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The cause and impact of increasing frequencies of wildfire correlated with humidity

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ABSTRACT:

The pervasive aftermath wildfires have left for humanity continues to entice more and more interest in researching it. With the push of various factors that drive wildfires to spread, it is crucial to understand how these perilous natural phenomena happen and threaten innocent citizens. This paper delineates the possible causes through the scope of capricious climate change, human activities, topography and weather, specifically about humidity. When these great impacts and causes are considered, readers will be able to acknowledge that these phenomena narrow down to one chief, standing idea of humidity and wildfire.

KEYWORDS: Climate, Humidity, Topography, Weather, Human Behavior, Wild fire,

Introduction:

With the rising number of wildfires, this phenomenon has affected almost every vegetated land on Earth. For decades, scientists and researchers have scrutinized the aftermath of wildfires, cause of minute to immense wildfires, and contribution to societal and environmental changes. Undoubtedly, as humanity further distresses the planet, the number of wildfires will significantly increase at an exponential rate. These atrocious and brutal consequences the wildfires have left for us has heightened my concealment into writing this research paper in order to examine numerous strategies to prevent wildfires, understand the major causes, and alleviate the cruelty of wildfires after they sweep the towns of innocent people.

Lists of organizations and institutions focused their visions in preventing wildfires that can be thwarted. WFCA stated that the U.S department of fire administration offers training courses, technologies, and materials in both preventing and ceasing fires to spread across the vast fields. Likewise, after the enormous wildfire during the 2019-2020 fire season in Australia, the government has input $200million dollars (U.S dollars) into recovering the native habitats and devastating impacts it has left, according to D.C.C.E.E.W. The most burning controversy in this field is about whether this natural phenomenon can be prevented through human effort and advancing technology.

While many more wildfire behaviors are being predicted and measured through concise and on-point technologies, it is unarguably true that the increasing rate cannot be returned within our own hands. Therefore, this paper will examine the impact, aftermath, and understanding what wildfires activities are. Understanding the phenomena, citizens will be able to be aware of its perilous consequences. The readers will hopefully be able to comprehend the vision that humanity is leaning towards the field of wildfire and the global trend of wildfire.

Methods:

Correlation of Climate Change and Wildfire:

The 2019-2020 fire season has left disastrous aftermath on the land of Australia. Around 45 million acres of land were burnt to ashes along with about 3000 houses that were home to innocent people, while also triggering 65000 new displacements for the households who were forced to move out (IDMC). Not only that, Australia has been financially damaged after the wildfire swept across the dry, arid lands. Between $44 million and $55 million had to be compensated just for the homes that were lost and abandoned due to the wildfire, and the agriculture of Australia, the primary economy in the nation, has been affected with an astounding amount of about $5 billion. This astronomical cost for the farmers is about 8 percent of the whole Australia's agriculture GDP (University of Sydney). As seen, consequences of the daunting wildfire are noxious for citizens. Indeed, the preeminent cause of the wildfire of the 2019-2020 Australian wildfire season was fluctuating temperature on the surface of the Indian ocean, a result of climate change.

El nino effect and Indian ocean Dipole, mainly caused by rise in ocean temperature, are the occurrences that have impacted the Australian primarily. El nino, meaning effect is a climate pattern that causes the surface of ocean temperature to unusually heat up than average climate years. This climate phenomenon affects continents from Australia to South America by heating their vegetated land, making vast fields of land vulnerable to wildfires. The El Nino effect has happened for more than 4 centuries. However, what makes the recent events more unique is that with the rising greenhouse gas, the temperature of the planet itself has risen to the point where ocean surface has increased with it too. The El nino effect specifically dried out Australia during the 2019-2020 season, which caused wildfires to spread at a speed that was unpredictable. Not only for Australia, the El nino effect was carried to parts of Americas, such as California, where many more frequent wildfires happened during the El nino seasons. FIG 1) Area burned in million acres along with the years. Each color is indicated by the legend. The more area of red means more greenhouse gases.

