A Cartographic Exploration of Census Data on Select Housing Challenges Among California Residents

by

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To my family, Eric, Aurora and Miranda, you fill my cup with joy (even while you deplete my midnight oil); to my sisters Tania and Indira, I know I can do all things because you have blazed trails before me; to my cohorts, Ari and Nathan, you have provided me with focus, perspective and wit exactly when and how I needed them.

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Abbreviations

ACS	American Community Survey
AHS	American Housing Survey
AMI	Area Median Income
ARP	American Rescue Plan
CDBG	Community Development Block Grant
CEQA	California Environmental Quality Act
CHAS	Comprehensive Housing Affordability Strategy
COPRAS	Complex Proportional Assessment
GIS	Geographic Information System
HA	Housing Affordability
HAS	Housing Affordability Stress
HEI	Housing Expenditure to Income
HUD	US Department of Housing and Urban Development
LIHTC	Low Income Housing Tax Credit
MCDM	Multi-Criteria Decision Making
MOE	Margin of error
SSI	Spatial Sciences Institute
US	United States of America
USC	University of Southern California
VMT	Vehicle Miles Travelled

Abstract

Short of becoming homeless, everyone must live somewhere, but the circumstances leading to an individual's choice of housing can be complex. Housing choices represent both personal factors and outside influences and are often wrapped up in the overly simplified concept of "housing affordability." In California, the unaffordability of housing is particularly acute. This thesis uniquely combined multiple datasets from the US Census Bureau and the US Department of Housing and Urban Development to classify areas of the state according to the number of select housing-related challenges that residents experienced as a result of their housing accommodations. The challenges were then mapped, individually and collectively, to observe the geographic distribution of the phenomena. This innovative method supplements the 30-percent ratio (of housing costs to income) methodology traditionally used to denote housing affordability and adds a visual and spatial display of housing challenges at a statewide level and in several focus areas that have been negatively impacted by the current housing crisis. Finally, a review is provided of existing and potential solutions to the four housing challenges investigated. The results may be of interest to affordable housing providers, legislators, and even residents.

Chapter 1 Introduction

Housing is the largest expense in most household budgets. The affordability of housing is often defined by a housing cost that does not exceed 30 percent of a household's income, but this is only a partial description of the difficulties households can experience with finding and maintaining a place to live (Jewkes and Delgadillo 2010). Some recent research has sought to determine the prevalence of "housing affordability stress" (HAS) or the difficulty of paying housing costs that are more than what a household can pay while still being able to afford the other necessities of life (Baker, Mason, and Bentley 2015). Yet another vein of research has focused on "sustainable housing affordability," an attempt to combine the fiscal, social, and environmental factors related to housing that influence a household's residential circumstances (Mulliner and Maliene 2015). For research related to housing and housing problems in the US, the most comprehensive and widely available sources of data come from the US Census Bureau and the Department of Housing and Urban Development (HUD) (US Department of Housing and Urban Development Office of Policy Development and Research 2021). This thesis combines that data regarding various housing-related challenges to explore the distribution of these difficulties of life experienced by households across the State of California by Census tract and to envision existing and possible solutions for these challenges.

1.1. Study Area

The State of California is well known around the world as the "Golden State" for its natural beauty, agricultural bounty, technological epicenters, ecological diversity, and cinematic history. Covering more than 163,000 square miles, California is the third largest state in the union (see Figure 1). It is divided into 58 counties and has the highest population of any state, all of whom must live somewhere, as housing is one of our most basic needs.

Figure 1. State of California

Unfortunately, California's housing market is one of the most expensive in the US for renters and homeowners alike. A 2019 Bloomberg article, aptly (and ambitiously) titled "California's Affordable Housing Crisis: Why Prices Are So High and How to Solve It," pointed out that the state has a median home price more than twice the national average, four of the five most expensive housing markets and outsized populations of both persons experiencing homelessness and residents living below the poverty line.

Not surprisingly, in such a large region, the resident population is spread unevenly throughout the state (see Figure 2), having been shaped by the influence of topography, hydrology, climate, and historical development patterns.

1.2. Background

There are many contributing factors to the current state of California's unaffordable housing market. The location of major employment centers, both currently and historically, and the geography of physically desirable areas contribute to the uneven distribution of population and its concomitant demand for housing (Gregory 1993). Jurisdictions throughout the state have relative autonomy to set their own zoning and land-use regulations and often are subject to the pressures exerted by single-family homeowners protecting their home values. Combined with a desire to preserve community character, this results in opposition to more—and more dense—housing, creating a patchwork of housing-development capacity (Fischel 2001).

After decades of such jurisdictional limits or outright prohibitions on the construction of new housing, there has been inadequate new housing development. In addition, the overall supply of residential units is insufficient and expensive, and existing housing stock is aging, sometimes with deferred maintenance. In fact, a study of housing regulation in California found a direct correlation between land-use restrictions and higher prices of rental and owner-occupied

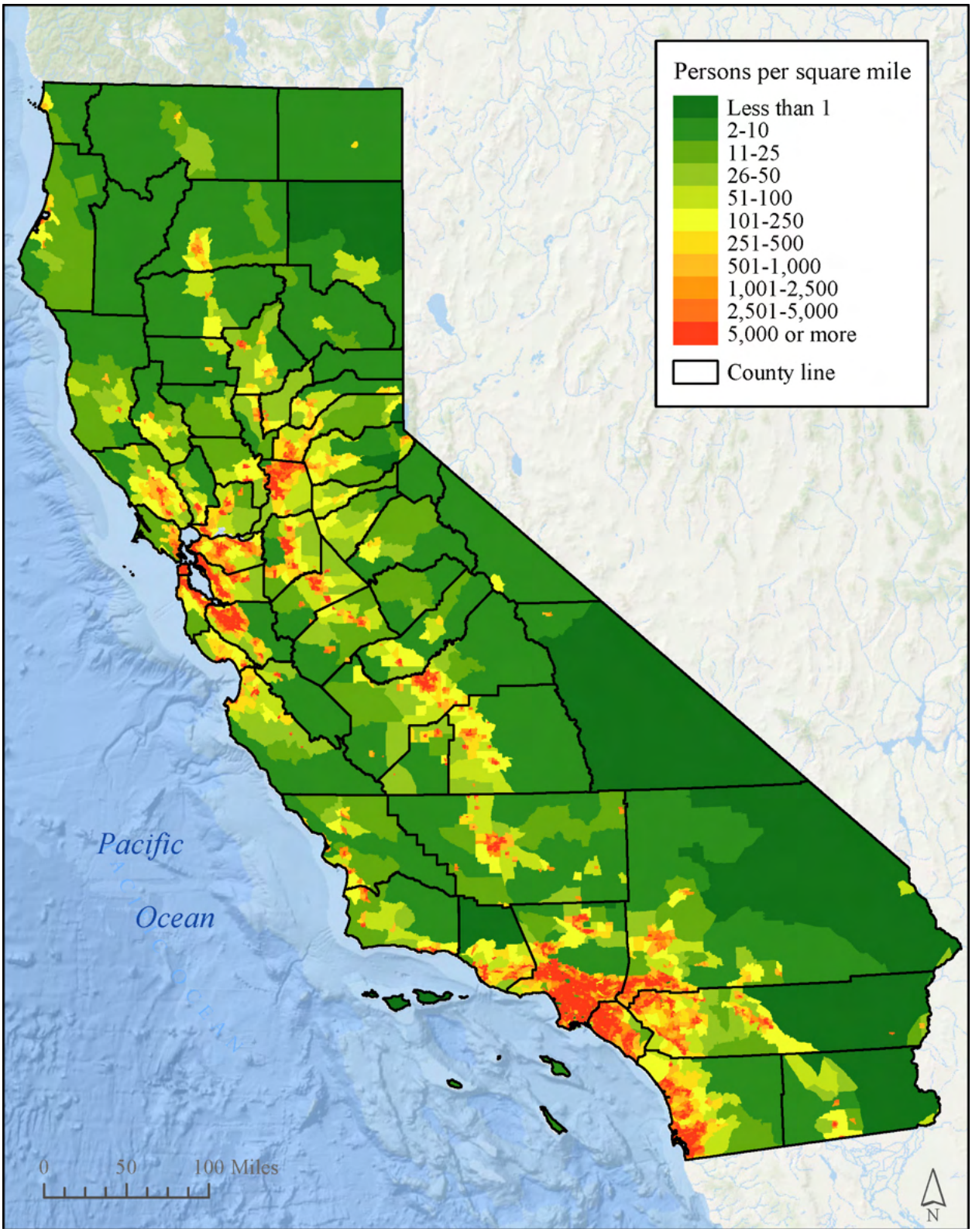

Figure 2. California Population Density (Source: US Census Bureau 2021b)

housing (Quigley and Raphael 2005). And California's consumers of housing are as diverse as its housing stock: while many residents live in poverty, the state is home to a greater number of billionaires than any nation in the world after the US and mainland China, according to Forbes Magazine in its 2020 list of the World's Billionaires.

On an individual level, households choose where to live based on the cost, condition, and supply of available housing, as well as the particular household's financial resources and personal preference for amenities (Stone 2006). For the most part, these elements are not captured in the 30-percent housing-expenditure-to-income (HEI) ratio that is often used to assess housing affordability, set maximum rents in rent-restricted housing, or qualify applicants for a mortgage. The HEI ratio also does not account for the fact that personal finances, expenses, and employment vary widely among households and even over time. The experience of housing-related difficulties then can occur at different income levels and in different geographic locations. While city centers and coastal areas may have higher real estate costs per square foot than other areas in the state, the actual affordability of housing and accessibility of employment involves a complex interplay of different factors. When viewed together, the occurrence of housing-related challenges can reveal the difficulties of life-impacting residents in unique and insightful ways.

1.3. Motivation

The problems experienced by residents in California's housing markets have far-reaching implications. While the affordability of housing has received much attention since the US Housing Act of 1949, the focus in recent decades has been almost exclusively on the HEI ratio of housing costs to income. The HEI is a simple ratio that fails to consider external factors or internal preferences affecting a household's choice of residence. In response, some recent

research incorporates a wider range of housing-related criteria to calculate housing affordability or the newer concept of sustainable housing affordability (Mulliner, Smallbone, and Maliene 2013). However, the success of such methods may be hindered by their increased complexity, requiring data and processing times that may be unavailable or cost prohibitive. Furthermore, most of the research on housing affordability fails to include a spatial component, such as a spatial analysis of where and possibly why housing affordability is a problem. The motivation for the spatial analysis conducted in this thesis project was to design a process to identify and display geographic areas in the state of California where households are impacted by a select set of challenges.

1.4. Research Overview and Objectives

This thesis project entailed a multi-step process to identify areas in the state of California where households are most impacted by certain housing-related challenges. In the context of this thesis, "most impacted" is defined as being in the top quartile of a statistical dataset. The housing-related criteria that are the focus of this research were chosen as they intersect with several key aspects of life: household budgets, household size, physical conditions, and transportation (US Census Bureau 2018, US Department of Housing and Urban Development 2020). Accordingly, the specific criteria chosen were Housing-Cost Burdened households, or those paying 30 percent or more of the household's income on housing; Overcrowded households, or those with more than one person per room in the housing unit; housing units Lacking Complete Plumbing or Complete Kitchen Facilities, meaning having hot and cold water, a flush toilet and a bathtub or shower in the bathroom and having a kitchen sink with a faucet, a stove or range, and a refrigerator; and workers aged 16 or older with a Longer-Than-Average Commute Time, or 30 minutes or more each way. The focus criteria were not ranked in terms of

relative importance but rather were considered as individual factors and then combined to identify areas experiencing one, two, three, or all four housing-related challenges.

The Census and HUD data were imported into Esri's ArcGIS Pro version 2.8.0 and mapped to identify those areas where the top quartile of Census tracts experienced each of the four challenges (US Census Bureau 2018, US Department of Housing and Urban Development 2020). The primary objective of this project was to conduct a spatial analysis that could answer these key research questions:

- Are there any areas of the state plagued by all four housing difficulties?
- In what areas of the state are residents the most beleaguered by these challenges?
- Do metropolitan areas experience more housing difficulties?

1.5. Thesis Structure

The remaining chapters contain additional, detailed information regarding the motivation for this thesis project and about how the research questions were approached and the spatial analysis was carried out.

Chapter 2, Related Literature, summarizes the history of housing and affordable housing in the US. Unfortunately, efforts to achieve longstanding goals of affordable and attainable housing for all Americans have fallen short, so there is now several decades' worth of empirical literature related to unaffordable housing and its consequences. The definition of housing affordability is also discussed, as the term is used with great frequency but with little consensus across professional fields.

Chapter 3, Methods, provides an outline of the steps taken to format the Census and HUD data and spatially analyze the housing-related challenges. The key housing difficulties were identified, and data sources of appropriate vintages were selected. Each tabular dataset was

filtered, formatted, and mapped individually before combining the four datasets and mapping the results to produce both statewide maps and urban and non-urban local or focus-area maps.

Chapter 4, Results, describes the results of the spatial analysis. Maps and tables provide detail on the housing difficulties, both statewide and in select, local focus areas determined to be the most impacted by the phenomena.

Chapter 5, Discussion and Conclusion, includes an extensive discussion of the study's findings and potential implications. Challenges and flaws encountered in the study are explained in detail to the best of the author's knowledge, possible solutions to the housing challenges are discussed, and suggestions for future studies are outlined.

Chapter 2 Related Literature

The availability, condition, and affordability of housing have real implications for society in terms of public health, economic activity, and social equity. This chapter examines the origins of housing discussions, explains the concept of housing affordability (and unaffordability) and the lack of consensus on definitions, presents a modern way of incorporating related affordability criteria into a spatial analysis, and summarizes the various analytical methods available.

2.1. The Effect of Housing Unaffordability

In 1948, the United Nations declared housing to be a human right. The US Housing Act of 1949 aspired to make decent housing available to every American. However, currently, no state in the US has sufficient residential units to house its extremely low-income residents who earn just 30 percent of the area median income (AMI) (Aurand et al. 2020). The State of California in particular has a shortage of nearly one million housing units for such households.

It is not only the lowest income categories that experience the adverse effects of HAS, which are widespread and can be manifested in ways that may not be initially or intuitively obvious. Housing affordability is often conceptualized as a combination of two binary factors: first, whether a household has a permanent place to live, and second, if the cost of the household's housing exceeds a certain (arbitrary) percentage of income. The demand for housing is one of the most basic requirements in Maslow's (1943) hierarchy of needs, but of course, not all housing is comparable in quality, location or amenities. Rather than face homelessness, many households will accept poor quality housing if higher quality housing is unattainable or in insufficient supply. Therefore, substandard housing can actually be a byproduct of housing unaffordability (Stone 2006). Moreover, poor quality housing can negatively affect public health, both directly and indirectly. For example, exposure to pests and lead-based paint can degrade

residents' health, and paying too much for unaffordable housing leaves too little for other essential costs like adequate healthcare (Freeman 2002).

Unfortunately, certain segments of the population may experience HAS more acutely than other groups. Children, in particular, are at increased risk of physical and mental health impacts, such as illness, child abuse, and developmental delays, when they and their families experience unaffordable housing and "hypermobility," defined as moving more than five times during childhood (Crowley 2003). Ethnographer Matthew Desmond chronicled his studies of the plight of evicted families in the city of Milwaukee, Wisconsin, and he pointed out that in 2011, 75 percent of those in the city's eviction court were black, of which 75 percent were women (Desmond 2016).

On a broader societal level, disproportionately high housing payments leave little, if anything, for the accumulation of savings and eventual achievement of the idealized American Dream of homeownership. This is unfortunate, as it turns out that parental housing tenure influences the eventual outcomes of children in terms of education, wealth accumulation, and homeownership. Parental homeownership is an important advantage for all three measures and is a key source of intergenerational wealth accumulation (Boehm and Schlottman 2001) and therefore a component of social equity. Clearly then, programs to promote secure housing and to minimize HAS are key for a stable, prosperous society.

Fortunately, there are existing programs and mechanisms that aim to address some of these housing issues. Starting with the US Housing Act of 1937, the federal government began providing loans and grants to local housing agencies for subsidized public housing. Shortly thereafter, and the Housing Act of 1949 expanded funding to clear slums and promote urban redevelopment (US Department of Housing and Urban Development 2014b). Further federal

legislation in subsequent decades provided housing for veterans and college families; authorized rent-control provisions and relocation assistance payments; insured housing mortgages; and outlawed housing discrimination. In recent years, state governments have exercised their power to intervene in housing matters as well. For example, the State of California has passed several laws with comprehensive approaches to transportation and housing problems. In 2008, Senate Bill 375 was passed as the Sustainable Communities and Climate Protection Program in an attempt to curtail air pollution and climate change through coordinated planning of transportation, housing, and land use (California Air Resources Board 2021). At the local level, counties and municipal governments have the ability to allow or require price- and rent-restricted housing in their jurisdictions. Throughout California, jurisdictions have enacted inclusionary-housing programs that require a certain percentage of new housing developments be offered at prices and rents affordable to certain lower-income categories (Calavita and Grimes 1998). Additional efforts and increased funding should be considered at all levels, which is discussed further in Chapter 5, Discussion and Conclusions.

