

The Environmental, Economic, and Social Impacts of California's Wildfires

Introduction

In 2020, California's wildfires were significantly more destructive than they had been in previous years, and scientific research suggests that the wildfires will continue to intensify if adequate solutions are not implemented quickly (Harder, 2021). About 4.1 million acres of California forest were burned by wildfires in 2020, which was the largest area of burning to have ever been recorded (California Department of Forestry and Fire Protection [CAL FIRE], 2021). The 2020 California wildfires illustrate the disturbing trend in the destruction being caused by California wildfires. Wildfires are increasingly causing negative environmental, economic, and social impacts on the state of California. After a century of harmful fire suppression policy that destabilized California forest ecosystems, there is now an abundance of understory vegetation that requires burning. This, combined with the fact that anthropogenic climate change is making California increasingly hot and dry, is leading to a massive uptick in the intensity of California wildfires. If sufficient solutions are not implemented soon, the wildfires will only continue to get more intense as climate change intensifies.

Background

To put the 2020 California wildfire statistics into perspective, during the five previous years (2015-2019), California wildfires burned an average of about 400,000 acres per year, meaning that 2020 constituted a ten-fold increase from this average (CAL FIRE, 2021). So far in 2021, California wildfires have continued to wreak havoc at an unusually high intensity, though slightly less so than the 2020 record-breaking wildfires. Still, compared to any year other than

2020, 2021 is a very high outlier. As of October 25, 2021, about 2.5 million acres of California forest has been burned in 2021 (CAL FIRE, 2021).

California's 20th century fire suppression policies, at the time enacted to contain wildfires, have actually contributed substantially to the increasing intensity of California's wildfires. Suppressing all these forest fires has destabilized California's forest ecosystems, as fires play a natural and important role in the ecosystems. As part of the natural fire cycle, fires burn understory vegetation. As a result, more sunlight reaches the ground and fire-dependent seeds can sprout, leading to new vegetation growth (Miller, 2020). By suppressing all 20th century California forest fires, a large amount of understory vegetation that should have been burned to allow for new growth did not get burned (Miller, 2020). As a result, California's wildfires are becoming more intense, since there is now a high amount of understory vegetation that needs to be burned. In fact, there is so much understory vegetation that it allows the forest fires to now also reach canopy trees, which are not supposed to be burned in the natural fire cycle (Miller, 2020). This has several serious consequences; it makes the ecosystem even more unstable, allows for much larger fires to form and spread, and significantly increases the amount of resulting greenhouse gas emissions (Miller, 2020).

In addition to fire suppression policies, anthropogenic climate change is another significant factor contributing to the increase in California's wildfires. A 2019 research article published in *Earth's Future* showed that there is a direct relationship between climate change and California's wildfires and that this relationship is nonlinear, in that the increase of climate change has become increasingly impactful on wildfires (Williams, et al., 2019). Climate change has made California forest ecosystems more hot and dry, which creates ideal conditions for wildfires to start and spread.

Furthermore, the Santa Ana winds play an important role in large wildfires in southern California, since the high wind speeds generated by the Santa Ana winds allow for wildfires to spread much faster. A study analyzing 158 fire events in southern California between 2001 and 2009 found that “burned area per day” was 3.5-4.5 times larger on Santa Ana wind days than on non-Santa Ana wind days (Billmire, French, Loboda, Owen, & Tyner, 2014). Thus, it is also important to consider the potential influence that anthropogenic climate change will have on the Santa Ana winds. The few research publications that do address this question state that there is a great deal of uncertainty and debate among scientists regarding the topic as of now. In a 2019 research article published in *Geophysical Research Letters*, Guzman-Morales & Gershunov state that while the link between climate change and the Santa Ana winds is still an area with some uncertainty and debate, studies so far have indicated that climate change is causing an overall decrease in the strength of the Santa Ana winds. However, they emphasize that climate change also seems to be increasing the maximum intensity that the Santa Ana winds hit with (Guzman-Morales & Gershunov, 2019). Hence, it seems that climate change is making extreme Santa Ana wind events more likely, but it does seem to be favoring extremely low intensity events to extremely high intensity events for now. This suggests that very severe Santa-Ana fires will actually likely become more common. Guzman-Morales & Gershunov (2019) state that this also suggests that California wildfires will likely increasingly occur toward the end of the typical wildfire season.

Description of Environmental Impacts

Wildfires are having several substantial environmental impacts on California. In 2020, about 4.1 million acres of California forest were burned by wildfires, constituting the largest area of burning to have ever been recorded (CAL FIRE, 2021). The statistics from 2020 contrast

starkly with the statistics from the previous five years, where California wildfires burned an average of about 400,000 acres per year; this means 2020 California wildfires burned just over ten times as much forest area as the 2015-2019 California wildfire yearly average (CAL FIRE, 2021). Meanwhile, while 2021's wildfires do not seem to be quite as destructive as 2020's, they are certainly more intense than those before 2020. As of October 25, 2021, 2021 California wildfires have burned about 2.5 million acres of forest, which is already over six times higher than the 2015-2019 average (CAL FIRE, 2021)

In addition to destroying forests, California wildfires are also increasingly contributing to greenhouse gas emissions. The California Air Resources Board (CARB) estimates that in 2020, California wildfires emitted 112 million metric tons of greenhouse gases, which is about twice the estimated 2020 California automobile carbon dioxide emissions (CARB, 2021). This is by far the most greenhouse gas emissions that have ever been attributed to a year of California wildfires. During the five previous years (2015-2019), California wildfires emitted on average about 20 million metric tons of greenhouse gases, meaning that 2020 constituted 5.5 fold increase from this average (CARB, 2021).

