

Vulnerability Analysis of the Orcutt Neighborhood in Santa Barbara County



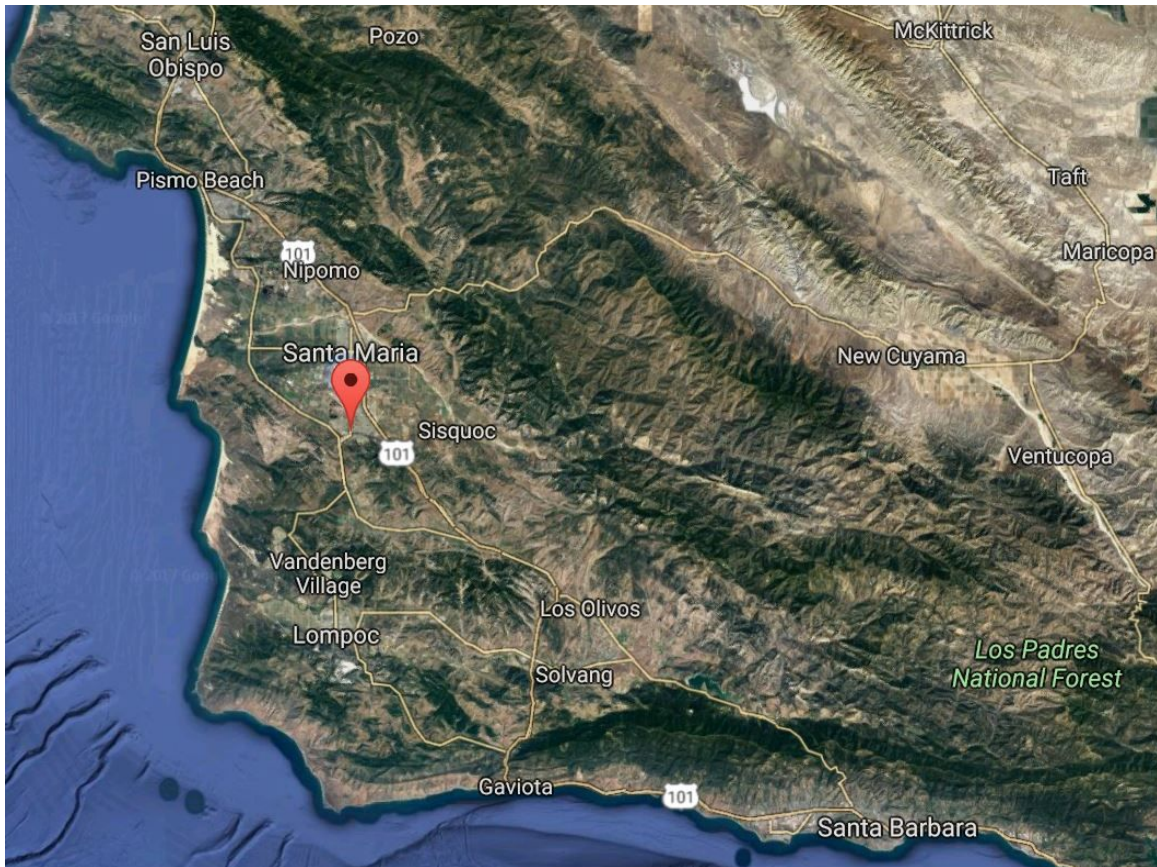
1. Problem Question

The effects of climate change are already apparent throughout California, including higher temperatures, more extreme wildfires, and rising sea levels. These changes could have devastating effects on the regional economy of Orcutt, infrastructure, public health, recreation, wine country tourism, agriculture, and the environment.

In recent climate change literature, the idea of adaptive capacity has become a prominent way to measure an ability to cope with climate change. The adaptive capacity concept is founded on the assumption that all urban infrastructure is interrelated. As such, as climate change impacts affect one infrastructure system, others will too be impacted. Groundwater-replenishing infrastructure is one system that many California communities have begun to prioritize in recent years as wells and aquifers have dried up throughout the state.

A second assumption that supports adaptive capacity is that the impacts of natural disasters will be heightened because of climate change. Earthquakes are a recurring hazard throughout California. Urban emergency response systems will need to update their protocols when climate change impacts worsen because infrastructure systems may behave differently at variable temperatures and precipitation levels and because people who are most vulnerable will be at even higher risk.

For my project, I've decided to assess the vulnerability of Orcutt in relation to climate change and earthquakes. My question was "How vulnerable is Orcutt to climate change and earthquakes?" Existing health and drainage infrastructure are two markers that I used to assess the community's vulnerability to climate change. GIS is an appropriate tool for approaching this issue, because GIS data already exists on these topics. The place-based nature of GIS makes it a prime tool through which to understand dynamic issues like climate change, public health, infrastructure, and earthquakes.



Locator map showing Orcutt, which is south of San Luis Obispo and north west of Santa Barbara.

2. Data

To assess the vulnerability and adaptive capacity of Orcutt, I have selected two natural hazards: climate change and earthquakes. Adaptive capacity is the capacity of a system, or neighborhood, to adapt if the environment where the system exists changes. According to the American Lung Association, year-round and short-term particle pollution, ozone, and other pollution will get worse with climate change, according to the Natural Resources Defense Council (NRDC). Climate change vulnerability is often determined by the adaptive capacity of a community, and a community's adaptive capacity is measured by its health. Therefore, I decided to use data from the CalEnviroScreen 3.0 to assess the community's health.

I decided to measure the community of Orcutt's adaptive capacity in regard to how vulnerable its drainage infrastructure is to earthquakes. I thought this data was important because capturing stormwater and replenishing aquifers is especially important for California towns that are reliant on private wells and agriculture. Orcutt is a semi-rural community that houses many private wells and agricultural operations. Since California has been plagued by drought in recent years, ensuring the viability of Orcutt's drainage infrastructure in years to come will be important.

