

BUILDING CODES AND HOUSING RESILIENCE IN CALIFORNIA: DISPLACED HOMEOWNERS' PERCEPTIONS ON SUSTAINABLE REBUILDING

1 ABSTRACT

Traditionally, the federal public land management policy has largely addressed wildfires as unwanted (i.e., to be prevented or suppressed). It was only in the early 1970s that federal policy began to recognize wildland fire as a historical, ecological factor (Pyne, 1982) that could not be fully eliminated. This new ecological understanding of wildfires gained traction in 1985, and became a nationally recognized issue. Being prone to recurring wildfires, California has constantly implemented policies that require or incentivize home hardening to seek greater housing resilience. However, property owners do not always correctly perceive risks. Especially while navigating disaster displacement, homeowners' rationale for rebuilding more resilient homes can represent an additional challenge to their traumatic experiences. Building codes ensure that minimum, acceptable standards are used in designing, constructing, and maintaining housing. Understanding how code change impacts the rebuilding process from the homeowner perspective is imperative in informing new directions for more appropriate, human-centered sustainable rebuilding. By focusing on wildfire-responsive building codes, we ask, "How have changing building codes impacted displaced homeowners' rebuilding experiences?" A historical analysis characterized how building codes changed throughout time for increased wildfire resilience in California and qualitative interviews with individuals displaced in 2018 revealed that participants experienced added emotional, social, and financial tolls related to building codes. These results pointed to two anemic areas (i.e., education and context-based innovation), leading to a systematic selection and analysis of successful documented experiences worldwide. Recommendations incorporate sustainable building practices that consider the displaced homeowner's perspective, supporting social-ecological health and vitality.

1.1 Keywords

Disaster displacement, building codes, home hardening, homeowner perception, post-disaster sustainable building practices.

1 INTRODUCTION

General building code changes are constantly driven by technological advancements and increased body of knowledge on specific areas that support sustainable development goals (e.g., improvement of urban dweller's health and well-being or urbanization's environmental impact). In addition, lessons learned from the devastating impacts of natural disasters can promote planning and policy change in various ways. Unlike recent times, most fires historically spread during conditions that were less than high to extreme severity. However, as one of the consequences of climate change, current wildfires during severe conditions have led to extreme, uncontrollable fire conditions. It is suggested that wildfires are inevitable, however, fire disasters are not.

This paper indicates that Wildland-Urban (WU) fire disasters are principally a home ignition problem (where an effective reduction is possible), and not a problem of controlling extreme wildfires (where control is not possible). Further, because WU fire destruction is a home/structure ignition problem, an appropriate problem definition must relate the "wildland" ignition factors to the "urban" ignition due to a structure's flammable materials and design.

Therefore, building codes have been constantly updated to promote Home Hardening, which aims to increase housing resilience and reduce the susceptibility of a home being lost in a WU fire disaster. Among U.S. states, California has gone the furthest in mandating take-up of wildfire resilience investments by property owners. However, the application of these codes varies throughout the state, and is still very much dependent on homeowners proper perception of risks.

2 RESEARCH OBJECTIVES

Understanding how code change impacts the process of rebuilding from the perspective of the displaced homeowner is imperative in informing new directions for more appropriate, human-centered sustainable rebuilding. By focusing on wildfire-responsive building codes, we ask, "How have changing building codes impacted displaced homeowners' rebuilding experiences?"

3 METHODS

3.1 Research Design

A qualitative interpretivist framework was best suited for this study. Interpretivist researchers view experience and perspective as valuable sources of knowledge and seek to uncover the interpretations of reality that people have based on their understanding of the world. This study has thus defined the person-in-environment as the unit of analysis and obtaining "as complete a picture as possible" of the phenomenon was needed to understand how these people see the world, the way they perceive constraints, and how they choose to act (Mazumdar & Geis, 2001, p. 262).

A Naturalistic Field Research (NFR) method was carried out because it neither focuses solely on the human/social dimension (as in the Social Sciences) nor strictly on the physical aspects (which is often the case in Architecture, Planning, and Design). In this way, this method allowed for the study of both human/social and physical dimensions in their symbiotic relations (i.e., a socio-physical phenomenon) in context. Data collection involved multiple sources of information aimed at achieving an in-depth understanding of the phenomenon to allow for triangulation or confirmation (Mazumdar & Geis, 2001; Yin, 1994). Data collection techniques used in this research are described next.

3.2 Data Collection

Archival data, government statistics, and documents were analyzed to corroborate objective information (e.g., dates, meteorological data, and names of organizations involved in specific events mentioned by survivors). This also included a code survey, in which relevant codes, regulations, and requirements (e.g., California regulations and requirements, local building codes, etc.) were analyzed to track code change in response to fire disasters, among other updates.

In addition, significant data came from interviews conducted in 2019. These include twenty-five survivors of nineteen households displaced by the Woolsey Fire. Some interviewees were interviewed more than once. Interviews were conducted by phone or in-person in appointments that each lasted between 1 and 4 hours. These interviews were audio-recorded and later transcribed for analysis. Eligible participants were individuals (18 years of age or older) from any of the communities affected by the Woolsey Fire that

suffered a total loss of their homes. Recruitment started through social media (i.e., Facebook). By identifying virtual groups dedicated to fire survivors involved looking for keywords included in their names (e.g., Woolsey Fire, California wildfires, etc.), and reaching out to each group's administrator, who invited eligible participants to contact me (i.e., process of referral).

In-depth, semi-structured interviews were conducted mostly in a participants' temporary housing. Questions were brief and simple, so that the different dimensions introduced in the answers could be pursued. Introducing questions asked to all survivors included their experience of the disaster and subsequent displacement, as well as their relocation and rebuilding plans. Such opening questions often yielded spontaneous, rich, descriptions where the participants themselves provided the highlights of what they experienced, i.e., participants select the main dimensions of the phenomenon under investigation (Kvale, 1996). In this way, relevant questions arose from interactions during each interview, and each interview had the potential to generate new questions to be included in a subsequent interview.

Opting for an in-depth approach to interviews was informed by the type of knowledge sought and necessarily linked to the research question and underlying philosophical assumptions of this study. In-depth interviews are especially effective for collecting information to answer certain types of research questions, particularly, when the interest is in "understanding the perceptions of participants or learning how participants come to attach certain meanings to phenomena and events..." (Taylor & Bogdan, 1998, p. 98). Therefore, this type of interview was the most appropriate to seek a deeper understanding of people's experiences (e.g., feelings and thoughts), and what these meant to them.

