

Job Accessibility Analysis An Integration of GIS and SAS Applications

Southern California Association of Governments
Division of Land Use and Environmental Planning
Department of Research and Analysis

2016 ESRI User Conference
San Diego Convention Center

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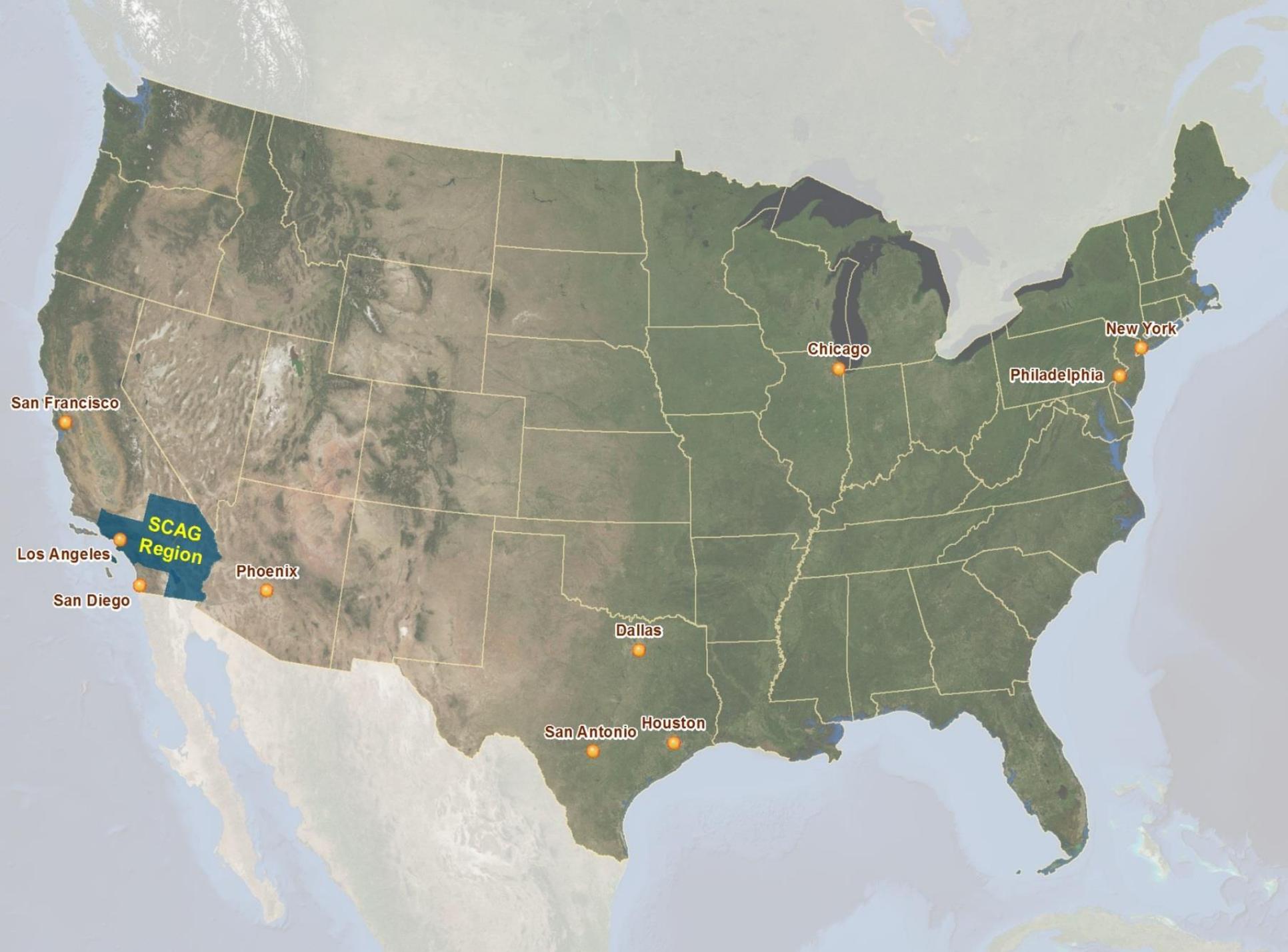
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Content

- Introduction of SCAG
- Research Intention
- Theoretical Background
- Methodology
- Results and Conclusions
- Future Improvements



San Francisco

Los Angeles

San Diego

**SCAG
Region**

Phoenix

Dallas

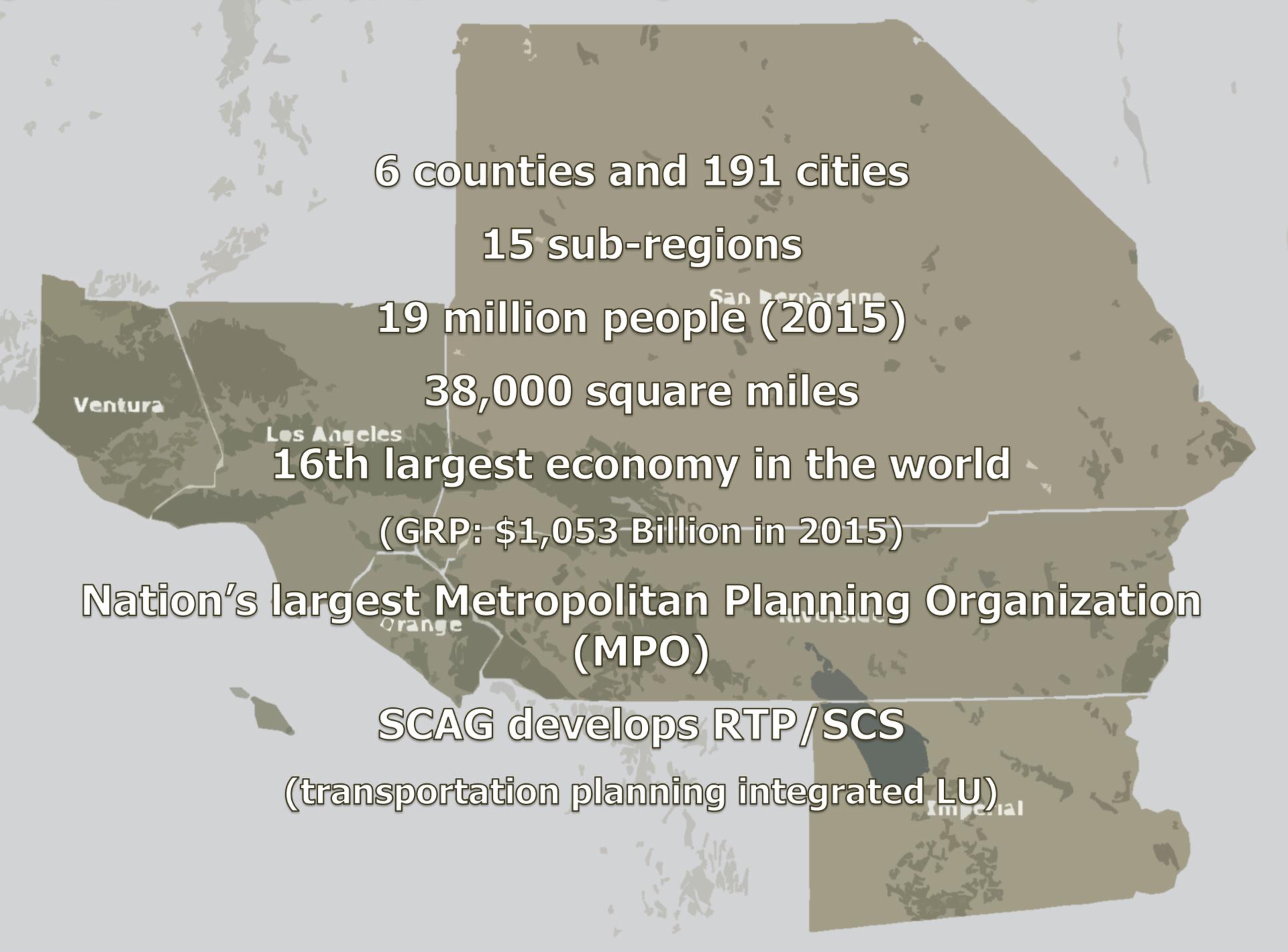
San Antonio

Houston

Chicago

Philadelphia

New York



6 counties and 191 cities

15 sub-regions

19 million people (2015)