Another potential environmental problem from the increasing intensity of California wildfires is that it may lead to an increase in "fire tornado" events. Fire tornados are exactly what they sound like; they are tornados that contain fire and flame. During fire tornados, smoke plumes can reach as far as 50,000 feet high, and winds often reach greater than 100 miles per hour (Harder, 2021). Fire tornadoes have generally been regarded as a possible but very rare event, but in the last few years there have been multiple large fire tornados in California as a result of wildfires (Cappucci, 2021). In addition to allowing the fires to be significantly more

destructive, fire tornados also make it extremely risky for firefighters to make any attempt at controlling the situation.

Description of Economic Impacts

California's wildfires are also causing increasingly severe economic losses, and given the fact that the wildfires are still likely to intensify further, these economic consequences are also likely to worsen. First off, when comparing the economic impacts of California wildfires by year, it is vital to distinguish the difference between economic cost and accounting cost. Accounting cost only measures explicit costs, such as the money paid by insurance companies to homeowners whose homes burned down, or the money paid by the California government to combat the wildfires. Conversely, economic cost measures both explicit and implicit costs. Implicit costs, also called opportunity costs, include the cost associated with opportunities that are forfeited by being unable to put resources to their best alternative use. For example, in the context of the California wildfires, implicit costs would include the cost associated with broader economic disruption that occurs within the regional and national supply chains. Had the California wildfires not occurred, this economic disruption would not have occurred, and this amount of money would have been generated. Instead, economic disruption did occur, so the amount of money that would have been generated is instead borne as an implicit cost. Lastly, it is important to note that all dollar values mentioned throughout this paper have been adjusted to be in terms of 2021 United States Dollars (USD).

When analyzing the economic repercussions of California wildfires, it is critical to recognize that economic cost provides a much more complete understanding of total economic impact. However, determining economic cost also requires the time and expertise of research economists, while measuring accounting cost is relatively simple. Currently, the 2018 California

wildfires are the only ones that economists have published an estimation of the total economic cost, and it took almost two years for this economic analysis to be conducted (Wang, et al., 2021). After conducting this analysis, the eleven economists who authored the publication estimated that 2018 California wildfires had an economic cost totaling \$148.5 billion, which is about 1.5% of California's 2018 GDP (Wang, et al., 2021). They also created a 95% confidence interval to provide a more accurate understanding of their estimation, which stated that they were 95% confident that the economic cost was between \$126.1-192.9 billion (Wang, et al., 2021). In addition, Wang, et al. also analyzed the components that contributed most significantly to this economic cost: 19% of the 2018 economic losses were from destroyed and damaged capital, 22% were from health costs, and 59% were from indirect losses (Wang, et al., 2021).

Meanwhile, the accounting cost of the 2018 California wildfires is estimated to be only about \$26.3 billion, meaning the economic cost was more than 5.5 times larger (CAL FIRE). Because 2018 is the only year where the total economic cost has been estimated, it is still worthwhile to analyze historical accounting cost data in order to get a sense of the trend in economic consequences. However, it is important to keep in mind the limitations of only being able to analyze historical accounting costs to estimate economic effects. While analyzing historical accounting cost data will provide an understanding of the direction of the trend in economic impact (increasing, decreasing or constant), analyzing historical economic cost data would allow us to better understand the nature of the trend. For example, an analysis of the accounting cost data may tell us that there is a linear increase in impact, while an analysis of the economic cost data could potentially demonstrate that the increase in impact is actually exponential, rather than linear.

Still, even without taking these nuances into account, comparing the 2018 California wildfires' accounting cost to other years provides cause for extreme concern. From 2002-2014, the average yearly accounting cost of California wildfires was about \$873 million, and the average yearly acres burned was about 700,000 acres (CAL FIRE). Conversely, in 2018, when nearly 2 million acres of area was burned, the accounting cost was \$28.8 billion (CAL FIRE). With over 2.5 times more area being burned, the accounting cost increased more than 30-fold. Furthermore, California wildfire accounting cost and area burned has continued to increase in the years since 2018. In 2020, about 5 million acres of area was burned, and the accounting cost was about \$59.4 billion (CAL FIRE). This means that compared to 2018, 2020 California wildfires burned about 2.5 times more area and had more than double the accounting cost. This trend suggests that as wildfires continue to become more severe, their economic influence will also grow.

