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14. ABSTRACT

California, along with much of the nation's west, is experiencing a vast increase in the number and overall severity of wildfires. According to the California Department of Forestry and Fire Protection (Cal Fire) there has been a 358% increase in total acreage burned by wildfires in the past three years. If past trends are indicative of future results, we can expect to see even more devastation and destruction this fire season. The need for shared learning and best practice assessments has never been greater. Local governments owe it to their residents to provide up to date policy and stringent regulations in order to secure public safety.
A comparison was made with other jurisdictions, both locally and internationally, based on the criteria of climate, topography and fuel source. Through the analysis and comparison of the described sample, it was established that the city of Los Angeles has comparably stringent building code and defensible space requirements. Building code and defensible space are important factors in wildfire mitigation but there is still room for improvement. Through increased collaboration with WUI communities and greater regional collaboration the City of Los Angeles can continue to be at the forefront of wildfire mitigation policy and practices.

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City of Los Angeles Wildfire Mitigation Assessment

University of Southern California

Sol Price School of Public Policy

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Executive Summary

California, along with much of the nation's west, is experiencing a vast increase in the number and overall severity of wildfires. According to the California Department of Forestry and Fire Protection (Cal Fire) there has been a 358% increase in total acreage burned by wildfires in the past three years. If past trends are indicative of future results, we can expect to see even more devastation and destruction this fire season. The need for shared learning and best practice assessments has never been greater. Local governments owe it to their residents to provide up to date policy and stringent regulations in order to secure public safety.

A comparison was made with other jurisdictions, both locally and internationally, based on the criteria of climate, topography and fuel source. Through the analysis and comparison of the described sample, it was established that the city of Los Angeles has comparably stringent building code and defensible space requirements.

Building code and defensible space are important factors in wildfire mitigation but there is still room for improvement. Through increased collaboration with WUI communities and greater regional collaboration the City of Los Angeles can continue to be at the forefront of wildfire mitigation policy and practices.

I. Introduction

This report was conducted by Master of Public Administration students at the University of Southern California Sol Price School of Public Policy. The purpose of this report is to demonstrate best practices for brush fire mitigation that can be applied to the City of Los Angeles. The student-led team assessed Los Angeles' current building codes and brush clearance standards and compared them to various applicable jurisdictions by using government data and reports, published studies, journal articles, and by seeking expert knowledge from those within field, including fire officials and other key stakeholders.

Terms

Brush refers to stands of vegetation that are shrubby, woody plants, or low growing trees.[1]

Defensible space is an area around a building in which vegetation, debris, and other types of combustible fuels have been treated, cleared, or reduced to slow the spread of fire to and from the building.[2]

Fuel is combustible material, including vegetation, such as grass, leaves, ground litter, plants, shrubs and trees, that feed a fire.[3]

Topography describes the shape of the land, including slope, elevation, and aspect.[4]

Wildland Urban Interface is the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels.[5]

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[1] United States Forest Service (n.d.). Fire terminology. Retrieved from https://www.fs.fed.us/nwacfire/home/terminology.html

[2] Federal Emergency Management Agency (2008). Defensible space: Home builder's guide to construction in wildfire zones. Retrieved from https://www.fema.gov/media-library-data/20130726-1652-20490-9209/fema_p_737_fs_4.pdf

[3] Ibid., United States Forest Service

[4] United States National Park Service (2017). Wildland fire behavior. Retrieved from https://www.nps.gov/articles/wildland-fire-behavior.htm

[5] Ibid., United States Forest Service

Abbreviations

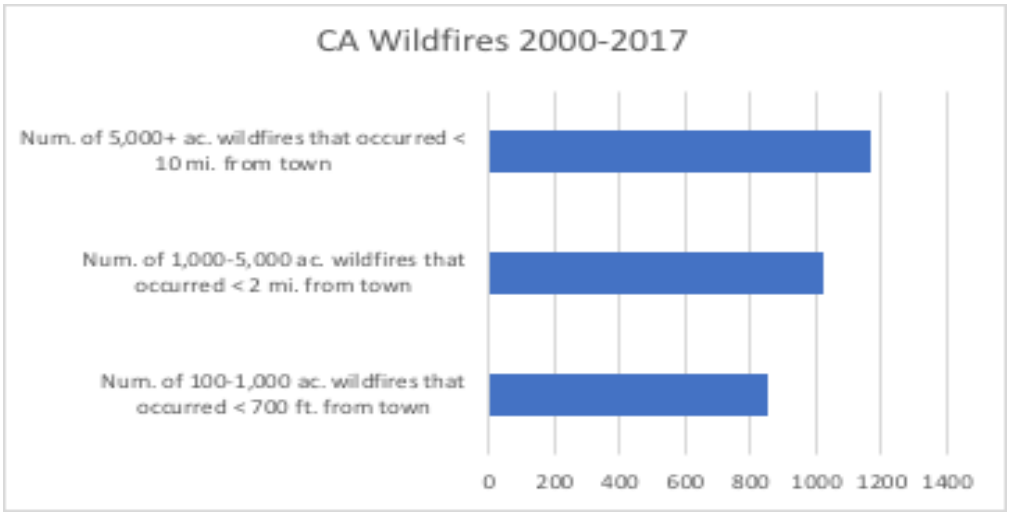
BCU	Brush Clearance Unit
CAL FIRE	California Department of Forestry and Fire Protection
CBC	California Building Code
CPUC	California Public Utilities Commission
CWPP	Community Wildfire Protection Plan
FEMA	Federal Emergency Management Agency
FHSZ	Fire Hazard Severity Zone
HFHSZ	High Fire Hazard Severity Zone
IWUIC	International Wildland Urban Interface Code
LAFD	Los Angeles Fire Department
LRA	Local Responsibility Area
PRC	Public Resources Code
SRA	State Responsibility Area
VHFHSZ	Very High Fire Hazard Severity Zone
WUI	Wildland Urban Interface

II. Background

California's Growing Wildfire Threat

California's Mediterranean climate causes long dry summers and mild, wet winters.[6] With the mixture of drought and high winds, California experiences extreme fire weather.[7] Within the past three years, there has been a 358% increase in total acreage burned by wildfires.[8] The state's most destructive fire has been the Camp Fire in 2018, which burned 153,336 acres, resulting in the loss of 18,804 structures and 85 lives. According to CAL FIRE, protection against wildfires involves constructing buildings with fire resistant materials and removing flammable materials around the building.[9] California's Government Code highlights fire protection in Chapter 4 and in Chapter 10 under health and safety.[10] While fires are a public safety concern for the state, they fall under the jurisdiction of municipal responsibility. Along with California's government code, local agencies are given the authority to impose stricter safety requirements and laws to offer further protection against fires.[11]

Figure 1: Wildfire Severity from Year 2000 - 2017



Source: Headwaters Economics (2018)

[6] Cornell, M. (2018, November). How catastrophic fires have raged through California. *National Geographic*. Retrieved from https://www.nationalgeographic.com/environment/2018/11/how-california-fire-catastrophe-unfolded/

[7] Stephens, S. L., Adams, M. A., Handmer, J., Kearns, F. R., Leicester, B., Leonard, J., & Moritz, M. A. (2009). Urban–wildland fires: How California and other regions of the US can learn from Australia. *Environmental Research Letters, 4*(1). Doi: 10.1088/1748-9326/4/1/014010

[8] CALmatters (2018). Tracking california's deadly wildfires. Retrieved from https://calmatters.org/articles/california-wildfires-statistics-tracker/