38,000 square miles

16th largest economy in the world

(GRP: \$1,053 Billion in 2015)

**Nation's largest Metropolitan Planning Organization
(MPO)**

SCAG develops RTP/SCS

(transportation planning integrated LU)

Research Intention

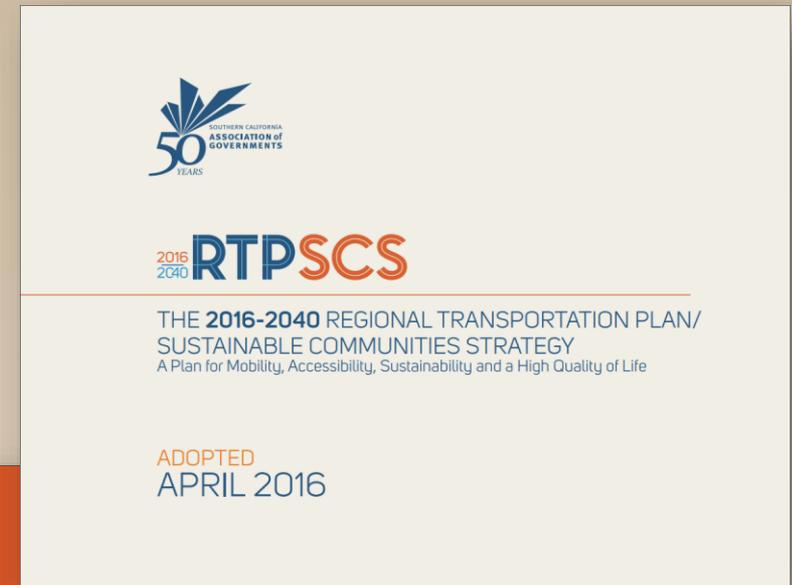
- **SCAG Mission Statement**
 - Under the guidance of the Regional Council and in collaboration with our partners, our mission is to facilitate a forum to develop and foster the realization of regional plans that improve the quality of life for Southern Californians
- **2016-2040 RTP/SCS**
 - SCAG envisions a region that has grown by nearly four million people—sustainably. In communities across Southern California, people enjoy increased mobility, greater economic opportunity and a higher quality of life
- **Title VI of the 1964 Civil Rights Act**
 - Environmental Justice Analysis seeks to avoid disproportionately high and adverse impacts on minority and low income populations with respect to human health and the environment



Environmental Justice Analysis

2016 RTP/SCS EJ Appendix

- SCAG identified 18 performance measures. Here are some of the areas we analyzed:
 - Distribution of travel time savings and travel distance reductions
 - Jobs-housing imbalance or jobs-housing mismatch
 - Accessibility to employment and services
 - Gentrification and displacement
 - Emissions impacts analysis
 - Climate vulnerability
 - ...and more!



Theoretical Background

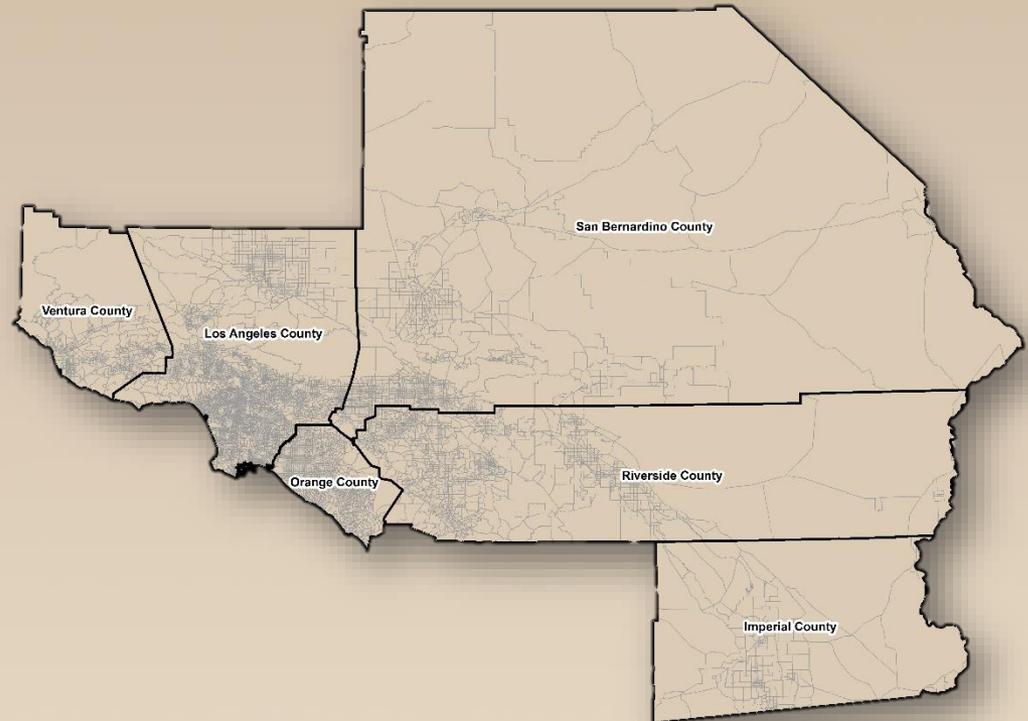
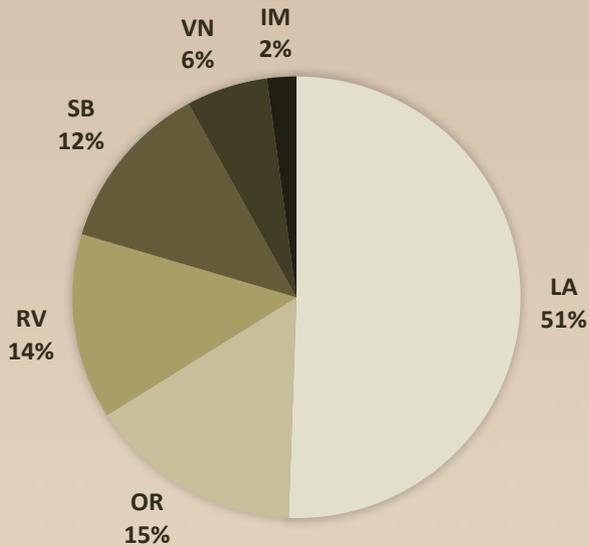
- Transportation and land use decisions determine access to opportunities and have far-reaching effects on social justice and equity
- Land use patterns or the distribution of activities within the urban landscape describe the spatial dispersion of these destinations, and together transportation and land use influence the ability of households to meet their daily needs
- Accessibility is measured by the spatial distribution of potential destinations, the ease of reaching each destination, and the magnitude, quality and character of activities at potential destination sites

Methodology

- **There are two types of analysis on accessibility: time and distance**
 - Time-based Job Accessibility
 - Measure the accessibility by travel time using street network
 - Distance-based Job Accessibility
 - Measure the accessibility by distance from a centroid of a TAZ
 - This approach can be useful for determining the relative accessibility for short trips, such as those that are more likely to be completed using active transportation modes.

Methodology (Cont.)

- 11,267 Transportation Analysis Zones (TAZs) in SCAG region



Methodology (Cont.)

