*	Greenville-Spartanburg, SC	105	Charleston, SC	99

as well as 2012.

Asheville, NC	98	Fayetteville, NC	106	Columbia, SC	109*
Hickory, NC	102	Wilmington, NC	103	Florence, SC	105
Charlotte, NC	104*	New Bern, NC	99	N. Myrtle Beach, SC	98
Greensboro, NC	102	Hatteras, NC	91	Georgetown, SC	102
Raleigh, NC	105*	Greenville-Spartanburg, SC	107*	Charleston, SC	98

Here, a general trend can be formulated. Although there are certainly times where temperature may fluctuate, this does not take away from the fact that a general upward trend in maximum temperatures is indeed present. An excellent example reported from the Charlotte Observer stated on July 11, 2018, “Charlotte's six warmest summers since 1878 have all occurred since 1986, the National Weather Service reports. It's seen temperatures of 90 degrees or higher on eight days this month and 19 days in June” (Henderson, 2018, para. 5). This is further illustrated by Figure 4, below.

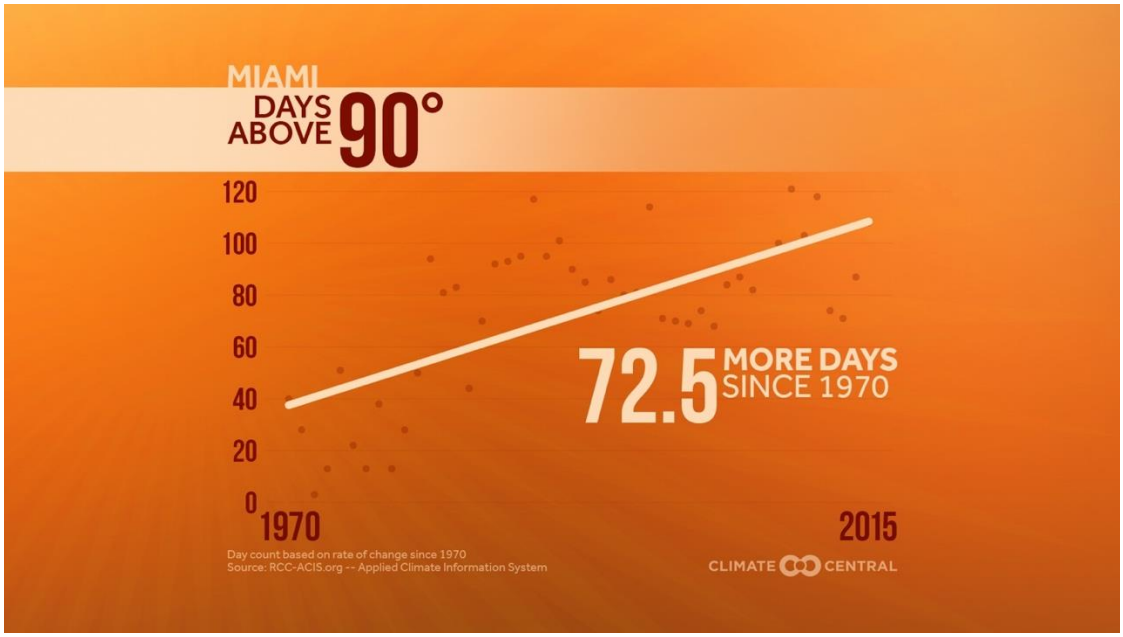
Figure 4:



Source: Henderson, 2018

These same trends can be seen in Florida, according to Figure 5, pictured below, with an upward trend in Miami with days above 90°F since 1970 increasing by 72.5.

Figure 5:



Source: Climate Central, 2016

Although this data depicts temperature changes from 1970 to 2015, it is important to document that 2017 tied for the warmest year in Miami history, with the mean average temperature being recorded at 79.1°F according to the National Weather Service (Iannelli, 2018). With that being said, seven of the ten hottest years in Miami occurred between 2007 and 2017 (Iannelli, 2018). Additional climate information is expected to be released so as to compare to 2017 in the coming months.

Ultimately, by the end of the century, it is expected that once-in -20-year extreme heat days that were one day events are projected to occur every two or three years over most of the United States, which is likely to disrupt the normal functions that occur in the public and private sectors of the United States daily (Global Climate Change: Effects, 2019). Droughts are just one of the impacts that is likely to affect the public and private sector economically.