2.2. Defining Housing Unaffordability

Any study of the affordability of housing must begin with a clear and concise definition of affordability, as the term is oft used but ill defined. Although the use of the term is problematic, the phrase "housing affordability" is applied regularly in at least six different contexts, among them: the description of household expenditures, analysis of trends, administration of housing subsidy programs, definition of housing need, prediction of a household's ability to pay, and selection criteria for renters or buyers (Hulchanski 1995). Hulchanski (1995) ultimately recommends avoiding the use of the term "housing affordability," although his 1995 seminal article is cited frequently by housing researchers since its publication.

Not only is the terminology of affordability problematic, but the underlying concept of affordable housing is also ambiguous. Market-rate housing that consumes some reasonable portion of a household's income should be distinguished from price-restricted, below-market housing. A 30-percent HEI ratio is commonly used to set maximum rent amounts for price-restricted housing and as a proverbial rule of thumb of affordability by housing professionals and lenders. A critique of the HEI ratio method, however, is that it is arbitrary, representing either a "normative standard" or an empirically observed value but not necessarily an appropriate cost (Stone 2006). Nor does the HEI ratio encompass the fact that particular households may have "diverse and incompatible definitions of affordability" for their budgets.

2.3. Difficulties Related to Housing Affordability

Given the complexity of issues related to housing affordability and the drawbacks of the 30-percent HEI ratio, there is the opportunity for new methods of evaluating the affordability of housing by area. Housing professionals and researchers are concerned with affordability, especially given that nearly a third of all Americans spend more than 30 percent of their income on housing (Veal and Spader 2018). More than 40 percent of Californians are similarly Housing-Cost Burdened (Buyahar and Cannon 2019). The incorporation of a broader range of criteria improves the accuracy of any measure of affordability, making it more reflective of the true conditions experienced by households.

Several recent attempts have been made to improve the assessment of affordability by accounting for a variety of household costs. The Center for Neighborhood Technology and the Center for Transit Oriented Development developed an alternative affordability index, incorporating not only the direct costs of housing but also transportation, commute, and associated opportunity costs as a share of household income, to approximate the effects of

residential location (Jewkes and Delgadillo 2010). Interestingly, while developing their affordability index, the authors found in Minneapolis, Minnesota, that a commute distance longer than 12-15 miles resulted in an increase in transportation costs that usually negated the savings on housing costs. In California, the statewide average travel time to work for workers aged 16 or older is 30 minutes (US Census Bureau 2018).

Relatedly, a new conceptualization of affordability is sustainable housing affordability, bringing together the concepts of housing affordability, social well-being, and sustainable communities (Mulliner and Maliene 2015). Mulliner and Maliene (2015) proposed a set of 20 distinct criteria of sustainable housing affordability and surveyed 600 housing professionals in the United Kingdom to determine the relative importance of the criteria. In order of importance, the ranked criteria included: (1) housing prices in relation to income; (2) rental costs in relation to income; (3) interest rates and mortgage availability; (4) availability of rented accommodation (private and social); (5) quality of housing; (6) access to employment; (7) energy efficiency of housing; (8) availability of low-cost home ownership products; (9) access to good quality schools; (10) access to public transport; (11) access to health services; (12) availability of market value home ownership products; (13) access to early-years child care; (14) access to shopping facilities; (15) safety (crime); (16) low presence of environmental problems; (17) deprivation in area; (18) access to open green public space; (19) waste management; and (20) access to leisure facilities.

Naturally, though, a more complex index also means a more complicated one, with a greater number of datasets, longer processing times, and more opportunity for error. This may prove cost- (or time-) prohibitive for many housing professionals, which therefore would be a

barrier to adoption of such a new calculation methodology. A more manageable but nevertheless expanded subset of criteria may be warranted.

2.4. Spatial Analyses of Housing Difficulties

There are many ways to define and assess the affordability of housing. A recent study cataloged different approaches to the measurement of housing affordability and, for each method, described the weaknesses that should be considered prior to use in future research (Ezennia and Hoskara 2019). One method, the Multi-Criteria Decision Making (MCDM) approach, which combines multiple factors into one index for analysis, was found to be beneficial and the best choice for complex decision making. MCDM allows for incorporation of many criteria with different units of measure; however, it was also noted that applying MCDM can be time-consuming and that different MCDM approaches can produce different results.

While MCDM methods are useful, this concerning critique of the process—that different MCDM methods sometimes yield different results for the same analytical subject—means that selection of the particular methodology is critically important. Therefore, Mulliner, Malys, and Maliene (2016) did a comparative analysis of six MCDM methods: the weighted product model, the weighted sum model, the revised analytic hierarchy process, the technique for order of preference by similarity to ideal solution, and the complex proportional assessment method (COPRAS). Ultimately, the recommendation was to use more than one method whenever possible in order to make more informed decisions. Of the six approaches studied, the COPRAS method was selected by Mulliner, Malys, and Maliene (2016) as the best combination of consistency, transparency, low processing time, and ease of use.

An important aim of this thesis project is to implement a multifactor review of the geographic distribution of housing-related challenges as a measure of HAS. Relatively few

studies of housing affordability have incorporated spatial analysis. One study focused on the concept of HAS and the relationship between housing costs and income levels within and between major Canadian cities pointed out that "[m]ost existing research dealing with housing affordability issues remains aspatial and does not indicate where the greatest affordability problems can be expected to be" (Bunting, Walks and Filion 2004). This thesis proposes a relatively simple—and therefore easily replicable—multifactor methodology for incorporating a spatial component into discussions of housing affordability.

Observation of any unevenness in the distribution of housing challenges could add dimension to existing data on poverty. Also, information on HAS may provide insights of value to land-use planners, housing professionals, and residents.

2.5. Housing Datasets

Reliable data is key to accurate assessments of housing affordability. There are several types of Census and survey data gathered by the US Census Bureau, which in turn provide high-quality housing-related datasets.

The decennial census is a requirement of the US Constitution, and it has collected data on the population of the nation since 1790 (US Census Bureau 2002). What began as a simple count of population steadily grew to include a longer form with a range of questions covering demographics, income, housing, employment, transportation, race/ethnicity, and more, until the long form was replaced by two separate innovations: the American Community Survey (ACS) in 2005 and the Census short form in 2010. Whereas the decennial census is conducted every 10 years and provides population counts (which then determine congressional representation), the ACS is conducted every month of every year and provides annual estimates of many more topics. ACS data is available in 5-Year Estimates and 1-Year Estimates. The 1-Year Estimates

are more current than the 5-Year Estimates but offer lower statistical certainty of estimates. In addition, small cities and geographic units, such as Census tracts, are not included in the 1-Year Estimates, so the 5-Year Estimates must be used when a count of complete estimates is needed for areas at the Census tract level.

Overall, the Census tract is an exceedingly useful geographic entity. Census tracts are small geographic units, containing roughly 2,500 to 8,000 residents, within a larger county area (US Census Bureau n.d.). Census tract boundaries are set by visible, logical features, and they do not often change, only when major changes in the demographic or economic makeup of the area occur and only during the decennial Census. It is worth noting that the geographic area of a Census tract is inversely proportional to its resident population size—the higher the population in an area, the smaller the Census tract. In dense urban areas, Census tracts are relatively small and numerous.

Every year, ACS 5-Year Estimates data is provided by HUD in the form of custom tabulations, known as the Comprehensive Housing Affordability Strategy (CHAS) data (US Department of Housing and Urban Development 2021a). The additional processing time required to prepare the CHAS data for public release means that the most recent dataset is several years behind the current ACS estimates. This data is valuable for government and housing professionals as it provides information on existing housing problems across all income levels but especially at Low-Income levels. The CHAS data are used by HUD to inform the distribution of grant funds, and local governments use it to identify need and plan the expenditure of HUD funds. HUD relies on CHAS and other Census data regarding housing-related issues to determine need and allocate funding to jurisdictions nationwide. For example, funds under HUD's HOME Investment Partnerships Program (HOME Program) are distributed to those areas experiencing

(1) insufficient housing stock, (2) substandard housing, (3) low-income households in units that are likely to need rehabilitation, (4) local costs of producing new housing, (5) poverty rates, and (6) relative fiscal difficulty of carrying out housing activities (US Department of Housing and Urban Development n.d.). Similarly, the federal Community Development Block Grant Program (CDBG Program) funds are allocated based on a jurisdiction's population as well as the slowing of its population growth since 1960, the number of residents living in poverty, the incidence of overcrowded housing, and the number of housing units built before 1940 (US Department of Housing and Urban Development 2012).

Consequently, a subset of housing challenges was selected for this project; namely, Housing-Cost Burdened households, or those paying 30 percent or more of the household's gross income on housing expenses, which includes rent or mortgage and utilities; Overcrowded households, or those with more than one person per room in the housing unit; housing units Lacking Complete Plumbing or Complete Kitchen Facilities, meaning having hot and cold water, a flush toilet and a bathtub or shower in the bathroom and having a kitchen sink with a faucet, a stove or range, and a refrigerator; and workers aged 16 or older with a Longer-Than-Average Commute Time for California, or 30 minutes or more each way. The 2013-2017 5-Year Estimates of CHAS and ACS data were obtained as the most current dataset available.

Chapter 3 Methods

As a review of the associated literature reveals, the subject of the affordability of housing has been discussed at length. Housing affordability can be assessed in a number of different ways, each of which has its strengths and weaknesses. Applying a geographic component to the study of HAS for households in California provides an additional facet to a housing-affordability analysis. For this study, a set of housing-affordability criteria were selected, which then guided the collection of relevant data, specifically the Census ACS and HUD CHAS 2013-2017 5-Year Estimates. The attribute tables of each variable were considered and filtered separately before being imported into ArcGIS Pro for mapping and spatial analysis of individual and combined housing challenges. Finally, the resulting maps were reviewed, compared with income maps and other pertinent datasets, and analyzed for potential insights.

3.1. Initial Planning and Selection of Housing Difficulties

Data-driven information and analytical methods regarding the incidence of housing-related challenges can provide valuable insights to housing professionals, such as the administrators of subsidized housing programs, developers of nonprofit housing, and legislators who fund housing grant programs. A reliable and replicable methodology could supplement the often critiqued but widely applied HEI ratio method if a mix of housing-related criteria is chosen so that the methodology fits the needs and budgetary constraints of the housing industry. In the United Kingdom, Mulliner and Maliene (2015) proposed a set of 20 economic, social and environmental criteria for assessing a concept they referred to as sustainable housing affordability, which brings together the ideas of sustainable communities and housing affordability. This thesis project considered a subset of criteria similar to Mulliner and Maliene's, namely: (1) housing costs in relation to income (Housing-Cost Burden); (2) an aspect

of household size (Overcrowding); (3) a physical housing problem (as represented by the Lack of Complete Plumbing or Kitchen Facilities in a unit); and (4) a Longer-Than-Average Commute Time (longer than the statewide average of 30 minutes).

3.2. Housing Data

The datasets for each of the housing-related challenges and demographic characteristics were acquired (see Table 1). Information on four housing-related challenges, Housing-Cost Burdened households, Overcrowded households, housing units either Lacking Complete Plumbing or Complete Kitchen Facilities, was obtained from HUD's Consolidated Planning Comprehensive Housing Affordability Strategy (CHAS), which is a further refinement of the US Census Bureau's American Community Survey (ACS) 5-Year Estimates data. To create the

Table 1. Data Sources for the Four Housing-Related Challenges

Information/ Criteria	Source	Geographic Scale	Year
Housing Cost-Burdened Households	HUD CHAS – Census ACS 5-Year Estimates Table 3	Census tract	2013-2017
Overcrowded Households	HUD CHAS – Census ACS 5-Year Estimates Table 3	Census tract	2013-2017
Occupied Housing Units Lacking Complete Plumbing or Complete Kitchen Facilities	HUD CHAS – Census ACS 5-Year Estimates Table 3	Census tract	2013-2017
Travel Time to Work	Census ACS 5-Year Estimates Table B08303	Census tract	2013-2017
Census data polygons	Census TIGER/Line shapefiles	Census-designated place, Census tract, water polygons	Most recent
Jurisdictional boundaries	California State Geoportal	State, County, City, Census Designated Place	Most recent

CHAS data, HUD creates customized tabulations of ACS data from the US Census Bureau. As a result of the additional processing time, the most recent, available CHAS dataset is several years behind the most current ACS dataset. At the time of this writing, the latest available version of the CHAS data was the 2013-2017 5-Year Estimates dataset. The 2013-2017 ACS 5-Year Estimates of Travel Time to Work were utilized for commute times and to ensure consistency with the CHAS data.

An important consideration in any analysis is the selection of an appropriate scale, and Census data is available in a range of geographic units (see Figure 3). The Census block or block group can be unavailable for specific subjects or, if available, can be too small area-wise, making the data difficult to display or interpret, while the County level would likely be too large to the

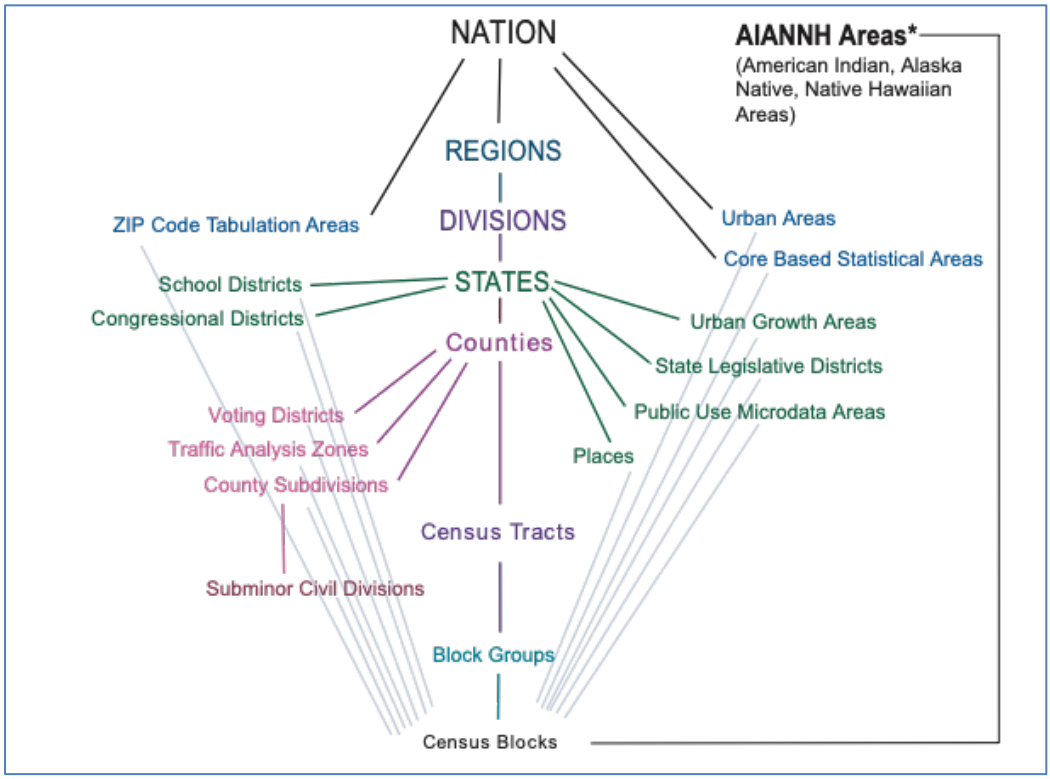

Figure 3. Standard Hierarchy of Census Geographic Entities (Source: US Census Bureau 2017)

point of obscuring any valuable insights to be gained from this spatial analysis. Therefore, the Census tract was determined to be the ideal areal unit for spatial analysis of housing issues. Census tracts are available for all locations and represent a fine enough resolution, meaning the most appropriate map scale, to be informative.

3.3. Individual Housing Difficulties

Once all the relevant data for the criteria were obtained, the data tables were reformatted, and the criteria summed, as explained in detail in the next section of this chapter. Each dataset contained more information than was needed for this thesis, so the data fields for each criterion were reviewed for inclusion or exclusion, e.g., travel times to work of less than 30 minutes were excluded.

The dataset for each housing-related challenge required unique, customized summation and calculations. For the proportions of housing units that were Housing-Cost Burdened, Overcrowded or Lacking Complete Plumbing or Complete Kitchen Facilities, data came from HUD CHAS – Census ACS 2013-2017 5-Year Estimates Table 3, whereas Longer-Than-Average Commute Times were calculated from the US Census ACS 2013-2017 5-Year Estimates Table B08303.