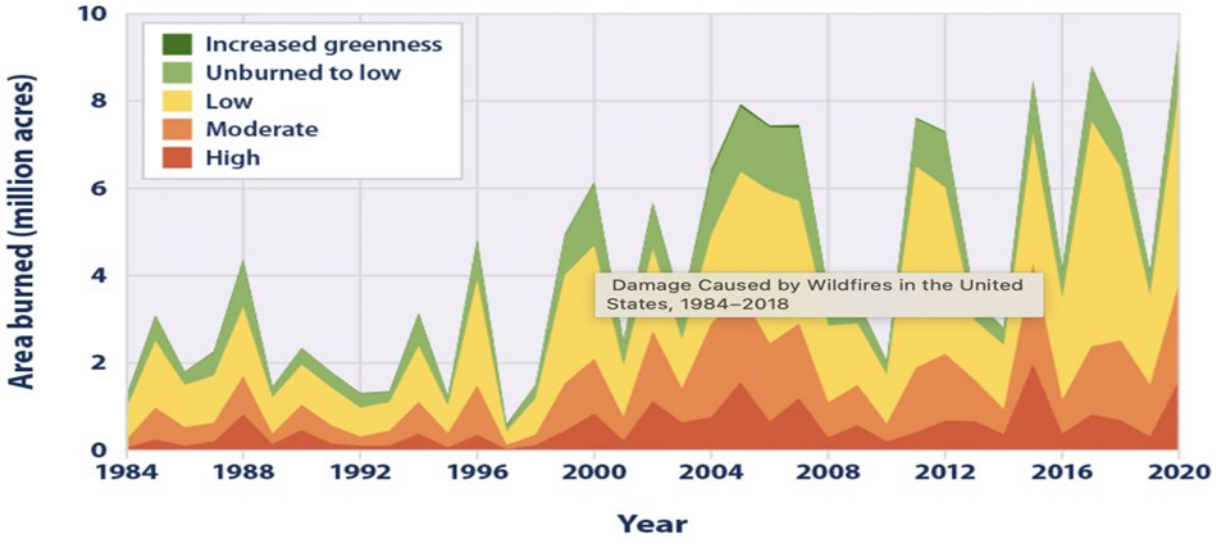

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Figure1) Area burned in million acres along with the years. Each color is indicated by the legend. The more acres of red means greenhouse gases

The figure above, from the United States E.P.A, focuses on the severity of wildfire as the year progresses, along with the worsening of climate change. In addition, the acres burned in 2020 contrasts dramatically with that of 1984, depicting the

The Indian Ocean Dipole Mode Event is the other natural phenomena that contributed to the great wildfires in Australia. This event is when the western Indian ocean surface is warm compared to the eastern Indian ocean surface. The temperature difference causes unusual climates in the regions that the Indian ocean meets with. For instance, because of this phenomena, Australia had to go through drier and arid spring seasons compared to Africa where the climate was clearly the opposite. It is prominent to realize the severity of the increasing dates of these events because the Indian Ocean Dipole Mode Event increases the threats of flooding in Africa and perilous wildfires in Australia.

The correlation between wildfires and climate changes has been studied for years now, and many researchers found out that the more humans worsen and speed up climate change, it is unavoidable to encounter wildfires that are greater than ever before.

Human activities and Wildfire :

While climate change is one of the main causes of wildfires that happen in various continents, human activities are also a great cause of wildfire. Studies have shown that 86 percent of United states' wildfires are ignited by human activities, such as discarded cigarette put to dried bush, leftover camping material dumped, and equipment malfunctions. Furthermore, human activities causing wildfires were responsible for about 97 percent of the houses burnt from wildfires that happened in California.

Not only the fact that human caused fires are very common, they are more perilous and easily spread compared to other wildfires that happen in fire hazard regions. Through probing about 220 wildfires that happened between 2011 and 2020, when a fire was started by human activities such as burning cigarettes, camping apparatus and manmade objects, the average speed of the fire spreading was 1.83 km per day (Hanston). On the other hand, lightning-induced burns were spreading at a speed of about 0.83km per day, which is nearly half the speed of that of human ignited fires.

Year	Acres burned (lightning-caused fires)	Acres burned (human-caused fires)
2021	4,101,884	3,023,759
2020	4,123,523	5,998,813
2019	3,447,038	1,217,324
2018	3,127,003	5,640,489
2017	5,195,610	4,830,476
2016	1,743,385	3,766,610
2015	8,112,688	2,012,461
2014	2,012,843	1,582,770
2013	3,057,566	1,261,980
2012	6,825,989	2,500,249

FIG 2) Acres burned annually. The left side shows lightning caused fires and the right side data shows human caused fires.

Figure 2 specifically shows the acres that were burned by both lightning-caused fires and human-caused fires. The fact that the fire started out by human activities is taking more and more land is devastating.