Furthermore, specifying questions framed in a more operationalizing manner (e.g., What did you think at the time? How did you feel about that?) were also utilized to comprehend participants' emotional reactions to certain narrated events. This allowed for learning from the participants as much as they were willing to share, as the goal was to get past the general accounts and reach for answers that reflected many layers of depth.

3.3 Data Analysis

In NFR, analyses will emerge from the interaction between collected data and fo-cusing decisions. The purpose of this process is to achieve interpretations that arise from the data (Lofland & Lofland, 1995). Coding initiated the process of sorting, organizing, and categorizing data. Of critical importance was not to simply label parts of the data, but rather, to develop categories and, subsequently, themes that emerged from the array of data. Simultaneously, memos were written to elaborate on the coding and categories process, allowing for continual reflection and ultimately achieving "an interrelated set of memos that form a coherent analysis" (Lofland & Lofland, 1995, p. 193). As a result, the relevant literature and the findings in this study are organized in two empirical sections: The Wildland-Urban (WU) Fire Problem in California, and Displaced Homeowners' Perceptions on Sustainable Rebuilding.

4 RESULTS

4.1 The Wildland-Urban (WU) Fire Problem in California

This first section focuses on characterizing the problem at hand by presenting a conceptual and historical overview of fire management approaches adopted in the United States throughout time, and fire survivors' conceptualization of the fire problem in California. This is followed by an overview of relevant codes, regulations, and requirements articulates how building codes have changed to respond to failed responses to fire disasters and its significance in improving housing resilience, especially amid homeowners' often inadequate perceptions of risk.

The fire destruction of urban, suburban and exurban development during wildfires has been commonly referred to as the wildland-urban interface (WUI) fire problem (Cohen, 2010; 2019) at least since 1974 (Butler, 1974). Traditionally, the federal public land management policy has largely addressed wildfires as unwanted (i.e., to be prevented or to be suppressed at the smallest area possible). It was only in the early 1970s that federal policy began to recognize wildland fire as a historical, ecological factor (Cohen, 2010; Pyne, 1982) that could not be fully eliminated.

This new ecological understanding of wildfires gained traction in 1985, after a period of significant destruction of property and lives (Cohen, 2010), and home destruction related to wildfires became a nationally recognized issue, motivating fire protection officials from federal and state agencies to initiate a

collaborative effort with the National Fire Protection Association (NFPA). This initial fire management response resulted in the 1986 Wildfire Strikes Home conference (Cohen, 2010), and since then, wildland fire management policy has recognized the WUI fire problem as a principal issue in several documents including the National Fire Plan (2000), the Federal Wildland Fire Management Policy (2001), the 10-Year Comprehensive Strategy (2001), and the Healthy Forests Restoration Act (2003). These initiatives consolidated programs such as the Firewise and Fire Adapted Communities, which focus on fire exclusion and suppression.

However, there is no historical evidence or current management trend to suggest that all wildfires can be excluded and if not excluded, controlled with an initial suppression response (Cohen, 2019). For instance, examinations of WUI fire disasters over one-hundred years in the U.S. showed that fire suppression has successfully controlled around 95 percent of wildfires upon discovery and initial attack during the conditions when most historical fires spread. Meanwhile, wildfires that produced extreme fire behavior conditions – characterized by high wind speeds, low relative humidity and continuous flammable vegetation producing rapid fire growth rates, high fire intensities and showers of burning embers (firebrands) across wide areas downwind from the wildfire – are among the 5 percent of wildfires where initial attack has failed (Cohen, 2010).

When attempted wildfire exclusion and suppression fails, the third step in the reactive fire management approach is to resort to structure protection (Cohen, 2010). This process is described in Figure 1.

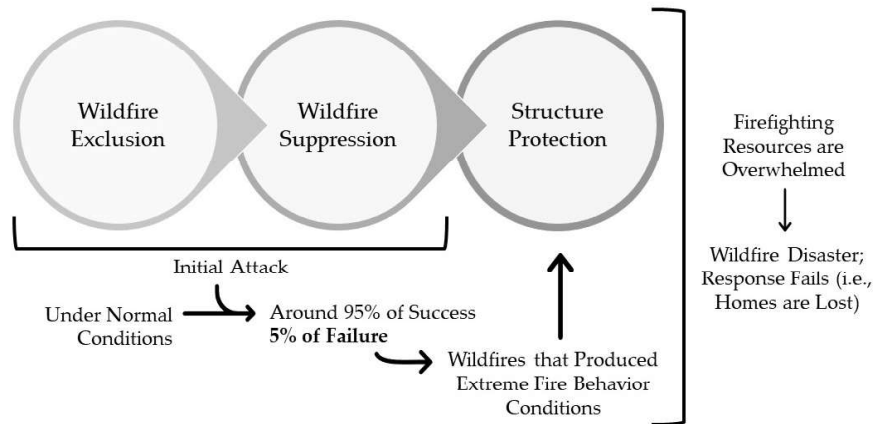


Figure 1. The Reactive Fire Management Approach. Diagram by the author based on based on Cohen (2010; 2019).

When the initial attack fails, and wildfire occurrence with extreme wildfire conditions, structure protection is not guaranteed. In extreme fire conditions, firefighting resources are overwhelmed quickly, and the response fails, characterizing a fire disaster, in which homes are often lost to partial or total fire damage. Due to climate change, extreme fire behavior conditions are becoming more common, and it is reasonable to assume the inevitability of wildfire occurrence with extreme wildfire conditions (Baylis & Boomhower, 2021a; Williams, 2013), resulting in more frequent and more intense fire disasters.

Given the inevitability of extreme wildfire conditions, the inevitability of WUI fire disasters seems assured if the emphasis continues to be on a reactive management of wildland and structure firefighting approach. Fortunately, scholarship has advanced enough to say that WUI fires can occur without a WUI fire disaster, even in extreme wildfire conditions. This happens because although this type of community destruction is initiated by wildfires, structure ignitions are not determined by geographic location; rather, the fire destruction is determined by the ignition conditions of a structure in relation to its immediate surroundings. If homes are made ignition-resistant and most homes do not ignite, fire protection resources are not overwhelmed, the available structure protection is effective for ignitions that do occur, and WUI fire disasters are prevented (Cohen, 2019).