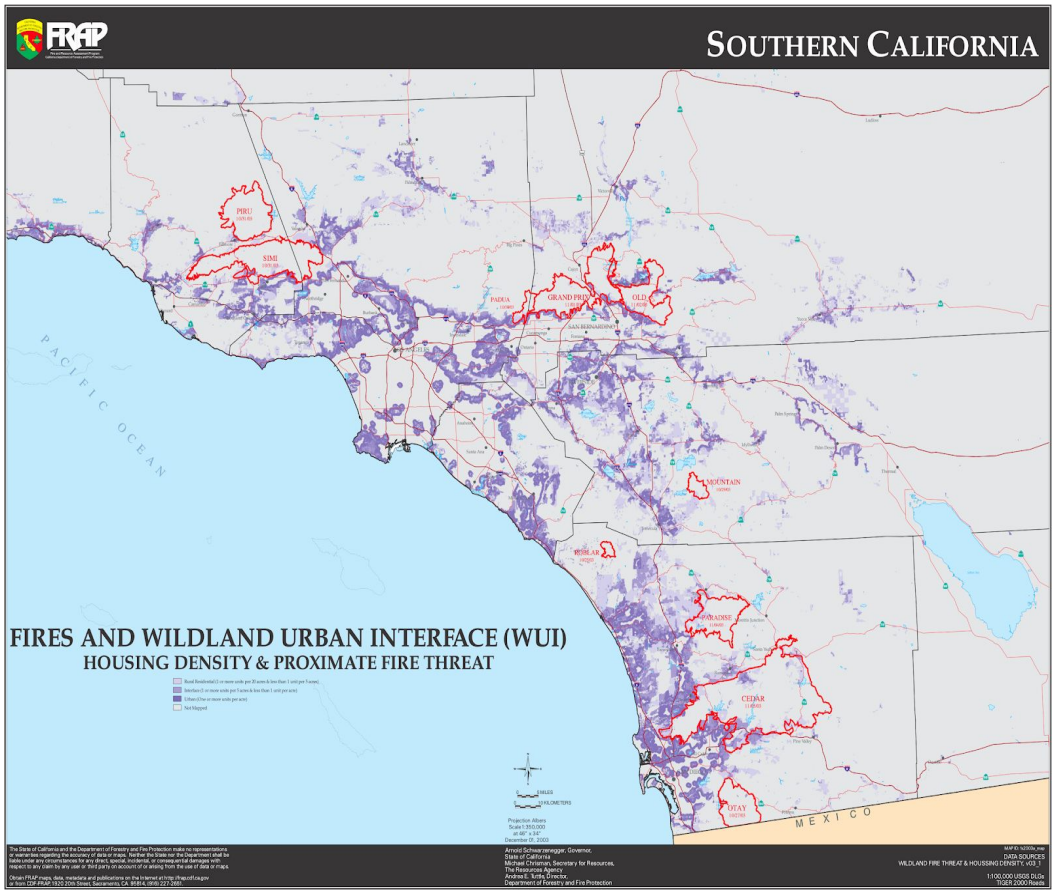
[9] State of California (2012). Wildland hazard & building codes. Retrieved from http://www.fire.ca.gov/fire_prevention/fire_prevention_wildland_codes

[10] California Legislative Information (n.d.). California law. Retrieved from https://leginfo.legislature.ca.gov/faces/codedisplayexpand.xhtml?tocCode=GOV

[11] California Department of Forestry and Fire Protection (n.d.). California codes government code section 51175-51189. Retrieved from http://www.fire.ca.gov/fire_prevention/downloads/GovernmentCode51175.pdf

Due to a changing climate, drier conditions, drought, and high wind speeds, California has been experiencing larger wildfires that burn longer and cause more damage. The intensity and destructiveness of these fires is captured by Figure 1. The graph demonstrates how the majority of California's recent wildfires have burned more than 5,000 acres.[12] According to the California Department of Insurance, 2017 was the costliest fire season on record thus far. However, costs from the 2018 Camp and Woolsey fires will likely surpass this record.[13]

Figure 2: Southern California Wildland Urban Interface



Source: California Department of Forestry and Fire Protection (2003)

[12] Rasker, R. (2018). Communities threatened by wildfire 2000-2017. Retrieved from https://headwaterseconomics.org/dataviz/communities-wildfire-threat/

[13] Insurance Information Institute (2019). Facts+Statistics: Wildfires. Retrieved from https://www.iii.org/fact-statistic/facts-statistics-wildfires

With over five million homes located in the WUI, California has the highest number of dwellings within these zones.[14] While most states have relied on guidance from the IWUIC for their state-level codes, California is one of the few states that has adopted their own state-level building codes for high hazard areas in order to prevent the spread of wildfires and protect life and structures.[15] California's statewide standards for HFHSZs offers protection for buildings within the WUI from flames and embers that may spread from a vegetation fire.[16] However, data from 1960 through 2007 indicates there has been a rise in the number of buildings lost in the WUI due to wildfires in California.[17] The WUI in Southern California is mapped in Figure 2. Wildfires that have threatened communities within the WUI can be seen outlined in red. Even with ignition-resistant standards in place, we are seeing a rise in wildfires that are threatening the WUI areas in California.

III. Fire Conditions

Climate

The City of Los Angeles has prime climate for wildfire destruction. Wildfire outbreaks are largely due to the climate of the area.[18] Los Angeles has a dry, temperate climate that sees little rain and a lot of wind and is the perfect situation for the outbreak of wildfires. Los Angeles has a warm, temperate climate year-round that averages between 55 degrees Fahrenheit in the winter and 74 degrees Fahrenheit in the summer.[19] With an annual average rainfall of 18.6 inches and the vast majority occurring in January and February, Los Angeles is extremely dry during the remaining 10 months.[20] This dry, warm, high wind, low humidity climate makes the city of Los Angeles extremely prone to wildfire outbreak as well as make it extremely difficult to combat.

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[14] Stephens, S. L., Adams, M. A., Handmer, J., Kearns, F. R., Leicester, B., Leonard, J., & Moritz, M. A. (2009). Urban–wildland fires: How California and other regions of the US can learn from Australia. *Environmental Research Letters, 4*(1). Doi: 10.1088/1748-9326/4/1/014010

[15] Headwaters Economics (2018). Building a wildfire-resistant home: Codes and cost. Retrieved from https://headwaterseconomics.org/wildfire/homes-risk/building-costs-codes/

[16] International Code Council (2016). 2016 - california building code, part 2, volume 1 - includes september 2017 errata. Retrieved from https://codes.iccsafe.org/content/chapter/9997/

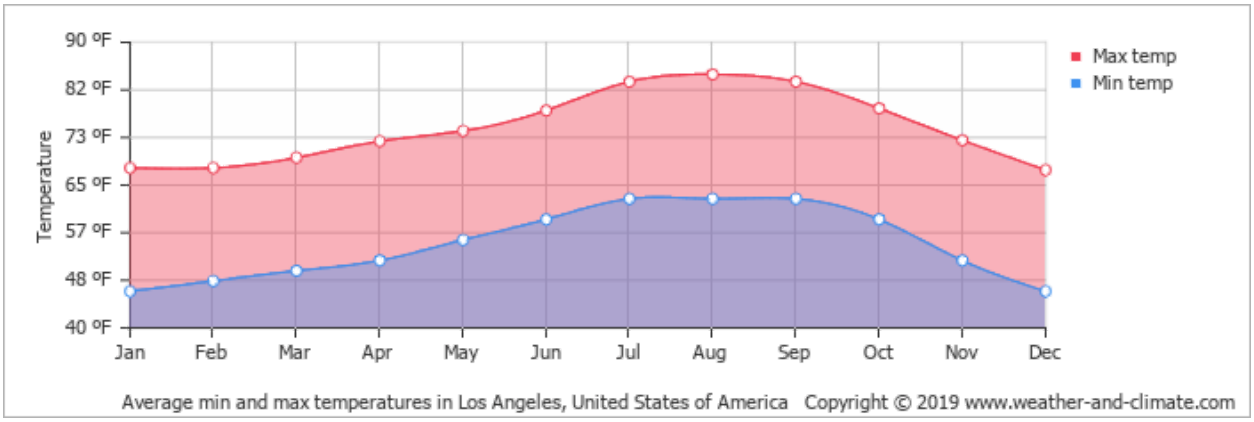
[17] Stephens, S. L., Adams, M. A., Handmer, J., Kearns, F. R., Leicester, B., Leonard, J., & Moritz, M. A. (2009). Urban–wildland fires: How California and other regions of the US can learn from Australia. *Environmental Research Letters, 4*(1). Doi: 10.1088/1748-9326/4/1/014010

[18] Climate Los Angeles - California. (2019). Retrieved from U.S. Climate Data: https://www.usclimatedata.com/climate/los-angeles/california/united-states/usca1339

[19] Home>United States>Los Angeles>Temperatures. (2019). Retrieved from World Weather and Climate Temperatures: https://weather-and-climate.com/average-monthly-min-max-Temperature-fahrenheit,Los-Angeles,United-States-of-America

[20] Climate Los Angeles - California. (2019). Retrieved from U.S. Climate Data: https://www.usclimatedata.com/climate/los-angeles/california/united-states/usca1339

Figure 3. Climate in Los Angeles



Source: World Weather and Climate[21]

Topography

Los Angeles' temperate climate and thus increased fire risk, is mostly caused by its distinct geography and topography. Los Angeles have similar terrain features which leads to similar weather patterns. The Sierra mountain chain and more specifically the Santa Monica Mountain chain that runs along the coast into Los Angeles creates not only a "blocking" effect from the rest of the weather of the Midwest but also a funneling and marine effect from the Pacific. These land features help create the climate and create a funneling effect for high winds.[22] Additionally, the majority of Los Angeles county lies on uneven terrain. Fire spreads much faster on slopes with inclines and/or declines present. A fire will burn faster going downhill than on flat plain, and it will burn even faster still going uphill. This is because the fuel is actually closer to the fire that is already burning. The flames can easily reach more unburnt fuel in front of it. Radiant heat also pre-heats the fuel in front of the fire, making the fuel that much more flammable.[23]

