Living Alongside Wildfire

PEOPLE AND CLIMATE COLLIDING IN THE SAN GABRIEL VALLEY

Author: Matthew J. Mello, MURP '21 | **Faculty Chair:** Professor Stephen Commins | **Client:** Jane Tsong, Project Manager (WCA)

A comprehensive project submitted in partial satisfaction of the requirements for the degree Master of Urban & Regional Planning

Contents

M. MELLO
UCLA LUSKIN
MASTER OF URBAN & REGIONAL PLANNING '21

DISCLAIMER

This report was prepared in partial fulfillment of the requirements for the master's in Urban and Regional Planning degree in the Department of Urban Planning at the University of California, Los Angeles. It was prepared at the direction of the Department and of the Watershed Conservation Authority as a planning client. The views expressed herein are those of the author and not necessarily those of the Department, the UCLA Luskin School of Public Affairs, the University of California, or the client.

ACKNOWLEDGEMENTS

I would like to extend my gratitude to the following individuals and organizations for their contributions to this project.

Dr. Stephen Commins
UCLA, Faculty Chair

Jane Tsong
Watershed Conservation Authority, Client Advisor

Professor Taner Osman
UCLA, Applied Planning Research Project Instructor

Sarah Soakai
UCLA, Applied Planning Research Project Teaching Assistant

Noy Ramon
UCLA, Graphics & Design Teaching Assistant

D. Kalani Heinz
UCLA, Graduate Writing Center Mentor

Professor Michael Lens
UCLA, Faculty Adviser

EXECUTIVE SUMMARY

Introduction

The Watershed Conservation Authority (WCA) is charged with providing for "a comprehensive program to expand and improve the open space and recreational opportunities for the conservation, restoration, and environmental enhancement of the San Gabriel and Lower Los Angeles Rivers Watershed area consistent with the goals of flood protection, water supply, groundwater recharge and water conservation." Implicit in this mission is protection of open space for people and wildlife. This stewardship encompasses the wildland-urban interface (WUI) where elevated fire risk and housing development intersect at potentially great cost to life, property, and biodiversity. The WCA identified a need to study the topic of fire in the San Gabriel Mountains Foothills WUI in the context of a concurrent study on open space acquisition prioritization.

Literature Review

This study examines wildfire management through the lens of social justice. I specifically analyze how wildfire activity, as it relates to housing developments in the wildland-urban interface of the San Gabriel Valley in Los Angeles, CA, has demonstrated a pattern of permitting development, combined with the belief that home hardening and fuel modification are enough to mitigate fire risk- resulting in taxpayer costs that benefit a select few while risking the lives of firefighters, some of whom are underpaid and incarcerated. This project will challenge the current models of firefighting by looking at historical models of fire management and testimony from industry experts to better model a strategy of resilience (Raish, González-Cabán, and Condie 2005).

This project also questions if a reliance on prison labor for fighting fires is either just or sustainable. In the camps inmates are working side-by-side with professional firefighters, facing the same life-threatening fire conditions, in exchange for only a nominal wage and California law severely restricts access to disability benefits for prisoners; injured inmates must rely on the limited protections offered by the California Labor Code (Stygar 2019).

Data and Methods

Using a combination of case studies, interviews, and historical analysis this project will map fire management recommendations. My primary goal is to credibly corroborate these suggestions with stakeholder analysis and historical data. It is important to position myself as a former wildland firefighter with that lived experience. A similar instance of potential bias is the omission of interviewees from the housing sector.

The geographic scope of this study is the San Gabriel Valley in Los Angeles County, CA. The primary unit of analysis is wildfire activity in Southern California.

Findings and Analysis

Current city plans need updating in regard to wildfire prevention and safety to ensure every municipality is employing proven strategies for resiliency. Land use planning tools should align with wildfire prevention and safety. Lack of funding for wildfire prevention and safety is a problem given the current funding structure of prioritizing emergency response. Agencies should examine creative solutions concerning wildfire prevention and safety whether that is introducing fire-resistant flora, exercising more prescribed burns, or moving housing development away from fire-prone areas. Long-term solvency of the inmate firefighting program is a concern if criminal justice reforms drain the pool of low-risk, eligible offenders from the penal system. The money saved from their cheap labor will prove short-sighted if the state is then unable to attract enough civilian firefighters to join the various agencies charged with combating wildland fires. The intensity and rate of fires statewide has increased at the same rate as housing development in the WUI suggesting a strong relationship between the two. Fire prevention only goes so far when natural forces beyond our control make the risk of catastrophic burns almost inevitable.

Conclusions and Recommendations

Increase housing density away from fire-prone areas in the WUI. Municipalities can meet housing demand by building up or repurposing larger parcels into multi-unit developments. Centering housing stock around transit hubs and then creating reliable transit networks with WUI access will make the wildlands still available for safe recreation.

Defensible space is the key component to a shelter-in-place strategy if evacuation is not an option. However, vegetation management and fuel abatement are only effective insofar as they are enforced. Furthermore, expand LA County's oak tree ordinance to protect species known to be flame-resistant.

Manage unoccupied or older structures. Ensuring new developments meet contemporary fire codes miss the risk presented by older structures that may or may not accelerate the spread of a wind-driven fire. Addressing any gaps in unincorporated county lands while bringing older units up-to-speed will improve relations between neighboring communities that may have otherwise prioritized abatement differently.

Increase funding to agencies that manage fire prevention. Current incentive structures prioritize the agencies that deal with fire suppression after the fact as well as the ensuing recovery process. Putting all our public funds into firefighting does not protect all the communities that are put at-risk by the many externalities of catastrophic wildfires or their causes.

Reexamine the efficacy of an incarcerated firefighting contingent and explore alternatives for eligible inmates. The state would counterintuitively be making better use of its funds by paying trained civilian firefighters to manage blazes when they occur, and reallocating other monies earmarked for the conservation camp program to less costly diversion programs. Allowing eligible inmates to enjoy similar privileges and time credits while pursuing a viable, less dangerous vocation meets their rehabilitation needs without neglecting the state's forestry defense.

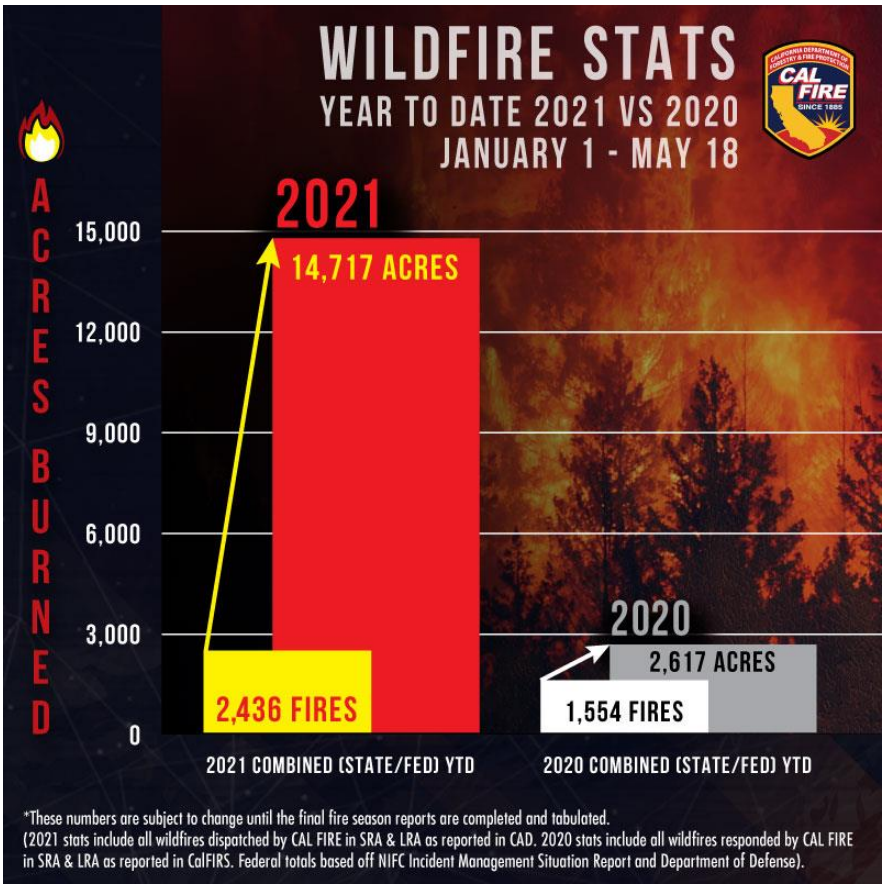
Consider acquiring land for conservation purposes in the WUI. The costs of managing conservation lands with little human interference would ultimately be a cost-savings when measured against the increasing costs of fighting the fires that are otherwise starting in these areas when developments arise. Singing out the hardest to reach parcels would better conserve the energy and resources of first responders who would otherwise have to access an endangered structure there while eliminating the need to manage precarious evacuation routes for the homeowners.

INTRODUCTION

- Context -

Wildfires have been a facet of human existence since before the time early humans discovered combustion. As wildfires ravage California's pristine landscape, we are just now reckoning with the reality that 'fire season', defined as dry period(s) of the year during which wildland fires are likely to occur, spread, and affect resource values sufficient to warrant organized fire management activities, is rapidly becoming an evergreen mainstay rather than a seasonal occurrence (Stuart, 2019). These periods were typically from June at the earliest with a predictable conclusion in October given the onset of seasonal rain. At the time of this writing in Spring 2021 the forecast for this year's fire season looks especially grim given near-drought conditions and the extent of unmanaged fuels. (Early Signs Show 2021 Could Be an Especially Catastrophic Wildfire Season in California, April 2021). The smell of ashen debris and burning timber has become as synonymous with the golden state as the very redwood forests now at-risk. Disaster management involving more labor and preparation has evolved from fire suppression programs to being one critical piece of the overall resilience strategy for affected municipalities. Along with prevention measures centered on forest management policies and land use decisions, California has long relied on prison labor to shoulder a disproportionate share of front-line firefighting. Gradual reforms to the criminal justice system, coupled with the viral COVID-19 pandemic, have diminished the pool of otherwise eligible prisoners for these work

assignments, which affects the capacity of fire agencies at a time of increased demand over a longer timeframe.



Credit: ABC10

- Client -

The Watershed Conservation Authority (WCA) is a government agency charged with the protection of open space for people and wildlife. A core tenant of their mission is to "inspire environmental stewardship in diverse communities and among urban users of recreational resources." (Vision & Goals, n.d.). This stewardship encompasses the wildland-urban interface (WUI) where elevated fire risk and housing development intersect at great cost to life, property, and the system's ecology.

The WCA's territory includes, but is not limited to, the foothill cities between Sierra Madre to the west and Claremont to the east. These dynamic landscapes nestled below the San Gabriel Mountains are directly adjacent to some of the densest urban environments in the state. The need for additional housing units in a region with a severe housing crisis, coupled with suburban

residential preferences closer to nature among those with means, has pushed development further into otherwise undeveloped lands. This trend towards sprawling homes in difficult terrain has taxed the agencies responsible for disaster response.

- Research Question -

The purpose of this study is to examine current policies regarding wildfire, including financial and regulatory structures, and to propose alternative methods that better align public and private interest toward overall safety, social/cultural equity, stewardship, and long-term sustainability. The question this research will seek to elucidate is, what equitable strategies for managing and preventing wildfires in California can reduce the costs (economic, environmental, lives & property, etc.) of what is seemingly an adverse externality of climate change and various factors of human activity, including housing development? The topics explored include innovative ways to increase housing availability without expanding into the wildland-urban interface (WUI) such as zoning reform along with decreasing the reliance on inmate labor without eliminating their access to vocational training. Both topics will address underlying equity issues in labor and development with an emphasis on the long-term financial solvency of a new wildfire resilience strategy.

- Justification -

Fire has indeed been an element of the natural world long before homo sapiens made permanent settlements. Fire has also been a resource used by Native Americans to shape the landscape for their subsistence needs. However, both the increase in said settlements and a changing climate have compounded the severity of our interactions with fire. The U.S. Forest Service estimates that over 85% of wildland fires are the direct result of preventable human activity. The public cost of fighting these infernos has laid bare the shortcomings in our current models of countering wildfires.