Hence, extreme wildfires can occur without WUI fire disaster if the emphasis shifts to a pro-active management of wildland and structure fire-fighting approach. This process can have a different outcome

because of changes (i.e., Resilient Structures) that affect the third stage (i.e., Structure Protection) of the fire management process, as diagrammed in Figure 2.

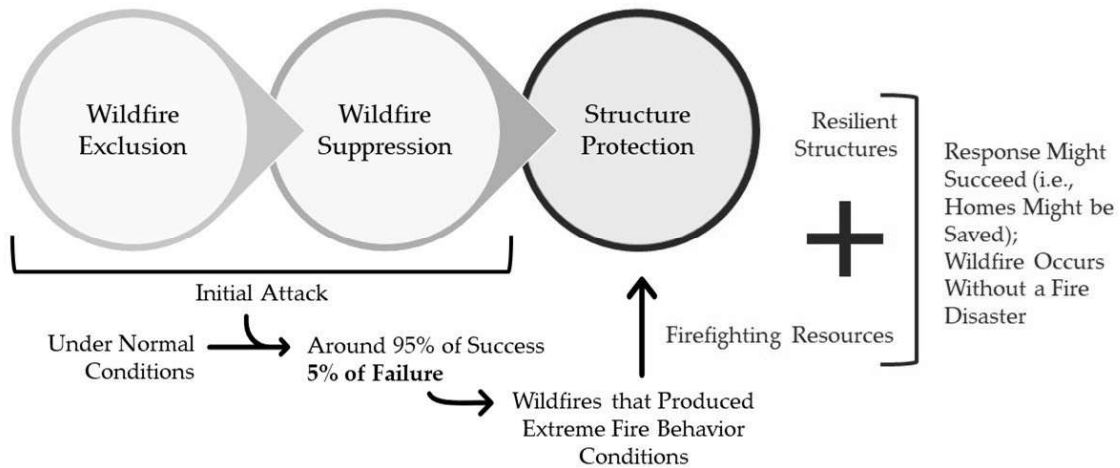


Figure 2. The Pro-active Fire Management Approach. Diagram by the author based on based on Cohen (2010; 2019).

This indicates that WU fire disasters are principally a home ignition problem (where an effective reduction is possible), and not a problem of controlling extreme wildfires (where control is not possible). In this way, community destruction during wildfires is more appropriately referred to as simply wildland-urban (WU) fire (Cohen, 2010). Because WU fire destruction is a home/structure ignition problem, an appropriate problem definition must relate the “wildland” ignition factors of firebrands and flames to the “urban” ignition due to a structure’s flammable materials and design (as shown in Figure 2). In essence, the WU fire correct definition is a statement relating the heat transfer of burning objects (flames and firebrands) to a structure’s ignition. The patterns of destruction previously discussed (Cohen, 2010; 2019) indicate that required heat transfer for a sustained home ignition is determined by the conditions of a structure in relation to a structure’s immediate surroundings.

However, the global (e.g., climate change) and local variables (e.g., a structure and its surroundings) herein described are not always known, especially by those most impacted by the WU fire disasters: the displaced survivors. As previously described, climate change impacts extreme fire behavior conditions, making inevitable the occurrence of wildfires with extreme wildfire conditions (Baylis & Boomhower, 2021a; Williams, 2013).

Accordingly, “Climate Change” and “Global Warming” were terms constantly used interchangeably by participants to assign blame for the latest fire disasters in two opposite ways. First, most participants blamed the environmental phenomena for changing long-standing, “sustainable” patterns (e.g., of local weather, water scarcity, and normal fire seasons) that led to more disastrous fires. However, some mentioned the phenomena while assigning blame elsewhere. Connie, for instance, said that government institutions and the scientific community justify the disastrous fires based on a hoax. In other words, she described the above-mentioned phenomena as a fabricated explanation to deflect blame for their failed responses to disasters. This reinforces what researchers who defend the enforcement of renewed building codes versus the voluntary take up of recommendations have reasoned, that the enforcement of housing resilience through code change can be justified by the common misperception of risk by homeowners (Baylis & Boomhower, 2021b; Turner & Vaughan, n.d.).

In the U.S, building codes usually refer to model codes developed in a national forum, taking the views of all interested parties – as well as state and local codes -- into consideration. Codes are designed to protect buildings and the people and property inside them from extreme events such as WU fires. They also ensure structural integrity; electrical, plumbing, and mechanical system safety, as well as accessibility and practical and achievable levels of energy efficiency (Turner & Vaughan, n.d.).

Architects and engineers must ensure their building designs meet or exceed the minimum, legally mandated code requirement for a particular jurisdiction. The local building department reviews plans submitted to them before construction and issues permits before the project can proceed. Inspectors verify the project, as constructed, complies with the code. Building industry stakeholders affected by building codes include contractors and subcontractors, manufacturers of building products and materials, insurance companies, facility managers, building owners and tenants, and building inspectors. However, there seems to still be a lack of communication of the potential benefits (e.g., reducing WU fire disaster risks) to those most impacted code change at the residential level.

4.2 Fire-Responsive Code Change

As previously discussed, the patterns of fire destruction in the U.S. (Cohen, 2010; 2019) indicate that required heat transfer for a sustained home ignition is determined by the conditions of a structure in relation to a structure's immediate surroundings. This area, a structure/home and its immediate surroundings, is called the Home Ignition Zone (HIZ) (Cohen, 2001; 2010; Cohen & Stratton, 2008). Further research into how structures can ignite during extreme wildfire conditions has enabled the identification and assessment of ignition vulnerabilities with guidance for effectively increasing home ignition resistance during extreme wildfire conditions (How to Prepare Your Home for Wildfires, 2022).

Learning from failed responses, in this case, calls for code change to increase housing resilience by regulating the HIZ at various levels. In this way, land use planning can reduce wildfire risk by helping communities grow and develop with wildfire in mind. Land use planning tools such as zoning, plans, regulations, and building codes can influence the design, layout, and placement of homes built in wildfire-prone areas (Wildfire Risk to Communities, 2022).