The US Census Bureau defines Housing-Cost Burden as paying more than 30 percent of gross income toward housing expenses. The percentage of Housing-Cost Burdened households was calculated using Equation 1, where R is renter-occupied, and O is owner-occupied housing units with housing expenses greater than 30 percent of income but less than or equal to 50 percent, and those with housing expenses greater than 50 percent, and T is the total number of occupied housing units.

$$\left(\frac{R_{30-50\%} + R_{50\%+} + O_{30-50\%} + O_{50\%+}}{T}\right) \times 100 \quad (1)$$

Overcrowding is defined by the Census Bureau as more than 1.0 person per room (US Census Bureau 2021a). Accordingly, Overcrowded households were tallied using Equation 2, where *R* is the number of renter-occupied housing units and *O* is the number of owner-occupied housing units with more than 1.0 person but less than or equal to 1.5 persons per room, and those with more than 1.5 persons per room, and *T* is the total number of occupied housing units.

$$\left(\frac{R_{1.0-1.5} + R_{1.5+} + O_{1.0-1.5} + O_{1.5+}}{T}\right) \times 100 \quad (2)$$

Likewise, the percentage of housing units Lacking Complete Plumbing or Complete Kitchen Facilities was calculated using Equation 3, where *R* is the number of renter-occupied housing units and *O* is the number of owner-occupied housing units lacking either complete plumbing or kitchen facilities, and *T* is the total number of occupied housing units.

$$\left(\frac{R_P + O_P}{T}\right) \times 100 \quad (3)$$

Finally, a one-way commute time of 30 minutes or more was classified as a Longer-Than-Average Commute Time for this study because the average travel time to work in California is 30 minutes (US Census Bureau 2017). Using Equation 4, Longer-Than-Average Commute Time was calculated, where *M* is the share of workers whose travel time to work was 30 to 34, 35 to 39, 40 to 44, 45 to 59, 60 to 89, and 90 or more minutes and *W* is the total number

of workers. In this case, workers were defined as workers aged 16 and over who did not work from home, including members of the Armed Forces and civilians who were at work the week of the survey.

$$\left(\frac{M_{30-34} + M_{35-39} + M_{40-44} + M_{45-59} + M_{60-89} + M_{90+}}{W}\right) \times 100 \qquad (4)$$

3.4. Classification of the Data

The four housing-related challenges that are the focus of this research undoubtedly share a common theme in that they are related to and have an impact upon housing and affordability; they differ, however, in an important way: how the data are distributed statistically. As the frequency distribution charts (Figure 4 to Figure 7) illustrate, some of the housing-related challenge datasets are normally distributed or symmetrical about the mean, which indicates that data near the mean occur more frequently than data far from the mean. Other datasets are distinctly not normally distributed.

Given the variation in data distribution among the four housing-related challenge datasets, it was necessary to classify the data for mapping in a way that would minimize false comparisons or "comparing apples to oranges." Each dataset was classified into quartiles, which divides the number of features into four classes to obtain an average, and finally counts the quantity in each group and arranges them as close to the average as possible. In this manner, it was possible to correlate the top quartile for each housing-related criteria with the areas most impacted by the particular phenomenon, and map the data for visual spatial analysis.

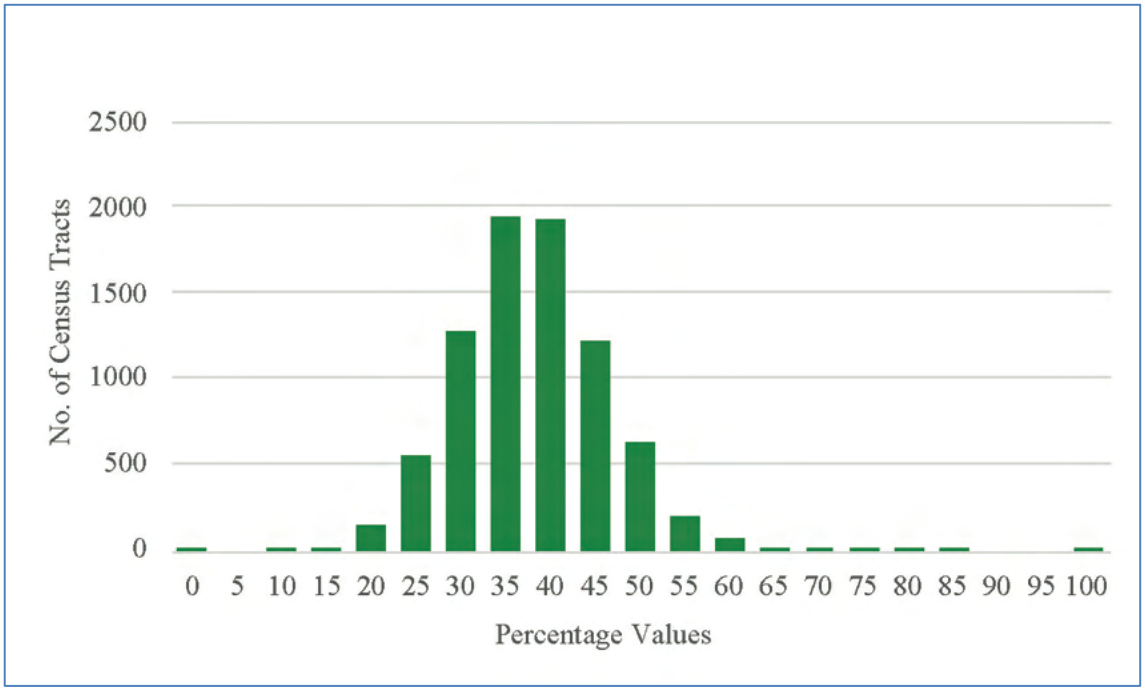

Figure 4. Data Distribution: Percent of Housing-Cost Burdened Households

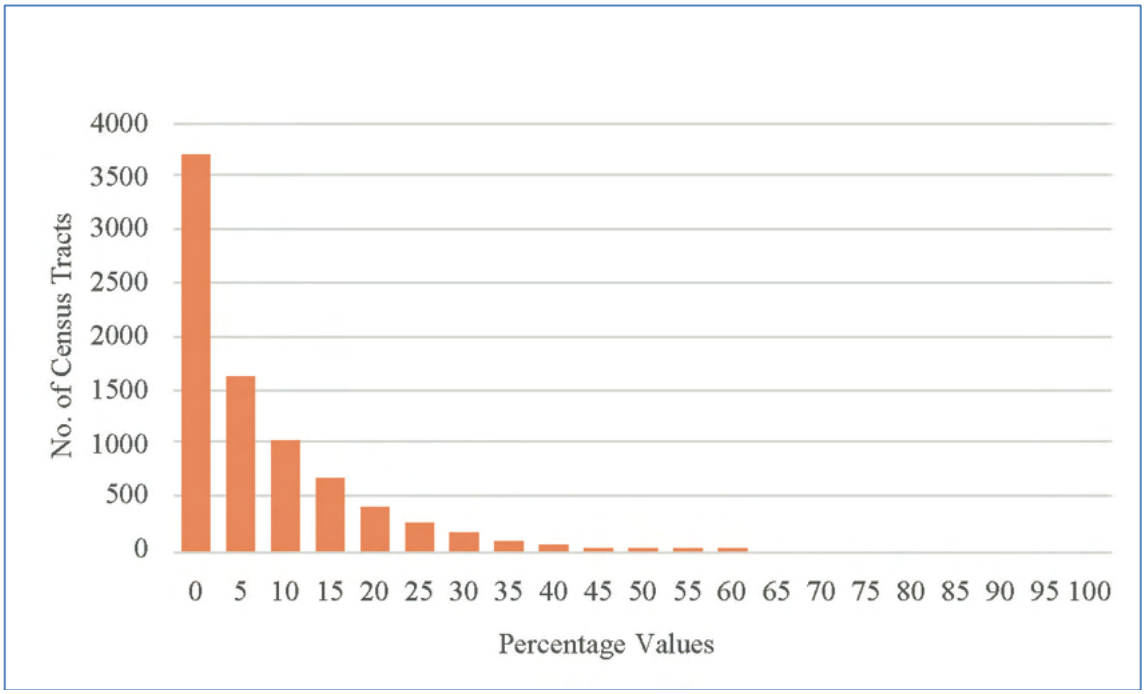

Figure 5. Data Distribution: Percent of Overcrowded Households

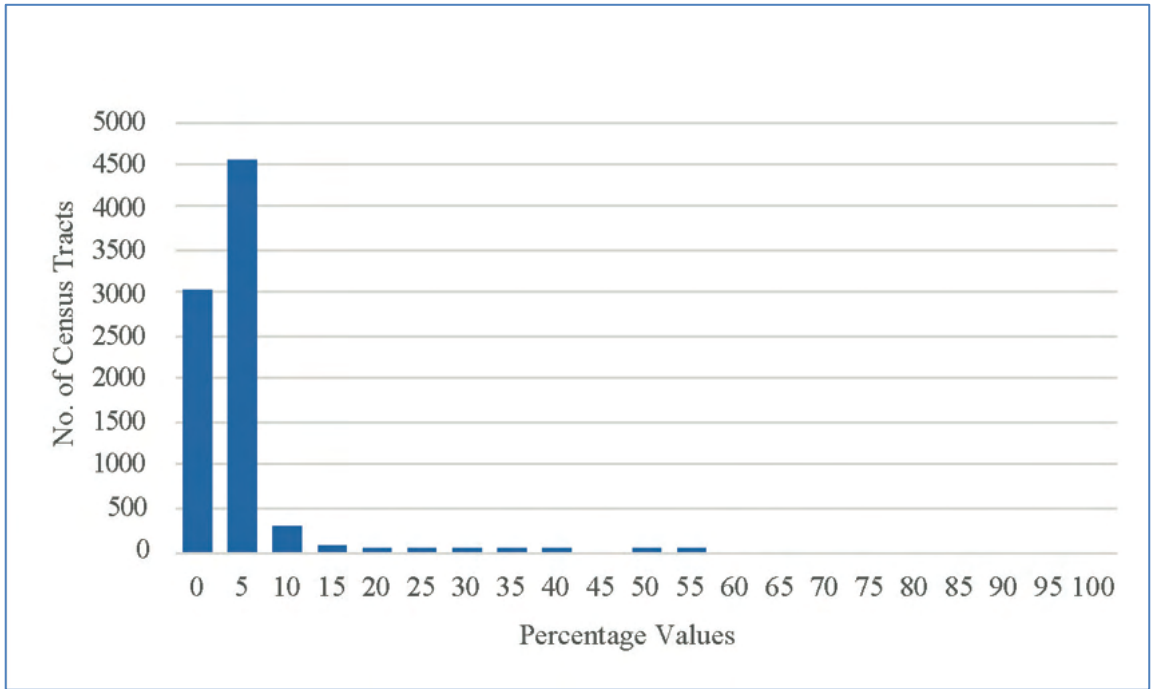

Figure 6. Data Distribution: Percent of Units with Lack of Plumbing

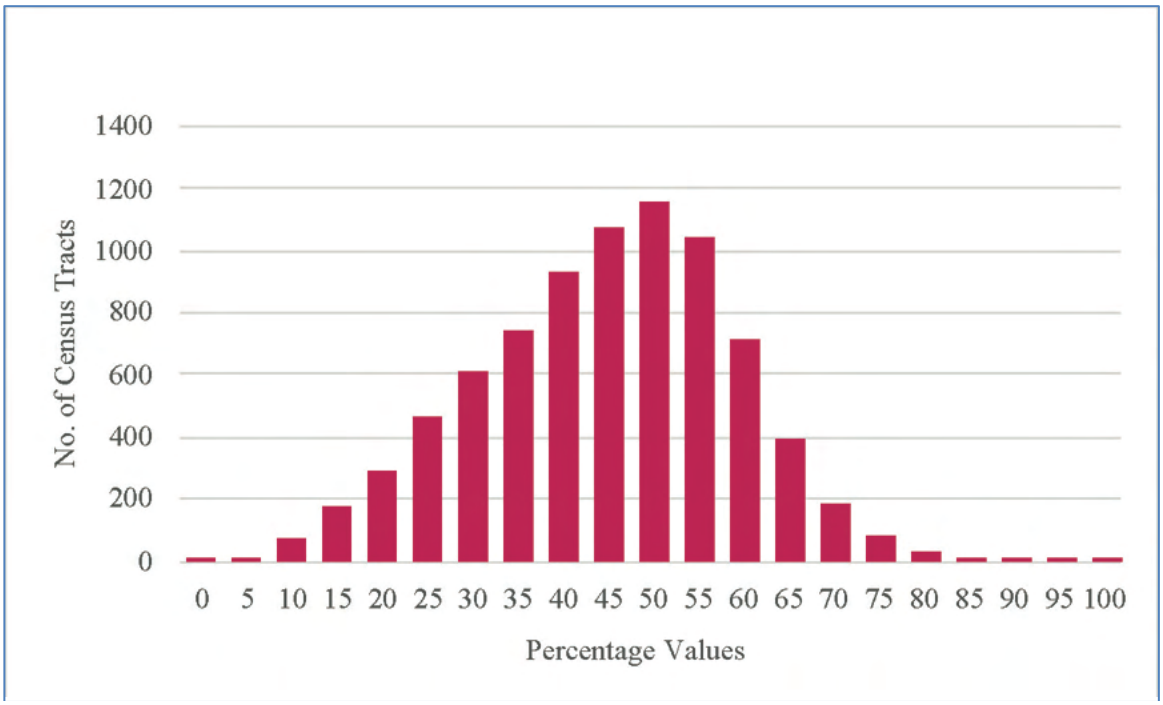

Figure 7. Data Distribution: Percent of Workers with Long Commute

It is worth noting that while this method results in a more evenly distributed grouping of the data, the absolute values within each class may vary considerably from the lowest value to the highest value in the class. Nevertheless, this method of analysis makes it possible to evaluate the classes that are impacted by the selected housing-related challenges as a comparison of greater or lesser negative impacts and also allows for comparison among classes and between the different criteria.

To map the data, geographic information system (GIS) feature layers for the geographic boundaries of Census tracts and counties were added to an Esri Geodatabase then mapped in ArcGIS Pro using a geographic projection for the State of California. The individual housing-criteria datasets were imported into the Geodatabase as well, then joined with the Census-tract polygon features. The symbology of the resulting feature sets was modified to classify the percentage data into quartiles. The top quartile of each criterion was first displayed independently on a statewide-level map before reviewing overlap among the different criteria.

3.5. Combined Housing Difficulties

The aim of this study was not only to find the regions and local areas in California most impacted by one of the four selected housing-related challenges but to identify those areas experiencing two, three, or all four challenges, which ostensibly compounds the difficulties experienced by households. The top quartiles of each challenge were successively combined into multiple individual maps, as illustrated in Figure 8.