The necessity of this research could not be more topical or timely. According to CAL Fire, half of the twenty largest fires in recorded state history have occurred within the last decade. The costs of protecting private property in the WUI are being borne by all taxpayers. The USDA's Office of the Inspector General issued a report in November of 2006 suggesting WUI growth is pushing firefighting costs higher, adding urgency to our need to understand this topography (Stewart et al., 2007). Due to the link between conservation of remaining open space lands and fire management practices, WCA has suggested that Master of Urban Planning students address this topic. It is hoped that this and further research can clarify barriers to better fire management practices and

point the way to solutions that are better aligned with the public interest in watershed health, flood management, and biodiversity.

Ironically, one of the most effective tools to reduce the incidence and severity of unplanned wildfires is planned wildfires (i.e., prescribed fire), which work by reducing the buildup of vegetation and restoring the natural fire resiliency of a given ecosystem by eliminating fire-prone plant species (Engel 2013). The focus of natural hazards research has slowly moved away from the 'command and control' actions that largely rely on technology to control nature and wildfire, to a social focus that emphasizes the role of human behavior, values, attitudes, and decisions in managing wildfire.

Meanwhile, the California Department of Corrections & Rehabilitation's (CDCR) "fire camp" program is an effective tool of correctional control given that the firefighting work performed by camp prisoners is valorized by the media and by the Department of Corrections in its promotional materials; the belief that competition with civilian firefighters is minimal, ostensibly because there is so much wildland firefighting work to be done in California and not enough trained people to do it; that it teaches many camp prisoners "good work ethic;" that at least a few camp inmates secure jobs as wildland firefighters upon release from prison; and that only well-behaving inmates are offered the opportunity to go to a fire camp (P. Goodman, 2012a). In the camps, inmates are working side-by-side with professional firefighters, facing the same life-threatening fire conditions, in exchange for only a nominal wage. The causes of injury on a fire line range from those inflicted by the heavy machinery and tools used by crewmembers or the dangers found in the natural environment. California law severely restricts access to disability benefits for prisoners so injured inmates must rely on the limited protections offered by the California Labor Code (Stygar 2019).

Credit: AFP/Getty Images

- Procedure -

Interviews are a primary component of the evidence I rely on to make recommendations. An interview with a blogger and former inmate firefighter who writes extensively about his experiences as a prisoner has proven to be foundational for my understanding of the program's strengths and shortcomings. I have also explored the perspectives of stakeholders in the affected San Gabriel Valley communities from an engaged homeowner in the watershed, the municipal planning authorities responsible for resiliency planning, and the fire industry professionals at the front line of the crisis through formal interviews.

LITERATURE REVIEW

Fire In Urbanized Areas

Fire needs three combined ingredients to thrive: Heat, oxygen, and fuel. Understanding these factors has advanced our understanding of fire risk and management. Fuel is generally the only category that we can manipulate in the natural environment. Fuel reductions are particularly important during extreme fire years (Braziunas et al. 2020). Vegetation management and fuel clearance are the methods most employed by local fire authorities in the San Gabriel Valley (Gude and Rasker 2008). Eliminating one of the ingredients for rapid fire growth and movement is an effective short-term mitigation and prevention strategy. Some agencies have experimented with unorthodox strategies such as using goats for weed clearance (Knowles and Moritz 2016) while the majority lean on heavy machinery to clear brush in fire prone areas (Syphard et al. 2008). Unfortunately, even with requirements for 'fuel modification' and 'weed abatement' in place, the San Gabriel Valley is vulnerable to the consistently increasing costs of wildfire ("Wildfire Management in the United States: The Evolution of a Policy Failure" n.d.).

Proactive fire preparedness planning relies on an understanding of the trends in wildland fire risk factors, including the growth of the WUI. Fire prevention efforts commonly focus on the WUI and wildland fire control efforts are increasingly being directed to protect structures in the WUI. Previous research established that 9% of the land area and 39% of all housing units in the coterminous USA are in the WUI (Hammer et al. 2007). Although population growth has had an impact on the emergence of the WUI, the deconcentrating of population and housing, amenity-driven population growth in select nonmetropolitan counties, and interregional population shifts to the West and Southeast have had and will continue to have much greater impacts (Hammer, Stewart, and Radeloff 2009). During the 1990s, for every 100 additional housing

units constructed nationally, 53 housing units were added to the WUI (Hammer, Stewart, and Radeloff 2009). However, the extent to which municipalities encroach into the wildland varies by region. In most southeastern states, WUI housing units are predominantly in intermix WUI, defined as the area where houses and wildland vegetation directly intermingle. Interface WUI, which includes developed areas that have sparse or no wildland vegetation but are within proximity of a large patch of wildland, is more common in western states, occupying up to a third of the WUI area and containing up to two-thirds of the WUI houses (Radeloff et al. 2005).

Past fire history shows that much of the landscape within both fire perimeters had gone 75 or more years without fire due to highly successful fire suppression, on a landscape known to have historically experienced frequent fires (Keeley and Syphard 2019). A 2019 study out of the University of Wisconsin-Madison's Department of Forest and Wildlife Ecology and the U.S. Forest Service found that more than 90% of homes destroyed by fire in California are outside of urban areas (Kramer et al., 2019). The California Department of Forestry and Fire Protection has largely sidestepped any discussion of whether fire-prone landscapes should be off limits to new home construction given the propensity of most Governors to view such prohibitions as a detriment to California's "pioneering spirit" (J. E. Smith, n.d.). Furthermore, Cal Fire downplays the idea that building in the WUI will guarantee catastrophic wildfires or provide more ignition sources since people will still pursue leisure or recreation activities in these areas regardless. In terms of defensible space, the state of California requires fire-exposed homeowners to create a minimum of 30 m of defensible space around structures, and some localities are beginning to require at least 60 m in certain circumstances (Syphard and Keeley 2019).

Although previous studies have found that local, neighborhood, and landscape scale factors predict building loss due to wildfire, WUI fire risk assessments often characterize risk to structures only based on local scale burn probability and fire intensity (Braziunas et al. 2020). For western dry-mixed conifer WUI regions of the U.S., we see that forest density near WUI homes is negatively associated with house values, as denser forests are realized as a net wildfire risk (Hjerpe, Kim, and Dunn 2016). Fires have been perceived as controllable, but history reveals that much of the recent increase in human fire impacts has resulted from communities being in areas where fires are inevitable (Keeley and Syphard 2019). Landowners can control some forest characteristics that facilitate fire spread, and when a single landowner controls the entire landscape, a rational landowner accounts for spatial interactions when making management decisions (Lauer, Montgomery, and Dietterich 2020).

The current system's prioritization of wildfire suppression over forest treatment and management prior to the development of wildfires is deeply flawed. The costs of protecting private property in the WUI from wildfire are being externalized on the nation, and they are rising at an alarming rate. The USDA's Office of the Inspector General issued a report in November of 2006 suggesting WUI growth is pushing firefighting costs higher, adding urgency to our need to understand the WUI (Stewart et al. 2007). A proposed National Wildfire Insurance Plan aims to mitigate the rising costs of wildfire management by using the federal taxing power as a means of influencing behavior that lies outside the reach of the federal power to regulate commerce (Reilly 2015), but this method may not be enough. It would essentially provide nominal insurance discounts for properties that tend to their own wildfire risk mitigation. The most effective way to reduce the cost of wildfires incurred by the public is to shift the costs of suppression to homeowners of the WUI. However, the WUI homeowner I interviewed believes he is entitled to better protection and even additional grant funds from the state for citizens' wildfire prevention efforts. The rebuilding just produces bigger, more expensive homes, while the trailer parks and the homes of people who did not have adequate fire insurance through wealth are displaced (Weissman, n.d.).

Causes and Conditions

Resilience to climate change is a global concern given the potential effects of increased disturbance activity, warming temperatures, and increased moisture stress on plants. These adverse externalities further exacerbate the prevalence of wildfires. Warmer spring and summer temperatures and earlier snowmelt are extending the wildfire season and increasing the intensity of wildfires in the western United States. Human impacts on forest fires in the western United States since Euro-American settlement are well documented and primarily resulted from altered ignition patterns associated with land and debris clearance, agriculture, fire suppression, and fire exclusion more broadly (Marlon et al. 2012). Most wildfires in the western United States are caused by lightning and human carelessness, and therefore forest dryness and hot, dry, windy weather are the necessary and increasingly common ingredients for wildfire activity for most of the summer (Running 2006).

There are expectations that increasing fire frequency can decrease fire intensity in forest ecosystems and that feedbacks between fire and vegetation may trigger shifts in long-term fire regimes with climate warming (Braziunas et al. 2020). As wildfire severity and frequency increase in the American West, economic impacts may also grow given that fires can last significantly longer than other natural disasters (Davis et al. 2014). The number of large fires trended

higher in seven out of nine ecoregions, and the increased trends were significant in the Southern Plains, Arizona-New Mexico Mountains, Rocky Mountains, and Sierra/Klamath/Cascade Mountains ecoregions (Dennison et al. 2014). Increasing areas of high-severity fire can occur when greater area is burned at constant proportion of high-severity fire, or when the proportion of high-severity fire within fire perimeters increases, or some combination of both (Jay D. Miller and Safford 2012).

Grasslands which included meadows and scattered woodlands was the fuel type for only 7% of the lightning-caused fires whereas 27% of the man-caused fires occurred in grasslands (Keeley, n.d.). Man-caused fires occur at lower elevations than lightning-caused fires where fuel conditions are more conducive to fire spread.

Catastrophic wildfires take a large economic toll on communities through property losses, decreased tourism, even changes in the long-term structure of the local economy. While fires displace some economic activity, suppression efforts can increase economic activity, especially when suppression efforts utilize the local community. In Southern California, where wildfires in the WUI destroyed 3,079 structures in 2007 and suppression costs to the state totaled nearly $300 million, which may serve as the bellwether for other areas of the West, the Southeast, and nationally (Hammer, Stewart, and Radeloff 2009). In ecosystems where fires tend to be very large, liability regulations could substantially increase the variance in landowner outcomes, which would reduce the wellbeing of risk-averse landowners (Lauer, Montgomery, and Dietterich 2020).

Models of Resilience

Studies demonstrating the effectiveness of prescribed fire in reducing the risk of catastrophic wildfires suggest that we would be better off with more prescribed fire and fewer catastrophic wildfires (Engel 2013). A "Prescribed fire" or a "Prescribed burn" is a fire intentionally lighted by managers to meet specific resource management objectives. Enabling the public to influence when and where prescribed fire occurs with nuisance law, when a person unreasonably interferes with a right that the public shares in common, arguably distorts fire policy; it emphasizes the burdens of prescribed fire over its benefits in potentially reducing the likelihood and extent of an unplanned wildfire (Engel 2013). Ironically, one of the most effective tools to reduce the incidence and severity of unplanned wildfires is planned wildfires-prescribed fire or wildfire managed for resource benefits-which work by reducing the buildup of vegetation and restoring

the natural fire resiliency of a given ecosystem by eliminating fire-prone plant species (Engel 2013).

The simulated prescribed fires, on the other hand, result in much less heterogeneity, because the model limits prescribed fire intensity to a narrower range and ensures the burning of the entire grid (C. Miller and Urban 2000). In a real fire, these smoldering flames can flare up into more intense fires when the weather changes and extreme conditions of wind, temperature, and relative humidity set in. Early control is crucial when conditions favor rapid spread. Not only does the rapid growth of the fire perimeter greatly complicate containment, but the heat of a large fire dries neighboring fuels and generates its own winds, facilitating both the spread of the fire and extreme fire behavior that increases the risk to fire fighters and the public (Anthony L. Westerling et al. 2004).

The topic of prescribed fire feeds directly into the biodiversity implications of responsible fire stewardship (Cavender-Bares et al. 2015). Research has suggested that the mulch of certain species of live oak such as Quercus virginiana (Varner et al. 2016) have demonstrated a capacity to diminish embers. It is important to note Quercus virginiana is native to the Southeastern U.S., and not to Southern California. Yet, this species is commonly planted in Southern California planned landscapes. The Southern California native, Quercus agrifolia, Coast Live Oak, is considered to be fire-safe by Los Angeles County, when planted at a required distance from structures and if 'fuel ladders' are eliminated. Exploring the state of oak ordinances in unincorporated areas of the valley can show what relationship exists between oak management and fire resilience (Proceedings of the Symposium on the Ecology, Management, and Utilization of California Oaks: June 26-28, 1979, Claremont, California 1981).

