VISUALIZATION OF ORIGIN-DESTINATION COMMUTER FLOW USING CTPP DATA & GIS APPLICATIONS

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ABSTRACT

Analyzing the origin-destination commuter flow at the local jurisdictions level is important for understanding workers' commuting patterns among local jurisdictions. Southern California Association of Governments (SCAG), the nation's largest Metropolitan Planning Organization (MPO) representing six counties and 191 cities, has conducted an origin-destination commuter flow analysis for all jurisdictions in the region using Census Transportation Planning Products (CTPP) dataset. Understand this particular relationship has the potential to improve our transportation model which may lead to better projections. Therefore, this project is aimed to visualize the work trip distribution in an intuitive way that all parties—state, regional, and local governments, researchers, stakeholders, and residents—can be benefited from.

In addition, this project is an expansion of an existing project at SCAG, which is known as the Local Profiles. One of SCAG's programs and projects is to produce the Local Profiles for each jurisdiction in the SCAG region every two years. The Local Profiles are planning data reports prepared for each city, unincorporated area of the county and entire county within the SCAG Region. They provide current and historical demographic, socio-economic, housing, transportation and education data, gathered from a variety of sources. Local Profiles have served as information and communication resources for elected officials, business and residents in the SCAG Region. In preparation for the 2013 Local Profiles, SCAG staff has conducted an analysis of major work destinations for each jurisdiction in the SCAG Region using automated mechanisms in Geographic Information System (GIS) and Python programming language.

Visualizing the origin-destination commuter flow has generated several noteworthy lessons. The visualization of the major work flows helps stakeholders—residents and decision makers—to easily understand the spatial interaction of small areas through commuting. Automated GIS allows analysts to efficiently produce the visualized GIS maps of work flows between many small areas. Major work flows can increase public interest and can promote public participation in the planning process.

OBJECTIVES

- Understanding the commuting patterns of workers in SCAG region
- Accessing and investigating the relationship between workplace and residence
- Visualizing commuter flow by incorporating CTPP, SAS, Python, and GIS applications

METHODOLOGY

Similar to major work destination analysis in the discussed Local Profile project, to analyze and visualize the origin-destination commuter flows, SCAG staff has developed an automated workflow by utilizing CTPP Origin-Destination dataset, ArcGIS, Statistical Analysis Software (SAS) and Python scripting. With the development of the automated GIS system, SCAG staff effectively visualized the origin-destination commuter flow for 191 cities and 6 counties in the region in a time and labor efficient manner. The maps depict the commuter flows and patterns between home and work place throughout the region. The maps help jurisdictions, business community and residents to visually understand where workers are employed and where workers live in the region.

CTPP is developed and mainly used by transportation professionals, specifically transportation planners. The CTPP dataset consists of various special tabulations derived from large sample surveys of the Census Bureau. Decennial census long form was utilized for conducting CTPP from 1970 to 2000; after the year of 2000, this particular dataset is currently using a continuous survey called "the American Community Survey" (ACS). This commuter-flow project utilizes the most recent CTPP that was officially released in October 31, 2013, which is conducted from ACS 2006-2010 (5-Year Summary). In addition, this version of CTPP includes small geographic units such as Census Tracts and Transportation Analysis Zones (TAZs). The dataset categorizes these special tabulations into three sections: 1) Residence-based tabulations summarizing worker and household characteristics; 2) Workplace-based tabulations summarizing worker characteristics; and 3) Worker flows between home and work, including travel mode. Section three is most applicable for the purpose of commuter flow analysis.

One of the most important programs that has been used in this analysis is known as SAS. It is a statistical program to allow users to manipulate, organize, and refine large datasets in an efficient and cost-effective way. The origin-destination commuter flow data, obtained from CTPP, has numerous records due to the size of SCAG region, which consist of 197 jurisdictions. For the purpose of accuracy and quality, the flow data was inputted into SAS program to create correspondence table between census tracts and places, merge original-destination dataset with places, and export for GIS compatibility.