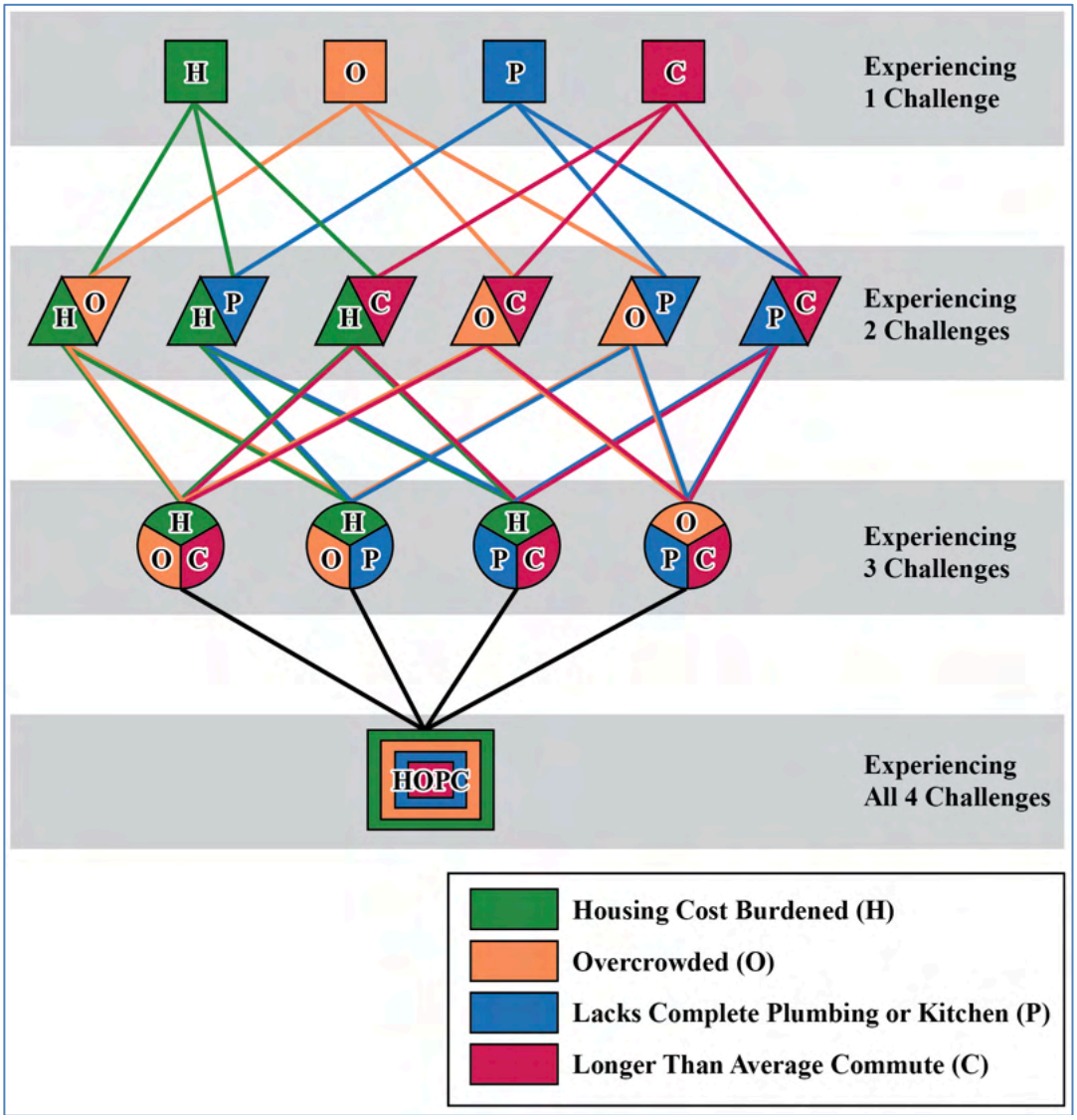

Figure 8. Relationship Diagram of Maps Showing Combined Housing-Related Challenges

GIS provides an optimal method for accomplishing this type of spatial analysis. After reviewing the individual datasets for each housing challenge and joining them in ArcGIS, SQL-syntax queries of the tables yielded those Census tracts affected by two, three, and four of the top quartiles of each factor. The SQL query to select the Census tracts affected by all four housing challenges is shown in Figure 9. Statewide maps showing the spatial distribution of those results

were created, depicting one, two, three and four criteria combined, as well as focus-area maps to provide a detailed view of the affected areas, particularly in dense urban areas.

```
CostBurdened.Percent_costburdened > 40.5 AND
    Overcrowded.Percent_overcrowded > 13.1 AND
        Plumbing.Percent_lacksplumbing > 2.1 AND
            Commute.Percent_commute30ormore > 52.1
```

Figure 9. Sample SQL Query for Top Quartiles of Housing-Related Challenges

3.6. Focus Studies

In addition to the single and combined housing-related challenges at a statewide level and in the most impacted areas, several focus areas and topics were chosen for closer analysis based on characteristics that are often associated with housing challenges (California Department of Housing and Community Development 2021b). These focus areas and topics included:

- A comparison of Overcrowding in urban versus rural counties
- A review of areas most impacted by four housing challenges in relation to income
- A comparison between Housing-Cost Burden and Low-Income households

The next chapter, Chapter 4, presents the outputs of these spatial analyses. Chapter 5 follows with a discussion of the results in the context of steps that may be taken to alleviate the impacts of the housing-related challenges investigated in this study.

Chapter 4 Results

The application of the research methods described in Chapter 3 of this thesis resulted in 15 maps displaying various combinations of the four housing-related challenges. Overall, it was observed that for each map where the number of challenges depicted increased, the number of Census tracts negatively impacted by the housing-related challenges decreased.

4.1. Individual Housing Difficulties

As outlined previously, a map was created to display each of the four individual housing challenges, each with a symbol corresponding to the housing-related challenge or combination of challenges shown in Figure 8. Each map reveals the areas that, in relation to the rest of the state, are most impacted by each housing challenge.

The maps cover the range of housing-related challenges examined in this thesis and exhibit the uneven distribution of these issues throughout the state. For Housing-Cost Burdened households, Figure 10 shows the Census tracts where 40.5 to 96.0 percent of all occupied housing units reported spending more than 30 percent of their gross income on housing expenses. The areas most impacted by Overcrowding, depicted in Figure 11, are those Census tracts with 13.1 to 65.0 percent of total occupied housing units inhabited by more than 1.0 person per room. For Lack of Complete Plumbing or Complete Kitchen Facilities, Figure 12 displays those Census tracts where 2.1 to 52.3 percent of renter- and owner-occupied housing units were lacking either complete plumbing facilities or complete kitchen facilities. Finally, Figure 13 shows the Census tracts throughout the state where 52.1 to 100 percent of all workers aged 16 years of age or older reported a one-way commute of 30 minutes or more, representing a Longer-Than-Average Commute Time.

Figure 10. Top Quartile of Census Tracts with Housing-Cost Burdened Households

Figure 11. Top Quartile of Census Tracts with Overcrowded Households

Figure 12. Top Quartile of Census Tracts with Units with Lack of Plumbing

Figure 13. Top Quartile of Census Tracts with Workers with Long Commute

4.2. Two Housing Difficulties

The next step in the analytical process was to combine the data to reveal the areas impacted by two housing-related difficulties. With four challenges, there are six possible ways in which Census tracts could be affected. Figure 14 shows areas that experienced a combination of Housing-Cost Burden and Overcrowding. Figure 15 depicts areas with both Housing-Cost Burden and a Lack of Complete Plumbing or Kitchen Facilities, while Figure 16 displays areas most affected by both Housing-Cost Burden and a Longer-Than-Average Commute Time. Figure 17 and Figure 18 show those Census tracts most impacted by Overcrowding and a Longer-Than-Average Commute Time and those with the most Overcrowding and a Lack of Complete Plumbing or Kitchen Facilities, respectively. Finally, areas experiencing the most Lack of Complete Plumbing or Kitchen Facilities and a Longer-Than-Average Commute Time are displayed in Figure 19.

4.3. Three Housing Difficulties

The next analytical step of reviewing the areas impacted simultaneously by three housing difficulties resulted in four maps. Because the number of Census tracts affected by three of the challenges was significantly lower, zoomed-in maps of certain local areas assist with a visual investigation of those areas most negatively impacted by all three challenges. Figure 20 depicts the combination of Housing-Cost Burden, Overcrowding, and Longer-Than-Average Commute Time. Figure 21 demonstrates areas with Housing-Cost Burden, Overcrowding, and Lack of Complete Plumbing or Kitchen Facilities. Figure 22 shows Housing-Cost Burden, Lack of Complete Plumbing or Kitchen Facilities, and Longer-Than-Average Commute Time. Finally, Figure 23 shows Overcrowding, Lack of Complete Plumbing or Kitchen Facilities, and Longer-Than-Average Commute Time.

Figure 14. Areas with Most Housing-Cost Burden and Overcrowding

Figure 15. Areas with Most Housing-Cost Burden and Lack of Plumbing

Figure 16. Areas with Most Housing-Cost Burden and Long Commute

Figure 17. Areas with Most Overcrowding and Long Commute

Figure 18. Areas with Most Overcrowding and Lack of Plumbing

Figure 19. Areas with Most Lack of Plumbing and Long Commute

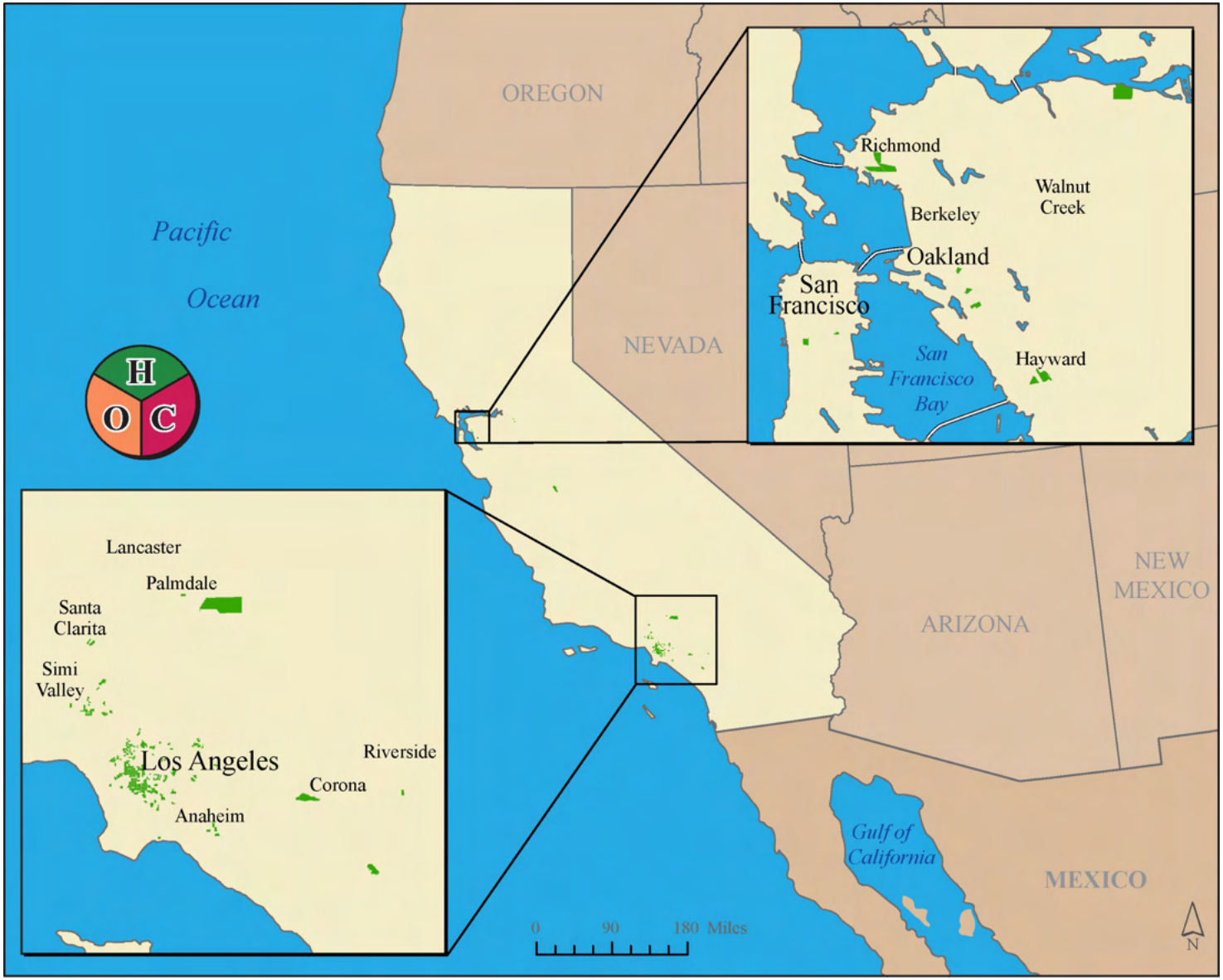

Figure 20. Areas with Most Housing-Cost Burden, Overcrowding, and Long Commute

Figure 21. Areas with Most Housing-Cost Burden, Overcrowding, and Lack of Plumbing

Figure 22. Areas with Most Housing-Cost Burden, Lack of Plumbing, and Long Commute

Figure 23. Areas with Most Overcrowding, Lack of Plumbing, and Long Commute

4.4. All Four Housing Difficulties

Finally, refining the selection criteria further to those Census tracts that experienced a combination of all four housing-related difficulties reduced the number of the most negatively impacted areas significantly. The result was a mere 65 Census tracts—out of a total of 8,057 tracts in California—throughout three urbanized areas (see Appendix A). As illustrated in Figure 24, the vast majority of impacted Census tracts were located in the Los Angeles metropolitan area, while two were identified in the greater San Francisco Bay Area and one in the downtown area of the City of Stockton.

4.5. Focus Studies

In addition to viewing the individual and combined housing-related challenges, a subset of the challenges was selected for juxtaposition with additional factors to see if further insights could be gleaned from the combined datasets at local scales. One of the apparent differences between impacted and non-impacted areas was urban status, so the spatial distribution of the most Overcrowded areas was reviewed in several urban and rural counties. In addition, the distribution of Low-Income households was assessed in the areas determined to be impacted by all four housing challenges. Finally, the correlation between income and housing costs as a portion of income was analyzed to determine if Low-Income groups are disproportionately affected or if Housing-Cost Burden seems to affect all income groups.

Figure 24. Areas Impacted by All Four Housing-Related Challenges

4.5.1. Urban vs. Rural Overcrowding

California has a mix of urban and rural areas throughout the state. To compare the occurrence of Overcrowding in different urban and rural configurations, three counties were reviewed, as shown in Figure 25. The Counties of Los Angeles and San Francisco were selected as the urban counties, and the County of Santa Barbara was selected as the rural county. In Los Angeles and Santa Barbara Counties, the most Overcrowded Census tracts were found outside of the park and national forest lands, shaded in green, and correlated to the most densely populated areas of incorporated cities. For example, see Figure 26 for a population density map where the most densely populated areas, depicted in red, resemble the areas with Overcrowding shown in Santa Barbara County in Figure 25. However, in the City and County of San Francisco, which is an urban county like Los Angeles and also infamous for its expensive housing market, Overcrowding occurs only in a few select areas in the eastern and southeastern portions of the city, with no obvious pattern.

4.5.2. All Four Housing-Related Challenges in Relation to Low-Income Areas

As one of the motivations for this thesis project was to review housing affordability, a review of the results in the context of where households have the lowest incomes is also warranted. Toward that end, Figure 27 highlights those Census tracts most negatively impacted by the top quartile of all four of the focus housing-related challenges, overlaid onto a map showing the percentage of Low-Income households by Census tract (US Department of Housing and Urban Development 2020). The Low-Income category includes all households whose incomes do not exceed 80 percent of the HUD-Adjusted Median Family Income (HAMFI). There is a strong apparent correlation between the 65 Census tracts experiencing all four housing challenges and the tracts where more than 75 percent of households are Low Income.

