

Suitable California Opportunity Zone (COZ) Locations for Affordable Housing Development in
the Cities of Bakersfield, Los Angeles, and Palmdale

by

Andre Charles McClure

A Thesis Presented to the
FACULTY OF THE USC DORNSIFE COLLEGE OF LETTERS, ARTS AND SCIENCES
University of Southern California
In Partial Fulfillment of the
Requirements for the Degree
MASTER OF SCIENCE
(GEOGRAPHIC INFORMATION SCIENCE AND TECHNOLOGY)

May 2021

Dedication

Dedication to my parents from whom I received my drive and dedication.

Acknowledgements

I would like to acknowledge Professor Bernstein for her direction, insight, and patience as well as the other committee members for their input during this thesis process. Furthermore, I would like to thank the Military Intelligence community for providing me with the knowledge to develop a passion for Geospatial Information Science.

Table of Contents

Dedication	ii
Acknowledgements	iii
List of Tables	vi
List of Figures	vii
Abbreviations	viii
Abstract	ix
Chapter 1 Introduction	1
1.1. Addressing the Housing Burden Affecting the Low-Income Population	3
1.2. COZs and Suitable AH Locations	4
1.3. Motivation and Research Objectives	5
1.4. Thesis Structure	6
Chapter 2 Background and Related Work	8
2.1. Social Housing Designations	8
2.2. Decrease in Number of Affordable Housing Units	8
2.3. The Affordable Housing Crisis in the City of Los Angeles	9
2.4. State of California	9
2.5. California Opportunity Zones (COZs)	10
2.6. The Role of Public Transit	11
2.7. The Role of the U.S. Department of Housing and Urban Development	12
2.8. Role of Income	13
2.9. The Role of the Rent Burden	13
2.10. Summary	13
Chapter 3 Research Methods and Data	16
3.1. Geospatial Data	16
3.2. Hard Criterion	17
3.3. Soft Criteria	18
Median Income	19
Census tracts	19
3.4. GIS Analysis and Modeling	20

Chapter 4 Results	23
4.1. Current COZ Locations in Three Study Cities	23
4.2. Conceptualization of Specification of Criteria Used to Find Candidate AH Areas	23
4.3. Final Weighted Overlays	24
Chapter 5 Discussion and Conclusions	30
5.1. Weighted Overlay Findings	30
5.2. Limitations	31
5.3. Recommendation for Future Study Enhancements	31

List of Tables

Table 1. Feature Data Source Information	17
Table 2. Feature Metrics Criteria	19
Table 3. Model Builder Processing Tools	21

List of Figures

Figure 1. Study Area Overview Map	2
Figure 2. Percentage of California residents seriously considering moving because of housing costs. Source: PPIC (2017)	4
Figure 3. California Opportunity Zone (COZ) maps for the cities of Bakersfield, Los Angeles and Palmdale	18
Figure 4. Analysis Combined with Model Builder to Produce Weighted Overlay	20
Figure 5. Criteria Feature Calculation for the City of Bakersfield	24
Figure 6. Weighted Overlay Results for the Cities of Bakersfield, Los Angeles, and Palmdale	25
Figure 7. AH Opportunities in the City of Bakersfield	27
Figure 8. AH Opportunities in the City of Palmdale	28
Figure 9. Weighted Overlay Results for the city of Los Angeles	29

Abbreviations

AEI	Administrative Enforcement Initiative
AH	Affordable Housing
AOI	Area of Interest
AVTA	Antelope Valley Transit Authority
CADRG	Compressed ARC Digitized Raster Graphics
COZ	California Opportunity Zone
EOI	Education and Outreach Initiative
EDD	Employment Development Department
FHIP	Fair Housing Initiatives Program
FHOI	Fair Housing Organizations Initiative
FIPS	Federal Information Processing Standards
GIS	Geographic Information System
HUD	U.S. Department of Housing and Urban Development
HSRT	High- Speed Rail Terminal
LIHTC	Low-Income Housing Tax Credit
NAD	North American Datum
PEI	Private Enforcement Initiative
PPIC	Public Policy Institute of California
TRN	Transit Rich Neighborhoods
VMT	Vehicle Miles Traveled

Abstract

California Opportunity Zones (COZs) provide tax incentives to investors and developers who are interested to build housing units containing affordable housing (AH). The population in California continues to increase while the cost of housing has increased significantly due to high demand. Low-income populations lack access to AH and this contributes to the financial burdens of residents who are working but cannot afford where they live. The cost of homes and rent is rising faster than the wages earned by those who work full time at minimum wage. This thesis analyzes demographic data from the U.S. Census and other sources using geospatial and statistical methods to propose new COZs in the cities of Bakersfield, Los Angeles, and Palmdale. The ideal locations for newly designated COZs would have lower population densities than much of the city of Los Angeles and labor opportunities that do not require higher education or training and that can be accessed via public transportation. The geographic placement of AH is critical to the potential positive impact on low income communities. A weighted overlay model was used to determine site suitability within each city based on features related to desirable characteristics. The new zones will provide economic opportunities for residents, alleviate problems related to population density and overcrowding, and improve the quality of life for not only low income populations but also the cities as a whole.

Chapter 1 Introduction

Affordable Housing (AH) is designed to provide medium to low-income individuals with access to housing commensurate with their income. The U.S. Department of Housing and Urban Development (HUD) sets income limits to determine eligibility for assisted housing. “For extremely low-income households (those earning 30% of area median income or less), the housing choices were even more limited. In 2013, 11.2 million extremely low-income households competed for only 7.3 million affordable units, implying a significant supply and demand imbalance” (Colburn and Allen 2018, 228). This leaves many people who are employed but in poverty without a stable home to live in or homeless. The California State Government recognizes the importance of AH, and in 2017 Governor Brown signed 15 Bills into law such as Assembly Bill 73 and Senate Bill 540 which provide incentives to cities who plan new development and designate 20% of the dwelling units to middle and low-income residents. These bills were designed to fund new construction and restoration projects that provide low-income housing. Even with new regulations and funding provided by the state and certified by the Secretary of the U.S Treasury in April 2018, there is still a lack of AH (Kimberlin 2017). The dilemma that persists for developers and government officials is that real estate values are too high and new locations for developing AH are minimal in the city of Los Angeles (Tax Policy Center, 2020).

This thesis provides a Geographic Information System (GIS) analysis of potential low-income housing development locations in the cities of Bakersfield, Los Angeles, and Palmdale (Figure 1). These three cities were chosen based in part on their proximity to each other and their need for AH. The supply of AH within the city of Los Angeles, California cannot accommodate the thousands of eligible recipients. The 2017 laws designated selected census tracts as

California Opportunity Zones (COZs). These COZs are defined by the Internal Revenue Service (IRS) as economically distressed communities where new development and revitalization are eligible for preferential treatment via IRS Code Section 45D(e) (Tax Policy Center, 2020). The dilemma that persists for developers and government officials is that real estate values continue to rise and new locations to develop low income housing are limited in the city of Los Angeles and surrounding cities such as Bakersfield and Palmdale. In addition, AH cannot be forced on property owners of high-value land and some of the working residents in large cities such as Los Angeles end up homeless and destitute.



Figure 1. Study Area Overview Map

The need for AH is prevalent and acknowledged by the citizens of California. Based on the Public Policy Institute of California (PPIC) Statewide survey taken in 2017, 60% voted in favor of changing California's environmental regulations and permitting processes to make housing more affordable for those in need.

The use of land in opportunity zones designated by the state of California influences society's potential for growth and development by offering tax incentives to build AH in these locations (Wardrip et al. 2011). The planning, design, and construction of AH can potentially improve the lives of residents and the people who live in surrounding areas. The high demand for AH and the financial benefit for developers could spur economic growth, so long as the AH is located in areas that can sustain low income populations currently living and working in small (Bakersfield and Palmdale) and large (Los Angeles) cities.

1.1. Addressing the Housing Burden Affecting the Low-Income Population

HUD defines AH as a dwelling that is designated for those who are in the low to medium income bracket for their region (HUD Public Affairs, 2020). The low-income dwelling can be obtained for 30 percent or less of a low-income worker's salary. Accessibility to AH is a major topic in Los Angeles, as there is a high demand for low-income homes. The cities of Bakersfield and Palmdale can sustain more AH at a lower cost and provide access to long-term employment.