Land use planning measures are diverse and can be customized to fit the needs of the neighborhood, community, or county. For example, land use planning regulations can require defensible space in the home ignition zone, adequate water supply, road widths and access, and home hardening materials for homes built in high wildfire hazard areas. Land use planning tools can also restrict development in areas of highest hazard. These and other tools are described in Table 1.

Table 1. Land Use Planning Tools with Potential to Reduce WU Fire Disaster Risk. Table by the author based on Wildfire Risk to Communities.

Watershed Management Plans	Reduces wildfire through fuel treatments, protecting vital water resources.
Land Preservation Tools	Encourages agricultural lands to buffer development from wildfires.
Building Codes	Requires ignition-resistant construction materials for new developments and retrofits.
Forest Management Projects	Reduces fuels within the wildland-urban interface (WUI).
Landscaping Regulations	Requires property owners to manage hazardous vegetation and maintain their properties.
Steep Slope Ordinances	Restricts development within high wildfire-risk areas.
Land Use and Development Codes	Incentivizes developers to plan open space and recreational trails, creating fuel breaks.
Subdivision Design Standards	Requires risk reduction features, such as minimum road widths, secondary access, and adequate water supply.
Local Government Support	Supports fire adapted communities through good land use planning.

Focusing on building codes and standards allows for the advancement of the HIZ, by introducing important concepts such as Home Hardening, which is an important component of the HIZ. Also referred to as Defensible Space, the HIZ is an area 100-200 feet from the foundation and includes vegetation, the home itself, and other structures or attachments like decks, furniture, fences, and outbuildings (Wildfire Risk to Communities, 2022).

Homes lost to wildfire are most often ignited by embers or small, low-intensity fires. Ember ignition can occur when embers enter the building through vents or an open window. Once inside, embers can ignite furnishings or other combustible materials stored there. Ember ignition can also occur when embers accumulate and ignite combustible parts of the building, such as a wood shake roof, combustible decking, or debris accumulated on a roof or in a gutter. Vegetation or other nearby combustible materials can be ignited by embers, causing a spot fire and subjecting a portion of the siding, windows, or doors to fire (Cohen, 2010; 2019; Wildfire Risk to Communities, 2022). Therefore, building codes have been constantly updated to promote Home Hardening, which aims to help reduce the susceptibility of a home to a WU fire disaster. In the Home Hardening process, several components of the home should be addressed, including the roof, gutters and eaves, vents, siding, windows and doors, and decks, fences, and other attachments.

Among U.S. states, California has gone the furthest in mandating take-up of wildfire resilience investments by property owners. However, the application of these codes varies throughout the state (Baylis & Boomhower, 2021). In areas where CAL FIRE provides firefighting services (State Responsibility Area – SRA), the state directly determines building standards. Within incorporated cities and other areas with their own fire departments (Local Responsibility Area – LRA), local governments have historically had greater control over code requirements (Baylis & Boomhower, 2021).

The first of these was the Bates Bill of 1992 (As-sembly Bill 337), which is further described, along with the subsequent code changes in Table 2.

Table 2. Fire-responsive Code Change in California. Table by the author based on Baylis & Boomhower (2021).

The Bates Bill, 1992	It encouraged stronger building standards in LRA areas by requiring CAL FIRE to produce maps of recommended Very High Fire Hazard Severity Zones (VHFHSZ). Local governments could then choose to adopt these recommended hazard maps and their accompanying building standards.
Assembly Bill 3819, 1994	It increased requirements for ignition-resistant roofs in all SRA areas and in the subset of LRA areas where local governments had adopted the VHFHSZs. <ul style="list-style-type: none"> • In 1995, it required Class B roofs on newly-constructed or reroofed homes in regulated areas. • In 1997, the requirement increased to Class A roofs in high-hazard areas.
Assembly Bill 423, 1999	It simplified enforcement of the new roofing codes by outlawing the use of unrated roofing materials throughout the state.
Chapter 7A standards of the California Building Code, 2008	Applied to all homes built in 2008 or later in SRA areas and in LRA areas where the VHFHSZ designations had been accepted, to many dimensions: <ul style="list-style-type: none"> • Roofs must be rated class A or B, • Eaves and exterior siding must be fire resistant, • Vents must be covered by a fine wire mesh to resist ember intrusion, • Windows and doors must resist fire for at least 20 minutes, • Decks and other building appendages must be built of noncombustible materials, and • Additional requirements for defensible space.

A recent, comprehensive empirical evaluation of California's strict wildfire building codes, by analyzing a new dataset of property-level data on U.S. of homes destroyed by wildfires up to 2020 (Baylis & Boomhower, 2021). First, this study found a remarkable impact of code change in housing resilience to WU fire disasters by comparing three types of jurisdictions: SRA areas, where compliance with California building codes was mandatory, LRA areas that were ever recommended by CAL FIRE as VHFHSZ areas (regardless of whether local governments accepted the designation), and the areas without fire-responsive building codes (which included LRA areas in California that were never recommended for consideration as VHFHSZ, as well as areas in areas of other states without any state or local fire-responsive building codes).

The empirical strategy isolates the effect of building code changes using a fixed effects design that compares outcomes for pre- and post-code homes on the same residential street. This approach narrows the comparison to homes experiencing essentially identical wildfire exposures. For instance, one analysis reported that about 35% of homes exposed to fire that were built prior to the mid-1990s were destroyed.

The destruction decreased to about 20% for homes built after the mid-1990s. This sharp improvement in resilience corresponds in time to the post-Oakland Firestorm building code reforms. Evidence also showed that homes built before about 1980 may be less likely to be destroyed than homes built just prior to the roof requirements, because they are more likely to have been re-roofed at least once after the mid-1990s and complied with the new requirements for ignition-resistant materials at roof replacement (Baylis & Boomhower, 2021).

Among other things, the study also looked at the spillover benefits of code-induced mitigation to neighboring homes. In other words, the extent to which each resilient home improves overall community resilience. In sum, the results show that compared to reliance on voluntary action alone, California's fire-responsive building codes reduced average structure loss risk during a WU fire disaster by 16 percentage points, or about a 40% reduction. They also reduced the risk to a close neighbor's home by about 2 percentage points or 6%. These striking results imply materially different levels of resilience in communities with and without such codes. "Moreover, the spatial externalities provide a classic rationale for public policy intervention even if homeowners were fully informed and rational about wild-fire risk" (Baylis & Boomhower, 2021, p. 33).