Environmental Systems Research Institute (ESRI) is an international supplier for GIS software program. GIS has the capability of managing and visualize data. This mapping program allows its users to visualize, analyze, and interpret data to help them with understanding the spatial patterns, trends, and relationships. Many private firms and government agencies are shifting towards GIS for displaying their data and performing various spatial analyses. Furthermore, GIS also has a functionality to perform flow map that can be useful for visualizing origin-destination commuter flow.

Python is a programming language that can be incorporated with GIS to create automated workflow process. It is an interpreter, object-oriented, and high-level general-purpose programming language including high productivity, fast editing-testing, and debugging cycle. There are numerous modules and packages that are well-integrated with ArcGIS such as ArcPy. In addition, this package allows coders to access and utilize functions in ArcGIS via Python codes. It is also supported by a series of modules, including a data driven page, data access module, mapping module, spatial analyst extension module, and others. ArcPy is efficient and beneficial when performing geographic data analysis, data conversion, data management, or map automation for 197 jurisdictions.

CONCLUSIONS

Visualization is the key to this origin-destination commuter flow. Several cities will be chosen as a case study to visualize their spatial relationships between origin and destination of work trips. This particular visualization is useful and potential for regional and local governments, stakeholders, business owners, and residents to understand the spatial distribution of commuters. CTPP official website has provided useful resources such as tutorials and videos to guide users to efficiently download various datasets (i.e. commuter flows, characteristics of workplace and residence, etc.). With a combination with all the aforementioned programs, SCAG staffs were able to develop an automated process to produce origin-destination commuter flow for all jurisdictions in SCAG region. These particular applications have helped SCAG staff to produce commuter flow maps of all jurisdictions in SCAG region in an efficient and timely manner.

FUTURE IMPROVEMENTS

- Compare origin-destination commuter flow between Census Transportation Planning Products (CTPP) and Longitudinal Employer-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES)
- Develop interactive web-based map application to access the commuter flow between CTPP and LODES
- Model and forecast commuter flow by using different types of planning scenarios
- Narrow the commuter flow dataset to smaller geographical areas such as census blocks and block groups for detailed analysis