3. Data Sources

For this reason, I chose to analyze data from the CalEnviroScreen 3.0 (CES 3.0) as a way to understand Orcutt's adaptive capacity. The CES 3.0 paints a holistic picture of the existing health conditions at a census tract level. Using ArcGIS, I mapped several CES 3.0 factors in Orcutt.

To understand the adaptive capacity of Orcutt to change in the face of climate change, I mapped the following indicators using CalEnviroScreen 3.0 data:

- Percentage of Persons Over 65 Years
- Percentage of Persons Under 10 Years
- Percentage of Linguistically Isolated Households
- Percentage of People Over 25 With No High School Diploma
- Percentage of Population Living Under Twice the Federal Poverty Line
- Percentage of Unemployed Persons Over 16 and Eligible to Work
- Daily Maximum 8 Hour Ozone Concentration
- CalEnviroScreen Pollution Score

I decided to look at the vulnerability of Orcutt's water circulation and drainage infrastructure in the face of an earthquake. With the high cost of water projects, municipalities and planning agencies must consider the impact of natural disasters on the ability to facilitate stormwater recapture and water circulation. Since I am a (new) employee of Santa Barbara County, I was able to access drainage and water circulation GIS data. And, I found earthquake fault lines from USGS. All of my data was in the form of shapefiles or tables that I could convert into shapefiles. I mapped the faults in and near Orcutt with a 1 mile buffer to be able to see where infrastructure is most vulnerable.

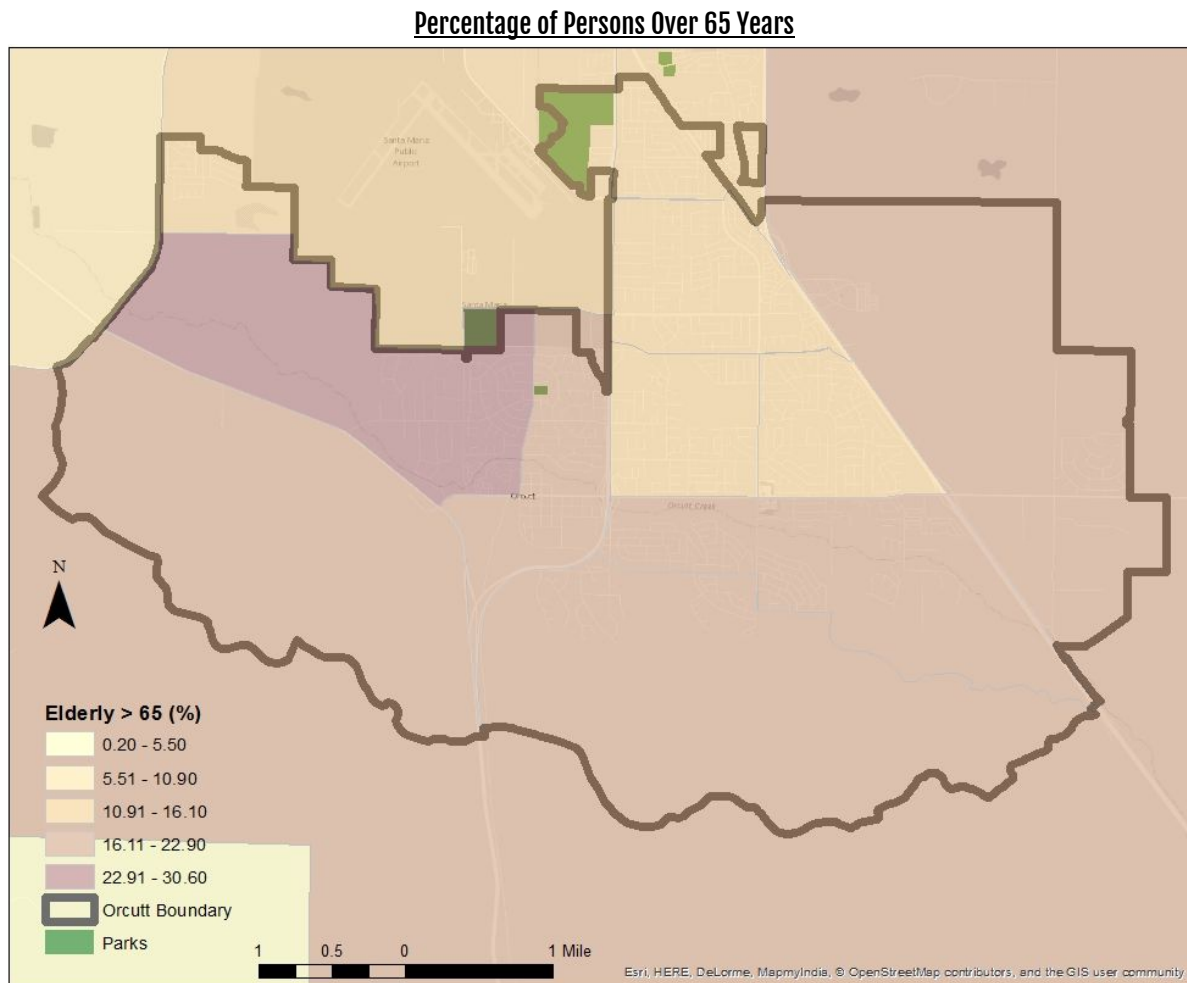
4. Data Limitations

When I first began the project, I hope to include more information about existing temperatures and predicted future temperatures resulting from climate change. Temperature is very important in understanding the impact on vulnerable populations (children and adults over the age of 65), so it would have been impactful to display the predicted temperature increases on a map. Then, I could evaluate how those increases would impact different parts of Orcutt. Relatedly, it would have been awesome if I could have explored the urban heat island effect in Orcutt using the Trust for Public Land's Climate-Smart Cities tool. This tool has been hugely helpful in my research in Los Angeles, but since the tool only contains data for Los Angeles, New York, and Seattle, I could not use it for my project. And lastly, I wish I had access to GIS shapefiles of additional water infrastructure types such as sewage and septic systems.