Having documented these large resilience benefits, the next section turns to homeowners' perceptions on sustainable rebuilding, which included dealing with an array of fire-responsive codes.

4.3 Displaced Homeowners' Perceptions on Sustainable Rebuilding

The Woolsey Fire was a precise illustration of a WU fire disaster, according to the historical and current approaches to the WU fire problem in California, as described earlier. This section describes the way in which the events unfolded while the Woolsey Fire reached the homes of participants in this study (i.e., the circumstances of their forced displacement), after the failed response that prioritized a reactive wildland and structure fire-fighting approach. These circumstances shaped fire survivors' subsequent experiences of displacement, relocation, and rebuilding after the fire.

The disaster killed three people, destroyed 1,643 structures, and burned approximately 96,949 acres (Top 20 Most Destructive California Wildfires, 2019). Although not the largest nor the deadliest wildfire in California's history, the Woolsey Fire was so damaging in terms of home environments that it currently ranks seventh among the most destructive wildfires in California's history and the fourth most destructive fire in the last decade (Top 20 Most Destructive California Wildfires, 2019), after destroying at least 300 homes, and immediately displacing their occupants.

Previous studies on displacement suggest that in general, more reliable data is available when analyzing internal displacement than when looking at cross-border migration trends, "...because vulnerability differs significantly across disaster-affected communities" (Mearns & Norton, p. 26). Thus, the somewhat homogeneous make-up of the population in the area affected by the Woolsey Fire validates them as a group of people with similar circumstances. For instance, the median household income in the area affected does not vary greatly, with the majority of households affected earning between \$100,000 and \$150,000, there is a 75 percent rate of homeownership, in comparison to renting and other arrangements, the population is predominantly white and the median age is between 45 to 54 years (The U.S. Census Bureau GIS mapping files by Census Tract, 2019; 2020).

According to the After-Action Review of the Woolsey Fire Incident (AAR), commissioned by the Los Angeles County to evaluate the causes and their response to the event, meteorologist and fire technical staff saw evidence of increasing fire weather conditions on November 6, 2018 (Citygate Associates, 2019). Per existing protocols, fire agencies up staffed predetermined resources and the CalFire relocated resources across the State. On November 8, the relative humidity dropped from 100% at 7:00 AM to 7% at 11:00 AM, and although the weather forecast called for moderate temperatures in the mid-70s, winds blowing from the east became sustained, hot, and dry. At 2:30 PM, these winds were sustained at 23 miles per hour (mph) with gusts up to 37 mph. Meteorologically, "the conditions for a large-scale fire incident were perfect" (Citygate Associates, 2019, p. 19).

Historically, two distinct fire seasons existed in California depending on geography. These regional differences had always allowed for statewide firefighting resources to be redeployed to Southern California, to stand ready for regional threats once Northern California fires had ceased. Although the Woolsey Fire erupted late in the traditional fire season of Southern California, Northern California was still experiencing extreme fire weather conditions. Approximately eight hours before the ignition of the Woolsey Fire, the Camp Fire (the deadliest in California history) ignited in Butte County just east of Paradise. Significant to

the Woolsey Fire is that over 1,000 fire per-sonnel were assigned to the Camp Fire, pulling from the statewide pool of firefighting resources (Citygate Associates, 2019).

Seven hours later, the major Hill Fire ignited in the Hill Canyon area of Santa Rosa Valley, only 3.5 miles east of the City of Camarillo. The Ventura County Fire Department deployed a full brush fire ground and aerial unit response to the Hill Fire. Initial fire attack resources were outflanked, the fire quickly jumped Highway 101 within approximately 15 minutes from the time of dispatch, running approximately three miles in 15 minutes. Crews were quickly overpowered, and direct operations were rendered ineffective by strong winds, steep topography, and flammable, drought-stricken fuels in the path of the fire (Citygate Associates, 2019). Based on these initial conditions, the Hill Fire was believed to have the potential to reach the coast by nightfall.

Meanwhile, at approximately 2:24 PM, the Woolsey Fire was first reported at the Ventura County Emergency Communications Center as a request for a “smoke check,” resulting in the initial deployment of the Rocketdyne Fire Department and one Ventura County fire engine. Initial ignition occurred in the Woolsey Canyon of the Santa Susana Mountain range on the old Santa Susana Field Laboratory (SSFL) property in Chatsworth. At 2:33 PM, before fire engines arrived on the scene, the event was upgraded to a full wildland fire unit response, which also triggered Los Angeles County Fire and the Los Angeles City Fire to respond per the established Santa Susana Mutual Threat Zone (MTZ) agreement. The first two ground units and a helicopter arrived on the scene between 2:45 PM and 2:51 PM. All reported a wind-driven fire growing from five to approximately 30 acres in six minutes. The initial wind direction pushed the fire in a southerly direction the first day. The fire then crossed the 101 Freeway and headed into the Santa Monica Mountains, in alignment with the geographic canyon features, and thus, conducive to a rapid-fire run toward the Pacific Ocean (Citygate Associates, 2019).

The Santa Susana MTZ agreement calls for a massive initial joint response from three fire departments: Ventura County Fire, Los Angeles County Fire, and Los Angeles City Fire. However, due to the two other competing fires in the state, local and eventually region and statewide mutual aid systems were unable to respond to the many incident resource requests. Through the mutual aid request system records, the AAR emphasized that resources were repeatedly requested for the Woolsey Fire, but those requests went unfulfilled in the first 21.5 hours of the incident. The report concluded that during the first two days of the Woolsey Fire, 53 percent of the fire engine mutual aid requests were unfilled, which totals 874 units not sent to the site (Citygate Associates, 2019). During these 48 hours, the fire burned 96 percent of its final footprint.

The large differences in wildfire acres burned in California are primarily due to variable weather conditions and situations in which fires occur in remote locations that are difficult to access (California’s Forests and Rangelands: 2010 Assessment, 2019). In other words, the size of a fire is influenced by the presence of strong winds, the dryness of vegetation due to lack of rainfall, and the ease of accessibility to firefighters. In this case, the extensive drought of previous years, the lack of availability of personnel, and the difficult terrain in which the fire gained momentum played an important role in the disastrous outcome. Additionally, the high fire frequency in the Santa Monica Mountains, especially in the corridor that goes from the Santa Susana Pass in the Simi Hills down to the coast through Malibu Canyon, led to very little “old growth” chaparral and a complex vegetation pattern created by overlapping fires. These non-native, younger species burned easier, faster, and were certainly factors in the quick spreading of the wildfire. Therefore, the fire immediately presented unprecedented complexities, that led to one survivor describing their experience as “a surreal disaster response” (Ralph, July 12, 2019, Interview).