Similarly, increased levels of drought are likely to affect the amounts of wildfires likely to occur as a result of climate change. Evidence to support this statement lie in the fact that 15 of the 20 largest fires in California history have occurred since 2000, which will be discussed further in the following sections of this paper (Borunda & Elliott, 2018).

Due to geographic location, some regions of the United States will not suffer differently in the private sector as a result of climate change. Although climate change is the same in regard to scientific process, different areas will suffer unique impacts from one another. This can be seen specifically in agriculture. Although some types of agricultural production will be relatively resilient to climate change as it evolves, other locations and crop types will suffer from stresses due to extreme heat, drought, disease, and heavy downpours. Due to climate change heavily impacting the likelihood of droughts, it is not only crop production that is likely to suffer, but also livestock and the role that is plays in food security in the United States. Research has

shown that climate disruptions to agricultural production have increased in the past 40 years and are projected to increase over the next 25 years (National Climate Change Assessment - A). There are many detrimental effects on crops and livestock as a result of climate change such as suffocation due to weeds and growing problems due to diseases and insect pests (National Climate Change Assessment -A).

Similarly, there is a large issue regarding lack of precipitation that is prohibiting appropriate growth of agricultural products. Lack of rain has and will continue to limit growth if conservation efforts are not undertaken to preserve water where drought is likely. Water conservation methods will need to be innovative and effective in order to prove beneficial for agricultural security (National Climate Change Assessment -A). The detriments that drought as a result of climate change poses for the United States and abroad impacts not only crop yield, but also food processing, storage, transportation, and overall food prices for retailing (National Climate Change Assessment -A). In order to combat climate change and alter the toll that climate change is taking on food security, acknowledging the threat and taking adaptive measures can assist in delaying the effects.

It is evident that food security is essential for quality of life nationally and internationally and is being threatened by climate change; however, agriculture plays a complex role in social and economic systems with the United States producing nearly $330 billion per year in agricultural commodities (National Climate Change Assessment -A). Climate change can alter location, timing, productivity of crop, livestock, and fishery systems on local, national, and global scales.

The production of such commodities is heavily reliant and vulnerable to impacts on crop and livestock development which is heavily impacted by weather extremes. It is expected that

the U.S. will be feeding nine billion people nationally and internationally by 2050, and with increasing food stability challenges exacerbated by climate change, it is less likely for adaptations to be able to be made to continue to feed the growing population if drought as a direct result of climate change is ignored as it relates to crop fertility (National Climate Change Assessment -A).

A specific crop yielding location where drought is likely to continue impacting agricultural patterns is in California where evidence is showing alterations to yields of annual and perennial crops. As noted, there are many secondary effects of drought as it relates to agricultural security. As a result of climate change and drought, there is significantly less water, which is detrimental to the number of crops able to be produced out of California. Not only do these realities impact the food supply for Californians and food consumers across the nation, but also the multibillion-dollar agricultural economy as well as the migrant farm workers reliant on the agricultural industry for employment (Farquhar & Shinkle, 2010).

Drought as a result of climate change does not just mean that there will be little to no rainfall. Surface warming leading to drought also impacts ocean conditions. Stone fruits were mentioned previously relating to freezes and lack of rainfall; however, changes in ocean conditions have the potentially to impact fish stocks (Farquhar & Shinkle, 2010). Diminished stream flows, warming ocean temperatures and ocean acidification could contribute to a decline in fisheries as well as fishery output. Higher sea surface temperatures in 1997-1998 during the El Niño significantly affected market squid, California's largest fishery by volume (Farquhar & Shinkle, 2010). The California Regional Assessment reports that landings fell to less than 1,000 metric tons in that season, compared to 110,000 tons during the 1996-1997 season. Other unusual events included poor salmon runs, a series of plankton blooms, and seabird deaths. As

with agricultural crop yields, significant fish declines will adversely affect availability and price of fish produced from a domino effect of drought as a result of climate change (Farquhar & Shinkle, 2010). Climate change results in more frequent drought conditions, warming oceans, and many other impacts all negatively impacting the selling and harvesting of foods not only in popular food producing states such as California, but in states throughout the nation, ultimately causing detriment to agricultural security across the nation and abroad.

With that being said, climate change is complex in regard to drought, precipitation, and flooding due to the fact that greenhouse gases cause atmospheric warming, which ultimately results in more wet conditions where wet conditions are typically prevalent. This is partially a result of warm air facilitating greater evaporation from oceans and waterways, and when this evaporation happens, the warm air tends to hold in the moisture; ultimately, resulting in larger amounts of precipitation and flooding (Schwartz, 2018).