- Distance-based Job Accessibility Calculation
 - Calculate regional job share within one mile buffer from a TAZ's centroid

$$\text{Regional job share} = \frac{\text{jobs within one mile}}{\text{total regional jobs}}$$

- Calculate Weighted Average Job Accessibility within One Mile Distance (Measured as the Percent of Regional Employment Accessible for Each Cohort)

$$\text{Job Accessibility for Hisp.HH} = \sum \left(\frac{\text{Hisp.HH}_{TAZ1} * \text{regional job share}_{TAZ1}}{\text{Total Hisp.HH}} \right) + \left(\frac{\text{Hisp.HH}_{TAZ2} * \text{regional job share}_{TAZ2}}{\text{Total Hisp.HH}} \right) + \left(\frac{\text{Hisp.HH}_{TAZn} * \text{regional job share}_{TAZn}}{\text{Total Hisp.HH}} \right)$$

Methodology (Cont.) - GIS

- Utilizing spatial analysis and data management tools in ArcGIS to calculate jobs within one-mile buffer



Centroid



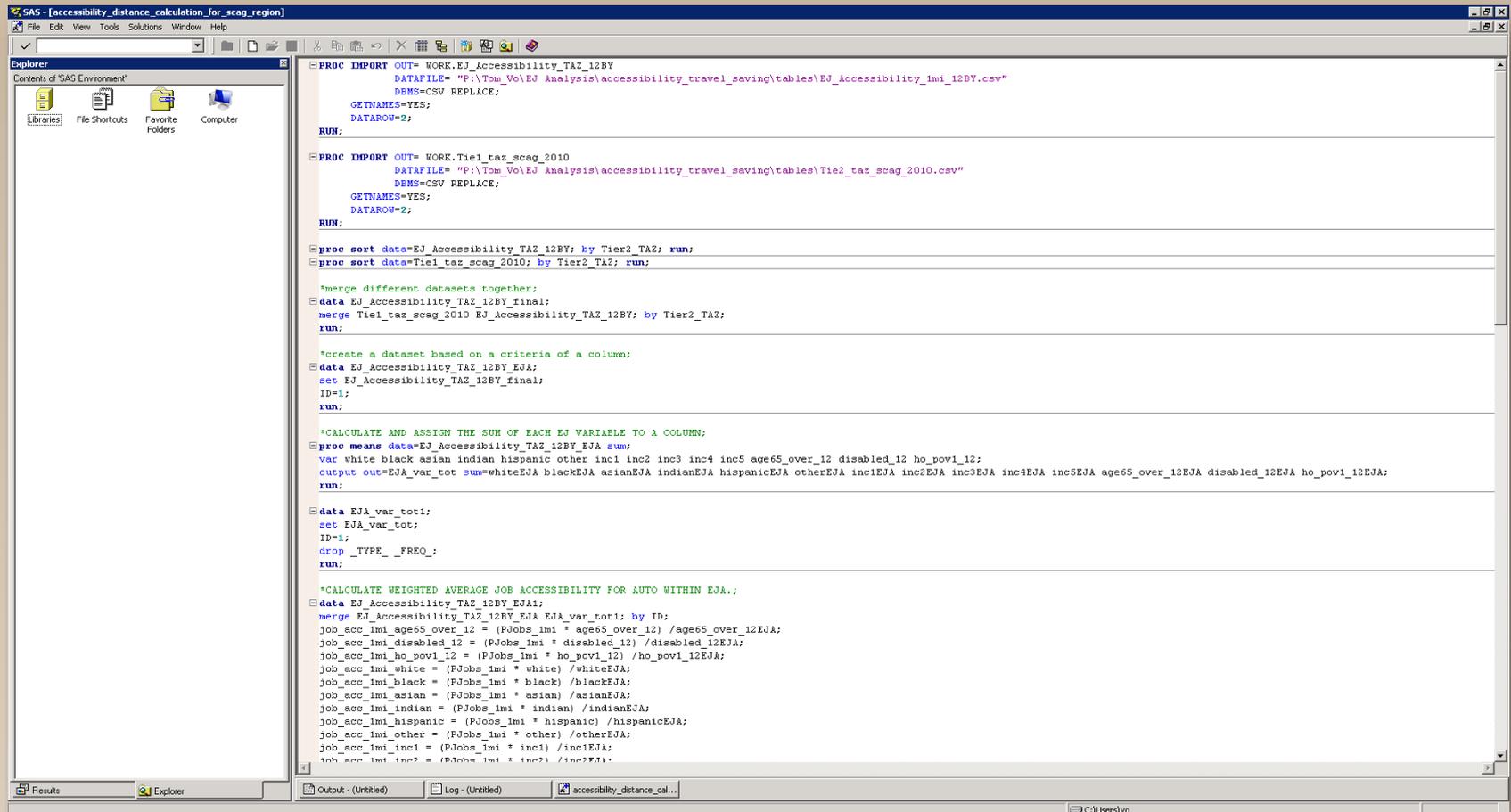
Buffer



Intersect

Methodology (Cont.) - SAS

Statistical Analysis Software (SAS)



The screenshot displays the SAS software interface with a program editor window. The program code is as follows:

```
PROC IMPORT OUT= WORK.EJ_Accessibility_TAZ_12BY
  DATAFILE= "P:\Tom_Vo\EJ_Analysis\accessibility_travel_saving\tables\EJ_accessibility_lmi_12BY.csv"
  DBMS=CSV REPLACE;
  GETNAMES=YES;
  DATAROW=2;
RUN;

PROC IMPORT OUT= WORK.Tier2_taz_scag_2010
  DATAFILE= "P:\Tom_Vo\EJ_Analysis\accessibility_travel_saving\tables\Tier2_taz_scag_2010.csv"
  DBMS=CSV REPLACE;
  GETNAMES=YES;
  DATAROW=2;
RUN;

proc sort data=EJ_Accessibility_TAZ_12BY; by Tier2_TAZ; run;
proc sort data=Tier2_taz_scag_2010; by Tier2_TAZ; run;

*merge different datasets together;
data EJ_Accessibility_TAZ_12BY_final;
merge Tier2_taz_scag_2010 EJ_Accessibility_TAZ_12BY; by Tier2_TAZ;
run;

*create a dataset based on a criteria of a column;
data EJ_Accessibility_TAZ_12BY_EJA;
set EJ_Accessibility_TAZ_12BY_final;
ID=1;
run;

*CALCULATE AND ASSIGN THE SUM OF EACH EJ VARIABLE TO A COLUMN;
proc means data=EJ_Accessibility_TAZ_12BY_EJA sum;
var white black asian indian hispanic other incl1 incl2 incl3 incl4 incl5 age65_over_12 disabled_12 ho_pov1_12;
output out=EJA_var_tot sum=whiteEJA blackEJA asianEJA indianEJA hispanicEJA otherEJA incl1EJA incl2EJA inc3EJA inc4EJA inc5EJA age65_over_12EJA disabled_12EJA ho_pov1_12EJA;
run;

data EJA_var_tot1;
set EJA_var_tot;
ID=1;
drop _TYPE_ _FREQ_;
run;

*CALCULATE WEIGHTED AVERAGE JOB ACCESSIBILITY FOR AUTO WITHIN EJA.;
data EJ_Accessibility_TAZ_12BY_EJA1;
merge EJ_Accessibility_TAZ_12BY_EJA EJA_var_tot1; by ID;
job_acc_lmi_age65_over_12 = (PJobs_lmi * age65_over_12) /age65_over_12EJA;
job_acc_lmi_disabled_12 = (PJobs_lmi * disabled_12) /disabled_12EJA;
job_acc_lmi_ho_pov1_12 = (PJobs_lmi * ho_pov1_12) /ho_pov1_12EJA;
job_acc_lmi_white = (PJobs_lmi * white) /whiteEJA;
job_acc_lmi_black = (PJobs_lmi * black) /blackEJA;
job_acc_lmi_asian = (PJobs_lmi * asian) /asianEJA;
job_acc_lmi_indian = (PJobs_lmi * indian) /indianEJA;
job_acc_lmi_hispanic = (PJobs_lmi * hispanic) /hispanicEJA;
job_acc_lmi_other = (PJobs_lmi * other) /otherEJA;
job_acc_lmi_incl1 = (PJobs_lmi * incl1) /incl1EJA;
job_acc_lmi_incl2 = (PJobs_lmi * incl2) /incl2EJA;
```

Methodology (Cont.) - SAS

- Utilizing SAS to calculate job accessibility within one-mile buffer weighted by different population groups
 - Proc import, proc sort, proc means, merge

Results

The screenshot displays the SAS software interface. The main window is titled "Results Viewer - SAS Output" and shows the output of a PROC MEANS procedure. The output is a table with two columns: "Variable" and "Sum".

