Urban Quality of Life: An Assessment of San Bernardino County

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Literature Review / Background

The principal question I am trying to answer is the following: what is the quality of life in San Bernardino county in 2020? Within this over-arching question, I would also like to know what spatial analysis techniques will prove most effective in measuring quality of life, along with which data indicators are most useful in assessing quality of life.

Urban Quality of Life

Urban quality of life is a term used to describe the relationship and the dynamics that exist between physical features in an urban environment. The definition of urban quality of life is multi-faceted in nature, and is the influenced by changes in physical, mobile, economic, and other systems that affect urban residents. I was inspired to conduct this study in the manner similar to the paper
"Principles of urban quality of life for a neighborhood", written in the Housing and Building National Research Center Journal, which was published in May 2013. The paper separates the discussion of urban quality of life into seven spheres: environmental, physical, mobility, social, psychological, economic, and political. Of these seven spheres I decided to focus on three: environmental urban quality of life, mobility urban quality of life, and social urban quality of life. The specific criteria for each of these spheres of urban quality of life are listed below.

Environmental Urban Quality of Life

1. Promote the access to clean air, water, land and non-toxic materials; in order to protect people and maintain biodiversity.
2. Preserve resources and minimize energy demand by taking energy saving technologies.
3. Give the ability to enjoy natural landscape by providing a range of green areas distributed within the neighborhood.
4. Provide appropriate ways to control and manage wastes.

Mobility Urban Quality of Life

11. Provide alternatives to using car in order to reduce traffic load, minimize air pollution and conserve energy.
12. Provide activities of daily living and transit stops within walking distance to allow independence to elderly, young and who do not drive.
13. Provide fine network interconnecting streets to encourage walking.
14. Provide streets friendly with pedestrian, cycle and vehicle.

Social Urban Quality of Life

15. Promote social justice and equity by providing equal access to affordable housing, economic activities, services and facilities.
16. Remove all barriers that reduce the participation in daily life of certain social groups, such as those with disabilities, women, children and elderly.
17. Design of streets and buildings should reinforce safe environments.
18. Promote social integration by providing a broad range of housing types, tenure types and prices levels.
19. Promote good relationships and daily interaction between people by providing civic buildings and public gathering places.
20. Promote social participation in all the project processes.
21. Promote the liveablilty of streets by providing safe, comfortable, interesting streets and squares to the pedestrian.
22. Promote neighborhood stability by ensuring secure tenure.

In addition to the paper mentioned above: Hamam Serag El Din, Ahmed Shalaby, Hend Elsayed Farouh & Sarah A. Elariane (2013) Principles of urban quality of life for a neighborhood, HBRC Journal, 9:1, 86-92, DOI: 10.1016/j.hbrcj.2013.02.007,

The following papers and journal articles were examined prior to collecting initial data for this study:
Mittal, S., Chadchan, J. & Mishra, S.K. Review of Concepts, Tools and Indices for the Assessment of Urban Quality of Life. *Soc Indic Res* **149,** 187–214 (2020). https://doi.org/10.1007/s11205-019-02232-7

Garau, C.; Pavan, V.M. Evaluating Urban Quality: Indicators and Assessment Tools for Smart Sustainable Cities. *Sustainability* **2018**, *10*, 575. https://doi.org/10.3390/su10030575

Merschdorf, H.; Hodgson, M.E.; Blaschke, T. Modeling Quality of Urban Life Using a Geospatial Approach. *Urban Sci.* **2020**, *4*, 5. https://doi.org/10.3390/urbansci4010005

Enrico Ivaldi & Guido Bonatti & Riccardo Soliani, 2014. "Composite Index for Quality of Life in Italian Cities: An Application to URBES Indicators," Review of Economics & Finance, Better Advances Press, Canada, vol. 4, pages 18-32, November. https://ideas.repec.org/a/bap/journl/140402.html

Study Area - San Bernardino County

Total Population: 2,180, 085
Male: 49.8%
Female: 50.2%

Age Range	Percentage

Under 18	26.1
18 – 24	10.1
25 - 39	15.4
40 – 49	12.3
50 – 59	11.9
60 and over	17.3

Race Category	**Percentage**
One Race	97.9
White	49.3
Black/African American	1.7
American Indian/Alaska Native	0.3
Asian	22.1
Native Hawaiian/ Other Pacific Islander	0.3
Other race	24.2
Two or more races	2.1