It is true that solving problems such as climate change to prevent wildfires can be started; however, implementing campaigns and spreading words in the areas of easily inflammable mountains can assuredly bring up the possible awareness of citizens to realize how much they are leading themselves into the igniter. In fact, it is somewhat ironic to witness the human built infrastructure such as gas stations, electric wires, and many other man-made objects for human convenience to come back as an immense wildfire, killing hundreds of people.

Topography and wildfire:

While many individuals consider the causes as the essential point of researching, it is also crucial for people to understand how wildfire is spread. There are a broad spectrum of factors that lists from weather to building materials. However, the geographical effect of wildfire is often overshadowed by other well-known factors. Indeed, understanding the topographical effect of wildfire spreading will bring readers of this paper better knowledge about numerous ways immense fire can be prevented. Furthermore, topography in fact contributes as a pivotal role in the dynamic of wildfire with various aspects : slopes, aspect, fuel, and weather.

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Slope gradient is indeed the most important factor that contributes to spread of wildfire. For example, many researchers from different intuitions have strongly affirmed that the higher the incline of a hill is, the faster the wildfire spreads along the hills of vulnerable areas. Along with the fuel materials on the ground, the wildfires spread their heat uphill faster than they do when a fire is heading downhill. To be more specific, when heat is created and it ascends up to the sky, it preheats the fuel of wildfire, such as dried leaves;woody debris; and vegetation, allowing the speed of wildfire to accelerate even higher. In fact, according to a notion from Charles Darwin University, every 10 percent increase in the slope can almost double the rate of fire spread.

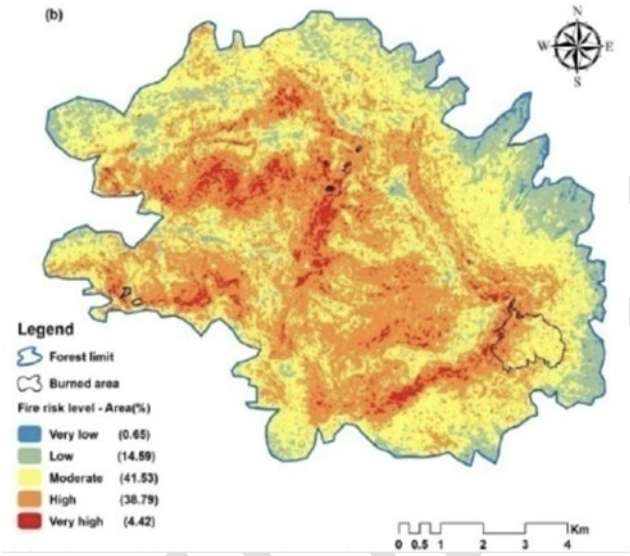
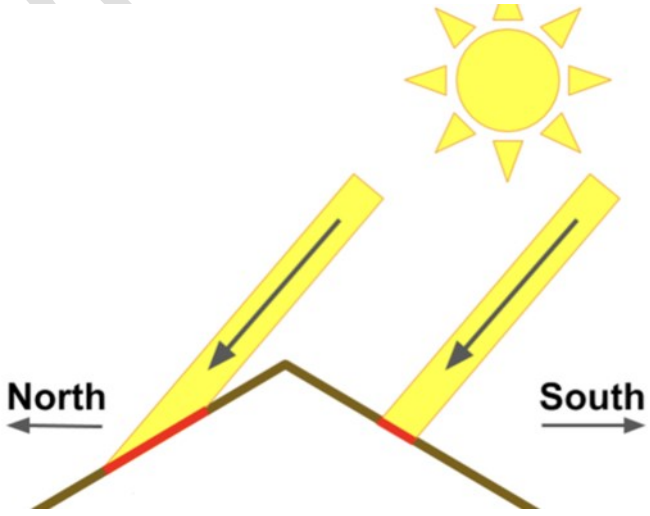


FIG 3) The mountain range is drawn in 3D.

The red parts are more inclined. The blue parts are less inclined. Each color represents different fire risks.

Slope is not the only reason why topography is significant in examining the spread of wildfire. Aspect, which is the direction a geographical terrain is facing, such as the mountains and high hills, is one of the most influential factor of topography that accelerates fire spreading; for instance, south and southwest facing



mountain sides of mountain ranges tend to receive more light which leads to having fuels already preheated before the fire contacts. On the other hand, north-facing sides are known to be less vulnerable to fire spread than the south-facing hills, even though wildfire somehow still spreads. Nevertheless, because there is more fuel loading in the north side, the severity of the wildfire is usually more hazardous, according to Oregon state university. Admittedly, it is not going to be a panacea by just looking around the south sides, but giving more attention to south facing sides will undoubtedly be helping to detect fire.