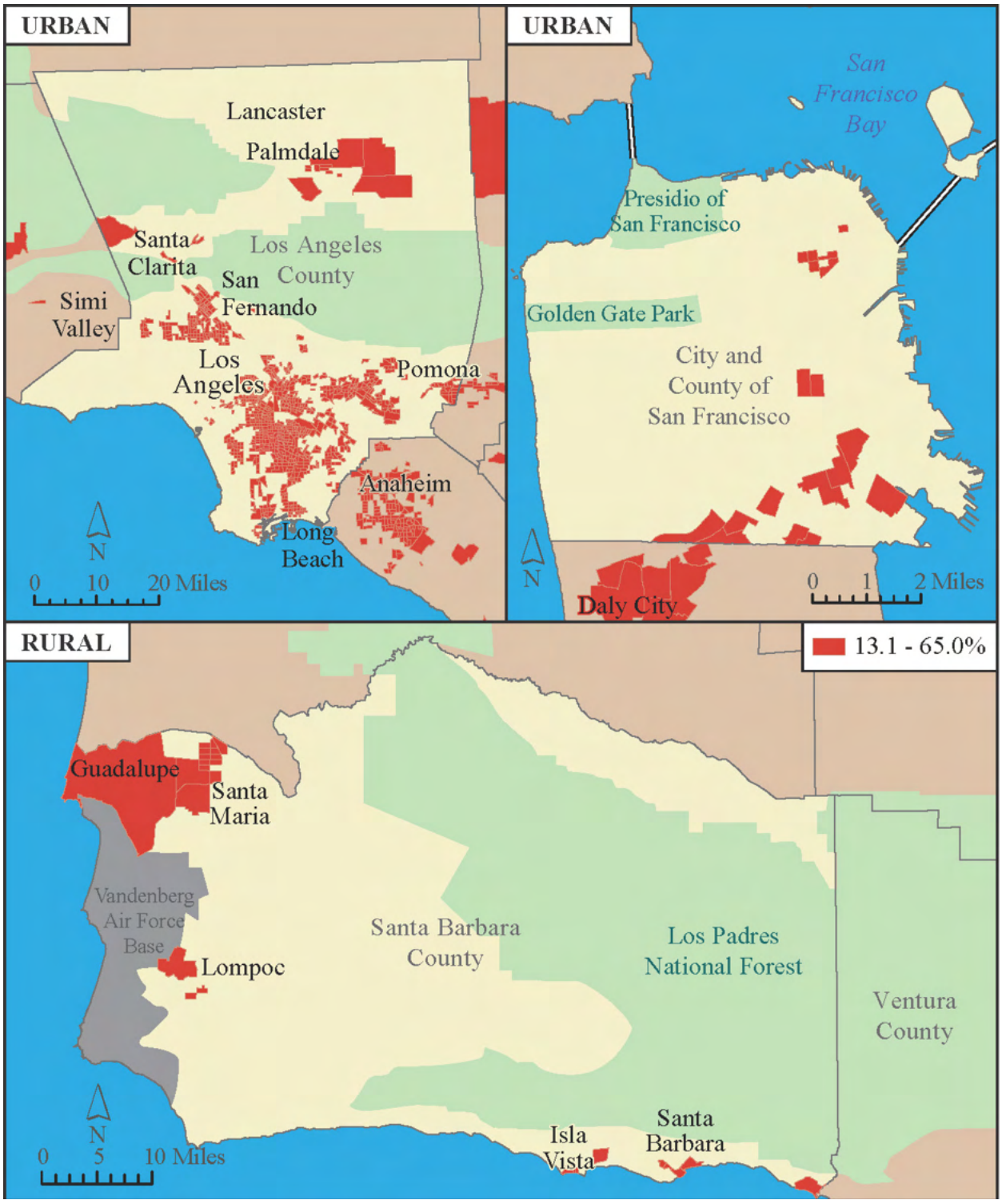

Figure 25. Overcrowding in Urban and Rural Counties

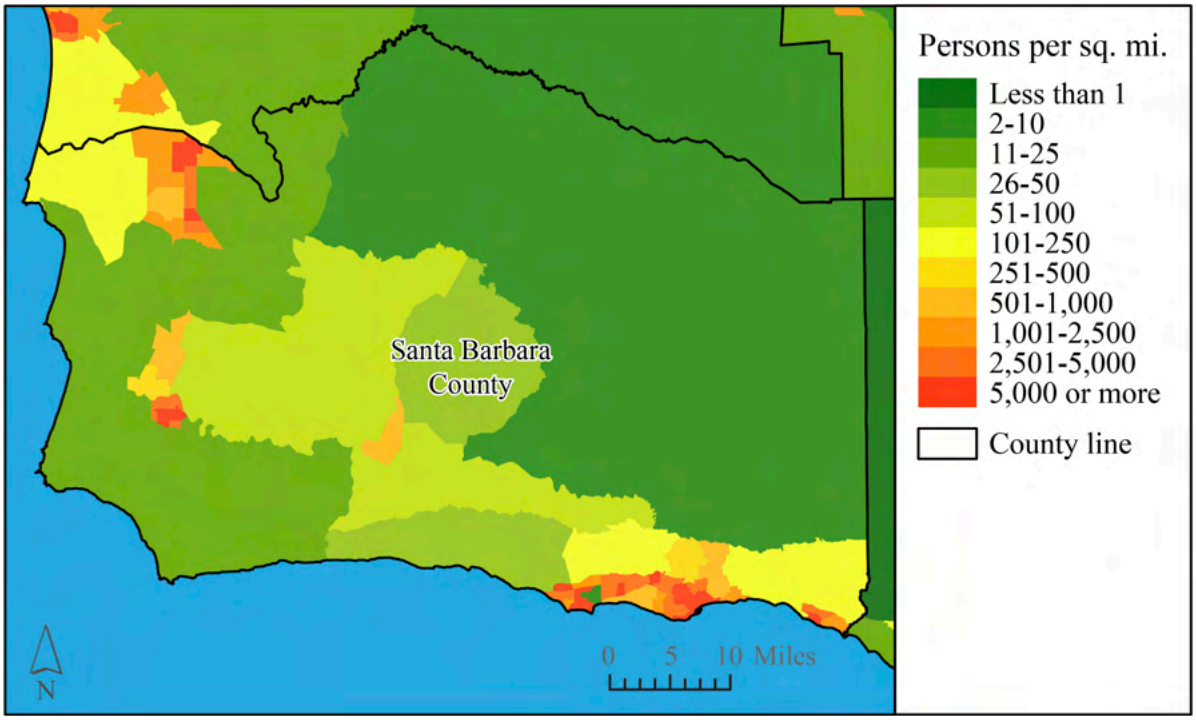

Figure 26. Santa Barbara County Population Density

4.5.3. Focus Area: A Look at Overcrowding in the City of Los Angeles

The housing problem of Overcrowding is thought-provoking because it may have human impacts beyond housing and housing affordability. Public health directives to isolate or quarantine, such as those issued during the ongoing COVID-19 pandemic, may be difficult to follow in Overcrowded residences. If not correctly recorded or accounted for, Overcrowding could obscure the need in a given housing market for more numerous or larger housing units from local jurisdictions and housing providers. Households might have preferred to lower the number of persons per bedroom by obtaining separate units if other, larger, or more affordable housing options had been available. It is also possible that large families—either those with more children than the 1.9 children that the average American family with children has (US Census Bureau 2020) or those with extended-family living arrangements—might not wish for separate housing units but rather larger units that the local housing market may not be able to provide.

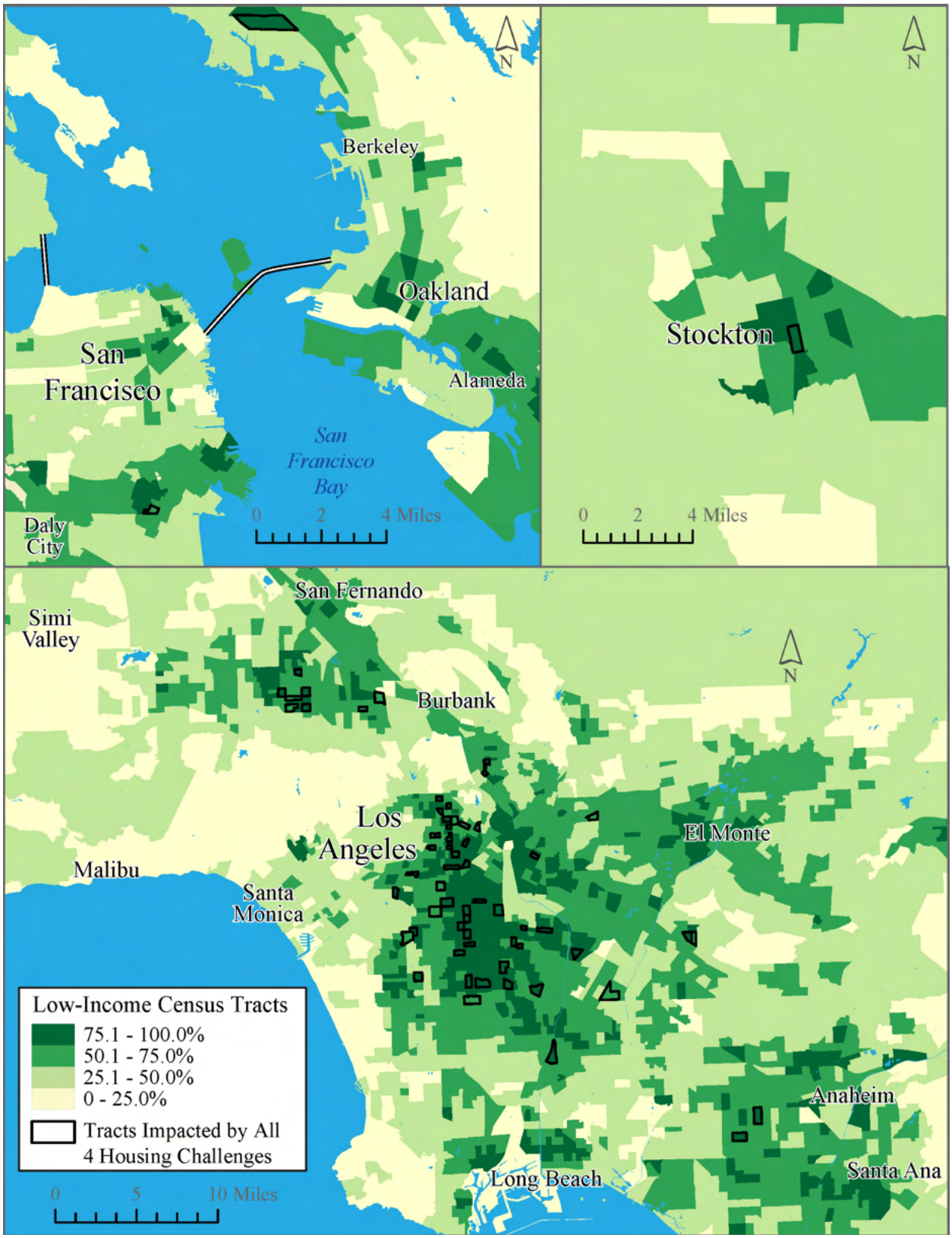

Figure 27. Census Tracts with 4 Housing Challenges and Low-Income Households

For these reasons, Overcrowding in the City of Los Angeles was juxtaposed with two different but interrelated factors: Housing-Cost Burden and (Low) Income (see Figure 28).

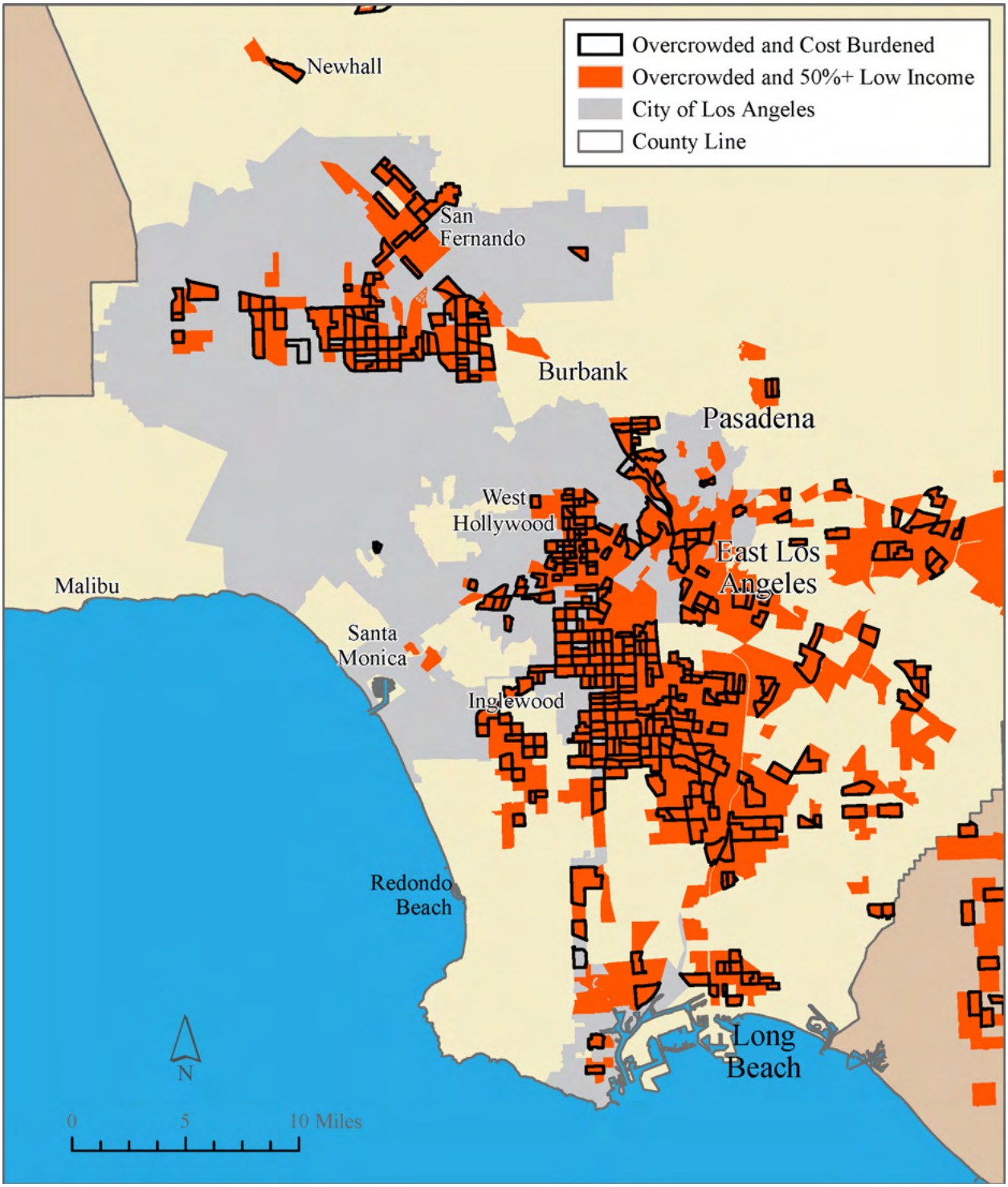

Figure 28. Los Angeles Census Tracts with Overcrowding and Low-Income Households

While it is probable that not all Housing-Cost Burden is reserved for lower-income categories nor that all Low-Income households experience Housing-Cost Burden, information may be revealed by comparing these challenges, as they relate to Overcrowding. Figure 28 shows the two most negatively affected groups: those Census tracts most impacted by Overcrowding and Housing-Cost Burden, and those where a majority of households qualify as Low Income. These maps and information demonstrate some of the housing problems currently experienced by residents in California.

The next chapter further discusses these results, in the context of existing and potential solutions, at all government bureaucratic levels, providing insights and suggestions for ways these issues might be addressed at present and in the future.

Chapter 5 Discussion and Conclusions

The intent of this project was to investigate several questions about housing affordability and challenges in the State of California. Spatial analysis proved effective in answering those questions and providing additional information that may be of interest to housing professionals.

5.1. Discussion

Displaying the results of the spatial analysis of the housing-related challenges using maps clearly illustrated the extent of housing problems throughout California and that urban areas have been most impacted by all four of the housing challenges analyzed in this study; however, not all urban areas experienced these impacts to the same degree.

5.1.1. Top Quartile Maps

When viewed individually, the first set of maps showing the geographic distribution of each housing-related challenge, Figure 10 through Figure 13, were all quite different from each other, with seemingly little overlap among them. Even in the early stages of the process, it seemed likely that areas where all of the housing problems were compounded would be somewhat limited.

5.1.2. Combination Maps

For the maps displaying two housing-related challenges, Figure 14 through Figure 19, there appeared to be a concentration of these issues in the metropolitan areas of Los Angeles and San Francisco, but there were also several notable outliers. For example, Northern California had several areas experiencing Housing-Cost Burden and Lack of Complete Plumbing or Kitchen Facilities (see Figure 15), as well as Lack of Complete Plumbing or Kitchen Facilities and Longer-Than-Average Commute Time (see Figure 19). The areas with Overcrowding and

Longer-Than-Average Commute Time, as shown in Figure 17, were again mainly in the greater Los Angeles and San Francisco areas. At the same time, Central California and a large Census tract near the southern border with Mexico were also identified as experiencing these problems. The map of Overcrowding and Lack of Complete Plumbing or Kitchen Facilities, illustrated in Figure 18, exhibited the most concentration in Los Angeles, Orange, and Riverside Counties, a few Census tracts around the San Francisco Bay, and some notable areas in the Central Valley and near the southern border.

The next set of maps of the areas that experienced three housing-related challenges is displayed in Figure 20 through Figure 23. The locations most impacted by Housing-Cost Burden, Overcrowding, and Longer-Than-Average Commute Time, depicted in Figure 20, were concentrated in the Los Angeles area and some surrounding bedroom communities such as Chatsworth and Santa Clarita. The San Francisco Bay Area seemed, unexpectedly, to be less impacted by these three challenges. This could be a function of a combination of factors, such as the Bay Area having a greater proportion of higher-income jobs (e.g., in technology-based sectors) and more efficient public transit (e.g., the Bay Area Rapid Transit system) (Jessen 2021). The map of Housing-Cost Burden, Lack of Complete Plumbing or Kitchen Facilities, and Longer-Than-Average Commute Time shown in Figure 22 displays the greatest concentration in the small, dense Census tracts of the Los Angeles and San Francisco areas. There were also some apparent anomalies northeast of Los Angeles and northwest of San Francisco. Still, upon closer inspection, those turned out to be relatively unpopulated areas of national parks, military bases, or airports. In general, these unpopulated areas lack sufficient residents for accurate estimates, such as Overcrowding or Housing-Cost Burden, and therefore the data can seem over- or under-representative of true conditions.

The geographic distribution of the areas most impacted by the top quartile of all four housing-related challenges shown in Figure 24 supports the conclusion that some areas of the state are more impacted than others and reveals that the Los Angeles area seems to be more impacted than any other urban metropolitan areas in the state. Although the relative impacts of the individual housing-related problems vary throughout the state, there are markedly few areas impacted simultaneously by all four challenges, as illustrated in Figure 24. There are 65 Census tracts in this category (see Appendix A), almost all of which are in the Los Angeles/Orange County area, while two are in the greater San Francisco Bay Area and one in downtown Stockton.