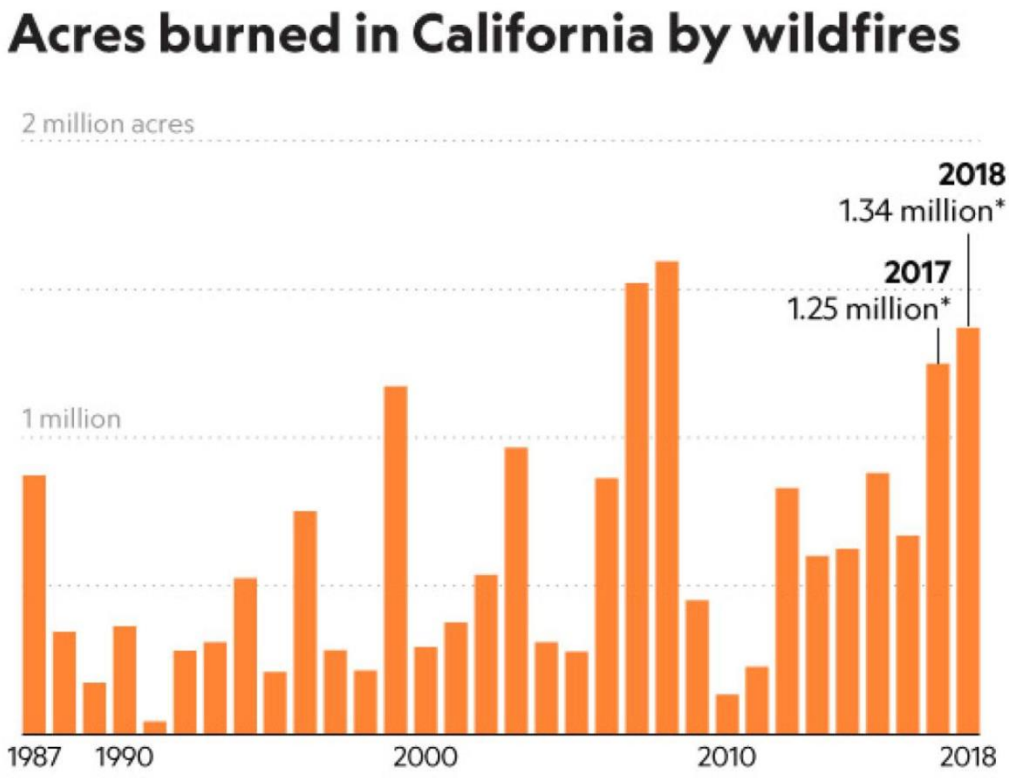
It is evident that there are many ways in which climate change is likely to impact the public and private sectors socially and economically if not addressed as a hazard in emergency management preparedness. Drought exacerbating lack of agricultural security is one way in which the economy and social structure of the United States will be impacted as illustrated by the effects of drought in California.

Wildfires

As mentioned previously, climate change not only aids in creating conditions for drought, but also creates an environment conducive to wildfires with the lack of regular rainfall. California is an excellent example of a geographic area impacted by both drought and wildfires as a result of climate change. There has been a steady increase in temperature of approximately three degrees Fahrenheit over the past century, resulting in drought as well as

wildfires (Borunda & Elliott, 2018). The way that the relationship between a dry environment contributes to the increase in wildfires is due to the warmed air that extracts water out of already dehydrating plants and soils. When this occurs, trees, shrubs, and rolling grasslands typically found in areas such as California are left in a dry state that is essentially "primed" for burning (Borunda & Elliott, 2018, para. 3). Daniel Swain, a climate scientist at the University of California, Los Angeles explains this concept simply "that vegetation-drying effect compounds with every degree of warming" (Borunda & Elliott, 2018, para. 4). Essentially, this relationship means that plants are losing water more efficiently today than they did a century ago before the rapid warming of the state by climate change" (Borunda & Elliott, 2018, para. 4). Figure 6, below, depicts the acres burned by wildfires by year, which shows that there are indeed more fires occurring and causing more damage as the climate warms.