A high cost of living causes those who are not homeless to suffer financial burdens, rendering them unable to break out of increasing debt. A survey conducted by PPIC (2017) suggests that nearly one-in-three renter households spend at least half of their income on rent. The survey further shows that because of their status, many of those who are older or who support family members cannot relocate easily (Figure 2).

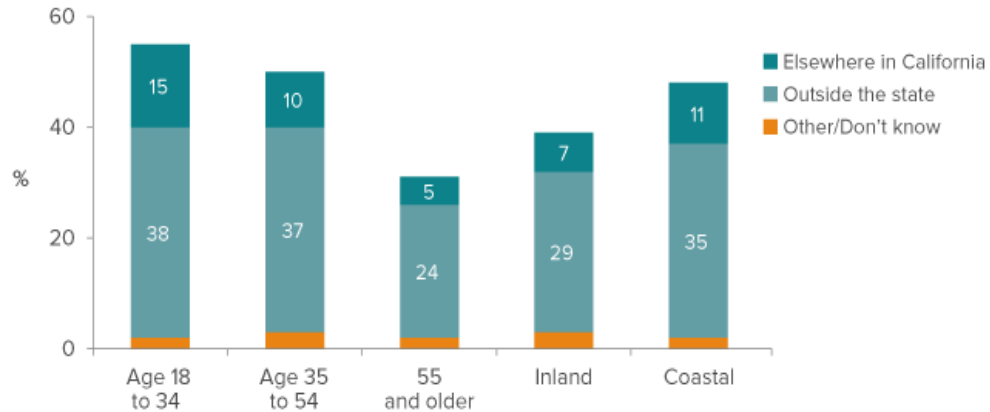


Figure 2. Percentage of California residents seriously considering moving because of housing costs. Source: PPIC (2017)

While Figure 2 represents people potentially leaving the state, this is not always an option for those living in low-income housing. The survey results show attitudes and potential moves. This study provides an in-state solution for development of AH so that low-income populations can maintain residence in California but in alternative locations where more affordable housing and employment opportunities exist. The low-income homeless population has access to shelters and social services in the city of Los Angeles. Large cities also provide employment opportunities, but the high cost of living can quickly offset the opportunities for gainful employment (PPIC 2017). The chart reproduced in Figure 2 shows the strain that housing cost has on different age groups. Without greater opportunities for employment outside of major cities or reliable transportation over short and long distances on a daily basis, low-income communities will struggle financially.

1.2. COZs and Suitable AH Locations

This thesis determines the accessibility of AH in two cities near Los Angeles. The cities of Bakersfield and Palmdale provide potential locations where AH can be developed to accommodate those who are working but unable to rise above extreme poverty. Public transportation in these cities may support low-income populations working locally or commuting

to urban areas like Los Angeles for work while maintaining residences in nearby cities that have a more affordable cost-of-living.

COZs are designated to encourage developers to build new AH developments to address and assist disadvantaged low-income communities. COZs not only provide tax incentives for AH, but they also allow the city to receive new tax revenue and revitalize distressed areas within the COZs. Developers and investors are encouraged to build and refurbish housing in these locations to spur economic growth and provide AH. According to the Tax Cuts and Jobs Act of 2017, the reinvestment of capital gains from investors and sizable tax incentives are used to improve distressed neighborhoods in opportunity zones. In California, opportunity zone real estate has successfully seen a boost in investment and this increased investment has extended to even the most distressed areas of the state (Miller, 2019). A number of financial lenders and developers in California contribute to potential development within COZs. These organizations focus on economic, social, and environmental impacts as they develop AH and other types of infrastructure in these zones.

1.3. Motivation and Research Objectives

AH is a major issue in Los Angeles, California because of the high demand for low cost housing. This thesis project is important because it addresses the basic need for housing and shelter. The motivation for this study is to explore possible locations for low-income populations to live, work, and build community. Other states could utilize the model presented in this thesis project and apply it to their cities in order to increase AH accessibility. The AH crisis is detrimental to the low income community in Los Angeles who are mired in poverty and may become homeless. The rent burden may lead to low income communities spending less money on basic necessities such as food and health care (Colburn and Allen 2018).

This thesis sought to determine possible locations where AH can be provided to those who need it, with access to transportation in order to find and maintain a job in one or more of the cities of Bakersfield, Los Angeles, and Palmdale. Given this goal, the thesis tackles three questions:

1. Where are the existing COZs in the cities of Los Angeles, Palmdale and Bakersfield?
2. What criteria should be used to determine suitable locations for AH?
3. What areas provide the most suitable AH based on the aforementioned criteria and are some of those locations located outside the existing COZs?

Based on a thorough review of the literature, which will be discussed in more depth in Chapter 2, a number of features were identified to determine the suitability of a location for AH. These criteria include variables related to median income, public housing and transportation. It is expected that areas with the highest suitability score based on these features are ideal locations for potential AH development. It is argued that AH development in these locations would help alleviate issues of overpopulation and homelessness in the Los Angeles area. The site suitability of locations is conducted using a weighted overlay model. This suitability model's objective was to identify locations for AH development that are not part of the existing COZs. The cities may want to promote AH in these areas by asking the state to designate these as new COZs since this would provide tax incentives for developers and increase the availability of AH.

1.4. Thesis Structure

The remainder of the thesis consists of four chapters. The second chapter provides additional background and reviews related work. The third chapter describes the methods and data used. The fourth chapter presents the results. The fifth and final chapter summarizes the

major findings and suggestions for future work on affordable housing opportunities in California and other parts of the country.

Chapter 2 Background and Related Work

This chapter reviews findings from other studies and articles related to site suitability analysis as it relates to the placement of COZs and AH. The sections which follow review conditions of people in low income communities, the problems faced by the developers of AH and possible solutions that have been developed to overcome these issues.

2.1. Social Housing Designations

The term AH refers to rentals which can be privately owned, managed by the state, non-profits organizations, and/or developers. The LIHTC which was created under the Tax Reform Act of 1986, provides tax credits for the development of AH (Tax Policy Center 2020). The COZs are designated by the Governor of the state of California and certified by the Secretary of the U.S. Treasury. COZs provide developers of AH with tax incentives. HUD housing locations are also often placed within the COZ designations.

2.2. Decrease in Number of Affordable Housing Units

In Los Angeles County, state funding decreased 15% while federal funding increased 68% for housing production and preservation from FY 2008-2009 to FY 2018-2019. However, nearly half a million low-income renter households in the county do not have access to an affordable housing (Schwartz 2020). Many neighborhoods in the city of Los Angeles, for example, that once housed low-income residents, have undergone gentrification and revitalization. These changes caused AH unit decreases as well as adverse effects on the cost of living of many residents. Many households experience rent burdened based on the rising cost of living. The U.S. Federal Government and state of California have enacted new laws aimed at financial developers and city planners. Under the Federal Tax Cuts and Jobs Act, for example

COZs, can be designated to help provide a solution to the AH crisis. Their numbers and locations are a key part of this study.

2.3. The Affordable Housing Crisis in the City of Los Angeles

Access to AH in the city of Los Angeles and surrounding areas has become a pressing issue. In California, state legislators have created policies to combat the problem. Large corporations such as Apple have contributed \$2.5 billion to build AH throughout California. Apple has also contributed \$1 billion to first-time home buyers (Lee 2019). Industry not only provides new employment opportunities, but also helps states in the funding of new AH developments.

2.4. State of California

The State of California is the most populous state in the U.S., with approximately 39 million people. With an estimated population of four million, Los Angeles is the second largest city in the country. The population density in the city of Los Angeles is 8,515 people per square mile (U.S. Census Bureau 2017). In 2017, over 20% of the city's population was living below the federally designated poverty threshold and one-in-four homeless individuals was located in downtown Los Angeles. The occupancy numbers for single and multi-family homes is 92%. Nearly 34% percent of Los Angeles residents are unemployed, showing the dire need for AH (World Population Review 2019).

The city's population growth has caused an increase in housing and rental prices, which creates problems and financial hardship for the 20% of the city population whose income falls below the federal poverty threshold.