Vegetation

Dry vegetation due to the combination of long periods of drought and heat waves intensify probability of wildfire outbreak. The fuel that vegetation provides in Los Angeles has origins non-native to Los Angeles. Interestingly, native species of Los Angeles county are actually not very flammable. The green and purple that can be seen on the mountain sides are native to Southern California, but tend to grow very slowly and hold a lot of water. The culprit and the main reason the vegetation of Los Angeles burns so well is because of the non-native species of vegetation that has been brought to the area by ranchers, years ago to feed the cattle. All the white and yellow grass and flowers mixed with the green is actually non-native and extremely flammable. While the Mustard plants are putting out pretty yellow flowers, they are growing

[21] Ibid., Climate Los Angeles
[22] Thomsen, M., Reszka, P., Fuentes, A., & Fernandez-Pello, C. (2018). Berkeley Review of Latin American Studies, Spring 2017. *Center for Latin American Studies University of California, Berkeley*, 1
[23] How Fire Behaves. (2019). Retrieved from County Fire Authority: https://www.cfa.vic.gov.au/plan-prepare/how-fire-behaves)

much faster and stronger than the native chaparral and are much more flammable. These plants "crowd out" and kill off the native vegetation that takes a longer time to grow.[24]

Fuel Rank

California Department of Fire has developed a fuel rank assessment that takes these three inputs and others into account, and develops a fuel rank by area. The fuel ranking methodology assigns ranks based on expected fire behavior for combinations of topography, vegetation and climate.

Climate + fuel + slope = initial rank;
Surface rank + ladder index (brush density) + crown index (crown cover) = fuel rank.

IV. Very High Fire Hazard Severity Zones (VHFHSZ)

Determination

Very High Fire Hazard Severity Zones (VHFHSZ) are areas that are at high risk of wildfire during windy, hot, and dry days in Southern California.[25] "The Very High Fire Hazard Severity Zone (or "Zone") was first established in the City of Los Angeles in 1999 and replaced the older "Mountain Fire District" and "Buffer Zone." The "Zone" was carefully determined according to California State Law."[26]

Fire Hazard Severity Zones (FHSZ) are mapped areas that designate zones (based on fuel, slope, and weather) that have varying degrees of susceptibility (moderate, high, and **very high**). FHSZs do not predict where wildfires occur, they do take into account these factors that could make wildfires more severe should one ignite, therefore making it an area of greater concern.[27]

VHFHSZs are classified as zones that have the highest combination of how a fire will behave and the probability that flames and embers will threaten structures. Zone boundaries and hazard levels for urban areas are based on vegetation density, proximity to wildland and adjacent zones classifications.[28]

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[24] Cart, J. (2019, March 3). *California Wildfires: New Plants Bloom-Buts Its Not All Good*. Retrieved from KQED News: https://www.kqed.org/news/11730331/california-wildfires-new-plants-bloom-but-its-not-all-good

[25] Very High Fire Hazard Severity Zones. (2016, March 16). Retrieved from GeoHub LaCity: http://geohub.lacity.org/datasets/b29c71016bab4384923f0336ca5d040f_11?geometry=-120.268%2C33.627%2C-118.411%2C34.424

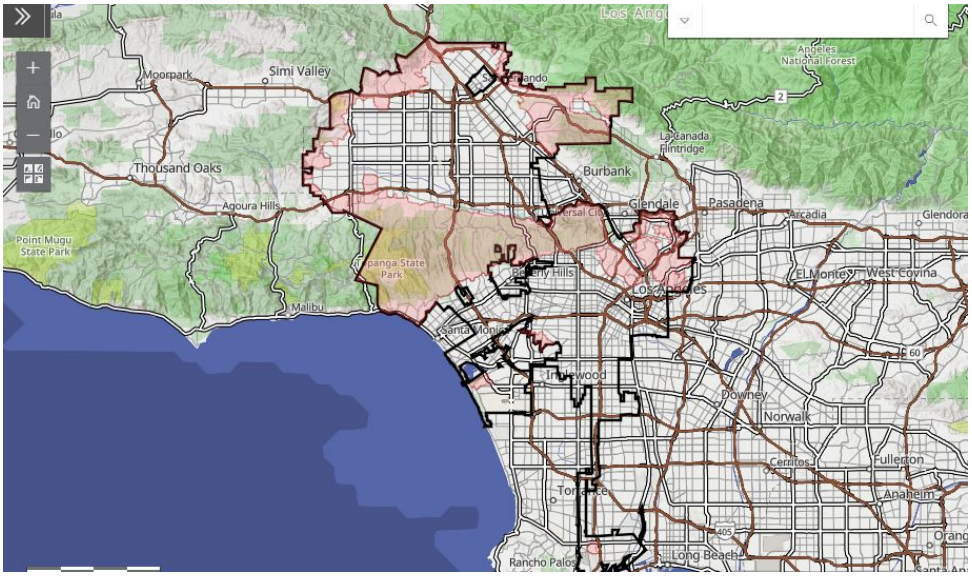
[26] Department, L. A. (n.d.). *Fire Zone History*. Retrieved from LAFD.ORG: https://www.lafd.org/fire-prevention/brush/fire-zone/fire-zone-history

[27] Wildland Hazard and Building Codes FAQ. (2012). Retrieved from CAL FIRE: https://www.fire.ca.gov/fire_prevention/fire_prevention_wildland_faqs#fhsz01

[28] *Ibid (2012).*

Location
As can be seen in the below map of Los Angeles, the majority of the county is in a VHFHSZ, making it increasingly difficult to combat. As the city and county of Los Angeles not only become denser with residents, but also spread further into the Wildland-Urban Interface the threat of wildfire increases.

Figure 4. VHFHSZ



Source: CAL FIRE[29]

Depicted in the map above, the areas shaded red show the VHFHSZs. These VHFHSZs tend to be more densely populated areas with the majority of them bordering the Wildland-Urban Interface..

Population Affected
The VHFHSZ makes up a lot of the hilly and more mountainous regions of the City of Los Angeles. Slope and proximity to the WUI play a large role in this determination. It includes multiple communities including Brentwood, Bel Air, Chatsworth, Echo Park, Granada Hills, Sherman Oaks, Studio City, Hollywood and many others. The city of Los Angeles holds the title of most populous city in the United States, boasting more than 4 million people living in its limits. With the number of communities affected by the VHFHSZs this easily effects over 1 million residents.[30]

[29] County FHSZ Map. (n.d.). Retrieved from CAL FIRE: Los Angeles http://www.fire.ca.gov/fire_prevention/fhsz_maps_losangeles
[30] Los Angeles, California Population. (2019). Retrieved from World Population Review: http://worldpopulationreview.com/us-cities/los-angeles-population/

V. Organizations

LAFD

According to its mission statement, the Los Angeles Fire Department (LAFD) "is a full spectrum life safety agency protecting more than four million people who live, work and play in America's second largest city."[31] The department is responsible for the not only fighting wildfires when they occur but also providing necessary safety information to residents. The Los Angeles Fire Department puts out information such as the different fire zones in the city, the brush clearance requirements, safety tips for residents in the event of a wildfire, etc. LAFD is the most well-known fire safety organization and is counted on to carry out the majority of the fire safety operations.

Brush Clearance Unit

Fire hazard reduction programs are a necessity in Los Angeles. The Brush Clearance Inspection Program is a joint effort between the County of Los Angeles Fire Department (Forestry Division) and the County of Los Angeles Department of Agriculture Weed Abatement Division. The enforcement requires the clearance of hazardous vegetation to create defensible space. The Brush Clearance Unit ensures fire codes according to brush clearance are being adhered to with coordinated inspections and complying with the local fire stations. It also provides brush clearance training to firefighter personnel.[32]

WUI Hazard Mitigation Task Force

During the destruction of the Woolsey Fire, Councilman Mike Bonin outlined a motion introducing the Wildland Urban Interface Task Force. It would be aimed at considering new solutions to fighting and preventing destructive wildfires. The task force would examine current building codes, preventative wildfire requirement enforcement, emergency alert systems, VHFHSZs and more. The recent increase in wildfires has made it a priority to local government. The task force is led by LAFD and includes representatives from the Police Emergency Management, Transportation, Recreation and Parks, Animal Services and others.[33]

VI. Fires and Policy

Los Angeles has been hit with wildfires throughout history. Many of them changing policy surrounding wildfire prevention and protection. The Very High Fire Hazard Severity Zone was first established in the Los Angeles in 1999 and replace the "Mountain Fire District" and "Buffer Zone."[34]

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[31] Our Mission. (n.d.). Retrieved from Los Angeles Fire Department: https://www.lafd.org/about/about-lafd/our-mission

[32] Fire Hazard Reduction Programs. (n.d.). Retrieved from County of Los Angeles Fire Department: https://www.fire.lacounty.gov/forestry-division/fire-hazard-reduction-programs/

[33] (Woolsey fire prompts LA City Council members to propose wildfire task force, 2018)

[34] Woolsey fire prompts LA City Council members to propose wildfire task force. (2018, November 20). Retrieved from Los Angeles Daily News: https://www.dailynews.com/2018/11/20/woolsey-fire-prompts-la-city-council-members-to-propose-wildfire-task-force/

Bel-Air Fire 1961
In November 1961 a two-day fire raged through Bel-Air and Brentwood. It claimed 500 structures, but surprisingly no lives. Directly following the fire, LAFD created the Mountain Fire District which serves the same purpose as the VHFHSZ today.[35]

Chatsworth Fire 1971
The Chatsworth Fire was relatively small by comparison, but destroyed 198 structures and was largely destructive because of wind driven embers. This prompted the creation of the "buffer zone," or otherwise known now as defensible space.