Comparatively, countries like Australia, Greece, and Portugal have similar climates, topography, development patterns, and as such recurring wildfire events. Although fire ignitions in Portugal, as in other regions where fires are human caused, are much more likely close to roads, recent analysis suggested that ignitions that resulted in large fires occur further away from roads (Marques et al. 2011). Interactions between wildfire and post-fire drought may decrease forest resilience through reduced conifer tree regeneration, potentially resulting in forest ecosystem conversion to persistent alternate shrub or grassland states or different tree species assemblages in the Portuguese countryside (Stevens-Rumann et al. 2018). The most important progress in fire safety in this region are to come from advances in fire prevention, fire preparedness, and land-use planning that includes fire hazard patterns.

The cities of Malibu and Berkeley serve the purpose of illustrating two differing approaches to development in the WUI (Goldman n.d.). The city of Malibu scrapped a prohibition on housing in the fire-prone canyons from their master plan due to objections from affluent developers while Pepperdine University in the city limits chose to adopt the original strategy. Past fire activity has shown that Pepperdine's conditions have spared the campus any serious fire damage while homes in Malibu are routinely at-risk during fire season ("Pepperdine Shelters in Place as Malibu Wildfires Burn - Curbed LA" n.d.). Meanwhile, Berkeley went forward with severe restrictions on new developments in the WUI stopping just short of a moratorium on new construction (SFGATE 2020).

Relying only on compliance with fire codes in new developments ignores the risk of existing, vulnerable structures (Saafi 2002). Refurbishing older buildings to catch up with current requirements is an underutilized measure with empirically demonstrated success in other communities (Sturtevant et al. 2009). How housing is arranged in the WUI can also serve a fire prevention purpose by creating new exit routes, repurposing existing trails as fire breaks, and spreading out ignition points ("Housing Arrangement and Location Determine the Likelihood of Housing Loss Due to Wildfire" n.d.). Banning new construction in wildland areas opens cities up to costly litigation that makes compliant enforcement a more feasible management strategy overall ("Rapid Growth of the US Wildland-Urban Interface Raises Wildfire Risk | PNAS" n.d.).

The focus of natural hazards research has slowly moved away from the 'command and control' actions that largely rely on technology to control nature and wildfire, to a social focus that emphasizes the role of human behavior, values, attitudes, and decisions in managing wildfire (Prior and Eriksen 2013). Is the Australian "stay and defend or leave early" approach an option for wildfire management in the United States? The concept for this and other similarly named programs is that if you have carefully planned for fire, implemented the plan before the fire starts, and are well prepared, then the risks of staying are greatly decreased. Ultimately, decades of fire science strongly indicate that fuel management, prescribed fires and allowing wildfires to burn under moderate fire weather conditions will protect and promote ecological and cultural resources, and communities, far more effectively and efficiently than trying to eliminate fire from landscapes (McWethy et al. 2019).

Connecting the dots between proven resiliency models and learning from abject failures will shield future communities from the tragedy of ravaging wildfires in the WUI foothill neighborhoods (McCaffrey et al. 2013). The politics of disaster funding ties in directly with our inherent inability to accurately predict

future risks (C. Miller and Ager 2013). By untangling the perverse financial motives, endemic in elected politics with special interest funding, for policymakers to pursue risky budgetary allocations that ignore the reality of wildfire inevitability, the residents most affected by the danger can adequately voice their willingness to invest in long-term resiliency (Calkin, Thompson, and Finney 2015).

METHODOLOGY

This project is concerned primarily with the current state of fire management in California with an eye towards shifting our focus away from strategies that exacerbate the risks, damages, costs, and propensity of catastrophic wildfires. For the sake of this project, I plan to analyze the risk factors of WUI (Wildland Urban Interface) housing developments vis-à-vis the imbalance in compliance costs and the long-term solvency of an incarcerated labor force.

The maintenance costs borne by public municipalities disproportionately exceed that of residents choosing to live close to nature in the WUI or the developers incentivized to build there stemming from the fact that developing in the WUI is cheaper and faces less resistance than infill development in already established urban areas. Meanwhile, changing trends in criminal justice reforms and momentary public health precautions during the novel coronavirus pandemic have laid bare the economic and social tradeoffs of leaning on a temporal, imprisoned firefighting force. After elucidating these standard practices, I will analyze the efficacy of alternative models given historical traditions (e.g., Native American prescribed burns) and contemporary practices (e.g., development restrictions in Berkeley, CA "fire zones"). The assumption is that business as usual is woefully inadequate given the rising intensity and frequency of state wildfires.

Positionality/Researcher Perspective

My own perspective of fire stems entirely from my own experiences as a wildland firefighter with the Los Angeles County Fire Department from 2010-11. While serving on a fire crew in the Santa Clarita and Antelope Valleys I was privy to the challenges, procedures and lifestyles of the trained professionals risking their bodily safety to protect life, property, and the environment. As such, I recognize how my own lived experiences may reflect an implicit bias in the recommendations I make at the conclusion of my research presentation. It is my sincere commitment to divorce myself from any residual emotional attachments

to the firefighting discipline as well as any foregone conclusions that stem from my concurrent project work as a student of urban planning.

Units of Analysis

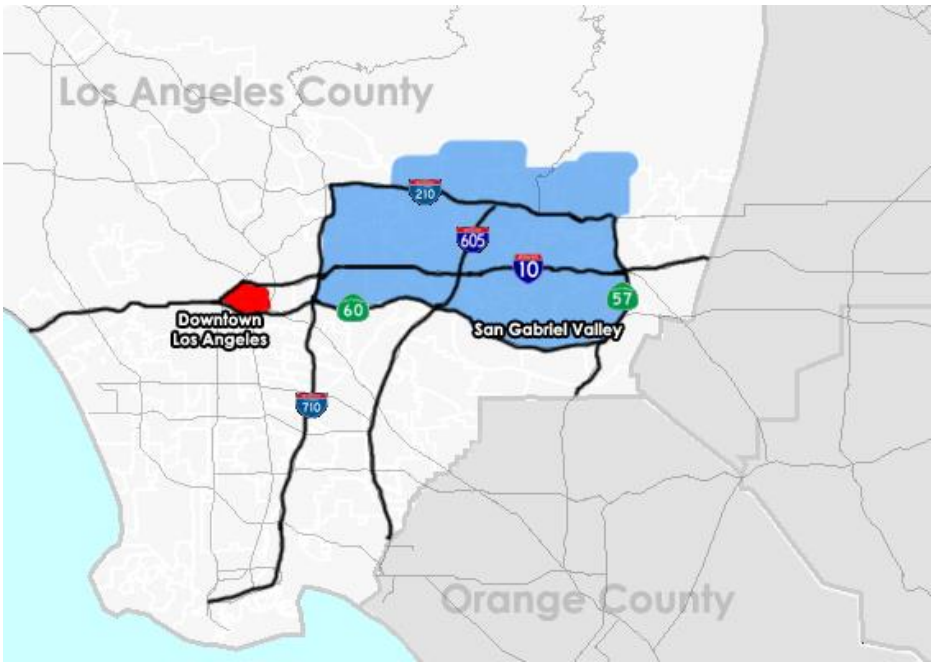
The primary units being analyzed are wildfire activity in Southern California. The inferences made will be based on the evidence of wildland fire activity throughout the state's recorded history with a focus on the last decade (2009-19). Wildfire can be defined as "an uncontrolled fire that burns in the wildland vegetation, often in rural areas." The activity of these units will be measured, compared, and studied to better predict future trends. Wildfires as a unit of analysis will best inform how to live productively alongside these destructive forces. The assumptions gleaned from existing literature suggests that wildfires are inevitable when controlling for human activity and living harmoniously alongside them would necessitate a proactive strategy of management versus the current model of reactive containment.

Variables

The variables surrounding wildfire activity that I will study are as follows: first, housing development in the WUI; second, the changing scope and consequences of wildfire activity in these areas; third, our current approach to wildfire management with a look at the California Department of Corrections & Rehabilitation (CDCR) conservation camp program; fourth, how past stewardship models and innovative approaches can inform our future strategies.

Geographic Scope

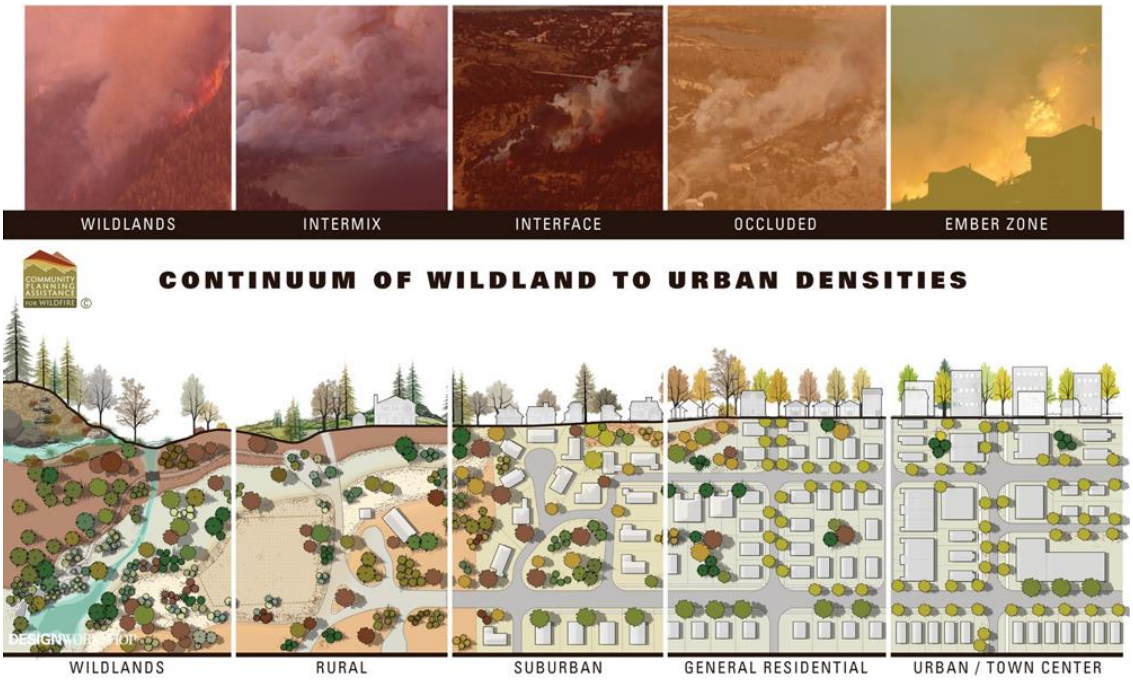
The primary area for this study will be the San Gabriel Valley (SGV) foothills. The foothills range from Sierra Madre (West) to Claremont (East). The SGV is on the eastern front of Los Angeles county. Pasadena is the largest city therein while the overall population boasts a majority Asian-American population and average household sizes (3+) larger than that of the county (US. Census, 2010).



Credit: Wikimedia Commons created using census data.

Key Constructs

WUI: "an area where human made structures and infrastructure (e.g., cell towers, schools, water supply facilities, etc.) are in or adjacent to areas prone to wildfire."



Source: American Planning Association: *Living on the Edge: Get to Know Your WUI*

Disaster Management: "the organization and management of the resources and responsibilities for dealing with all humanitarian aspects of emergencies. The aim is to reduce the harmful effects of all hazards, including disasters."

Resilience: a system that "involves helping communities prepare for, cope with, and manage the impacts of wildfires, including bolstering fire planning and response, supporting those needing to rebuild after fires and managing the secondary impacts of wildfires."

Compliance Costs: expenditure of time or money in conforming with government requirements such as legislation or regulation.

Conservation: protecting species from extinction, maintaining, and restoring habitats, enhancing ecosystem services, and protecting biological diversity.

Stewardship: the responsible planning and management of resources.

Innovation: provides the conceptual framework for identifying and advancing the change ideas most likely to generate the value needed to create sustained success.

Equitable strategies: In operational terms, and for the purposes of measurement, equity can be defined as the absence of disparities in costs and responsibilities that are systematically associated with social advantage/disadvantage.

Literature Review

The first source of data for this project was a reiterative literature review conducted between September 2020 and December 2020. Databases of journals, including Google Scholar, JSTOR, Scopus, and ScienceDirect were utilized to collect peer-reviewed academic literature and reports, along with Google search engine searches for reports by nonprofit organizations and government agencies, government websites, and news articles. This review consisted of two main phases: a general literature review (looking at wildfire history in California, wildland-urban interface development, risks and perceptions of wildfire risk, wildfire mitigation, management, and adaptation strategies, managed retreat and alternatives, policy and governance related to development and wildfire risk management in the WUI.