FIG 4) Yellow line indicates the light from the sun.

The figure emphasizes the effect of direction of the Mountain.

An image from UBC, fig 4, contains the sunlight hitting the mountain sides and explains how the mountains in the northern hemisphere get affected with more solar radiation and heat on the south side of the hills/ mountains.

The landscape of the geographics is the chief idea to understand the spread of wildfire. When wind passes canyon, ridges, and mountain ranges, the wind pattern fluctuates from being very slow to extremely fast, causing wildfire to intensify rapidly. As researchers from Oregon State University state, many wildfires are driven and led by wind, which controls how wildfires spread and maximize their size. Therefore, if wind velocity is increased through the landscape of mountain ranges, the spread of wildfire will evidently increase too. Valley winds are winds that build up in valleys and they take about 1 to 2 days to build up. The 2017 Tubbs fire and 2016 Chimney Tops 2 Fire are great examples of wildfires that were pushed by high-speed winds. In fact, lasting for more than 27 days, the Tubbs Fire burnt 3000 homes of innocent families and killed 22 people. When the valley wind is at its highest speed, the spreading of wildfire will be inexorable (NWCG members). Conversely, landscapes such as cliffs, rivers, lakes, and manmade roads are stopping points for wildfires to slow their speed down. Indeed, roads do adversely affect wildfires for a few cases. Many researchers from WildEarthGurdians state that the climates within the forests are impacted by the artificial roads since they consume heat and alter the normal climate pattern that exists within the region. The arrangement of the roads can be a significant influence to where the fire is started and how it is spread, causing few predicaments to the ecology.

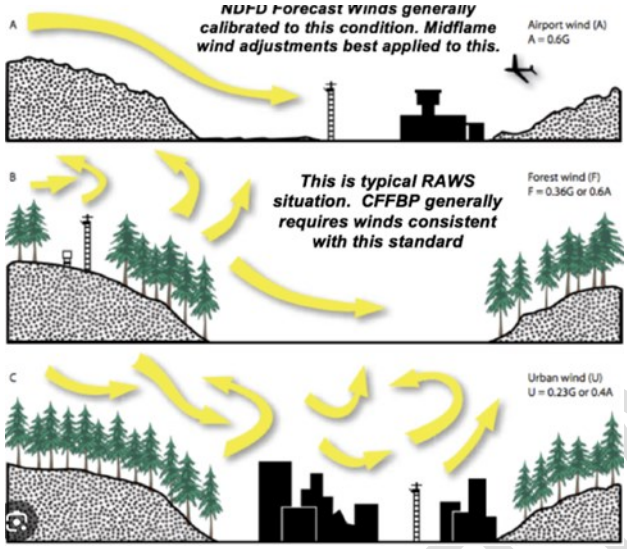


FIG 5) The figure from NWCG shows wind Pattern in different landscapes.

Figure 5, according to NWCG, wind patterns vary when the landscape differs. For instance, when there is an urban city in between hills or mountains, the building alters the wind flow, which changes how wildfires spread too. However, when wind is heading straight forward towards another geographic feature, and no obstacle thwarts the windflow, the wildfires that accords with the wind will spread rapidly.

Humidity and Wildfire :

As our planet goes through many incidents of extreme weather, and change in climate behavior, many wildfires are unable to be predicted. Burning lightning can drop from the sky all of the sudden, starting as a little, minute fire and growing into a life-taking wildfire. Lightning occurs in various parts of the world, but the United States encounters more frequently than some parts of the globe. Thus, in the terms of wildfire behavior, weather is the most unexpectable factor that influences the most to being the precursor of wildfires. Humidity contributes to broad ranges of the start factor of forest fires, and also weather can correlate with the start of the wildfires.