Oakland Hills Fire 1993
In 1993 the Oakland Hills Fire burned over 3,400 homes with about a quarter of them lost within the first hour. Reaction to this fire was the Bates Bill which required each local jurisdiction to identify and establish VHFHSZ. This essentially did away with the Mountain Fire District and the Buffer Zone in 1999, because they were identifying similar areas.[36]

La Tuna Fire 2017
Known for being the largest fire in LA city history, the La Tuna fire burned over 7100 acres through the Verdugo Mountains. The La Tuna fire proved the usefulness of defensible space. By the time the fire was out, there were 1400 homes in the fire perimeter or within 200 feet of its path, but only five were destroyed. Unremarkably these five houses had somehow escaped the annual defensible space monitoring or had not been updated with ember-proof vents.[37]

Figure 5. La Tuna Fire

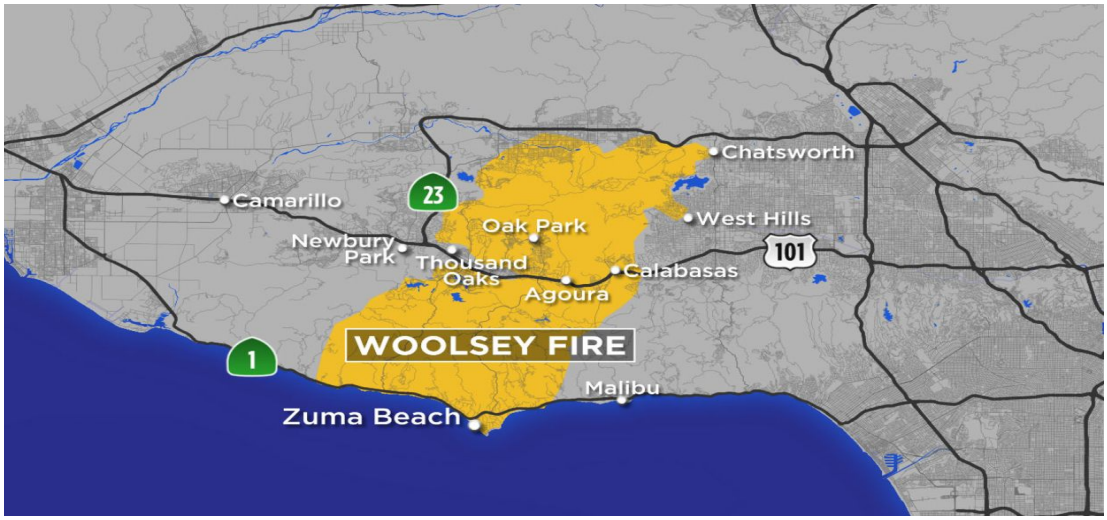
Source: scpr.org[38]

[35] Chiland, E. (2018, November 20). Here's how the Woolsey Fire stack up to LA's most destructive wildfires. Retrieved from Curbed Los Angeles: https://la.curbed.com/2018/11/14/18095121/los-angeles-fire-history-woolsey-california
[36] Fire Zone History. (n.d.). Retrieved from LAFD: https://www.lafd.org/fire-prevention/brush/fire-zone/fire-zone-history
[37] Hanson, C. (2018, August 10). Lessons from La Tuna fire. Retrieved from LA Times: https://www.latimes.com/opinion/op-ed/la-oe-hanson-latuna-fire-homes-20180810-story.html
[38] McNary, S. (2017, November 17). *Neighborhoods downslope of La Tuna Fire vulnerable to mudslides*. Retrieved from 89.3KPCC: https://www.scpr.org/news/2017/11/17/77787/neighborhoods-downslope-of-la-tuna-fire-vulnerable/

Woolsey Fire 2018

Last years Woolsey Fire ended up being the most destructive fire in LA County history. Burning from almost as far north as Chatsworth, south across the 101 freeway through Thousand Oaks, over the Santa Monica Mountains into Malibu and to the Pacific Coast Highway and Pacific Ocean. The fire consumed almost 100000 acres and more than 1500 homes. Taking almost 2 months to contain, the Woolsey Fire has become known as the worst fire in LA history.[39]

Figure 6. Woolsey Fire



Source: ABC7[40]

VII. Importance of Building Codes and Defensible Space

With flying embers destroying homes up to a mile from a wildfire, fire building codes and defensible space requirements are essential to improving the likelihood of structural survival in the Wildland Urban Interface (WUI). Fire reports show that homes with fire-resistant building materials and maintained defensible space, have a higher chance of surviving a wildfire. For example, a recent Federal Emergency Management Agency (FEMA) report found that homes in a San Diego destructive fire were saved due to their well-maintained defensible space and the fire-resistant building materials used during construction.[41]

[39] Incident Information Woolsey Fire. (2019, January 4). Retrieved from CAL FIRE: http://cdfdata.fire.ca.gov/incidents/incidents_details_info?incident_id=2282

[40] FIRE MAP: Woolsey Fire burning in Ventura County, northwest LA County. (2018, November 9). Retrieved from ABC7: https://abc7.com/fire-map-woolsey-fire-headed-to-the-ocean/4654421/

[41] Federal Emergency Management Agency. (2015)., Defensible Space and Fire-Resistant Building Materials Save Home from Wildfire: Full Mitigation Best Practice Story, San Diego County, California https://www.fema.gov/media-library/assets/documents/111784

Building Codes

Fire building codes for both existing and new developments play a critical role in wildland-urban interface areas due to the flammability of materials and construction spacing. Codes are relevant because they serve as the direct means in which local jurisdictions can address threats. Despite the city's ability to update building codes, codes are not retroactive, and updates on the code mainly apply to new structures or structures undergoing repair. This action leaves older homes built before the updated codes, not only vulnerable to wildfires but also creates a potential financial burden on homeowners looking to upgrade and protect their home.

Defensible Space

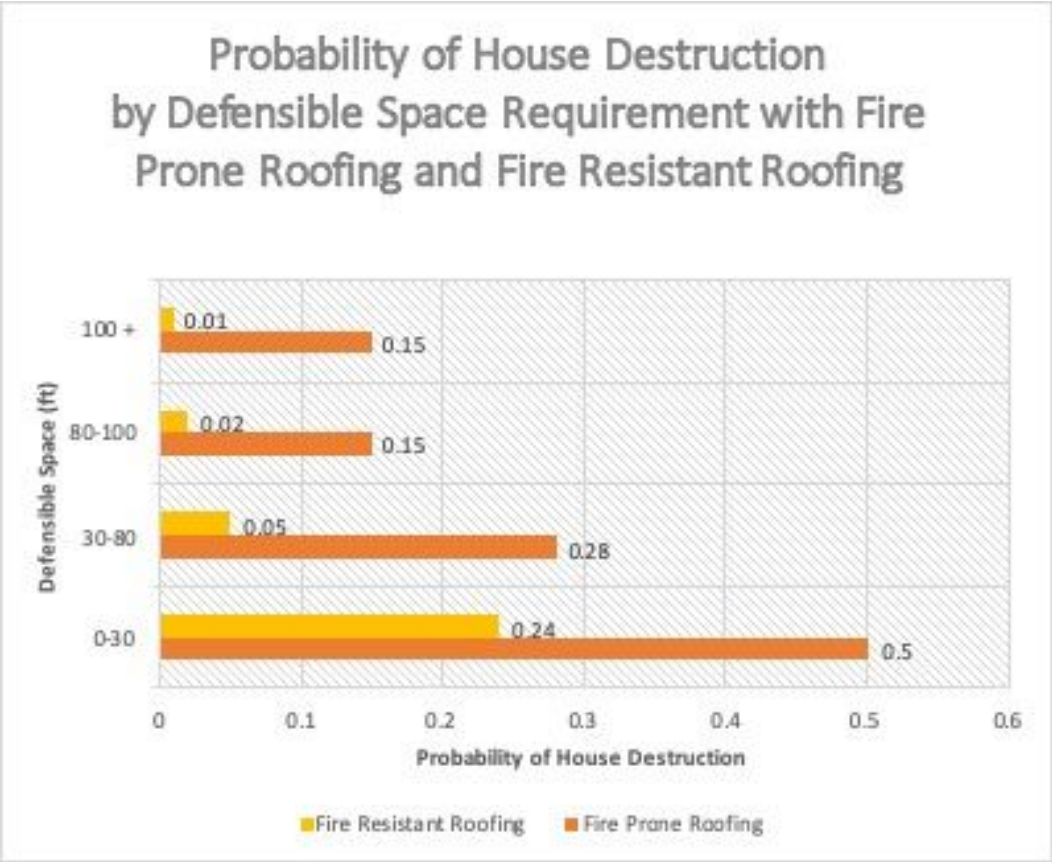
Unlike building codes, defensible space requirements are retroactive as when a home was built or when a parcel was acquired does not matter since vegetation must be maintained. Adequate defensible space requirements create a buffer between property and surrounding flammable vegetation during a wildfire. The buffer space is critical for not only stopping the spread of wildfires but for the protection of firefighters while defending homes.[42] In California, local jurisdictions must adhere to the minimum state requirements but can impose more stringent requirements on themselves. Setting higher defensible space clearance distances does not make an agency more effective; instead, it demonstrates the aggressiveness of the agency on the matter.