Variable	Sum
job_acc_1mi_age65_over_12	0.0012955
job_acc_1mi_disabled_12	0.0013582
job_acc_1mi_ho_pov1_12	0.0017257
job_acc_1mi_white	0.0012357
job_acc_1mi_black	0.0013210
job_acc_1mi_asian	0.0015874
job_acc_1mi_indian	0.0010117
job_acc_1mi_hispanic	0.0012813
job_acc_1mi_other	0.0013625
job_acc_1mi_inc1	0.0017242
job_acc_1mi_inc2	0.0014669
job_acc_1mi_inc3	0.0013731

Below the table, the SAS code used for the procedure is displayed in the Log window:

```
run;
proc means data=EJ_Accessibility_TAZ_12BY_EJA1 sum;
var shop_acc_2mi_age65_over_12 shop_acc_2mi_disabled_12 shop_acc_2mi_ho_pov1_12 shop_acc_2mi_white shop_acc_2mi_black shop_acc_2mi_asian shop_acc_2mi_indian shop_acc_2mi_hispanic shop_acc_2mi_other;
output out=EJA_EJ_ACC_SUM sum=age65_over_12EJA_ACC_SUM disabled_12EJA_ACC_SUM ho_pov1_12EJA_ACC_SUM whiteEJA_ACC_SUM blackEJA_ACC_SUM asianEJA_ACC_SUM indianEJA_ACC_SUM hispanicEJA_ACC_SUM other;
run;
```

The Log window also shows the following output:

```
NOTE: There were 11267 observations read from the data set WORK.EJ_ACCESSIBILITY_TAZ_12BY_EJA1.
NOTE: The data set WORK.EJA_EJ_ACC_SUM has 1 observations and 16 variables.
NOTE: PROCEDURE MEANS used (Total process time):
      real time          0.07 seconds
      cpu time           0.09 seconds
```

Results (Cont.)

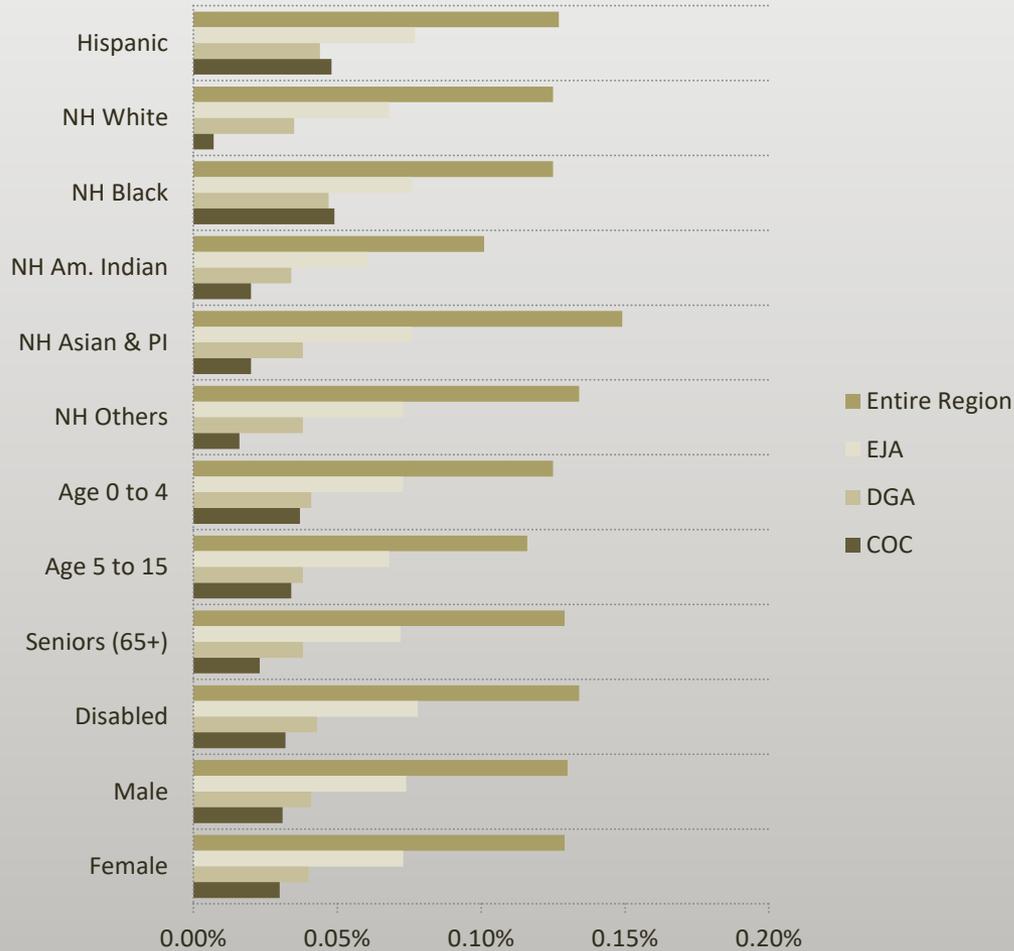
- Utilizing SAS script to efficiently generate summary table

Weighted Average Job Accessibility within One Mile Distance (Measured as the Percent of Regional Employment Accessible for Each Cohort)