2.5. California Opportunity Zones (COZs)

The state of California has argued that COZs offer a new tool for community development. Established in the Tax Cuts and Jobs Act of 2017, COZs provide tax incentives for investment in designated census tracts. California Opportunity Zones can support investments in environmental justice, sustainability, climate change, and affordable housing” (State of California 2020). In addition, the California State Density Bonus Law 65915-18 financially incentivizes housing developers to produce affordable housing by granting density bonuses to those who designate a percentage of the total units for low or moderate-income households (Ryan and Enderle 2012). This law encourages the development of AH, benefiting low income and homeless populations across the state.

A census tract is eligible to serve as a COZ if either the median household income in the tract is < 80% of the area’s median household income, or if the tract has a federally designated poverty rate greater >20% (State of California 2020). The opportunity zone incentive is intended to enhance the economic performance of specific geographic areas. The law imposes few restrictions on qualifying investment type or purpose, allowing investment across a variety of asset classes to encourage capital flows to the designated zones (Lester et al. 2018). Despite potential challenges with the implementation of the policy, the incentives provided by COZs present an opportunity to redirect wealth to benefit low income areas in California's small and large cities.

There are 879 COZs today that span 57 counties and house an estimated 3 million California residents (State of California 2020). On June 30, 2020, over \$40 million was granted to promote fair housing across the U.S., including \$475,000 that was granted to the city of Los Angeles and \$360,000 that was granted to Greater Bakersfield Legal Assistance, Inc. The Fair Housing

Initiatives Program (FHIP) has four parts: (1) the Fair Housing Organizations Initiative (FHOI); (2) the Private Enforcement Initiative (PEI); (3) the Education and Outreach Initiative (EOI); and (4) the Administrative Enforcement Initiative (AEI). The EOI “offers a comprehensive range of support for fair housing activities, providing funding to State and local government agencies and non-profit organizations for initiatives that educate the public and housing providers about equal opportunity in housing and compliance with the fair housing laws” (HUD Public Affairs, 2020, 1).

2.6. The Role of Public Transit

Low-income residents often rely on reliable public transportation to provide access to employment opportunities (Wang and Woo 2017). Access to transportation is therefore an important feature for locating potential areas for AH development because these services allow AH residents access to employment opportunities in surrounding areas. Access to public transportation also improves overall quality of living and mobility as many AH residents do not own cars. This is a long-standing problem:

“Getting to work, keeping appointments, and taking advantage of employment support services require suitable transportation. Many low-income Californians do not own cars and, outside of large metropolitan areas, public transit services are often sparse or non-existent, making it difficult for jobless individuals to make the transition from welfare-to-work” (Cervero et al. 2002, 1).

There may be additional advantages as well. Some recent studies, for example, have found “that location-efficient affordable housing is an effective climate strategy” and that “developing parcels for lower-income households in location efficient areas is likely to lead to higher

reductions in vehicle miles traveled (VMT) than developing those parcels for higher-income populations” (Newmark and Hass 2015, 22).

Wang and Woo (2017) examined the importance of decentralizing poverty and its relationship to the transportation patterns of low income communities living in suburban regions. The authors found that the “trend toward decentralized poverty has led to increased demand for transit investment in suburban areas ... and that ... the decentralization of poverty is likely to increase the transit ridership of low-income populations in suburban Transit Rich Neighborhoods (TRNs)” (Wang and Woo 2017, 194). Similarly, Barton and Gibbons (2015) examined the difference in transit patterns between low and higher income households and found that lower income populations were more likely to use buses. Thus, based on the literature, bus stops were included as a key feature for AH development as they are more commonly used by low income populations.

2.7. The Role of the U.S. Department of Housing and Urban Development

The U.S. Department of Housing and Urban Development (HUD), created in 1965, noted the housing hardships that many low-income Americans were facing and created programs to improve the housing conditions. The HUD programs are federally funded but it is up to individual states to provide adequate homes for those who apply for AH. HUD defines AH as a dwelling that is designated for those who are in the low to median income bracket for their region. The average low-income rent in the city of Los Angeles is \$2,182 per month. The income needed to afford the average asking rent is \$7,273. The minimum wage should increase or the cost of living should be less than 30% of the salaries of low-income workers (Schwartz 2020).

The materials used for AH dwellings are often of higher quality given that federal housing is built to be cost efficient to minimize the expenses incurred by taxpayers. AH also can

be owned by private, public and not-for-profit entities who receive tax incentives to rent their properties to low-income populations.

2.8. Role of Income

Median household income divides the income distribution into two equal parts below and above the median value. For households and families, the median income is based on the distribution of the total number of households and families including those with no income (U.S. Census Bureau, 2020). As previously addressed, studies have found that decentralized poverty leads to increased demand for transit investment in suburban areas (Wang and Woo 2017). Albright et al. (2013) observed the potential negative externalities of impoverished people living in suburban areas or nicer neighborhoods, testing the idea that low-income people would tarnish the area. This was deemed to be a false narrative because access to improved opportunities such as better schools, transportation and employment, can provide an escape from systemic poverty.

2.9. The Role of the Rent Burden

The term rent burden describes those who pay more than 30% of their monthly income on rent (HUD Public Affairs 2020). The number of households in poverty has increased following the Recession of 2007-2008, particularly for large households. Studies on rent burden also reveal that renters have experienced increased financial stress related to their housing compared to home owners (Colburn and Allen 2018). The PPIC Statewide Survey found that 47% of Californians say housing costs place a financial strain on themselves and their families (PPIC 2017).

2.10. Summary

The results of this review shows how the economic features of potential locations of AH development influence the affordability of housing. Without appropriate employment

opportunities, AH residents are at greater risk of being rent burdened and spending a significant percentage of their income on housing costs and other basic necessities. Households are “moderately- and severely-burdened households paying more than 30 and 50% of their income, respectively, on residential rent” (Gabriel and Painter 2020, 3). As of 2014, approximately 90% of city of Los Angeles residents making less than \$15,000 per year were rent burdened while approximately 80% of residents making \$30,000 to \$44,999 were rent burdened (Gabriel and Painter 2020).

Gabriel and Painter (2020) noted that adverse congestion, pollution, public health, and like externalities have been associated with lack of adequate affordable housing supply within proximity of jobs. The authors also identify how outcomes for individuals and families are inferior when rents increase faster than income and suggest that rising rent burdens may reduce the economic potential of metropolitan areas (Gabriel and Painter 2020). The COVID-19 pandemic that swept across the nation during the past nine months may exacerbate these negative consequences.

There may be a spatial element to the efforts to lift people out of poverty as well. Wang and Woo (2017), for example, examined the importance of decentralizing poverty and its relationship to the transportation patterns of low-income communities in suburban areas. Albright et al. (2013), on the other hand, examined the affordable housing based on “Place” theory which links aspects of affordable housing design to levels of social disorganization that are not conducive to improving the social and economic stability of low income communities. These authors referenced Wilson’s (1987) social isolation hypothesis which argues that “concentrated poverty produces social disorganization by isolating poor residents from

“mainstream” society, concentrating crime- prone people spatially to produce a social environment that perpetuates criminality” (Albright et al. 2013, 3).

Chapter 3 Research Methods and Data

This chapter describes the research methods and data used to determine suitable areas for the development of AH based on income, public transit, housing costs and HUD low income housing tax credit (LIHTC) areas in the cities of Bakersfield, Los Angeles, and Palmdale. The data, existing COZs, the soft criteria used to rank suitability, and the GIS analysis conducted to calculate their rankings are described in separate sections below.

3.1. Geospatial Data

Table 1 lists each of the features included in the study's weighted overlay analysis. The data was sourced from ArcGIS Online and by request from the Antelope Valley Transit Authority (AVTA) in California. The various features in these datasets were used to conduct site suitability analyses within the chosen cities. The second column lists hard and soft criteria because suitability was calculated for areas outside the COZs (which served then as a hard criterion) and the soft criteria were used along with ranked condition rasters and weights to calculate a suitability index. The third data source column points to the owners and locations of the individual datasets. The data used ranged from October 2016 to January 2020 and therefore provide accurate and current content. The geometry type lists the types of features used for the source geospatial data. The points and polygons in these datasets were projected to NAD 1983 State Plane California V FIPS 0405 US Feet within ArcGIS to align them with a Compressed Arc Digitized Raster Graphics (CADRG) map. The weighted influence column lists the weights (expressed here as percentages) given to the ranked features that is explained in more detail in Section 3.4.

