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California Wildfire Mitigation-Room for Improvement

Introduction-

Throughout history, wildland fires have been an immense problem in California. The top ten costliest wildland fires in the United States all took place in California (Insurance Information Institute 2019). As of 2017, California was listed as the most prone state for wildfires. In 2017 there were 2,044,800 California households at risk or extreme risk from wildfires (Insurance Information Institute). Given the statistics on California wildfires, risk mitigation and fire prevention are imperative to decrease the frequency and damage.

California wildfires have been more destructive, costly, and frequent in the last couple of years. The top two largest and most destructive California wildfires occurred in 2018 and 2017. In November of 2018, the Camp Fire in Butte County incinerated 153,336 acres, 18,804 structures, and killed 85 people (Insurance Information Institute). In October of 2017, the Tubbs Fire in Napa and Sonoma County consumed 36,807 acres, 5,636 structures and killed 22 people.

In July of 2018, the Mendocino Complex Fire in Colusa County, Lake County, Mendocino County, and Glenn County became the largest wildfire in California history (Insurance Information Institute). The fire was responsible for 459,123 acres lost. In December of 2017, the Thomas Fire in Ventura and Santa Barbara County burned 281,893 acres, making it the second largest California wildfire on record.

In 2017, there were 71, 499 wildfires, compared to the 65,575 wildfires in the same period of 2016, according to the National Interagency Fire Center. About 10 million acres were burned in 2017 which is higher than the 10-year average. This was a huge increase from the 5.4 million acres burned in 2016. The California Department of Insurance reported that insurance claims from the October to December fires accumulate to almost 12 billion dollars, making the 2017 fire season the costliest on record. However, it is likely that after the insured loss data is compiled, the 2018 Camp and Woolsey fire claims the spot for the most costly fire in United States history.

In 2018, The Mendocino Complex fire grew to be the largest fire in state history. On July 23rd, 2018, the Carr Fire became the eighth most destructive fire in the state's history. 2018 is projected to be among the costliest wildfires on record after the Camp and Woolsey Fires insured losses are released.

It is very important that the state of California acknowledges the increase of wildfire costliness, destruction, and frequency. Emergency managers, risk mitigators, and fire departments need to scrutinize these wildfires and identify the causes to the amplified effects.

California continues to partake in urban sprawl within wildland urban interfaces (WUI), a zone of transition between wildland and human development. There is a conspicuous correlation between human expansion in WUI and more destructive, frequent, and costly wildfires. According to researchers at the University of Wisconsin-Madison, as of 2010, more than thirty percent of California's housing stock was located in the WUI. The stock has increased twenty-five percent since 1990.

According to the U.S. Department of interior, over 90 percent of wildland fires in the United States are caused by people. Some examples of human caused fires are: campfires left unattended, the burning of debris, downed power lines, negligently discarded cigarettes and intentional acts of arson (Insurance Information Institute). More housing development means higher chances of ignition, more houses to defend, and more people to protect.

California is not doing everything they can to mitigate for wildland fires. State leaders in California are trying to protect their residents from destructive fires. However, many of the land-use regulation attempts to mitigate fire risks are answered with hostility from homeowners.

The California Board of Forestry and Fire Protection recommends that homes in the WUI have a defensible space between 30 to 100 feet (Doumar 1). A defensible space is a residential environment whose physical characteristics function to hinder fire growth. These spaces have little to no flammable structures or plant life. The California Board of Forestry and Fire Protection, and the California fire commission only have the authority to regulate state lands. The board can offer recommendations, but the cities are free to ignore them (Doumar 6).

It is crucial for the state of California to convince the public to participate in the wildfire mitigation movement. California's risk mitigation can only reach its full potential if the public cooperates. However, there are many cases where the public turns its back on fire prevention.

The City of Berkeley and the Oakland hills are extremely vulnerable to wildfires and have been considered part of the wildland-urban interface for many years. In 1991, the Tunnel Fire scorched the Oakland hills fueled by highly rich fuel, eucalyptus trees (Doumar 4) The fire killed twenty-five people and destroyed three thousand homes. The Berkeley hills community has been suggested to better design their roads for mitigation purposes. The roads are winding and very small. Usually there are cars parked on both sides of the road which leaves little room

for emergency vehicles to maneuver. The Council members of Berkeley have discussed implementing red striping on the curbs to prevent people from parking on certain streets. However the public is extremely reluctant toward that movement.

Residents, in general, have this thought process that a disaster will never happen to them. This attitude results in little to no participation regarding community mitigation plans. In 2017, FEMA offered funding to remove eucalyptus trees off public land in the hills. This action seemed very responsible and rational. FEMA had identified a main factor to the intensity of the Tunnel Fire, the eucalyptus trees. They attempted to address the issue by providing funding. However, the funding was pulled due to a lawsuit that claimed the project was unnecessary.

Another city that ignored the California Board of Forestry and Fire Protection's recommendations is Susanville, California. In response to the California Board of Forestry and Fire Protection's recommendations to the city's general plan related to fire prevention, the city sent back a note that effectively stated it wouldn't be implementing most of the recommendations (Doumar 6). This formal denial was recorded in documents obtained through a California Public Records Act request.

Another problem, in respect to fire mitigation in California, is allocations of resources are usually directed toward fire suppression rather than fire mitigation.

