Contribution of Weather Conditions on the Spread of Wildfires with Management System for Preparedness Enhancement

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Abstract

Natural or human-caused wildfires happen in different parts of the world. Its harmful effects have increased over the past few years in all aspects. This paper aims to study one of the main important factors affecting both the initiation and propagation of wildfires. A root cause analysis was done to study the most dominant weather conditions across the five largest wildfires that took place in California in the last few years. Another analysis was performed using the IFTDSS software to investigate and determine which of the fire weather conditions had the greatest impact on the wildfire's various parameters. A preparedness management system for wildfires has been created, focusing on the main areas that need to be taken care of.

Keywords
Fire weather, Climate change, Fuel buildup, Burning Index, Preparedness management plan

1. Introduction

Wildfires are known to be a natural phenomenon that helps preserve the ecosystem of forests by cleaning the floor from debris and nourishing the soil. These wildfires occur regularly since the birth of the earth. However, the intensity of such fires has been increasing in the last decade due to reasons related to drought, a century of suppression that led to the accumulation of unburned fuel and climate change. Since then, huge efforts and investments have been placed to combat the spread of wildfire by using weather predictions, artificial intelligence, and management plans in terms of staffing, preparedness, and prevention. Weather is a driving factor in determining the intensity and scale of a wildfire. Improving weather predictions in areas prone to a wildfire can help prevent such phenomena from spreading beyond control. Conditions such as temperature, relative humidity, wind, and precipitation are driving factors of any large wildfire. By studying the effect of each factor, the existing efforts can be further improved to better prepare and enhance the combating plans already in place.

1.1 Objectives

1. Study the effect of weather conditions on wildfires
2. Provide a preparedness management plan to deal with wildfires more efficiently
3. Decrease the cost of firefighting, fuel management, insurance and disaster assistance

2. Literature Review

2.1 Wildfire definition and statistics:

According to the International Disaster Database, wildfires can be defined as "uncontrolled burning fire in wildlands that damages forestry, agriculture and buildings". They can ignite accidentally through natural causes such as lightning or deliberately by human beings. Such phenomena can be essential for the conservation of ecosystems and vegetations if it happens in a controlled and natural manner. However, once it expands beyond control, it can cause severe effects on the environment, society and economy (Freiria 2011). Wildfires have been burning more acres since the 1990s, indicating a major concern to the public over the main reasons for this phenomenon. According to NICC (The national Interagency Coordination Center) Wildland Fire Summary and Statistics annual reports, there is a slight decrease of the number of major wildfires in the US between 1991and 2020. However, as Figure 1 shows, the trend of the number of acres burned indicates an increase from 2 million acres in 1991 to 10 million acres in 2020. These numbers become even more concerning when they're put against all the data collected since 1960. According to the same resource and as shown in Figure 2, the largest wildfires ever recorded since 1960 based on acreage burned in the US have occurred in the last two decades (2007 – 2020 specifically). (Hoover 2022)

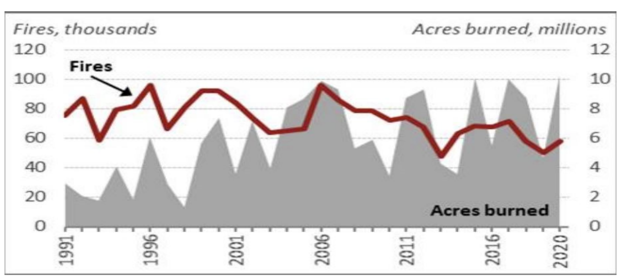

Figure 1. Annual wildfires and acres burned (1991 - 2020)

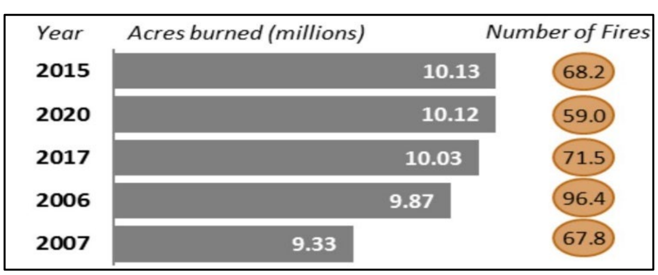

Figure 2. Top five years with largest wildfires acreage burned since 1960

In addition, wildfires have a large impact on communities, lost lives, and damaged structures. They disrupt transportation, power and gas services, water supply and communications. In 2018, wildfires have burned around 24,488 structures in the US, 70% of which are residential places, and most of these structures happen to be in California. According to the National Fire and Aviation Management, structures burned are increasing over the last 16 years due to the increase in the size of wildfires. These wildfires are causing home loss, evacuation of people and even fatalities. Figure 3 shows the structures destroyed by year in the US Figure 4 shows the expenses of firefighting wildfires over the years. (Barrett 2022)