5. Results

First, I wanted to assess the population in Orcutt to see the percentage of elderly over 65 years old, who are most vulnerable to increased temperatures that will occur due to climate change. From the image above, we can see that the northwest portion of Orcutt has the highest percentage of elderly of between 22.91% to 30.6%. Then, most census tracts in Orcutt are made up of between 16.11% to 22.9% of persons over 65 years of age. For older adults, the changing climate means heightened vulnerability to environmental risks, including extreme weather events, reduced availability of fresh water, exacerbated vector-borne diseases, compromised agriculture, and decreased habitability of human population centers. People over 65 years of age

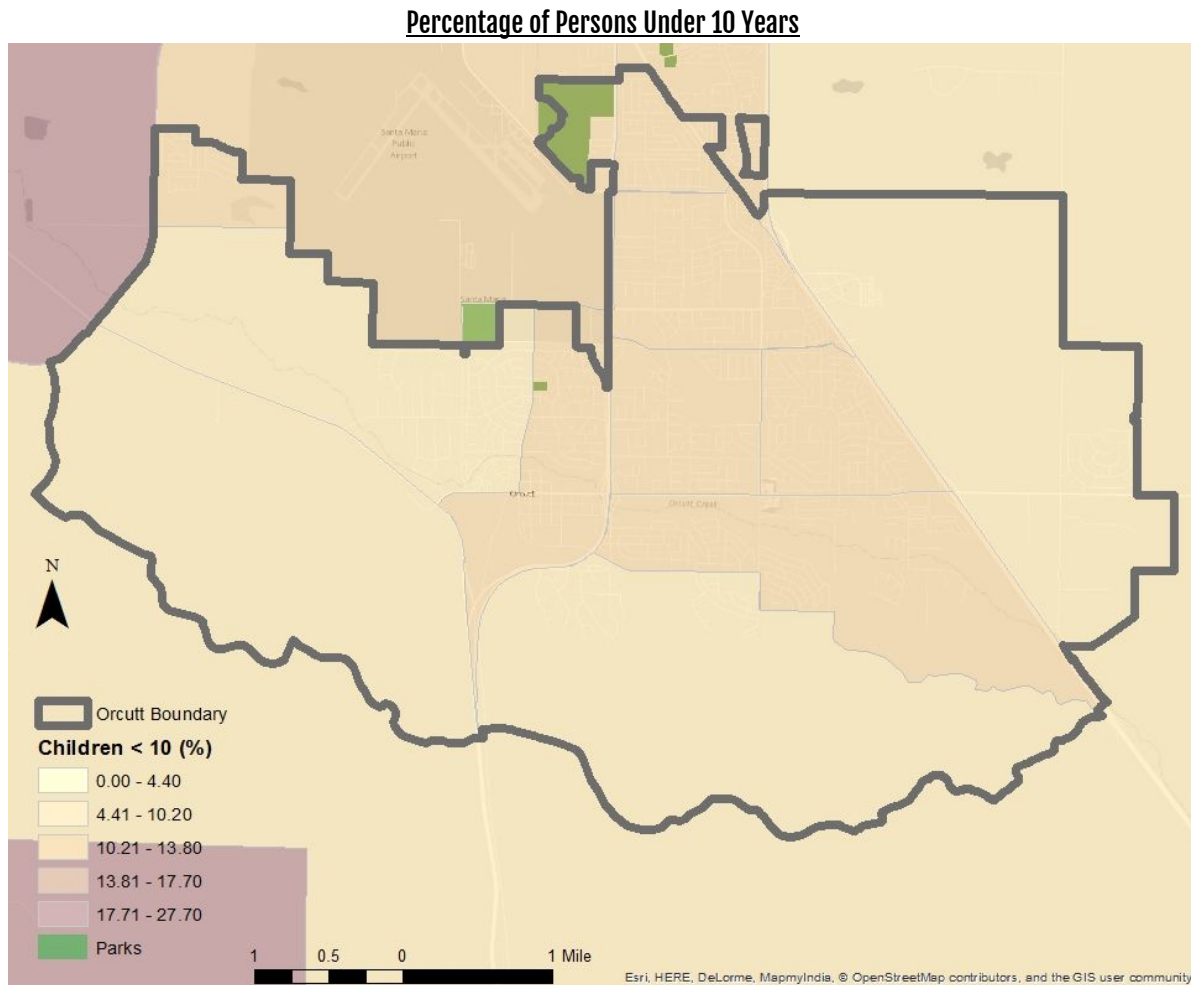
are more vulnerable to the effects of temperature extremes and have a higher mortality risk in extreme weather events.



The older population is at greater risk because of increased susceptibility to disease and effects of stresses on the food and water supply, as well as reduced ability to mobilize quickly. Research suggests that greater physiological susceptibility and social vulnerability may account for many of the negative health effects of climate change on older people (Filiberto, 2011). The effects of climate change are variable, depending on pre-exposure health status, psychological well-being, and social characteristics. Turning age 65 does not in itself make a person more vulnerable to the negative effects of climate change, but the individual physiological and social factors associated with aging may worsen negative impacts (Filiberto, 2011).