Table 1. Feature Data Source Information

	Feature	Type of Criteria	Data Source	Geometry Type	Weight Influence
1	COZs	Hard	California Opportunity Zones (3/18/2019) https://services7.arcgis.com/lpTX3280urZ21frb/arcgis/rest/services/OpportunityZones_CA/FeatureServer	Polygon	N/A
2	Bus Stops	Soft	AVTA (7/30/2020) – Requested and received by email from the transit organization	Point	40
3	Median Household Income (last 12 months)	Soft	Low Income and Disadvantaged Tracts ArcGIS Online (2016) https://services1.arcgis.com/jUJYIo9tSA7EHvfZ/arcgis/rest/services/LowIncomeAndDisadvantaged/FeatureServer	Polygon	30
4	Rent Burden (30% spent on living costs) Housing	Soft	Employment Development Department, State of California (2020) https://services1.arcgis.com/4yjifSiIG17X0gW4/arcgis/rest/services/LongCommuters_Income_HousingBurden_byCATract/FeatureServer	Polygon	20
5	LIHTC-HUD	Soft	LIHTC Housing (10/18/2018) https://services7.arcgis.com/7mumd837TsKeePXs/arcgis/rest/services/LIHTCHousing/FeatureServer	Point	10

3.2. Hard Criterion

The COZs referred to in the first row of Table 1 provide tax incentives for the development of AH in the state of California and served as a hard criterion to exclude these areas from further study. However, the best areas to develop AH may be located outside of COZs and this study will present state officials and developers with possible locations for additional COZs designations. Figure 3 shows the locations of the current placement of COZs in the three cities of interest.

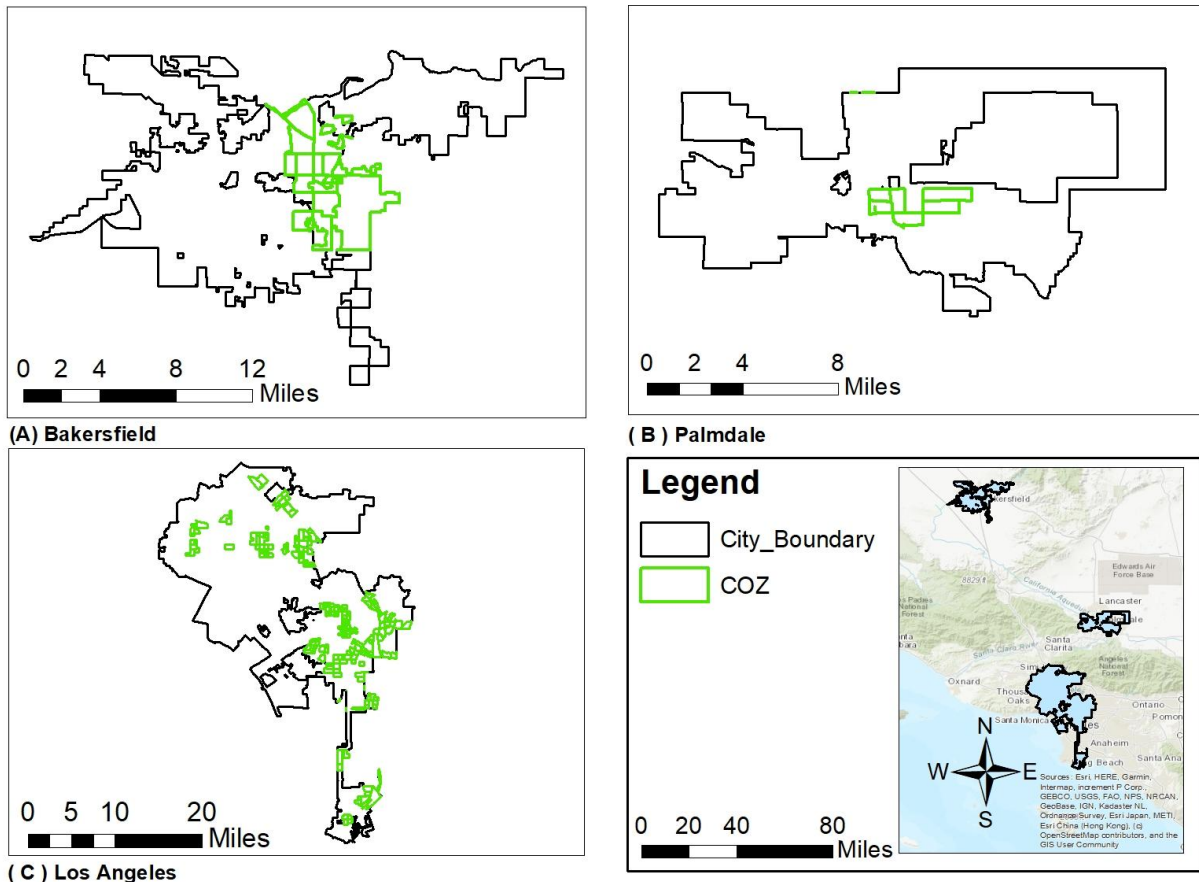


Figure 3. California Opportunity Zone (COZ) maps for the cities of Bakersfield, Los Angeles and Palmdale






The COZ designated locations as seen in Figure 3 are designated by the state and local governments for the purposes of pre-development, acquisition, renovation, and new residential development.

3.3. Soft Criteria

The final four themes listed in Table 2 provided the soft criteria used in the weighted overlay analysis. The soft criteria were assigned values from 1 to 5 indicating their suitability for AH (see Table 2 for additional details).

Bus stops represent access to public transportation. A multiple ring buffer was used to measure walking distance to the bus stops themselves and assign suitability ranks accordingly.

Table 2. Feature Metrics Criteria

Feature	Geographic measurement	1	2	3	4	5
Bus Stops	Buffer Distance Rings (Feet)	> 1,321 ft	1,320 ft Quarter mile	990 ft	660 ft	330 ft
Median Income	Census tracts	0-30K	30-60K	60-90K	120-180K	90-120K More Suitable
Rent Burden >30%	Census tracts	50%	40%	30%	20%	10%
LIHTC - HUD	Buffer Distance Rings (Feet)	1 ft	330 ft	660 ft	990 ft	1,320 ft
Color Scale						
Defined Suitability		Poor	Below Average	Average	Above Average	Excellent

Median household income was used to represent income by census tract. The suitability scores favored moderate income levels versus low and high median household income so that the candidate areas for AH avoided the poorest and most affluent neighborhoods.

Rent burden was employed in this study to identify census tracts in which households pay more than 30 percent of their income to housing expenses. This attribute points to low-income areas in which poverty is concentrated and an effort was made in this work to avoid these areas so as not to make this problem worse.

The LIHTC sites funded by HUD support low-income communities as well. Although the LIHTC-HUD program provides much needed housing, it also encourages the spatial concentration of poverty and may have negative impacts on surrounding communities.

3.4. GIS Analysis and Modeling

The Model Builder tool strings geospatial processes together in a graphical interface used to combine existing sequences of data in order to produce the calculated result. The model structure for this study was developed to produce a Weighted Overlay model that uses a set of reclassified ranked condition rasters and weights to calculate a suitability index (Price 2016).

The Model Builder interface within ArcMap 10 was used to perform different calculations on the datasets within the study to produce the weighted overlay results as shown in Figure 4.