Coupled Approach

Fire-resistant building materials mandated through building codes, coupled with adequate defensible space requirements, increase the ability of buildings to resist the intrusion of flames or embers. The City of Los Angeles has adopted the basic provisions required by the state for fire-resistant material and construction in the wildland-urban interface. An example of the impact of proper building codes such as regular wood shingle roofs and setting defensible space requirements can be seen in Figure 7. The graph shows that with regular wood shingle roofs, the probability of structure destruction decreases as defensible space increases, but only to a certain point. Since there is a direct link with structural survivability, both adequate defensible space requirements and the use of fire-resistant building materials are widely used practices in the Wildland Urban Interface (WUI), as both combined increase the protection of life and property.

[42] California Department of Forestry and Fire Protection. Retrieved April 10, 2018, from http://www.readyforwildfire.org/Defensible-Space/

Figure 7. House Destruction and Defensible Space



Source: Data from Fire Safe Sonoma (2005)[43]

VIII. Current Standards

Roofing is divided into classes (A, B, & C) dependent on their resistance to combustion. As stated by the University of California Division of Agriculture and natural resources, Class A roofs can include "asphalt glass fiber composition, clay tiles, concrete tiles, slate, aluminum, fire retardant treated wood shakes, and some recycled rubber or plastic composite materials."[44] The State of California mandates the minimum requirements for roofs and vents through California Code of Regulations Title 24, California Building Code (CBC). The requirements are dependent on the type of construction and the location of the structure.

[43] Fire Safe Sonoma. (2005). Living with Fire in Sonoma County. Author. Retrieved April 1, 2019, from http://www.firesafesonoma.org/main/sites/default/files/living_with_fire.pdf

[44] University of California Agriculture and Natural Resources. (n.d.). University of California Homeowner's Wildfire Mitigation Guide: Roof Covering. Retrieved March 22, 2019, from https://ucanr.edu/sites/Wildfire/Roof/Roof_Covering/

CBC Chapter 15 mandates that within VHFHSZ, any new roof, entire roof coverings of structures were more than 50% of the roof has been replaced within a one-year period, and roof coverings done in repair or remodel of any existing structure needs to be rated at Class A. Roof coverings in non VHFHSZ are only required to be at Class C.

Section 706A[45] of the CBC mandates metal wire mesh coverings, vents or any other material that meets the following requirements for enclosed attics ventilation and other enclosed areas requiring ventilation.

Table 1: Vent requirements as stated in Section 706A of the CBC

	Vent Requirements
1	American Standard for Testing and Materials E2286 Compliant
2	No flaming ignition of cotton material during ember intrusion test.
3	No flaming ignition during the Integrity Test portion of the Flame Intrusion Test
4	Unexposed side of vent shall not exceed 662^{o}F
5	Opening shall be between 1.6mm and 3.2mm
6	Must be non-combustible
7	Must be corrosion resistant

The city of Los Angeles Municipal Code Chapter 9, Article 1, Section 91.1505 adopts section 1505 of the California Building Code (CBC) but makes a clear expressed prohibition on any wood shake or shingle roof covering. This prohibition is city-wide, not purely in VHFHSZ[46].

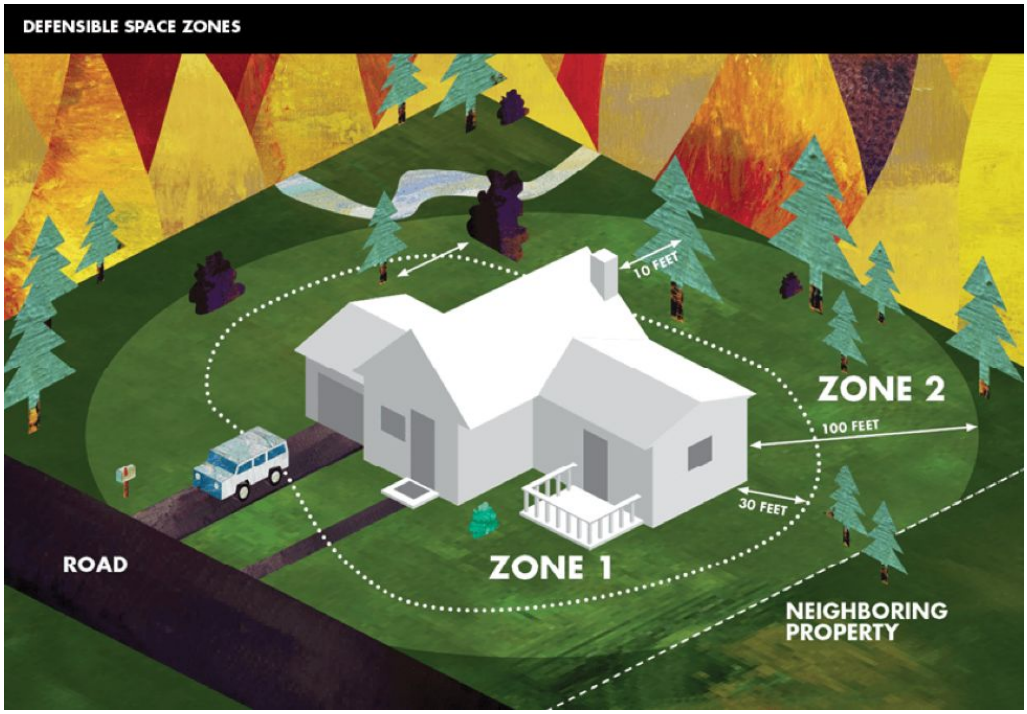
[45] State of California. (n.d.). Chapter 7A Materials and Construction Methods for Exterior Wildfire Exposure. Retrieved March 22, 2019, from https://up.codes/viewer/california/ca-building-code-2016-v1/chapter/7A/sfm-materials-and-construction-methods-for-exterior-wildfire-exposure#7A

[46] Los Angeles Department of Building and Safety. (n.d.). Roofing Requirements for Wood Shakes and Shingles. Retrieved March 22, 2019, from

Defensible Space

The Federal Emergency Management Agency (FEMA) defines defensible space as "an area around a building, in which vegetation, debris, and other types of combustible fuels have been treated, cleared, or reduced to slow the spread of wildfire to and from the building"[47]. The state of California mandates this through the Public Resource Code (PRC). Section 4291 mandates a 100ft minimum requirement for all structures within the state. The 100ft requirement is a little more complex than pure space. California's defensible space is split into two zones, zone1 and zone 2 as noted by figure 8.