Income & Education

Annual Earnings	**Percentage of Population 16 years and over with earnings (208,172)**	**Educational Attainment**	**Percentage of Population 25 years and over (1,390,788)**
$1 - $9,999 or loss	2.1	Less than HS Graduate	19.3
$10,000 - $14,999	3.3	HS Graduate, GED, or alternative	25.8
$15,000 - $24,999	16.2	Some college or associate's degree	32.5
$25,000 - $34,999	19.4	Bachelor's degree or higher	22.5
$35,000 - $49,999	21.2		
$50,000 - $74,999	18.9		
$75,000 or more	18.8		

Housing Type	**Percentage**
Owner – occupied	60.6
Renter – occupied	39.4

Data

Proposed Quality of Life Indicators

Environmental	Mobility	Social
Diesel PM	High Quality Transit Areas	Education
Traffic	Bicycle Paths	Linguistic Isolation
Protected Open Space Areas	Sidewalk Coverage	Percent of Adults with access to Exercise opportunities
Municipal Green Building Performance		Environmental Justice Areas
Waste Performance		Prevalence of Food Insecurity
Public Health Performance		

Actual Quality of Life Indicators

Environmental	Mobility	Social
Diesel PM	Metrolink Routes	Education
Traffic	Bicycle Paths	Linguistic Isolation
Protected Open Space Areas		Supermarkets Count
Ozone		Housing Burden
Residential Land Use		
Other Land Use		

Environmental Urban Quality of Life Indicators – Definitions

- Diesel PM: Diesel Particulate Matter, measurement of Diesel emissions from cars, trucks, and busses.
- Traffic: Traffic Density, measured by dividing total traffic volume in a specific region by the total road length across the county.
- Protected Open Space Areas: boundaries of California Protected Areas, areas ranging from small urban parks to large national parks and forests.
- Ozone: Mean of summer months (May – October) of the daily maximum 8 – hour ozone concentration.
- Residential Land Use: Land area containing houses, townhomes, apartments, and other living units.
- Other Land Use: Land area containing office space, businesses, restaurants, and all other non-residential parcels.

Mobility Urban Quality of Life Indicators - Definitions

- Metrolink routes: Placement and total route length of Metrolink lines that run through San Bernardino county.
- Bicycle Paths: Placement and total length of bicycle paths within San Bernardino county.

Social Urban Quality of Life Indicators - Definitions

- Education: Educational attainment, percent of the population over age 25 with less than a high school education.
- Linguistic Isolation: Percent of limited English-speaking households.
- Supermarkets Count: Number of supermarkets per census tract in San Bernardino county.
- Housing Burden: Percent of households in a census tract that are both low income(making less than 80 percent of the HUD Area Median Family Income) and severely burdened by housing costs(paying greater than 50 percent of their income to housing costs).

In addition to the three urban quality of life indicator categories selected for this study, the following indicator categories were outlined within the Housing and Building National Research Center Journal paper that served as the basis for this study.

Physical urban quality of life

5. Neighborhood should be compact, pedestrian friendly and mixed use.
6. Provide the access to adequate services and facilities that fulfill people's needs.
7. Provide the access to adequate eco-buildings and housings that fulfill people's needs and national building code.
8. Provide well-defined streets and open spaces by a well-structured building layout.
9. Provide a hierarchy of complete street networks based on pedestrian and vehicle load.
10. Take into account projected management, maintenance and repair policies to ensure the sustainability of neighborhood.

Economical urban quality of life

26. Provide job opportunities and promote local business by supporting locally owned stores and business as well as by encouraging mixed use development.
27. Minimize cost of living by promoting the access to affordable housing, services and facilities.

Political urban quality of life

28. Promote integrated urban governance.
29. Provide codes and legislation to control evolution.
30. Promote the community involvement in council decision making.

Data Processing

For each of the QoL sub-indicators, there should be a discussion regarding how the data was processed - both using GIS and any other manipulations / calculations (Z-scores, etc.).

Diesel PM
Traffic
Protected Open Space Areas
Ozone, Metrolink routes
Bicycle Paths
Education
Linguistic Isolation
Supermarkets Count
Housing Burden

Joined each layer to CalEnviroScreen 3.0 data, using the tabulate-intersect tool within a Jupyter notebook. Then joined each layer to the master layer, which contains all of the sub-indicators from the three Quality of Life categories being examined. From there a z-score for each layer was calculated, and was stored within the attribute table of the master layer.