Children are also vulnerable to rising temperatures, so I mapped the percentage of children under 10 years old. Children are particularly vulnerable because higher temperatures have been linked to increased rates of malnutrition, cholera, diarrhoeal disease and vector-borne diseases like dengue and malaria. Children's underdeveloped immune systems put them at greater risk of contracting these diseases and succumbing to their complications (Filiberto, 2011). Below, we

see that the same census tracts that have higher percentages of elderly have low percentages of young children. This is likely due to the large number of retirement homes in Orcutt, where we would expect to see very few children live. Nonetheless, Orcutt's percentage of persons under 10 years old ranges between 4.41% to 13.6%.

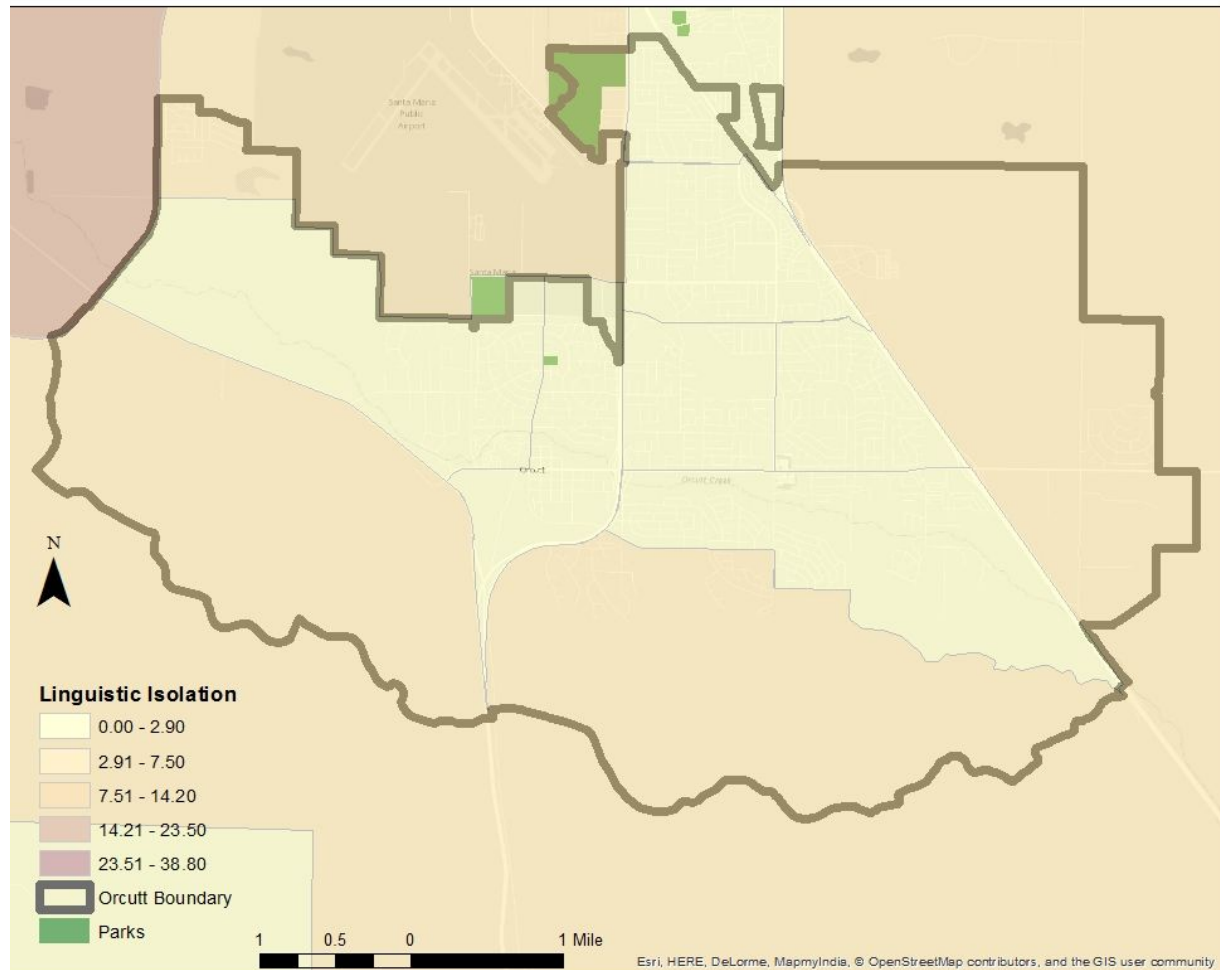


Another important indicator of adaptive capacity is linguistic isolation. Linguistic isolation measures the percentage of households that have limited ability to speak English fluently. The Census Bureau maintains information on the rate of linguistic isolation in different areas in California. The indicator is the percentage of households in which no one age 14 or above speaks English “very well” or speaks only English. The level of linguistic isolation in the community is also associated with cognitive scores but the greatest variation in scores across communities occurs among children of U.S. born mothers.

These households would have a more difficult time adapting in the face of natural disasters and increased temperatures due to climate change. Adults who are not able to speak English well often have trouble talking to the people who provide social services and medical care. As a result, they might not get the health care and information that is needed. Linguistically isolated

households may not hear or understand important information at the time of an emergency. In Orcutt, the percentage of households that are linguistically isolated is under 7.5%.