Figure 8: Defensible Space Graphic



Source: Maintain Defensible Space by CAL Fire[48]

Zone 1 is comprised of 30 feet of absolute clearance. This includes the removal of all dead vegetation included bushes, trees, weeds and grass, as well as a 10ft minimum distance requirement between any tree branch and any part of the roof of the house. Zone 2 extends out 70 more feet making the total defensible space requirement of 100 ft. The 70 additional feet are considered a fuel reduction zone and serves to weaken the flames before approaching any structure. Zone 2s requirements included keep grass to a maximum of 4 inches long, creating 6

[47] FEMA. (2008). *Defensible Space Technical Fact Sheet No. 4*(United States of America, Federal Emergency Management Agency, Department of Homeland Security). Retrieved April 1, 2019, from https://www.fema.gov/media-library-data/20130726-1652-20490-9209/fema_p_737_fs_4.pdf

[48] CAL Fire. (2017). MAINTAIN DEFENSIBLE SPACE. Retrieved April 1, 2019, from http://www.readyforwildfire.org/Defensible-Space/

feet of vertical clearance between the ground the lowest branches on trees, as well as horizontal clearance between shrubs and trees. The state offers the option for local governments to amend the requirements as long as they are still complying with the minimum set forth. The city of Los Angeles has defined requirements that go beyond the state requirements through Los Angeles Municipal Code **57.322.**

Table 2. Requirements

Requirements	**State of California**	**City of Los Angeles**
Total Defensible Space (Zone 2)	100 ft	200 ft
Clearance Zone (Zone 1)	30 ft	100 ft
Fuel Modification Zone	Additional 70 ft	Additional 100 ft
Grass / Weeds Length	4 Inches	3 Inches
Clearance between ground and tree branch	Maintain lower 1/3rd of tree up to 6 ft	Maintain lower 1/3rd of tree up to 6 ft
Clearance between roof and branches	5 ft	N/A
Clearance around Chimney outlet	10 ft	10 ft
Recycled Mulch	N/A	Up to 3 inches within 30 feet Up to 6 inches for 30+ feet 10 ft clearance around combustible fences and roads

IX. Enforceability

To assess the effectiveness of current wildfire mitigation practices in the City of Los Angeles, the following criteria were considered: 1) reduction of risk with structural ignition, 2) resident feasibility with policy implementation, and 3) enforcement.

Risk of Structural Ignition

The City of Los Angeles, much like other jurisdictions in the WUI, takes the coupled approach of imposing fire building codes and setting defensible space requirements to reduce the risk of structural ignition. In 1997, the city increased its brush clearance to its current standard of 200ft. Increasing the standard to 200ft is an example of how local jurisdictions make existing codes more stringent. Even for 1997 standards, the increase in brush clearance distance is significant since the current State brushfire clearance requirement as of 2005 is 100ft.[49]

At 200ft, the City of Los Angeles has the most stringent requirements when compared to other local jurisdictions and even the state. Since the city has adopted the basic provisions required by the state for fire-resistant materials and no additional stringent regulations have been placed on building codes, there is room for improvement on requirements for vents and attics. Based on the assessment of current practices, the City of Los Angeles' current defensible space requirements are adequate; however, the building codes require a revision since no additional requirements have been added to the minimum state requirements.

Feasibility for Residents

In the Wildland Urban Interface, individuals are responsible for wildfire protection and prevention. Individuals must adhere to zoning and building codes that are developed by state and local agencies. Homeowners and landowners in a community collaborate with government agencies to plan and implement fire prevention measures. These stakeholders face most of the impacts of wildfires and policies set in place by governing agencies.

According to data provided by the Los Angeles Brush Clearance Unit, in 2018 the agency received 355 complaints and 16,000 phone calls. While the nature of the complaints and phone calls were not made available, the number of complaints are minimal when compared to the population living in the WUI. Additionally, while conducting research, no additional resident complaints on current policy standards were discovered. While no complaints were found, an assumption can be made that any changes to the existing building codes, may be a financial burden to residents in the WUI as fire-resistant upgrades are typically costly.

[49] The City of Los Angeles. Los Angeles Municipal Code. Retrieved March 20, 2019, from http://library.amlegal.com/nxt/gateway.dll/California/lamc/municipalcode?f=templates$fn

City Enforcement

In the City of Los Angeles, wildfire mitigation relies on inter-agency coordination. Each level of government has agencies that have wildland fire protection responsibilities. While each agency has its own unique mission and responsibilities, wildfires transcend jurisdictions.

In the City of Los Angeles, the Brush Clearance Unit partners with Los Angeles Fire Department and conducts inspections of properties. Inspections are tracked on a computer system, and property owners are notified when their property is due for inspection. The first inspection is done by the LAFD Brush Task Force during the first week of May and parcels found in violation are issued a first notice and a non-compliance fee.[50]

To get the information to parcel owners, the BCU sends out a mailer with instructions, important dates, and the costs of fines for failing to meet clearance requirements in a timely manner. During an interview, Chief Hayden, Los Angeles Fire Department, provided information regarding a team of 50 fire volunteers that conduct inspections, take pictures, and give notices of violations.[51] Since the city is currently relying on volunteer firefighters to assist with wildfire mitigation, it is likely that any additional policies requiring more personnel or resources will burden the city's manpower and finances.

[50] Los Angeles Fire Department. Retrieved April 12, 2019, from https://www.lafd.org/fire-prevention/brush/inspection-process

[51] Interview with Chief Hayden, Los Angeles Fire Department on 20 March 2019.

X. Best Practices in Fire Damage Prevention in WUI from Comparable Agencies

In addition to reviewing Los Angeles' current standards, brush fire mitigation practices of other agencies both in California and internationally were assessed and compared to Los Angeles' practices. The agencies selected are listed in the table below:

Table 3: Agencies used in Comparative Analysis

Responsible Agency Name(s)	Location
Ministry of Public Order and Citizen Protection, Hellenic Fire Brigade, and local jurisdictions	Athens, Greece
Los Angeles County Fire Department; Los Angeles County Building and Safety Division	Los Angeles County, California
Santa Rosa Fire Department; Santa Rosa Building Division	Santa Rosa, California
Corporación Nacional Forestal (CONAF); Oficina Nacional de Emergencia del Ministerio del Interior (ONEMI); Instituto Nacional de Normalización (INN)	Santiago, Chile
Ventura County Fire Department; Ventura County Building and Safety Division	Ventura County, California
Victorian State Government; Country Fire Authority (CFA); Department of Environment, Land, Water and Planning (DELWP); local jurisdictions	Victoria, Australia

This best practices assessment of comparable agencies will provide a small sample "industry standard" that will serve to help develop policy alternatives..

Selecting Comparable Agencies

For the purposes of this analysis, three criteria that influence wildfire behavior called the "fire triangle" were used to select comparable agencies: climate, vegetative fire fuels, and topography. Extreme wildfire behavior events is are often the result of adverse conditions in all three aspects of the "fire triangle" and can lead to virtually unstoppable fires.[52] It is assumed that if these three

[52] Fire Safe Sonoma. (2016). Sonoma County Community Wildfire Protection Plan. Sonoma: Fire Safe Sonoma.

criteria are similar, then the risk of wildfire are similar and mitigating practices can be applicable to Los Angeles.

Comparison Methodology

This analysis compared defensible space requirements in terms of feet from structure subject to the ordinance and building material requirements in the WUI.

Building Material Requirements in High Fire Risk Zones

All of the agencies within California adopted the state building code standards for building materials allowed in the WUI. Our research was unable to discern specific performance standards for Athens or Santiago. However, Victoria Australia described a specific construction requirement defined by a specific Bushfire Attack Level (BAL). A BAL of 12.5 to prevent ember attack ignition requires sealing of roofs and around doors and windows and window screening to block ember entry.[53]

Figure 9: Bushfire Attack Level Rating System

BAL-FZ	BAL-40	BAL-29	BAL-19	BAL-12.5
Direct exposure to flames from the fire front in addition to heat flux of greater than **40 kW/m²** and ember attack	Increasing levels of ember attack and ignition of debris with a heat flux of up to **40kW/m²** and increased likelihood of exposure to flames	Increasing levels of ember attack and ignition of debris with a heat flux of up to **29kW/m²**	Increasing levels of ember attack and ignition of debris with a heat flux of up to **19kW/m²**	Ember attack with heat flux of up to **12.5 kW/m²**

Source: Brushfire Prone Planning Consultants

[53] The State of Victoria Department of Planning and Community Development (2011). Planning and building for brushfire protection.

Table 5: Building Code Requirements

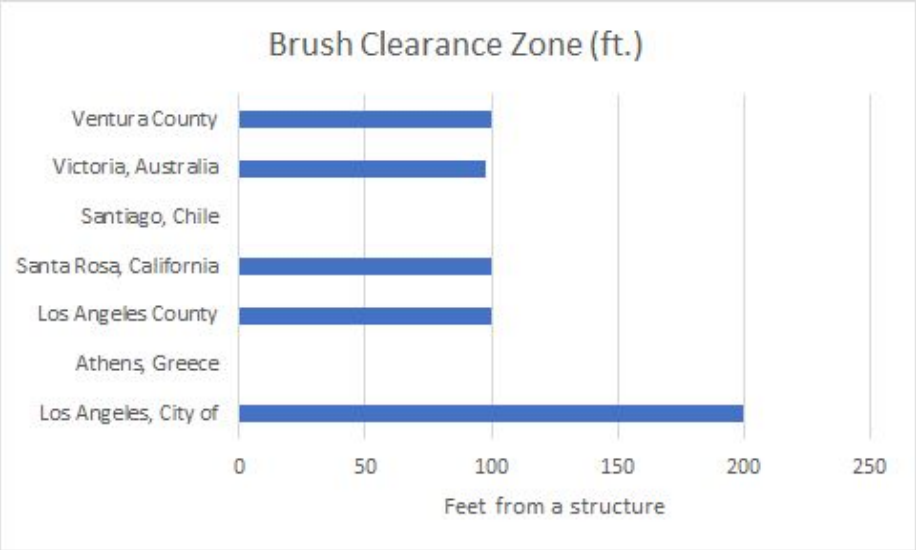
Agency	Building Code Requirements in WUI
Los Angeles, City of	California Building Code Chapter 7A & City-wide prohibition of wood shake or shingle roof covers
Athens, Greece	No Specific Standard identified
Los Angeles County, California	California Building Code Chapter 7A
Santa Rosa, California	California Building Code Chapter 7A
Santiago, Chile	No Specific Standard identified
Ventura County, California	California Building Code Chapter 7A
Victoria, Australia	Bushfire Attack Level 12.5 Construction Requirements

Brush Clearance Requirement in the High Fire Risk Zones

The City of Los Angeles featured the most stringent defensible space requirements in terms of distance from a structure subject to mandatory brush clearance. Other jurisdictions within California adhered to the state's minimum defensible space requirement of 100 feet. Additionally, the Australian State of Victoria required 30 meters (approximately 98 feet) of defensible space around a dwelling.[54] Our research was unable to determine a specific defensible space requirement for Santiago and Athens.