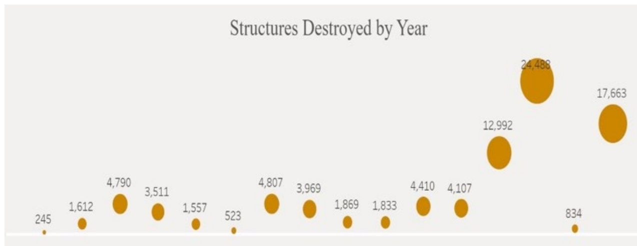

Figure 3. Structures destroyed by wildfires in the US (2004-2020)

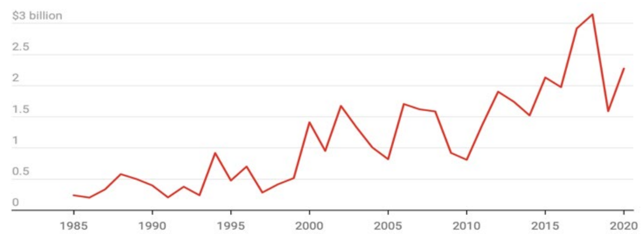

Figure 4. Total costs of Wildfire Firefighting over the years

2.2 Why do we have wildfires?

Wildfires are considered to be a natural phenomenon that has to exist in the ecosystem to maintain the balance, remove exotic species, add nutrients for trees and vegetation, and remove undergrowth. However, they have dramatically increased in the past few decades, causing a lot of severe damage to properties, the economy, and human lives. Wildfires occur for several reasons that influence either their initiation or their propagation. The main leading causes of wildfires can be regulated by the interaction and relationship between the different elements, including fuel structure, climate, weather, composition, as well as the topography of the area experiencing wildfires [9]. Wildfires at these locations will occur and expand massively under suitable environmental conditions that vary in both space and time at different landscape locations, resulting in heterogeneous patterns of wildfire across the areas and varying in terms of severity and probability of occurrence.

Human activities, called anthropogenic variables, are considered to be one of the main reasons that play a huge role in the initiation and propagation of wildfires. The human population has increased in the last few decades, forcing them to build and live in any area that could meet their needs. As a result of that, a huge population starts to crawl toward natural vegetation areas, creating what is called a "Wildland Urban Interface" (WUI). The use of these forest lands by humans alters the nature of wildfires through unintentional or accidental ignitions, fuel alteration, and cultivation .There are a few things that influence the occurrence of wildfires due to WUI, including increasing road traffic, trial (Rasch et al. 2019)density, and the urge to increase transmission lines and electrical infrastructure, making these areas more prone to wildfire. Other activities include mining products, smoking, burning vegetation, campfires, and accidental ignition, which leads to the initiation of fires. The researchers found out that about a third of the total cost used to firefight wildfires is human-caused and half of the firefighting costs go to repair, fix, and protect buildings and houses in that area. Figure 5 illustrates the main causes leading to wildfires.