A review and summary of literature and sources occurred after the data collection phase, including a search for themes across the sources. Although

literature for the exact subject of this study was quite limited, commonalities and salient points were discovered throughout the sources in different themes.

Although the literature review expanded beyond academic and government sources to be as comprehensive as possible, the process has some inherent bias. Some information and articles may have been missed due to the selection of or absence of certain search terms. Additionally, citations and suggestions from reviewed articles to identify new sources may have led to sources with similar approaches and conclusions and missed some opposing approaches.

Interviews

Interviews were one component of the evidence I relied on to make recommendations. These are necessary to bridge the gap between objective analysis and the subjective experience of affected individuals. I learned how residents and municipalities alike frame the threat of wildfire. Sampling from a collection of city planning practitioners, fire professionals, WUI residents and those impacted by the criminal justice fire program give a holistic look at the current playing field. The choice of diverse stakeholders reduces the risk of a lopsided bias towards one predefined recommendation. Ultimately the topic of living alongside wildfire and the costs of disaster management concerns all Californians, but especially the people living and working directly in the line of fire.

I explored the perspectives of stakeholders in the affected San Gabriel Valley communities. These perspectives ranged from public safety officers trained to understand fire activity plan for its behavior, residents living alongside the intensifying risk of catastrophic fire loss, municipal planners balancing the priorities of multiple constituencies and incarcerated men (and women) who put their lives on the line as a form of penal sanction. These interviews were conducted via Zoom, Microsoft Teams, and telephone at the leisure of each interviewee for approximately 45 minutes each. Leaving out the perspective of housing or real estate developers in the area does run the risk of research bias if their perspective would have informed a different path going forward. This sampling bias will continue to be acknowledged and accounted for in subsequent analysis.

I interviewed Matthew Hahn, a blogger and former inmate firefighter who writes extensively about his experiences as a prisoner. Similarly, officials involved with the conservation camp program were consulted for its value and effectiveness. City planning employees in Duarte and Monrovia were interviewed

for their perspective on best practices while professionals in the fire industry were surveyed for their strategic preferences.

Case Studies

Case studies were compiled to add further legitimacy to any measures being proposed. Case studies are appropriate given the available example of other areas employing innovative or historical methods to coexist with the realities of California wildfires. Each represents communities living in or near the WUI. The data sources will be local ordinances, historical record, and secondary accounts. The cases will be reviewed for their novelty and efficacy as measured against the currently employed models.

Malibu, CA: The abandoned master plan for the city of Malibu, CA originally advised against building in the canyons which is a lesson that was ultimately heeded by Pepperdine University making it a consistent model for successful coexistence with wildland fires. While the students of Pepperdine successfully shelter-in-place the city residents are forced to flee in the face of approaching flames.

Australian Brushfires: Wildfires in Australia have become more noteworthy as the intensity and human toll rises. However, fire has shaped the face of the Oceania continent for millions of years. Eastern Australia is one of the most fire-prone regions in the world. Like the United States, indigenous peoples there historically wielded fire to their advantage with controlled burning practices while post-industrial developers exacerbated the occurrence of severe fire storms in WUI land. The government's response to deadly wildfire trendlines is an effective comparative analysis for how the San Gabriel Valley could model their own resilience plan.

Portugal: The westernmost country on mainland Europe features all the same risk factors of Australia but serves as a comparative model for how not to successfully mitigate future wildfire risk in the face of a changing climate. Poor forest management and firefighting techniques make Portugal especially vulnerable to wildfires as climate change makes hotter, longer summers more likely. The mass migration of Portuguese from rural hillsides into WUI suburbs has exacerbated the modern problem. A largely volunteer firefighting force and natural vegetation that is highly flammable makes the small country a proverbial tinderbox each year.

Native American Traditions: Radical disruption of Indigenous burning practices in the United States occurred with European colonization and forced

relocation of tribes who had historically maintained the landscape. Some colonists understood the traditional use and potential benefits of low-intensity broadcast burns ("Indian-type" fires), but others feared and suppressed them. In the 1880s, impacts of colonization had devastated indigenous populations, and fire exclusion had become more widespread. By the early 20th century, fire suppression had become the official US federal policy.

FINDINGS

The data collected from interviews and case studies highlights recommendations in addressing the research question posed:

1) Current city plans need updating in regard to wildfire prevention and safety

Planning departments are required to mitigate potential hazards such as wildfire. A chief planner noted that their city's safety element concerning wildfire is 'severely outdated' and the city tends to outsource research to outside consulting firms. The planning department also leans heavily on the individuals running emergency operations to plan for all contingencies. One city, Monrovia, is currently in the middle of updating their overall general plan.

2) Land use planning tools should align with wildfire prevention and safety.

Fire prevention measures should address not only future building structures but existing ones as well. Regular updates should account for changes in climate and weighing the risks of using WUI space as a solution for housing demand. Using the environment to our advantage by predetermining evacuation/access routes and allowing for ample defensible space would mitigate the inherent risk of human habitation in fire-prone areas.

3) Lack of funding for wildfire prevention and safety.

Smaller cities like Duarte rely on grant assistance to meet their budgetary obligations in terms of fire mitigation yet still find themselves lacking the requisite funds to mount an acceptable defense. Much of the federal and state funding for wildfire efforts go to agencies charged with fire suppression and our collective reaction to fires once they start (e.g., Cal Fire, U.S. Forestry, LACOFD, etc.) which, while undoubtedly vital, leaves a pittance for the powers that are otherwise responsible for both prevention and recovery.

4) Examine alternative, creative solutions concerning wildfire prevention and safety.

Several innovative strategies were either evident in case studies or presented by interviewees. Examining all alternatives to business-as-usual strategies is an essential step to living alongside wildfire harmoniously after years of an adversarial relationship and the resulting carnage. A concerned homeowner in Duarte has invested in fire cameras for his property and nearby conservation space while lamenting that the city or county has not used their resources to employ a similar strategy in remote wildland space.

5) Long-term solvency of the inmate firefighting program is a concern.

While the controversial inmate firefighting program is widely approved of by imprisoned participants, trends in public health and criminal justice have threatened the long-term viability of the program. The ensuing reduction in eligible inmates has reduced the number of inmate crews in LA County from 33 to 8 over the last decade. Furthermore, the difficulty in hiring civilian firefighters has created gaps in manpower that necessitates a holistic strategy that no longer puts the lions share of the burden on first responders.

INTERVIEWS

Interview with Sheri Bermejo, Planning Division Manager for the City of Monrovia:

The city of Monrovia is a city centrally located in the San Gabriel Valley. The city is currently in the middle of updating their overall general plan. The primary focus for the new plan will be its housing element as that is the most regulated section of the plan. In accordance with AB 747 (Planning and zoning: general plan: safety element) the planning department is required to mitigate potential hazards such as wildfire. This safety element is "outdated" according to Ms. Bermejo, but small cities like Monrovia tend to outsource the necessary research to outside consulting firms. The planning department also leans heavily on the individuals running emergency operations to plan for all contingencies.

Monrovia treats its residents as stakeholders in their own city government, so community input is weighed heavily in all planning changes. The Monrovia Area Partnership, also known as MAP for short, is a community-based program run out of the Community Development Department, Neighborhood and Business Services Division at the City of Monrovia that connects neighborhoods directly with local government decision-makers. The recent 2020 'Bobcat Fire' changed everything for the city's fire prevention measures. Landscape standards have been scrutinized to prevent future property loss; however, these standards currently only apply to subsequent developments. The requirements would need to be

expanded to cover existing structures. A similar issue is the addition of accessory dwelling units (ADUs) to WUI residences. If the master property falls under an outdated fire code such as mandated sprinklers, then the new ADU will not be required to meet the contemporary requirements. So, in this example the ADU would be exempt from the current sprinkler rule since the primary residence on the parcel predates that policy.

Monrovia is currently meeting the RHNA (Regional Housing Needs Assessment) goals set down by the state. The driving force of all new housing is transit-oriented development (TOD). New developments are often being located close to light-rail and/or major bus line networks. This dense agglomeration of units is therefore not adjacent to the WUI. Planning for housing in the WUI is an issue of appropriate zoning, not fire risk. If a developer chooses to build in accordance with the corresponding land use the planning department cannot arbitrarily deny their arrangements. It is the purview of the fire department to handle how the fire code is implemented and routinely complied with. The Neighborhood Services office educates homeowners on the importance of compliance prior to any enforcement measures up-to and including monetary fines. The Monrovia WUI is a loosely populated area away from the services and goods that developers favor for a multifamily structure.

<u>Interview with Brad Dover, Chief of Monrovia Fire:</u>

Given that most fires are the fault of human activity the job of a fireman is always going to be essential. Monrovia has implemented new ignition standards and buffer zones to enhance fire safety. The highest value real estate properties are indeed in the WUI, however, the people living there have by-and-large been residents for decades so not necessarily affluent given the property tax rates frozen under Prop 13 and/or home inheritance trends in the community. Many of these residents are financially vulnerable and unlikely to afford fire insurance although the CA FAIR Plan does assure the availability of basic property insurance to people who own insurable property in the State of California and who, beyond their control, have been unable to obtain insurance in the voluntary insurance market.

The department's current fire management strategy hinges largely on annual brush inspections. The department contracts with a private trash hauling company (Athens) to perform free debris removal up to a certain amount. They also burn approximately 60K acres of brush in prescribed burns. They conduct education programs teaching residents how to "harden" their structures if vulnerabilities against fire damage exist. Residents can explore no-cost measures

such as tempered glass. The Chief believes strongly that an unequal focus on fuels has neglected the risks of vulnerable structures.

There are currently three fire compact agreements in the SGV. One is a mutual threat zone agreement with the county (LACOFD) which outlines certain zones where the state (CAL Fire) will act in conjunction to dispatch a joint aviation attack if a fire erupts in said zones. A cooperative agreement with the federal government (USF) coordinates a sharing of costs between agencies when a fire's size encompasses multiple areas of jurisdiction. The third is a smaller arrangement with Glendale's Verdugo Fire Communications to ensure a unified response and flexibility in adjusting red flag warnings. The current fire warning system is based on winds, temperature, etc. Three levels can trigger closures in the recreation areas depending on fire risk. Not an exact science. Hurricanes are easier to predict. We do not know what Santa Ana winds are going to do or where.

Labor/staffing costs are reimbursed during fire season and tracked with management analysts. There is a robust brush program where all the citywide brush is done by the city with private contractors depending on grants and other funding sources. Monrovia has been through its fair share of development fights in the WUI. The city wants to use developments to create buffer zones and better roadways to mitigate any potential risks their very presence might create. The current county budget allocates $1 billion for firefighting efforts. LA County is uniquely resource-rich compared to other counties in the state. That money would be well spent on retrofitting or refurbishing vulnerable structures that would not pass muster when put up against the most recent fire codes. We must give people incentive to put screens around homes, replace windows, fix those vulnerabilities. The fire response in Monrovia is excellent, but prevention vis-à-vis structures is a glaring problem.

The Chief signaled out San Diego county as having a good model for identifying vulnerable structures in their wildfire risk analysis. They can ultimately correlate structure losses with the year of the ordinance it was built under. Rancho Santa Fe employs a shelter-in-place (SIP) strategy that is immensely expensive but has thus far spared residents from significant losses during full borne wildfire events.

<u>Interview with Jason Goldman, Head of Planning for Duarte:</u>

The cost of disaster management is a major concern for small cities like Duarte due to a lack of funding. The city routinely seeks out grant assistance. However, Duarte has not had too much difficulty discourage additional housing in the WUI since residents value open space and "don't want to look like Glendale"

in terms of hillside scarring. The rivers and mountains conservancy grant awarded to the city allows for the preservation of some open space which is a community effort led by department staff. Parcels are typically chosen based on flood, rather than fire, protection. The right to develop in the WUI is protected by the planning department to avoid any litigation over 'inverse takings' which is how a complete prohibition on building would qualify. However, restrictions falling just short of a ban would be appropriate and supported by the city's planning staff. CalFire sends a map to state municipalities every couple of years to color code (red, yellow, orange) to address new development in the most fire prone areas. The most adopted restrictions are grading, drainage, cut-and-fill and other design strategies rolled into the fire code.

Fire agencies play a vital role in conservation efforts by thinning underbrush and trees within the city boundaries. The city wants to address issues of fire resilience without decimating the region's biodiversity. One less than traditional approach is the hiring of goat herders to employ their ruminants in the eating of invasive weeds.