Residential Land Use
Other Land Use

Joined each layer to CalEnviroScreen data, using the tabulate-intersect tool within a Jupyter notebook. Then joined each layer to the master layer, which contains all of the sub-indicators from the three Quality of Life categories being examined. Z-scores for each of these layers were not calculated.

Data Analysis

The discussion here will focus on the spatial analysis performed:

Step 1: Used the explode tool within ArcMap to split up the protected open space areas layer into many individual parcels, each representing a different park within the county.

Step 2: Dissolved the resulting layer, then created a half-mile buffer to show residents' access to individual parks.

Step 3: Dissolved the metrolink layer on the San Bernardino county data, then created a half-mile buffer around the dissolved layer to show residents' access to the metrolink.

Step 4: Using the Z-scores for each of the sub-indicators in the three Quality of Life categories (with the exception of residential land use and other land use) an index calculation was calculated. Each of the three categories were weighted equally using the following equation:

.33*(((-1*[Diesel_PM_zscore] + -1*[Traffic_zscore] + [park_serve_zscore] + -1*[Ozone_zscore] + -

1*[PM2_5_zscore]) /5)) +.33*((([metrolink_zscore] + [bike_routes_zscore]) /2)) +.33*(((-1*[Education_zscore] + -1*[Linguistic_Isolation_zscore] + -1*[Housingburden_zscore] + [Supermarkets_zscore]) /4))

Step 5: Using the Z-scores for each of the sub-indicators in the three Quality of Life categories (with the exception of residential land use and other land use) an index calculation was calculated. In this scenario, Environment was weighted at 50 percent, while Mobility and Social were each weighted at 25 percent. Two additional index calculations were computed, the first weighting Mobility at 50 percent, and the second weighting Social at 50 percent.

Environment 50 percent:

.50*(((-1*[Diesel_PM_zscore] + -1*[Traffic_zscore] + [park_serve_zscore] + -1*[Ozone_zscore] + -1*[PM2_5_zscore]) /5)) +.25*((([metrolink_zscore] + [bike_routes_zscore]) /2)) +.25*(((-1*[Education_zscore] + -1*[Linguistic_Isolation_zscore] + -1*[Housingburden_zscore] + [Supermarkets_zscore]) /4))

Mobility 50 percent:

.25*(((-1*[Diesel_PM_zscore] + -1*[Traffic_zscore] + [park_serve_zscore] + -1*[Ozone_zscore] + -1*[PM2_5_zscore]) /5)) +.50*((([metrolink_zscore] + [bike_routes_zscore]) /2)) +.25*(((-1*[Education_zscore] + -1*[Linguistic_Isolation_zscore] + -1*[Housingburden_zscore] + [Supermarkets_zscore]) /4))

Social 50 percent:

.25*(((-1*[Diesel_PM_zscore] + -1*[Traffic_zscore] + [park_serve_zscore] + -1*[Ozone_zscore] + -1*[PM2_5_zscore]) /5)) +.50*((([metrolink_zscore] + [bike_routes_zscore]) /2)) +.50*(((-1*[Education_zscore] + -1*[Linguistic_Isolation_zscore] + -1*[Housingburden_zscore] + [Supermarkets_zscore]) /4))

Step 6: Using the Z-scores for each of the sub-indicators in the three Quality of Life categories (with the exception of residential land use and other land use) an index calculation was calculated. In this scenario, Environment was weighted at 60 percent, while Mobility and Social were each weighted at 20 percent. Two additional index calculations were computed, the first weighting Mobility at 60 percent, and the second weighting Social at 60 percent.