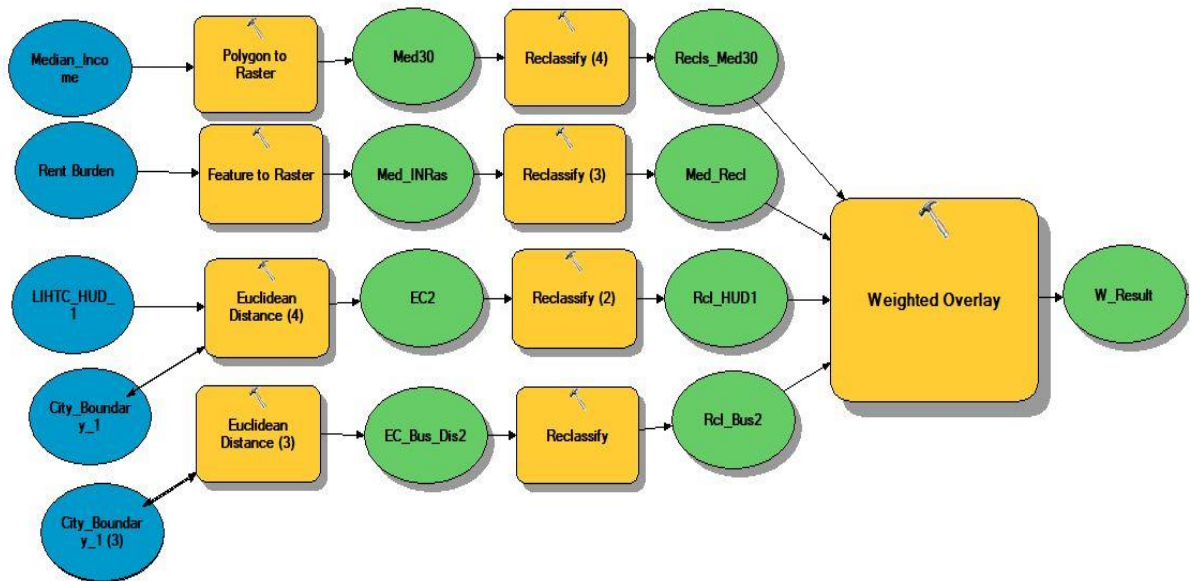


Figure 4. Analysis Combined with Model Builder to Produce Weighted Overlay

The GIS modeling process illustrated in Figure 4 encompassed the GIS methods described in more detail in Table 3. The model in Figure 4 depicts the process used to determine COZ site suitability for AH development based on the data collected for the AOIs. The four soft criteria were scored and assigned weights as follows: Rent Burden was given a weight of 20, Median

Table 3. Model Builder Processing Tools

Processes	Definitions
Project	Mathematical transformation that converts spherical units of latitude and longitude to a planar x-y coordinate system
Clip	Remove feature and portions of features that lie outside of the features of another layer
Polygon to Raster	Any feature class (geodatabase, shapefile, or coverage) containing polygon features can be converted to a raster dataset. The input field type determines the type of output raster. If the field is integer, the output raster will be integer; if it is floating point, the output will be floating point.
Reclassify	Replace stress ranges of values in a raster with different sets of ranges of values
Euclidean Distance	The straight-line distance between two points
Weighted Overlay	An analysis that uses a set of reclassified ranked condition rasters and weights to calculate a suitability index
Raster to Polygon	The input raster is a floating-point raster, you must use the Map Algebra Expression parameter to convert it to an integer raster.
Multiple Ring Buffer	The generation of several buffers at set distances. Multiple ring buffers can have overlapping or non-overlapping rings

Source: Price 2016

Income was given a weight of 30, LIHTC-HUD was given a weight of 10, and Distance to Bus Stop was given a weight of 40.

The weights for AH development were chosen using the weighted overlay and pairwise comparison methods. Bus stops were assigned the largest weights followed by median income. Both of these criteria were treated as positive influences on AH suitability, whereas the high rent burden and LIHTC-HUD regions were assigned lesser weights and treated as negative influences. Pairwise comparison is the general process of comparing elements of data in pairs (Esri 2020), and this approach was used in this study to determine to calculate the final AH suitability scores.

Additional work was required to calculate the weighted overlay because this function used a set of reclassified ranked condition rasters and weights to calculate a suitability index. This requirement explains why the second column reproduced in Figure 4 shows the need to convert the polygon datasets to rasters. These reassigned values of the polygon features were

converted to a single dimensionless scoring range from 1 to 5 using the ranges listed in Table 3 as well. The darker the color, the more suitable it is to be designated a COZ for AH to be built. The polygon and feature to raster operations used the cell centers to decide the value of each raster pixel.

Chapter 4 Results

To help address the needs of the approximately 2 million low-income households in California who either lack a permanent residence or are severely cost burdened, more COZs to encourage the development of AH will need to be established. The results of this study suggest high priority areas for AH based on the model criteria set forward in Chapter 3. The three sections which follow endeavor to answer the three main questions that were specified in Chapter 1:

1. Where are the COZs in the cities of Bakersfield, Los Angeles, and Palmdale?
2. What criteria should be used to determine suitable locations for AH?
3. What areas provide the most suitable AH opportunities based on the criteria and are some of those areas located outside of the existing COZs?

The thesis argues that areas with the highest suitability scores are ideal. These areas are located outside of the existing COZs given the methodology chosen for this work and therefore the case can be made for each of the three cities – Bakersfield, Los Angeles, and Palmdale – to provide developers with tax incentives to promote AH development.

4.1. Current COZ Locations in Three Study Cities

The maps reproduced in Figure 3 show the locations of the existing COZs in the cities of Bakersfield, Los Angeles, and Palmdale. This study assumed that these COZs do not provide sufficient opportunities (i.e. locations) for AH development and sought to delineate new areas based on a series of criteria that would provide low-income communities with public transportation and economic opportunities moving forward.

4.2. Conceptualization of Specification of Criteria Used to Find Candidate AH Areas

Four criteria – proximity to public transportation, neighborhoods with median incomes, avoiding areas with high housing costs (i.e. rent burden), and avoiding locations that already

make use of LIHTC-HUD benefits – were used for the site suitability analysis presented in Section 4.3. The derivation of these criteria was provided in Section 3.3 and the results captured in Figure 5 show how these criteria were calculated in a small part of Bakersfield, California.

