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# Assessing Urban Canopy Program in Redlands California

Joseph Angel Rocha IV

# ASSESSING URBAN CANOPY PROGRAM IN REDLANDS CALIFORNIA

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A Thesis

Presented to the

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San Bernardino

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by

Joseph Angel Rocha

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## ABSTRACT

Climate change can cause major environmental and human health issues especially in lower income and minority communities (Ros et al. 2020; Bethel et al. 2022). Although studies note tree coverage alone cannot solve all climate related problems (Pataki, et al. 2021, Ross, 2021), tree coverage does provide alleviation for climate change related factors (Free-Smith, et al. 2004). Some ways trees can combat climate change is through improved air quality, improved water quality, and decreasing impacts of Urban Heat Island Effect (UHIE) (Nowak et al. 2018; Liu, Liu, 2021; Wang, Zhao, et al 2017). Although throughout the United States there is a problem with tree equity with higher income white majority areas having more tree cover than low income minority areas (Poon, 2021). In California particularly there are tree equity issues stretching from Sacramento, Fresno, Los Angeles, and San Diego to name a few cities where lower income communities lack coverage compared to wealthier areas (Gammon 2021; American Forests, 2022). California Governor Gavin Newsome signed into action California Climate Action Corps (CAC) with the goal of supporting communities throughout the state to fight climate issues (Civic Sparks, 2020). The CAC partnered with the Inland Empire Resource Conservation District (IERCD) to increase canopy cover in northern Redlands, CA (IERCD, 2021). Part of the project goal for CAC and IERCD was to serve lower income minority communities (IERCD, 2021). The goal of the research is twofold, the first being looking at the spatial extent of environmental and socio-economic issues to

understand the extent of tree canopy across diverse socio-economic communities within the City of Redlands while the second is understanding the success and limitations of the program based on the CAC and IERCD goals.

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# CHAPTER ONE

# INTRODUCTION

## Global to Local Trends and Observations

Canopy and shade cover have both environmental and economic benefits; however, these benefits are not often realized within disadvantaged communities (DACs) and underserved landscapes. The California Office of Environmental Health and Hazard (OEHHA) and California EPA designate a disadvantaged community as those in the 25% bottom in terms of socioeconomic and environmental standards that the CalEnviroScreen sets (OEHHA, 2018; CAL Rodriquez, Brown, 2017). From improved air quality, to reduced localized temperatures (e.g. impervious surfaces, heat island effects), and enhanced water quality, higher density tree canopy and in turn shade can greatly benefit a community environmentally (Free-Smith, et al. 2004). Economically increased tree canopy, green spaces and street scaping a community can produce rewards due to higher housing values with trees on a property and even lower electric bills (Yang et al; 2012). The lack of canopy coverage in urban and urbanizing areas poses major threats often referred to as the Urban Heat Island effect (UHIE). The UHIF is defined by urban areas with increased temperature compared to its surrounding due to impervious surfaces such as high density of roads and infrastructure on the landscape that emits heat (EPA) when exposed to prolonged sunlight (Taha, 2021). Studies have shown the adverse impacts of

UHIE around the world, collectively observing the advantages and extent to which canopy coverage can alleviate some of the UHIE increasingly experienced by urban and urbanizing landscapes (Ross, 2021; Ow et al 2020). Yet, planting trees alone will not solve issues like UHIE, rather it takes an interdisciplinary approach including careful and strategic city planning, and community outreach and education, coupled with canopy expansion to alleviate issues like UHIE (Ross, 2021). Trees alone do provide a variety of benefits but have limitations and are not alone the answer to alleviate all the environmental issues caused by climate change. Yet, not having enough tree coverage does affect communities (Pataki, et al. 2021, Ross, 2021). For example, Poon (2021) observed that a majority of economically disadvantaged communities have less than 41% tree compared to the wealthier communities in America. The same study found communities with people of color have over 30% less coverage than white majority communities (Poon 2021). Places across America including dense urban areas such as Durham, North Carolina also show the socioeconomic disparities within its own communities (Duke, 2021). Pulido (2017) suggests that most research would classify these socioeconomic disparities in regard to lack of tree coverage and lack of tree equity as environmental racism.  Given the spatial reach related to the lack of tree canopy cover in disadvantaged communities that compound socio-economic, environmental, and public health disparities, it has become increasingly important to understand how such landscape structure can be reimagined. One such state with diverse cultural and environmental landscapes as well as a region experiencing extreme climatic shifts due to climate change, is the state of California. Given the landscape diversity coupled with dynamic climatic changes (i.e. fires, flooding, drought), California presents a relevant focus area where approaches and opportunities may then be applied to regions with similar human-environmental disparities.

Trends and Opportunities Across California

California has unique landscapes from coastal ranges, deserts, mountains, chaparral shrublands in the south and densely forested areas in the north. Climatically, the north generally is moister with higher rainfall compared to the south which tends to be dryer and some areas can experience less than 5 inches of rain in the year (UCAR, 2020). Throughout the state of California there are issues with tree equity across urban and suburban areas typically classified as disadvantaged or underserved, creating opportunities for state agencies and  organizations such as American Forest Foundation to address tree canopy inequities that subsequently resolve ancillary environmental, social, and public health issues (e.g. air, water quality; quality of life). The American Forest Foundation, who measure tree equity have found cities in California such as Los Angeles, San Diego, Fresno, and Sacramento, observed that every city could greatly benefit from tree equity projects, especially in areas characterized with low median household incomes (Gammon 2021; American Forests, 2022). Utilizing state and federal tools aimed at identify socio-economic and environmental inequality as well as tree canopy coverage (i.e.

CalEnviroScreen and Tree Canopy) coupled with research studies, the city of Los Angeles landscape illustrates tree equity and related community issues where tree  canopy coverage is lacking compared to wealthier communities in the city with higher density tree coverage, a trend that can also be observed  a viewing online mapping tools , including the Forest Service map (Lara, Manthey, 2021; Wright 2021; OEHHA, 2018; Forest Service, 2018) . Further south, San Diego, California has its own tree equity inequalities with studies observing the urban landscape would need an estimated 4 million trees in targeted areas to achieve tree equity (Moran, 2021). Across the Central Valley, the city of Fresno has been identified as lacking trees in low-income areas mimicking trends of observations further north into South Sacramento, which is largely lacking trees compared to the rest of the city (Cusick, 2021; Montalvo, 2021). Although disadvantaged communities are common focal points of low tree canopy coverage, more affluent cities such as the city of Berkeley represent areas void of adequate tree canopy due to larger percentages of impervious surfaces in a compact urban landscape Berkeley (Metcalfe, 2021).

Within California there are statewide initiatives, mapping tools and programs with collective objectives to combat climate issues including the lack of trees and green space, with a priority focus on disadvantaged and underserved communities. For example, the CalEnviroScreen tool developed by Office of Environmental Health Hazard Assessment (OEHHA) provides an index or quantifiable scores for socio-economic and environmental issues to determine which areas of the state are at greater risk for either environmental or socioeconomic issues (OEHHA, 2018). Another tool is the California Environmental Protection Agency (CALEPA) Heat Island Index which provides quantifiable grades regarding heat island effect. This was created so regions of California could pick actual numbered target goals to decrease heat island effect in their areas and in turn the state. Mapping aids such as the California Urban Tree Canopy provided by the forest service assists with identifying areas by canopy coverage (Forest Service, 2018). Governor Gavin Newsome launched a new program in 2020 titled the California Climate Action Corp Fellows which was supposed to help communities deal with climate issues they are facing locally. Recent or current graduates are placed in certain communities to work for 11 months on climate projects along with trying to educate and empower those communities (CivicSparks, 2021; IERCD, 2021).

One example in southern California with tree canopy disparities is the City of Redlands, where tree canopy is unevenly distributed between the southern and northern reaches of the city. Through the state funded, and the Inland Empire Resources Conservation District (IERCD) support, Climate Action Corp Fellows were tasked with an urban canopy expansion project specifically targeting participation in receiving free trees in DACs across the city has been implemented to provide opportunities to increase tree canopy equity and density across the entire city boundary, with a targeted focus on northern Redlands. Redlands, a city in the Inland Empire region of southern California has the distinction of being a Tree City USA for 24 years straight which is awarded through the arbor day with conjunction of the US forest service (Civic Sparks, 2021; Arbor Day Foundation, 2021). The spatial issue is the stark differences between tree canopy in the northern DAC areas of the city, which is greatly lacking tree coverage, and the southern areas, characterized by higher income residents and housing prices where most of the tree canopy is located, illustrating spatial inequality in tree canopy coverage even within a single city landscape (OEHHA, 2018; Forest Service 2018). The Interstate ten freeway (I-10) sits as a divide between the pollution-free southern end and the disadvantaged polluted northern section (Figure 3) (OEHHA, 2018). This causes the northern residents, who are majority Hispanic and African American, to be greatly disadvantaged in relation to tree shade and related public and environmental health benefits, compared to the majority white southern populations (OEHHA, 2018). This is why the California Climate Action Fellows have partnered with the Inland Empire Resource Conservation District to help target northern Redland's residents to participate in a free tree program. The goal of the program is not to just combat climate change through the fellows but to also empower the community through knowledge of climate change. This program seeks to utilize community partnerships to encourage participation from the DACs of northern Redlands (CivicSparks, 2021; IERCD, 2021). The program will not only seek to give trees away, but assist in planting, future care, and council from master gardeners if requested by participants (IERCD, 2021). The results of this program could help other cities with strategies in getting their communities involved with battling climate change issues, especially those issues caused by lack of tree canopy.

# CHAPTER TWO

# LITERATURE REVIEW

## Climate Change Risks

Climatic changes propose numerous and spatially variable barriers to ensuring conditions that support environmental and public health. Several studies ranging from global to regional and local perspectives have observed the extent to which Climatic changes proposes numerous and spatially variable barriers to ensuring conditions that show climate change will affect general well-being across the globe, and some insist climate change is on track to lead to more premature deaths around the world making it a major public health issue (Ros et al. 2020; Fan et al. 2015). One of the great public health risks associated with climate change is due to increased temperatures that research observed increases in cardiovascular issues, chronic kidney conditions, and heat strokes contributing to an increase in deaths (Sarofim, 2016; Glaser, et al. 2016; Fan et al. 2015; Kizer, 2021; Scarborough et al. 2012; Gold & E Samet, 2013). Climate change will also change the seasonality of vector diseases around the world putting more people at risk during longer seasons increasing the extent and severity of vector diseases in various places across the globe (Ramirez, 2017; Dhimal et al. 2015; Monaghan et al. 2015; Purse et al. 2017). Environmentally, climate change has brought forth an increased risk for forest fire disasters that both increase the fire season and intensity of the fires (Williams, et al 2019; Tian, et al 2014). With the increased risk of forest fires comes an increased risk of human life and health due both to the fire and smoke from the fires (Cascio, 2018; Aguilera et al 2021; Black, et al. 2017). Hurricanes are another disaster that has had an increase in its intensity due to climate change factors (Balaguru, et al 2018; Holland & Bruyere, 2013). This has public health issues especially with mortality rate increases after the storm passes especially when the storm damage has long term disruption to healthcare and other benefits (Kim et al. 2017; Kishore, et al. 2018). In relation to DACs, climate change also places DAC and Indigenous communities at greater risk and frontline targets for many of the climate change issues because these areas are often characterized by lower household incomes, education, health, and environmental issues (Bethel et al. 2022; Taupo, et al. 2018; Fernandez-Bou, et al. 2021). All groups are at risk, especially older populations who are at higher risk for climate change issues such as fires, floods, heat related health issues, respiratory issues due to pollution (Goldblum, 2011; Kinay et al. 2019).