Environment 60 percent:

.60*(((-1*[Diesel_PM_zscore] + -1*[Traffic_zscore] + [park_serve_zscore] + -1*[Ozone_zscore] + -1*[PM2_5_zscore]) /5)) +.20*((([metrolink_zscore] + [bike_routes_zscore]) /2)) +.20*(((-1*[Education_zscore] + -1*[Linguistic_Isolation_zscore] + -1*[Housingburden_zscore] + [Supermarkets_zscore]) /4))

Mobility 60 percent:

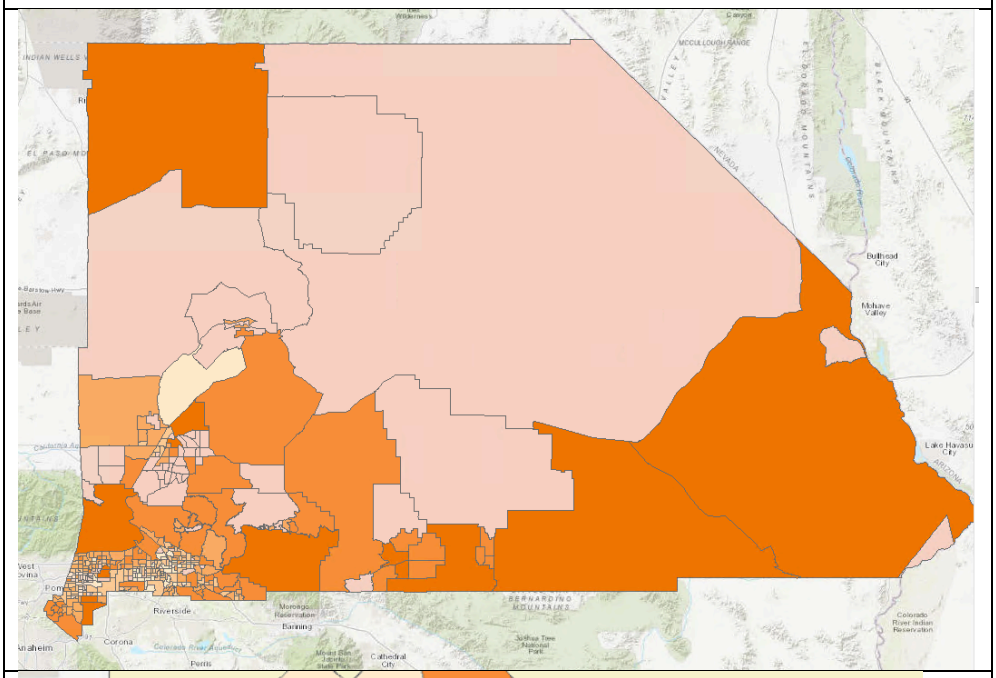
.20*(((-1*[Diesel_PM_zscore] + -1*[Traffic_zscore] + [park_serve_zscore] + -1*[Ozone_zscore] + -1*[PM2_5_zscore]) /5)) +.60*((([metrolink_zscore] + [bike_routes_zscore]) /2)) +.20*(((-1*[Education_zscore] + -1*[Linguistic_Isolation_zscore] + -1*[Housingburden_zscore] + [Supermarkets_zscore]) /4))

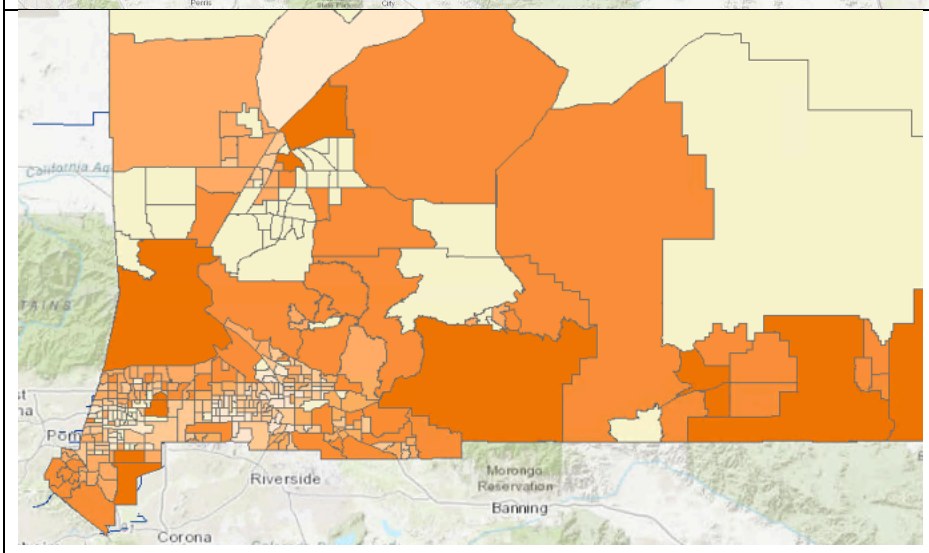
Social 60 percent:

.20*(((-1*[Diesel_PM_zscore] + -1*[Traffic_zscore] + [park_serve_zscore] + -1*[Ozone_zscore] + -1*[PM2_5_zscore]) /5)) +.20*((([metrolink_zscore] + [bike_routes_zscore]) /2)) +.60*(((-1*[Education_zscore] + -1*[Linguistic_Isolation_zscore] + -1*[Housingburden_zscore] + [Supermarkets_zscore]) /4))

Results

Equal Weights





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-0.340090 - -0.073000
-0.072999 - 0.216665
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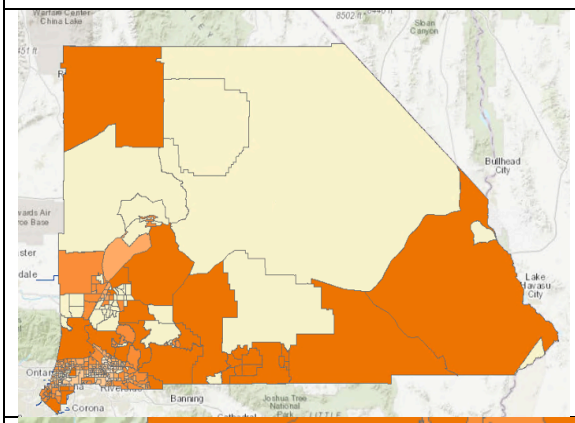
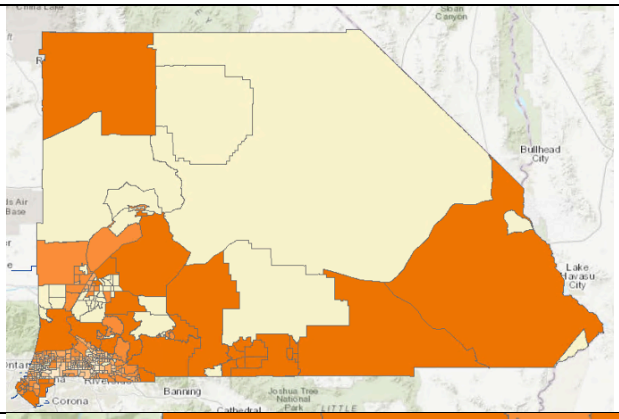
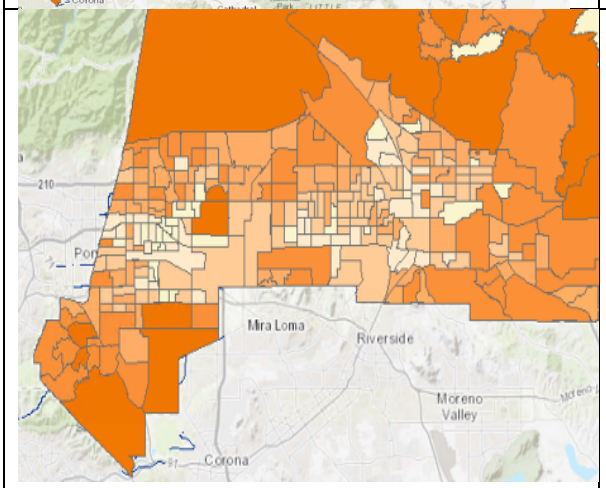
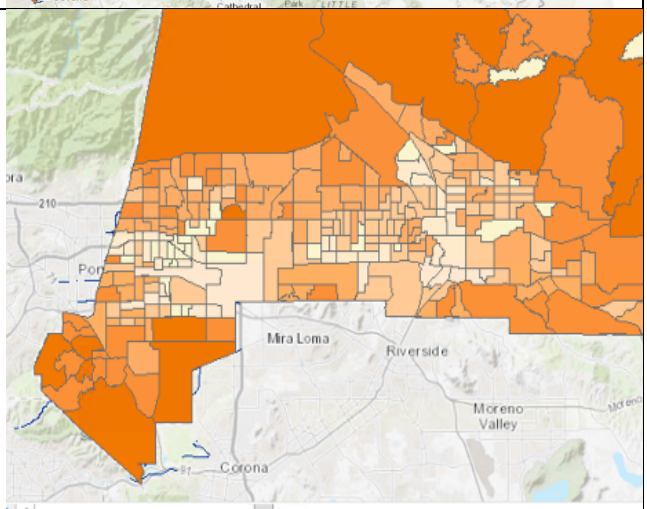
Environment 50% weight Mobility & Social each weighted 25%	Environment 60% weight Mobility & Social each weighted 20%
 	