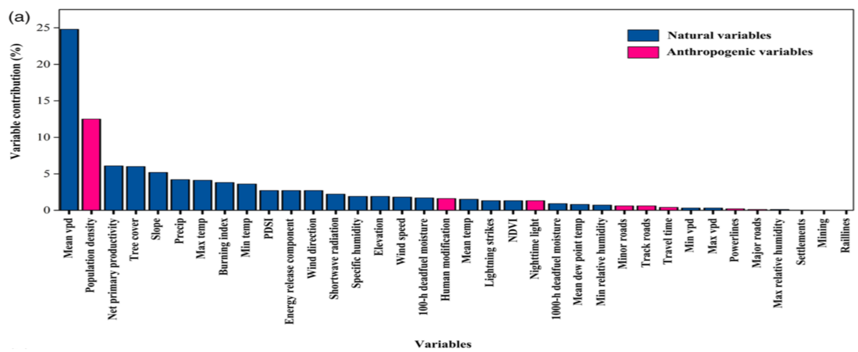

Figure 5. Natural and Anthropogenic causes leading to wildfires

2.3 Fire weather Factors

Meteorological circumstances pertain to fire weather, which analyzes times with a high probability of fire as a result of a combination of weather elements that aid and speed up the wildfire process. Temperature, relative humidity, wind, and precipitation, as well as the instability of atmospheric conditions, are all important factors that influence the intensity and severity of a fire. Three primary factors have been studied: temperature, relative humidity, and wind. Different investigations have shown that when these three factors interact and converge, fire development occurs in specific places. The measure of how near the air is to being saturated by water vapor is known as relative humidity.
Three primary factors have been studied: temperature, relative humidity, and wind. Different investigations have shown that when these three factors interact and converge, fire development occurs in specific places. The measure of how near the air is to being saturated by water vapor is known as relative humidity. When humidity levels are extremely low, air molecules become dry, sucking moisture from the ground and vegetation, leaving them parched and exposed to fire. Temperature and relative humidity have a definite inverse relationship. The relative humidity decreases as the temperature rises.

Reduced relative humidity, according to the study, can exacerbate and increase the number of fires. Furthermore, temperature contributes to the heating of the fuels, increasing the likelihood of their ignite. The wind is also a significant factor since it supplies oxygen to the fire and helps to increase the land's dryness rate, allowing for more fuel to be burned. The direction and speed of the wind are also vital to consider because they aid in shifting the fire, boosting its spread and intensity over a vast region. These ingredients must be present at a particular level for fire weather to exist (Mhawej et al. 2015). According to NOAA (National Oceanic and Atmospheric Administration), if the relative humidity is within 5% of regional thresholds defined, temperatures of at least 45–55°F, depending on the season (winter: 45°F; summer: 55°F; spring and fall: 50°F), and sustained wind speeds of 15 mph or greater are considered to be the threshold of the weather elements, and the areas experiencing these conditions are more likely to experience fires. Figure 6 shows the effect of these elements and their exitance in different parts of the US. Recent studies showed that the increase in worldwide temperatures and frequent heatwaves have increased the wildfire likelihood by promoting dry conditions that are considered conducive to fire weather (Matthew et al. 2020).

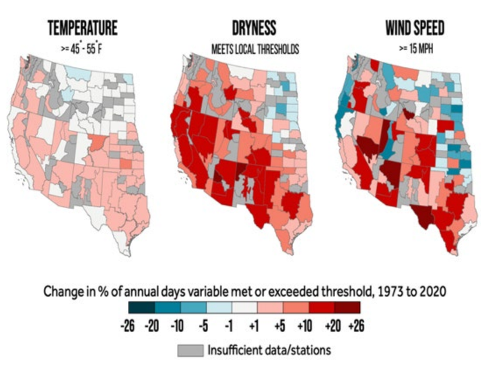

Figure 6. Fire weather elements in different parts of

2.4 Fire weather and Climate change

It has been observed that for the past few years, fire weather days have increased in countries experiencing wildfires, approximately in all the regions where they are mainly driven by two main factors, which are heat and dryness. Climate change can be defined as a noticeable long-term change in weather conditions and their patterns, mainly temperature and precipitation, that shapes and defines our planet locally, regionally, and globally across the continents. There are many factors contributing to climate change. However, studies and research have shown that human activities were the primary cause of this phenomenon over the last 50-100 years. Human activities include fuel burning, such as fossil and coal for industrial purposes and power generation. These activities increase the amount of carbon dioxide as well as the other greenhouse gases such as methane, nitrous oxide, and water vapor, which mainly work as preventative layers to protect the air from the harmful effects of the ultraviolet coming from the sun. Yet when it increases over the years, it affects negatively since they absorb the light waves and do not re-emit them and acts as a natural heat trap, which causes the surface of the earth to be warmer year by year. There are several indicators and data observed to study the climate change including precipitation, temperature, dew point temperature, vapor pressure deficiency, relative humidity, wind speed and direction, dead fuel moisture, fire index, and lighting strike density.

Observing, recording, and analyzing data on climate change and weather conditions is of extreme importance to studying and predicting the ignition and propagation of wildfires. The climate, with its slowly varying aspects of the atmosphere, hydrosphere and land surface system, which determines the total quantity of vegetation (fuel) available for combustion in certain locations, also indicates both the duration and degree of severity of the wildfire seasons. The weather on specific days with all of its parameters helps in monitoring and regulating the moisture content of vegetation and, consequently, its flammability potential. The frequency and severity of extreme fire weather are increasing as a result of climate change. According to studies in some parts of the world experiencing fire weather seasons, such as Australia, these conditions were approximately 30% more likely to happen due to climate change compared to past decades, and if the global temperature increases beyond 2℃, it will increase the probability of experiencing fire weather by four-fold. As a result of fire weather increasing, it drives changes in fire patterns and regimes. Figure 7 depicts the rate of increase in CO_2emissions over time, which has resulted in severe climate change patterns. (Matthew et al. 2020).