By noon on Friday (November 9), the fire had burned all the way to the Pacific Ocean in Malibu. Most of the fire growth occurred after the fire crossed Highway 101 and required approximately 6.5 hours to reach the ocean. At times the agencies re-ponding to the fire were “overwhelmed in the first hours by this incident’s speed and weight of impact, exposing some limitations between the agencies and systems as they meshed into a single, wide-area regional response team in less than 24 hours” (Citygate Associates, 2019, p.5).

The expected fire behavior and rate of spread far exceeded the past experiences of emergency responders, policymakers, and the community members in the Santa Monica Mountains fire corridor areas with canyon or drainage generally running to the ocean. Experienced firefighters recounted witnessing fire behavior unlike anything they have witnessed in the past (Citygate Associates, 2019), and this surprise factor is also consistent with most of the survivors’ recounted experiences.

Patricia, for instance, remembers that her children called her that night to say that their old neighborhood was on fire, which was only three miles away from where she had been living. To her surprise, flying embers were the cause of houses burning in their old neighborhood. On this point, Patricia remarked: "you would think that just the houses up against the mountains would be in danger, not the ones in the middle of the community. But the ones in the middle of the community were burning too". Patricia also attributed her late evacuation to the disbelief of such unexpected fire behavior:

We didn't really think the fire was going to come, [that] it was going to burn your house down, because for the past 50 years, the fires would go straight to the canyons, to the beach, and they would pass right by us... We are... like in a mini valley. So, they just went all around us every time (Patricia, July 12, 2019, Interview).

Only when Patricia saw the flames coming over the crest did she realize that "it didn't look good". Other participants expressed similar surprise on how the fire behaved that night in comparison to many other fires of previous decades they had experienced while living in the area. Cecilia, for example, recalls coming back from a camping trip on that Thursday morning and hearing about the Hill Fire. However, she only heard about the rapid start and spread of the Woolsey Fire in the evening, at about 7:00 PM:

So, I started paying attention to that one... I started slowly packing some things up, and I told my son, you know, "It's getting a little closer," and he said, "Don't worry," because we have evacuated about 5... 7 times... And he goes, "We always come back, it'll be fine." It would have to go through... all this [pointing the nearby grocery store and school] to get to us, but we didn't take into consideration [the fire] coming from the back to us (Cecilia, August 6, 2019, Interview).

Thus, not only did the fire spread quickly, but it also shifted its usual course. According to another survive named Linda, as the fire advanced, she monitored her surroundings from her house that sat upon the top of a crest. Linda's neighbor of half-mile down the hill could not "see north," so she kept calling to check-in on the fire progress. Linda recalls not seeing anything and repeatedly replying: "It still has to go down three more ravines before it gets here... just don't worry about it... it's nowhere near us". However, at about 9:15 in the next morning, a Monrovia Sheriff's Department patrol car came up the street with sirens, as she recounts:

He wasn't telling us mandatory evacuation, he was screaming "Evacuate!" I'm looking to the north, north-south, and there's nothing up there... So, I walk outside... I had to walk up a little... the fire was there. So, the previous 10, 15 years that I've been doing that, 58 years I've been dealing with [fires], all the fires have come from the north-south. This fire came from the west. So, by the time I got to the driveway, it was too late... I ran back to my house, grabbed the animals... Put [them] in the car and drove down my canyon... And by the time I got [a] that point of less than a mile away, I watched my house blow up. It was that fast (Linda, August 19, 2019, Interview).

Thus, expectations by community members regarding the fire agencies' capabilities to safely order evacuations and to confront a fast-moving wildfire were harshly reset by the many surprises presented by the Woolsey Fire.

The Woolsey Fire was so surprising that Patricia and Ralph never received an official evacuation order. To warn them, a neighbor called at about 2:30 AM. Patricia and Ralph had a unique perspective as the fire approached, as she was the president of their homeowners' association, and Ralph, the chairman of the emergency preparedness committee. Their own evacuation decisions were thus tempered by the absence of official evacuation orders and firefighting response:

We looked at each other, and we said, "Are we going to start putting things in the cars? Or... should we go around? You're the president. I'm the chair of the emergency preparedness committee. Should we just go around to all the homes, that 214 other homes, and evacuate the elderly and the handi-capped because everybody is sleeping?" (Ralph, July 12, 2019, Interview).

Throughout the night, while evacuating neighbors and tending to his wife, who tried to pack some clothes and documents, Ralph's frustration became directed at the lack of firefighting presence. As he fought back the tears eight months later, he described one of his biggest disappointments that night:

We responded to a 93-year-old man's house because we saw a fire truck come ahead of the ambulance. In this country, when you have an ambulance going through any zone, when a fire truck can accompany, they do, but the fire truck, in this case, was ahead of the

ambulance by about five minutes. We responded to that man's house with the fire engine, the fire truck, and we asked them, "When will backup be here?" And they said, "Soon," but backup never showed up before the fire got there. The ambulance came, they picked up the 93-year-old man, his caretaker had called, and he left in an ambulance, and I saw the ambulance go out with the fire truck behind it (Ralph, July 12, 2019, Interview).

Especially in the Malibu coastal area, residents expected a more robust firefighting response. Still, as described in the AAR, many factors prevented that from happening (Citygate Associates, 2019).

Throughout this study, participants who lost their homes in the Malibu coastal area expressed frustration regarding inadequate fire response. Cassie, who lives about a mile and a half up from the Pacific Coast Highway, explained why she thinks her area burned so terribly: "It was because it came over in the Santa Monica Mountains where there were no structures. No air drops. No effing fireman, no water... I'm so angry. My house and 200 of my... neighbors did not have to burn".

Furthermore, a decisive event that was continually mentioned by almost every participant in this study:

We evacuated and we went down to Zuma Beach parking lot. Where they had 10 or 12 fire trucks lined up sitting there because some head honcho told them, for their orders, they were not to put out structure fires that were there, to only save lives. Excuse me, we all evacuated. So what life are you going to save? (Cassie, December 17, 2019, Interview).