Relative Humidity (RH) and Dew point are measures of moisture in the air and ground. Dew point is defined as the set temperature in order for a dew, or a fog, to be produced. Relative humidity is measured in percentile and as the percentage drops, it indicates that there is less water vapor in the air. Relative Humidity and dew point have direct influence in fire behaviors. These two phenomena connect closely to the fuel of the fire. For example, if dry fuels and relative Humidity drop more than 30 percent, there is a high possibility that if a fire breaks out, the spread of it will be fast and vast (DEFS). This natural phenomenon shows how the low moisture content of the fuel on the ground of the field where a fire starts can lead to behaviors that are amorphous and dubious. According to the study by open snow, humidity values that are 15 percent or lower can lead to an elevated fire. Also, when that percentage drops by less than 10 percent, a perilous and immense fire danger can be seen. The change in dewpoint and relative humidity might also indicate the change in wind pattern

Temp (C)	Dew Point (C)	RH (%)	Dead fuel moisture (%)	Relative Rate of Spread
25	10	39	7	x 1
25	0	19	4.5	x 2

FIG 6) Figure from DEFS shows the relationship between RH and Dew Point with the rate of spread of wildfire.

FIG 6 from DEFS clearly shows in numbers how RH and Dew Point relates to the relative rate of spared of wildfire. As the Dew point decreases by 10 degrees and RH decreases, the relative rate of spread has increased by scale factor of 2.

Conclusion:

With the escalating wildfire phenomenon across the globe, the paper has dived into the intricate and close relationship between wildfire and humidity, focusing primarily on climate change, human activities, topography and moisture contents. The results after examining these distinctive methods were indeed surprising in a way that all factors have connections to each other that narrows down to one idea.

When examined through the lens of climate change, specifically the Indian Dipole Mode Effect and El nino effect, the majority of the wildfire behavior was stratified into one clear idea. Both Indian dipole mode effect and el nino effect contributes to the temperatures of countries this paper has mentioned about. In addition, the two natural phenomena have relations with dryness of the regions these effects happen. This link between temperature and effects emphasizes the importance of humidity in wildfire along with these ideas. For instance, as stated in the methods, as the Indian Dipole Mode effect brings a sudden rise in temperature for a country like Australia, it will go through a dry fall season that is drier than ever before. Furthermore, when a state like California encounters El nino phenomena during its fall season, fuel dries up faster than ever before, bringing up the possibility of starting a wildfire. Indeed, according to a research by iopscience, for example, during the past 2 decades, the relative humidity (RH) has been affected additionally by the El nino effect, dropping the average humidity by around 1.5 to 5 percent. Not only that, a research on the Indian ocean and humidity's correlation, the researchers have specifically elucidated that the difference in the highest RH and lowest RH during the season

when Indian dipole mode was about 10 percent when recorded data. This quantitative data illuminates the idea of the chain between climate change and humidity.

Although it might be overshadowed by other factors, human activities are the main cause of wildfire. High percentage of the wildfires are caused by human activities such as remnants of campfires, cigarette, and mountain activities. Additionally, when this cause of wildfire is delved and examined, many acknowledge human activities that cause wildfire are precisely connected with change in humidity, too. As spoken in the paper, human caused fires are not known to be spread at a very fast speed that makes many forest fires to be unpreventable.

Topography with its various causes of wildfire and its contribution to accelerating, it also connects with the notion of humidity and wildfire. Topography as said in the paper, its slope affects the spreading of wildfire. For instance, the steeper the mountain or the hill is, the faster the wildfire will expand on the dry land. Furthermore, when the direction the mountain side is facing is towards the south, mountains have a higher possibility of starting an immense wildfire than the sides of mountains that face the north. In addition, their geographical formation leads to altering the wind pattern; therefore, the rate of spread of wildfire is accelerated even faster and may even change the direction the fire is heading towards. All of these factors have some connection to moisture content in the fuel since the lower the RH of the region is, the higher the chance of the possibility of starting a wildfire is. To extend this idea, the geographical effect to creating these dry fuels and where they are formed are closely related to the topographical effects to forest fires. In addition, mountain ranges have a relative humidity of around 30% to 50 % on average days. However, when this percentage drops down to 20%, the risk of causing fire skyrockets. This links how relative humidity has great connection with topography when touching on the field of wildfire.

As said through all 3 methods, when relative humidity and moisture content in fuel plays a chief role in causing a wildfire. The El Nino effect drops significant amounts of RH by around 1.5 to significant 5 percent, and topography of the area indicates the average relative humidity. Thus, when organizations measure and monitor, specifically during the dry fall seasons, the relative humidity and notice that the RH level has dropped more than 5 to 7 percent, they should start comparing previous knowledge of natural phenomenon going on around and alert nearby fire stations to start watching fire hazardous areas by imputing unmanned drones or balloons. These methods narrow to one but foremost idea of connection between humidity and climate change; human activities to fire; and topography.

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