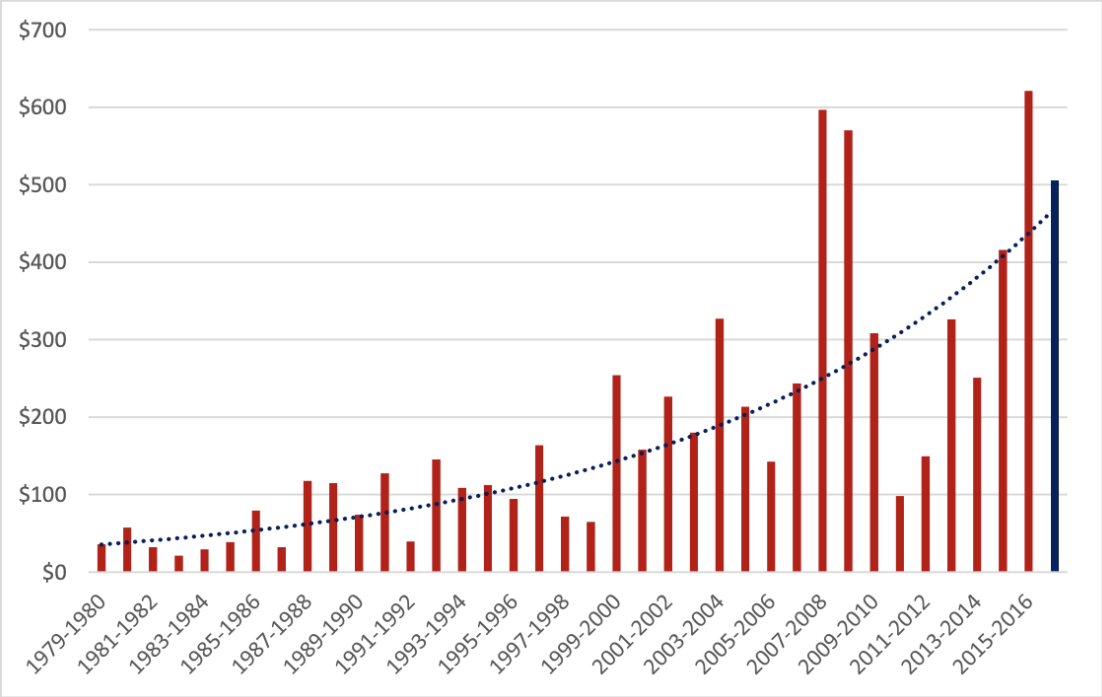
Figure 6:



Source: Borunda & Elliott, 2018 via CA.gov

It is due to the effect of climate change that wildfires are increasing in size in California and across the Western U.S. This was further explained by Park Williams, a fire expert at Columbia University (Borunda & Elliott, 2018). Since the 1980's, he and a colleague reported in 2016, climate change contributed to an extra 10 million acres of burning in western forests— an area about the size of Massachusetts and Connecticut combined, as illustrated in the graphic above. "These same fires today are occurring in a world roughly three degrees Fahrenheit warmer than it would have been without warming," says Williams (Borunda & Elliott, 2018, para. 12). Essentially, this means that fires are becoming more difficult and costly to fight and put out than they would have been in a cooler environment. Similarly, the cost to suppress these fires is increasing each year, which is also taxing the resources particularly in California. This can be seen in Figure 7 below which indicates that California fire suppression costs (millions of 2017 USD) is increasing by fiscal year.

Figure 7:



Source: Cal Fire, 2017

Similarly, it is important to note the steep incline in monetary cost and fatalities wildfires are exacerbating throughout in the United States, as illustrated by the following chart.

Table 1:

Year	Amount (CPI Adjusted Estimated Cost in Billions)	Fatalities
2003	5.4	22
2006	1.9	28
2007	3.6	12
2008	1.5	16
2009	1.2	10
2011	2.1	5
2012	1.9	8

2015	3.3	12
2015	4.9	0
2016	2.6	21
2017	18.5	54
2018	24.2	106

Source: NOAA National Centers for Environmental Information. Adam.Smith@noaa.gov

Figure 7 and Table 1, above, illustrate how quickly and significantly the trends regarding billions of dollars in damage as well as fatalities have significantly increased as wildfires, specifically in California have grown more powerful and costly as a result of climate change and overall warming of the Earth.

As alluded to in previous sections, changes in precipitation leading to drought are another factor. One way of explaining this concept is to identify that California's summer dry season is lengthening. As the dry season lengthens, this allows plants to dry out more as each day passes; thus, increasing their likelihood to burn. "We've been lengthening fire season by shortening the precipitation season, and we're warming throughout," says Swain. "That's essentially what's enabled these recent fires to be so destructive, at times of the year when you wouldn't really expect them" (Borunda & Elliott, 2018, para. 9).