WORKFLOW

CORRESPONDENCE BETWEEN CENSUS TRACT CODES & PLACE CODES

MERGING O-D DATASET & PLACE CODES BY CENSUS TRACTS CODES

CALCULATING JOB NUMBER FOR RESIDENTS OF EACH O-D AT PLACE LEVEL

SORTING DATASET IN DESCENDING ORDER

RANKING TOP 10 WORK DESTINATION

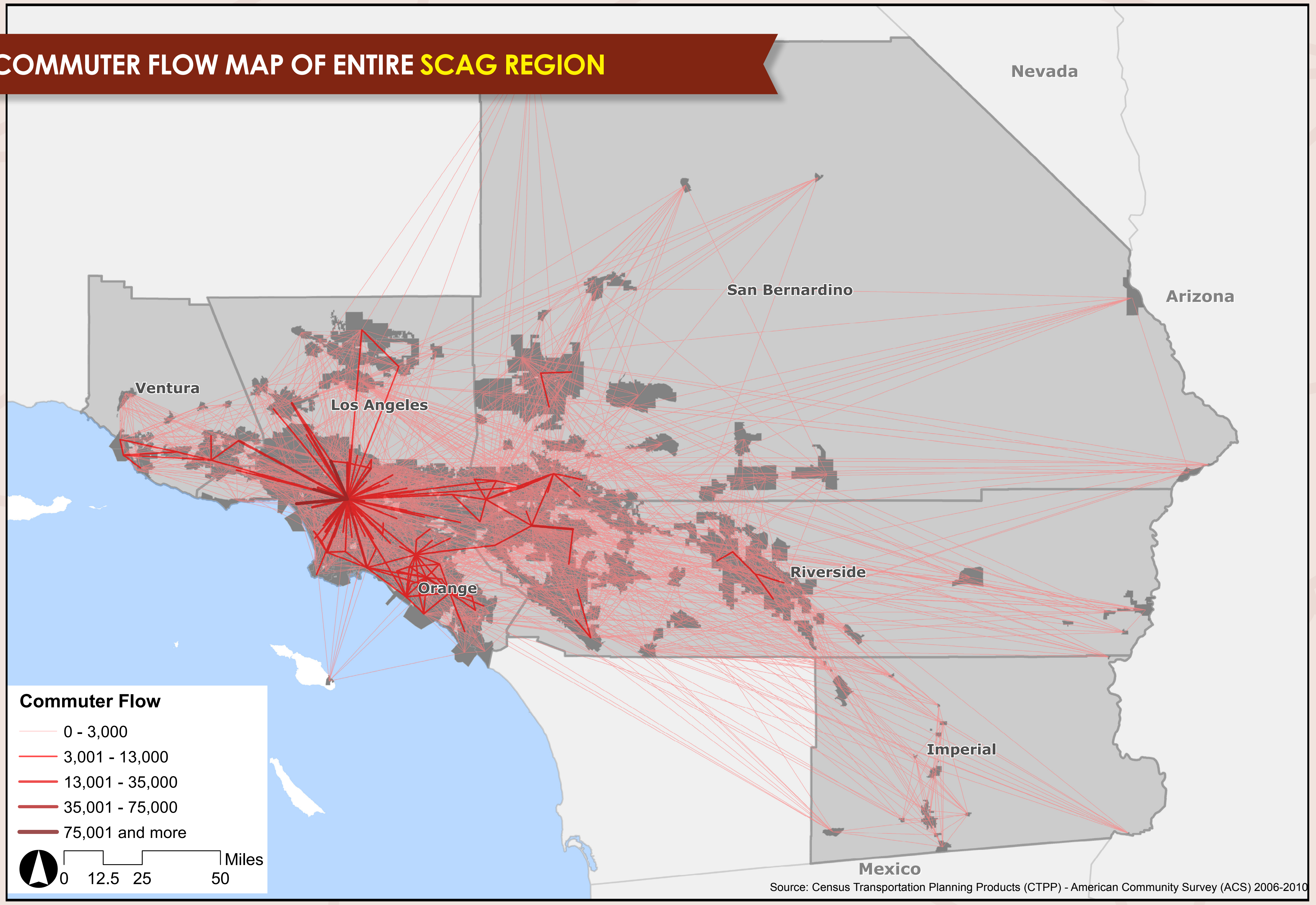
EXPORTING CSV DATASET TO DBF FILE FOR GIS