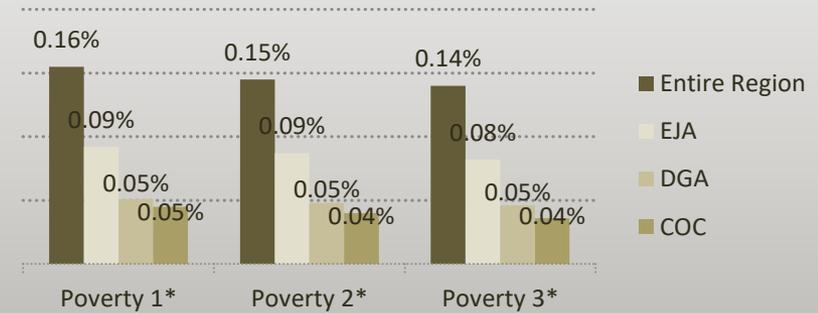
	SCAG (BY)	SCAG (BL)	SCAG (PL)	EJA (BY)	EJA (BL)	EJA (PL)	DGA (BY)	DGA (BL)	DGA (PL)	CoC (BY)	CoC (BL)	CoC (PL)	Urban (BY)	Urban (BL)	Urban (PL)	Rural (BY)	Rural (BL)	Rural (PL)
Elderly	0.13%	0.13%	0.14%	0.15%	0.15%	0.17%	0.17%	0.17%	0.20%	0.14%	0.14%	0.15%	0.13%	0.13%	0.15%	0.00%	0.00%	0.00%
Disabled	0.14%	0.12%	0.13%	0.15%	0.13%	0.15%	0.16%	0.15%	0.17%	0.14%	0.13%	0.14%	0.14%	0.13%	0.14%	0.00%	0.00%	0.00%
Poverty	0.17%	0.15%	0.17%	0.19%	0.16%	0.18%	0.21%	0.17%	0.21%	0.16%	0.14%	0.15%	0.18%	0.15%	0.17%	0.00%	0.00%	0.00%
NH-White	0.12%	0.12%	0.13%	0.15%	0.15%	0.16%	0.18%	0.18%	0.21%	0.13%	0.15%	0.15%	0.13%	0.13%	0.14%	0.00%	0.00%	0.00%
NH-Black	0.13%	0.11%	0.11%	0.14%	0.11%	0.12%	0.15%	0.12%	0.13%	0.12%	0.11%	0.11%	0.13%	0.11%	0.12%	0.00%	0.00%	0.00%
NH-Asian	0.16%	0.15%	0.16%	0.18%	0.17%	0.19%	0.20%	0.19%	0.22%	0.18%	0.17%	0.18%	0.16%	0.15%	0.17%	0.00%	0.00%	0.00%
NH-Indian	0.10%	0.10%	0.11%	0.11%	0.11%	0.12%	0.16%	0.14%	0.16%	0.13%	0.12%	0.12%	0.11%	0.11%	0.12%	0.00%	0.00%	0.00%
Hispanic	0.13%	0.12%	0.13%	0.13%	0.13%	0.14%	0.15%	0.15%	0.16%	0.14%	0.13%	0.14%	0.13%	0.12%	0.14%	0.00%	0.00%	0.00%
NH-Other	0.14%	0.13%	0.14%	0.16%	0.15%	0.17%	0.18%	0.18%	0.21%	0.14%	0.15%	0.16%	0.14%	0.14%	0.15%	0.00%	0.00%	0.00%
Income 1	0.17%	0.15%	0.17%	0.19%	0.16%	0.18%	0.22%	0.18%	0.21%	0.17%	0.14%	0.15%	0.18%	0.15%	0.17%	0.00%	0.00%	0.00%
Income 2	0.15%	0.14%	0.16%	0.16%	0.15%	0.18%	0.18%	0.17%	0.20%	0.15%	0.14%	0.15%	0.15%	0.14%	0.16%	0.00%	0.00%	0.00%
Income 3	0.14%	0.13%	0.15%	0.15%	0.15%	0.17%	0.16%	0.17%	0.20%	0.14%	0.14%	0.15%	0.14%	0.14%	0.16%	0.00%	0.00%	0.00%
Income 4	0.13%	0.13%	0.15%	0.15%	0.15%	0.17%	0.16%	0.17%	0.21%	0.14%	0.14%	0.15%	0.13%	0.14%	0.15%	0.00%	0.00%	0.00%
Income 5	0.14%	0.14%	0.15%	0.17%	0.16%	0.19%	0.17%	0.19%	0.23%	0.14%	0.15%	0.16%	0.14%	0.14%	0.16%	0.00%	0.00%	0.00%
Average	0.139%	0.130%	0.143%	0.154%	0.145%	0.163%	0.176%	0.167%	0.194%	0.145%	0.141%	0.147%	0.143%	0.135%	0.150%	0.002%	0.002%	0.001%

Results (Cont.)

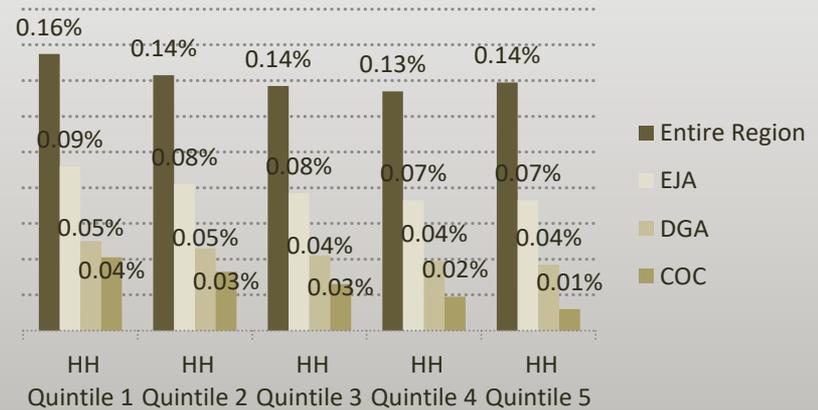
Existing Distanced-Based Job Accessibility (one-mile) of 2012 Base Year by Different Population Groups



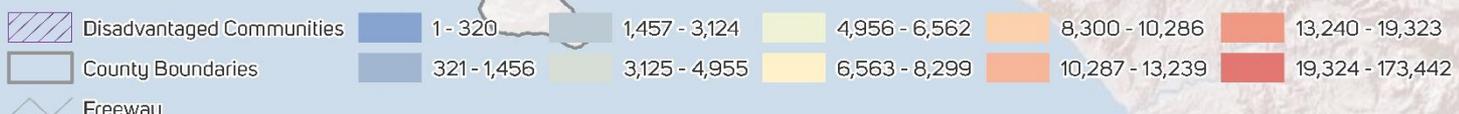
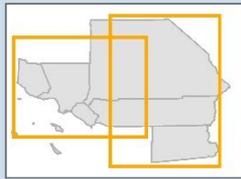
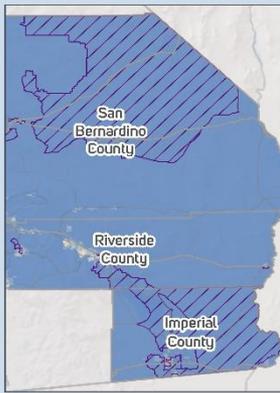
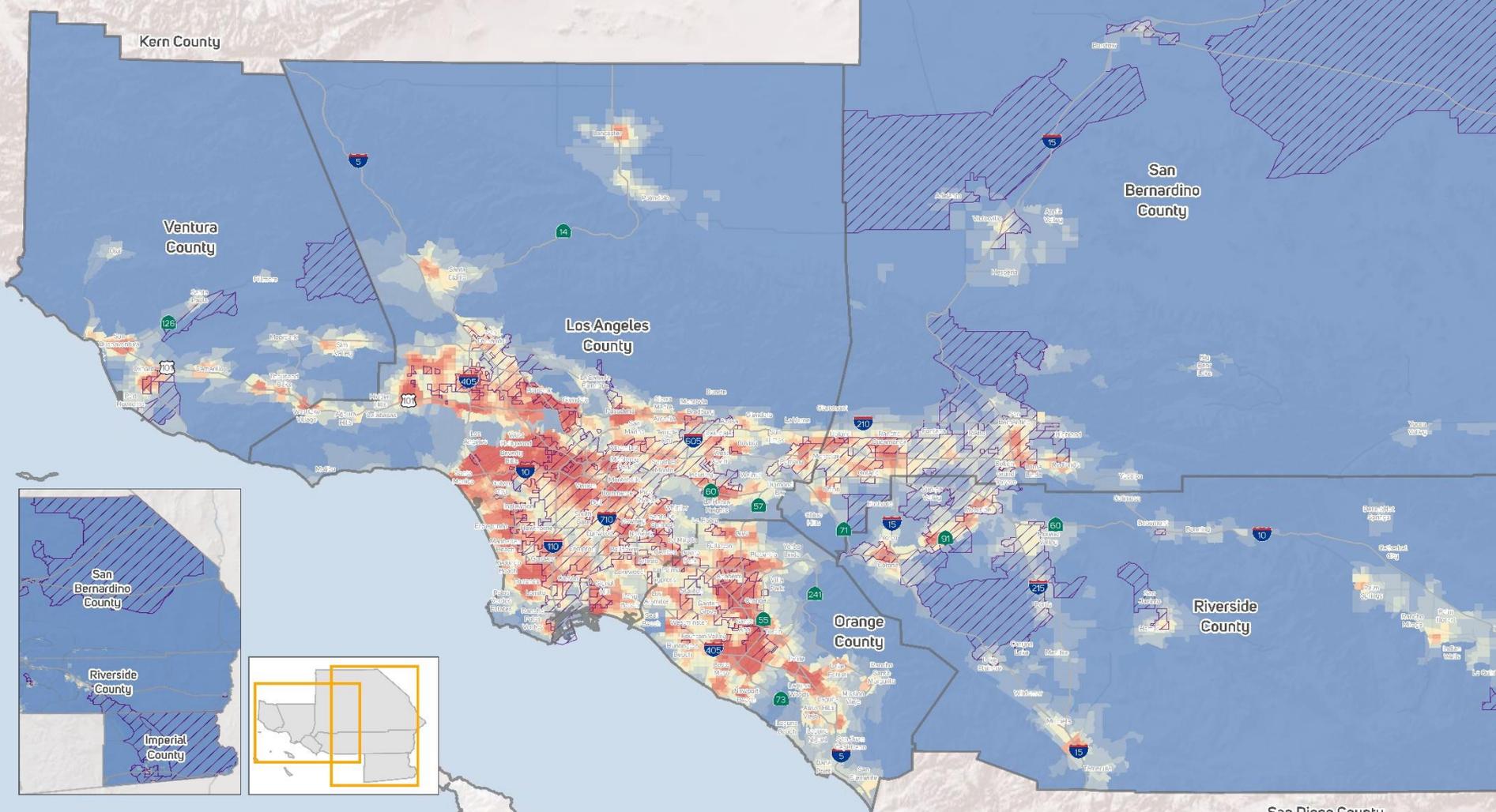
Existing Distanced-Based Job Accessibility (one-mile) of 2012 Base Year by Different Household Poverty Levels