 	
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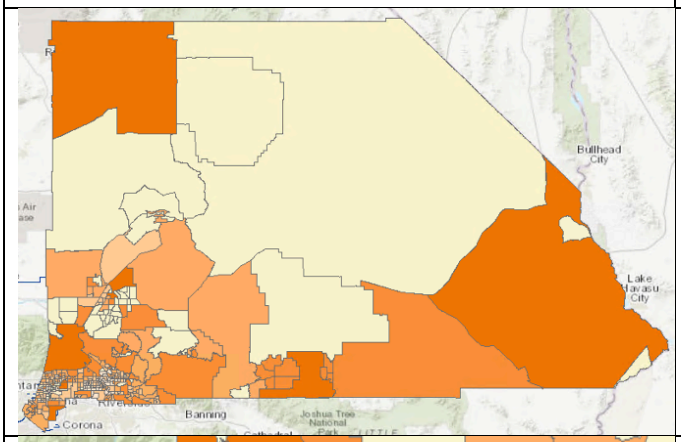
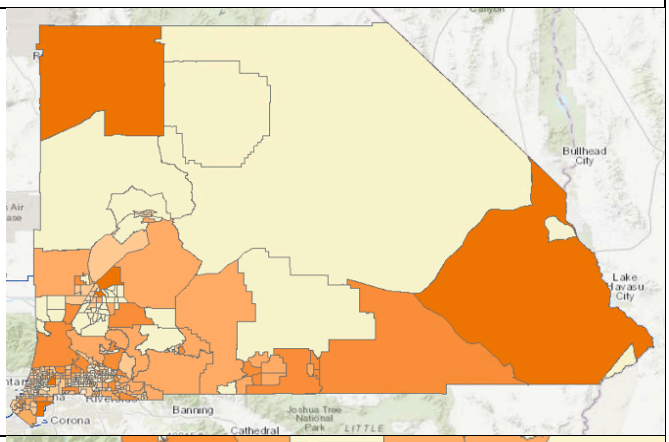
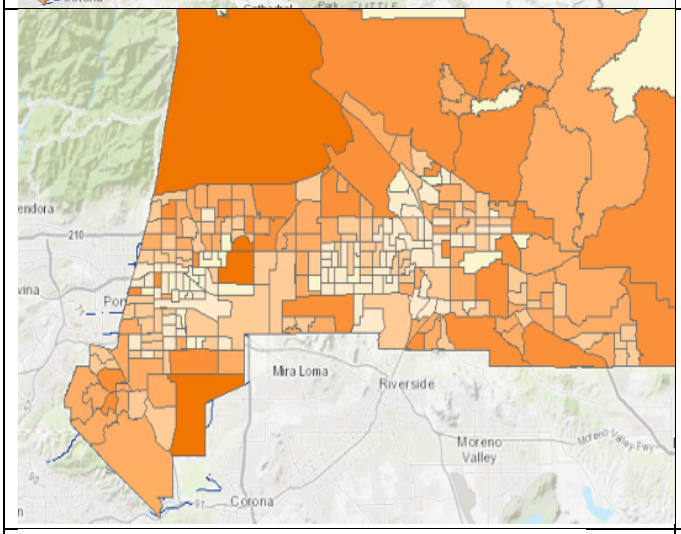
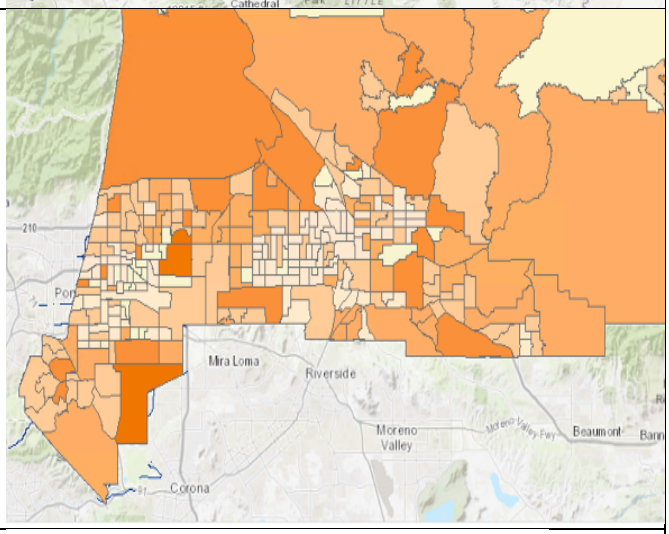
Mobility 50% weight Environment & Social each weighted 25%	Mobility 60% weight Environment & Social each weighted 20%
	