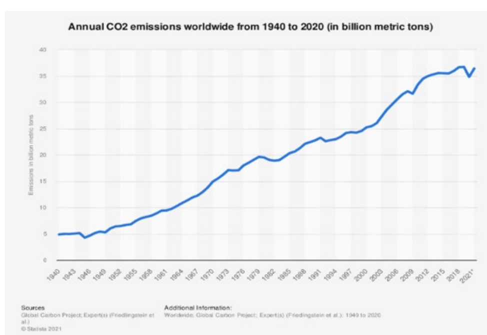

Figure 7. Annual CO2 emissions from the year

2.5 HSE codes and standards

Several wildfires codes and standards have been developed and implemented in areas of prevention, mitigation, suppression, ignition hazards and firefighter qualifications. The most used standards are:

- NFPA 1141: provides requirements to develop fire protection and emergency infrastructures to make sure wildland, rural, and suburban areas have the resources in place to protect people and properties from fire dangers.
- NFPA 1142: identifies the method of determining the minimum water supply necessary for structural firefighting purposes in areas where water supply can be a concern
- NFPA 1144: Provides methodology for assessing wildland ignition hazards and provide requirements for new buildings to reduce potential ignition from wildfires
- NFPA 1143: specifies management practices and policies needed to develop a wildfire management program

3.0 Methods

In order to investigate the effects of fire weather conditions on wildfire severity and fire behavior in general, two main methods were used. The first one is the root cause analysis to identify the root causes of the fire weather and the second methodology is by using special software (IFTDSS) to check which weather factors affect the wildfires the most.

3.1 Root cause analysis

The research investigates the main root causes of the top five wildfires in California's history. It sheds light on the worst fires to recognize the biggest common factor that causes incidents and to be able to control them. The 5 worst California's wildfires are ordered as August Complex, Dixie, Mendocino Complex, SCU Lightning Complex, and Creek. Figure 8 summarizes the studied wildfires:

FIRE	YEAR	ACRES BURNED
1 August Complex *Counties affected: Mendocino, Humboldt, Trinity, Tehama, Glenn, Lake, Colusa*	2020	1m
2 Dixie *Butte, Plumas, Lassen, Tehama*	2021	922.2k
3 Mendocino Complex *Colusa, Lake, Mendocino, Glenn*	2018	459.1k
4 SCU Lightning Complex *Stanislaus, Santa Clara, Alameda, Contra Costa, San Joaquin*	2020	396.6k
5 Creek *Fresno, Madera*	2020	379.9k

Figure 8. Top Wildfires in California

3.1.1 Root cause analysis results

According to the collected information about California's largest wildfires, the main common cause of all wildfires accidents is climate change which impacted different weather conditions such as humidity, wind, and drought. The root cause analysis of the California wildfire is summarized and mapped below in Figure 9:

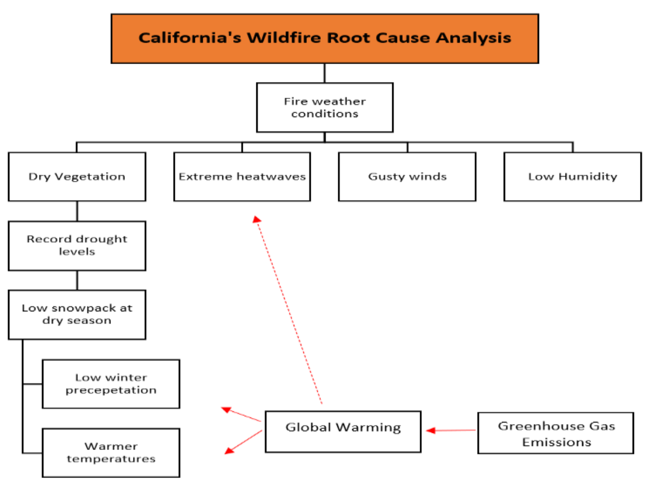

Figure 9. Root Cause of a fire weather conditions

3.2 IFTDSS Analysis

Introduction to National Fire Danger Rating System (NFDRS):