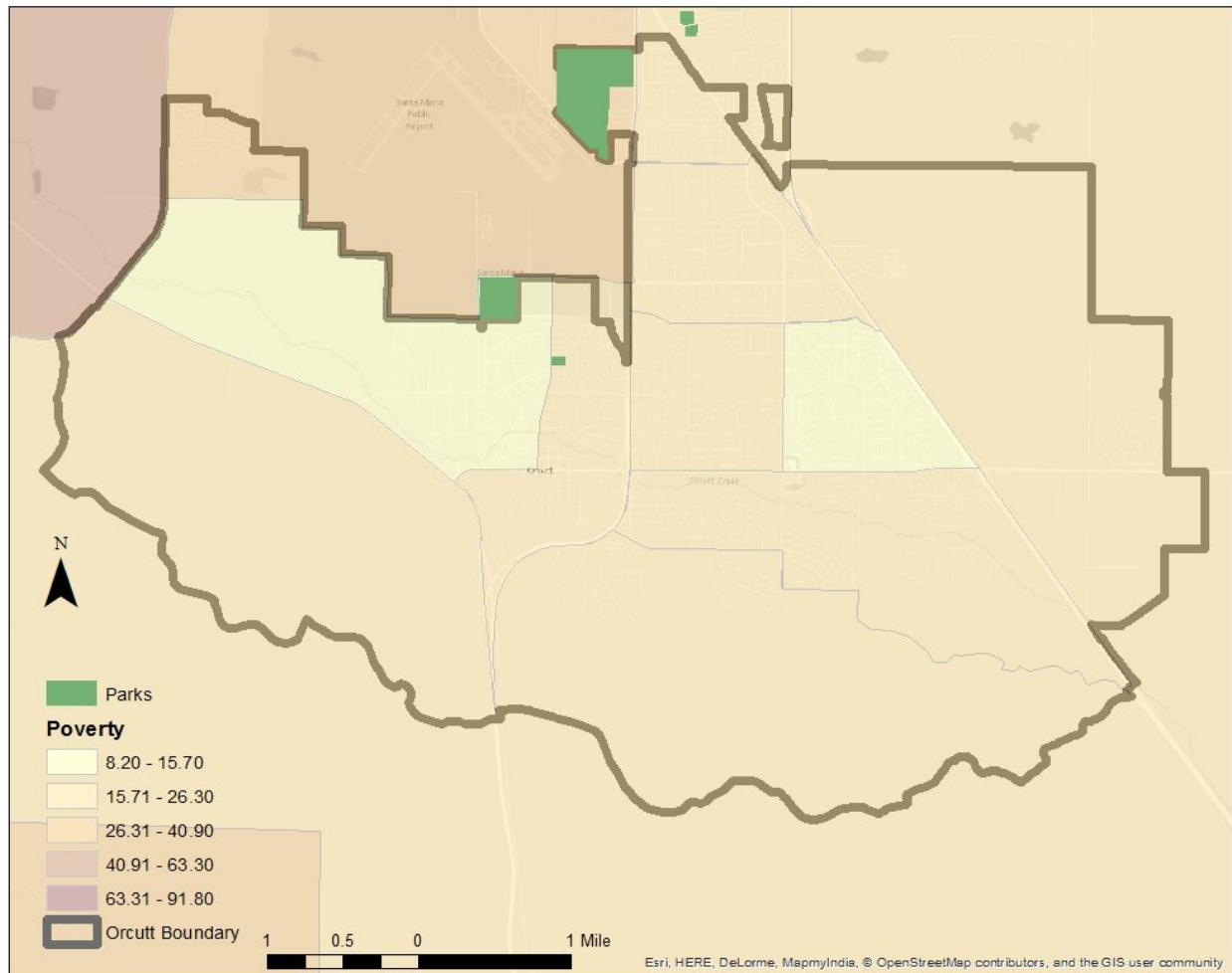
Percentage of Linguistically Isolated Households



Poverty is also a telling indicator of a community's adaptive capacity, since people who have low annual income are less able to adapt to changes brought on by climate change and natural disasters. People who live in poverty may have difficulties coping with changes, because they have limited financial resources to cope with heat, relocate or evacuate, or respond to increases in the cost of food (Carnemark 2015).

Climate change hits poor people the hardest, because those living in areas with the fewest resources have less help adapting or recovering quickly from shocks. Additionally, as the effects of climate change worsen, escaping poverty becomes more difficult (Bullard 2015). As the map below shows, many of the census tract populations in Orcutt have 26.31% to 40.9% that live below twice the federal poverty line.