	
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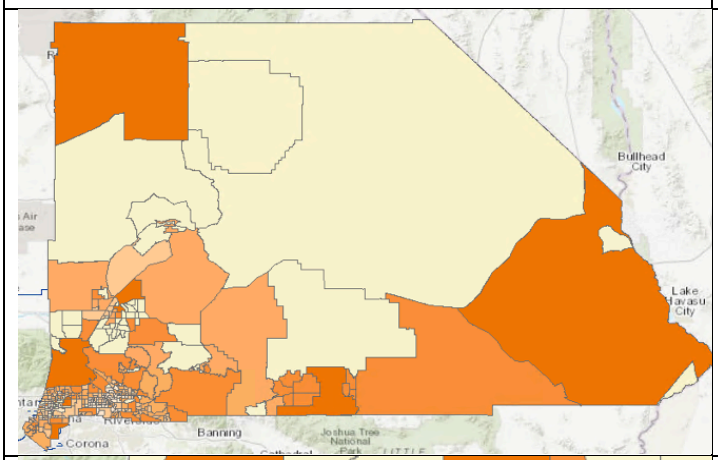
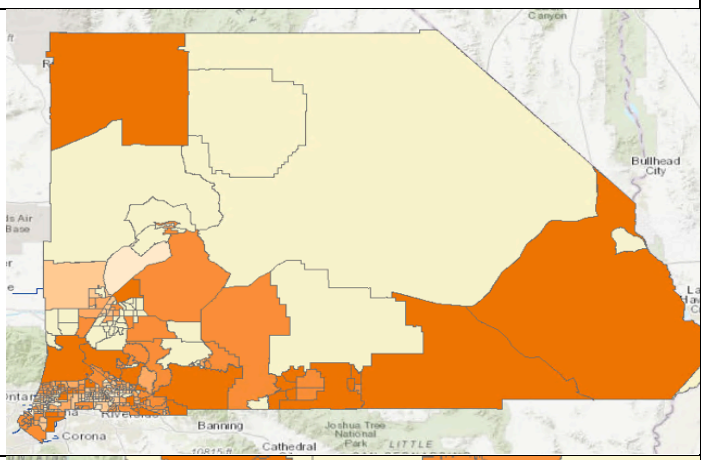
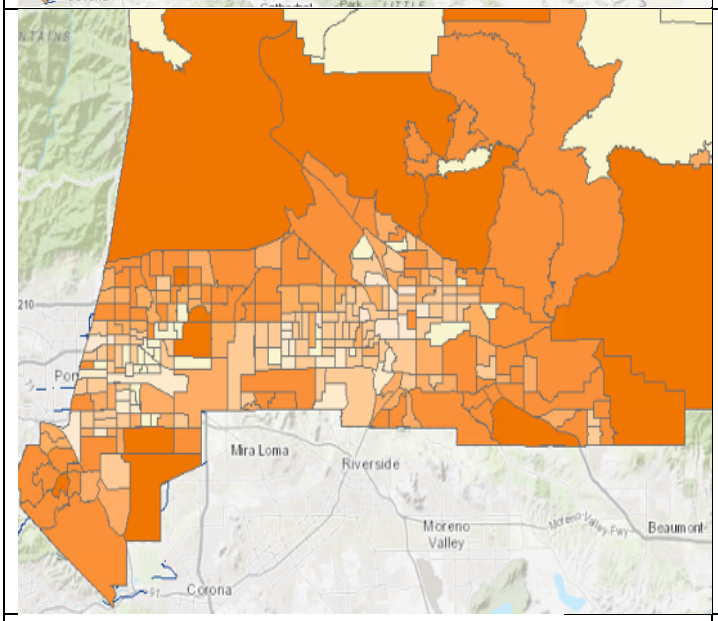
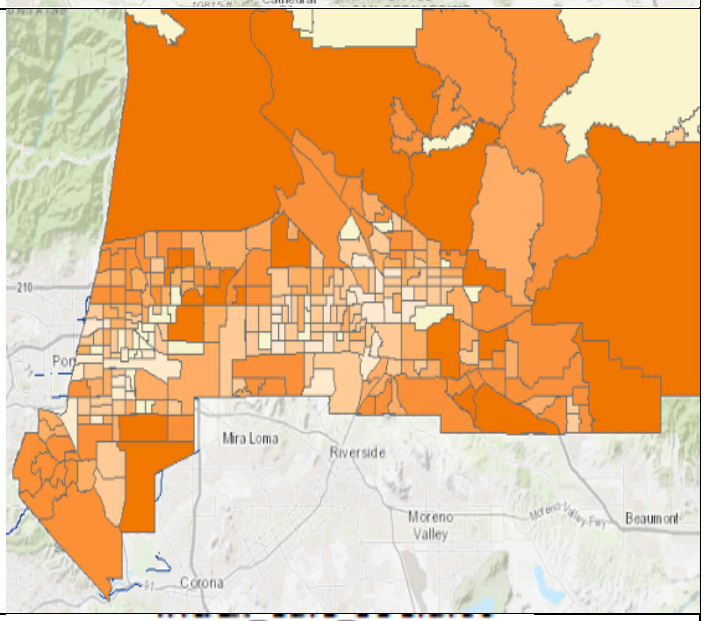
Social 50% weight Environment & Mobility each weighted 25%	Social 60% weight Environment & Mobility each weighted 20%
	