California has always been prone to wildland fires, however 2018 had the deadliest and most destructive fires in state history. In 2018, the California fires burned nearly 1.7 million acres of land, the most in state history. 2018 also came with the most fire deaths in state history, over 100 deaths (Insurance Information Institute). Unsurprisingly California experienced its most costly year regarding wildfire costs. There are three areas that need to be explored in order to identify the best solution to California's wildfire problem. The three areas consist of: The

negative impact of climate change and increased urban sprawl in wildland urban interface zones; What California has been doing wrong in respect to fire mitigation; and Mitigation methods and programs that California could be utilizing to hamper the destruction of future wildland fires.

Climate conditions and urban sprawl in wildland urban interfaces are two main contributors to the increasingly destructive wildfires in California. Climate conditions, such as moisture levels, precipitation, and temperature play a huge role with the fuel for a fire (Wresterling 1). Hotter temperatures result in drier plant life. The dry vegetation increases the flammability of the fuel. On the other hand, precipitation and moisture levels cause wildlands to flourish. Urban sprawl in wildland urban interfaces is also responsible for the increased intensity of the California wildfires. Humans are the leading cause of wildland fires, therefore increasing the human population in vulnerable areas such as the WUI is asking for a higher frequency of wildland fires.

California cities aren't helping the wildfire situation. Fire mitigators understand the leading causes of California's most destructive wildfire, however the cities need to contribute to the fire mitigation plans. Unfortunately, many cities does not implement the recommendations from the California Board of Forestry and Fire Protection.

There are many programs that have worked for other states in America. However, California isn't implementing any of these plans or programs.

These are three areas that should be addressed in order to mitigate the catastrophic wildland fires in California.

The three areas previously discussed are all big contributors to the increased intensity of the California wildfires. It is very important to diligently study the causes of a problem to come to a solution. The following will discuss the solutions to the areas: The negative impact of

climate change and increased urban sprawl in wildland urban interface zones; What California has been doing wrong in respect to fire mitigation; and Mitigation methods and programs that California could be utilizing to hamper the destruction of future wildland fires.

The first action regarding the negative impact of climate change and urban sprawl in wildland urban interfaces, is to convince California's cities to take advice from the California Board of Forestry and Fire Protection, and Cal Fire. There is really no way to stop climate change unless there is a universal movement. Therefore, we can only acknowledge climate change and prepare for how it affects wildfires.

California has made many mistakes relating to fire mitigation. California needs to convince its cities and residents to participate in mitigation programs and take action. Residents should makes sure that their homes have defensible spaces. The state should provide financial assistance to those who lack the money to forest thin and remove shrubs. California needs to prioritize fire mitigation and prevention education. They need to utilize those programs to educate the public. Hopeful the State can convince the residents to take part in the fire mitigation movement. . They need to put away their personal vendettas of personal financial growth.

California needs to take advantage of its resources. There are accessible documents and files that contain successful mitigation programs. California should be implementing those programs.

As noted, towns and the state have to collaborate to mitigate and prepare for the catastrophic wildland fires. California, as a whole, has to accept that the wildland fire situation is the worst it has ever been. Therefore, we need to come together to prepare and minimize the damage of the fires.

The purpose of this study was to scrutinize the means of mitigation that California executed prior to the 2018 wildland fires to identify what, if anything, could have been done to minimize the death rates, property damage, and cost loss for residents in the state of California

Last year, 2018, California had experienced its most destructive wildfire season in state history (Insurance Information Institute). A key factor to the magnitude of the fires was poor mitigation and poor execution of fire prevention. If California doesn't take drastic measures to mitigate and prepare for wildfires, it will continue to experience fire seasons like 2018's immensity or worse. With climate change increasing the intensity of the wildfires, the already vulnerable state of California is bound to have a fire season worse than the year of 2018 which had the deadliest fires in state history.

To identify better means of mitigation for California wildfires, the researcher studied past California wildfires along with a plethora of wildfires in the United States. The researcher utilized many databases and sources to find the most effective mitigation plan for California wildfires.

As a result of research on United States wildfires, the most effective means of mitigation was meant to be identified. Another goal was to understand why 2018 was the most destructive wildfire season in California's state history in order to decrease the deadliness of the future wildfires.

The questions related to the research problem are: what means of mitigation has worked for other States or towns regarding wildfires?; what will it take to convince the towns in California to stop or slow down the urban sprawl?; how can the town convince the towns and cities in California to participate in mitigation programs?; why do cities in California continue to neglect recommendations from professional risk mitigators?

There are no participants involved in this study, however this study is relevant and significant in the field of emergency management. It will scrutinize the methods of mitigation used prior to the 2018 wildland season in California. The research will identify the best means of mitigation for future fires.

There are many terms throughout this research paper that need to be explained. Those terms are: mitigation; wildland urban interfaces; climate change; urban sprawl; fire suppression; forest thinning; fine fuels; energy-limited fire regimes; and moisture-limited fire regimes.

Mitigation is the action of reducing the severity, seriousness, or painfulness of something. The wildland urban interface is where houses, and the infrastructure that goes with them, meet and intermingle with wildland vegetation, making them vulnerable to wildfire (Doumar, 2018). Climate change is a change in global or regional climate patterns in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.

Urban sprawl is simply the uncontrolled expansion of urban areas. Fire suppression is a reduction in heat output from the fire and control of the fire to restrict its spread from its seat and reduce the flame area. Forest thinning is the selective removal of trees, primarily undertaken to improve the growth rate of health of the remaining trees. A fine fuel can be determined by any fuel with a high surface-area-to-volume ratio that dries rapidly and is rapidly consumed by fire when dry (National Wildfire Coordinating Group).