## California Climate Risk

California experiences a certain amount of climate risk factors that range from public health and environmental issues caused by changes to water, fire, and temperature in the state that risk human health in many ways (EPA, 2016). California is expected to have an increase in drought frequency and severity going into the future (Mount et al. 2019; Cvijanovic et al. 2017). One of the main risks to California is the issue of drought which increases the state's need for water with less water availability which is only made worse with the increase of temperature (EPA, 2016; Cheng et al. 2016). The dryer soils mean farmers in California have to increase watering causing a feedback that adds more stress to water scarcity (EPA, 2016; Cheng, et al. 2016). Agriculture productivity specifically is at a great risk for being reduced due to drought related effects (EPA, 2016; Cheng, et al. 2016). Drought also presents an issue for public health and is often referred to as the silent public health issue (Sena, et al. 2014; UNESCO, 2020). Drought all around the world plays a role in major health implications that can be physical or mental (Sena, et al. 2014; UNESCO, 2020). Another major climate risk that affects California is the increase in severity and frequency of forest fires (Miller, et al. 2009; EPA, 2016). This could have drastic effects in California as research on forest fires indicate it to be a major public health threat around the globe (Dennekamp et al. 2015; Yao et al. 2017). Another risk for California is the increase in temperature that has risen over 2 degrees Fahrenheit roughly over the last 100 years (EPA 2016; McBride, Lacan, 2018). The increase in temperature has a direct effect on human health and can even cause increased mortality rates (EPA, 2016).

## Combating Climate Change in California

### <u>Environmental and Social Justice</u>

The complexities of climatic changes results in a highly variable and spatially diverse environmental and social justice issues. Tree coverage across communities or the lack of can often be attributed to ethnicity and/or affluence of an area. Terms characterized by these landscapes include ‘environmental privilege,’ which is the more privileged populations attain higher levels of environmental quality and ‘Environmental Racism Gap,’ is the gap in quality between white and nonwhite populations (Locke et al 2021; Pulido, 2017). Some studies sought to determine if there were any environmental injustices surrounding tree coverage specifically in race/ethnicity and income (Locke et al 2021; Heynen, Perkins, & Roy, 2006; Locke and Grove 2014; Mincy et al; 2016; Kim, Zhou; 2013). The research was consistent with finding high income neighborhoods would have higher urban canopy coverage than that of low-income neighborhoods (Locke, et al 2021; Heynen et al 2006; Watkins, et al; 2017). Research also found to some extent that race and ethnicity played a part in urban canopy coverage by showing minority communities are more often than not in areas with less tree coverage (Heynen, Perkins, & Roy, 2006; Pedlowski, et al 2002; Locke et al 2021; Zhou, Kim, 2013). The clear indication of environmental injustice against poor and minority groups when it comes to urban canopy coverage (Locke, et al 2021; Heynen, et al 2006; Mincy et al; 2016; Zhou, Kim, 2013).

Climate Risks from Lack of Tree Coverage

Some of the major environmental issues affected by lack of tree cover include air quality issues, groundwater threats, and Urban Heat Island Effect (UHIE). Studies find that especially low income areas are at risk for having to deal with bad air quality around their homes (Degeun, Zmirou-Navier, 2010; Ngo et al, 2015; Pratt, et al. 2015.) Other studies have found that there are inequalities in air pollution environmental racism with minority communities experiencing worse air pollution than white communities (Tessum, et al. 2019; Hackbarth, et al. 2011). One of the biggest air quality risk factors is adjacency to high density traffic (Houston et al. 2004; Pratt, et al. 2015.) Another major risk factor is exposure to particulate matter (P.M) that can cause heart and lung health concerns. Bad air quality from exposure to P.M. can especially cause issues like Asthma (EPA, 2021; CDC, 2019). Other studies have noted that groundwater threats are especially found in low income areas (Nayebare et al, 2022; Dobbin, 2020; Mahed, et al. 2019). Groundwater is used for a variety of sources such as drinking water, and irrigation so keeping it clean and contamination free is priority (CDC, 2022; EPA, 2022; California Water Board, 2018). Contamination can cause disease, and ruin sources of freshwater (CDC, 2022; EPA, 2022).

Tree Canopy Role in Mitigating Climate Change

One-way trees combat climate change is through improving air quality (Nowak, et al 2006; Nowak et al. 2018; Ouldfiled, et al 2013). Researchers in the US and Canada found that urban canopy coverage from trees removes a significant amount of pollution from the air (Nowak, et al., 2006; Nowak et al. 2018). The estimated savings from the pollution removal in the United States has been estimated in the billions while select Canadian cities saved upwards of 400 million through its urban forest (Nowak, et al 2006; Nowak et al. 2018). The research found that pollution removal was low overall city to city at around 1%, but that 1% makes a significant difference in money saved from cleaning air and for human health (Nowak, et al 2006; Nowak et al. 2018). Some studies also observed that trees impact against particulate matter further noting that the lack of tree canopy poses grave issues for human health in urban and suburban areas due to the effect it has on respiratory and vascular diseases (Free-Smith et al. 2004; Nowak et al. 2018). Studies have found the removal of pollution directly improves human health keeping it less risk of respiratory and cardiovascular diseases. (Free-Smith, et al. 2004; Nowak et al. 2018)

Another area trees assist with combating climate change is through increasing groundwater recharge and improving water quality. Researchers show that there is a correlation between water scarcity and economic poverty (Liu, Liu, 2021; Bargues-Tobella, 2016). Tree coverage can be a key component in increasing groundwater recharge (Bargues-Tobella, 2016; Ilstedt, et al. 2016). Research notes often in dryer climates tree planting is discouraged because it is believed that tree cover decreases groundwater recharge, but studies observe and illustrate how certain tree densities can actually maximize groundwater recharge (Bargues-Tobella, 2016; Ilstedt, et al. 2016). Trees can also improve water quality (Forest Service, 2012; Oldfield, et al 2013; Parkyn, et al. 2005). One way trees can do this is through reducing storm water runoff and through sequestering Carbon that is held in water (Forest Service, 2012; Oldfield, et al 2013). Trees can also improve water quality through riparian buffer zones which if trees are spaced properly can lower the nutrient pollution in rivers and streams (Forest Service, 2012; Parkyn, et al. 2005).

Rising temperatures are only exacerbated by the heat island effect, but tree coverage can help mitigate against UHIE. The EPA defines Heat islands as urban areas that experience higher temperatures than outlying areas, and the cause is structures like roads and other infrastructure that absorb and emit heat at a high rate (EPA, 2021). Trees can combat this by providing shade, and studies show it is one of the most effective vegetation types for heat island mitigation (Wang, et al. 2016; ROSENZWEIG et al. 2009). Providing green spaces, especially with trees, can lower temperatures compared to surrounding areas and help combat heat island effect (Bowler et al 2010; Oliveira, et al 2011; Wang, Zhao, et al 2017). Research also shows that trees will increase thermal comfort for humans (Helletsgruber et al 2020; Wang, et al 2016).

Aside from the environmental advantages of having urban trees there are also economic advantages specifically through saving money from electric bills, raising home value, and through air quality clean up. Trees have shown to lower electric bills while also lowering heating bills (Butry, Donovan, 2009; Nowak, et al

2016; Forest Service, 2018). Studies have also shown that through providing air quality cleaning trees save millions of dollars every year. Research clearly shows that having trees on a property can increase the value of that home and property and even increase the value of homes in the community (Butry, Donovan, 2009; Wolf, 2007).

## Engaging Communities on Climate Change

There is a major need to communicate and educate communities about climate change and climate change risks (UN, 2020; Ros, et al. 2020). Educating the public can encourage people to take action against climate change, and increase participation in climate action (UN, 2020; Allen, Crowley; 2017). Understanding your audience though is a very key component to engaging any community about climate issues (Ros et al., 2020) This can mean pairing climate change with issues important to communities or important to people on a personal level (Jennings, et al 2020; Barrett et al 2016; Bouman & Stegg 2020). Government participation is important, but in order for significant climate action change to take place you need participation from citizens (Schrot, et al. 2020; Bouman & Stegg 2020). Research also shows the importance of letting community members voice their choice for climate change mitigation and development of goals specific and important to their communities (Bollinger et al; 2013; Schrot, et al. 2020).

## Tree Programs

Much like the current Redland’s Canopy project there are other similar programs whose goal is to expand urban tree canopy. Similar to Redland's project many programs have tried to provide free trees as a way to gain participation (Norco, 2018; Monrovia, 2020; CCI, 2018) Some programs identify and target disadvantaged communities for tree planting programs (USC, 2021; CCI, 2018). Other programs open the tree plantings to anyone who will take the watering responsibility (Norco, 2018; Monrovia, 2020). One program that has seen 20,000 trees get into the ground only does large scale plantings (CaseyTrees, 2021). Certain programs use community partnership or volunteers to help provide participation, planting and maintenance (USC, 2021; CaseyTrees, 2021). While some programs use the government to plant and maintain the health of the tree (Norco, 2018; Monrovia, 2020). Tree monitoring is an important aspect to increasing tree surval post planting (Roman et al, 2018.) This is especially important when post tree planting mortality is considered (Roman et al; 2018; Widney, et al; 2016). Also having early intervention can increase tree survival (Widney, et al; 2016).

## Study Purpose

The goal of the research is twofold, the first being looking at the spatial extent of environmental and socio-economic issues to understand the extent of tree canopy across diverse socio-economic communities within the City of Redlands while the second is understanding the success and limitations of the

CAC urban canopy program. Part of the research will be highlighting how areas in Redlands experience environmental racism gaps, not only through stark tree equity issues but also through higher pollution burdens. An important part of the research is empowering communities in Northern Redlands through education on climate change and recognizing the value of gaining participation and knowledge from disadvantaged areas. It is also important that communities know how climate change will hit them locally as often academics and media speak to a more global audience. An educated public is an empowered public that can then better combat climate change at the local level. The research is being built from a body of literature that studied communicating to communities the dangers associated with climate change, education strategies to promote mitigation practice, strategies to garner participation from disadvantaged communities. The second part of the literature reflects perspectives from the environmental, medical, and economic disciplines noting advantages of tree coverage that put communities without urban tree coverage at stark disadvantages. Finally, reflecting on the lessons from past tree programs and the impact on their community.

## Study Site

The City of Redlands is the study site for the current research (Figure 1, Figure 2). Historically Redlands has a rich history in the citrus agricultural market. In its peak, the city would send over 1 million boxes from its 30 packing houses across the state and country via the railway system. Currently many citrus groves are protected in the city preserving an important part of its history. Current Census data has the city at around 70,000 people with an over 70% majority white with Hispanic being the next largest demographic, while Asian, black and other round at the rest in terms of population. Redlands water resources come majority from 15 city owned wells that pump groundwater and two wells from the south mountain water company. The two big above water systems moving through the city are the Mill Creek stream and the Santa Ana River Watershed. The city gets an average of 13.26 inches of rain a year with the wet season being November through April (Redlands, 2020). The average high is just under 80 degrees Fahrenheit with the average low being around 50 degrees Fahrenheit (USA Climate, 2020).