Climate change as it relates to wildfires is not secluded to property and habitat damage. Another area where climate change and wildfires impact the public and private sectors is in regard to the spreading of disease as a result of mass forced migration, which is often overlooked. With increasingly spreading wildfires happening more frequently, such disasters could affect the spread of infectious diseases, including vector-borne diseases, zoonotic diseases such as animal diseases that can be spread to humans, water and foodborne diseases, and

respiratory diseases (Farquhar & Shinkle, 2010). In California, predictions for more frequent wildfires, droughts and heat waves may cause a forced migration of entire communities. These changes could enhance transmission of disease due to crowding, homelessness, poverty and scarce resources (Farquhar & Shinkle, 2010). This goes to show that climate change and increased wildfires are not only detrimental to property, but also to aspects of public health if such variables are neglected.

Hurricanes

As mentioned previously, storms, particularly hurricanes are increasing in frequency, intensity, and duration. It can be concluded from investigating these variables that larger intensity storms are indeed occurring more frequently, and this is occurring at a steady rate with the warming of the climate. Hurricane-associated storm intensity and rainfall rates are projected to increase as the climate continues to warm. According to a new NASA study, "a string of nine years without a major hurricane landfall in the U.S. is likely to come along only once every 177 years" after noting that there had not been a Category 3 hurricane as of 2015 since 2005; however, there were four Category 3 or higher hurricanes in 2016 (Beven, 2017), six in 2017 (Extremely active 2017 Atlantic hurricane season finally ends), and two in 2018 (Facts Statistics: Hurricanes).

Table 2, below, illustrates storms since 2005 through 2018 to depict just how severe the increase in frequency of hurricanes has grown in addition to their associated wind speed, physical costs, and loss of life due to hazardous weather impacts.

Table 2:

				Amount (CPI Adjusted	

Name	Year	Intensity and Barometric Pressure	Wind Speed	Estimated Cost in Billions)	Fatalities
Dennis	2005	3 = 850 mb	21mph gust	$3.3	15
Katrina	2005	3 = 927 mb	175 mph	$166.3	1833
Rita	2005	3 = 897 mb	180 mph	$24.6	119
Wilma	2005	3 = 500 mb	185 mph	$25.3	35
Dolly	2008	2 = 967 mb	95 mph	$1.5	3
Gustav	2008	2 = 700 mb	110 mph	$7.2	53
Ike	2008	2 = 945 mb	100 mph	$36	112
Irene	2011	1 = 952 mb	85 mph	$15.5	45
Isaac	2012	1 = 993mb	75 mph	$3.1	9
Sandy	2012	NA	NA	$72.8	159
Matthew	2016	1 = 940 mb	140 mph	$10.7	49
Harvey	2017	4 = 937 mb	115 kt	$128.9	89
Irma	2017	4	185 mph	$51.5	97
Maria	2017	4 = 985.4 mb	105 kt	$92.7	2981
Florence	2018	1 = 1007.5 mb	36 kt	$24.2	53
Michael	2018	5 = 922 mb	150 mph	$25.2	49

Source: NOAA National Centers for Environmental Information. Adam.Smith@noaa.gov

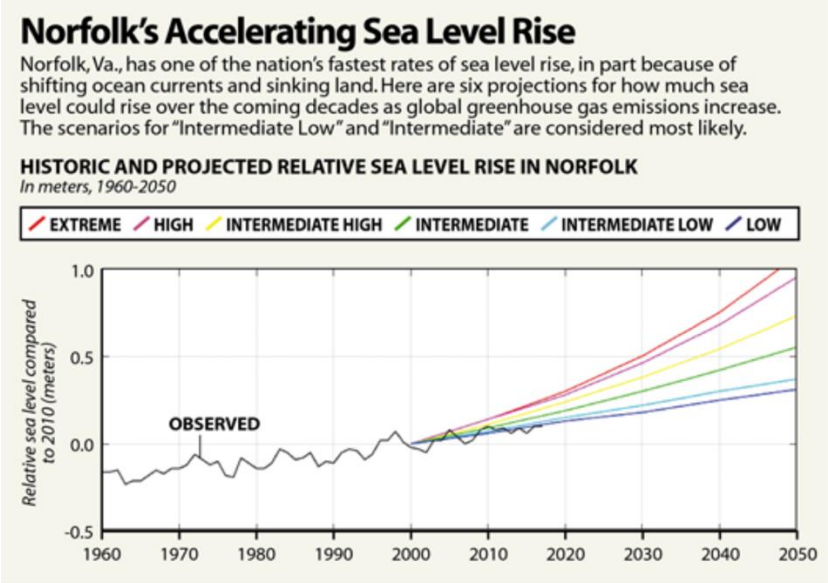
In addition to the effects mentioned above, the effects of climate change have specifically impacted the Norfolk Naval shipyard on a different scale, but still relating to hazardous weather