Linda also mentioned the Zuma beach incident, but from a different perspective: "At one point I had my brother's T-shirt on that said, 'Fire Department' and said 'Captain' on it. I had to turn it inside out. My neighbors were screaming at me" (Linda, August 19, 2019, Interview).

In this context, the ARR also addressed the Zuma beach incident:

Due to the Unable to Fill (UTF) requests and the fire storm's impact on roads through the mountains, units in Malibu consisted only of locally assigned units and a very small quantity of mutual aid. This is why the public observed that the normally heavy fire unit response was not occurring... On Friday evening, there were still nowhere near the units requested. As a result, the public observation was, of course, valid; active structural fire-fighting in the coastal plain in the early hours of the fire was not possible (Citygate Associates, 2019, p. 29).

They concluded by recommending "Public education to increase awareness re-garding public impact when a devastating fire incident shifts from direct control methods to Fire Front Following and Life Safety First tactics" (Citygate Associates, 2019, p. 8). Thus, be them long-standing responsibilities or new orders given during the event, the fact is that such protocol was not known by the community, leaving many members feeling un-heard and abandoned.

The community has a perception that public agencies can continuously protect them, but as an incident and the size of the Woolsey Fire shows, this is not always possible. Hence, the urgency to abandon reactive wildland and structure firefighting approaches to WU fires and focus policy and planning efforts to more pro-active strategies such as the effective reduction of home/structure ignition through new standards of building safety.

Furthermore, in massive, dynamic wildfires, some life and structure loss are tragic but expected possibilities; however, what occurred in less than 24 hours was not anticipated by any prior plan or preparedness exercise. This only reinforces the need to learn from failures and promote fire-responsive change in housing codes, regulations, and requirements.

So far, this section described the way in which the events unfolded while the Woolsey Fire reached the homes of participants in this study (i.e., the circumstances of their forced displacement), after the failed response that prioritized a reactive wildland and structure firefighting approach. These circumstances shaped fire survivors' subsequent experiences of planning their relocation and rebuilding after the fire.

4.4 Displaced Homeowners' Perceptions on Sustainable Rebuilding

All participants reported similar traumatic experiences of the fire, and post-disaster psychological consequences ranging from frustration, to anger, and trauma. The psychological implications of such experiences are thoroughly discussed elsewhere (Junqueira, 2020). Of importance to this discussion is that decisions regarding relocation and rebuilding were made amid such challenging conditions. First, this section will discuss participants' relocation experiences, characterized by multiple moves and trade-offs to remain local.

A common reason provided by participants to explain their pattern of serial relocation (multiple moves) was the fact that during the first few weeks after the fire, they had little knowledge about their options. By the time they were able to turn their attention to begin planning their relocation, fewer solutions were attainable.

In a state that is experiencing a widespread housing shortage—ranking 49th among the 50 United States in housing units per resident (The U.S. Census Bureau GIS mapping files by Census Tract, 2019; 2020), the abrupt loss of homes to disasters worsens the existing imbalance between supply and demand. One of the reasons that exacerbated housing market struggles seems to be that efforts from the Woolsey Fire overlapped with those of people displaced by other fires (e.g., Thomas, 2017; Hill, 2018; and Getty, 2019). Thus, people displaced by distinct fires that hit contiguous areas of Southern California in a two-year interval were often navigating the housing market together.

A considerable group of participants reported relocating as opportunities arose. For instance, Cecilia evacuated with her son Hudson and their dog to a friend's house in Pacific Palisades. Within twelve hours, they heard that their home was gone. According to Cecilia, she reported the incident to her home insurance company the next day and received no guidance: "I have never had to use insurance in that way. So, I had no idea how it worked. And he didn't tell me anything. So, I reported it. That's all I did" (Cecilia, August 6, 2019, Interview). After living on her friend's couches for two weeks, Cecilia moved two more times after different arrangements were made by her church leaders. After one month, she was able to start looking for an apartment closer to her original neighborhood, after receiving information about how to afford temporary housing.

Cecilia's trajectory illustrates the relocation pattern found among participants in this study and is representative of what happened after the Woolsey Fire in Southern California. This relocation pattern was characterized by consecutive moves with stays that became longer towards the end of the process. Another characteristic seen in Cecilia's journey also found in most participants' relocation patterns was the desire to stay local, i.e., to return to the area of their pre-fire residence. This desire heavily influenced participants decision-making processes during relocation and rebuilding planning.

In some instances, push drivers (e.g., being a fire-prone area or the expensive housing market) were downplayed by interviewees, and appropriate relocation was delayed and even avoided, reasoned by one's emotional investment deposited into a place or a group (e.g., the original area of residence). Therefore, temporary, local relocations were predominant in the aftermath of the Woolsey Fire. Further, the desire to remain local was often a reason to compromise on the size or quality of the temporary housing, i.e., a decision-making process that involved trade-offs.

Challenges to permanent relocation were similar to those encountered while in temporary housing: expensive housing market, downsizing, and other trade-offs. A different mindset was found, however, when discussing permanent rebuilding plans. One neighborhood that originally housed many participants in this study is used to illustrate some of these challenges, identified as significant roadblocks that burdened survivors' processes of recovery.

A central issue was the fact that rebuilding after the fire was taking much longer than it should, in many cases. Justine, one of the most vocal survivors in her community, signaled to part of the problem, more than one year after the fire, as she rhetorically asked: "So what's wrong with this picture? Why aren't people rebuilding their houses?" (December 17, 2019, Interview). What Justine called a "post-fire chaos" included, on average, an additional six months to have a burned property cleaned and cleared through state-wide programs, which added a first layer of uncertainty and delay to the process of rebuilding.

In many cases, survivors depleted their rebuilding resources much before they were allowed to start the rebuilding process. Some had their alternative living expenses (ALE) benefits expiring within six to 12 months from the day of the fire and had to transition to paying rent out-of-pocket, some were simultaneously paying multiple bills on the burned-down house and on the temporary housing, some were not insured, underinsured, or were never even approved for ALE benefits through FEMA due to their lifestyle (e.g., autonomous worker or not legally married partners).

Moreover, a rapidly changing housing market and urbanistic legislations hindered some survivors to plan for rebuilding in their pre-fire lots, mainly in two ways. First, the one participant in this study who was a long-time renter (of more than three decades) was communicated by her landlord that he would not be rebuilding a house similar to the one she lived in, but rather, he would take the opportunity to build a multi-family property for renting. Even among homeowners, being "priced-out" of their own lots was also a concern, especially for residents of unincorporated areas in the Santa Monica Mountains.