Fire behavior in the United States is monitored using the National Fire Danger Rating System (NFDRS) which is a system developed to assess the severity and seriousness of burning conditions and it includes user-defined constants and measured variables such as weather factors (temperature, humidity, precipitation and wind speed). In addition, it includes climate factors such as the vapor pressure deficit and the slope class, which is related to the topography. It also relies on the fuel moisture of a given place to predict the behavior of a wildfire using four main components:

1- Ignition component: the probability of a wildfire happening given the conditions provided
2- Spread component: the rate of spread of a wildfire in chains/hours
3- Energy Release Component: the expected heat release of a fire
4- Burning Index: combines both the Spread component and Energy Release component and is equal to the flame length of a wildfire multiplied by 10.

The burning index has a range from 0 to 110 and each range categorizes the fire based on its severity as follows:

- BI < 40: Fires can be attacked at the head or flanks by persons using hand tools
- BI = 40 – 80: Fires are too intense for a direct attack on the head by persons using hand tools. Equipment such as dozers, pumpers, and retardant aircraft can be effective.
- BI = 80-110: Fires may present serious control problems torching out, crowning, and spotting. Control efforts at the fire head will probably be ineffective.
- BI > 110: Crowning, spotting, and major fire runs are probable. Control efforts at the head of the fire are ineffective.

These ratings of wildfire help decision-makers, firefighting departments and forest service management better prepare for such incidents in applications such as staffing plans, preparedness, prevention and restriction plans. Figure 10 shows the NFDRS model with all its components, inputs and applications. (Walding et al. 2018)

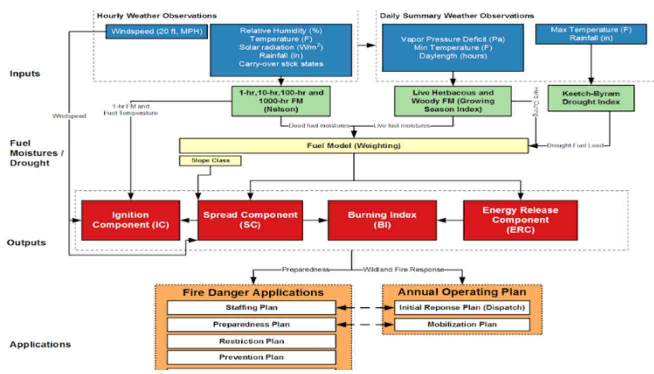

Figure 10. The NFDRS model

Drought factor

The NFDRS model relies heavily on the drought conditions of the forest, that is, the vegetation (fuel) moisture content. The hourly weather factors affect the moisture content of dead fuels. These can be categorized into different types based on the time (sometimes referred to as time lag) needed to reach an equilibrium moisture content, which is around 30%. Finer fuels such as dead grass or leaves are called 1-hr fuels because they take around this time to change their moisture. Bigger fuels such as 100-hr & 1000-hr are the branches and logs, which need a longer time to reach the equilibrium moisture content. (Matthews 2014)

Simulation on fire behavior based on weather inputs:

To assess the weather factors and relate them directly to the behavior of wildfire, a simulation was done to determine the contribution of each factor to the fire rating system components. An online simulation tool called "IFTDSS" was used for the study. It provides the ability to model fire behavior across an area of interest under a variety of weather conditions. A summary of the important inputs and outputs of the simulation are shown in tables 1 & 2:

Input	Details
Landscape	Vegetation Type
	Topography
Weather conditions	Temperature
	Relative Humidity
	Wind Speed
	Precepitation

Table 1. Inputs of IFTDSS

Output	Corresponding NFDRS component
Flame length (feet)	Burning Index
Rate of spread (chains/hr)	Spread Component
Heat per unit area	Energy Release Component

Table 2. Outputs of IFTDSS

The selected landscape for the simulation was Mendocino National Forest and the weather conditions were taken from Remote Automated Weather Stations. The following assumptions were made before starting the simulation:

- Ignition is assumed
- Same vegetation types
- Same topography
- Same initial fuel moisture
- Fuel moisture conditioning: adjustments of dead fuel moistures across a landscape based on the input weather factors 1 day before the wildfire starts
- When changing one weather variable, the other variables are assumed to be the same as the reference

Simulation Graphical Results
The effect of changing fire weather variables on the Burning Index, Spread Component and Energy Release Component can be seen in Figures 11, 12, and 13.