In addition, it is also worth noting how the specific environmental factors contributing to a given fire can influence the fire's economic ramifications. For example, despite the fact that both Santa Ana fires and non-Santa Ana fires burned approximately the same amount of area in California from 1990-2009, Santa Ana fires accounted for about 80% of the total economic losses from California wildfires during that time (Jin, et al., 2015). Through their research, Jin, et al. conclude that this is due to the fact that Santa Ana fires spread three times faster than non-Santa Ana fires, occurred closer to urban areas, and burned into areas with greater housing values (Jin, et al., 2015).

Description of Social Impacts

Thirdly, California's wildfires are increasingly widening existing social disparities among the state's residents. A 2021 study published in the *International Journal of Environmental*

Research and Public Health found that areas that suffered from higher fire frequency and burned areas (from 2000-2020) had higher proportions of elderly residents, low-income residents, and Native American residents (Masri, Scaduto, Jin, & Wu, 2021). In addition, a 2020 study published in *Counselling Psychology Quarterly* found that following wildfires, many individuals experienced exploitation from rent inflation, insurance scams, and larger systemic issues related to the rebuilding of the community (Domínguez & Yeh, 2020). These studies provide insight into how the California wildfires are having a disproportionate effect on certain social groups, and this is essential to address when considering actionable solutions.

In addition, many of the response and recovery resources that vulnerable communities rely on are significantly underfunded. Funding for these resources has not increased enough to match the increase in destruction that the wildfires are now causing. A 2021 study published in *PLOS ONE* found that underfunded response and recovery resources leave many Californians unable to restabilize emotionally, financially, and physically (Rosenthal, Stover, & Haar, 2021). The study specifically mentions four sectors of resources that are currently underfunded: community support services, county agencies, the Federal Emergency Management Agency (FEMA), and philanthropic organizations (Rosenthal, Stover, & Haar, 2021).

Discussion

One important action that should be taken is that more government resources should be invested into nurturing healthy forest ecosystems. Specifically, by allocating resources to different groups tasked to overlook each unique California forest ecosystem, specific solutions could be tailored to each. However, while each group would work primarily on one specific ecosystem, it also would be important for these groups to meet each other consistently in order to collaborate and broaden goals, as well as to share with each other their various approaches.

Prescribed burns is one particular forest management technique that should be used. Prescribed burns are low-intensity fires that are purposefully set in order to carry out the essential ecosystem function of natural fires, while at the same time minimizing the potential for larger, uncontrolled fires to start as a result of excess understory vegetation (Miller, 2020).

In regards to mitigating the economic impact of future wildfires, it is difficult to calibrate specific solutions, as it is hard to predict exactly how devastating the economic losses will be. It will be crucial for research economists to continue to estimate the total economic cost of yearly California wildfires, as it will help policymakers better understand the actual economic consequences caused by the wildfires. Regardless of just how bad the future economic impacts of wildfires is, the forecast is certainly grim and provides a compelling reason for dramatic action to be taken via broader economic policy changes at the federal level. For example, policies that redistribute wealth more evenly among the population could be taken in order to address the underlying issue of economic inequality. Potential policies could include reforming the income tax levels in order to require high-income individuals to pay more taxes, and then using this money to invest in the larger community or redistribute directly through Universal Basic Income.

Moreover, it is also important that California government officials keep in mind this contrast in economic impact between Santa Ana and non-Santa Ana fires. Firefighters should prioritize closely following the Santa Ana winds forecast and be fully prepared to respond to these wildfires when meteorologists do project Santa Ana winds to occur on a given day. In addition, it will also be essential for environmental scientists to conduct further research into the influence that anthropogenic climate change will specifically have on the Santa Ana winds. There is a great deal of academic literature discussing how climate change will continue to

amplify California wildfires by making forest ecosystems more hot and dry, but there is very little published research regarding the potential effects of climate change on the Santa Ana winds, which would also likely affect Santa-Ana wildfires in California. Given that the Santa Ana winds cause particularly destructive wildfires in southern California, as well as the fact that there is still scientific uncertainty as to exactly how and to what degree the Santa Ana winds will be impacted by climate change, it is urgent that environmental scientists further investigate this link.

Lastly, in order to address the social impacts of the California wildfires, more government funding should be invested into response and recovery resources, such as community support services, county agencies, FEMA, and philanthropic organizations. Though taking this step would not be sufficient in fixing underlying systemic issues, it would provide much needed help to vulnerable communities that are disproportionately suffering from the wildfires. Similar to potential policies to address economic impact, social impacts could also be mitigated by broader federal policy reform, such as income tax level reforms, Universal Basic Income, and Universal Health Care.

Conclusion

Ultimately, though wildfires certainly impose California with daunting environmental, economic, and social impacts, there are several steps that the state government can take in order to mitigate these impacts. The most important steps that California should take is to invest more state funds in response and recovery resources, as well as create ecosystem management teams for each unique forest ecosystem in California. These ecosystem management teams could then collaborate with each other to find effective ecosystem solutions, like carrying out prescribed burns, in order to mitigate the intensity of future wildfires.

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