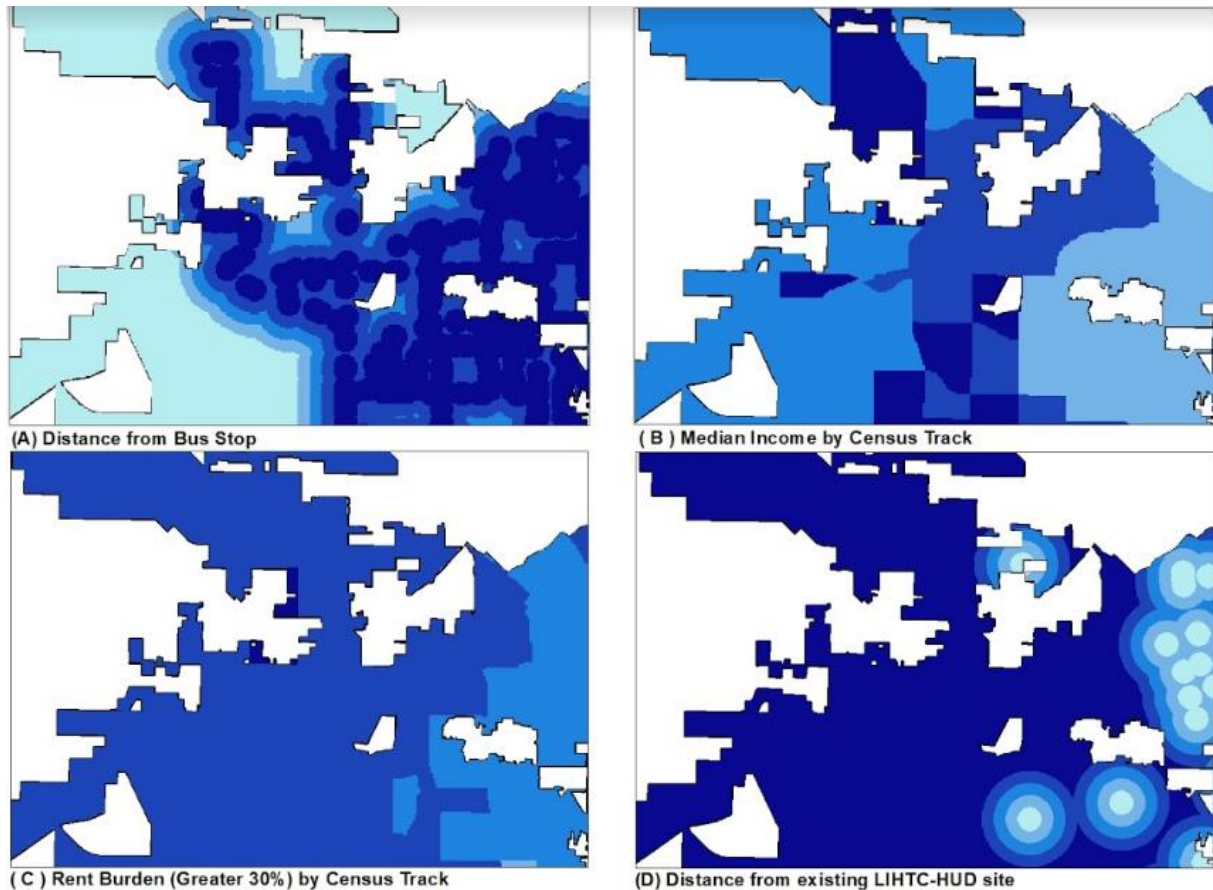


Figure 5. Criteria Feature Calculation for the City of Bakersfield

The polygons displayed in the maps reproduced in Figure 5 were later transformed into rasters to produce the final weighted overlays presented in Section 4.3 below.

4.3. Final Weighted Overlays

The results presented in Figure 6 answer the question: What areas provide the most suitable AH opportunities based on the criteria and are those locations within COZs? Locations designated in dark blue have a suitability score of 5 and represent excellent candidate locations for future AH development. There are extensive areas that run north-south in the western half of

Bakersfield (Figure 6a) and a series of scattered areas in Los Angeles and Palmdale (Figures 6b and c) that produced suitability scores of 5 and large areas in all three cities with suitability scores of >3 (Figure 6).

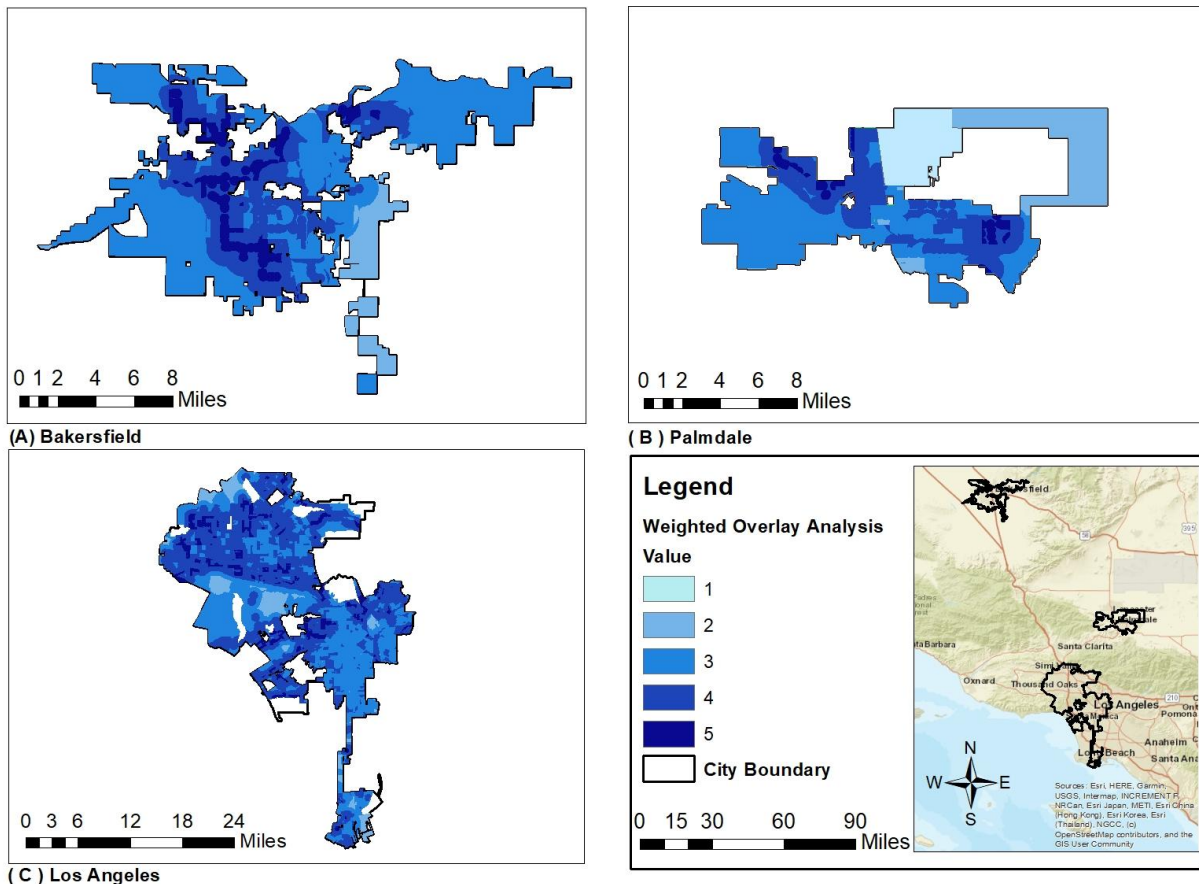


Figure 6. Weighted Overlay Results for the Cities of Bakersfield, Los Angeles, and Palmdale

Comparing the results in Figures 3 and 6, it is clear that the most suitable locations for AH development within the cities of Bakersfield and Palmdale are not located within existing COZs. The COZ locations for the cities of Bakersfield, Los Angeles and Palmdale are still viable locations for AH, but the results in Figure 6 show that many additional areas could be designated as COZs to incentivize AH development in locations with good access to public transportation and employment opportunities.

The opportunities in Bakersfield and Palmdale can be further illustrated by zooming into examples of neighborhoods in each city with suitability scores of 5. Figure 7, for example, shows a candidate area in the city of Bakersfield which could be designated as a new COZ. The first map in Figure 7a shows a Compressed ARC Digitized Raster Graphics (CADRG) with the weighted overlay results layer. The COZs, bus stops, and LIHTC-HUD are shown on this map. The close-up map reproduced in Figure 7b depicts areas that have been assessed to be the most suitable regions where COZ designations can be established. The region is located in the northwest quadrant of the city. The satellite image view reproduced in Figure 7c shows areas that have yet to be developed. This image shows a highway, buildings, and suburban homes, and these are all positive factors that can contribute towards a suitable environment for AH to be developed.

The Palmdale weighted overlay analysis results map in Figure 8 display similar AH opportunities and neighborhoods in which additional AH areas could be designated. The first map in Figure 8a shows a CADRG with the weighted overlay results layer. The COZs, bus stops, and LIHTC-HUD sites are shown on this map as well. There are fewer HUD sites and this allows for more flexibility in COZ designations. The close-up map reproduced in Figure 8b depicts areas that would be acceptable or excellent for AH according to Table 3. This region is located in the northwest part of the city of Palmdale. The satellite image view reproduced in Figure 8b depicts areas that have yet to be developed. This image shows a highway, buildings, and suburban homes. These are all positive factors that would contribute towards a suitable environment for AH to be developed.