The city of Duarte does not garner many financial benefits from the development of new housing and the projects are almost exclusively developer funded to begin with unless the city owns an adjacent property. Most residential development is a net loss for smaller cities since only about 1/9th of property tax dollars end up returning to city coffers. Los Angeles county gets most of those tax dollars. The general plan would need to be revised to allow for more housing density away from the WUI to account for a housing shortage without encroaching further into fire prone areas. The housing element of their plan is updated once every eight or four years.

Duarte has historically always done a "fantastic" job ensuring the proper maintenance of WUI land. Community input is somewhat "fickle" in terms of city led conservation efforts and manifests most viscerally when a project is first proposed. The city does not currently involve itself with real estate disclosures including fire susceptibility. Isolating fire risk at the expense of seismic and flooding activity would be a shortsighted disaster management approach. The residents of Duarte generally do not pay attention to the politics of disaster funding unless it directly impacts them.

CalFire updates the fire codes every few years. Enhanced defensible space and new construction standards are Duarte's focus. Cities can choose to modify the code to be more stringent than state standards, but not less. Duarte and similar foothill cities tend to stick with the state's guidance since going beyond

tends to be politically tricky and smaller municipalities lack the staffing or expertise to do so. It also snowballs into why the city should not address ALL risks rather than fire exclusively. The city fire department enforces the maintenance of land vulnerable to fire on private property. Property owners do have compliance costs including weed abatement. The city could potentially be fined by the county for not enforcing the abatement standards set by the county's agriculture department.

In terms of rebuilding efforts, the city has seen a few instances of mass property loss. A 1980 fire (unnamed) scorched the hillsides of Duarte claiming one life and 40+ homes as the result of arson. $50,000 was the eventual cost borne by the LACOFD. In response the city set-up mobile permitting stations and waived fees for damage victims. The city then restricted two-story homes in affected neighborhoods although that was not altogether related to fire risk. A 2016 fire (Fish) came within 20 feet of homes, but the ensuing debris flow after the fire turned out to be the costliest disaster issue. Parking restrictions were subsequently implemented to increase accessibility for emergency response vehicles.

<u>Interview with Mike Inman, Assistant Fire Chief, Division 2, L.A. County Fire Department:</u>

Approximately four to five cities have outsourced all of their firefighting and wildland duties to the LACOFD. The costs associated are complex. If an area is not part of the consolidated fire protection district organized in 1988 it would have to pay the county a fee-for-service. The county also pays a substantial amount with its camp contracts housing inmate firefighters for the California Department of Corrections & Rehabilitation (CDCR). The inmate population in the camp has been steadily dwindling due to criminal justice reforms reducing the number of eligible offenders but took a steep drop after the COVID-19 pandemic necessitated additional releases for public health reasons. LA County currently has eight inmate crews ready to deploy down from 33 a decade ago. The salaries/benefits of career firefighters make incarcerated labor an attractive program for the sake of cost-effectiveness, but also benefits the affected men who garner intangible benefits beyond monetary compensation.

The county fire department does not have much say in terms of what areas can or cannot be developed in the WUI. There are some enforcement measures that the department monitors if development does occur. For instance, residents need to have two means of ingress egress (will add to my key constructs section for definition). Water tanks are maintained to serve the community and vegetation

clearance is offered. Prescribed burns are currently underutilized county-wide. CEQA, "environmentalists", and south coast air quality restrictions make the practice challenging. Vegetation management should be performed at lower prescribed burn intensity to lessen the amount of smoke when a fire does burn and disperse accordingly to eliminate the instant fear factor of people seeing smoke. Use weather to their advantage so that it is "our terms v mother nature's terms". LACOFD does work with USF at the forest boundary to extend the interface beyond residential dwellings.

LA County is self-insured which proves to be advantageous from a budgetary standpoint. The cost of water reimbursement depends entirely on where the water is procured from. Municipal water supplies from dams, lakes, reservoirs, etc. are utilized when fires ravage the interface. Water is a readily available resource utilized by emergency powers for betterment of the community. LA County is one of six contract counties in California paid to cover the cost of initial fire actions by the state. The master mutual aid concept provides for the reciprocation of resources between agencies. In other words, LACOFD's position is that they want to help where there is a need regardless of future reimbursement or financial liability. LA County Fire is an "all-risk" organization that address both the wildlands AND structures. LA County does not have an emergency fire fund, so all their money comes directly from the budget which is easily over a million dollars per each large wildfire incident lately. The size of a fire is irrelevant in measuring the costs or danger, rather the values at risk are the primary determinant on a scale of type 1-5, one being the largest.

<u>Interview with Matthew Hahn, Blogger @ hahnscratch.com and former inmate firefighter:</u>

Matthew Hahn served almost a decade behind bars, but a significant portion of that was as part of the department's conservation camp (aka 'fire camp') program. He began his service on a firefighting hand crew but concluded his commitment as a clerk for the camp's correctional office. He has since written extensively about his time as a ward of the state both within a penitentiary and in the camp setting.

Mr. Hahn fears that raising inmate wages would threaten the long-term solvency of the conservation camp program. There might be less willingness for the department to train, house and then supervise the affected men if it entailed paying them a higher wage. The current system saves state firefighting agencies significant expenses while providing them a comparable labor force to combat the largest blazes in hostile terrain. He believes alternative programs (e.g., Caltrans

work) could be just as effective. Benefits were less about the compensation and more about the quality of life, dignity, intangible skills, and time shaved off sentence. The current strength of the program is that it is entirely voluntary and provides incentives beyond what eligible offenders will find in penitentiary based programs. The biggest selling point is that inmates serving time in the camp earn "one-third" time meaning that each actual day served equals three off their sentence. He believes that the diminishing number of inmates volunteering may lead CDCR to send eligible prisoners to the camps against their will.

<u>Interview with Dr. Andrew Raubitschek, Duarte homeowner:</u>

The city of Duarte is besieged by, in Dr. Raubitschek's estimation, "lack of funding", and is thus highly cynical towards past actions of the county regarding fire planning. He is a huge proponent of the Duarte wilderness preserve which is 330 acres of conservation land purchased by the state. He recalls it being developed by Nelson Chung.

The practice of using goats to abate weeds is counterproductive when the seeds of invasive species end up being discharged back into the environment and simultaneously fertilized by the animal's excrement. Monrovia bought land with city money, not state. They never budgeted to take care of the land despite having the best of intentions. 15 years since the land was acquired there has been no annual report or reviews.

According to Dr. Raubitschek, LACOFD is notorious for destroying the foothill topography. There has not been enough focus on biodiversity in terms of the species that are most resistant to wildfire. Ponderosa pines are far more flammable than live oaks. Native Americans used to refer to the latter as "fire catchers" given their canopy's propensity to extinguish embers. As such there is an oak tree ordinance in LA County unless it is an incorporated city. These ordinances would make the removal of oak trees on any unincorporated properties illegal without approval from the county. Expanding these ordinances county-wide could go a long way towards mitigating future destruction.

City not helping support the efforts of individual homeowners erecting costly wildfire cameras to monitor secluded areas for flare-ups. Unraveling the politics of city funding is key to exposing mismanagement. The Rivers and Mountains Conservancy is a state funded agency with an appointed Board of Governors. Money is what moves people to action in the SGV. Water management is another key component of wildfire resilience since the SGV supplies water directly to the City of Los Angeles.

"The question is not what to do, but how to get it done". Less wealthy cities must rely on rugged individualism to protect their properties while cities like Bradbury have the means to implement effective plans. A grant from the state for citizens wildfire prevention would go a long way.

Interview with Ken Pellman, Public Information Officer for Los Angeles County Department of Agriculture:

Fire resilience is a multi-department effort, but each of the agencies outside agriculture operates as their own "little kingdom". There is a weed abatement division in the office. They routinely visit vacant, unimproved parcels in unincorporated towns (e.g., Altadena). Some incorporated cities contract with the county to abate their weeds. They seek to educate residents before potentially billing them for non-compliance. The goal after all is to get the property cleared, not to "punish". Depending on the property, they might find it cheaper to let the agency do the work rather than hire a private company. In that case it would be considered "assessing a charge to the property", still not a fine or tax. Handling the unoccupied properties makes it easier to then defend occupied properties if that time comes.

The department is doing their part to demonstrate efficacy. That being said, "more resources would not be wasted". Disking is the process of tilling the soil to maintain a mix of perennial plants and set back plant succession. Any process implemented should be effective but keeping all externalities in-mind. For instance, herbicides are incredibly effective at killing weeds but lead to a plethora of additional issue for wildlife, humans, and the environment. Weeds are also not the only flammable species of vegetative fuel. Heavy machinery or small handheld tools are the currently favored methods.

Newly occupied units are the county's current priority for fire protection. In terms of new building, we should be mandating less flammable construction materials. There are always going to be tradeoffs when the county is experiencing a housing shortage and fewer parcels of developable land. If encroaching further into the WUI is an inevitable or our best option, then we must do everything in our power to do so safely or risk losing all these new units eventually.

Interview with Vincent Anderson, Fire Marshal for City of Sunnyvale:

Mr. Anderson formerly worked as the Fire Marshal for the city of Redlands which has a large proportion of WUI territory. There is a significant amount of money in these developments so a complete prohibition would be politically insurmountable. He would not be opposed to increased enforcement of fire

mitigation measures, but "compliance costs money." House hardening and vegetation management are the current approaches to ensuring development is up-to-speed on fire codes. The developers initially pay for the costs associated with compliance, but ongoing maintenance can be difficult and unexpected costs fall on the shoulder of the homeowner or city in cases where the resident is negligent.

Requiring retroactive hardening is a measure that could be explored. Defensible space is a key measure of how prepared a property is for wildfire risk. Undeveloped parcels are the most difficult to reach in terms of the ownership. Redlands tries to take a "customer service" approach to advising residents on their failure to comply with certain measures. They are given 30-days to retrofit before any sanctions are used. Soil erosion is a risk with untargeted weed abatement. The city of Redlands pays $30,000/year for weed abatement on negligent properties alone. The municipality does bear the brunt of maintenance compliance in most cases. If a homeowner has thus far refused to comply then the public agency is going to eventually foot the bill unless they eventually relent. The removal of hazardous materials is also the sole responsibility of homeowners.

Showing due diligence is the best approach for agencies to prevent wildfire disasters. It always boils down to communication with other agencies, residents, and developers. Fire Service industry leader Chief Alan Brunacini once said there are two things that firefighters hate: change and the way things are. This aspect of Fire Service culture creates inertia even when fires are consistently becoming more dangerous and costly. Enforcement and prevention are tied to each responsible jurisdiction. Redlands has a bi-annual inspection program but increases those rounds if they predict a volatile fire season based on the winter's precipitation levels.

Malibu/Pepperdine University:

Credit: Pepperdine University *Graphic*

Pepperdine University is a private institution situated along Pacific Coast Highway and nestled just below the canyons of the Santa Monica Mountains in Malibu. It was uniquely designed to be fire-resistant after the city abandoned similar measures in its general plan. The plan was never made public, perhaps because William Pereira's idea, "clusters of houses set off by huge natural preserves", would have put the housing much closer together and left more of the land undisturbed. This SIP strategy is like that employed by Rancho Santa Fe (San Diego County) with similar success. It is particularly vital when the normal residents of Malibu attempt to evacuate along the heavily impacted PCH. Attempting to evacuate a student body from largely out-of-town would only add to these dangerous conditions. The practice of "sheltering-in-place" is relocating to a safe location on the premises and remaining there until authorities deem it safe to return to residences or offices. Pepperdine University uses this procedure during wildfires affecting its Malibu campus. The reasons for sheltering-in-place are listed below:

The Los Angeles County Fire Department reviews Pepperdine's shelter-in-place plans on a regular basis and supports the plans as the safest course of action. Pepperdine University works closely and cooperatively with the Los Angeles County Fire Department. As a result, the Los Angeles County Fire Department maintains a strong presence on campus during a fire.

Campus buildings are constructed with fire-resistant materials whenever possible; campus roads provide natural fire breaks; fire resistant landscaping is utilized throughout the campus. Brush is cleared annually at least 200-feet from campus buildings. This practice creates firebreaks around campus buildings. In some locations, brush is cleared beyond the 200-foot mark.

This policy is not without criticism from the community. Mandatory evacuations for all properties beyond the campus creates the impression that fire fighters are concentrating all their efforts to protect the campus versus the many homes built along the canyon. In fact, the opposite is true because while the homes were built in fire prone areas against the initial counsel of architect Pereira, the campus is designed to resist without a massive firefighting presence meaning that resources can then be funneled towards the endangered parcels.