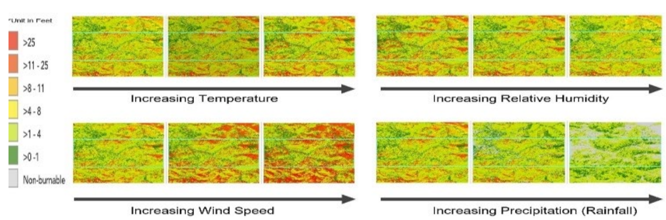

Figure 11. Effect on Flame Length (Burning Index / 10)

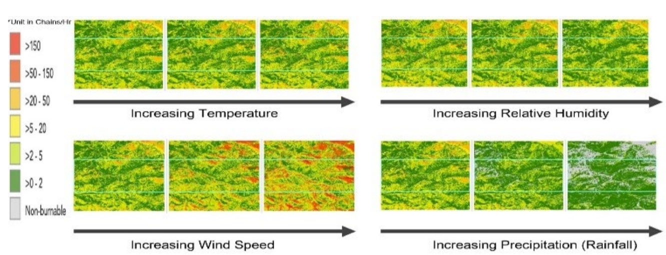

Figure 12. Effect on Rate of Spread (Spread Component)

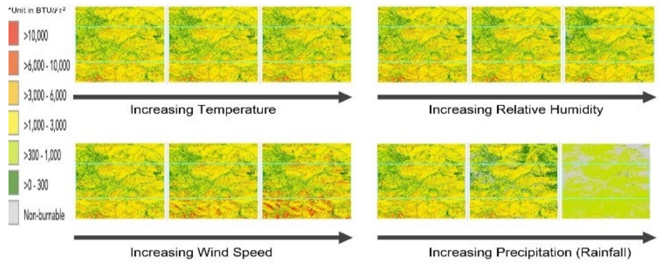

Figure 13. Effect on Heat Per Unit Area (Energy Release Component)

4. Discussion of the results

As seen from the results, the effect of increasing the temperature on fuel conditioning one day before the start of a wildfire has almost no impact on the three components studied in the simulation. The same results can be drawn with regard to increasing humidity. The reason might be because fuel needs more time to change its moisture content and sudden changes in temperatures and humidity, even with extreme changes, do not have a measurable effect on the wildfire behavior. Therefore, the previous day's data need to be incorporated into the simulation to determine the contribution of those two factors. On the other hand, the wind had a significant effect on the three components and a more substantial one on the Burning Index and Spread Component. Increasing the wind from 10 mph to 20 mph increase the expected flame length of fire and increasing it to 30 mph makes the fire catastrophic, resulting in a Burning Index of more than 110, a wildfire that is beyond control. Moreover, the spread component increases significantly when increasing the wind, meaning that such conditions are very favorable for wildfire to spread rapidly over large areas. Finally, having average daily rainfall one day before a wildfire can drastically minimize the possibility of having a wildfire beyond control. The findings emphasize the importance of wind in determining the severity of a wildfire. Having extreme heatwaves and drought conditions can indicate a chance for a wildfire to occur. However, monitoring wind speed is crucial to assess the size of the wildfire, and therefore, correctly assess the preparedness measures to match the expected magnitude of such incidents.

Areas for improvement of the simulation

The simulation results could be used to assess weather conditions in all areas of the United States by using a different landscape. By incorporating the relationship between weather, vegetation type and topography, such results could provide a better understanding of the wildfire intensity and spread. In addition, these factors can be used to assess the probability of a wildfire occurring which can be integrated into the prevention and fuel management efforts. Finally, using previous data on the effect of climate can give a good indication or prediction of future wildfire behavior, an area that must be considered as well.

5. Recommendations and further developments

5.1 Wildfires Preparedness Management Plan

Wildfires are one of the most catastrophic natural disasters that can happen and can cause severe damage in many areas. It can be inevitable sometimes, and a full management plan for preparing for it to come is necessary in order to minimize its harmful effects of it as much as possible. A management plan has to be created covering all the aspects and all the parties that may be involved in fighting the fire. The preparedness management plan for wildfires will cover different areas, including a fuel management plan to maximize the reduction of the amount of fuel that might be present in a wildland area, making it more prone to fire. The second area covers the latest and newest technologies to help us build a strong prediction and understanding of the potential fires that may occur and their behavior. Moreover, the third part of the management plan covers the readiness of the firefighting agencies. The wildland-urban interface areas that can be described as high-risk communities for being in or near the wildland must be prepared for wildfires and the urbanization has to be more monitored to protect people’s lives.