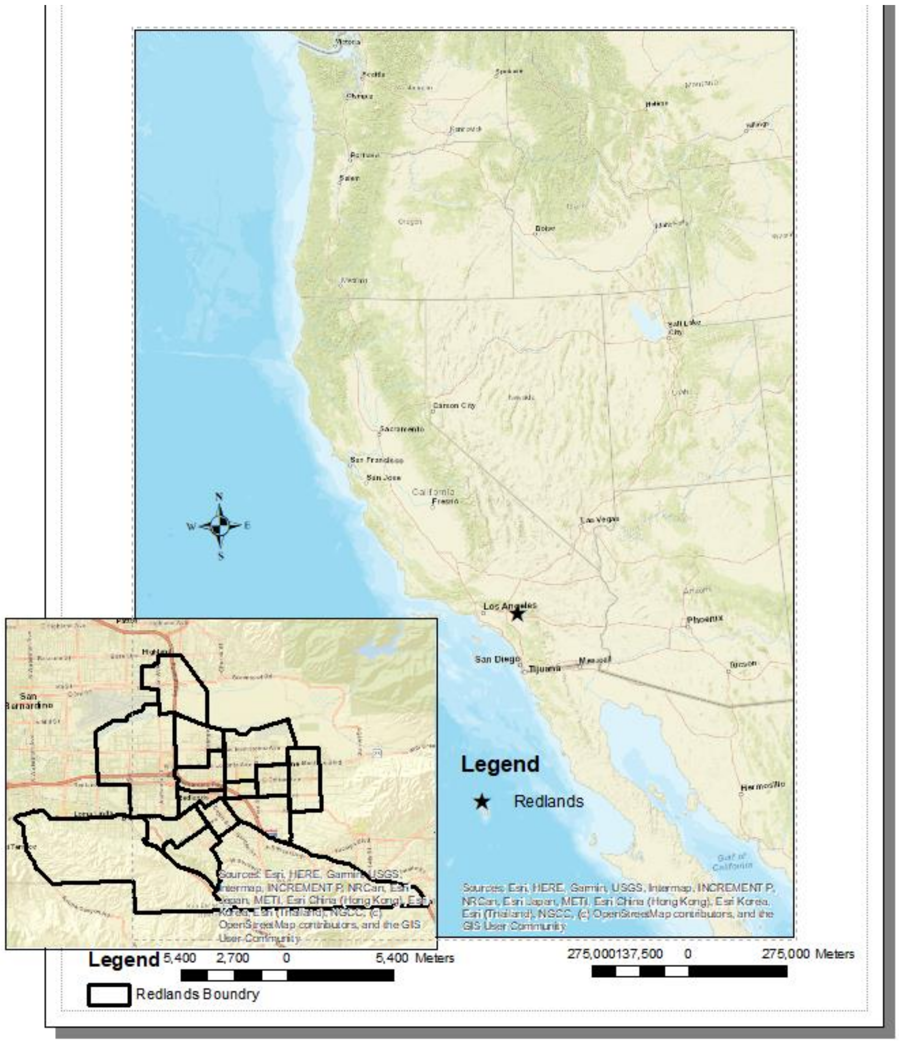



Figure 1. Map of Redlands

# CHAPTER THREE

# METHODS

The goal of the research is twofold, the first being looking at the spatial extent of environmental and socio-economic issues to understand the extent of tree canopy across diverse socio-economic communities within the City of Redlands while the second is understanding the success and limitations of the CAC urban canopy program.

## GIS Mapping

For the mapping, the CalEnviro tool from OEHHA, the Urban Canopy Map of California from the Forest Service, and the California Environmental Protection Agency (CALEPA) Urban Heat Index map is used to identify the disparities between the two regions of the city spatially. The OEHHA tool will be used to highlight the economic and health issues that different parts of the city face, highlighting census tracts that are disadvantaged (OEHHA, 2018). The Urban canopy map will show the differences in tree coverage in the city highlighting the uneven tree coverage in the city (Forest Service, 2018). Another mapping tool is the CALEPA Urban Heat Index map tool to show the differences in temperature between areas with more vegetation against areas with less (CalEPA, 2015). The CalEPA tool measures heat island index and the original goal was to help regions in California combat heat by creating quantifiable goals through targeting areas within the map's readings to reduce heat island effect (CalEPA, 2015). Finally, the California Department of Water Resources (DWR) uses the DAC mapping tool to highlight areas of the state that are considered DAC. All these mapping tools are made to work in conjunction to find if there is any significant correlation between lacking green space and being at a disadvantage in any way if that be socioeconomic or environmental. It will also ultimately highlight areas of Redlands that need to be focused on when the city looks to increase its green space.  The research will not only show uneven tree equity, but also uneven pollution burdens in low-income minority areas. These mapping tools coupled with the Urban Canopy map will highlight the environmental racism gap within the city of Redlands. (Pulido, 2020).

The DWR DAC mapping tool shows areas of the city considered DAC. This interactive map allows users to overlay census tracts, census blocks, or census place. For the use of this research, census blocks are the appropriate viewing point allowing to compare easily across all mapping tools. The map shows DAC which are areas at least 80% under the state's average median household income (MHI) (DWR, 2018).

CalEnviroScreen tool is a unique piece of data that highlights disadvantaged communities in California quantifiably by giving a grade based on a series of socio-economic and environmental issues. For this project, the tool will be used to compare different census blocks within the city of Redlands to see if there is a connection between regions of the city being more disadvantaged than other parts. A few of the areas within the tool that will be specifically highlighted will be the overall pollution burden which measures Ozone, toxic release, groundwater threats, and more. Also, an important comparison will be of the socio-economic overall grade which consists of poverty, unemployment, housing burden and other criteria. Finally comparing population, gender, and race/ethnicity between census blocks in the city (OEHHA, 2018).

Urban Tree Canopy in California mapping tool will be used to specifically view tree coverage throughout the city of Redlands. The map’s intention is to highlight areas of California that have low levels of tree canopy, but also used as a comparison that could be used on scales from city to city or Census tract to census tract. It is expected that the areas with the lowest tree coverage in Redlands will be in Northern Redlands where citizens are greatly disadvantaged (CalEPA, 2015).

CalEPA Heat Island Index Tool provides scores for the heat island effect throughout the city of Redlands. This tool will be used to gather data and give an average score based on the findings from the tool as to what each census block is dealing with when it comes to the heat island effect. Coupled with the two other tools this will provide insight into how a lack of green space affects communities who are battling climate change (Forest Service, 2018).

## Climate Fellows Method

The Redlands Tree Planting Program is set up into three main phases. Each phase area builds onto the next and targets the two most disadvantaged census tracts of Redlands (Figure not available yet). The two tracts in 2018 were considered SB 535 disadvantaged communities under OEHHA. Through a variety of outreach efforts participants in the community are gathered to receive a free tree which will be planted and checked on periodically by San Bernardino County master gardeners. Aside from receiving a free tree, participants will be surveyed both pre and post tree planting process by IERCD and the climate action fellows.

Community Partners

A variety of community partners are used in the program to gain participants who are interested in adding a tree to their property understanding of the community, and other partners to keep operations of the program going. The Common Vision Coalition was a key partnership as they have been trusted by the North Redlands community so gaining willing participants was easier with community trust through this organization. The Inland Empire Resource Conservation District (IERCD) who also has worked in projects throughout the area also host the Climate Action Corps group in charge of leading the project as well as provide resources and connections that will be mentioned in this section. University of California Agriculture and Natural Resources (UCANR) has done the research and developed the tree list that will best help fight climate change as well as survive in the harsh climate. The University of Redlands has helped with outreach as they maintain ties to the community and have also stored trees for the program. Both the Adam's Hall Nursery and the Mountain View Nursery supplied the trees that are used in the program. The Southern California Mountains Foundation helps with the delivery and planting of trees to participants. Finally the Master Gardeners of San Bernardino will aid in both planting and running occasional checkups on the trees.

Trees

The plan for the project was to have climate-ready trees that are approved by UCANR to be drought and heat tolerant (Hartin, Vela, 2021). UCANR climate ready trees had a survival rate in studies of 88% (Mcpherson Et al, 2020). The project used three of the listed trees for the plantings. These trees included: Celtis reticulataa (Netleaf Hackberry), chilopsis linearis 'Bubba'c (Desert Willow), and Pistacia 'Red Push'a (Red Push Pistache)  (Mcpherson, Et al, 2020).

Climate Fellow Outreach Strategies

There are five main ways trees were planted for the program. First through community partners like the Common Vision Coalition, University of Redlands, and Master Gardeners used connections in the city and to organize a tree planting in Redlands Sports Park. These partners also played a role in letting community members know they could receive a free tree. Second through social media postings by community partners like the IERCD. Next is through the local newspaper posting asking community members to sign up. Next is through door flyers which are placed in the phase zones to educate the community and gain participation. Finally, through tabling in various places in the community like grocery markets. Participants are also encouraged to tell their neighbors, family, and friends about the tree program. These strategies are even more important in a COVID environment when speaking in front of large groups is not possible.

In a COVID environment it can be difficult to educate the public about climate change, and how tree canopy coverage can combat it. In order to effectively teach the public education flyers are drafted with information on them and given to people during checkups in hopes this will increase the chances they are read compared to just leaving them at the door.

CHAPTER FOUR

RESULTS AND DISCUSSION

Trends Across Redlands

The California Department of Water Resources Disadvantaged Communities Mapping tool gives a guide to locate areas within Redlands that are considered disadvantaged. The CalEnviroScreen tool has given an outline of what census tracts within Redlands show characteristics of being disadvantaged and also shows characteristics and indicators for census tracts that struggle with environmental and health hazards. These two tools can help show areas of Redlands that are most at risk for future environmental and socioeconomic issues. The CalEnviroScreen mapping tool provides a percentile grade which is called CalEnviroScreen Percentile, with low scores being better than high scores. Criteria for scoring includes two main grading criteria. The first criteria is a pollution burden which considers all of the following in its grading system: Ozone quality, Particulate Matter, Diesel Particulate Matter, Pesticide Use, Toxic Release from Facilities, Traffic Density, Drinking Water Contamination, Cleanup sites which are sites with chemical contamination, Groundwater Threats, Hazardous Waste Facilities, Impaired Water Bodies, and Solid Waste Facilities. The second overall part of the grade is called Population Characteristics which includes all of the following in its grading criteria: Asthma Rate, Low Birth Infant Rate, Cardiovascular Disease Rate, Education Attainment, Linguistic Isolation which is households who speak limited English, Poverty Rate, Unemployment Rate, and Housing Burden which are low income households that spend a majority of their budget on their home.  The 15 Census Blocks in Redlands which are within the blue lined border, with darker reds and oranges being worse grading, and greens and yellows being better ratings (OEHHA, 2018; Figure 2). These grades will be compared when applied to DAC which is shown by the DWR mapping tool (DWR, 2018; Figure 3).