The policy has also evolved over the past couple of decades. The example of Hurricane Katrina forced them to reconsider their food storage standards moving from having five days' worth of rations to two weeks' worth for up to 5,000 people. Anticipating potential poor air quality due to fires, the medical center is now prepared with N-95 particle masks, and students have access to emergency inhalers, nebulizers, and oxygen. One of the administrative buildings is even outfitted with communications equipment and generators that can function as an incident command center for the county to use for any emergency operations that might block PCH, from car crashes to landslides. The steel-framed structures make good use of fire-resistant decorative materials like glass and ceramic tile. The shapes of the buildings, with their steep Spanish-tile rooflines, also ensure that fast-moving fire will not get trapped beneath deep eaves. Smaller structures and architectural elements are covered in stucco, without any exposed wood trim.

Of Pepperdine's 830 acres, about 500 acres have no structures, thanks to Pereira's dense clustering of buildings and maintained open spaces. School officials are diligent about brush clearance as well, eliminating combustible vegetation at least 200 feet around all buildings. Even the campus's sprawling front lawn, a natural meadow that was planted with grass, plays a role in fires. The lush green slope is part of a water conservation system that allows Pepperdine to recycle wastewater and store it on site. Runoff that is waiting to be reused is captured in two lakes—which firefighters used to help manage the Woolsey Fire. The preservation of the meadow and the design of the water infrastructure were envisioned by Pereira as well.

Pereira's vision proved to be quite prescient as the campus has withstood at least seven major catastrophic fires in the surrounding hillsides. The model of

avoiding ecological destruction and "fortress-like fireproof buildings" calling for expensive steel-reinforced concrete is a model for other new, growing, and existing communities. Investing in the right strategy at the outset can diminish the later costs that come from inadequate preparation.

Native American tribes:

Credit: NPR: *To Manage Wildfire, California Looks To What Tribes Have Known All Along*

Indigenous people have been practicing controlled, deliberate burns in North America, and around the world, for millennia. For the Yurok, Karuk and Hoopa Tribes of Northern California, human-managed fires across their traditional lands are vital. They promote the growth of traditional food sources, like acorns, and basket-weaving materials, like hazel. Between lightning strikes and Indigenous burns, most landscapes in North America were shaped by fire, and many landscapes need it. But for most of the 20th century, U.S. federal fire policy was guided by a strategy of fire suppression, designed to protect watersheds, communities, and commercial timber supplies.

Without moderate or low intensity burns to clear fuel, landscapes became primed for more destructive wildfires. And with increased temperatures and lower humidity caused by climate change this year saw record wildfires across the Western states. But restoring cultural burning practices is not a simple task. While there is increased recognition for how past policies of fire suppression

destabilized U.S. landscapes and cultures, and an understanding that controlled burns are one of the best methods to limit catastrophic wildfires, the dominant fire agencies and regulatory frameworks today still pose significant hurdles to the setting of cultural fires.

The Indigenous Peoples Burning Network (IPBN) is a support network among Native American communities that are revitalizing their traditional fire practices in a contemporary context.

The Prescribed Fire Training Exchange (TREX) is one of nearly two dozen that The Nature Conservancy (TNC) and partners organize across the country every year to build skills and encourage collaboration in controlled burning. The TREX program provides a cooperative burning model that meets the needs of diverse entities, including federal and state agencies, private landowners and contractors, tribes, academics, and international partners while incorporating local values and issues to build the right kinds of capacity in the right places. One of the many benefits of the TREX model is its ability to test innovative ideas and seize opportunities as they arise which is a failing of the current business-as-usual firefighting strategies used by government entities.

"Today there is ample science supporting the use of prescribed fire and a growing body of research pointing to the role Indigenous communities play in landscape management. Such findings prompted the Forest Service to begin to consider the role of cultural burns in its plans."

Australia:

Credit: Redux Pictures

Australia has been particularly aggressive in adopting new measures to reduce the threat of damage from fires, including identifying fire-prone areas, setting up planning and permitting requirements to curb risky development in those areas, and launching a voluntary buyback program to move people off land threatened by repeated burning. Additionally, Australia overhauled its warning system for bushfires, creating a six-stage program that encourages people to leave early rather than stay and try to defend their property.

Drier, hotter conditions driven by climate change can add to the size and intensity of bushfires, as moisture levels in the soil shrink and vegetation dries up. Since 1950, temperatures in Australia have risen about 2.7 degrees Fahrenheit, and the country has experienced drought for the last three years. Under these conditions, fires spread rapidly and burn extremely hot. At such high temperatures, the fires can create their own weather, including producing lightning that can ignite additional bushfires. There is another worrisome connection to climate change: the loss of vegetation that absorbs carbon. A burning forest emits carbon dioxide that is normally reabsorbed over time as the forest regrows. But scientists fear that the scale and intensity of the current bushfires will cause Australian forests to regrow more slowly, reducing their ability to rapidly absorb excess carbon. With more carbon in the atmosphere, the earth will continue to warm.

California has hardly lived up to the example of responding appropriately after historic losses. Days after the devastating Camp Fire in 2018, which killed more than eighty people, Los Angeles County approved the development of nineteen thousand homes in an area that the state had already designated as being at high or very high fire risk. Similarly, after a wildfire burned the neighborhood of Coffey Park in Santa Rosa, California, the city declined to impose stricter building standards for fire prevention. State and local governments in the United States should heed Australia's unfolding tragedy and curb development in areas facing a growing threat of fire.

Portugal:

Credit: DW*: Hundreds of firefighters combat Portugal wildfires*

An example of how not to successfully manage wildfire risk. Most firefighters in the Atlantic coast country are volunteers and a fast-spreading fire can quickly overwhelm their efforts to contain it. They also fail to use chemical retardants on extinguished flames meaning often a fire is controlled at night and then it rekindles in the morning.

Portugal also needs to plant more oak, chestnut, and other more fire-resistant trees instead of the pines and eucalyptus found across the country. Despite the combustion risks, quick-growing eucalyptus trees, a highly flammable species, are planted to meet demand from Portugal's key paper pulp industry. Large swathes of central and northern Portugal are covered in unbroken stretches of forest, without any gaps in vegetation that can slow or stop a wildfire. Portuguese towns and villages are often nestled in or next to forests, and many farmers and residents continue to burn dead leaves on their land even in drought conditions which highlights the need for more education and spreading awareness to elderly property owners.

Portugal is one of the most heavily forested countries in Europe, but most of the woodland (85%) according to the World Forest Institute is privately owned. Lack of management of the forest is a key part of Portugal's problem. As rural populations have dwindled, many of these privately owned plots have been neglected, with brush and detritus accumulating - which become fuel for the

flames when a fire breaks out. The current emphasis is on the emergency response to outbreaks of fire, rather than the longer-term territorial management that would lower risk and minimize the spread of the flames. There is a lack of "safety lanes" creating a break between dwellings and forest that would enable firefighters to focus on fighting fires rather than evacuating people. Houses should be built with safe rooms where people could take shelter if forest fires drew near. Other observers have also criticized the latitude given to the forestry companies. Critics say the lack of a modernized warning system means local people are not fully informed and begin acting on instinct. Communication problems even extend to the emergency services, which have found themselves unable to communicate after emergency network phone masts burned down.

CONCLUSION & RECOMMENDATIONS

The risk of wildfires across the state of California will increase in the coming years due to the combination of climate change and future housing developments, thus the risk is intensifying as a confluence of factors work against our efforts to avoid annual catastrophes. A business-as-usual approach to wildfires has seen a trend of ever-increasing fire intensity, loss of property, fatalities, ecological damage, and seemingly insoluble revenue losses. Professionals in all affected agencies, laborers battling the infernos, and residents with the most to lose all agree that the current system is not working despite the best of intentions. If the conclusion of this work could be summed up in one sentence it would be quite simply that cities in the San Gabriel Valley are trying their hardest to manage wildlife danger but simply do not have the resources or infrastructure to do so effectively.

Therefore, drawing upon tested methods and the expertise of contemporary stakeholders have led to the following recommendations.

1. Increase housing density away from fire-prone areas in the WUI. Municipalities can meet housing demand by building up or repurposing larger parcels into multi-unit developments. Centering housing stock around transit hubs and then creating reliable transit networks with WUI access will make the wildlands still available for safe recreation. A complete prohibition on housing development in the WUI is politically palatable in neither conservative nor liberal communities. Regardless, there are takings implications that could make such outright bans a legal liability for the responsible municipality. In lieu of incentivizing development away from these otherwise ripe lands there should be strict

compliance costs to ensure new activity does not present unreasonably high fire risk.

2. Defensible space is the key component to a shelter-in-place strategy if evacuation is not an option. However, vegetation management and fuel abatement are only effective insofar as they are enforced. Furthermore, expand LA County's oak tree ordinance to protect species known to be flame-resistant. The incursion of irrigated residential landscapes into the WUI contribute to the spread of fire-prone invasive species into conservation lands. To limit degradation of conservation lands caused by WUI development, develop landscape standards for WUI zones that balance fire-resistance, fire-resilience, and biodiversity.
3. Manage unoccupied or older structures. Ensuring new developments meet contemporary fire codes miss the risk presented by older structures that may or may not accelerate the spread of a wind-driven fire. Addressing any gaps in unincorporated county lands while bringing older units up-to-speed will improve relations between neighboring communities that may have otherwise prioritized abatement differently. Acknowledging that some homeowners cannot afford the costs of compliance, let alone fire insurance, requires a willingness to subsidize their share rather than leaning on fines that may never be paid due to lack of funds. It is ultimately in everyone's best interest for all units to be compliant regardless of who foots the bill.
4. Increase funding to agencies that manage fire prevention. Current incentive structures prioritize the agencies that deal with fire suppression after the fact as well as the ensuing recovery process. Effectively communicating why these funds are necessary will be the proverbial spoonful of sugar that makes the medicine goes down. Our collective failure to adequately assess risk makes any form of insurance payment incredibly painful. Putting all our public funds into firefighting does not protect all the communities that are put at-risk by the many externalities of catastrophic wildfires or their causes. These new funds would be used for preventive measures such as controlled burns to thin out the underbrush and protect native species.
5. Reexamine the efficacy of an incarcerated firefighting contingent and explore alternatives for eligible inmates. While employing a captive work force (literally) does save the state money in the short-term, the shifting nature of criminal justice sanctions make that fluid labor pool unreliable as the rate of fires reliably increase. The state would counterintuitively be making better use of its funds by paying trained civilian firefighters to manage blazes when they occur, and reallocating other monies earmarked

for the conservation camp program to less costly diversion programs. Allowing eligible inmates to enjoy similar privileges and time credits while pursuing a viable, less dangerous vocation meets their rehabilitation needs without neglecting the state's forestry defense.

6. Consider acquiring land for conservation purposes in the WUI. A complete prohibition on building in risky areas seems unlikely and even the most stringent precautions will not prevent future burn events in areas that are designated as Very High Fire Hazard Severity Zones. The costs of managing conservation lands with little human interference would ultimately be a cost-savings when measured against the increasing costs of fighting the fires that are otherwise starting in these areas when developments arise. Singling out the hardest to reach parcels would better conserve the energy and resources of first responders who would otherwise have to access an endangered structure there while eliminating the need to manage precarious evacuation routes for the homeowners. Conserving the farthest reaches of wildland and moving towards the intermix WUI would slowly push development back into the suburbs and urban core. Conservancies would make these natural resources available for visitor recreation and appreciation while preventing the fire risks posed by long-term habitation. This is another example of when spending a little more upfront will save taxpayers on the back end.

These recommendations should not be treated as fragmented or separate policies but understood as part of an essential integration and coordination of wildfire policies at state, county, and municipal levels. The lack of a coherent set of policies that address all the elements of the current and projected wildfire risks presents a problematic that can only be resolved through greater coherence, collaboration, and policy alignment.

WORKS CITED

04-IFFN-34-Portugal-Country-Report-3-3.pdf. (n.d.). Retrieved March 13, 2021, from https://gfmc.online/wp-content/uploads/04-IFFN-34-Portugal-Country-Report-3-3.pdf

2014 LHMP.pdf. (n.d.). Retrieved May 19, 2021, from https://www.cityofberkeley.info/uploadedFiles/Fire/Level_3_-_General/2014%20LHMP.pdf

2018_Portugal_Wildfire_Management_in_a_New_Era_Engish.pdf. (n.d.). Retrieved March 13, 2021, from https://www.isa.ulisboa.pt/files/cef/pub/articles/2018-04/2018_Portugal_Wildfire_Management_in_a_New_Era_Engish.pdf

Alexandre, P. M., Mockrin, M. H., Stewart, S. I., Hammer, R. B., & Radeloff, V. C. (2015). Rebuilding and new housing development after wildfire. *International Journal of Wildland Fire*, *24*(1), 138–149. https://doi.org/10.1071/WF13197

Anderson, M. K. (2013). *Tending the Wild: Native American Knowledge and the Management of California's Natural Resources*. Univ of California Press.