such as hurricanes – specifically storm surges and flooding. These effects can be seen within the last ten years by examining the nine major floods that have caused damage to equipment that is used to repair ships, which has been a detriment to the Navy. In fact, in 2016 two feet of rain left by Hurricane Matthew caused nearly 1.2 million dollars in necessary repairs in the shipyard, and such rainfalls and storms are only expected to worsen in coming years (Kusnetz, 2018).

Impacts from climate change including flooding and more intense storms and the damage that would burden the Naval shipyard can be illustrated by the statement that "It would have the potential for serious, if not catastrophic damage, and it would certainly put the shipyard out of business for some amount of time," according to Ray Mabus, who was the Navy Secretary under President Barack Obama. "That has implications not just for the shipyard, but for us, for the U.S. Navy" (Kusnetz, 2018, para. 6).

Of great concern, is the fact that the dry docks in the shipyard "were not designed to accommodate the threats" of rising seas and stronger storms, according to a 2017 report by the Government Accountability Office (Kusnetz, 2018, para. 8). At present, there are already significant maintenance delays as a result of high tide flooding in the shipyard (Kusnetz, 2018). This is partially due to sea level rise of 1.5 feet in the past century, which is twice the global average partially due to coastline sinking. Figure 8, below, shows just how quickly sea level is rising in Norfolk. Significant changes would need to be made to the docks to accommodate the changes caused by climate change in an attempt to reduce dock vulnerability and general vulnerability to the Navy (Kusnetz, 2018).

Figure 8:



Source: Kusnetz, 2018 via NOAA

As a mitigation strategy, the Navy has constructed temporary flood walls and has implemented the use of sandbags to protect the dry docks at Norfolk Naval Shipyard. In addition, some equipment has been elevated so as not to be damaged by storm surges and flooding. With the public being aware of these changes, a survey conducted by the Department of Defense revealed that the shipyard is still extremely vulnerable to the effects of extreme weather on military bases. After reviewing the survey, the Navy proposed a more permanent barrier estimated to cost more than $30 million, part of a 20-year, $21 billion plan that is intended to be submitted to Congress this year to modernize Norfolk as well as Navy shipyards in Maine, Washington and Hawaii (Kusnetz, 2018). This new project has not been yet approved.

A model was developed and evaluated by the Federal Emergency Management Agency to depict the effects of a Category 4 hurricane on the naval shipyard through computer modeling (Kusnetz, 2018). The model simulated 140 mph winds that damaged powerlines and cell towers, heavily impacting the communications grid and buried the Chesapeake Bay under 12-15 feet of storm surge water (Kusnetz, 2018). With the likelihood of storms of this magnitude occurring in

the Chesapeake Bay where the shipyard is located, it is clear that the Navy could suffer detrimental effects, hindering United States security.

It is essential to comprehend why climate change causes moisture and how the phenomena happen. Overall, these patterns of increased water vapor in the atmosphere result from increasing temperatures. In general, as temperature increases, more water vapor can be present in the air (Molloy, 2015). This concept is crucial in regard to hurricanes. As warming of the surface occurs, areas surrounding large bodies of water also warm. During typical hurricane season, depending on the time of year, warm water gathers in coastal areas prone to hurricane conditions.

There are many ways in which the changing conditions of hurricanes have impacted and are likely to continue impacting the public and private sector. Ultimately, the issues posed as a result of climate change will expose people who live in cities across the United States to several severe threats.

Economic Impacts

Climate change does not just affect the economy as previously mentioned. There are many other societal changes that are likely to occur from drastic changes. This will be felt by the built, natural, and social infrastructure of cities. Some of the infrastructure that has already been and will continue to be damaged from the effects of the changing climate include storm drains, urban waterways, and ultimately the capacity of emergency responders (National Climate Change Assessment - B).

Additionally, there are other factors that do not include the built environment, but still impact the social dynamic of urban and rural areas. As a result, climate change is likely to invoke increases of extreme events such as heat waves, heavy downpours, flooding from deluge

rainfalls, increases in coastal storm surges following hurricanes, and disease incidence related to temperature and precipitation changes (National Climate Change Assessment - B).