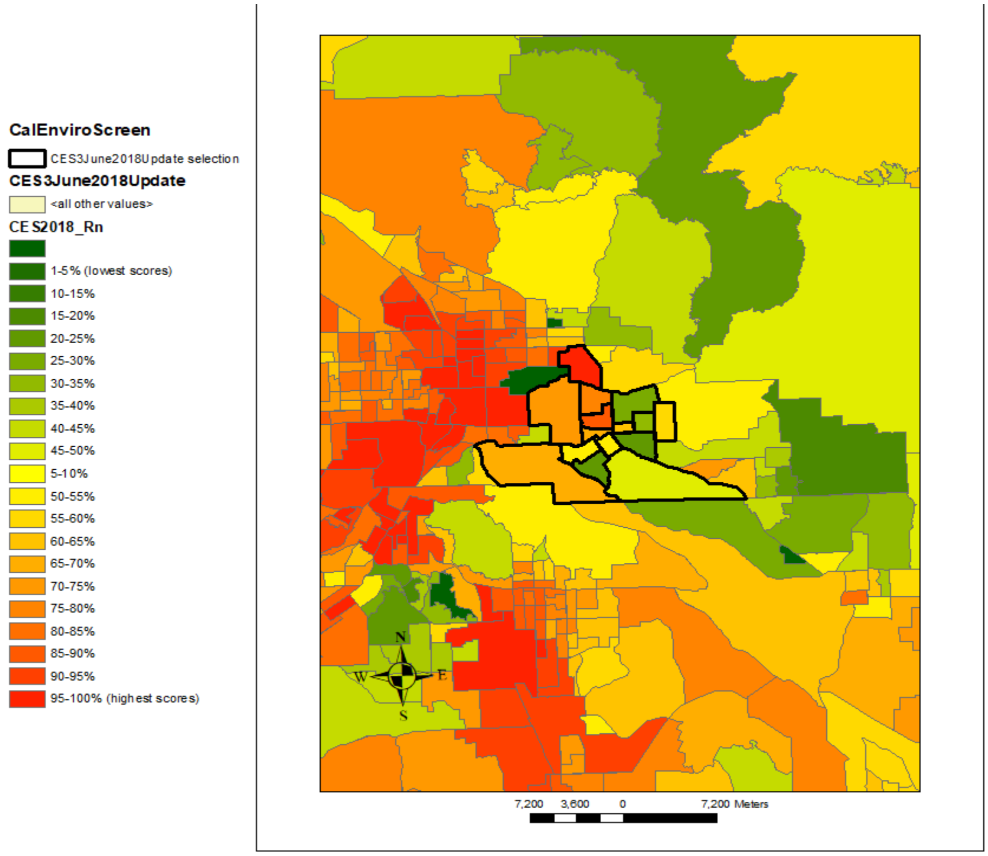



Figure 2. CalEnviroScreen Overview of Redlands (OEHHA, 2018).

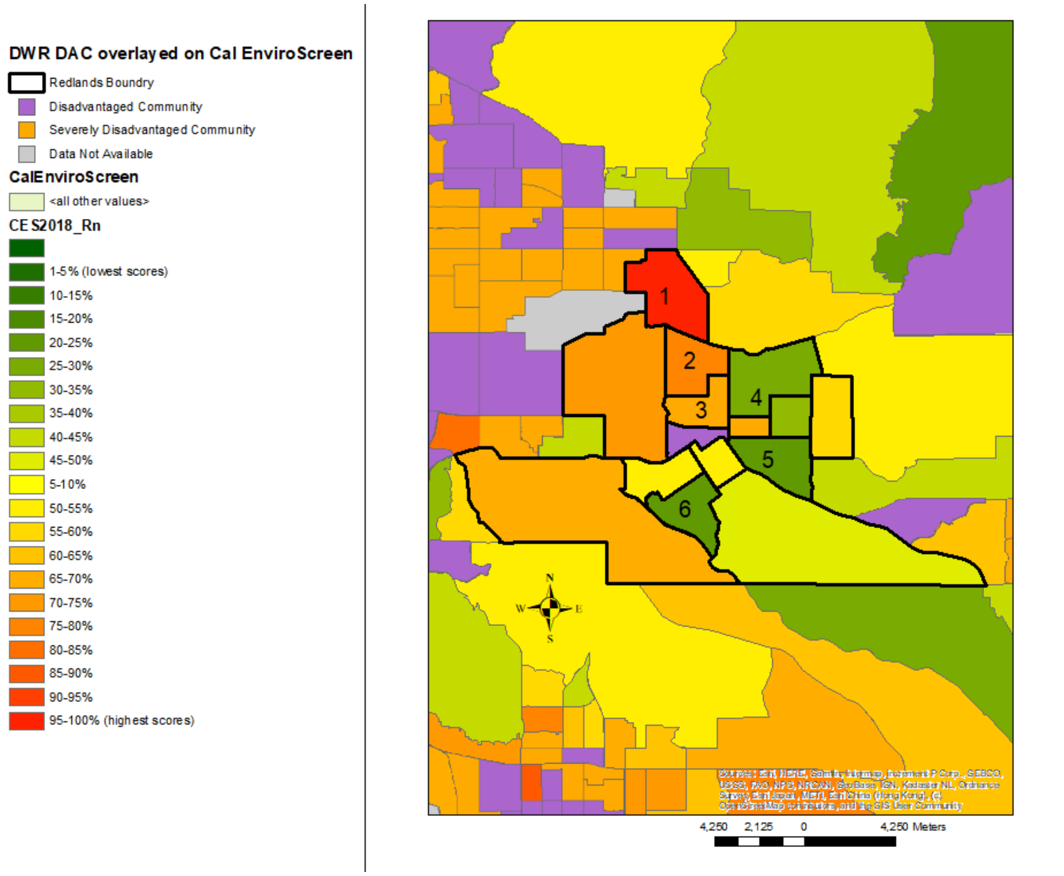



Figure 3. DWR DAC Mapping Tool with CalEnviroScreen Scores (DWR, 2018; OEHHA, 2018).

For the purpose of this research the three best grades and three lowest grades will be focused on when comparing across the other GIS tools used. Figure 5 highlights the 6 areas that will be focused on. Note that the three highest and three lowest scoring areas within the city were chosen (green scores are better than red and orange scores) (OEHHA, 2018).

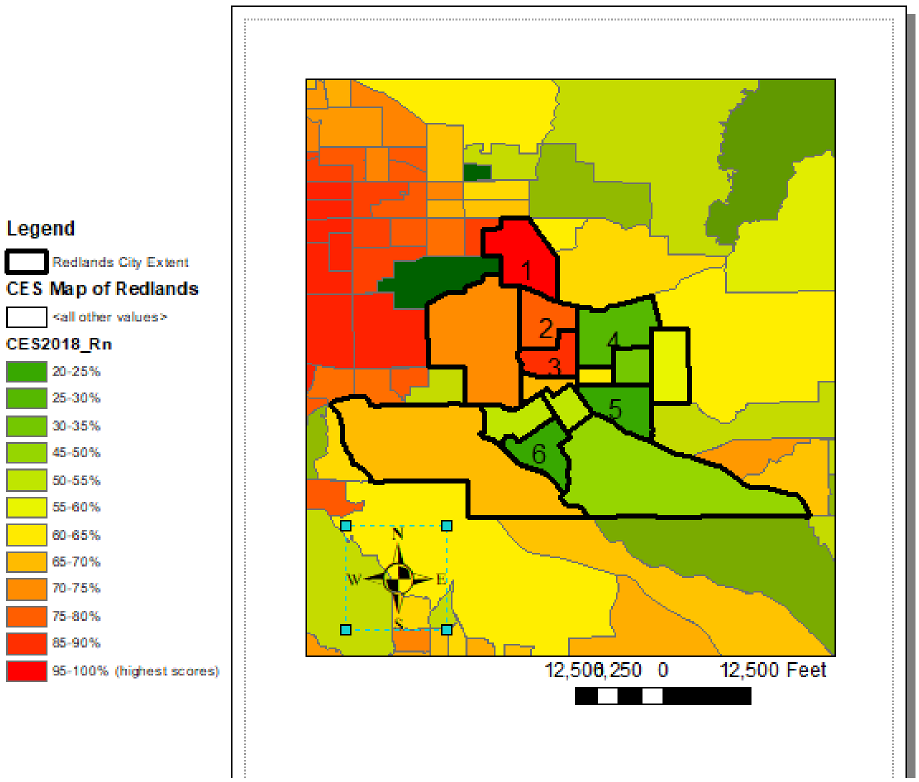



Figure 4. CalEnviroScreen Six Tract Focus (OEHHA, 2018).

Table 1 explores the 6 tracts and their respective scores along with their populations. One thing to note is that higher scores are worse grades overall while lower scores are better grades overall. Viewing Table 1, it is easy to see a major disparity within the city of Redlands. For example, tract 3 is classified as a disadvantaged community within the state of California according to the DWR

DAC tool with a HMI of 33,093. Although this is the only listed DAC within the six tracts chosen there are indicators in tracts 1, 2, and 3 that show these areas struggling economically, as well as dealing with major health and environmental hazards. There is an obvious racial disparity within the city with the first three tracts grading worse in the top 3 categories compared to tracts 4-6 which graded highest within the city. Table 1suggest a climate program would be best to serve the first three tracts rather than the last three.

Table 1. Tract Comparison 1.0 (OEHHA, 2018; DWR, 2018).

| Tract | CalEnviroScreen Percentile | Pollution Burden Percentile | Population Characteristics Percentile | Population | Highest Ethnicity Percentage | DWR DAC MHI for Listed Tracts Only |
|---|---|---|---|---|---|---|
| Tract 1 | 95-100% | 93% | 87% | 4,306 | 48% Hispanic | N/A |

| | | | | | | |
|---|---|---|---|---|---|---|
| Tract 2 | 75-80% | 82% | 76% | 7,256 | 54% Hispanic | N/A |
| Tract 3 | 85-90% | 84% | 66% | 6,513 | 66% Hispanic | 33,093 |
| Tract 4 | 25-30% | 46% | 20% | 9,953 | 51% White | N/A |
| Tract 5 | 20-25% | 59% | 15% | 5,833 | 67% White | N/A |
| Tract 6 | 20-25% | 39% | 19% | 3,106 | 76% White | N/A |

Urban Tree Canopy Coverage in California mapping tool provided by the forest service allows this project to explore the coverage within the city of Redlands and the specific 6 tracts selected for the study. Figure 6 shows the Redlands area along with the 6 census tracts selected for the study. Dark blues have canopy coverage under 14%, light blue between 15-24%, and green is 25-41%. Tract 1 which ranked as the worst in the city under the CalEnviroScreen and is considered a disadvantaged community in California is also the only area of the city with under 14% canopy coverage (OEHHA, 2018). Tracts 2 and 3 which ranked worse than tracts 4 to 6 have low canopy between 15-24%. Tract 4 is the only tract of the higher scoring tracts that is considered low canopy coverage with also having between 15-24%. Tracts 5-6 are among the best scores in the city for the CalEviroScreen also have some of the highest scores for canopy coverage in the city (OEHHA, 2018). In general, there is an obvious difference between north and southern Redlands tree canopy coverage with the southern half being more in the green higher ranking categories and the northern half being in the blue higher scoring categories. It would be recommended that a tree program focus on the northern side of the city while also targeting the more disadvantaged areas of Redlands population. (Forest Service, 2018).