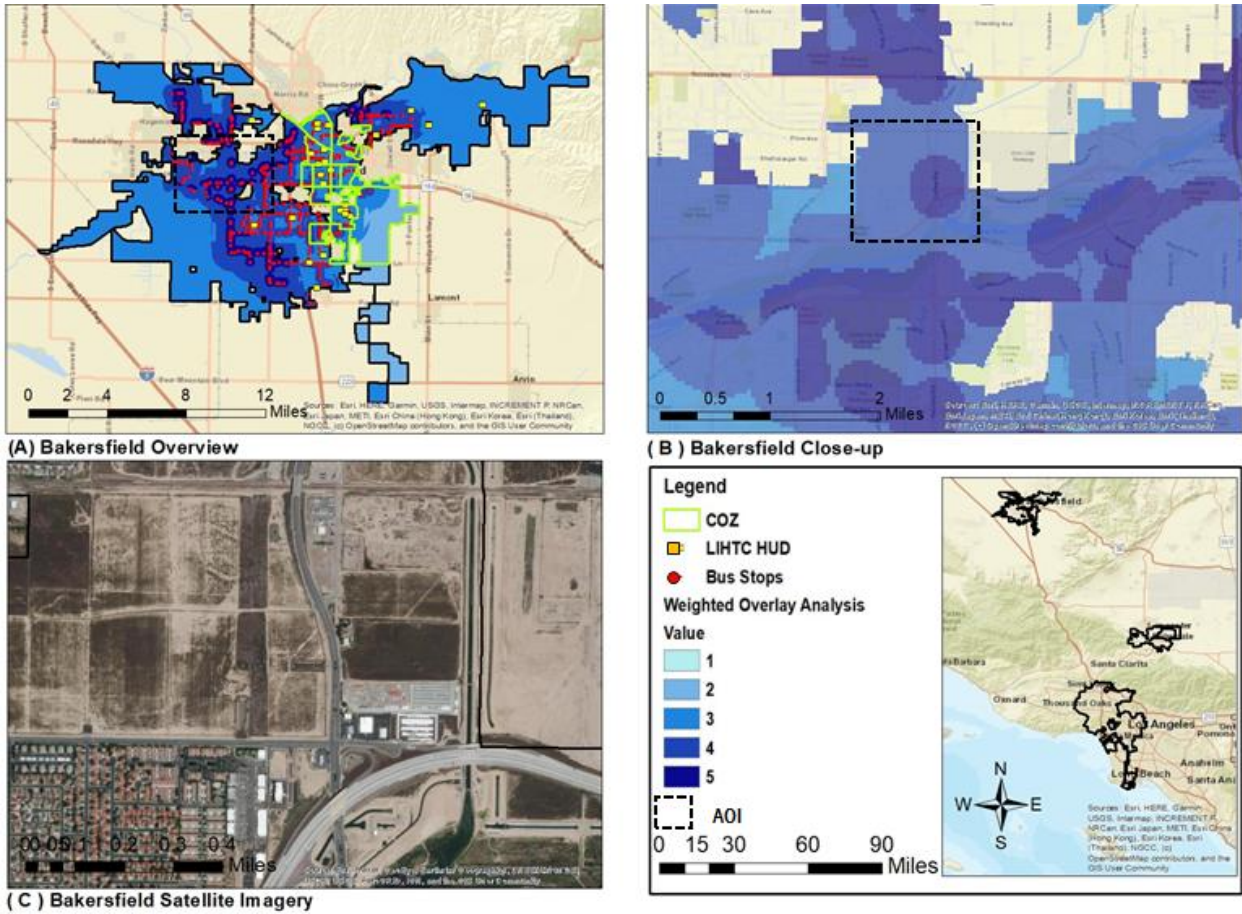
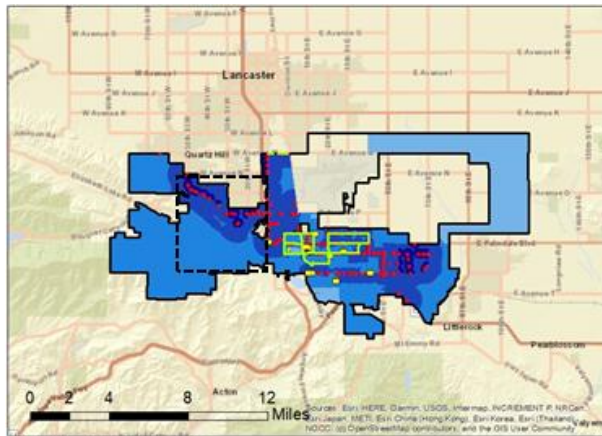
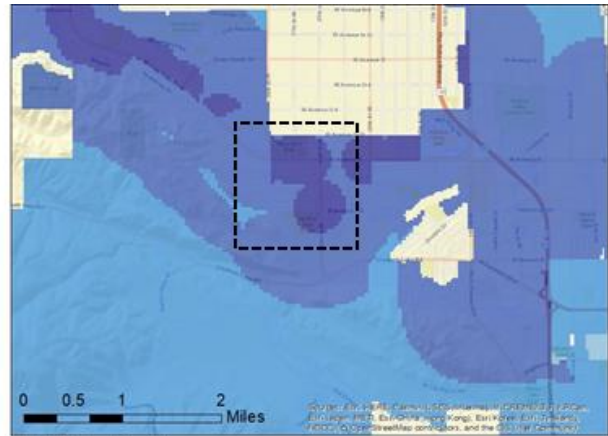


Figure 7. AH Opportunities in the city of Bakersfield

The weighted overlay results for the city of Los Angeles reproduced in Figure 9 show how difficult it is to find suitable locations for additional COZ designations here due to the high cost of living and existing development. The majority of the COZ locations within this map have a high number of LIHTC-HUD housing units. The lack of AH in Los Angeles for low-income communities provided the initial motivation for this thesis project. The results for Bakersfield and to a lesser extent Palmdale suggest that better opportunities for building AH can be found in other cities in southern California.