Rural areas have recently, as of 2019, experienced changes as a result of climate change that have posed significant threats as well. Specifically, Nebraska, Iowa, South Dakota, and Wisconsin are being heavily impacted by record-breaking rainfalls as a result of warming (Hassan, 2019). As the atmosphere has warmed, the capacity of water that it is able to hold has increased, resulting in a higher likelihood of deluge rainfalls (Hassan, 2019). In these specific areas, the excessive amounts of rainfall resulting from a warmer atmosphere able to hold more water, fell on frozen ground that taxed the resources of the geographic areas since amounts such as 6 inches of water in 24 hours is simply not to be expected (Hassan, 2019). As noted previously, it is both rural and urban areas that are feeling the effects of climate change.

It is important to consider that all of these effects will increase the vulnerability of specific populations, specifically in urban areas. If climate change is removed from the equation, it can be identified that there are already many stressors involved in living in an urban area, and these are exacerbated by the effects of climate change (Menu). Some of the existing stressors include deteriorating infrastructure, intense poverty, and already high population density which has the potential to vary based on the possibility of mass migration and increased risk of disease as a result of climate change (National Climate Change Assessment - B).

To put this in perspective, there are approximately 245 million people that live in the urban areas of the United States, and this number is expected to grow to 364 million by 2050 (National Climate Change Assessment - B). Stresses that are likely to be placed on urban areas can be illustrated by the way in which infrastructure has continued to deteriorate in the past. It is expected that some of the infrastructure that has suffered in the past such as buildings, energy,

transportation, water, and sanitation systems are likely to continually degrade as a result of climate change (National Climate Change Assessment - B). In future decades, if not addressed, these same infrastructures will become increasingly stressed.

The impact that climate change is likely to continue to have is especially detrimental in urban and suburban areas due to a high interdependency upon infrastructure. This is likely to have a cascading effect that is likely to impact the economies in the surrounding areas. As a result, additional "expansion of the U.S. urban landscape into suburban and exurban spaces is expected, and new climate adaptation and resiliency plans will need to account for this" (National Climate Change Assessment - B, para. 8).

State Plans

Overall, there are many impacts to the public and private sectors that must be taken into consideration regarding climate change. In order to minimize these effects, there must be mitigative measures in place contained in state emergency preparedness plans. It has been found that although there are many states that do take climate change into consideration in their plans, there are several states that do not mention climate change as a potential hazard or vulnerability area at all. Table 3, below, summarizes these findings.

Table 3:

State	Climate Change Preparedness Plan
Alabama	No
Alaska	No
Arizona	No
Arkansas	No
California	Yes

Colorado	Yes
Connecticut	Yes
Delaware	Yes
Florida	No
Georgia	No
Hawaii	Yes
Idaho	No
Illinois	No
Indiana	Not found
Iowa	No
Kansas	No
Kentucky	No
Louisiana	No
Maine	No
Maryland	No
Massachusetts	Yes
Michigan	No
Minnesota	No
Mississippi	No
Missouri	No
Montana	No
Nebraska	No
Nevada	No
New Hampshire	No
New Jersey	Not found
New Mexico	No
New York	Yes
North Carolina	No
North Dakota	No

Ohio	No
Oklahoma	No
Oregon	No
Pennsylvania	No
Rhode Island	Yes
South Carolina	No
South Dakota	Yes
Tennessee	Yes
Texas	No
Utah	No
Vermont	Yes
Virginia	No
Washington	Yes
West Virginia	No
Wisconsin	No
Wyoming	No

Interestingly, only 12 of the 50 United States include climate change impacts in their state emergency management plans. Specifically, Massachusetts addresses the mission and vision for mitigating risk and adapting to climate change is to "Reduce the statewide loss of life, and protect natural resources, property, infrastructure, public health and the economy from natural hazards and climate change impacts through the development of a comprehensive and integrated hazard mitigation and climate adaptation program" (Massachusetts State Hazard Mitigation and Climate Adaptation Plan, 2018, p. 7-2). Additionally, New York began and continues to address climate change through the establishment of "the New York State Climate