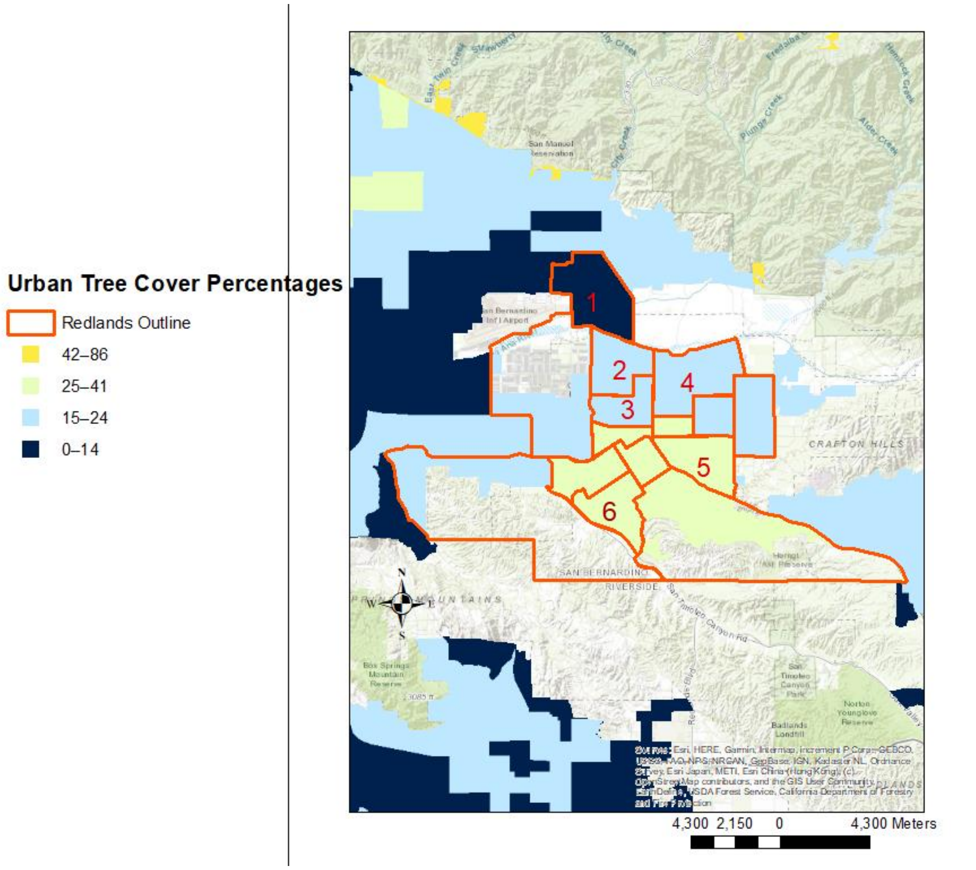



Figure 5. Tree Coverage (Forest Service, 2018)

Table 2 explores some of the specific CalEnviroScreen scores that affect tree equity issues like poverty rate along with areas that are specifically affected by lack of trees such as Asthma, Cardiovascular, Groundwater Threats (GWT), Particulate Matter (P.M.), and Diesel Particulate Matter (DPM). These categories were chosen because it has been observed that these issues were discussed as trees tend to have an effect within these categories (Ahn, Kim, 2021; Kontokosta, Lai, 2019; El-Khatib et al. 2003; Nowak et al. 2018; Forest

Service, 2012; Bradford et al 2013; Cooper et al. 2005; Crane, Nowak, Stevens, 2006; Nowak et al. 2018; Bradford et al. 2013). Tracts 1 to 3 with higher poverty scores which also have lower tree coverage also tend to have higher risk of Asthma and Cardiovascular disease aside from Tract 6 which has the highest cardiovascular rate within the 6 tracts. It is worth noting that in tract 1 this area has the lowest tree canopy and also has the highest Asthma rate by far, and the second highest Cardiovascular rate. The two lowest ranking GWT scores in tract 1 and 3 also score poorly when it comes to tree canopy while tracts 4, 5, and 6 have some of the lower ratings indicating their groundwater situation is better. An anomaly to note is the low rate of GWT for Tract 2. P.M. is relatively consistent among the 6 tracts, but DPM is where there are some changes. Tracts 1-3 greatly suffer from DPM with Tract 3 being the worst which could be due to its proximity from freeways. Tract 5 also has an high DPM when compared especially for scoring so high in other categories but this likely due to the proximity of freeways to this tract area. Drawing conclusion that tracts 1-3 are suffering from higher asthma rates and generally higher Cardiovascular rates, GWT, and DPM with a few expectations because of the significant lack of tree coverage in these areas compared to the tracts 4-6 areas.

Table 2. Comparing Tract Metrics (OEHHA, 2018).

| Tract | Poverty | Asthma | Cardiovascular | GWT | P.M. | DPM |
|---|---|---|---|---|---|---|
| Tract1 | 66 | 75 | 78 | 43 | 69 | 58 |
| Tract2 | 55 | 52 | 58 | 9 | 69 | 60 |
| Tract3 | 89 | 52 | 58 | 57 | 69 | 78 |
| Tract4 | 31 | 50 | 53 | 9 | 69 | 42 |
| Tract5 | 6 | 49 | 56 | 36 | 69 | 69 |
| Tract6 | 20 | 45 | 87 | 0 | 84 | 28 |

Urban Heat Island Index mapping tool provided by the California EPA provides scores on how areas are affected by Urban Heat Island Effect. Figure 7 shows Redlands and its Urban Heat Index. The reason for exploring urban heat island effect is because research has shown greater tree coverage can combat urban heat island effect (Song, et al. 2015; Cox et al. 2009). Table 3 explores scores between the 6 selected tracks. The score given is the average change in temperature throughout the 24-hour day in Fahrenheit. It is worth noting that the three worst temperature differences were found in tracts 4, 5, and 1, with the lowest being tracts 2,6, and 3. It is important to note also that Urban Heat Island Index temperature changes does not mean an area has higher temperatures but greater temperature changes (CalEPA, 2022).

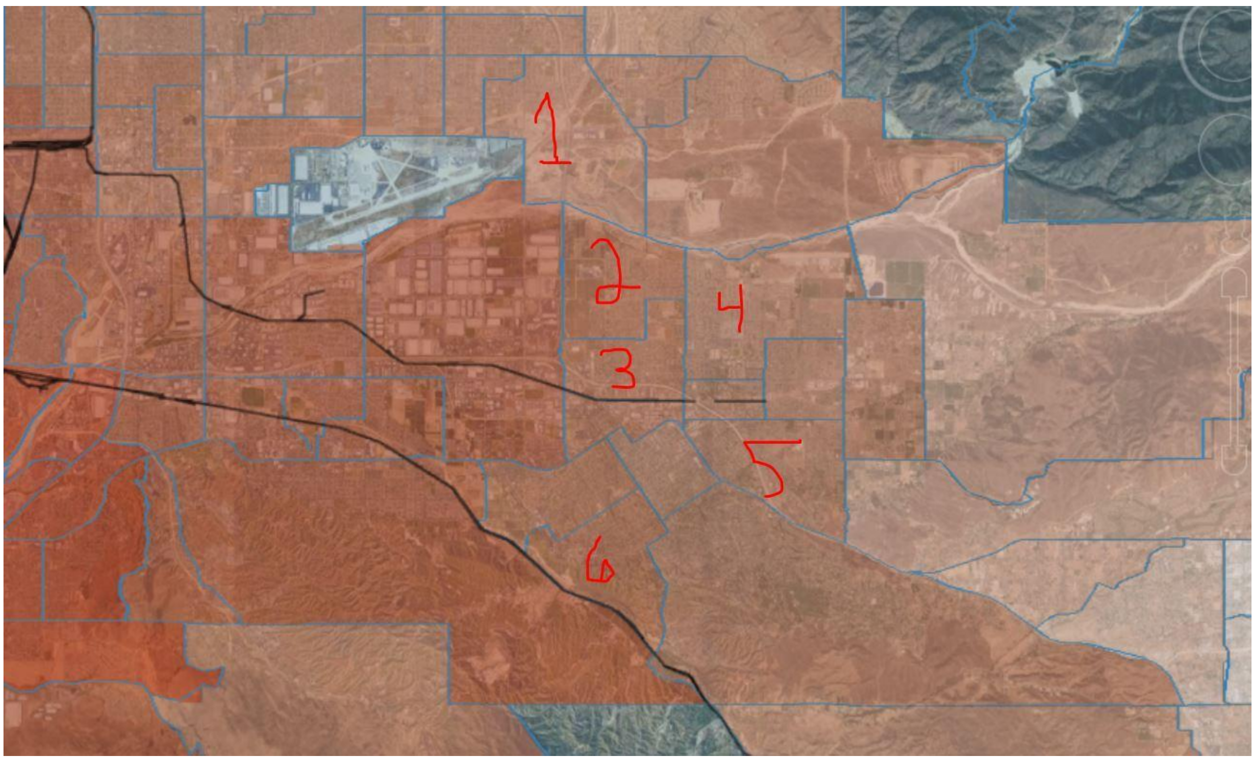



Figure 6. Urban Heat Island Effect 1.0 (CalEPA, 2015).

Table 3. Temperature Changes (CalEPA).

| Tract | Temperature Change (degrees in Fahrenheit) |
|---|---|
| Tract 1 | 15.1 |
| Tract 2 | 14.73 |
| Tract 3 | 14.98 |
| Tract 4 | 15.26 |
| Tract 5 | 15.25 |
| Tract 6 | 14.84 |

## Case Study: Northern Redlands Communities

### Case One: Tracts One and Six

Comparison one is between Tract one and Tract six since their population sizes are comparable. The first thing to compare below is Figure 8 which is the race and ethnicity chart for tract 1 while Figure 9 is the ethnicity chart for tract six. Tract six has an obvious difference with a white population at 76% while it is only at 31.7% in Tract one. Tract one greatest ethnicity population is Hispanic at 47.5% while Hispanic is at only 15% in tract six. These racial differences need to be noted as these areas are compared to note the disparities across these two tracts. It is important to note that between these two tracts, tract one has a lower tree coverage with under 14% while Tract 6 ranges between 25% and 41%. This is expected as the literature review shows how many California cities deal with tree equity issues across areas of ethnicity with minority areas of the city having fewer trees than White areas (Moran, 2021; Cusick 2021; SacTree; Metcalfe, 2021).