Existing Distanced-Based Job Accessibility (one-mile) of 2012 Base Year by Different Household Income Quintiles



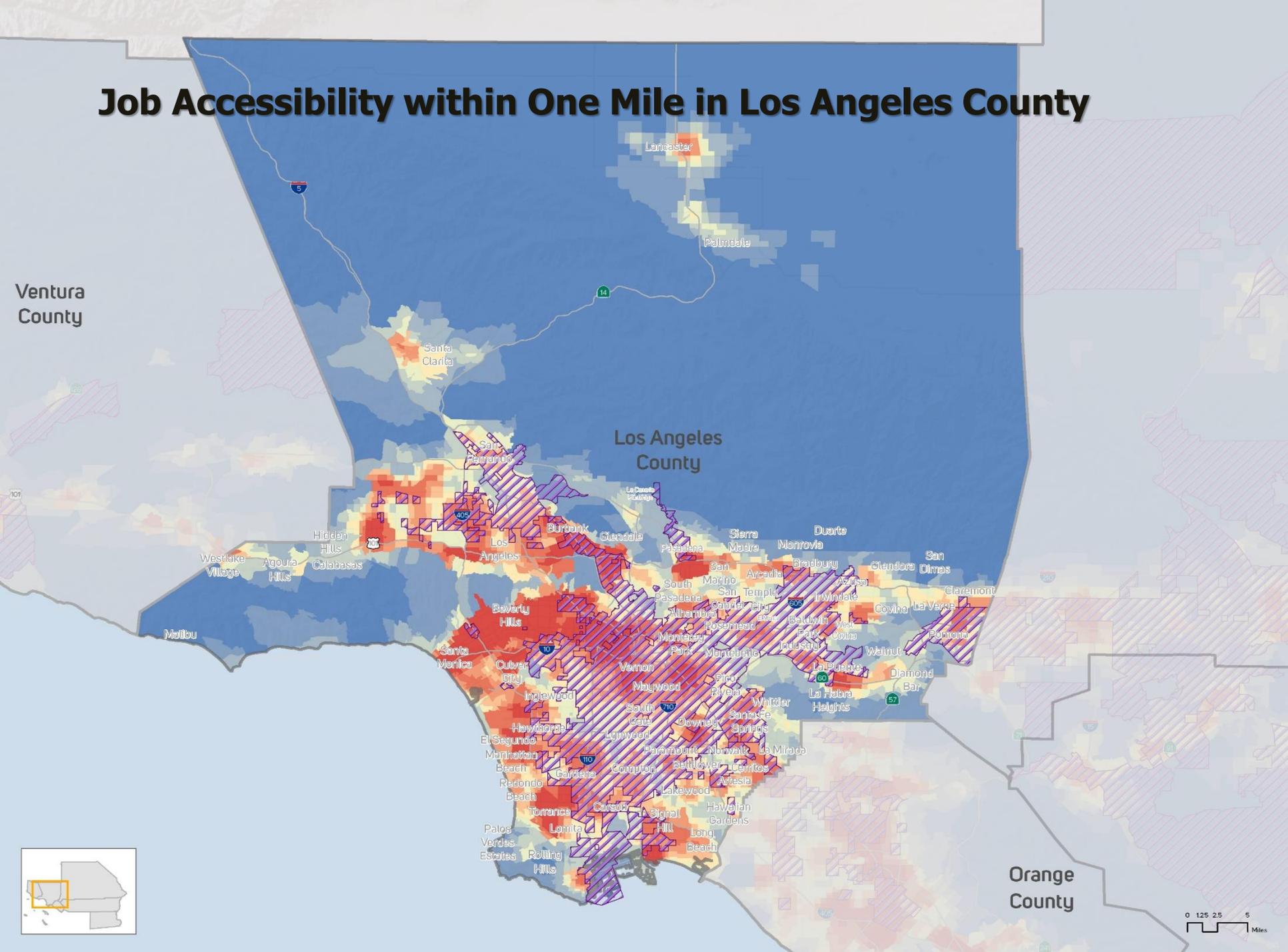
Job Accessibility within One Mile in SCAG Region