[54] The State of Victoria Department of Planning and Community Development (2011). Brushfire planning provisions.

Figure 9: Brush Clearance Zone Comparasion



Note: No data was available for Santiago and Athens

Regional Coordination

While reviewing other agencies, Santa Rosa highlighted a regionally coordinated approach to fire mitigation that stood out from other agencies. Regional Coordination
Santa Rosa participates in numerous collaborative efforts in fire mitigation throughout Sonoma County. It participates in a local Fire Safe Council, Fire Safe Sonoma, and the Sonoma County Community Wildfire Protection Plan (CWPP). These collaborative efforts produce reports that both inform local standards and provide unified public information to participating municipalities throughout Sonoma.

The California Fire Safe Council is a non-profit organization developed by CalFire in 1993 to bring together governmental agencies to provide education resources on wildfire danger to California residents. Sonoma County's local chapter, Fire Safe Sonoma, consists of local fire prevention professionals, public agency representatives, business owners and residents. In 1999, it launched it's Living with Fire program that aims to raise public awareness and education of fire prevention.

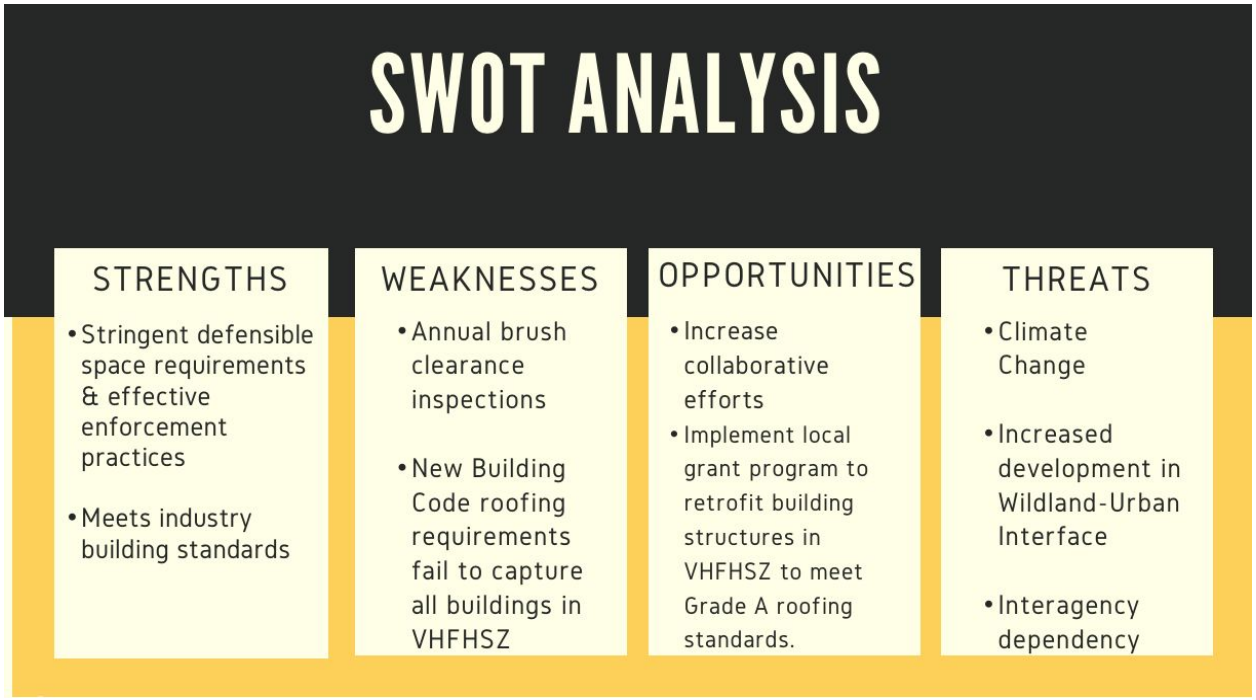
The Community Wildfire Protection Plan was defined by the Healthy Forests Restoration Act of 2003 to enhance collaboration between different levels of government and community groups to search for solutions to wildfire issues in the WUI.[55] CWPP are required to:

- Be developed collaboratively with input from agencies and community members
- Identify and prioritize treatment areas, mitigation strategies and treatments
- Recommend measures to reduce the ignitability of structures.

Santa Rosa collaborated with other Sonoma County agencies and community groups through Fire Safe Sonoma to develop the Sonoma County Community Wildfire Protection Plan, approved by the Sonoma County Board of Supervisors in 2016.[56]

XI. SWOT Analysis

To provide a comprehensive assessment of the City of Los Angeles wildfire mitigation policies and enforcement efforts, a SWOT Analysis was performed to highlight the current policies strengths, weaknesses, opportunities for improvement and threats.



Strengths

[55] Fire Safe Sonoma. (2016). Sonoma County Community Wildfire Protection Plan. Sonoma: Fire Safe Sonoma.
[56] Fire Safe Sonoma. (2016). Sonoma County Community Wildfire Protection Plan. Sonoma: Fire Safe Sonoma.

The City of Los Angeles has differentiated itself among other California municipalities in combating wildfires through its stringent land use planning efforts. This is shown through its defensible space requirements, enforcement efforts and the reinforcement of state roofing requirements.

The City of Los Angeles has adopted additional defensible space requirements, increasing from the state requirement of 100 feet of defensible space, to a 200 feet defensible space requirement. This additional requirement enhances mitigation efforts by reducing the probability of structure fires in VHFHSZ. Through the establishment of the Brush Clearance Unit and collaboration with the Los Angeles Fire Department, the City of Los Angeles has taken on a proactive approach in enforcing its mitigation policies. The City of Los Angeles has also maintained industry standards as it relates to the California Building Code. The California Building Code mandates that in VHFHSZ, any new roof, entire roof coverings of structures were more than 50% of the roof had been replaced within a one-year period, and roof coverings done in repair or remodel of any existing structure needs to be rated at Class A, which improves structures fire retardant capacity.[57]

Weaknesses

Despite the City of Los Angeles stringent land use policies, as they relate to mitigating structural burns caused by wildfires, there remain areas of weakness in the policy application. Although the additional defensible space requirements decreases the probability of structural burns, its effectiveness relies heavily on compliance. With the additional 100 feet defensible space requirement, annual inspections become less impactful. The additional burden placed on property owners creates more incentive to no longer maintain compliance following inspection. Not only can this impact the maintenance of the additional footage, but it can also sway property owners from maintaining any defensible space on their property.

Another weakness that has been identified is that the roofing requirements outlined in the adopted Building Code fails to capture all structures within VHFHSZ. Structures built prior to the new standards adoption, are only required to retrofit roofing structures when they apply for new permits. Therefore, existing structures that have not received permits for remodels or repairs are not required to have Class A roofing. The effectiveness of the roofing standards is then diminished as a result of the existence of structures with less fire retardant roofing.

Opportunities

As the best practices assessment shows, the City of Los Angeles has positioned itself as a leading organization by establishing some of the strictest wildfire mitigation policies in California.

[57] Los Angeles Department of Building and Safety. (n.d.). Roofing Requirements for Wood Shakes and Shingles. Retrieved March 22, 2019.

Nevertheless, there are several opportunities to improve its efforts in wildfire mitigation. These opportunities include, increasing collaborative efforts and the implementation of new programs.