In this study, energy-limited fire regimes are ecosystems where fuel flammability is usually the limiting factor for wildfire risks. In this study, moisture-limited fire regimes are ecosystems where additional vegetation quickly dries out and provides more continuous fuel coverage for fires.

There are limitations in my research design, qualitative research. Unfortunately, the researcher was limited in research studies pertaining to fire mitigation because fire science is a relative new and uncommon field of study. The researcher didn't have the resources or opportunity to talk to the California Department of Forestry and Fire Protection or any California risk mitigators for that matter. Some of the sources that the researcher analyzed are considered tertiary sources. Regarding time, the researcher only had about four months to conduct the study.

There were no procedures followed to ensure that research was conducted in an ethical manner. The researcher's study was qualitative, therefore there were no participants or consent forms involved.

Literature Review:

In American history, California has always been the biggest victim regarding costliness to wildland fires. California holds all ten of the top ten costliest wildland fires in United States history. Cleary, wildfires have been a running problem in California.

The literature review will address three areas of research related to California's most destructive wildfire year, 2018. In the first section, research studies related to the impact of climate change and increased urban sprawl in wildland urban interface zone will be addressed. In the second section, there will be a discussion on what California has been doing wrong in respect to hindering the immense destruction of the 2018 wildfires. Finally, the last section will focus on mitigation methods and programs that will help hamper the destruction of future wildland fires.

Two main factors that are responsible for the increased magnitude of California wildfires are: climate change; and urban sprawl in wildland urban interface zones. The majority of wildfires in the United States are caused by humans. With that fact in mind, it is only intuitive that increasing the population and residential buildings in an area would increase the risks of

wildfires. Therefore, urban sprawl is a key contributor to increased frequency of wildfires. Not only does urban sprawl increase the likeliness of a wildfire, but urban sprawl in a wildland urban interface zone immensely increases the potential destruction by a wildfire.

Climate change also increases the potential destruction of a wildfire. Climate change in the United States has resulted in hotter temperatures and droughts which are both key factors to greater fire spread and growth.

Fuel is necessary for the existence of fire. Densely forested ecosystems epitomize an environment with abundant fuel. One way to immensely increase wildfire risk is to develop housing in wildland-urban interface zones (WUI). The wildland-urban interface is where houses, and the infrastructure that goes with them, meet and intermingle with wildland vegetation, making them vulnerable to wildfires (Doumar 2018). Urban sprawl, the uncontrolled expansion of urban areas, in these WUI zones are contributing to devastating wildfires. Climate change is also another factor responsible for the increased intensity of California's most recent wildfires.

The purpose of the article was to explain how climate change and urban sprawl in wildland-urban interface zones is causing bigger, deadlier, and more costly wildfires in California.

The setting where the research was conducted is not applicable in this scenario because this piece of work is an Article from *Time*. There were also no participants since this source is an article and not a research study.

The authors of this article explored the negative effects of climate change and urban sprawl in respect to recent California wildfires. The article discussed California recently experiencing its hottest temperatures in state history. The authors explained the consequences of urban expansion into high-risk fire zones.

Because this source is not a research study, there wasn't a standard procedure used to conduct a study. However, the authors Laignee Barron and Mahita Gajanan used references in their article. Those references included: National Oceanic and Atmospheric Administration; California Environmental Protection agency; Verisk Analytics; and California's Fourth Climate Change Assessment.

There were no variables or measurement instruments involved in the article, *California's Wildfires Have Become Bigger, Deadlier, and More Costly. Here's Why.*

The article extracted information regarding the percentage of California housing in high or extreme wildfire risk. The article also provided statistics on the cost for wildfire damage in 2018 and 2017 as well as statistics on California's recently increased temperatures. According to the Environmental Protection Agency, 2017 was California's hottest summer in the state's record and July 2018 marked California's hottest month in recorded history at 79.7 degrees Fahrenheit. Authors, Barron and Gajanan, stated that Southern California has warmed by at least three degrees in the last century. In 2017, fifteen percent of California's homes are concentrated in high or extremely high wildfire risk zones. The damage costs of The Camp Fire in Butte County and Woolsey Fire in Los Angeles and Ventura County, are expected to top $19 billion in damages for homeowners.

There were no results for this source, however there were key facts and statistics that explained the increased destruction of California's wildfires. California recently experienced one of its most destructive fire; On November 8, 2018, The Camp Fire in the town of Paradise had become one of California's most destructive fires in at least a century. The article explained how climate change and urban expansion are causing more destructive wildfires.

According to the Environmental Protection Agency, California has warmed by at least three degrees in the last century. Los Angeles County Fire Chief, Daryl Osby, stated that the higher temperatures are leaving plant life very dry and flammable.

Urban expansions is also leading to higher wildfire risks; the number of properties at risk of wildfire threat has grown to nearly 7 million in California. One fourth of California's homes are at moderate to extremely high risk of being engulfed by a wildfire.

Several conclusions can be made about the effects of urban sprawl and climate change on California wildfires. First, the hotter temperatures and droughts in California are leading to more destructive fires. The increase in temperature leads to withered or dry plants which are very flammable. Urban sprawl in wildland-urban interface zones is increasing the number of properties at risk of wildfires, 7 million which is a 1,000% increase from 1940's number of homes and developed land in wildfire prone areas. It is only logical that the fires are more destructive because the leading cause of a fire is humans. In the past two years, California has endured its most costly fires. This article relates to my research because it is imperative to understand the roots of a problem. I strongly believe that climate change and urban sprawl are two reasons for the massive wildfires in California.