5.1.3. Focus Study Maps

Three focus studies further analyzed two of the housing problems in the context of affordability. The first focus study provided a comparison of two urban counties and one rural county, represented in Figure 25. Of the two urban counties, the first is the City and County of San Francisco, which is an internationally known and densely populated city approximately 50 square miles in area. In comparison, the County of Los Angeles is about 4,800 square miles, famous for its dependence on the automobile (Houston et al. 2015). The County of Santa Barbara is a rural county, about 3,800 square miles in area and located 100 miles west of Los Angeles. There are both similarities and differences among the three counties. Los Angeles and Santa Barbara have large swaths of primarily uninhabited land in the Angeles and Los Padres National Forests, whereas San Francisco has several smaller but sizable parks within its city limits, including Golden Gate Park and Presidio of San Francisco. Nevertheless, even accounting for uninhabited green spaces, Overcrowding is distributed uniquely in all three counties. The Census tracts in Los Angeles County most impacted by housing-related challenges seem to be spread

throughout the densely populated parts of the Los Angeles Basin and the San Fernando Valley area to the west, with some additional tracts in the Palmdale area to the north. A more limited distribution of impacted Census tracts occurred in San Francisco, where only 18 Census tracts are most impacted by Overcrowding, located in the east in a rough area often referred to as The Tenderloin (O'Mara 2018) and southeastern portions of the city. In Santa Barbara County, Overcrowding predominantly occurs in the most densely populated areas, namely the incorporated cities, e.g., Santa Barbara, Lompoc, Santa Maria. There is one apparent anomaly in the northwest of the county, owing to the small rural City of Guadalupe. According to the Census data portal (data.census.gov) has less than 8,000 residents, of which over 90 are Hispanic or Latino and almost 18 percent live below the poverty line.

A review of these three counties and the Census tracts therein affected by Overcrowding reveals further insights. Table 2 reveals that Los Angeles County has a far higher number of Census tracts than the other two counties and the greatest number of Census tracts affected by Overcrowding. Los Angeles County also has the largest average household size, with 3.01 persons per household, followed by Santa Barbara with 2.94 persons. Interestingly, while the counties of San Francisco and Santa Barbara have lower numbers of residents and Census tracts than Los Angeles County, they also exhibit higher proportions of their populations living below the poverty level, as defined by the US Census Bureau. In addition, of the three counties reviewed, Santa Barbara County has the highest percentage of total county residents living in Overcrowded housing units. These results are noteworthy as they invite further analysis as to the specific characteristics and underlying explanations of the differences experienced in urban areas as opposed to rural areas.

Table 2. Focus Study: Overcrowding in Urban and Rural Counties

County Name	Total No. of Census tracts	No. of Overcrowded Census tracts	Total Population in County	% of Total Population Overcrowded	% Below Poverty Level	Average Household size
Los Angeles	2343	973	10,105,722	10.6	9.8	3.01
San Francisco	195	18	864,263	3.5	11.7	2.35
Santa Barbara	89	26	442,996	18.0	11.7	2.94

The next focus study compared the areas most impacted by the housing challenges with Census tracts classified by their share of households with the lowest incomes. As illustrated in Figure 26, the 65 Census tracts determined to be most impacted by the top quartile of all four of the focus housing-related challenges were overlaid on a map showing the percentage, by Census tract, of Low-Income households earning no more than 80 percent of the HAMFI. Upon review, 48 of the 65 Census tracts experiencing all four housing challenges also had more than 75 percent of households in the Low-Income category (see Appendix A). In comparison, the remaining 17 Census tracts had 50 to 75 percent Low-Income households, confirming a correlation between the housing challenges and the lower-income categories. Income categories vary by area, however, so it can be informative to compare the relative income limits and population counts by county, as displayed in Table 3. Of the five counties with the most-impacted areas, Los Angeles County has more Census tracts and more residents than the other four counties combined. The 60 Census tracts in Los Angeles County determined to be most impacted contain 248,793 residents, whereas the remaining five tracts in the other four counties account for 23,279 residents. This data reinforces the initial impression that the greater Los Angeles area is impacted to a greater extent by the housing-related challenges examined in this study.

Table 3. Focus Study: Most Impacted Areas In Relation to Income By County

County Name	Total No. of Census tracts	No. of Census tracts impacted by all 4 housing challenges	Total population in County	Population in Census tracts impacted by all 4 housing challenges	Low-income limit ($) for 4-person household
Contra Costa	207	1	1,123,678	6,513	80,400
Los Angeles	2343	60	10,105,722	248,793	72,100
Orange	582	2	3,155,816	11,823	83,450
San Francisco	195	1	864,263	3,061	105,350
San Joaquin	139	1	724,153	1,882	48,900

The final focus study centered on the City of Los Angeles, with Overcrowding combined with both Housing-Cost Burden and (Low) Income data. It is important to note that not all households experiencing Housing-Cost Burden are Low Income and that not all Low-Income households experience Housing-Cost Burden. Nevertheless, they are interrelated since Housing-Cost Burden is a function of income, so a comparison of the two factors related to Overcrowding seemed warranted. Two groups are depicted in Figure 28: the Census tracts in both the top quartile in terms of Overcrowding, 13.1 to 65 percent, and the top quartile in terms of Housing-Cost Burden, 40.5 to 96 percent (represented with a thick black outline) and those Census tracts most impacted by Overcrowding where a majority of households qualify as Low Income (represented with orange shading). It is significant that, of all the tracts with both Overcrowding and Housing-Cost Burden in the City of Los Angeles, almost all are in tracts where more than half of households qualify as Low Income. Furthermore, there are more Census tracts experiencing the top quartile of Overcrowding where a majority of households are in the Low-Income category than there are Census tracts in both the top quartiles of Overcrowding and Housing-Cost Burden. This finding supports the conclusion that a portion of households may

experience more Overcrowding and less Housing-Cost Burden by securing smaller (cheaper) housing units than they would if larger (more expensive) accommodations were available.

Each of the above categories identified a selection of specific Census tracts as most impacted which could change slightly in future studies depending on the methodology used and the sampling error of the source data. While these concerns are discussed in the next section and should always be considered, the overall patterns identified in this study are illustrative and useful for identifying—in general—the geographic areas in need of the most housing resources.

5.2. Challenges

The methodology presented in this study has yielded valuable information about the housing-related challenges in the State of California. However, as with any multi-step process, there are weaknesses to consider and issues that warrant future investigation. This section examines the analysis challenges encountered in this thesis project.

There are two important limitations to consider in terms of the CHAS and ACS data used in this study. The first is the rounding scheme used by HUD in its custom tabulations, wherein total counts are not rounded, but other estimates are: values of zero remain zero, values of one through seven are reported as four, and all other values round to the nearest multiple of five (Foster 2007). This rounding methodology can result in inconsistencies within the CHAS data tables (internal calculations) and between CHAS data and other Census-generated tables (external comparisons). Within the CHAS data tables, rounding can result in summation calculations totaling more (or less) than 100 percent. The second limitation involves ACS data and the margins of error (MOE) provided, which can be significant in some cases. Per the ACS data table notes, the data are based on a sample of the population and are therefore subject to sampling variability, which is represented by an MOE. The MOE has approximately a 90-

percent probability that the true value is within the range of the estimate plus or minus the margin of error value (US Census Bureau 2018). In this study, for example, the Longer-Than-Average Commute Time data contained some significant MOEs of more than 10 percent (for example, see Appendix B). In light of these limitations, the findings of this study should be viewed as indications of larger trends or general needs, rather than pinpointing specific problems in an exact location.

Another limitation of this study involves the data used for the Lack of Complete Plumbing or Complete Kitchen Facilities. At the Census tract level, the incidence rates were found to be relatively low. While it would be ideal to have as few units as possible experiencing these housing problems, the data may not offer a complete picture of the true extent of the problem. As pointed out by O'Dell, Smith, and White (2004), physical housing condition problems, such as a Lack of Complete Plumbing or Kitchen Facilities, tend to be more localized to individual properties than other housing problems, such as Housing-Cost Burden, which tends to be more evenly distributed across blocks or neighborhoods. Future analysis could attempt to review the Lack of Complete Plumbing or Kitchen Facilities using other data sources or at different scales.

5.3. Conclusions

Of particular interest to this study were the following questions: Are there any regions or local areas of the state plagued by all four housing difficulties? In what parts or locations of the state are residents the most beleaguered by these challenges? Do metropolitan areas experience more housing challenges than rural areas?

Applying the methods described in this thesis study produced outputs that effectively answered these questions. While the spatial distribution of each individual housing difficulty

seemed different from the others, there were in fact some areas of the state impacted by all four housing difficulties. These areas were markedly concentrated in the greater Los Angeles area. Overall, urban metropolitan areas were identified as more negatively impacted by the housing problems than rural areas, but some of the more densely populated areas of non-urban areas were determined to experience multiple housing problems as well.

5.4. Solutions

This thesis project was envisioned to analyze the extent of housing problems in California as an extension to traditional calculations of housing affordability, based on the author's years of professional experience in land-use planning and affordable housing. Approaches to solving housing-related problems exist at every jurisdictional level, some instituted decades ago and some only recently passed (US Department of Housing and Urban Development 2014b). Table 4, Solutions to Housing-Related Challenges, contains a listing of some approaches that could be or have been implemented to alleviate problems of housing affordability, with varying degrees of success.

Additional programs are also currently being discussed since a "housing affordability crisis" has permeated the news media and general consciousness, as an internet search quickly reveals (Winck 2021). Solutions to housing problems can take many forms, from the local government or nonprofit agency level to the state and federal level.

The US federal government has a long history of attempting to address housing-related problems through public housing, grant programs, and tax credits (US Department of Housing and Urban Development 2014b). Beginning with the New Deal, the federal government built and managed public housing but discontinued building new public housing projects in 1974 when

Table 4. Solutions to Housing-Related Challenges

Solution	Status	Jurisdictional Level				Notes	Housing-Related Challenges* Addressed**
		Local	State	Federal	Other		
Housing assistance payments (e.g., Section 8, Veterans Affairs Supportive Housing)	Existing			X	X	Housing "voucher" programs provide funds to local housing authorities and other organizations to provide low-income households with monthly tenant assistance payments	H, O
LIHTC Program	Existing		X	X	X	Federal tax credit program, allocated to project applicants by individual states' tax-credit allocation committees to construct new affordable housing	H, P
HOME Program funding	Existing	X	X	X		Grant program to construct, acquire or rehabilitate affordable housing; federal funding is distributed to states & participating jurisdictions to fund housing developers, contractors, etc.	H, O, P
CDBG funding	Existing	X		X	X	Grant program to promote community development; federal funding provided to entitlement jurisdictions which is not primarily for housing but can be used to pay for rehabilitation of housing units	H, P
ARP Child Tax Credits	Existing			X		Direct payments to families with children	H, O
By-right allowance for ADUs	Existing		X			State legislation (2017 & 2020) to allow creation of additional dwelling unit(s) on residential and commercial properties	H, O, C
Changes to CEQA calculation of traffic impacts	Existing		X			Change to required environmental review of new projects to analyze transportation impacts in terms of generation of Vehicle Miles Travelled (instead of by traffic delays at intersections)	C
Housing cooperatives	Existing		X		X	Jointly controlled corporations established to provide housing for member households that own a share and occupy a unit of housing	H
Elimination of single-family residential zoning	Potential	X				Elimination of zoning regulations that restrict residential properties to only 1 unit	H, O, P, C
Elimination of minimum parking requirements	Potential	X				Elimination of minimum parking requirements that utilize limited available land and increase residential-project costs	H, C

Solution	Status	Jurisdictional Level				Notes	Housing-Related Challenges* Addressed**
		Local	State	Federal	Other		
By-right upzoning of residential properties (e.g., 2020 SB 10 Planning & Zoning, 2018 SB 50 Planning & Zoning)	Potential		X			State legislation to allow residential property owners to add additional units regardless of current local zoning laws	H, O, P, C
Subsidized childcare	Potential		X	X	X	Universal childcare facilities, funded by state or federal program and likely implemented by local agencies, which would cost less and presumably provide a range of convenient location options (e.g., near homes, near parents' jobs)	H, C

**H = Housing-Cost Burden, O = Overcrowding, P = Housing deficiencies (including Lack of Complete Plumbing or Complete Kitchen), C = Long Commutes*
***While solutions in this table may indirectly address all four of the housing-related challenges in this study, this table lists those most directly addressed..*

President Nixon issued a moratorium on housing spending; eventually, public housing was replaced by housing-voucher programs (National Low Income Housing Coalition 2019).

Housing vouchers, from such programs as Veterans Affairs Supportive Housing and "Section 8," are funded with federal dollars and distributed by local housing authorities or other agencies to landlords on behalf of tenant households (US Department of Housing and Urban Development 2021d). These vouchers effectively lower the housing costs of millions of families nationwide. There is also a Project-Based Section 8 program that provides financial assistance to developers of housing units that they contractually agree to retain as affordable for a certain period of time. Similarly, the Low-Income Housing Tax Credit (LIHTC) Program offers sizable federal tax credits to developers of affordable housing (US Department of Housing and Urban Development 2021c). Created in 1986, the program is "the most important resource for creating affordable housing in the United States today," according to HUD, which is why some housing professionals believe the program should be expanded.

The CDBG Program is another federal program, enacted in 1974, that provides annual grants to states and local governments to promote community development (US Department of Housing and Urban Development 2014a). The CDBG program's regulations include housing rehabilitation as an eligible use of funds. CDBG is one of HUD's longest-running programs and is quite effective as a whole. While housing rehabilitation is a relatively small share of the program's accomplishments, it is nevertheless a critical program funding the preservation and improvement of the physical condition of residential housing stock nationwide. In some jurisdictions, such as the County of Santa Barbara, CDBG funds are given to the local chapter of Habitat for Humanity to fund small home repairs. The HOME Program, in contrast, is intended solely for the purpose of creating and improving affordable housing by providing annual federal

grants to state and participating jurisdictions (US Department of Housing and Urban Development 2021b).

The HOME Program has been a key source of affordable housing for Low-Income households since it began in 1994, by funding new construction and rehabilitation of housing, assisting homeowners and providing monthly tenant-based rental assistance payments (US Department of Housing and Urban Development 2021b). Unfortunately, the program has seen steadily decreasing budget allocations for over a decade, which is undercutting its effectiveness. A recent federal program began providing child tax credits in the form of direct payments to families with children as part of the American Rescue Plan (ARP) (The White House 2021). While there are no restrictions or directives on the use of the funds, such a payment can be expected to alleviate the burden of living expenses such as housing costs. Another creative, potential solution that is being considered at the federal level is the provision of universal subsidized childcare (Warren Democrats 2021). Childcare is a significant expense for working families, so a program such as this would allow families more freedom to redirect income to housing expenses or other uses. Also, if subsidized childcare centers were conveniently located, it is possible that such a program would minimize daily family car trips or alleviate some traffic congestion and therefore shorten commute times. Such innovative solutions may be needed to solve problems as important as those related to unaffordable housing.

The State of California is also implementing creative solutions to housing-related challenges and a shortage of housing in general. In 2017 and again in 2020, the State Legislature enacted laws allowing for the creation of one or more accessory dwelling units (ADUs) on certain properties, despite any local zoning laws prohibiting them (California Department of Housing and Community Development 2021a). Although the ADUs are not required to be price

restricted and therefore are not necessarily affordable, they do add to the limited supply of housing units available. Also, ADUs are restricted in size compared with regular housing units, which may lower the rents charged for such units.

For the environmental review of new projects, the state enacted Senate Bill 743, which made a deceptively minor change to the California Environmental Quality Act (CEQA) for assessment of a project's environmental impacts: beginning in July 2020, transportation impacts would no longer be measured in terms of traffic delays caused, but rather by a measure of the number of Vehicle Miles Travelled (VMTs) generated (California Governor's Office of Planning and Research 2021). This is a significant change for the field of housing because traffic impacts have often been cited as justification for opposing new housing developments. Under the new law, projects that facilitate shorter commutes will be considered to have a lower environmental impact, which will likely allow for the construction of more infill housing development, discourage urban sprawl (or the development of housing and amenities at the edges of urban areas) and encourage the co-location of jobs and housing. Potential benefits are decreased air pollution, decreased commute times and costs, and increased equity for residents who can more easily access jobs, services, and high-opportunity areas. Another current program that is available to help lower Housing-Cost Burden involves limited-equity housing cooperatives, which independently provide permanently affordable homeownership for Low- and Moderate-Income households (California Center for Cooperative Development 2021). Each member household owns one share in the cooperative corporation, and the state ensures the long-term affordability of the shares by restricting price increases to no more than 10 percent per year and requiring that any profits from a sale of the cooperative as a whole be dedicated to charities. Additionally, the state has made several attempts to enact legislation that would grant property

owners the right to build multiple residential units on their property, regardless of local zoning restrictions, including several authored by State Senator Scott Wiener of San Francisco (California State Senate Democratic Caucus 2021). While such bills have been unsuccessful so far and have faced much opposition from single-family neighborhood groups in local jurisdictions, it seems likely that some version of the bill will pass in the future. The validity of accusations that such actions would irreparably damage community character remains to be seen. However, such a change would remove a major barrier to the creation of housing where it is needed. Increasing the allowable residential density in this manner could address the housing problems of Housing-Cost Burden, Overcrowding and Longer-Than-Average Commute Time (if more units, in convenient locations, at a range of price points are created), as well as Lack of Complete Plumbing or Kitchen Facilities and other physical problems since new units are inspected for minimum standards before being approved for occupancy.