For instance, homeowners displaced by this one neighborhood expressed concern for being in a one-of-a-kind collection of individual homes owned by co-operative members due to a concession from July of 1986, in which residents purchased the park by forming a non-profit mutual benefit corporation that continues to this day. Now, displaced shareholders participating in this study expressed fear of being forced out of such a unique arrangement.

Second, urbanistic legislations that materialized in the last few decades are not “catching up” to burned-out homeowners. Many participants expressed a dissatisfaction with the fact that they can no longer rebuild the exact same house that was lost. This has caused some hesitation in deciding to rebuild, not only because of the new house would have a different size and/or design, but also because survivors are dragging what they foresee as a stressful process of navigating new building codes and processes.

An additional roadblock was the fact that FEMA identified a floodplain area cutting through the center of the neighborhood, as shown in Figure 3, which requires action per the Floodplain Management Executive Order 11988, of 1977. The objective of this executive order is to require agencies to avoid the long and short-term adverse impacts associated with occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is practicable alternative.

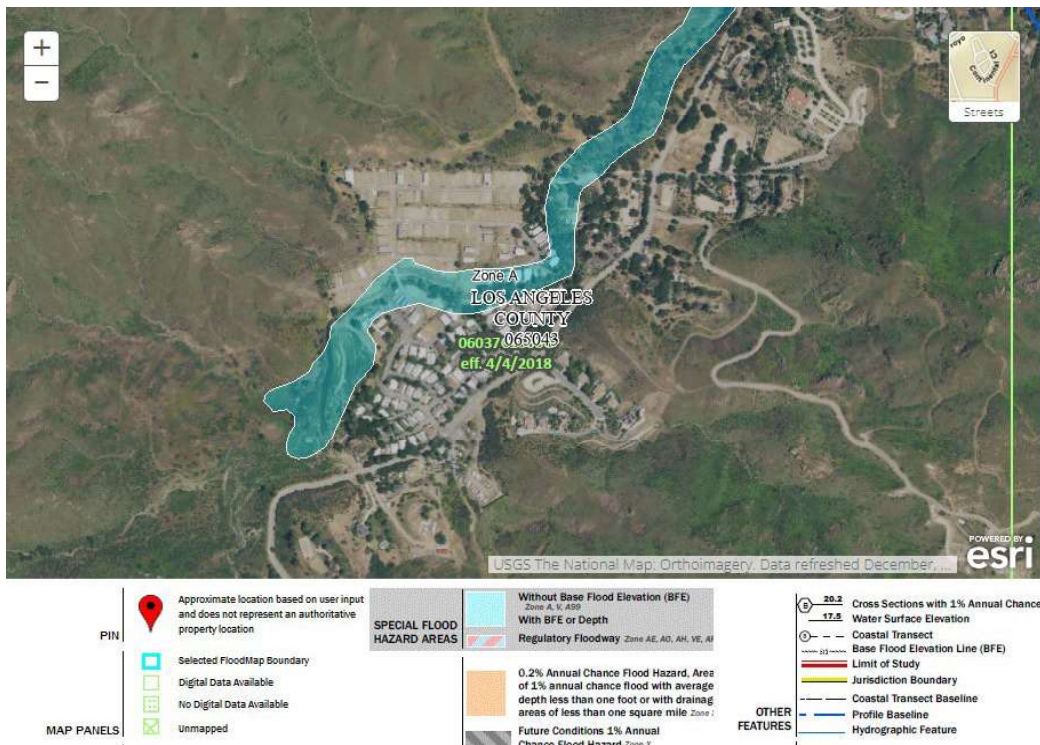


Figure 3: Floodplain identified by FEMA.

Homes that were standing (after surviving the fire) could remain in place. However, homes that burned down in that area could not be rebuilt.

The weather and development patterns in California leave watersheds and property prone to severe postfire flood damages. This well documented series of events is referred to as the fire/flood sequence, therefore the complete impacts of wildfire can only be seen over period of several years (Levy & Korkosz, 1997). Though naturally occurring in the Santa Monica Mountains debris flows are aggravated by any disturbance of slopes soils or vegetation including roads housing pads fire lines and fires.

The well-being of the area residents is closely reliant upon the overall condition of the watershed. Although most residents mentioned the terrible flood that followed the fire (acknowledging the water management issue), their overall perception was that government and environmental agencies were imposing yet another roadblock to their rebuilding.

Another roadblock was identified by those who advanced in the rebuilding planning process. Code change was commonly seen as an inconvenient obstacle to rebuilding. The most common changes were building setbacks, which would culminate in re-building a house considerably smaller than the original (pre-fire) home.

Another barrier to rebuilding a home similar to the original was put in place by the local homeowner's association in charge of regulating building aesthetic characteristics in the neighborhood. According to participants, this regulation became much stricter, including a restricted color palette (only white, grey, and beige) for new housing facades.

At some point during the year following the fire, some participants decided to move on and remake their homes elsewhere. For instance, Rita, although underinsured, was able to buy a new house in a different area in Southern California. There is an additional waiting time while her house is built, which contributes to her being the maximum number of moves among participants in this study (i.e., twelve in August and twenty by November 2019). Her decision-making process in rebuilding also involved compromise. In essence, Rita is downsizing and leaving her neighborhood of decades but hoping to still settle in Southern California sooner rather than later, since her original neighborhood encountered so many roadblocks that delayed the possibility of rebuilding on the same lot.

5 CONCLUSIONS

The results described above revealed that participants experienced added emotional, social, and financial tolls related to changes in building codes. These results pointed to two anemic areas (i.e., education and context-based innovation), leading to a systematic selection and analysis of successful documented experiences worldwide.

Code changes enable innovation in the building sector and permit more innovative products and processes to gain market share. As new building requirements are reviewed through the model code revision process (currently every three years in the U.S.), innovative stakeholders make their cases for inclusion. These innovations add value to buildings and improve their impact on health and safety.

Recommendations should incorporate sustainable building practices that consider the displaced homeowner's perspective, supporting social-ecological health and vitality. In this sense, how code changes are communicated to displaced homeowners is an area in need of further studies.

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