Fuel is considered to be one of the main elements of a fire behavior triangle that affects both the initiation and propagation of a wildfire. Having a very well-constructed fuel management plan for the different areas with an intensive study of the weather conditions as well as taking into consideration the topography of that area can really help in the reduction of heavy fuel buildup over the years. The most efficient way of preparing for a wildfire in the area of fuel management is through prescribed burning. These are considered controlled fires that are mainly done to serve certain objectives of reducing fuel amounts. It is done by experts at a certain time of the year at different locations to mainly reduce a large amount of hazardous fuel, improve the habitats, and promote the growth of new trees. However, the prescribed fire itself can't be enough, and sometimes it requires looking into different environmental, social, biological, legal, and economic aspects to be done, which sometimes restrains the full advantage of using the prescribed fires. Climate change also complicates prescribed fires because it affects weather conditions (Úbeda 2018). Other methods must be used side by side with the prescribed fires, including the mechanical treatments of the fuel in different areas.

Mechanical treatments mainly consider two strategies. The first one is the forest thinning. Thinning is mainly used to modify and adjust fuel structures in the lands which includes partial removal and removing trees and vegetation, which helps in reducing the potential of having wildfires. It can produce more rapid development of branches and coarse woody debris, therefore reducing the most favorable wildfire habitats. We can also use mastication to grind, crush, and chop the fuel that can lead to a severe fire [30]. A management plan has to be conducted to use both methods of reducing fuel buildup at the same time, and training has to be done for people who are assigned to do these tasks. We can involve people living in these areas to help with the mechanical means of fuel management, to provide a comprehensive and intensive analysis and simulation of when and where to use prescribed fires, and with a continuous weather tracking system.

One way of preparing is by using the technology of augmented and virtual reality to provide training tools and materials, as well as study the different scenarios of wildfires' existence in a near-real world experience. The other area to focus on to be fully prepared for a wildfire is the use of all the available technologies that predetermine wildfires' time of happening, their location, their expected severity, and intensity. This can be implemented inland areas using different wireless sensor networking systems that are distributed over large areas and can cover more exposed areas that are prone to wildfires. The proposed sensory system includes the use of different sensors. Cameras can be distributed all over the land with a very sensitive range that can detect both smoke and fire.

We can also install video cameras to observe all the living species on the land, especially beetles, which kill millions of acres of trees, causing fuel to increase in certain areas where they need to be detected and efforts must be made to reduce their huge numbers on land. Other sensors include infrared thermal imaging cameras that detect the heat flow of the fire and a spectrometer to define the smoke spectrum. Other sensors to be installed as well include light detectors, optical sensor systems, heat detection sensors, and tracking systems for all the indicators of weather conditions, including temperature, relative humidity, and wind, with very intensive readings and calculations of the months that are more expected to have fire weather. These sensors' readings can be interpreted and monitored by weather stations that have to be distributed all over the area. A sensory system can also be installed to track all the activities done by people who live near these areas. The tracking system will be able to record, control, and provide the needed precautions for fires that might happen due to human activities. Robotics and artificial intelligence are widely used nowadays and they have to be more incorporated into fire prevention and mitigation. They can also move around the land gathering all the needed information regarding fuel conditions and soil conditions. They can also be provided with systems that sense the dryness of the vegetation and have connected irrigation tools to spray water regularly in certain areas that suffer the most from dry conditions. (Mastication 2022)

Firefighting agents have to be fully prepared for a wildfire in both manpower and the needed tools and equipment to ensure their full readiness to fight the fire in the response time. During the COVID-19 pandemic, there was a lack of manpower to fight the fires and many firefighters died and some of them got isolated when being infected by the virus left the firefighting agencies facing difficult timing during that period of time to firefight wildfires that took place in 2020 and 2021[33]. In addition to that, agencies and governments can give intensive training to the people living in and occupying the wildland areas on how to use the different tools and how to be prepared if their efforts are highly needed. A collaboration between different states can also be a solution when we lack manpower in certain areas where they can provide their firefighters and move them quickly to the areas where they are needed the most with helicopters and planes. The extinguishment tools and equipment need to be available all the time and they have to be stored at locations where they will be easily accessed by the firefighters and the different agents. This equipment includes the full set of developed PPE with high resistance to fire material, fire beaters, fire rakes, fire axes, applying water or fire redundant either by fire engines or helicopter. There has to be an intensive plan for evaluating and updating risk before, during, and after the occurrence of wildfires. Furthermore, firefighting agents dig fire lines to stop the spread of the fire and arrest its advance. It is mainly done by human power. We can use robots with high capabilities to be on the site to do the mission more efficiently and optimize the time required to do the job.