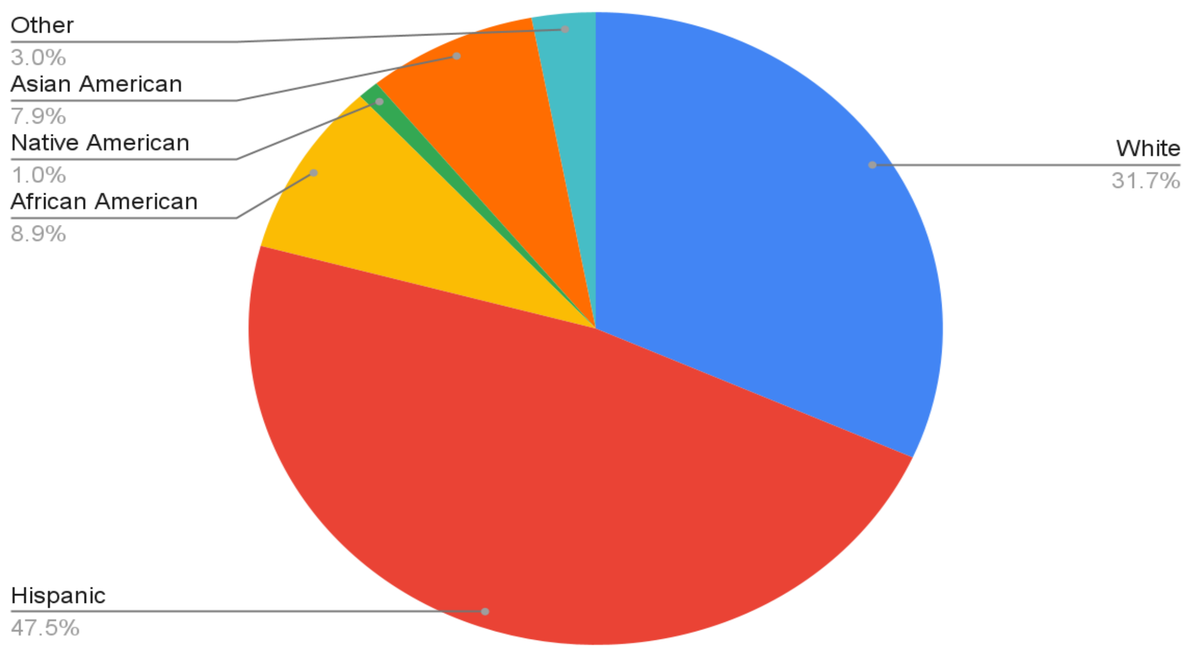
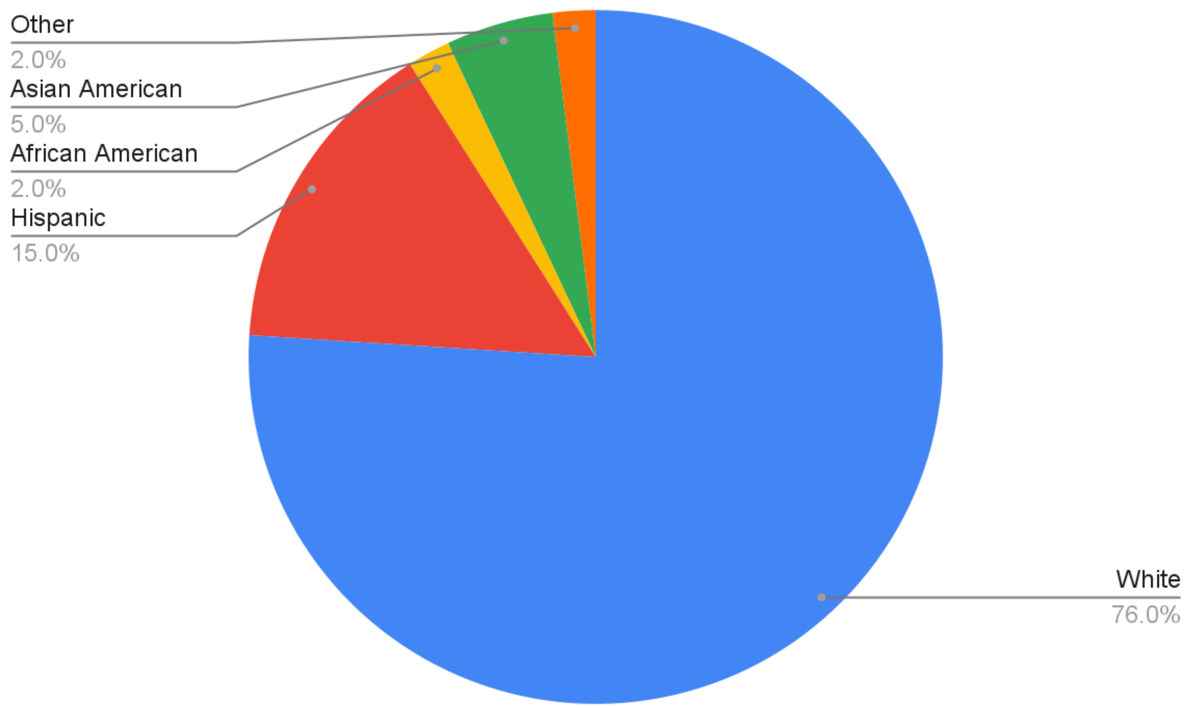



Figure 7. Ethnicity for Tract One (OEHHA, 2018).




Figures 8. Ethnicity for Tract Six (OEHHA, 2018).

Table 4 further explores the comparison between these areas. Table 4 explores CalEnviroScore (CES), pollution burden percentage score (PB), Population Characteristics Percentile (PC), Tree Coverage percentage (TC), Temperature Difference average (TD), and population. Between these two tracts there are some obvious differences between the two tracts that start with their CES score. Tract 1 scores in the highest category possible which causes the state to view tract 1 as a disadvantaged community. Tract 1 also has a greater pollution burden and greater overall population characteristic difference compared to tract 6. These two would indicate that tract 1 would be at greater risk for climate change than tract 6 (Bethel et al. 2021; Cuffe et al. 2018; Alverado et al. 2021; California Gov 2020). Finally, TC has a great difference with tract 1 scoring less than 14% and tract 6 scoring in the next category which means it has coverage at least above 25% more than doubling the tree coverage of Tract 1 at the least. Tract 1 is expected to have lower tree coverage with high PB, PC, and high minority populations in their tract (Boone et al; 2015, Locke and Grove; Heynen, Perkins, & Roy, 2006; Heynen, Perkins, & Roy, 2006; Pedlowski, Da Silva, Adell, & Heynen, 2002; Boone et al; 2015). Finally temperature difference is greater in tract one which means it has a worse urban heat island effect when compared to tract 6. The lower tree coverage in the tract would indicate worse urban heat island effect (Bowler et al 2010; Andrade et al 2011; Song et al, 2013).

Table 4. Case Study 1.1 Comparing Tracts One and Six (OEHHA, 2018; Forest Service, 2018; CALEPA).

| Tract | CES | PB | PC | TC | TD | Population |
|---|---|---|---|---|---|---|
| Tract 1 | 95-100% | 93% | 87% | 0-14% | 15.1 | 4,306 |
| Tract 6 | 20-25% | 39% | 19% | 25-45% | 14.84 | 3,106 |

Table 5 further explores PB and PC scores more specifically by exploring 3 categories in each section that help make up the total score. The scores for pollution burden that are closely examined are DPM, GWT, and Traffic Density. The reason for DPM and traffic density is because they can be indicators for higher pollution especially in DACs (Houstan et al, 2008; Brugge et al, 2020), and higher pollution rates particularly particulate matter can often be associated to areas with low tree coverage (El-Khatib et al. 2003; Nowak et al. 2018). GWT are examined because higher tree coverage often indicates less contamination in groundwater (Forest Service, 2012; Cooper et al. 2005). While the three for PC are Asthma, Poverty, Cardiovascular Rate (CR) which are often indicators for tree coverage All three of which are often indicators for tree coverage with higher rates having less trees and lower rates having more (Ahn, Kim, 2021; Kontokosta, Lai, 2019; Boone et al; 2015, Locke and Grove; Heynen, Perkins, & Roy, 2006; El-Khatib et al. 2003; Nowak et al. 2018). Tract one which has higher scores in every single category except CR. Some of the notable differences are in the traffic density which shows tract 6 with a low score of 7 and Tract one with a score of 58 which exposes the population to a lot more pollution from traffic conditions. This is further seen when comparing the DPM differences which is Particulate Matter pollution that is specifically from buses, trucks, and other vehicles and equipment that use diesel engines. DACs and minority communities like tract 1 often face greater emission threats primarily due to their homes and schools being located in closer proximity to roads and highways (Houstan et al, 2008; Brugge et al, 2020).  Another notable difference is the poverty rate is much higher in tract one along with the Asthma rate. Poverty is often an indicator for low tree coverage which tract 1 has when compared with tract 6 (Boone et al; 2015; Locke & Grove, 2014). The asthma rate being higher is also often associated with lower tree coverage while greater tree coverage tends to have lower rate when compared which is the case for tract 1 and tract 6 (Ahn, Kim, 2021; Kontokosta, Lai, 2019). The only area that is higher for tract 6 is CR but the difference is less than 10 pts.

Table 5. Case Study 1.2 Exploring Risks Associated with Tree Cover Tracts One and Six (OEHHA, 2018).

| Tract | DPM | GWT | Traffic Density | Asthma | Poverty | CR |
|---|---|---|---|---|---|---|
| Tract 1 | 58 | 43 | 58 | 75 | 66 | 78 |
| Tract 6 | 28 | 0 | 7 | 45 | 20 | 87 |

Tract 1 is dealing with many socioeconomic disparities compared to tract 6. It has a much higher pollution burden, traffic density, it is more prone to asthma, has an extremely high poverty rate, and a much lower tree density compared to tract 6. The lack of tree coverage in minority communities is expected as the literature review has shown areas not only in California but throughout the country that struggle with tree equity in poor and minority areas (Poon, 2021; Duke 2021; Hammer 2021; American Forests; Lara, Manthey, 2021; Wright, 2021; Moran, 2021; Cusick, 2021).

Case Two: Tracts Two and Five

Comparison Two is between tract 2 and 5 since their population sizes are comparable. Figures 10 and 11 explore the ethnicity chart of the two respective tracts. The first major difference in tract two has a majority Hispanic population at 54% while tract 5 only has a Hispanic population at 19%. Tract 5 majority is 67% white while tract two has only 26% white. With both of these ethnic population characteristics in hand it is important to note tree coverage between the two tracts differ. Tract two is between 15-24% tree coverage while tract 5 is between 24-41% tree coverage. Again, much like the comparison across tract 1 and 6 tract 2 and tract 5 show tree disparity in minority greatly Hispanic communities compared to the majority white lead tract 5. This also goes along with the literature review finding tree equity issues throughout the state of California (Moran, 2021; Cusick 2021; SacTree; Metcalfe, 2021).

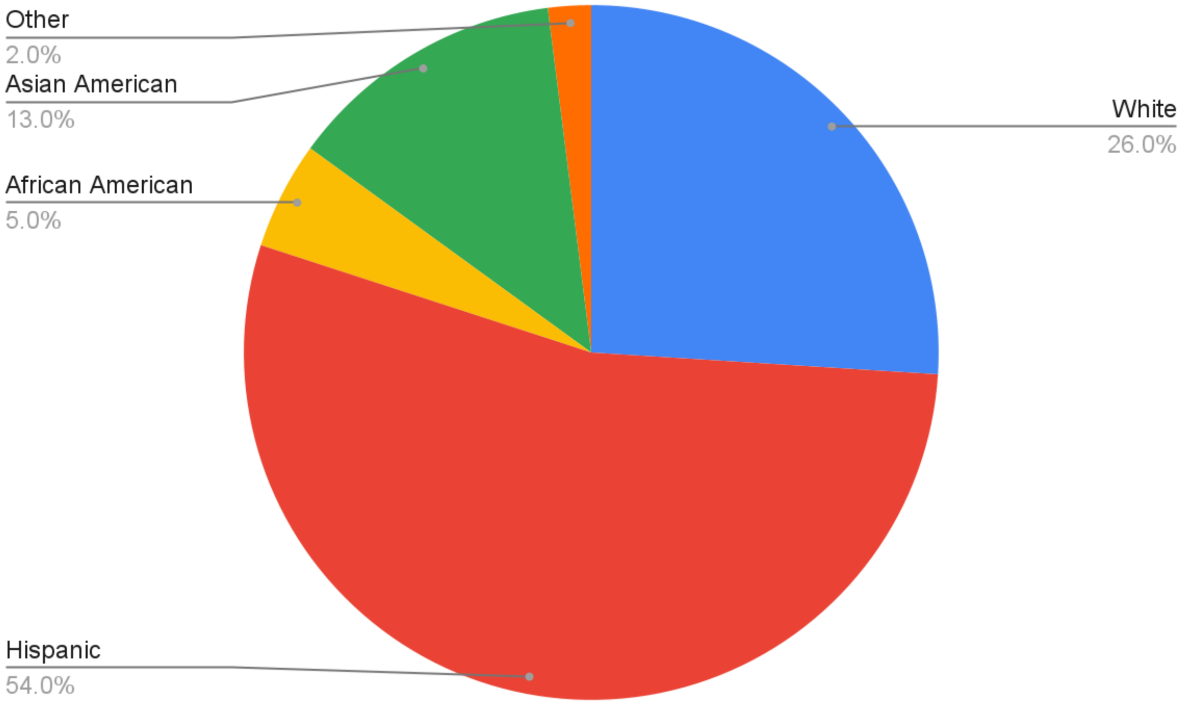
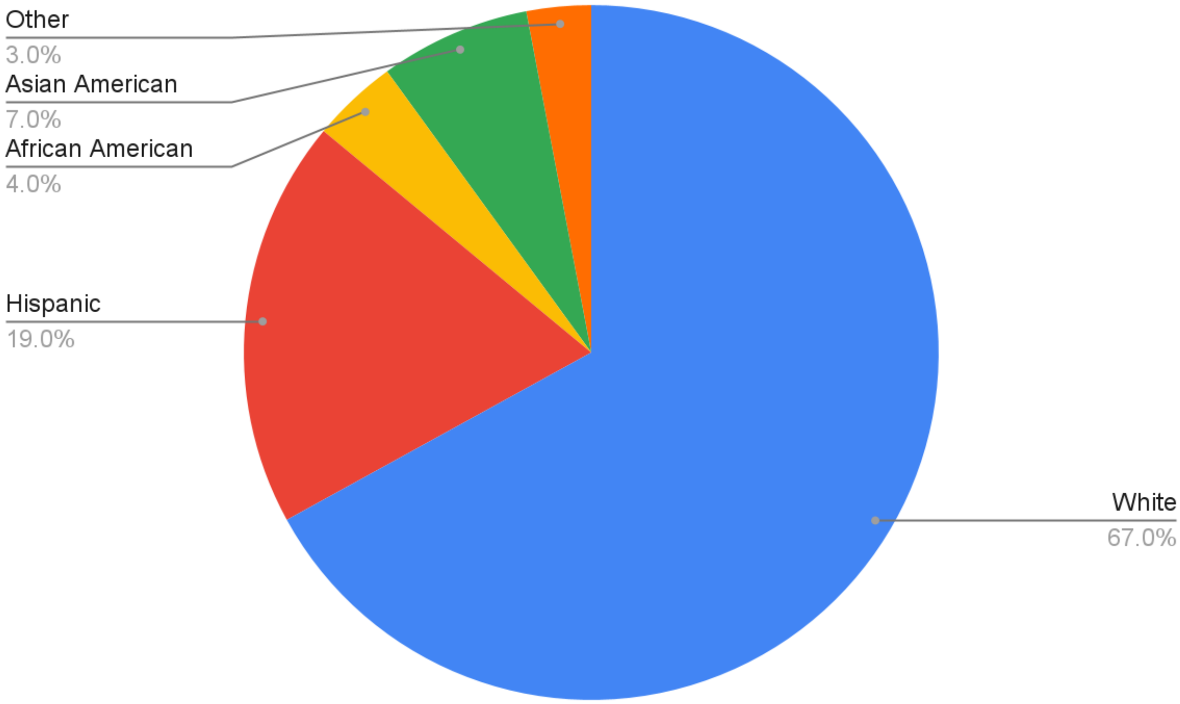