GEOCODING DBF FILE USING ARCGIS SOFTWARE

DESIGNING COMMUTING FLOW MAP LAYOUT USING ARCGIS SOFTWARE

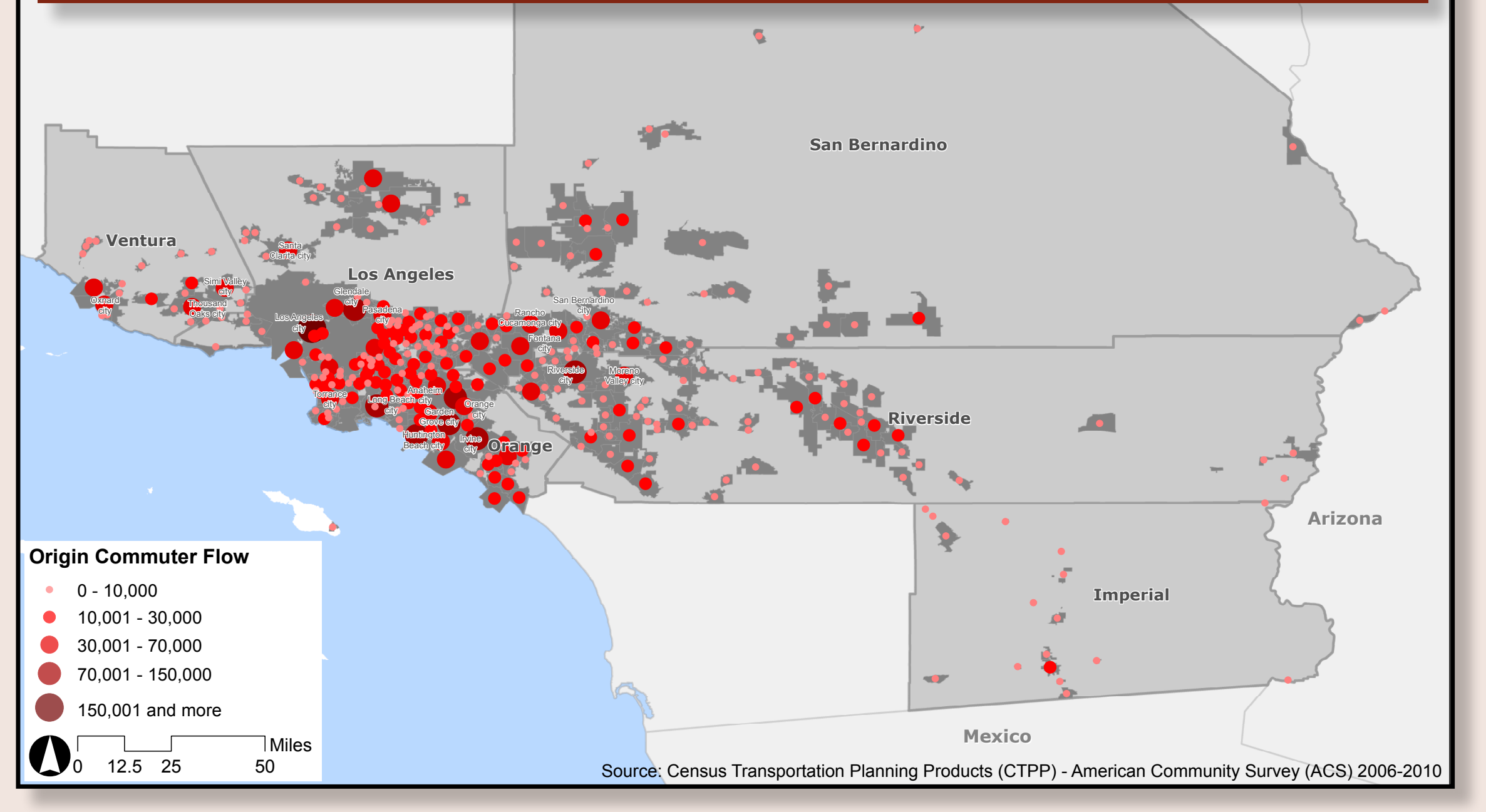
UTILIZING PYTHON TO AUTOMATICALLY CREATE COMMUTING FLOW MAPS

COMMUTER FLOW MAP OF ENTIRE SCAG REGION

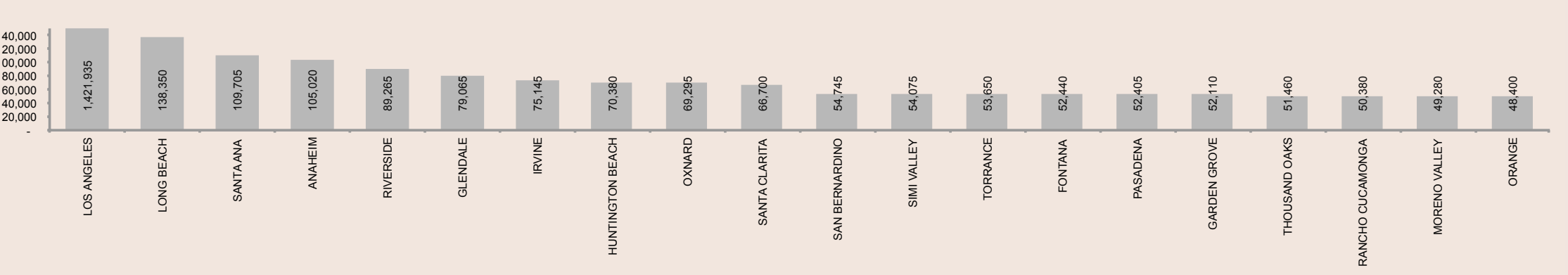


Source: Census Transportation Planning Products (CTPP) - American Community Survey (ACS) 2006-2010