The last area of the preparedness management plan is managing the areas, properties, and businesses that are near the land of fires and, before all of that, saving people's lives in these areas. The wildland urban interface area has to be fully prepared for the fires. That includes putting in some safety measures, for example, building houses with fire-resistant material. The houses should also be supplied with fire detection sensors that should be connected to the firefighting agent system that would be able to identify the fire and the source of it if it was caused by human activities. In addition, the owners of the properties should take the responsibility of removing and cleaning the area around the house of flammable vegetation such as trees, shrubs, grass, and dead leaves. Furthermore, the installation of a metal mesh screen over the house to prevent and stop embers from going into the house

. The government has to put people's lives at the top of their priorities, and this is done by providing the needed health and safety tools to be provided and distributed. A fully organized evacuation plan that keeps updating to accommodate all the residents without missing an area and in a short period of time. The governments also have to control the urbanization in the area since the number of people living nearby has increased tremendously over the years and, since most of the wildfires are caused by humans, controlling their numbers and activities can minimize the occurrence of wildfires. Figure 14 represents the system used for the preparedness management plan.

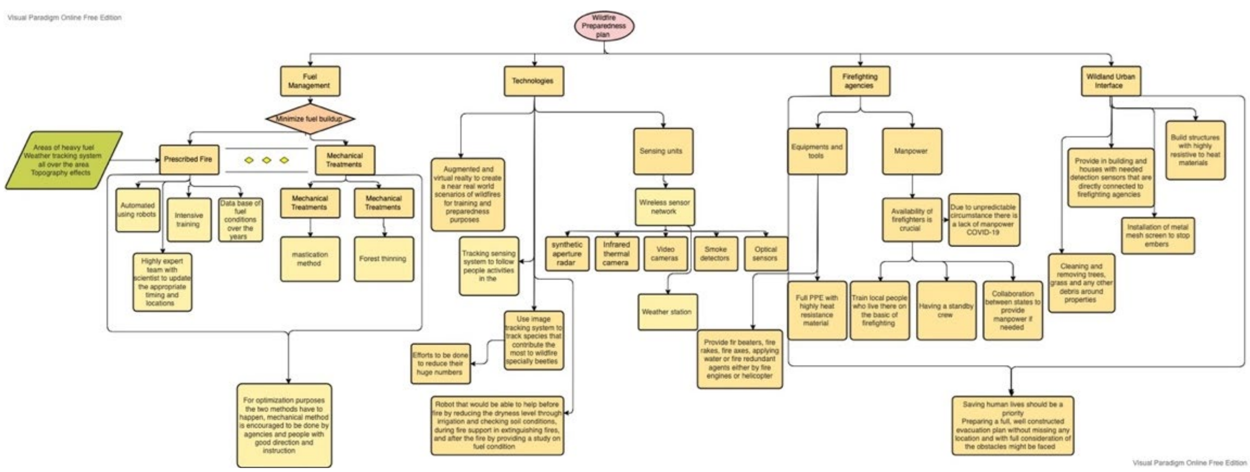

Figure 14. Preparedness for wildfire

6. Conclusion

The increase in the intensity of wildfires has become a concern to the public due to their drastic environmental, economic, and health impacts. Preventing wildfires might not be the best option for such natural phenomena. However, preparedness and predicting the behavior of wildfires by studying the major contributors in terms of weather provide the tools necessary to avoid wildfires from propagating beyond control. Analyzing the root causes of major wildfires' and studying weather patterns is essential and more efforts need to be placed in this area of study to provide a platform of actionable plans that can be implemented to communicate with the people in charge, as well as inform the public of the latest efforts in combating wildfires. Efforts such as simulation software are highly effective in predicting the behavior of wildfires in terms of ignition probability, spread and intensity. Moreover, wind speed can be a driving factor in the growth of a wildfire. Predicting mega wildfires can be further enhanced by studying wind patterns over the years to ensure the best preparedness and staffing plans are in place, which will crucially minimize the catastrophic impacts of such destructive fires. Wildfire preparedness is considered to be one of the most critical issues in dealing with fires. Having a well-prepared plan that tackles the main areas can contribute massively to the way we fight fires in the most efficient way.

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