As previously stated, this source is not a research study evaluation on the limitations and weaknesses is not applicable. However, the article has weaknesses as a source itself because it is most likely a tertiary source. There are strengths and weaknesses of a tertiary source. The positive is the message or main points are most likely more concise since it has been filtered twice as a source. The negative of a tertiary sources is that the original material or idea might have been diluted or misinterpreted. One more strength about this particular article is that the references used are very credible.

There are many claims that climate change is responsible for more destructive wildfires in California. A fire regime is the pattern, frequency, and intensity of the brush fires and wildfires that prevail in an area over long periods of time. Fire regimes may alter depending on climate such as temperature and precipitation. Climate affects wildfire risks primarily through its effects on moisture availability as well as its effects on dry conditions.

The purpose of the study was to examine how wildfire risks and property losses due to those risks will change under different climate scenarios relating to precipitation and temperature (Westerling & Bryant).

It is unknown where the study took place and there were no participants involved in the study, but the domain of the analysis covered California, Nevada, and parts of neighboring states.

This study did not involve an intervention. The phenomenon explored was the impact of climate change on the total burn areas and the severity of ecological and other economic impacts pertaining to wildfires. The different climate scenarios examined ranged from a scenario with increased precipitation and temperatures increasing less than 2℃, to a scenario with decreased precipitation and temperatures increasing more than 4℃. In the past couple of years, wildfires in the United States have been increasing in destruction. Climate change is one of the main factors to these recent catastrophic wildfires.

The analysis covered California, Nevada, and parts of adjacent states on a 1/8° grid contained within 124.5625° to 113.0625° West Longitude and 31.9375° to 43.9375° North Latitude. Researchers, Westerling and Bryant, developed a logistic probability model to estimate the probability of fires exceeding a threshold of 200 hectares occurring in any given month as functions of climate, hydrology, and topography.

The model was created using 1980-1999 statistics of large fire frequency, precipitation, temperature, simulated hydrologic variables, and elevation. The 1980-1999 period of time was used because it was the longest period of time of when the all of the data was available.

In order for Westerling and Bryant to estimate the economic damage caused by wildfires, they associated spatial property data with the geographic location of past and hypothetical wildfires to estimate the expected number of structures at risk, structures lost, and the value of these structures, for wildfires 200 hectares in size.

The A2 and B1 emissions scenarios from global climate models, Geophysical Fluid Dynamics Laboratory (GFDL) and the Parallel Climate Model (PCM), were used for comparison of the 1980-1999 model. The scenarios compared were from the time periods: (2005-2034); (2035-2064); and (2070-2099).

The dependent variable measured in this study was the predicted fire risks in California. There were four independent variables that were measured in this study: soil moistures levels; snow water equivalent levels; precipitation levels; and maximum temperature amounts.

The data was analyzed through the GFDL, PCM, A2, and B1 emissions scenario models. Data was also analyzed with the use of wildfire predictions based on fire history from (1980-199). The variable Infiltration Capacity hydrologic model was utilized as predictions of soil moistures and snow water amount. The results indicated that higher temperatures generally promotes fire risk overall, but a decrease in moisture due to lower precipitation and higher temperature leads to reduced fire risk in dry areas. The effects of lower moisture availability on fine fuel production, outweighs the effects of temperature on fuel flammability in dry grass and shrub lands at lower elevations.

Several conclusions can be made about the impact of climate change on wildfire risk. Higher temperatures increase wildfire risk in California. Higher temperatures lead to drier areas which increases the fuel flammability. At the same time, reduced moisture availability due to lower precipitation and higher temperatures will most likely reduce the fire risks. Fuel flammability and the availability of fine fuel are the two main factors that decide wildfire risk (Westerling 3). The wildfire risk is a positively correlated with the total burned area and economic impact. Understanding the impact that climate has on wildfires is very important when creating mitigation plans. The fire frequency and intensity will vary based on the climate. Overall, it seems that the increasing temperatures in California will lead to more destructive wildfires.

There were several limitations and weaknesses in this study that the current study addressed. First, there was no analyzation regarding the impact of the Santa Ana Winds. A Weakness on the prediction models and formulas is that they could be wrong. The model that the authors used contained data from 1980-1999. Also, fire predictions are extremely difficult because most of the time the origin of a wildfire comes from human action. It is tough to predict when a human will accidently ignite a fire.

In the past couple decades, wildland-urban interfaces have been growing in the conterminous United States. The wildland-urban interface (WUI) is the area where houses meet or intermingle with undeveloped wildland vegetation (Radeloff 2). The WUI is where human-caused fire ignitions are most common. It is very dangerous that the WUI increases to grow as time goes on.

The purpose of the study was to conduct a spatially detailed assessment of the WUI across the contiguous United States to provide a framework for scientific inquiries into housing

growth effects on the environment and to inform both national policymakers and local land managers about the WUI and associated issues (Radeloff 3).

The study took place the University of Wisconsin-Madison. There were no participants in this research study because it was a qualitative study.

The issue explored in this research study was the expansion of housing development in wildland-urban interfaces. Wildfire frequency increases, as housing development increases in the WUI.

The researchers utilized the existing WUI definition published in the Federal Register (USDA and USDI 2001), which was applied across the conterminous United States using housing density and land cover data in a Geographic Information System (GIS).The researchers also used the Federal Register definition to identify what classifies an area as a wildland urban interface. WUI areas must contain at least 6.17 housing units/ ㎢ (or 1 house/ 40 acres). The researchers analyzed housing unit counts from the U.S. 2000 decennial census at the census block level. In addition to housing density, the WUI assessment required fine-resolution vegetation data which was derived from the U.S. Geological Survey (USGS) and National Land Cover Data (NLCD).