	
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Conclusions

Overall, the urban/suburban census tracts, extending from Chino to Redlands, showed above average urban quality of life scores, while census tracts in less populated remote regions of the county exhibited close to or below average urban quality of life scores.

When the three quality of life categories were weighted equally there were specific pockets of the urban region within the county that showed positive quality of life, most notably the southwest corner of the county, the western-central end of San Bernardino, and the eastern edge of the populated region of the county, near Redlands.

Alternatively, in looking at the three categories each weighted at 50 percent, there is noticeable fluctuation in regions that exhibit an overall above average quality of life. The less populated inland census tracts' quality of life is shown to be relatively the same across the three scenarios of Environment, Mobility, and Social each being weighted at 50 percent. When Environment is weighted at 50 percent residents in the western and eastern portions of the population region of the county are the primary areas which exhibit noticeably good quality of life. Looking at Mobility being weighted higher than the other two categories, the majority of the populated urban/suburban region exhibits close to average quality of life. And in examining the Social category being weighted the highest there appears to be a consistently high quality of life across the cities and towns within the county.

When looking at the three categories each weighted at 60 percent, there is less variation amongst the three weighting scenarios in comparison with the equal weighting and 50 percent weighting scenarios.

The Environment and Social categories both exhibit a relatively uniform distribution of census tracts showing above average quality of life, with small pockets of close to average quality of life dispersed in a few regions in the urban/suburban section of the county. Meanwhile, with Mobility weighted at 60 percent the majority of census tracts within the urban/suburban sector show close to average quality of life, except for a small number of census tract blocks which show comparatively significant above average quality of life.

After examining the results of the three categories z-scores across the county within the different weighting scenarios, I was surprised by the number of remote census tracts showing high quality of life. These areas contain very few people in comparison to the urban/suburban areas surrounding San Bernardino, and because of this they most like do not contain much data for the majority of the data indicators across the three urban quality of life indicator categories. A possible explanation for this occurrence is the fact that these census tracts receive very little vehicles passing through, which would make their Traffic and Diesel PM scores be very low. I

also expected the Traffic and Ozone sub-indicators to have a more damaging impact on overall urban quality of life than the map results exhibit. There were pockets of the county where Traffic and Ozone greatly affected the overall urban quality of life level for particular census tracts, but the negative affects across the urban/suburban regions of the county were not as widespread as I originally anticipated. Ultimately, this variable effect of environmental indicators on the urban quality of life levels of urban/suburban residents leads me to infer that mobility and social indicators, such as access to the metrolink and access to supermarkets, are the better determinants of urban quality of life for San Bernardino county residents.

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