Articulo_6_Australia_eng.pdf. (n.d.). Retrieved March 13, 2021, from https://www.unisdr.org/2000/campaign/PDF/Articulo_6_Australia_eng.pdf

Australia's Fires Will Rage Again. Here's How the Government Can Prepare. (n.d.). Council on Foreign Relations. Retrieved March 13, 2021, from https://www.cfr.org/in-brief/australias-fires-will-rage-again-heres-how-government-can-prepare

Balch, J. K., Bradley, B. A., Abatzoglou, J. T., Nagy, R. C., Fusco, E. J., & Mahood, A. L. (2017). Human-started wildfires expand the fire niche across the United States. *Proceedings of the National Academy of Sciences*, *114*(11), 2946–2951. https://doi.org/10.1073/pnas.1617394114

Berg, E., & Boyarsky, B. (n.d.). *HOW TAXPAYER SUBSIDIES AND BALKANIZED GOVERNANCE PROP UP HOMEBUILDING IN WILDFIRE AND FLOOD ZONES*. 150.

Berkeley expert explains the wildland-urban interface: "We have to find a way to live with fire." (n.d.). Retrieved May 19, 2021, from https://www.sfgate.com/california-wildfires/article/Berkeley-expert-wildland-urban-interface-wildfires-15520238.php

Braziunas, K. H., Seidl, R., Rammer, W., & Turner, M. G. (2020). Can we manage a future with more fire? Effectiveness of defensible space treatment depends on

housing amount and configuration. *Landscape Ecology*. https://doi.org/10.1007/s10980-020-01162-x

California's 2021 wildfire season is shaping up to be especially bad | Fortune. (n.d.). Retrieved May 19, 2021, from https://fortune.com/2021/04/13/california-fire-season-moisture-levels-fmc-wildfires-drought-san-jose-state/

Calkin, D. E., Thompson, M. P., & Finney, M. A. (2015). Negative consequences of positive feedbacks in US wildfire management. *Forest Ecosystems*, *2*(1), 9. https://doi.org/10.1186/s40663-015-0033-8

Carruthers, T. (2018, January 14). *How we fight bushfires*. Curious. https://www.science.org.au/curious/earth-environment/how-we-fight-bushfires

Cavender-Bares, J., González-Rodríguez, A., Eaton, D. A. R., Hipp, A. A. L., Beulke, A., & Manos, P. S. (2015). Phylogeny and biogeography of the American live oaks (Quercus subsection Virentes): A genomic and population genetics approach. *Molecular Ecology*, *24*(14), 3668–3687. https://doi.org/10.1111/mec.13269

Chrobak, U. (2020). How to rebuild California forests, with climate in mind. *Knowable Magazine | Annual Reviews*. https://doi.org/10.1146/knowable-121420-2

Davis, E. J., Moseley, C., Nielsen-Pincus, M., & Jakes, P. J. (2014). The Community Economic Impacts of Large Wildfires: A Case Study from Trinity County, California. *Society & Natural Resources*, *27*(9), 983–993. https://doi.org/10.1080/08941920.2014.905812

Delfino, R. J., Brummel, S., Wu, J., Stern, H., Ostro, B., Lipsett, M., Winer, A., Street, D. H., Zhang, L., Tjoa, T., & Gillen, D. L. (2009). The relationship of respiratory and cardiovascular hospital admissions to the southern California wildfires of 2003. *Occupational and Environmental Medicine*, *66*(3), 189–197. https://doi.org/10.1136/oem.2008.041376

Dennison, P. E., Brewer, S. C., Arnold, J. D., & Moritz, M. A. (2014). Large wildfire trends in the western United States, 1984–2011. *Geophysical Research Letters*, *41*(8), 2928–2933. https://doi.org/10.1002/2014GL059576

Early signs show 2021 could be an especially catastrophic wildfire season in California. (n.d.). Fortune. Retrieved May 19, 2021, from https://fortune.com/2021/04/13/california-fire-season-moisture-levels-fmc-wildfires-drought-san-jose-state/

Engel, K. H. (2013). Perverse Incentives: The Case of Wildfire Smoke Regulation. *Ecology Law Quarterly*, *40*(3), 623–672.

Fighting fire in the land down under. (2020, June 9). https://www.doi.gov/wildlandfire/fighting-fire-land-down-under

Finlay, S. E., Moffat, A., Gazzard, R., Baker, D., & Murray, V. (2012). Health Impacts of Wildfires. *PLoS Currents*, *4*. https://doi.org/10.1371/4f959951cce2c

Fire Training Exchanges Expand Controlled Burns. (n.d.). Retrieved March 13, 2021, from https://www.nature.org/en-us/what-we-do/our-priorities/protect-water-and-land/land-and-water-stories/fire-training-exchanges-expand-controlled-burns/

Garrison, J. D., & Huxman, T. E. (2020). A tale of two suburbias: Turning up the heat in Southern California's flammable wildland-urban interface. *Cities*, *104*, 102725. https://doi.org/10.1016/j.cities.2020.102725

Goldman, J. G. (n.d.). *Living on the Edge: Wildfires Pose a Growing Risk to Homes Built Near Wilderness Areas*. Scientific American. https://doi.org/10.1038/scientificamerican0618-12

Goodman, P. (2012a). Hero and Inmate: Work, Prisons, and Punishment in California's Fire Camps. *WorkingUSA*, *15*(3), 353–376. https://doi.org/10.1111/j.1743-4580.2012.00398.x

Goodman, P. (2012b). "Another Second Chance": Rethinking Rehabilitation through the Lens of California's Prison Fire Camps. *Social Problems*, *59*(4), 437–458. https://doi.org/10.1525/sp.2012.59.4.437

Goodman, P. R. (2010). *Hero or inmate, camp or prison, rehabilitation or labor extraction: A multi-level study of California's prison fire camps* [Ph.D., University of California, Irvine]. https://search.proquest.com/docview/757701172/abstract/67DB1AF281FA4FCBPQ/1

Gude, P., & Rasker, R. (2008). Potential for Future Development on Fire-Prone Lands. *Journal of Forestry*, 8.

hahnscratch—One man's perspective on the inside. (n.d.). Hahnscratch. Retrieved December 17, 2020, from https://hahnscratch.com/

Hammer, R. B., Radeloff, V. C., Fried, J. S., & Stewart, S. I. (2007). Wildland–urban interface housing growth during the 1990s in California, Oregon, and Washington. *International Journal of Wildland Fire*, *16*(3), 255–265. https://doi.org/10.1071/WF05077

Hammer, R. B., Stewart, S. I., & Radeloff, V. C. (2009). Demographic Trends, the Wildland–Urban Interface, and Wildfire Management. *Society & Natural Resources*, *22*(8), 777–782. https://doi.org/10.1080/08941920802714042

Haring, B., & Haring, B. (2021, January 3). Los Angeles County Is The No. 1 Most Dangerous Area In The US, FEMA Says. *Deadline*. https://deadline.com/2021/01/los-angeles-county-number-one-in-danger-fema-says-1234664157/

Hawbaker, T. J., Radeloff, V. C., Stewart, S. I., Hammer, R. B., Keuler, N. S., & Clayton, M. K. (2013). Human and biophysical influences on fire occurrence in the United States. *Ecological Applications*, *23*(3), 565–582. https://doi.org/10.1890/12-1816.1

High-Risk Housing Developments Fan the Flames for Wildfire. (2018, September 4). Cal Alumni Association. https://alumni.berkeley.edu/california-magazine/just-in/2018-09-04/high-risk-housing-fans-flames-wildfire

Hillside Fire Zone—City of Berkeley, CA. (n.d.). Retrieved May 19, 2021, from https://www.cityofberkeley.info/Planning_and_Development/Building_and_Safety/Hillside_Fire_Zone.aspx

Hjerpe, E., Kim, Y.-S., & Dunn, L. (2016). Forest density preferences of homebuyers in the wildland-urban interface. *Forest Policy and Economics*, *70*, 56–66. https://doi.org/10.1016/j.forpol.2016.05.012

Housing Arrangement and Location Determine the Likelihood of Housing Loss Due to Wildfire. (n.d.). Retrieved March 7, 2021, from https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0033954

HUMAN INFLUENCE ON CALIFORNIA FIRE REGIMES. (n.d.). Retrieved March 7, 2021, from https://esajournals.onlinelibrary.wiley.com/doi/epdf/10.1890/06-1128.1

Keeley, J. E. (n.d.). *Distribution of Lightning- and Man-Caused Wildfires in California*. 7.

Keeley, J. E. (2002). Native American impacts on fire regimes of the California coastal ranges. *Journal of Biogeography*, *29*(3), 303–320. https://doi.org/10.1046/j.1365-2699.2002.00676.x

Keeley, J. E., & Syphard, A. D. (2019). Twenty-first century California, USA, wildfires: Fuel-dominated vs. wind-dominated fires. *Fire Ecology*, *15*(1), 24. https://doi.org/10.1186/s42408-019-0041-0

Kennedy, S., & Pincetl, S. (n.d.). *Political and Economic Drivers of Wildland-urban Interface (WUI) Development in California*. 18.

Knowles, S., & Moritz, M. (2016). Coexisting with Wildfire. *American Scientist*, *104*(4), 220. https://doi.org/10.1511/2016.121.220

Kolden, C. A., Smith, A. M. S., & Abatzoglou, J. T. (2015). Limitations and utilisation of Monitoring Trends in Burn Severity products for assessing wildfire severity in the USA. *International Journal of Wildland Fire*, *24*(7), 1023–1028. https://doi.org/10.1071/WF15082

Kramer, H. A., Mockrin, M. H., Alexandre, P. M., & Radeloff, V. C. (2019). High wildfire damage in interface communities in California. *International Journal of Wildland Fire*, *28*(9), 641. https://doi.org/10.1071/WF18108

Lauer, C. J., Montgomery, C. A., & Dietterich, T. G. (2020). Evaluating wildland fire liability standards – does regulation incentivise good management? *International Journal of Wildland Fire*, *29*(7), 572–580. https://doi.org/10.1071/WF19090

Long, J. W., Quinn-Davidson, L., & Skinner, C. N. (2014). Science synthesis to support socioecological resilience in the Sierra Nevada and southern Cascade Range. *Gen. Tech. Rep. PSW-GTR-247. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 723 p, 247.* https://doi.org/10.2737/PSW-GTR-247

Marlon, J. R., Bartlein, P. J., Gavin, D. G., Long, C. J., Anderson, R. S., Briles, C. E., Brown, K. J., Colombaroli, D., Hallett, D. J., Power, M. J., Scharf, E. A., & Walsh, M. K. (2012). Long-term perspective on wildfires in the western USA. *Proceedings of the National Academy of Sciences*, *109*(9), E535–E543. https://doi.org/10.1073/pnas.1112839109

Marques, S., Borges, J. G., Garcia-Gonzalo, J., Moreira, F., Carreiras, J. M. B., Oliveira, M. M., Cantarinha, A., Botequim, B., & Pereira, J. M. C. (2011). Characterization of wildfires in Portugal. *European Journal of Forest Research*, *130*(5), 775–784. https://doi.org/10.1007/s10342-010-0470-4

McCaffrey, S., Toman, E., Stidham, M., & Shindler, B. (2013). Social science research related to wildfire management: An overview of recent findings and future research needs. *International Journal of Wildland Fire*, *22*(1), 15–24. https://doi.org/10.1071/WF11115

McCoy, S. J., & Walsh, R. P. (2014). *W.U.I. on Fire: Risk, Salience & Housing Demand* (No. w20644). National Bureau of Economic Research. https://doi.org/10.3386/w20644

McWethy, D. B., Schoennagel, T., Higuera, P. E., Krawchuk, M., Harvey, B. J., Metcalf, E. C., Schultz, C., Miller, C., Metcalf, A. L., Buma, B., Virapongse, A., Kulig, J. C., Stedman, R. C., Ratajczak, Z., Nelson, C. R., & Kolden, C. (2019a). Rethinking resilience to wildfire. *Nature Sustainability*, *2*(9), 797–804. https://doi.org/10.1038/s41893-019-0353-8

McWethy, D. B., Schoennagel, T., Higuera, P. E., Krawchuk, M., Harvey, B. J., Metcalf, E. C., Schultz, C., Miller, C., Metcalf, A. L., Buma, B., Virapongse, A., Kulig, J. C., Stedman, R. C., Ratajczak, Z., Nelson, C. R., & Kolden, C. (2019b). Rethinking resilience to wildfire. *Nature Sustainability*, *2*(9), 797–804. https://doi.org/10.1038/s41893-019-0353-8

Melligan, K. M. (n.d.). *ON THE FIRE LINE: THE LIVED EXPERIENCES OF CALIFORNIA FEMALE INMATE FIREFIGHTERS*. 197.