The researchers collected the previously noted data to locate and mark the WUI in the Geographical information system maps. The Intermix WUI is defined by the Federal Register as an area above a threshold of 6.17 housing units/㎢ that is dominated by wildland vegetation. The researches set the threshold for wildland vegetation at 50% of the terrestrial area of a given census block.

There were variables measured in this research study. The researchers only extracted data from available documents and sources. Then they inserted the data into a geographic information system map.

The data was analyzed by studying the wildland urban interfaces with the qualifications of census blocks above 6.17 housing units/㎢ that contained less than fifty percent of wildland vegetation, bet is within 2.4㎢ and 5㎢ of an areas that is heavily vegetated. The researchers also conducted a sensitivity analysis to test the robustness of the estimates of WUI area and WUI houses. There was also a data coding consisting of the two WUI components: interface areas; and intermix areas. Areas where houses and wildland vegetation intermingle are referred to as intermix WUI. Developed areas that abut wildland vegetation are characterized as interface WUI.

The results indicated that across the conterminous United States, the WUI covers 719,156 km² (9.4% of the land area) and contains 44,348,628 housing units (38.5% of all housing units). State-level analysis showed that California contains the most homes in the WUI with 5.1 million. In the Midwest, less than twenty five percent of homes are found in the WUI due to low amounts of wetland vegetation. Metropolitan areas also tend to limit the proportion of a state's homes in the WUI. Intermix WUI areas account for 80.7 % of the WUI. Interface WUI are responsible for the remaining percentage.

Several conclusions can be made about the data pertaining to WUI in the contiguous United States. Housing development near vegetation is very common in the Conterminous United States. One-third of the housing units in the Conterminous United States are located in the WUI. The Southern California fires of 2003 are a perfect example of the devastating effects that wildland fires can have in WUI areas. The 2003 wildfires were immense and extremely

destructive, yet it only burned a lilliputian areas of the WUI. These past events should emphasize the magnitude of the task at hand regarding urban sprawl. It is imperative that California implements policies combined with fuel treatments to substantially decrease the fire threat to homes. It is very important for California to understand the effects of WUI and acknowledge the grand proportion of WUI in the United States.

The weakness in this qualitative research data is that it was conducted in 2005 which is fourteen years ago. This data is considered out of date for most research purposes, however the fact that this issues has been looked at over a decade and hasn't been solved or hindered is eye opening.

The research literature indicates that climate change and urban sprawl in WUI are the leading factors to California's recent and historical wildland fires. The three research articles that were evaluated in this section provide statistics and facts on the devastating effects of climate change and urban sprawl regarding the intensity and frequency of California wildfires. The articles did a phenomenal job of explaining how urban sprawl increases the chances of ignition to wildfires. The articles also proficiently explained how climate change affects the fuel quantity in an area, as well as the flammability of the fuel. Although the articles provided a plethora of credible information, there were several weakness to the studies. These limitations included one of the articles having been conducted in 2005 and another in 2008 which may be considered out of date research. One could question the relevance and accuracy of the information.

The intensity and danger of California wildfires has previously been addressed. Unfortunately, the magnitude of this wildfire issue has only gotten worse throughout the past decades. California has been doing many things wrong in respect to hindering the immense destruction of the 2018 wildfires. Urban sprawl is a main contributor to more dangerous

wildfires. However, California has continued to increase housing development in the wildland urban interface due to personal, financial vendettas. Many California cities and towns have continued to ignore fire mitigation advice. Implementation and enforcement of regulations is complicated due to jurisdiction of mitigation.

On October of 2017, the Tubbs Fire in Santa Rosa California consumed 36,807 acres of the Sonoma and Napa County. The fire also destroyed 5,636 structures and killed 22 people (Insurance Information Institute). In some scenarios such as the Great Chicago Fire of 1871, the city responds in a positive way. Chicago required all new buildings to be to be constructed with fireproof materials such as brick and stone. In Santa Rosa, the city dealt with a dilemma. It seems only logical to build the new houses with fire resistant material and sprinkler systems. However, there is a dire need for housing in Santa Rosa so they want to rebuild the houses as quickly as possible.

The purpose of this article was to inform the public that Santa Rosa is setting itself for failure. After Sonoma County lost 55,000 homes, they set themselves up for the same failure.

The setting where the research was conducted is not applicable in this scenario because this piece of work is an Article from *Los Angeles Times.* There were also no participants since this source is an article and not a research study.

The issue of the article was that California is not changing anything regarding fire mitigation. Many cities in California such as Santa Rosa do not want make their houses more fire retardant because those codes would tack on tens-of-thousands of dollars to the already expensive projects. Michael Steinberg, the wildfire division director for the National Fire Prevention Association, stated that Santa Rosa lacks the funds to enforce those codes, therefore

those codes would be useless. At the end of the day, people will build houses as cheap as possible to benefit their profits.

Because this source is not a research study, there wasn't a standard procedure used to conduct a study.

There were no variables or measurement instruments involved in the article, *How do you build a safer city after California's worst wildfire? Santa Rosa Officials Say the Answer May Have to Wait*.

The article extracted information regarding the destruction of the Tubbs Fire as well as direct quotes from fire safety experts, wildfire division director for the National Fire Prevention Assn, Santa Rosa's Mayor, Santa Rosa's assistant city manager, and the block captain for a fire-recovery neighborhood group.