At the local level, solutions to more significant housing problems have seemed more difficult to implement, but programs designed to ameliorate their effects are common. Local jurisdictions are primarily the pass-through agencies distributing federal and state grant funds, such as CDBG and HOME funds, to non-governmental organizations and non-profit agencies. As discussed previously, these programs are important sources of funds for the rehabilitation of housing and direct rental assistance payments to households. There are critical changes that cities and counties in California should still make to address housing problems. The elimination of restrictive single-family zoning regulations at the municipal level, such as the landmark policy enacted by the City of Minneapolis, Minnesota in 2019 (McCormick 2020), would allow for more housing units at greater densities per acre, with the advantage of allowing for community input in the zoning-code development process, in contrast to a top-down approach from the state

level. Unfortunately, such attempts to "upzone" or increase the allowable residential density on a property have thus far often been met with vehement neighborhood opposition. Another creative solution is the elimination of minimum residential parking requirements, which decrease land available for housing units and increase total development costs (Shoup 2014). Residential parking requirements are adopted and implemented at the local level, so such requirements can be eliminated if decision-makers and planners muster the political will and allay neighborhood apprehensions. In theory, less onerous parking requirements are an innovative approach that would facilitate the development of more housing in a broader range of sizes and price points, thereby addressing housing-related challenges, including those that were the focus of this study.

Governments, housing developers, and other organizations can and should think creatively to solve the housing problems experienced today. While some programs have been implemented and a modicum of progress has been made, the current circumstances demand further action at all bureaucratic levels to produce and preserve housing for individual households, make it more affordable, and address social disparities.

5.5. Future Work

The spatial analysis applied in this study proved useful for viewing and analyzing the CHAS and ACS data related to housing affordability. While the results of this thesis project were illuminating, the potential combinations that could be reviewed in future studies are seemingly endless. It would be interesting to analyze the same data using the more acute versions of Housing-Cost Burden and Overcrowding for comparison. Related to the criteria investigated used in this study, the Census defines severe Housing-Cost Burden as spending more than 50 percent of gross income on housing expenses and severe Overcrowding as housing units with more than 1.5 persons per room (US Census Bureau 2021a). The consideration of race and

ethnicity data into this type of study would also be beneficial. The CHAS data contains racial and ethnic data as part of its tabulations, and given the uneven distribution of housing affordability and related problems across demographic groups, valuable insights could be gained. Consideration of additional datasets is also warranted; for example, for the Lack of Complete Plumbing and Complete Kitchen Facilities, the Census Bureau's American Housing Survey (AHS) or other datasets should be reviewed for suitability. Finally, if analyses like this are to be replicated, methods of automation should be developed for tallying data fields and for mapping the data, such as writing Python scripts and using ModelBuilder in ArcGIS Pro to automate the methodology workflow calculations in the interest of time and cost efficiencies. An Esri GIS Story Map may also be a worthwhile exercise to better explain research findings to decision makers and the public.

The methodology explored in this study was determined to be simple—in terms of calculations—but effective. The outputs demonstrate that housing problems occur at different intensities throughout the state and identify areas experiencing the most acute challenges that warrant additional resources and program efforts. While individual agencies and developers can work to make changes, large-scale governmental programmatic changes seem to be the most effective way to solve the current housing problems in California.

References

Aurand, A., D. Emmanuel, D. Threet, I. Rafi and D. Yentel. 2020. "The Gap: A Shortage of Affordable Homes." National Low Income Housing Coalition: Washington, DC, March 2020. https://reports.nlihc.org/gap

Baker, E., K. Mason and R. Bentley. 2015. "Measuring housing affordability: A longitudinal approach." *Urban policy and research* 33(3): 275-290.

Boehm, T. P. and A. M. Schlottmann. 2001. "Housing and wealth accumulation: intergenerational impacts." *Low-Income Homeownership Working Paper Series* 2001(1.15).

Buhayar, N. and C. Cannon. 2019. "California's Affordable Housing Crisis: Why Prices Are So High and How to Solve It." *Bloomberg*, November 6, 2019. https://www.bloomberg.com/graphics/2019-california-housing-crisis/

Bunting, T., A. R. Walks, and P. Filion. 2004. "The uneven geography of housing affordability stress in Canadian metropolitan areas." *Housing Studies* 19(3): 361-393.

Calavita, N. and K. Grimes. 1998. "Inclusionary housing in California: The experience of two decades." *Journal of the American Planning Association* 64(2): 150-169.

California Air Resources Board. 2021. "Sustainable Communities & Climate Protection Program," California Air Resources Board website. https://ww2.arb.ca.gov/our-work/programs/sustainable-communities-climate-protection-program/about

California Center for Cooperative Development. 2021. "Housing Co-ops," California Center for Cooperative Development website. https://cccd.coop/co-op-info/co-op-types/housing-co-ops

California Department of Housing and Community Development. 2021a. "Accessory Dwelling Units (ADUs) and Junior Accessory Dwelling Units (JADUs)," HCD website. https://www.hcd.ca.gov/policy-research/accessorydwellingunits.shtml

——. 2021b. "Overpayment and Overcrowding," HCD website. https://www.hcd.ca.gov/community-development/building-blocks/housing-needs/overpayment-overcrowding.shtml

California Governor's Office of Planning and Research. 2021. "SB 743 Frequently Asked Questions," OPR website. https://opr.ca.gov/ceqa/updates/sb-743/faq.html

California State Senate Democratic Caucus. 2021. "Scott Wiener Representing Senate District 11: Legislation," California State Senate Democratic Caucus website. https://sd11.senate.ca.gov/legislation

Crowley, S. 2003. “The affordable housing crisis: Residential mobility of poor families and school mobility of poor children.” *Journal of Negro Education,* 22-38.

Desmond, M. 2016. *Evicted: Poverty and profit in the American city*. Crown Books.

Ezennia, I. S. and S. O. Hoskara. 2019. “Methodological weaknesses in the measurement approaches and concept of housing affordability used in housing research: A qualitative study.” *PloS ONE* 14(8): e0221246.

Fischel, W. 2001. *The Homevoter Hypothesis: How Home Values Influence Local Government Taxation, School Finance, and Land-Use Policies.* Cambridge, MA: Harvard University Press.

Foster, A. M. W. 2007. “The CHAS data: Obtaining estimates of housing market affordability.” *Cityscape,* 9(3): 161-170.

Freeman, L. 2002. “America's affordable housing crisis: A contract unfulfilled.” *American Journal of Public Health* 92(5): 709-712.

Gregory, J. N. 1993. “The Shaping of California History,” in *Encyclopedia of American Social History*, edited by M. K. Cayton, E. J. Gorn, and P. W. Williams. New York, NY: Scribner.

Houston, D., M. G. Boarnet, G. Ferguson, and S. Spears. 2015. “Can compact rail transit corridors transform the automobile city? Planning for more sustainable travel in Los Angeles.” *Urban Studies* 52(5): 938-959.

Hulchanski, J. D. 1995. “The concept of housing affordability: Six contemporary uses of the housing expenditure-to-income ratio.” *Housing Studies* 10(4): 471-491.

Jessen, C. 2021. “Where Do Workers Have It Better: SF or LA?” *The Muse* website. https://www.themuse.com/advice/where-do-workers-have-it-better-sf-or-la

Jewkes, M. and L. Delgadillo. 2010. “Weaknesses of housing affordability indices used by practitioners.” *Journal of Financial Counseling and Planning* 21(1): 42-53.

O’Dell, W., M. T. Smith, and D. White. 2004. “Weaknesses in current measures of housing needs.” *Housing and Society* 31(1): 29-40.

O’Mara, K. 2018. “Why Hasn't the Tenderloin Gentrified Like the Rest of San Francisco?” *KQED*. May 3, 2018.

Maslow, A. H. 1943. “A theory of human motivation.” *Psychological Review* 50(4): 370.

McCormick, K. 2020. “Rezoning History: Influential Minneapolis Policy Shift Links Affordability, Equity.” *Land Lines* 32(1): 8-19.

Mulliner, E. and V. Maliene. 2015. “An analysis of professional perceptions of criteria contributing to sustainable housing affordability.” *Sustainability* 7(1): 248-270.

Mulliner, E., K. Smallbone, and V. Maliene. 2013. “An assessment of sustainable housing affordability using a multiple criteria decision making method.” *Omega* 41(2): 270-279.

Mulliner, E., N. Malys, and V. Maliene. 2016. “Comparative analysis of MCDM methods for the assessment of sustainable housing affordability.” *Omega* 59: 146-156.

National Low Income Housing Coalition. 2019. “Public Housing History.” NLIHC website. https://nlihc.org/resource/public-housing-history

Quigley, J. M. and S. Raphael. 2005. “Regulation and the high cost of housing in California.” *American Economic Review* 95(2): 323-328.

Shoup, D. 2014. “The high cost of minimum parking requirements.” *Parking Issues and Policies: Transport and Sustainability*, 5: 87-113.

Stone, M. E. 2006. “What is housing affordability? The case for the residual income approach.” *Housing Policy Debate* 17(1): 151-184.

US Census Bureau. 2002. *Measuring America: The Decennial Censused from 1790 to 2000*, by Jason G. Gauthier. POL/02-MA(RV), September 2002.

——. 2017. *American Community Survey: Information Guide*, US Department of Commerce Economics and Statistics Administration, October 2017. https://www.census.gov/content/dam/Census/programs-surveys/acs/about/ACS_Information_Guide.pdf

——. 2018. “Table B08303: Travel Time to Work,” *2013-2017 American Community Survey 5-Year Estimates*, Census Data Portal. https://data.census.gov/cedsci/table?q=b08303&g=0400000US06,06.140000&tid=ACSDT5Y2017.B08303

——. 2020. “Table FM-3: Average Number of Own Children Under 18 Per Family, By Type of Family: 1955 To Present,” *Current Population Survey*, Census website. https://www.census.gov/data/tables/time-series/demo/families/families.html

——. 2021a. “Glossary,” US Census website. https://www.census.gov/glossary

——. 2021b. “Table B01003: Total Population,” *2015-2019 American Community Survey 5-Year Estimates* Census Data Portal. https://data.census.gov/cedsci/table?q=b01003&g=0400000US06.140000&tid=ACSDT5Y2019.B01003

——. n.d. “Census Tracts,” Geographic Products Branch presentation. https://www2.census.gov/geo/pdfs/education/CensusTracts.pdf

US Department of Housing and Urban Development. 2012. “Likely Trends in the Distribution of CDBG Funds.” *PD&R Edge*, January 13, 2012. https://www.huduser.gov/portal/pdredge/pdr_edge_featd_article_011312.html

——. 2014a. “About the Community Development Block Grant (CDBG) Program,” HUD Exchange website. https://files.hudexchange.info/resources/documents/About-the-CDBG-Program.pdf

——. 2014b. “Major Legislation on Housing and Urban Development Enacted Since 1932,” HUD website. June 2014. https://www.hud.gov/sites/documents/LEGS_CHRON_JUNE2014.PDF

—— . 2020. “2013-2017 Comprehensive Housing Affordability Strategy (CHAS) Data,” HUD User website. https://www.huduser.gov/portal/datasets/cp.html#2006-2017_data

——. 2021a. “CHAS: Background,” HUD User website. https://www.huduser.gov/portal/datasets/cp/CHAS/bg_chas.html

——. 2021b. “The HOME Program: HOME Investment Partnerships,” HUD Exchange website. https://www.hud.gov/hudprograms/home-program

——. 2021c. “Low-Income Housing Tax Credit (LIHTC),” HUD User website. https://www.huduser.gov/portal/datasets/lihtc.html

——. 2021d. “Section 8 Program Background Information,” HUD Exchange website. https://www.hud.gov/program_offices/housing/mfh/rfp/s8bkinfo

——. n.d. “The HOME Program Formula.” HUD User website. https://www.hud.gov/sites/documents/DOC_8404.PDF

US Department of Housing and Urban Development Office of Policy Development and Research. 2021. “CHAS: Background.” US Department of Housing and Urban Development. HUD User website. https://www.huduser.gov/portal/datasets/cp/CHAS/bg_chas.html

Veal, S. and J. Spader. 2018. “Nearly a Third of American Households Were Cost-Burdened Last Year.” *Housing Perspectives (blog).* Harvard Joint Center for Housing Studies. December 7, 2018. https://www.jchs.harvard.edu/blog/more-than-a-third-of-american-households-were-cost-burdened-last-year

Warren Democrats. 2021. “Universal Child Care,” Warren Democrats website. https://elizabethwarren.com/plans/universal-child-care

The White House. 2021. “The Child Tax Credit.” The White House website. https://www.whitehouse.gov/child-tax-credit

Winck, B. 2021. “Everywhere you look America’s housing crisis is getting worse.” *Business Insider*, August 3, 2021.

Appendix A: Most Impacted Census Tracts

				% of Total					
County	Census Tract	No. of Occupied Housing Units	No. of Workers aged 16 or over	Housing Units: Lacking Complete Plumbing or Kitchen	Housing Units: Overcrowded	Housing Units: Cost Burdened	Workers: Longer Than Average Commute	Location/ General Area	% of households in Low-Income category
Contra Costa	3790	1830	2455	4.4	16.4	41.5	52.4	SF Bay Area	75+
San Joaquin	6	565	711	7.1	15	45.8	54.4	Stockton	75+
San Francisco	264.04	720	1380	2.8	20.1	41	61.5	SF Bay Area	50-75
Orange	879.02	1240	2265	4.4	24.6	42.7	52.5	LA/SoCal	75+
	878.06	1575	2267	4.8	13.3	49.8	52.6	LA/SoCal	75+
Los Angeles	1926.1	1435	1968	3.5	28.2	45.6	61.4	LA/SoCal	75+
	1927	1040	1800	4.3	26	44.7	65.3	LA/SoCal	50-75
	1957.2	895	1226	3.9	13.4	41.3	56.3	LA/SoCal	50-75
	1958.02	935	1316	2.7	13.9	40.6	53.6	LA/SoCal	50-75
	1283.02	1455	2081	2.4	23	45.4	55.6	LA/SoCal	50-75
	2134.02	1505	2036	3	35.5	40.9	63.9	LA/SoCal	75+
	2324	1905	2924	2.9	16.3	45.7	62.2	LA/SoCal	50-75
	2328	955	1539	3.1	26.7	46.6	61.7	LA/SoCal	75+
	2393.1	1020	1582	4.8	25	42.2	63.5	LA/SoCal	75+
	2216.02	920	1106	4.9	26	42.9	62.2	LA/SoCal	75+
	2349.02	1390	1530	3.6	13.7	61.9	56.5	LA/SoCal	75+

				% of Total					
County	Census Tract	No. of Occupied Housing Units	No. of Workers aged 16 or over	Housing Units: Lacking Complete Plumbing or Kitchen	Housing Units: Overcrowded	Housing Units: Cost Burdened	Workers: Longer Than Average Commute	Location/ General Area	% of households in Low-Income category
	2396.02	875	1210	3.4	30.9	43.4	68.6	LA/SoCal	75+
	1200.3	700	1091	3.4	22.9	45.6	54.9	LA/SoCal	75+
	1282.1	1520	2086	3.3	30.9	49	54.3	LA/SoCal	75+
	2112.02	920	1393	3.8	21.1	45	62.4	LA/SoCal	75+
	2118.04	1310	1177	4.2	16.8	46.6	57.7	LA/SoCal	75+
	2121.01	1415	1829	2.8	15.5	48.4	60.1	LA/SoCal	50-75
	5331.05	640	1100	2.3	36.7	48.3	53.6	LA/SoCal	75+
	1231.03	1545	1883	4.9	14.6	46.6	53.5	LA/SoCal	50-75
	2119.21	1025	1125	3.9	15.6	51.2	57.2	LA/SoCal	75+
	2037.2	1010	1596	3	30.2	40.6	60	LA/SoCal	75+
	1905.2	1645	1815	2.4	19.8	42.2	53.6	LA/SoCal	75+
	1916.2	1200	1234	12.4	20.8	44.2	63.9	LA/SoCal	75+
	2123.03	1410	1780	3.9	28.4	42.1	60.3	LA/SoCal	75+
	1912.03	1170	1146	2.6	24.4	42.3	59.4	LA/SoCal	75+
	1279.1	1485	2536	2.7	25.9	49.8	52.2	LA/SoCal	75+
	3025.05	1495	1607	9.7	17.1	46.5	61.9	LA/SoCal	75+
	2371.02	895	1177	3.4	20.1	46.4	73.1	LA/SoCal	75+
	5018.03	1430	1651	4.5	23.4	49.7	52.2	LA/SoCal	75+
	5018.04	730	904	6.8	18.5	44.5	58.8	LA/SoCal	50-75
	1241.05	930	1160	3.8	19.2	42.9	52.7	LA/SoCal	50-75
	1277.12	1190	1363	3.8	15.1	53.4	67	LA/SoCal	75+