Figure 9. Ethnicity Case Study 2.0 Tract Two (OEHA, 2018).




Figures 10. Ethnicity Case Study 2.0 Tract Five (OEHA, 2018).

Table 6 further explores the comparison between these areas. Table 6 explores CalEnviroScore (CES), pollution burden percentage score (PB), Population Characteristics Percentile (PC), Tree Coverage percentage (TC), Temperature Difference average (TD), and population. Tract two has higher PB, higher PC, and lower TC when compared against Tract 5. The higher scores for PB and PC indicate a greater risk for climate change effects than tract 5 (Bethel et al. 2021; Cuffe et al. 2018; Alverado et al. 2021; California Gov 2020). Even with the greater TC tract 5 still has the highest TD between the two dealing with major urban heat island effect, although tract 2 is not far behind. The lower PB, PC, and higher minority population all indicate the lower TC that tract 2 has when compared to tract 5 (Boone et al; 2015, Locke and Grove; Heynen, Perkins, & Roy, 2006; Heynen, Perkins, & Roy, 2006; Pedlowski, Da Silva, Adell, & Heynen, 2002; Boone et al; 2015).

Table 6. Case study 2.1 Tracts Two and Five Exploring Tree Coverage and Risk Indicators (OEHHA, 2018; Forest Service, 2018; CALEPA).

| Tract | CES | PB | PC | TC | TD | Population |
|---|---|---|---|---|---|---|
| Tract 2 | 75-80% | 84% | 66% | 15-24% | 14.73 | 6,513 |
| Tract 5 | 20-25% | 59% | 15% | 25-45% | 15.25 | 5,833 |

Table 7 further explores PB and PC scores more specifically by exploring 3 categories in each section that help make up the total score. The scores for pollution burden that are closely examined are DPM, GWT, and Traffic Density. The reason for choosing DMP and traffic density is because these are often indicators for higher pollution emissions in DACs (Houstan et al, 2008; Brugge et al, 2020), and higher pollution is often an indicator for lower tree coverage (El-

Khatib et al. 2003; Nowak et al. 2018). While the three for PC are Asthma, Poverty, Cardiovascular Rate (CR), all three of which are often indicators for tree coverage with higher rates having less trees and lower rates having more (Ahn, Kim, 2021; Kontokosta, Lai, 2019; Boone et al; 2015, Locke and Grove; Heynen, Perkins, & Roy, 2006; El-Khatib et al. 2003; Nowak et al. 2018). Tract two has a much higher poverty rate which would coincide with the literature review showing how communities that struggle economically tend to have less trees when compared to communities with more affluence (Boone et al; 2015;  Locke & Grove, 2014; Heynen, Perkins, & Roy, 2006). Another area to note is the higher DPM in tract two when compared with tract. This is also expected as areas with higher tree coverage tend to have better air quality (Crane, Nowak, Stevens, 2006; Nowak et al. 2018). Less pollution also leads to less cardiovascular disease which is also observed with tract 2 having higher rate or CR than tract 5 (El-Khatib et al. 2003; Nowak et al. 2018). Lastly, Table 7 how close the traffic density is to each other, which can be attributed to both tracts having a freeway go through them.

Table 7. Case Study 2.2 Tracts Two and Five Exploring Risks Associated with Less Tree Cover (OEHHA, 2018).

| Tract | DPM | GWT | Traffic Density | Asthma | Poverty | CR |
|---|---|---|---|---|---|---|
| Tract 2 | 60 | 9 | 71 | 52 | 55 | 58 |
| Tract 5 | 55 | 36 | 70 | 49 | 6 | 56 |

Case Three: Tracts Three and Four

Comparison three is between the last remaining focus tracts of tract 3 and tract 4. Like before the ethnicity chart and the tree coverage will be compared between the tracts with figure 12, and 13 exploring the ethnicity chart of the tracts. There is a stark difference with regards to tract 3 representing a majority Hispanic population at 66% while tract 4 is only at 30.3%. Within Tract 4 the greatest population is white at 51.5% with tract 3 having white at 17%. The difference observed in this study would indicate the greater white majority tract 4 would have higher tree coverage when compared to tract 3 (Moran, 2021; Cusick 2021; SacTree; Metcalfe, 2021). Yet observations include that both of their tree coverage is the same percentage score between 15 to 24%. This would be the only example of our 3 case studies in which the majority white population did not exceed the percentage category of the minority opposing tract. It is also worth noting that table 1 shows tract 3 as the only DAC recognized by the state.

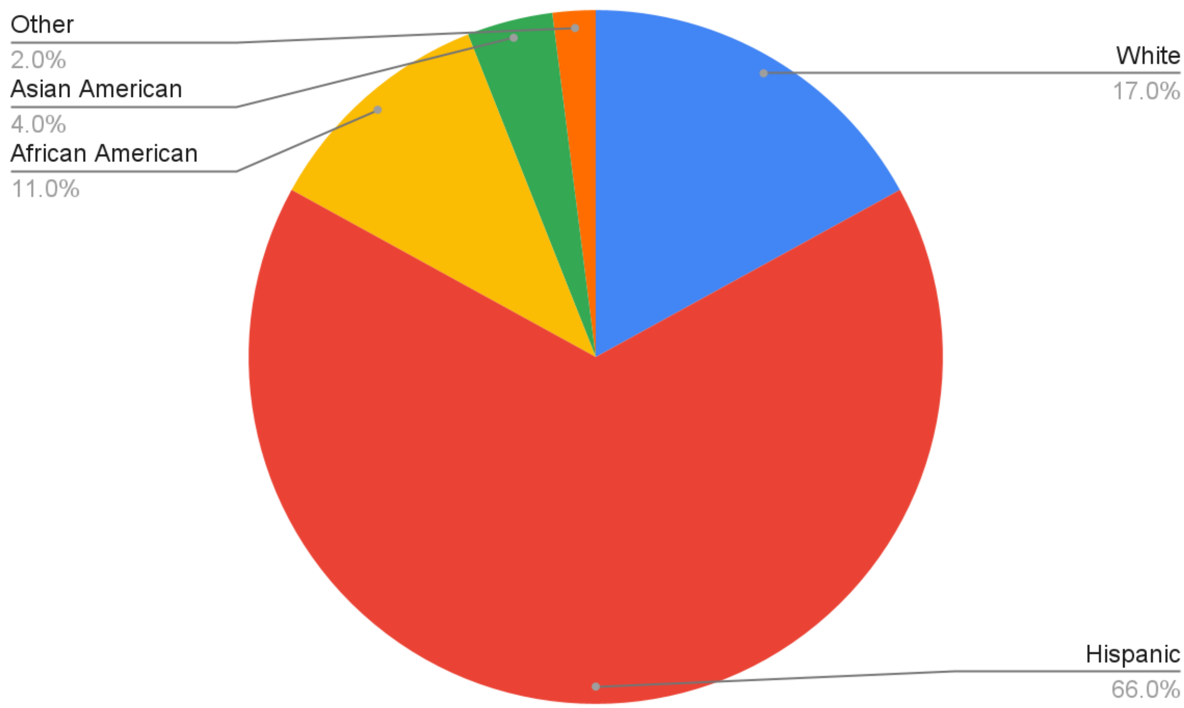



Figure 11. Ethnicity 3.0 Tract Three (OEHHA, 2018).

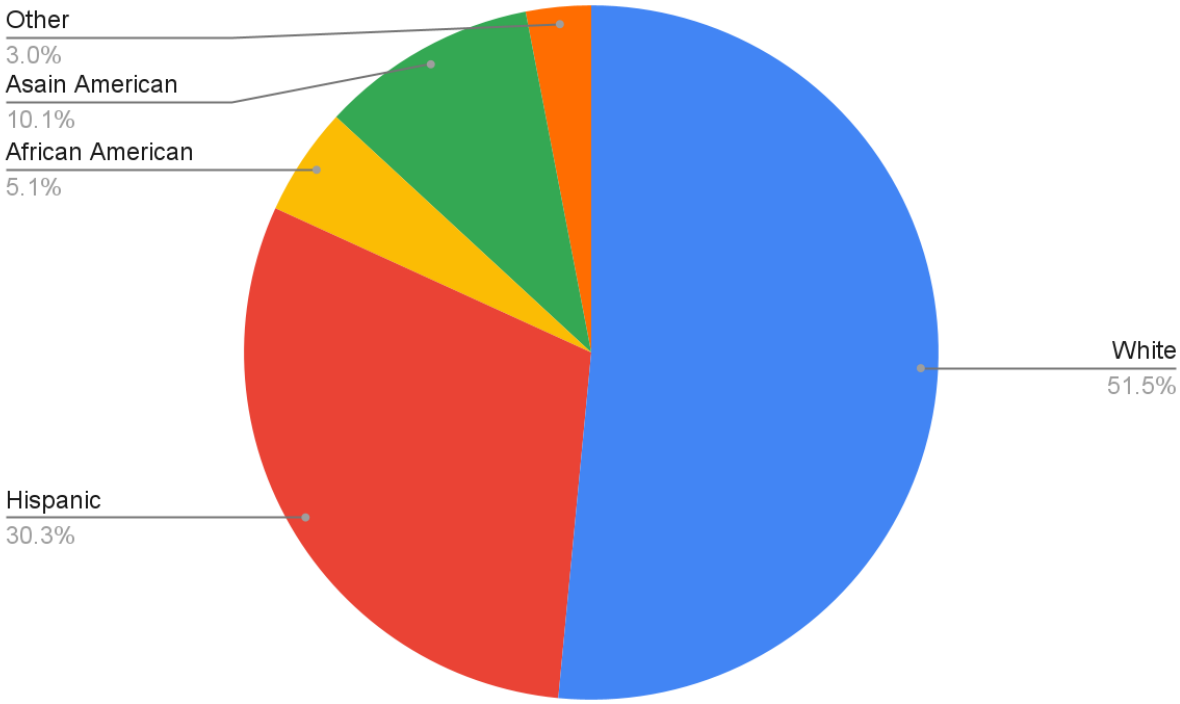



Figure 12. Ethnicity 3.0 Tract Four (OEHHA, 2018).