The data was analyzed through interviews from people of political and fire safety influence. The Results led in a clear message that fire mitigation and building codes are not the main priorities pertaining to rebuilding houses in the Sonoma County. There are no plans to impose zoning ordinances that might restrict building in an extremely fire-prone area.

It seems like California is what one would say "shooting themselves in the foot". In 1964, Santa Rosa developed its first mitigation plan after the Hanly Fire. The plan encourages developers to consider earthquakes and floods when designing and constructing new buildings. Over fifty years later, it seems that California continues to neglect the risk of wildfires.

Because this article was not a study, this piece would be considered very weak for a literature review. However, Los Angeles Times is a relatively credible source.

There is a lot of criticism when talking about fire mitigation in California. Many people blame the state of California for not implementing and establishing programs for fire mitigation

purposes. The fact is, California, as a state, is attempting to reduce the wildfire risks. However, only three percent of California's forestland are state-owned. Fifty eight percent of the forest land is federally owned and the last thirty nine percent is privately owned (fire.ca.gov).

The purpose of this article was to explain that California is attempting to better itself in respect to fire mitigation. California is investing unprecedented resources into improving forest management, combating tree mortality and increasing carbon capture in forests. However, the decrease of the federal government funds to the U.S. Forest Service is hampering California's endeavors to decrease the wildfire risks. The setting of this research study is unknown.

The issue of the research study is that the federal government has decreased the U.S. Forest Service's budget every year for last four years. California has invested 160 million dollars in the California Climate Investments Forest Health Grant Program to restore forest health. Also one hundred million dollars was invested to prescribed fire and fuel reduction. In the past year, the state has also boosted education and outreach to landowners on the most effective ways to reduce vegetation and other forest-fire fuel sources on private lands. California has also launched new training and certification programs to help promote forest health through prescribed burning. The federal government decreased its U.S. Forest Service's budget from 7.1 billion in 2016 to 4.8 billion in 2019.

Because this source is not a research study, there wasn't a standard procedure used to conduct a study. There were no variables or measurement instruments involved in the article, *Just the Facts: California Forest Management.*

The data listed everything California has done in the past year to decrease the wildfire risks. There were no results in this article because it was not a research study. California is helping the federal government manage its forests. Over the past two years, the state made more

than one hundred million dollars for treating the forest lands, 49 percent of which are federally owned. However, the government is hampering California's fire mitigation endeavors. The limitation of this study, is that this article was not a research study.

There are several bad decisions that California has made in respect to risk mitigation. The lack of plant management and removal of highly flammable trees is a problem in respect to mitigation purposes. Also, policy makers tend to spend their funds on fire suppression rather than fire mitigation. A survey of eight communities with histories of fire by the University of Wisconsin showed that they almost always react by putting more funding toward emergency response (Doumar, 2018).

The purpose of this study was to expose the flaws of California in respect to fire mitigation. The researcher explains how California should tackle wildfire prevention. The setting of this research study is unknown.

The issue of this research study is that California has minimum plant management regulations and for the existing regulations they have, they do not proactively enforce them. Cities rarely issue citations and many residents don't have the funds to remove highly flammable trees or shrubbery. Another issue is the low allocation funding for mitigation. There is a much greater emphasis on fire suppression. A survey of eight communities with histories of fire by the University of Wisconsin showed that they almost always react by putting more funding toward emergency response, and not mitigation (Doumar, 2018).

Because this source is not a research study, there wasn't a standard procedure used to conduct a study. There were no variables or measurement instruments involved in the article, *How California Cities Can Tackle Wildfire Prevention.* The major themes that were discussed in

the article were: jurisdiction of regulations and laws; the lack of resources and funding for mitigation; and the decision of California cities continuing to build in WUI.

California needs to understand the importance of mitigation. They need to allocate for more resources pertaining to mitigation, this includes a budget to support the enforcement of the implemented regulations. California also has to stop building in WUI.

There were many weaknesses in this article. For one, this literature review piece is an article, and not a research study. However, City Lab is relatively credible source.

California has made many mistakes in the past years to prepare for the destructive wildfires. California has continued to increase housing development in the wildland urban interface due to greedy motives. The housing developers do not want to build new houses that meet the fire codes and recommendations because it would cost significantly more. It is very important to convince the cities and the federal government to participate in the movement toward a safer California. The state needs to convince the federal government to increase the declining forest management budget. California also needs to create incentive for city residents to take the California Board of Forestry and Fire Protection's recommendations.

It is well known that California is very prone to wildfires and only is getting more destructive and frequent. However, California is failing to implement mitigation plans or programs that will help hamper the destruction of future wildland fires. There are other states in America as well as other countries that are facing the same predicament as California. However, these countries and states don't experience the same levels of destruction due to the implementation of policies, regulations, and mitigation programs.

California is not the only state that is experiencing wildland fire problems. In fact, the there are other countries that are facing similar problems as California. Australia has experienced

wildland fire problems, however they have developed a more effective policy to reduce the destruction of fire. Australia created and implemented a policy called ‘Prepare, stay and defend, or leave early’ policy. Using this approach, trained residents decide whether they will stay and actively defend their well-prepared property or leave early before a fire threatens them. Australian strategies have the distinct advantage of engaging and preparing those most affected by such fires: homeowners. Responses after immense UWI fires in California have been responded with the procurement of fire suppression resources, particularly at the state level.