Miller, C., & Ager, A. A. (2013). A review of recent advances in risk analysis for wildfire management. *International Journal of Wildland Fire*, *22*(1), 1–14. https://doi.org/10.1071/WF11114

Miller, C., & Urban, D. L. (2000). Modeling the Effects of Fire Management Alternatives on Sierra Nevada Mixed-Conifer Forests. *Ecological Applications*, *10*(1), 85–94. https://doi.org/10.1890/1051-0761(2000)010[0085:MTEOFM]2.0.CO;2

Miller, J. D., Skinner, C. N., Safford, H. D., Knapp, E. E., & Ramirez, C. M. (2012). Trends and causes of severity, size, and number of fires in northwestern California, USA. *Ecological Applications*, *22*(1), 184–203. https://doi.org/10.1890/10-2108.1

Miller, Jay D., & Safford, H. (2012). Trends in Wildfire Severity: 1984 to 2010 in the Sierra Nevada, Modoc Plateau, and Southern Cascades, California, USA. *Fire Ecology*, *8*(3), 41–57. https://doi.org/10.4996/fireecology.0803041

Pausas, J. G., Llovet, J., Rodrigo, A., & Vallejo, R. (2009). Are wildfires a disaster in the Mediterranean basin? – A review. *International Journal of Wildland Fire*, *17*(6), 713–723. https://doi.org/10.1071/WF07151

Pepperdine shelters in place as Malibu wildfires burn—Curbed LA. (n.d.). Retrieved January 31, 2021, from https://la.curbed.com/2018/11/20/18097889/wildfire-pepperdine-malibu-shelter-in-place

Portugal wildfires: Why are they so deadly? (2017, June 20). *BBC News*. https://www.bbc.com/news/world-europe-40341180

Prior, T., & Eriksen, C. (2013). Wildfire preparedness, community cohesion and social–ecological systems. *Global Environmental Change*, *23*(6), 1575–1586. https://doi.org/10.1016/j.gloenvcha.2013.09.016

Proceedings of the Symposium on the Ecology, Management, and Utilization of California Oaks: June 26-28, 1979, Claremont, California. (1981). Pacific Southwest Forest and Range Experiment Station.

Quiet Fire. (n.d.). The Nature Conservancy. Retrieved March 13, 2021, from https://www.nature.org/en-us/magazine/magazine-articles/indigenous-controlled-burns-california/

Radeloff, V. C., Hammer, R. B., Stewart, S. I., Fried, J. S., Holcomb, S. S., & McKeefry, J. F. (2005). The Wildland–Urban Interface in the United States. *Ecological Applications*, *15*(3), 799–805. https://doi.org/10.1890/04-1413

Raish, C., González-Cabán, A., & Condie, C. J. (2005). The importance of traditional fire use and management practices for contemporary land managers in the American Southwest. *Environmental Hazards*, *6*(2), 115–122. https://doi.org/10.1016/j.hazards.2005.10.004

Rapid growth of the US wildland-urban interface raises wildfire risk | PNAS. (n.d.). Retrieved March 7, 2021, from https://www.pnas.org/content/115/13/3314.short

Rego, F. C. (1992). Land Use Changes and Wildfires. In A. Teller, P. Mathy, & J. N. R. Jeffers (Eds.), *Responses of Forest Ecosystems to Environmental Changes* (pp. 367–373). Springer Netherlands. https://doi.org/10.1007/978-94-011-2866-7_33

Reilly, B. (2015). Free Riders on the Firestorm: How Shifting the Costs of Wildfire Management to Residents of the Wildland-Urban Interface Will Benefit Our Public Forests. *Boston College Environmental Affairs Law Review*, *42*(2), 541–576.

RestrictionsintheFireZone.pdf. (n.d.-a). Retrieved February 5, 2021, from https://www.cityofberkeley.info/uploadedFiles/Online_Service_Center/Planning/RestrictionsintheFireZone.pdf

RestrictionsintheFireZone.pdf. (n.d.-b). Retrieved May 19, 2021, from https://www.cityofberkeley.info/uploadedFiles/Online_Service_Center/Planning/RestrictionsintheFireZone.pdf

Richardson, L. A., Champ, P. A., & Loomis, J. B. (2012). The hidden cost of wildfires: Economic valuation of health effects of wildfire smoke exposure in Southern California. *Journal of Forest Economics*, *18*(1), 14–35. https://doi.org/10.1016/j.jfe.2011.05.002

Rulli, M. C., & Rosso, R. (2005). Modeling catchment erosion after wildfires in the San Gabriel Mountains of southern California. *Geophysical Research Letters*, *32*(19). https://doi.org/10.1029/2005GL023635

Running, S. W. (2006). CLIMATE CHANGE: Is Global Warming Causing More, Larger Wildfires? *Science*, *313*(5789), 927–928. https://doi.org/10.1126/science.1130370

Saafi, M. (2002). Effect of fire on FRP reinforced concrete members. *Composite Structures*, *58*(1), 11–20. https://doi.org/10.1016/S0263-8223(02)00045-4

SFGATE, A. B. (2020, August 27). *Berkeley expert explains the wildland-urban interface: "We have to find a way to live with fire."* SFGATE. https://www.sfgate.com/california-wildfires/article/Berkeley-expert-wildland-urban-interface-wildfires-15520238.php

Silva, D. (n.d.). *Why is Portugal so prone to wildfires?* Retrieved March 13, 2021, from https://phys.org/news/2019-07-portugal-prone-wildfires.html

Smith, J. (2019). Incarcerated Workers and Inmate All-Hazard Firefighters in Emergency Response and Disasters: A Captive Labor Force. *LSU Doctoral Dissertations*. https://digitalcommons.lsu.edu/gradschool_dissertations/5024

Smith, J. E. (n.d.). Researchers say continued home building in high-risk wildfire areas threatens lives and makes big blazes more likely. *Los Angeles Times*, 10.

Society, N. G. (2019, July 18). *Wildfires*. National Geographic Society. http://www.nationalgeographic.org/encyclopedia/wildfires/

"Stay or go" policy puts Australian families on front lines of. (n.d.). 10.

Stevens-Rumann, C. S., Kemp, K. B., Higuera, P. E., Harvey, B. J., Rother, M. T., Donato, D. C., Morgan, P., & Veblen, T. T. (2018). Evidence for declining forest resilience to wildfires under climate change. *Ecology Letters*, *21*(2), 243–252. https://doi.org/10.1111/ele.12889

Stewart, S. I., Radeloff, V. C., Hammer, R. B., & Hawbaker, T. J. (2007). Defining the Wildland–Urban Interface. *Journal of Forestry*, 7.

Stuart, G. (2019, May 13). California Is Entering an Era of Endless Wildfires. *Los Angeles Magazine*. https://www.lamag.com/citythinkblog/wildfire-california-future/

Sturtevant, B. R., Miranda, B. R., Yang, J., He, H. S., Gustafson, E. J., & Scheller, R. M. (2009). Studying Fire Mitigation Strategies in Multi-Ownership Landscapes: Balancing the Management of Fire-Dependent Ecosystems and Fire Risk. *Ecosystems*, *12*(3), 445. https://doi.org/10.1007/s10021-009-9234-8

Stygar, R. A. (2019). Thinking outside the Box: A Point-Based System of Reintegration for California's Inmate Firefighters Notes. *California Western Law Review*, *56*(2), 455–491.

Sugihara, N. G., Wagtendonk, J. W. van, Shaffer, K. E., Thode, A. E., & Fites-Kaufman, J. (2006). *Fire in California's Ecosystems*. University of California Press.

Syphard, A. D., & Keeley, J. E. (2019). Factors Associated with Structure Loss in the 2013–2018 California Wildfires. *Fire*, *2*(3), 49. https://doi.org/10.3390/fire2030049

Syphard, A. D., Radeloff, V. C., Keuler, N. S., Taylor, R. S., Hawbaker, T. J., Stewart, S. I., & Clayton, M. K. (2008). Predicting spatial patterns of fire on a southern California landscape. *International Journal of Wildland Fire*, *17*(5), 602–613. https://doi.org/10.1071/WF07087

Syphard, A. D., Rustigian-Romsos, H., Mann, M., Conlisk, E., Moritz, M. A., & Ackerly, D. (2019). The relative influence of climate and housing development on current and projected future fire patterns and structure loss across three California landscapes. *Global Environmental Change*, *56*, 41–55. https://doi.org/10.1016/j.gloenvcha.2019.03.007

Troy, A. (2007). Chapter 8 A Tale of Two Policies: California Programs that Unintentionally Promote Development in Wildland Fire Hazard Zones. In A. Troy & R. G. Kennedy (Eds.), *Living on the Edge* (Vol. 6, pp. 127–140). Emerald Group Publishing Limited. https://doi.org/10.1016/S1569-3740(06)06008-1

Vale, T. (2013). *Fire, Native Peoples, and the Natural Landscape*. Island Press.

Varner, J. M., Kane, J. M., Hiers, J. K., Kreye, J. K., & Veldman, J. W. (2016). Suites of Fire-Adapted traits of Oaks in the Southeastern USA: Multiple Strategies for Persistence. *Fire Ecology*, *12*(2), 48–64. https://doi.org/10.4996/fireecology.1202048

Vision & Goals. (n.d.). Watershed Conservation Authority. Retrieved January 22, 2021, from https://www.wca.ca.gov/vision_goals

Waltz, A. E. M., Stoddard, M. T., Kalies, E. L., Springer, J. D., Huffman, D. W., & Meador, A. S. (2014). Effectiveness of fuel reduction treatments: Assessing metrics of forest resiliency and wildfire severity after the Wallow Fire, AZ. *Forest Ecology and Management*, *334*, 43–52. https://doi.org/10.1016/j.foreco.2014.08.026

Weissman, S. (n.d.). *The disastrous fires in California expose the absurdity of a system that ignores nature, flouts climate change, and builds entire towns that will inevitably burn.* 5.

Westerling, A. L., & Bryant, B. P. (2008a). Climate change and wildfire in California. *Climatic Change*, *87*(1), 231–249. https://doi.org/10.1007/s10584-007-9363-z

Westerling, A. L., & Bryant, B. P. (2008b). Climate change and wildfire in California. *Climatic Change*, *87*(1), 231–249. https://doi.org/10.1007/s10584-007-9363-z

Westerling, Anthony L., Cayan, D. R., Brown, T. J., Hall, B. L., & Riddle, L. G. (2004). Climate, Santa Ana Winds and autumn wildfires in southern California. *Eos, Transactions American Geophysical Union*, *85*(31), 289–296. https://doi.org/10.1029/2004EO310001

White, D. (2019a, December 27). *California in the age of wildfires: Living in the state of denial*. Curbed SF. https://sf.curbed.com/2019/12/27/21039413/california-fire-wildfire-crisis-decade

White, D. (2019b, December 27). *California in the age of wildfires: Living in the state of denial*. Curbed SF. https://sf.curbed.com/2019/12/27/21039413/california-fire-wildfire-crisis-decade

Why We Work with Fire. (n.d.). The Nature Conservancy. Retrieved March 13, 2021, from https://www.nature.org/en-us/what-we-do/our-priorities/protect-water-and-land/land-and-water-stories/why-we-work-with-fire/

Wildfire Causes and Evaluations (U.S. National Park Service). (n.d.). Retrieved January 22, 2021, from https://www.nps.gov/articles/wildfire-causes-and-evaluation.htm

Wildfire Management in the United States: The Evolution of a Policy Failure. (n.d.). Retrieved March 8, 2021, from https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.1541-1338.2004.00066.x

Wildland urban interface (WUI). (2020, October 30). U.S. Fire Administration. https://www.usfa.fema.gov/wui/index.html