San Diego County



Job Accessibility within One Mile in Los Angeles County



Ventura County

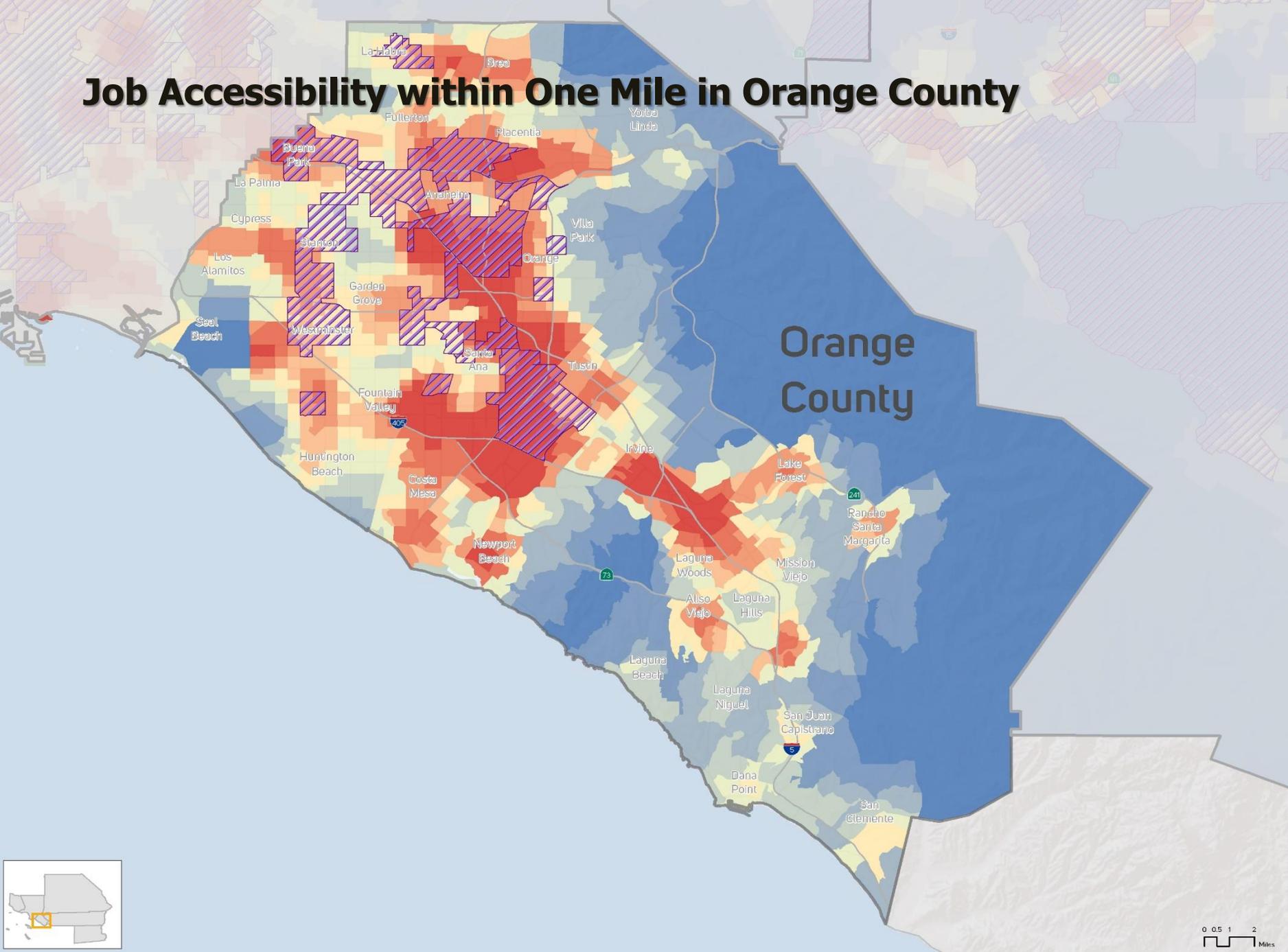
Los Angeles County

Orange County

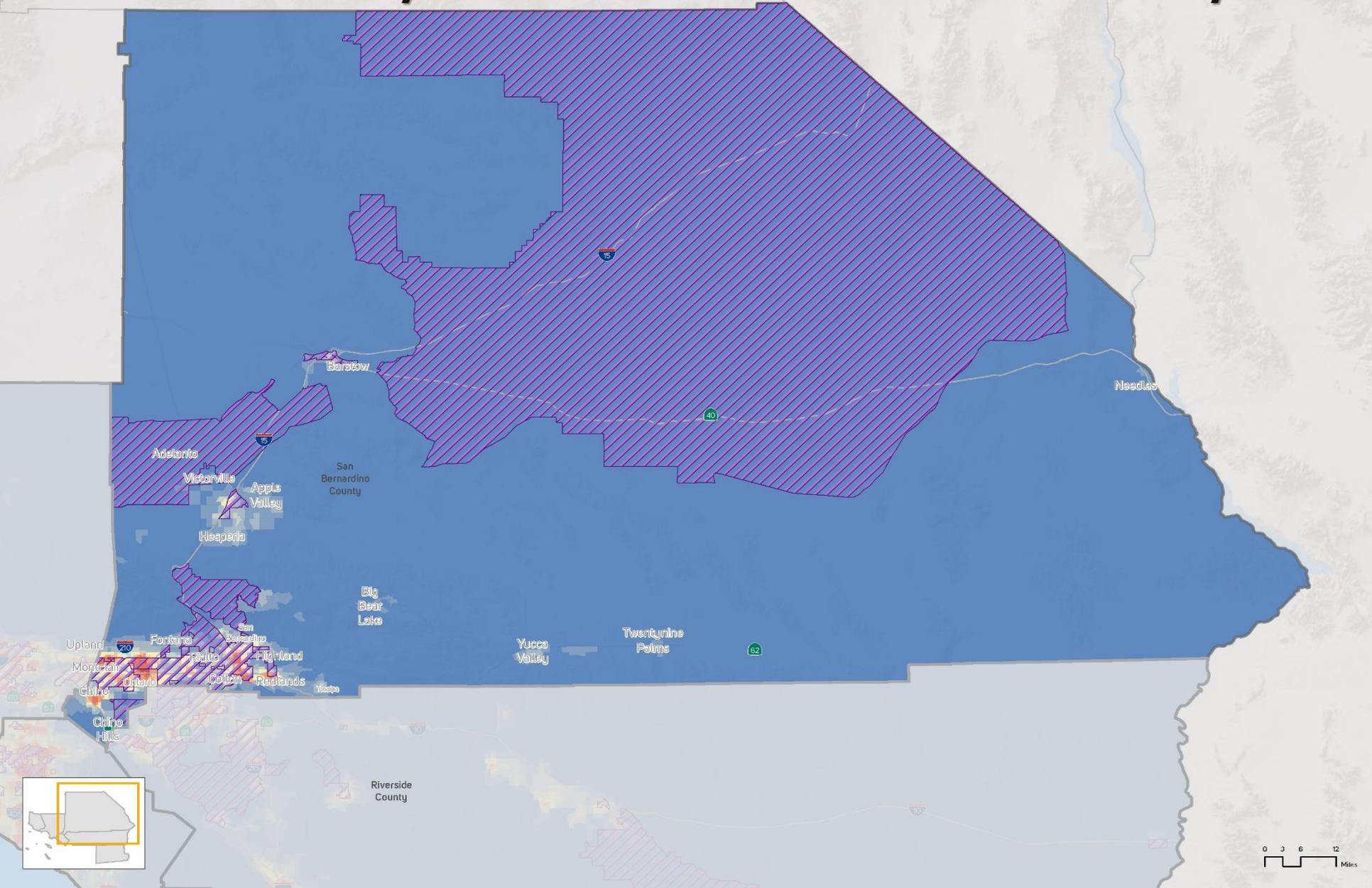


0 1.25 2.5 5 Miles

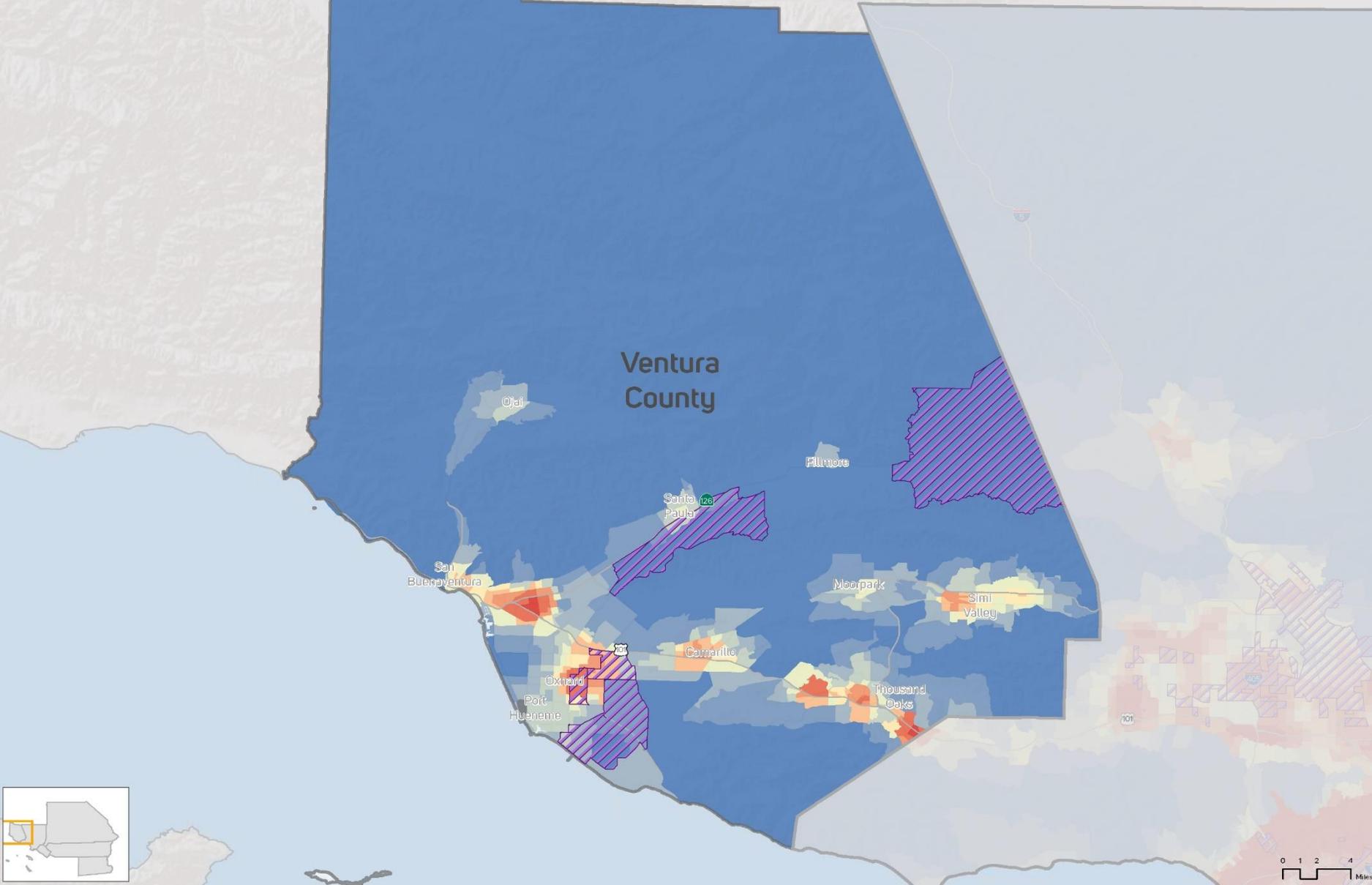
Job Accessibility within One Mile in Orange County



Job Accessibility within One Mile in San Bernardino County



Job Accessibility within One Mile in Ventura County



Job Accessibility within One Mile in Imperial County



Conclusions

- Significantly efficient and effective in processing job accessibility analysis with ModelBuilder and SAS script in lights of data processing, management, and visualization
 - ModelBuilder in ArcGIS
 - Automatically perform spatial analysis to proportionally calculate job availability within one mile from TAZ's centroid
 - SAS Script
 - Automatically calculate and summarize Weighted Average Job Accessibility within One Mile Distance (Measured as the Percent of Regional Employment Accessible for Each Cohort)

Future Studies

- Integrate both ModelBuilder and SAS script into Python environment to fully automate job accessibility calculation
- Elevate this application to ArcGIS Online to calculate and visualize data on the fly
- Statistical analysis to explore the relationship between job accessibility, built environment, and EJ variables
- Explore other methods to improve distance-based job accessibility calculation

Thank you!

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JOB ACCESSIBILITY ANALYSIS: AN INTEGRATION OF GIS AND SAS APPLICATIONS

BACKGROUND

In compliance with Title VI of the Civil Rights Act of 1964, Southern California Association of Governments (SCAG) is mandated to perform Environmental Justice (EJ) analyses as part of the Regional Transportation Plan/Sustainable Community Strategy. EJ seeks to avoid disproportionately high and adverse impacts on minority and low income populations with respect to human health and the environment. The intention of this research is to explore EJ as it relates to employment accessibility in the region.

Transportation and land use decisions determine access to opportunities and have far-reaching effects on social justice and equity. Land use patterns or the distribution of activities within the urban landscape describe the spatial dispersion of these destinations, and together transportation and land use influence the ability of households to meet their daily needs.

METHODOLOGY

Transportation Analysis Zones (TAZ) were the geographic unit used for analyzing access to employment. Job Accessibility was calculated as the number of jobs within one mile of each TAZ centroid. To accomplish this calculation, employment data (obtained from the California Department of Finance) was apportioned to respective TAZ centroids based on a one mile radial buffer using GIS. The corresponding map show the number of jobs available to each TAZ within a short distance trip.