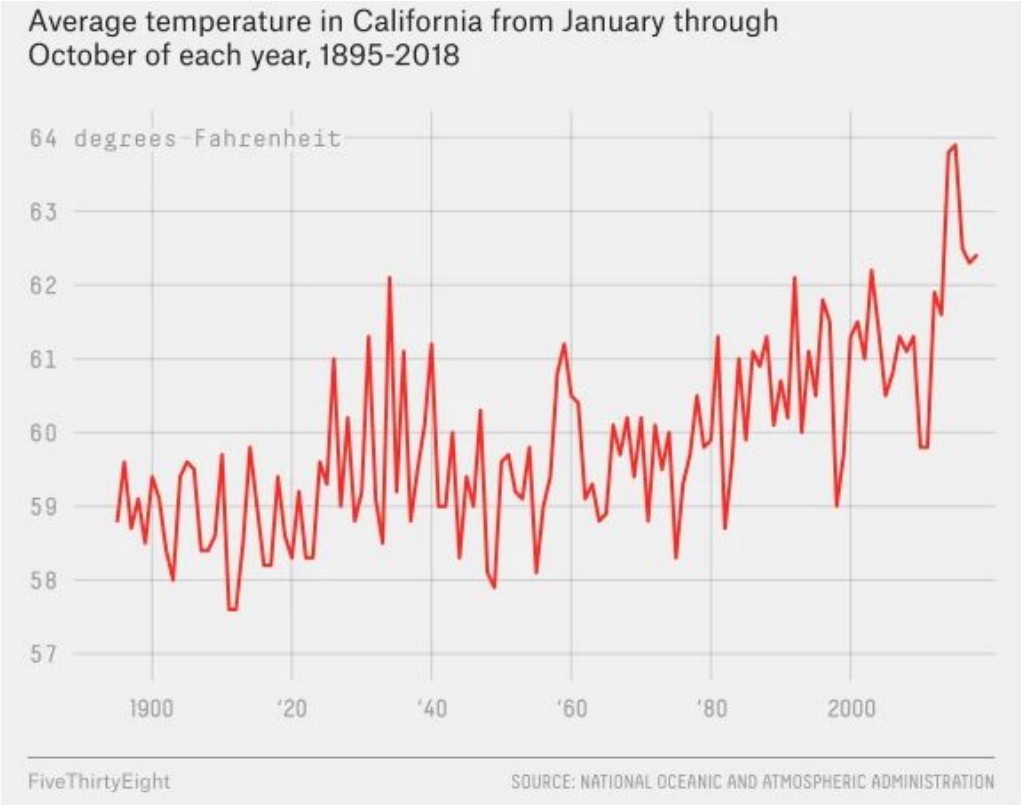
Increased collaboration for wildfire mitigation can take place by engaging the City of Los Angeles community members and outside agencies. By engaging and educating property owners, businesses, developers as well as other community members, the City of Los Angeles can improve wildfire awareness within its jurisdiction. Increasing the communities understanding of wildfires and mitigation policies, creates a sense of urgency and incentives policy compliance. The City of Los Angeles can also improve its collaborative efforts with outside agencies through information sharing and aligning similar goals and objectives.
There is also an opportunity for the City of Los Angeles to implement programs that are focused on retrofitting older structures in VHFHSZ. This can be done by leveraging federal and state funds as well as reallocating City resources. With the recent fires there has been a political shift at the State and Federal level, placing a greater sense of urgency among politicians to increase resource allocation towards wildfire prevention and mitigation efforts. California State Assembly Bill 38, Introduced by Assembly Member Jim Wood (D-2-Santa Rosa), proposes to establish the Fire Hardened Homes Revolving Loan Fund in the State Treasury, transfering $1,000,000,000 from the General Fund to the new fund for the purpose of providing financial assistance to owners of eligible buildings to pay for eligible costs of fire hardening; which would include retrofitting roofs. The City of Los Angeles can advocate for programs such as this at the state level and create similar programs locally.

Threats

Despite the City of Los Angeles efforts, there are several threats to the effectiveness of the adopted policies and enforcement practices. The biggest threat to wildfire mitigation policies, is continued climate change. Southern California has warmed an estimated three degrees farenheit in the last century and as temperatures continue to rise, wildfires will become even more prevalent.[58] Has demonstrated in *Figure 9* temperatures throughout California continue to rise. With rising temperatures, wildfires are increasing in size and are becoming more destructive. Climate change, as it relates to rising temperatures and unpredictable precipitation, will increasingly impact vegetation-drying effect and increase vegetative fuel. In addition to climate change, increased development in the Wildland Urban Interface poses additional threats to mitigation efforts. As structures continued to be developed in these areas, risk increases. Further development will also require additional resources for enforcement and fire protection efforts.

[58] Environmental Protection Agency,(n.d.) What Climate Change Means for California. Retrieved April 12, 2019.

Figure 10: Average California Temperatures



Source: National Oceanic and Atmospheric Administration

XII. Recommendation

Our analysis found that Los Angeles' standards for building materials and defensible space in the WUI are as comprehensive, if not more stringent, than other comparable agencies assessed. While our analysis did not find potential modifications to the city's requirements, our analysis did find potential for enhanced collaboration with neighboring agencies and WUI communities that could potentially improve fire mitigation efforts.

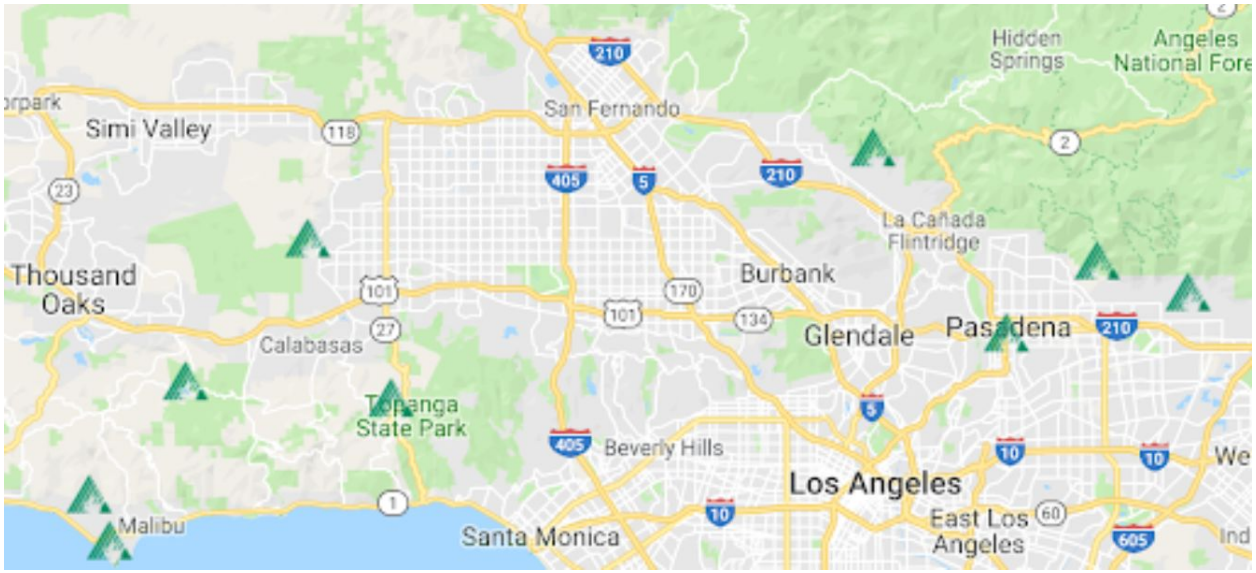
Benefits of Regional Collaboration

Regional coordination similar to that which is practiced in Sonoma County can provide multiple benefits. With regional coordination, there are opportunities to provide the public with educational materials, like "Living with Fire", that thoroughly describe the importance of maintaining building materials and defensible space in a simple and comprehensible way.

Pooling resources with other agencies can provide opportunities to pursue regional programs that improve fire resilience. For example, The Mountain Area Safety Task Force in San Bernardino County - a regional collaboration of public and private agencies - implemented a roof replacement program to incentivize older housing stock to upgrade their roofs to the current building code standard.[59]

Identifying regional priorities through collective action plans such as the Community Wildfire Protection Plans allows for research sharing and community participation. A regionally developed plan can enhance both proactive activities and coordinated emergency response programs that protect both life and property.

Figure 11: Locations of Local Fire Safe Councils in Los Angeles



Source: California Fire Safe Council: Local Map

Opportunities for Regional Collaboration

The city of Los Angeles, through the Department of Neighborhood Empowerment, can reach out to local Fire Safe Councils in the area as a first step in improving regional collaboration with communities within the WUI. With the help of technical expertise from city staff and neighboring fire agencies, a Community Wildfire Protection Plan could be developed for Very High Fire Hazard Severity Zones within the city limits.

[59] Mountain Area Safety Taskforce,(n.d.) REPLACING WOOD SHAKE/SHINGLE ROOFS IN THE SAN BERNARDINO COUNTY MOUNTAINS. Retrieved April 12, 2019.