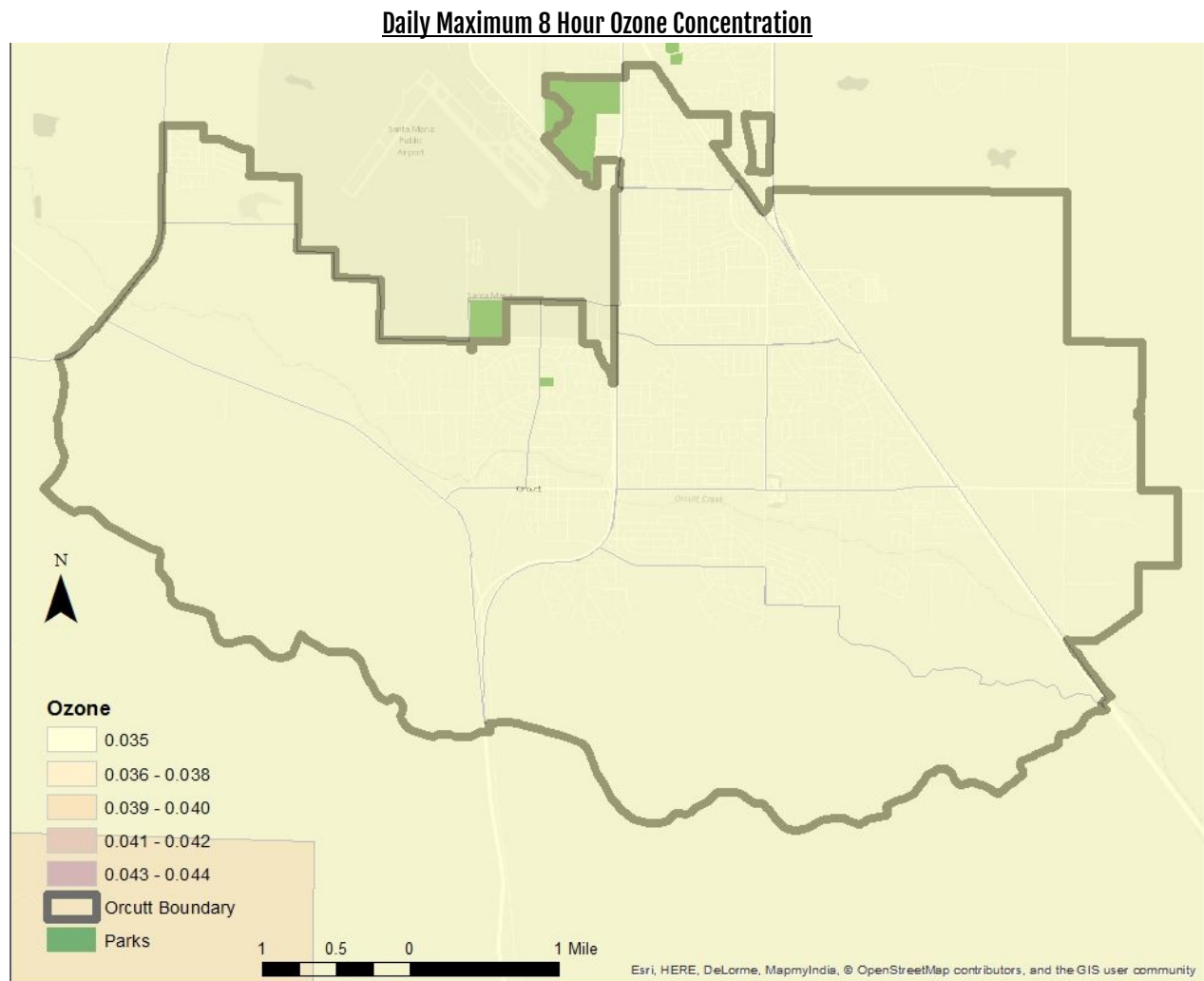
Percentage of Population Living Under Twice Federal Poverty Line



Next, I mapped two pollutant indicators. The first is tropospheric ozone, which causes a number of health impacts and increases with climate change. Ozone occurs naturally at ground-level in low concentrations, and the two major sources of natural ground-level ozone are hydrocarbons released by plants and soil and small amounts of stratospheric ozone, which migrate to the earth's surface. Neither contributes enough ozone to be a threat to human health or the environment.

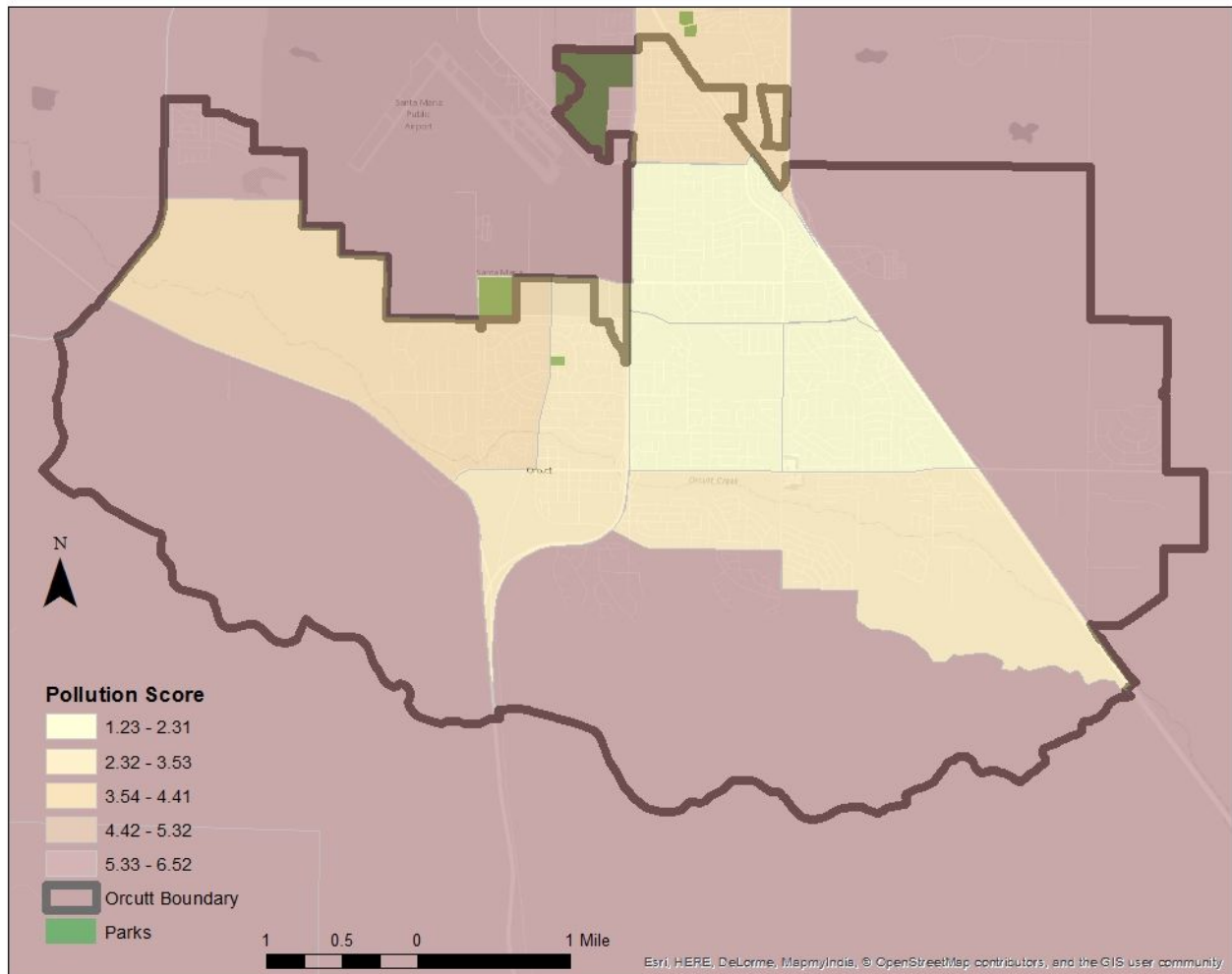
Ozone that is a byproduct of certain human activities becomes an issue at ground level. Increasing populations, automobiles, and industry cause more ozone to be in the lower atmosphere (USDA). Ozone is not directly emitted from any one source. Tropospheric ozone is formed by the interaction of sunlight, particularly ultraviolet light, with hydrocarbons and nitrogen oxides, which are emitted by cars, gas vapors, fossil fuel power plants, refineries, and