Table 8 explores CalEnviroScore (CES), pollution burden percentage score (PB), Population Characteristics Percentile (PC), Tree Coverage percentage (TC), Temperature Difference average (TD), and population. Tract 3 has much worse scores in terms of CES, PB and PC. When comparing to tract 3 against 4 one areas that shows a great distinction is PC which would indicate tract 4 has more affluence compared to tract 3, and affluence often is an indicator for having more tree coverage (Boone et al; 2015; Locke & Grove, 2014; Heynen, Perkins, & Roy, 2006), this is not the case between these tracts which are both in the same TC percent ranges. Along with having the same tree coverage rates tract 4 also has higher TD when compared to tract 3.

Table 8. Case Study 3.1 Exploring Indicators Tracts Three and Four (OEHHA, 2018; Forest Service, 2018; CALEPA).

| Tract | CES | PB | PC | TC | TD | Population |
|---|---|---|---|---|---|---|
| Tract 3 | 85-90% | 82% | 76% | 15-24% | 14.98 | 7,256 |
| Tract 4 | 25-30% | 46% | 20% | 15-24% | 15.26 | 9,953 |

Table 9 further explores PB and PC scores more specifically by exploring 3 categories in each section that help make up the total score. The scores for pollution burden that are closely examined are DPM, GWT, and Traffic Density. The reason for DPM and traffic density is because they can be indicators for higher pollution especially in DACs (Houstan et al, 2008; Brugge et al, 2020), and higher pollution rates particularly particulate matter can often be associated to areas with low tree coverage (El-Khatib et al. 2003; Nowak et al. 2018). GWT is chosen because less groundwater contamination can often be associated with higher tree cover (Forest Service, 2012; Cooper et al. 2005). While the three for PC are Asthma, Poverty, Cardiovascular Rate (CR) because these three rates often indicate tree coverage with lower rates having more coverage and higher rates having less (Ahn, Kim, 2021; Kontokosta, Lai, 2019; Boone et al; 2015, Locke and Grove; Heynen, Perkins, & Roy, 2006; El-Khatib et al. 2003; Nowak et al. 2018). A closer examination shows why tract 3 has such a higher PB percentage score. GWT and traffic both pop out as low scores especially in comparison to tract 4. Another great disparity is between the poverty rates which is much higher in tract 3. Although tract 3 also has higher Asthma and CR they aren't as staggering differences.

Table 9. Case Study 3.2. Exploring Risks Associated with Less Tree Cover Tracts Three and Four (OEHHA, 2018).

| Tract | DPM | GWT | Traffic Density | Asthma | Poverty | CR |
|---|---|---|---|---|---|---|
| Tract 3 | 78 | 57 | 75 | 52 | 89 | 58 |
| Tract 4 | 42 | 9 | 18 | 50 | 31 | 53 |

# CHAPTER FIVE

# SUMMARY AND CONCLUSIONS

California Climate Action Core has a strategic goal to provide trees to Residents in North Redlands. It worked well by choosing community partnership to increase participation, providing free trees to increase participation, working with master gardeners to help increase tree survival, and working with the city of Redlands to increase the program's capacity all of which are shown to increase success of tree programs. (Kretzer et al. 2020; Bowman, Stegg 2020; Norco, 2018; Monrovia, 2020; MBC, 2021; CCI, 2018; USC, 2021; CaseyTrees, 2021; Battles et al; 2013; Fischer et al; 2016;). The California Climate Action Core Redlands Tree Project had limitations in other areas though such as not expanding community partnership and engagement and having the bulk of the program's trees planted in Tract 4 as opposed to more disadvantaged tracts discussed such as 1, 2, and 3.

## Climate Action Core Redlands Successes and Limitation

### Successes

First Success was by choosing to work with Community Partners like Common Vision Coalition which is a local community organization in North Redlands which the North Redlands is familiar with. The Common Vision Coalition helped table with the team to try and gain participants within the community, and it also helped organize a large-scale planting at Redland's Sport Park. Common Vision Coalition is run by North Redlands residents who understand the needs of the community since they are a part of it which is a major component in gaining participation and trust (Chappin et al; 2013; Kretzer et al. 2020). This partnership would help with tabling events the Climate Fellows held to help bring trust and familiarity to the project. Similar to other programs utilizing community partnership helps to increase overall participation (USC, 2021; CaseyTrees, 2021). The community partnership will only benefit the program going forward.

Second Success of the program is through providing the trees free of cost. This is a common strategy to use to increase participation in tree programs (Norco, 2018; Monrovia, 2020; MBC, 2021; CCI, 2018). Yet, the program took it a step further by also targeting not only areas with low tree density but also DACs in Redlands. This is another strategy often used to serve DACs and increase participation from DACs (USC, 2021; CCI, 2018). The program wanted to target tracts 1, 2, and 3 which according to the CES tool were the most disadvantaged areas in the city with high PB, high PC, overall, the three highest CES scores (Table 1), and all three have high minority populations with the majority of all tracts being Hispanic. Being predominantly minority tracts, having high scores on the CES tool which means these areas are disadvantaged indicate these tracts are at greater risk for climate change issues (Bethel et al. 2021; Cuffe et al. 2018; Alverado et al. 2021; California Gov 2020). Like other minority and poor communities these areas are at greater risk for pollution related diseases, and heat related health issues (Garnaut, 2011; Harvison et al. 2011; Kinay et al. 2018). While increased tree coverage can combat these issues, Redlands like other cities is having unequal equity when compared to white, affluent areas (Heynen, Perkins, & Roy, 2006; Pedlowski, Da Silva, Adell, & Heynen, 2002; Boone et al; 2015). Providing free trees and targeting areas not only with low TC but with high CES scores helps assure the program serves the communities most at risk.

Third Success is from using the master gardeners as a resource to help with future tree care to assure trees survive to their max potential and climate benefit. Master Gardener (MGs) roles would come after the initial planting of the tree. Having early access to MGs who can help post planting especially in the early stages of tree development and so close to post planting can increase tree survival (Fischer et al; 2016).  The gardeners would provide advice on care, maintenance, watering, and other essentials to tree survival on the request of residents participating in the tree program. Having the MGs provide advice and do general monitoring can increase tree survival (Barnes et al, 2013; Fischer et al; 2016). This partnership could help convince novice planters to take on a tree while helping to assure tree survival. Using MGs to help with advice, maintenance, and tree monitoring is similar to other programs who used volunteers, or government for these roles with the same goal of helping the community realize the max benefit of their trees (USC, 2021; CaseyTrees, 2021; Norco, 2018; Monrovia, 2020).

Fourth Success is that the tree program was able to work with the city of Redlands to plant trees, and specifically through large scale planting. Focusing on large scale plantings as opposed to individual residential homes is a strategy shown to have success with other tree programs (CaseyTrees, 2021). In the case of Redlands, the city approved large scale planting of trees within one of its parks, and also agreed to take the cost of watering. The Redland's program is not the only one that works with the government to maintain trees, as other similar urban canopy projects also rely on government support in terms of helping to maintain healthy trees (Norco, 2018; Monrovia, 2020). This partnership opens the door for future large-scale plantings within the parks of Redlands.

## Limitations

First limitation is in only finding one community partnership and struggling with community engagement. Although the Common Vision Coalition is a great community partnership the program would have benefited from more partnerships especially those known locally to Redlands. This would help the program understand the needs of the community better which is an important piece of engaging with the community (Fortinsky et al. 2020). Understanding the community needs better could lead to more effective engagement by pairing the goals of the program with the needs of the community (Fecht et al 2020; Barrett et al 2016; Bowman, Stegg 2020). Research shows the most significant climate action comes not from government but through citizen participation (Kretzer et al. 2020; Bowman, Stegg 2020). The program was limited  due to Covid that it could not effectively add new community partners or properly engage the community. Hearing the community needs, and fitting program goals to fit those needs are also strategies that have served other climate action programs well (Chappin et al; 2013; Kretzer et al. 2020). As the program grows and Covid becomes less prevalent it would be wise to use some of these strategies going forward.

Second Limitation is the lack of trees planted in residential areas, and focusing planting on more affluent areas of the city. Most trees planted in the program were planted in Redlands Sport Park which from the comparisons is a part of tract 4 (Berry et al, 2021). In total the program planted 84 trees, with 71 going in Redlands Sports Park and 13 going to residential households (Taylor, 2021; Berry et al, 2021). Although Redlands Sport Park area had lower tree coverage percentage comparable with tracts 1, 2, and 3 the overall CES score of the more affluent and white tract helps make it less vulnerable than tracts 1, 2, and 3. Research backs up claims that minority and low income communities deal with more frontline climate change issues (Bethel et al. 2021; Cuffe et al. 2018; Alverado et al. 2021; California Gov 2020). Tracts 1, 2, and 3 carry higher pollution burden, higher poverty rate and overall higher CES, PB, and PC when compared to tract 4.

## Conclusion

The goal of the research is twofold, the first being looking at the spatial extent of environmental and socio-economic issues to understand the extent of tree canopy across diverse socio-economic communities within the City of Redlands while the second is understanding the success and limitations of the CAC urban canopy program. The research in this study found that indicators like high percentage of minorities, high poverty rates, and higher pollution burden often meant lower tree coverage when compared with more white, affluent, and less pollution burden tracts in Redlands. This research also found the climate action core project had found success through common practices from other urban canopy programs such as creating community partnership, providing the trees free of cost, having master gardener assistance available to increase tree survival, and working with the city of Redlands to focus on large scale plantings in Redlands Sport Park. Even so the program had limitations such as only finding one community partner based in Redlands and lacking community engagement due to Covid restrictions, and also focusing the majority of planting in Tract 4 instead of the less affluent minority communities in tracts 1, 2, and 3.

This study shows the importance of not only increasing tree coverage, but also trying to increase tree equity. Redlands, California has obvious inequality shown through tracts 1-6 used in this research, that is seen in tree coverage, pollution burden, and socioeconomic factors like poverty rates. The CES scores are generally higher in the southern part of the city as is the tree coverage when compared to the northern part of the city. The northern tracts 1-3 not only score much worse on the CES but are also majority Hispanic populated areas, while especially more southern tracts 5 and 6 are majority white. There is a need in the city for tree equity programs like the climate action corps project that seek to specifically address inequity in North Redlands. The research also shows the great potential and start for the climate action corps project in Redlands. The project will grow in the city as Covid barriers are lifted. Tracts 1-3 need to be a major priority moving forward as these areas have majority minority populations who struggle both environmentally and socioeconomically. The program had success planting trees in Redlands Sports Park, but this is a majority white and affluent tract. Moving forward its city, and community connections should organize plantings in tracts 1-3. Although trees won't solve all the socioeconomic, and environmental issues these climate action and other programs would do well to serve tracts 1-3 who have indicators such as ethnicity less affluence making it more vulnerable than other areas of the city.

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