(A) Palmdale Overview



(B) Palmdale Close-up



(C) Palmdale Satellite Imagery

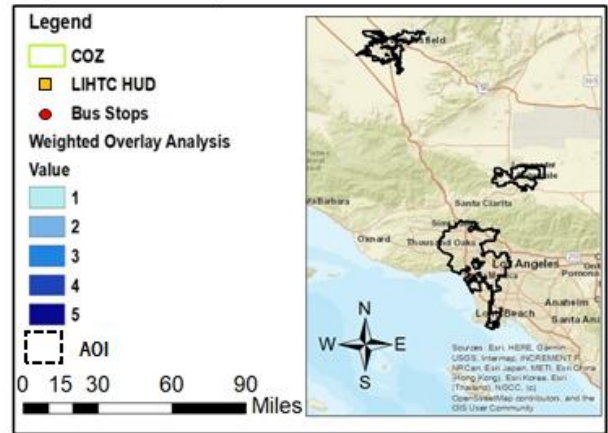


Figure 8. AH Opportunities in the city of Palmdale

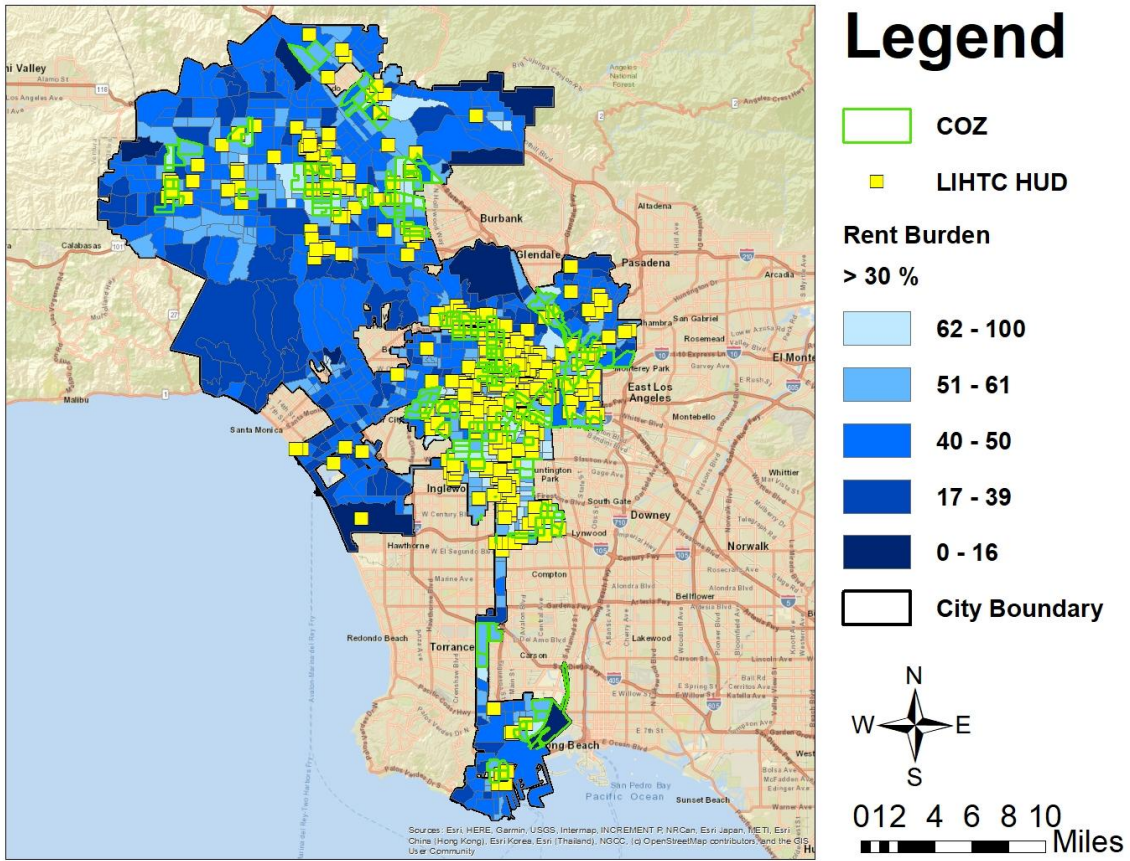


Figure 9. Weighted Overlay Results for the city of Los Angeles

Chapter 5 Discussion and Conclusions

This chapter provides a summary of results and some concluding thoughts. The findings for each city are discussed and policy recommendations are provided to address the lack of AH development and designate new COZs. Next, limitations based on the feature suitability criteria are addressed and some possible future enhancements of this study are provided. The last section of the chapter offers recommendations for future research that can build upon and enhance this study.

5.1. Weighted Overlay Findings

The results of this study confirmed the hypotheses that were initially proposed at the beginning of the study. Ultimately, the current COZs in the three cities are not sufficient to address the need for low income housing in southern California. The weighted overlay analysis results point to some additional areas that would provide suitable COZs to develop additional AH.

According to this study, the city of Bakersfield can support AH development in several neighborhoods that would provide low-income communities with public transportation and employment opportunities. There are similar but fewer such opportunities in the city of Palmdale. In addition, Palmdale is closer to Los Angeles than Bakersfield and this proximity would allow residents to commute to and from Los Angeles for employment as well. The commuter rail provider, Metrolink, runs regular services between the cities of Lancaster and Palmdale and Union Station in the city of Los Angeles for example. The city of Los Angeles, on the other hand, contains relatively few viable options for additional COZs or AH development due to escalating home prices, the high cost of living, large numbers of rent burdened residents, and large numbers of LIHTC-HUD sites spread throughout the city.

5.2. Limitations

The limitations are at least three. The first is the limited number of inputs used for the weighted overlay model and the likelihood that more inputs might provide a more nuanced assessment of the candidate AH neighborhoods in the three cities considered in this thesis project. The second is the potential to use more refined measures for the variables used here. For example, one could consider more than the locations of the bus stops to assess public transit accessibility. One possibility would be to consider the headways and the areas that could be reached in a certain time from each bus stop to provide more refined measures of mobility. The third is the reliance on census tracts and the likelihood that this relatively coarse resolution provided a relatively blunt instrument for the identification of areas that would be suitable sites for the designation of new COZs to promote AH in the three cities. Census block groups would provide better geospatial specificity but these units were not used because some of the datasets were not available at this level.

5.3. Recommendation for Future Study Enhancements

Future studies could build upon this research by including current housing costs and considering additional factors such as the cost of living beyond the rent burden indicator. The California High-Speed Rail project may connect Bakersfield with Los Angeles in the future and allow low-income residents living in AH in Bakersfield to commute to Los Angeles for work.

This thesis project provides a replicable and generalizable geospatial analysis workflow for determining suitable locations for COZs and AH development. This model could be implemented to analyze COZs and AH development opportunities in other California cities. Using geospatial analysis and census data to determine suitable locations for AH development, this study provides low-income residents the opportunity to find more sustainable housing.

References

- Albright, L., and Derickson, E.S., and Massey, D.S. 2013. “Do affordable housing projects harm suburban communities? Crime, property values, and taxes in Mount Laurel, NJ.” *City and Community*, 12(2): 89–112.
- Barton, M.S., and Gibbons, J. 2017. “A stop too far: How does public transportation concentration influence neighborhood median household income?” *Urban Studies*, 54(2): 538–554.
- Cervero, R., Tsai, Y.-H., Dibb, J., Kluter, A., Nuworsoo, C., Petrova, I., Pohan, M., Wachs, M., and Deakin, E. 2002. “*Reverse Commuting and Job Access in California: Markets, Needs and Policy Prospects.*” Berkeley, CA: University of California Berkeley Research Report: UCB-ITS-RR-2002-7.
- Colburn, G., and Allen, R. 2018. “Rent burden and the Great Recession in the USA.” *Urban Studies* 55(1): 226–243.
- Employment Development Department, State of California. 2020. “Jobs.” Retrieved from <https://www.edd.ca.gov/jobs.htm>
- Esri. 2020. “*How Pairwise Intersect Work.*” Retrieved from <https://pro.arcgis.com/en/pro-app/tool-reference/analysis/how-pairwise-intersect-works.htm>
- Gabriel, S., and Painter, G. 2020. “Why affordability matters.” *Regional Science and Urban Economics* 80: 103378.
- HUD Public Affairs. 2020. “*HUD awards over \$40 Million to fight housing discrimination.*” Retrieved from https://www.hud.gov/press/press_releases_media_advisories/HUD_No_20_097
- Kimberlin, S. 2017. “*Understanding the recently enacted 2017 State Legislative housing package.*” California Budget & Policy Center (blog). <https://calbudgetcenter.org/blog/understanding-recently-enacted-2017-state-legislative-housing-package/>
- Lee, T.B. 2019. “*Apple wants affordable housing in California—but laws stand in the way.*” Retrieved from <https://arstechnica.com/tech-policy/2019/11/apples-2-5-billion-affordable-housing-pledge-wont-be-enough/>
- Lester, R., Evans, C., and Tian, H. 2018. “*Opportunity zones: An analysis of the policy’s implications.*” Palo Alto, CA: Stanford University Graduate School of Business Research Paper No. 19-18.

- Miller, L. 2019. "California, the land of opportunity zones: Using the real estate market to evaluate a new tax program (Unpublished Senior Thesis)." Claremont, CA: Claremont McKenna College.
- Newmark, G., and Haas, P. 2015. *"Income, location efficiency, and VMT: Affordable housing as a climate strategy."* Chicago, IL: Center for Neighborhood Technology.
- PPIC (Public Policy Institute of California). 2017. *"Californians and housing affordability."* Retrieved from <https://www.ppic.org/publication/californians-and-housing-affordability/>
- Price, M.H. 2016. *Mastering ArcGIS* (Seventh edition). New York, NY: McGraw-Hill Education.
- Ryan, S. and Enderle, B.E. 2012. "Examining spatial patterns in affordable housing: The case of California density bonus implementation." *Journal of Housing and the Built Environment* 27(4): 413–425.
- Schwartz, M. 2020. *"Los Angeles County 2020 Affordable Housing Needs Report."* California Housing Partnership." San Francisco, CA: California Housing Partnership.
- State of California. 2020. *"CA Opportunity Zones."* Retrieved from <https://opzones.ca.gov/faqs/>
- Tax Policy Center. 2020. *"What are opportunity zones and how do they work?"* Retrieved from <https://www.taxpolicycenter.org/briefing-book/what-are-opportunity-zones-and-how-do-they-work>
- U.S. Census Bureau. 2019. *"Median Household Income."* Retrieved from <https://www.census.gov/quickfacts/fact/note/US/INC110218>
- U.S. Census Bureau. 2020. *"Quick Facts: Los Angeles City, California."* Retrieved from <https://www.census.gov/quickfacts/losangelesciticifornia>
- Wang, K., and Woo, M. 2017. "The relationship between transit rich neighborhoods and transit ridership: Evidence from the decentralization of poverty." *Applied Geography*, 86: 183-196.
- Wardrip, K., Williams, L., and Hague, S. 2011. *"The role of affordable housing in creating jobs and stimulating local economic development."* Washington, DC: Center for Housing Policy.
- Wilson, W.J. 1987. *"The socially disadvantaged."* Chicago, IL: University of Chicago Press.
- World Population Review. 2019. *"World population review 2019."* Walnut, CA: World Population Review.