certain other industries (American Lung Association). Ozone in the troposphere damages agricultural crops, destroys nylon materials, and damages living tissue (Krupa 2001). It is a threat to people who exercise outdoors or who have respiratory problems. According to the map below, ozone levels are quite low, with no census tracts that have an ozone amount above 0.035. In 2015, the EPA revised the primary and secondary ozone standard levels to 0.070 parts per million (ppm), so Orcutt falls well below that threshold (USEPA).



Lastly, I mapped the overall CalEnviroScreen 3.0 Score, which is the CalEnviroScreen Pollution Score multiplied by the Population Characteristics Score. The score is used to identify communities that are disproportionately burdened by multiple sources of pollution. CalEnviroScreen uses environmental, health, and socioeconomic information to produce scores for every census tract in the state. The scores are mapped so that different communities can be compared. An area with a high score is one that experiences a much higher pollution burden than areas with low scores. We can see that the more developed areas have a lower pollution burden, which means that the areas where people spend most of their time are less impacted by pollution.

CalEnviroScreen 3.0 Score



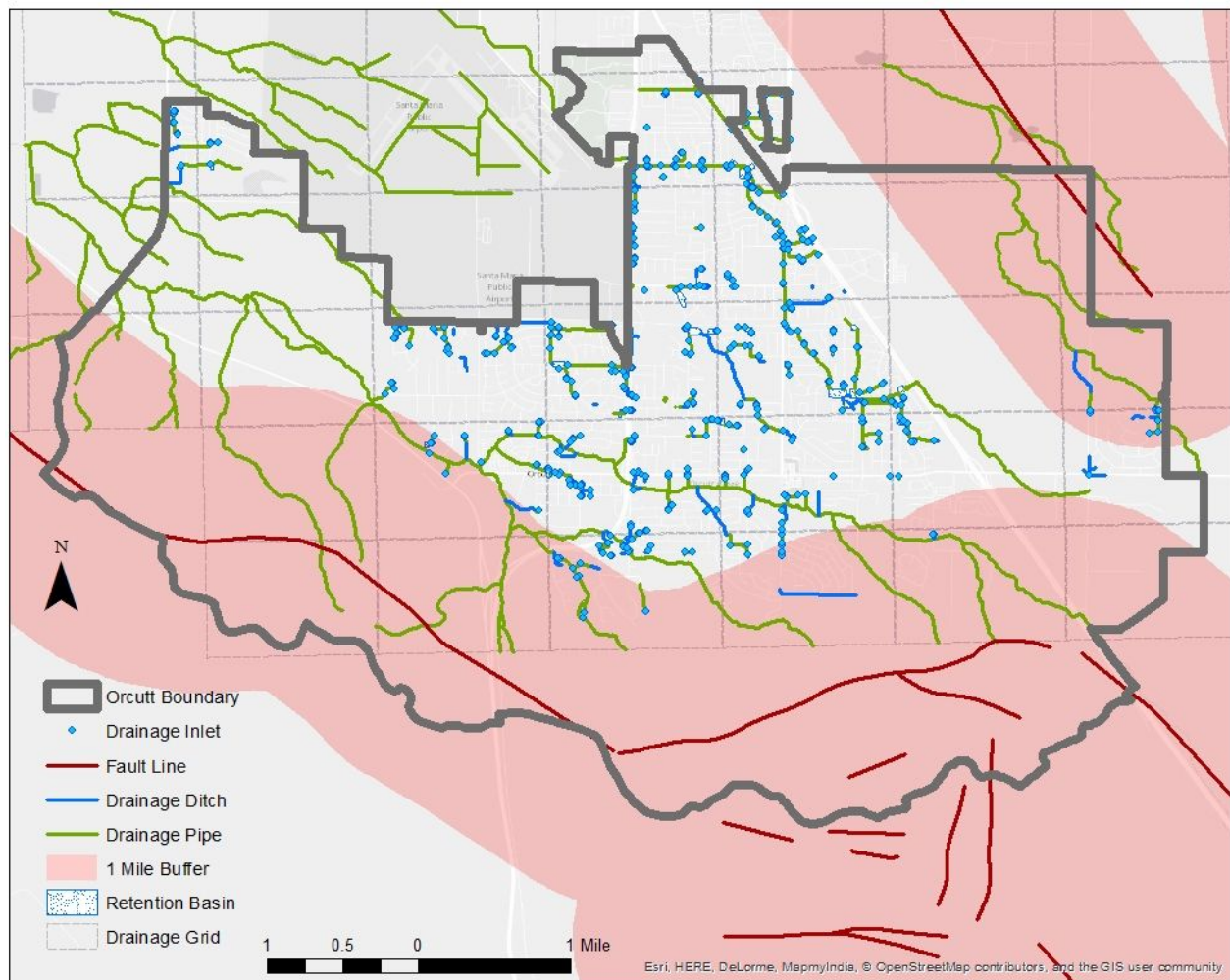
For my second natural hazard, I mapped the active faults with a one-mile buffer as well as drainage infrastructure, including:

- Drainage inlets
- Drainage ditches
- Drainage pipes
- Retention basins
- Drainage grid

Existing infrastructure is expected to become more stressed in the coming decades when the impacts of climate change are realized. Since infrastructure is highly interdependent, failure in some sectors is expected to have cascading effects on affected urban economies. Expansion of

the urban landscape into suburban and exurban spaces is expected to increase, and new climate adaptation and resiliency plans will need to account for this. Significant increases in infrastructure investments are expected as population density becomes more diffuse. Thus, the impact of earthquakes will worsen when compounded with climate change impacts. There are quite a few locations where the buffer and even the fault lines overlap with drainage infrastructure. However, most of the infrastructure is over one mile away from the fault lines, meaning that the majority of drainage circulation would not be heavily impacted by an earthquake.

Earthquake Fault Lines (1 Mile Buffer) & Drainage Infrastructure



Drainage infrastructure is particularly important in Orcutt because the community is working proactively to replenish its main water source, which is the Santa Maria Aquifer. In recent years, the aquifer has dropped to low levels due to the drought. As a result, the City of Santa Maria is planning to increase the current supplemental water fee to all water users in Orcutt. Supplemental water contracts are needed between the City and all people who wish to develop land in a way that would require additional water, such as home expansions and new

developments. To prevent people from using excess water and to fund the City's water maintenance processes, the City of Santa Maria has increased the supplemental water fee from \$22,000/acre foot to \$41,000/acre foot. As to be expected, the community has been upset. For this reason, it is beneficial to the City of Santa Maria and to the entire community of Orcutt to replenish the aquifer. Functioning drainage infrastructure does just that.

4. Conclusion

Overall, the vast majority of developed areas have a high adaptive capacity in relation to climate change and health as well as earthquakes and drainage infrastructure. The zoning and community planning in Orcutt has strived to regulate development in a way that promotes health, safety, and wellbeing for the community in a way that safeguards against social vulnerability. Social vulnerability describes characteristics of people that influence capacity to prepare for, respond to, and recover from hazards and disasters. It is the sensitivity of a population to climate change impacts and how it is more or less vulnerable to such impacts. Characteristics that most often influence differential impacts include socioeconomic status, age, gender, needs, race, and ethnicity. Inequalities reflecting differences in these areas influence coping and adaptive capacity, especially to climate-sensitive hazards.

To address social vulnerability, the Santa Barbara County General Plan's Seismic Safety & Safety Element explains that land use planning should strive to avoid construction of buildings of all types and most structures on or across historically active or active faults. Because of this, Orcutt's drainage infrastructure is well suited to handle and adapt in case of an earthquake along any of the local faults.

Santa Barbara County and the people who live, work, and recreate in Orcutt should remain on their same path to ensure that the community's adaptive capacity can handle impending climate change impacts and future earthquakes. One way of ensuring this would be to revise the Orcutt Community Plan to include a section on adaptive capacity that specifically addresses how the community will respond and adapt to climate change and natural hazards, such as earthquakes.

Sources

2015 National Ambient Air Quality Standards (NAAQS) for Ozone. United States Environmental Protection Agency. 2015.

www.epa.gov/ozone-pollution/2015-national-ambient-air-quality-standards-naaqs-ozone

American Community Survey. U.S. Census Bureau. 2015. <https://www.census.gov/>

ArcGIS Online. <https://www.arcgis.com/home/index.html>

Bullard, Gabe. See What Climate Change Means for the World's Poor. National Geographic. 2015.

<http://news.nationalgeographic.com/2015/12/151201-datapoints-climate-change-poverty-agriculture/>

CalEnviroScreen 3.0. Office of Environmental Health Hazard Assessment. California EPA. 2017. <http://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30>

Cal-Adapt: <http://cal-adapt.org/tools/factsheet/>

Carnemark, Kurt. Climate Change Complicates Efforts to End Poverty. The World Bank. 2015. <http://www.worldbank.org/en/news/feature/2015/02/06/climate-change-complicates-efforts-end-poverty>

Climate Change and Air Pollution. American Lung Association. 2017. <http://www.lung.org/our-initiatives/healthy-air/outdoor/air-pollution/>

Effects of ozone air pollution on plants. United States Department of Agriculture. 2016. <https://www.ars.usda.gov/southeast-area/raleigh-nc/plant-science-research/docs/climate-change-air-quality-laboratory/ozone-effects-on-plants/>

Filiberto, David. "Older people and climate change: vulnerability and health effects." Journal of the American Society on Aging. 2011.

Krupa, S, MT McGrath, C Andersen, FL Booker, KO Burkey, A Chappelka, B Chevone, E Pell, B Zilinskas. 2001. Ambient ozone and plant health. Plant Disease 85:4-17.

Orcutt Community Plan. Santa Barbara County. 2012. <http://longrange.sbcountyplanning.org/planareas/orcutt/orcutt.php>

Long Range Division Website. Planning and Development. Santa Barbara County. 2017. <http://sbcountyplanning.org/>

California Earthquake Faults. United States Geological Survey. 2016. <https://earthquake.usgs.gov/hazards/qfaults/>