				% of Total					
County	Census Tract	No. of Occupied Housing Units	No. of Workers aged 16 or over	Housing Units: Lacking Complete Plumbing or Kitchen	Housing Units: Overcrowded	Housing Units: Cost Burdened	Workers: Longer Than Average Commute	Location/ General Area	% of households in Low-Income category
	2088.01	1255	1537	8.8	29.1	40.6	67.9	LA/SoCal	75+
	2187.02	790	868	5.1	18.9	50.6	65	LA/SoCal	75+
	1278.05	1140	1800	7.9	17.5	42.5	64	LA/SoCal	50-75
	5511.01	1195	1563	2.4	15.9	42.3	52.8	LA/SoCal	50-75
	2117.03	2055	2858	4.1	13.8	45.5	60.4	LA/SoCal	50-75
	5342.02	1240	1948	3.6	33.9	41.5	61.6	LA/SoCal	75+
	5348.03	1150	1928	3	22.6	44.8	53.4	LA/SoCal	75+
	6006.02	740	985	2.7	28.9	44.6	58.8	LA/SoCal	75+
	5402.03	1280	2052	2.3	21.1	48	54.5	LA/SoCal	75+
	6009.12	1500	2488	2.7	14	45.7	56.5	LA/SoCal	50-75
	5409.01	1145	1850	3.9	23.1	45.9	62.2	LA/SoCal	50-75
	2225	1350	2103	3.3	21.9	44.4	65.2	LA/SoCal	50-75
	2383.2	1130	1192	4.9	23	43.4	68.3	LA/SoCal	75+
	2123.06	1175	1453	2.6	23.8	42.5	59.9	LA/SoCal	75+
	2126.2	1845	2352	2.4	28.5	50.4	55.5	LA/SoCal	75+
	2242	735	1187	8.2	29.3	42	59	LA/SoCal	75+
	2362.02	2520	2451	3.4	15.5	56.7	62	LA/SoCal	75+
	2283.2	715	1393	3.5	33.6	46.2	53.4	LA/SoCal	75+
	2288	1215	1983	2.9	27.2	45.7	59.4	LA/SoCal	75+
	2409	1435	2143	4.9	22	46	59.2	LA/SoCal	75+
	2411.2	1305	1727	3.1	24.5	53.6	65.8	LA/SoCal	75+

				% of Total					
County	Census Tract	No. of Occupied Housing Units	No. of Workers aged 16 or over	Housing Units: Lacking Complete Plumbing or Kitchen	Housing Units: Overcrowded	Housing Units: Cost Burdened	Workers: Longer Than Average Commute	Location/ General Area	% of households in Low-Income category
	2316	2000	2695	2.2	19.8	43	57.5	LA/SoCal	75+
	2319	1450	1875	3.1	24.5	53.4	57.8	LA/SoCal	75+
	2422	1645	1930	3.3	23.3	42.6	64.9	LA/SoCal	75+
	2431	1420	1635	3.2	19.7	48.9	60.8	LA/SoCal	75+
	5703.01	2255	3267	8.2	18.8	43.7	54.3	LA/SoCal	75+
	5336.01	1100	2013	2.7	22.3	45.5	54	LA/SoCal	75+
	4809.02	1325	2122	2.6	13.6	41.9	58.6	LA/SoCal	50-75

Appendix B: Margin of Error (Most Impacted Census Tracts)

Census Tract	Total No. of Occupied Units	MOE	Estimate: Lacks Plumbing	MOE	% Lacks Plumbing	MOE	Estimate: Overcrowded	MOE	% Overcrowded	MOE	Estimate: Cost Burdened	MOE	% Cost Burdened	MOE	Total No. of Workers	MOE	Estimate: Long Commute	MOE	% Long Commute	MOE
1926.10	1435	88	50	47.5	3.5	0.2	405	124.9	28.2	1.7	655	142.5	45.6	2.8	1968	255	1209	245.8	61.4	8
1927	1040	95	45	27.3	4.3	0.4	270	104.7	26	2.4	465	128.1	44.7	4.1	1800	322	1176	271	65.3	11.7
1957.20	895	53	35	30.5	3.9	0.2	120	65.5	13.4	0.8	370	86.5	41.3	2.4	1226	165	690	151.5	56.3	7.6
1958.02	935	51	25	24.2	2.7	0.1	130	55.2	13.9	0.8	380	82.2	40.6	2.2	1316	141	706	112.1	53.6	5.7
1283.02	1455	60	35	35.1	2.4	0.1	335	106.8	23	1	660	133.8	45.4	1.9	2081	205	1156	206.4	55.6	5.5
2134.02	1505	122	45	39.8	3	0.2	534	133	35.5	2.9	615	136.4	40.9	3.3	2036	259	1302	263.9	63.9	8.1
2324	1905	84	55	43.3	2.9	0.1	310	106.7	16.3	0.7	870	183.4	45.7	2	2924	297	1819	279.7	62.2	6.3
2328	955	41	30	29.5	3.1	0.1	255	69.3	26.7	1.1	445	89	46.6	2	1539	228	949	171.1	61.7	9.1
2393.10	1020	58	49	43.2	4.8	0.3	255	80.7	25	1.4	430	104.7	42.2	2.4	1582	220	1004	183.7	63.5	8.8
2216.02	920	26	45	34.2	4.9	0.1	239	56.9	26	0.7	395	81.4	42.9	1.2	1106	167	688	150.4	62.2	9.4
2349.02	1390	123	50	46.4	3.6	0.3	190	100.4	13.7	1.2	860	176.4	61.9	5.5	1530	292	865	227.7	56.5	10.8
2396.02	875	47	30	29.5	3.4	0.2	270	75.9	30.9	1.7	380	90.4	43.4	2.3	1210	148	830	151.5	68.6	8.4
1200.30	700	48	24	23.3	3.4	0.2	160	59.4	22.9	1.6	319	74.3	45.6	3.1	1091	169	599	139.7	54.9	8.5
1282.10	1520	59	50	36.2	3.3	0.1	470	116.1	30.9	1.2	745	137.2	49	1.9	2086	228	1133	210	54.3	5.9
2112.02	920	48	35	29.5	3.8	0.2	194	55.3	21.1	1.1	414	75.9	45	2.3	1393	153	869	139.1	62.4	6.9
2118.04	1310	82	55	45.6	4.2	0.3	220	85.3	16.8	1.1	610	149.3	46.6	2.9	1177	194	679	179.4	57.7	9.5
2121.01	1415	59	40	47.5	2.8	0.1	220	79.8	15.5	0.7	685	149	48.4	2	1829	259	1100	238.9	60.1	8.5

Census Tract	Total No. of Occupied Units	MOE	Estimate: Lacks Plumbing	MOE	% Lacks Plumbing	MOE	Estimate: Overcrowded	MOE	% Overcrowded	MOE	Estimate: Cost Burdened	MOE	% Cost Burdened	MOE	Total No. of Workers	MOE	Estimate: Long Commute	MOE	% Long Commute	MOE
5331.05	640	38	15	29.5	2.3	0.1	235	83.1	36.7	2.2	309	91.1	48.3	2.9	1100	168	590	131	53.6	8.2
1231.03	1545	55	75	48	4.9	0.2	225	101.7	14.6	0.5	720	148.5	46.6	1.7	1883	278	1007	212.1	53.5	7.9
264.04	720	42	20	26.8	2.8	0.2	145	61.1	20.1	1.2	295	85.6	41	2.4	1380	216	849	155.7	61.5	9.6
6	565	48	40	25.6	7.1	0.6	85	39.8	15	1.3	259	64	45.8	3.9	711	109	387	111.8	54.4	8.3
879.02	1240	66	55	34.7	4.4	0.2	305	114.1	24.6	1.3	530	131.5	42.7	2.3	2265	323	1188	265.4	52.5	7.5
878.06	1575	58	75	46.2	4.8	0.2	210	102.4	13.3	0.5	785	187.2	49.8	1.8	2267	282	1192	283.5	52.6	6.5
2119.21	1025	66	40	36.1	3.9	0.3	160	74.7	15.6	1	525	143.9	51.2	3.3	1125	168	644	202.4	57.2	8.6
2037.20	1010	63	30	40.8	3	0.2	305	94	30.2	1.9	410	123.1	40.6	2.5	1596	298	958	225.6	60	11.2
1905.20	1645	55	40	34.2	2.4	0.1	325	89.8	19.8	0.7	694	151.5	42.2	1.4	1815	230	973	205.3	53.6	6.8
1916.20	1200	46	149	53.9	12.4	0.5	249	87.8	20.8	0.8	530	129.3	44.2	1.7	1234	214	788	190.2	63.9	11.1
2123.03	1410	73	55	49.5	3.9	0.2	400	119.3	28.4	1.5	594	128.6	42.1	2.2	1780	234	1074	234.4	60.3	7.9
1912.03	1170	71	30	30.5	2.6	0.2	285	108.2	24.4	1.5	495	127	42.3	2.6	1146	174	681	202.1	59.4	9
1279.10	1485	90	40	49	2.7	0.2	384	126.4	25.9	1.6	740	163.6	49.8	3	2536	337	1323	248.6	52.2	6.9
3025.05	1495	72	145	63.2	9.7	0.5	255	94.6	17.1	0.8	695	148.2	46.5	2.2	1607	219	994	199.6	61.9	8.4
2371.02	895	53	30	30.5	3.4	0.2	180	65.8	20.1	1.2	415	96.3	46.4	2.7	1177	162	860	154.6	73.1	10.1
5018.03	1430	68	65	41.8	4.5	0.2	335	106.3	23.4	1.1	710	144.2	49.7	2.4	1651	212	861	176.6	52.2	6.7
5018.04	730	40	50	30.5	6.8	0.4	135	49.7	18.5	1	325	73.5	44.5	2.4	904	116	532	108.6	58.8	7.6
1241.05	930	47	35	30.5	3.8	0.2	179	71.1	19.2	1	399	98.5	42.9	2.2	1160	149	611	122.9	52.7	6.8
1277.12	1190	45	45	50.4	3.8	0.1	180	80.8	15.1	0.6	635	159.6	53.4	2	1363	238	913	206.5	67	11.7
2088.01	1255	75	110	48.5	8.8	0.5	365	102.6	29.1	1.7	510	123.6	40.6	2.4	1537	268	1043	265.8	67.9	11.8
2187.02	790	39	40	34.2	5.1	0.3	149	59.8	18.9	0.9	400	83.7	50.6	2.5	868	145	564	121.9	65	10.9

Census Tract	Total No. of Occupied Units	MOE	Estimate: Lacks Plumbing	MOE	% Lacks Plumbing	MOE	Estimate: Overcrowded	MOE	% Overcrowded	MOE	Estimate: Cost Burdened	MOE	% Cost Burdened	MOE	Total No. of Workers	MOE	Estimate: Long Commute	MOE	% Long Commute	MOE
1278.05	1140	56	90	75	7.9	0.4	200	90.1	17.5	0.9	485	152	42.5	2.1	1800	217	1152	234.9	64	7.7
5511.01	1195	40	29	28.2	2.4	0.1	190	82.3	15.9	0.5	505	136.6	42.3	1.4	1563	182	825	172.6	52.8	6.1
2117.03	2055	95	85	57.3	4.1	0.2	284	104.2	13.8	0.6	935	178.6	45.5	2.1	2858	331	1725	305.4	60.4	7
5342.02	1240	58	45	38.9	3.6	0.2	420	103.4	33.9	1.6	515	130.2	41.5	1.9	1948	301	1199	245.8	61.6	9.5
5348.03	1150	55	35	40.2	3	0.1	260	100.1	22.6	1.1	515	143	44.8	2.1	1928	277	1030	230.9	53.4	7.7
6006.02	740	44	20	21.6	2.7	0.2	214	60.4	28.9	1.7	330	79.1	44.6	2.7	985	152	579	128.4	58.8	9.1
5402.03	1280	66	30	38	2.3	0.1	270	91	21.1	1.1	615	145.6	48	2.5	2052	224	1119	240.5	54.5	6
6009.12	1500	68	40	48.1	2.7	0.1	210	79.4	14	0.6	685	144.5	45.7	2.1	2488	301	1406	261.6	56.5	6.8
5409.01	1145	83	45	46	3.9	0.3	265	109.8	23.1	1.7	525	137	45.9	3.3	1850	301	1150	299.1	62.2	10.1
2225	1350	53	45	42.5	3.3	0.1	295	90.8	21.9	0.9	600	145.6	44.4	1.7	2103	267	1372	258.3	65.2	8.3
2383.20	1130	61	55	54.3	4.9	0.3	260	93.9	23	1.2	490	128.7	43.4	2.3	1192	161	814	166.3	68.3	9.2
2123.06	1175	67	30	24.2	2.6	0.1	280	88.3	23.8	1.4	499	113.2	42.5	2.4	1453	228	870	233.8	59.9	9.4
2126.20	1845	69	45	45.6	2.4	0.1	525	143.1	28.5	1.1	930	184.1	50.4	1.9	2352	260	1305	243.7	55.5	6.1
2242	735	33	60	36.1	8.2	0.4	215	58.6	29.3	1.3	309	82	42	1.9	1187	177	700	149.2	59	8.8
2362.02	2520	119	85	72	3.4	0.2	390	152.1	15.5	0.7	1430	267.7	56.7	2.7	2451	325	1519	313	62	8.2
2283.20	715	51	25	29.5	3.5	0.3	240	72.9	33.6	2.4	330	76.5	46.2	3.3	1393	240	744	160.5	53.4	9.2
2288	1215	57	35	45.3	2.9	0.1	330	104.1	27.2	1.3	555	136.8	45.7	2.1	1983	235	1177	228	59.4	7
2409	1435	67	70	74.3	4.9	0.2	315	118	22	1	660	166.8	46	2.2	2143	373	1269	293.1	59.2	10.3
2411.20	1305	50	40	40.2	3.1	0.1	320	108.7	24.5	0.9	700	148.8	53.6	2.1	1727	342	1137	263.2	65.8	13
2316	2000	100	44	40.2	2.2	0.1	395	130.1	19.8	1	860	178.1	43	2.2	2695	307	1549	263.7	57.5	6.5
2319	1450	91	45	52.8	3.1	0.2	355	126.8	24.5	1.5	775	175.8	53.4	3.4	1875	265	1084	277.2	57.8	8.2

Census Tract	Total No. of Occupied Units	MOE	Estimate: Lacks Plumbing	MOE	% Lacks Plumbing	MOE	Estimate: Overcrowded	MOE	% Overcrowded	MOE	Estimate: Cost Burdened	MOE	% Cost Burdened	MOE	Total No. of Workers	MOE	Estimate: Long Commute	MOE	% Long Commute	MOE
2422	1645	58	55	50.9	3.3	0.1	384	113.8	23.3	0.8	700	149	42.6	1.5	1930	280	1253	242.3	64.9	9.4
2431	1420	71	45	52.8	3.2	0.2	280	103.2	19.7	1	695	161.9	48.9	2.4	1635	259	994	191.8	60.8	9.6
5703.01	2255	68	185	116.3	8.2	0.3	425	169.3	18.8	0.6	985	270.2	43.7	1.3	3267	390	1775	397.2	54.3	6.5
3790	1830	115	80	68.6	4.4	0.3	300	102	16.4	1	760	179.1	41.5	2.6	2455	301	1286	286.2	52.4	6.4
5336.01	1100	56	30	34.2	2.7	0.1	245	85.6	22.3	1.1	500	131.3	45.5	2.3	2013	243	1088	237.9	54	6.5
4809.02	1325	80	35	32.3	2.6	0.2	180	74.8	13.6	0.8	555	137.7	41.9	2.5	2122	251	1244	271.6	58.6	6.9