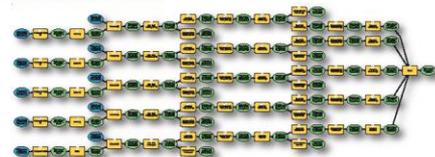


Analysis of EJ requires a comparison of relative accessibility by socio-economic groups. To determine the differential level of access, a weighted average of job accessibility for several demographic groups was calculated (measured as percent of regional employment accessible by cohort).

$$Job\ Accessibility\ for\ HH = \frac{\sum (HH_{i,j} \times regional\ job\ share_{i,j})}{Total\ HH_{i,j}}$$

The Job Accessibility calculation and apportionment was performed using ArcGIS Model Builder. Statistical Analysis System (SAS) was utilized to automatically calculate and summarize the Weighted Average Job Accessibility measure used for the Environmental Justice analysis.

MODEL BUILDER



CONTRIBUTIONS & FUTURE RESEARCH

This project provides valuable information on the EJ of job accessibility throughout the SCAG region. Additionally, the project serves as an intermediate step to a fully automated and publicly accessible application online. Eventually, both Model Builder and SAS script will be integrated in the Python environment. The final application will be available on ArcGIS Online for calculating and visualizing data on the fly.

Exploring methods to improve the distance-based job accessibility calculation will be an ongoing project. Future research will also explore possible relationships between the job accessibility measure, build environment and other EJ variables.

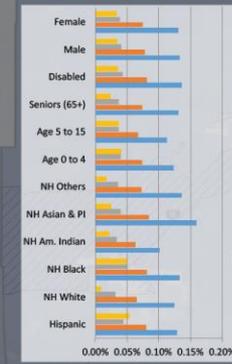
FINDINGS

Results show that all racial and ethnic minority groups have more employment opportunities within a one-mile distance than the White population. This is true at the regional level, as well as for each area of concern. Asians, African Americans and those identifying as "some other race" or "more than one race" have the highest accessibility to employment within a one-mile distance when looking at the greater SCAG region. When looking at accessibility for households in poverty, as household incomes increase, job accessibility within a one-mile distance tends to be lower.

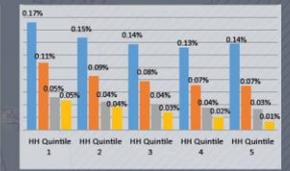
For additional information on distance-based job accessibility analysis, please visit our 2016 RTP/SCS Environmental Justice Appendix: <http://scagrtpscsc.net/>

EXISTING DISTANCE-BASED JOB ACCESSIBILITY (ONE MILE) OF 2012 BASE YEAR

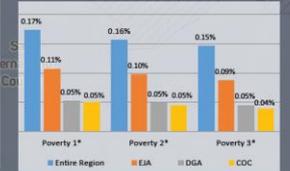
BY DEMOGRAPHIC GROUPS



BY HOUSEHOLD INCOME QUINTILES



BY HOUSEHOLD POVERTY LEVELS



Legend for Poverty Levels: 1* HH Below Poverty, 2* HH at 1.5x Poverty Level, 3* HH at 2x Poverty Level. Legend for Areas: Entire SCAG Region, Environmental Justice Area, Disadvantaged Communities, Community of Concerns.