Action Council (NYSCAC) and directed NYSCAC to create a climate action plan (Executive Order 24). In November 2010, NYSCAC released a 428-page Interim Report ("2010 Report" or "Report") including measures both to reduce emissions and to prepare for the impacts of climate change. The Interim Report was released for public comment" (Overview of New York's Climate Change Preparations - Georgetown Climate Center). California addresses climate change by creating a plan calling for "an ambitious but achievable reduction in California's carbon footprint – toward a clean energy future" (California's Climate Plan, para. 1). Similarly, Colorado also possesses a climate plan. Vermont also separately addresses their climate plan by stating "The cost of inaction on climate is unacceptable," said Ben Edgerly Walsh, climate and energy program director with the Vermont Public Interest Research Group. "Fossil fuel purchases are draining nearly $2 billion a year out of our state, to buy a product fueling the climate crisis. We're proud to stand with these organizations to say loudly and clearly that this is another way – and that state leaders must put us on that path, today" (Climate Action Plan for 2019, para. 8). South Dakota takes a fairly different approach by addressing climate change in their Wildlife Action Plan which discusses specifically how aquatic life will be impacted by the stressors of change (South Dakota Wildlife Action Plan). Additionally, Connecticut addresses climate change in a Climate Preparedness Plan aimed at "Intensify efforts to ensure preparedness planning;

- Integrate climate change adaptation into existing plans;
- Update existing standards to accommodate change expected during infrastructure design life;
- Plan for flexibility and monitor change; and

Protect natural areas and landscape features that buffer potential impacts from climate change" (Protection, D. O., para. 2). An excerpt from the plans in Rhode Island states "Rhode Island is already facing the challenges of climate change, including more frequent flooding events, rising sea levels, and overall changing precipitation patterns. These changes will affect citizens' daily lives and will have serious consequences for Rhode Island's citizens and infrastructure (State of Rhode Island: Division of Statewide Planning, para. 1). The state of Delaware simply posts several announcements on social media regarding the impacts of climate change, with updated progress reports about how climate change is being handled (Taking Action).
Washington State concludes "To take meaningful steps toward addressing climate change, states, cities, counties, and private businesses and organizations need to collaborate to find solutions" (Climate Change, para. 1). In Hawaii:

> "Act 234, Session Laws of Hawaii 2007, established the state's policy framework and requirements to address Hawaii's GHG emissions. In Act 234, the legislature recognized the following:
>
> "… climate change poses a serious threat to the economic well-being, public health, natural resources, and the environment of Hawaii. The potential adverse effects of global warming include a rise in sea levels resulting in the displacement of businesses and residences and the inundation of Hawaii's freshwater aquifers, damage to marine ecosystems" (Adapting to Climate Change, para. 3).

As stated previously, there are many impacts both in the public and private sector that are likely to increase as a result of climate change that can have impacts across the country. From these findings, there are many states that are not at all prepared for the hindrances that could

occur as a result of increasing drought, wildfires, flooding, and higher intensity storms resulting from surface warming.

Discussion

The overall findings of this research illustrate that the public and private sectors are being impacted by climate change in several ways dependent on geographic location. Although not all areas are impacted in the same way, climate change is altering the daily functions in agriculture, public health, and even military aspects of life. The fact that only 12 states have ways to address climate change as a hazard suggests that there is change that needs to be made by the remainder of the 50 states in order to better address how climate change is bound to impact the states. These impacts could involve flooding, deluge rainfall, drought, wildfires, and several other effects which must be integrated into emergency operations plans.

This evidence shows that greater attempts should be taken to take climate change into consideration as a hazard in all state emergency operations plans regarding preparedness because regardless of geographic location, climate change plays a role in everyday life. Although there are currently 12 states that address climate change in their state plans, it is important to note that not all of these states contain the information regarding climate change in the actual state plans, but rather in supplementary documents. With the impacts of climate change becoming more prevalent, it is essential for these impacts to be included in all state emergency operations plans. As mentioned previously, preparedness plays a large role in emergency response and recovery, and without plans that address how to combat climate change and recover from the impending effects, it is likely that states, communities, and economies will continue to suffer as a result of climate change.

Summary

Overall, there are many important factors as they relate to climate change in the public and private sector as well as in rural and urban areas. Although climate change is scientifically occurring each and every day, the concept that all disasters are local also applies to climate change, meaning that each geographic location is dealing with the effects of climate change in a different way. Agricultural areas are suffering crop damage with shorter growing seasons and flooding, urban areas are bearing additional stressors on aging infrastructure, rural areas are suffering flooding, Naval Shipyard dry docks are being flooded causing damage to the United States Military, wildfires are ravaging California, and Hurricanes are ever increasing along the East and Gulf Coasts.

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