The purpose of the study was to study effective mitigation plans and programs in Australia to identify what California can do to reduce the wildfire risks. By examining the Australian model, we may approach a more sustainable coexistence with fire as well.

There was no information regarding where the study took place, for this study was qualitative. There were no participants involved in this study. The issue of in this research study is that California has the potential to reduce the wildland fire risks, but they don’t help themselves. California and Australia face similar wildfire issues, however Australia implements mitigation programs, and California doesn’t at the same diligence.

There was no procedures involved in this research study, for it was a qualitative research. Due to the same fact, there were no variables or measurement instruments. The research study proves that mitigation plans can greatly reduce the wildfire risks. In this study, the data coding used was: UWI building codes; land-use planning; fire suppression; and insurance issues.

The research identified four areas that can reduce California losses in the WUI. Those four areas are: UWI building codes, land-use planning, fire suppression, and insurance issues. California started mandating building codes including ignition-resistant construction standards about a decade ago. The codes only apply to new buildings in very high WUI areas where the

state has financial responsibility. This policy, started in 2008, is a good start but much more needs to be done. The continued expansion of the UWI and fragmentation of fire-prone wildlands is also direction related to the increases in the number of ignitions. Alternative policies and regulatory approaches aimed at reducing the inconsistencies in local land-use planning should be implemented which Australia did in 1997 under the Rural Fire Act.

Fire suppression costs have been increasing both at the federal and state level. A large proportion of fire budgets are focused solely on fire suppression. There are limited funds for the reduction of hazardous fuels and public education. A 2007 study by the Natural resources Defense Council reported an average cost of only $2,510 per home to make improvements such as vent screening, and the enclosure of open eaves to prevent ember intrusion. Insurance companies can also get involved and provide incentives for homeowners to reduce structure-based wildfire hazards.

The weakness of this research study is that it was conducted in 2009, ten years ago. Therefore, the information isn't updated, but the issues discussed are still relevant.

The dramatic expansion into the WUI places property, natural assets, and human life at risk from wildfire destruction. The study of successful mitigation programs can be very useful because the information can then be distributed throughout the United States. Hopefully California receives that relayed information and implements those programs.

The purpose of this study is to research wildfire risk reduction programs in 25 U.S. states to identify the most effective programs. The setting of where the study took place is unavailable. There were participants in the survey portion of the research study. The participants were administrators or officials of the risk reduction programs list on the National wildfire Programs Database website.

The issue in the study is that urban sprawl in WUI is leading to more destructive wildfires. Starting in 2003, the researchers surveyed the administrators of regulatory and voluntary wildfire risk reduction programs in 25 U.S. states. The researchers analyzed the following of the mitigation programs: how they are organized; what they are trying to accomplish; what are the obstacles; and how well they may be working. The research consisted of two distinct parts. First, the researchers developed the National Wildfire Programs Data website, cataloging state and local wildfire risk reduction programs. As of the summer in 2003, the researchers had investigated 150 programs in 25 states. The second part involved a survey which gathered detailed information about the objectives, activities, and experiences of managers of state, county, and local risk mitigation efforts.

The variables measured or asked in the survey were: education; hazard assessments and mapping; homeowner assistance; and implementation of regulations. The data was analyzed through the responses in the surveys.

Fifty five out of fifty six managers reported that education and public outreach was part of the program's objective. Respondents listed their methods to educate the public about the dangers of living in wildfire-prone areas, and the importance of creating defensible space around their homes. The researchers had received important mitigation information such as a list of recommended fire-resistant plant species.

Forty-six out of fifty-six survey respondents claimed that they had completed or are working on state and local wildfire risk assessments and mapping projects. Forty-seven managers claimed that their programs provided direct assistance to homeowners. Twenty-six program managers reported that their wildfire mitigation program include a regulatory

component. Respondents indicated that the most serious obstacles to the success of their programs have to do with limitations of resources and negative attitudes of the residents.

The program activities that are seen as the most effective were evaluated. The responses indicated that a combination of program elements has the greatest effect on changing the behavior of residents of WUI communities to reduce hazardous fuels on their properties. The managers were very confident in their hands-on, practical assistance to private property owners. The two most important proactive management activities are collaborative planning and program evaluation.

One of the biggest challenges for risk mitigators is motivating the public to reduce wildfire risk. It is inherently difficult to change the behavior of property owners. Many residents within WUI communities had no direct experience with the devastating effects of wildfire and underestimate the risk.

The limitations of this study, involved the survey given through email. Surveys through email have the potential of technical difficulties with recording answers.

Between 2002 and 2011, the United States wildfire insured losses amounted to 7.9 billion dollars compared to the 1.7 billion dollars from the previous decade. Risk management can prevent future wildfire disasters in the wildland-urban interface.

The purpose of this article was to identify which strategies were best for preventing wildfires. The setting of this study was not provided and there were no participants required.

The issue of the article was the significant increase in wildfire damages. Because this article was not a research study, there was not procedure. There were no variables measured, but the articled explained the importance of improving three themes: fire adapted communities, wildfire response, and resilient landscapes.

It is very important to focus on protecting structures and improving community preparedness for inevitably extreme fire behavior and effects.

There were no limits to this article because it was not a research study. However the article is relatively old, it was published in 2013.

Climate change; and urban sprawl in wildland urban interface zones are very big problems regarding the destruction and frequency of wildfires. Humans are the leading ignition cause to wildfires, therefore increasing the human population in the WUI is very dangerous. Climate change strongly affects the fuel flammability and fuel richness. The amount of precipitation before a fire season affects the abundance and dryness of vegetation in the wildland.

As wildfires are getting worse, California has not been taking appropriate action in response. Urban sprawl is the huge factor to California's most destructive fires on record, however, many cities continue to increase housing development in WUI. There is only so much the State of California can do because they do not have jurisdiction to regulate local or federal land and unfortunately only three percent of California's forestlands is state-owned.

California is failing to implement mitigation plans or programs that will reduce the destruction of future wildland fires. Other countries such as Australia face the same wildfire issues but are reacting more rational. It is imperative that California finds a way to convince the Federal government and cities to participate in the goal to reduce wildfires. California should think of incentives for the residence to cooperate in plant management and fire mitigation.

Methods:

California has recently experienced its most destructive wildfires in state history due to climate change and urban sprawl. The questions explored in this research study are: what are the

most effective mitigation methods for California wildfires; how can California convince its residents to participate in plant management; what is California doing wrong in respect to fire mitigation; what mitigation programs are working for other countries. This research study was qualitative which involved researching of many different research studies and articles.

The Study took place at Anna Maria College which is located in Paxton Massachusetts. There were no participants involved in this study, because the research study involved exploring other research studies and articles.

In this research study, the research problem was broken into three different areas: research studies related to the impact of climate change and increased urban sprawl in wildland urban interface zone will be addressed; discussion on what California has been doing wrong in respect to hindering the immense destruction of the 2018 wildfires; mitigation methods and programs that will help hamper the destruction of future wildland fires. The researcher explored many different articles and research studies in order to conduct the qualitative research.

The Body is the longest section of your Thesis. Its length will depend on the complexity of the concepts and arguments you are employing and the amount of evidence you need to provide to convince your audience. Each paragraph in the body should make one point, expressed clearly in a topic sentence; the body paragraphs must provide evidence and analysis that support the topic sentence and each topic sentence should support the larger argument you are making in the Thesis.

Results:

Although California has recently experienced it's most destructive and dangerous wildfires, there are many mitigation plans and programs that can be implemented to dramatically

reduce the wildfire risks. In order to get the most out of the fire prevention attempt, it is very important to understand the causes to the increased magnitude of the California wildfires.

There are two main solutions to reducing the destruction of the wildfires in California: convincing the residence of California cities to partake in land regulations and building codes; convincing the housing developers to restrict urban sprawl in wildland urban interfaces.

Discussion:

California, throughout history, has been prone to wildfires. However, in the last couple of years, 2018 and 2017, the intensity and destruction of its wildfires has increased exponentially.

California needs to convince the city residents to participate in the mitigation movement. California might have to create positive or negative incentive such as taxes or tax reductions.

The purpose of this study is to find the best methods and programs to minimize the destruction of the California wildfires

California needs to convince its residents to take part in plant management, defensible space, and building codes. It really comes down to the participation of the residents. California as a state can implement regulations, and codes but that only pertains to state-owned land. Unfortunately, cities only have to abide as they see fit. Forest management also comes with jurisdiction issues. Only three percent of California's forestlands are state owned. The rest is federally or privately owned. Therefore any regulations pertaining to forest thinning and prescribed burns are directed only to state owned forestland. The federal government has continued to cut the US Forest Service budget, however that is most likely do to the poor participation rates of the cities regarding fire mitigation.

California also needs to convince its housing developers to restrict or at least reduce urban sprawl in the wildland urban interfaces. Urban sprawl is a main contributor to the more

frequent wildfires. After all, the majority of fire ignitions are human caused, therefore it is only intuitive that urban sprawl in the wildland would drastically increases the destruction of wildfires.

There are many limitations to this qualitative research study. Firstly, the fire science and emergency management is relatively new in terms of a field of study. Fire science is not as researched as other topics such as education, psychology, and history. Also the topic of my choice was very recent. I chose to conduct my research on California fires specifically the 2018 and 2017 fires. Therefore, there is limited research regarding my topic. Due to my limited resources, I wasn't able to find an abundance of research studies pertaining to California wildfires or other topics such as urban sprawl in wildland urban interfaces. Unfortunately, I had to resort to some articles which is made my literature review weaker. When I did find research relating to my topic, the studies were about a decade old.

For future reference, any researchers intending on conducting research similar to mine, should wait a couple years. This will most likely increase the resources that they can use. After a couple of years, there will be many more studies that the researcher can utilize.

The three main lessons learned throughout this research study is: California fires are progressively getting more destructive, costly, and deadly due to climate change and urban sprawl; jurisdiction limits mitigation plans and programs; and cooperation from the public is imperative to unlock the full potential of mitigation and fire prevention.

Climate change has a huge impact on the abundance of fuel as well as the flammability of the fuel. The hotter temperatures in California are leading to dryer plant life which increases the richness or flammability of the vegetation. High rates of precipitation increases the amount of vegetation which also leads to more destructive fires. Tackling the issue of climate change is a

whole other issue. However, this research study stresses the importance to be aware of climate change and how it affects wildfires.

The state of California only has a limited amount of impact toward fire prevention and mitigation. The state understands and acknowledges the fact that California wildfires are getting worse. However the state cannot enforce any land management regulations to cities. This is why the question should be redirected to: how can California convince its citizens to get on board with land management and building codes. California also has to find a way to convince housing developers to discontinue expansion in the WUI whether it has to be through education or disincentives.

It absolutely necessary that California finds a way to get the city residents and the federal government part of the mitigation plan.

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