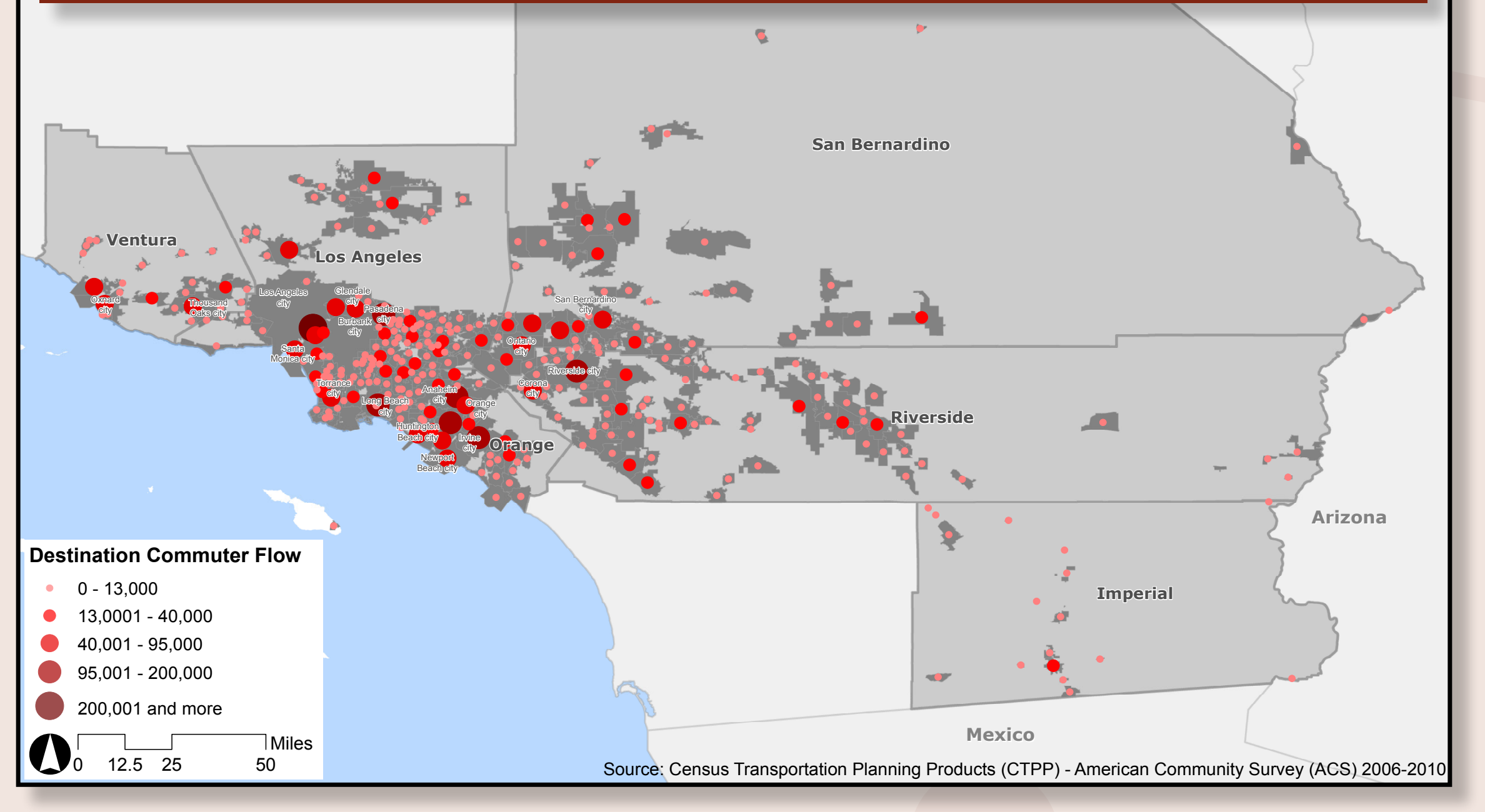
TOP 20 COMMUTING ORIGINS IN SCAG REGION



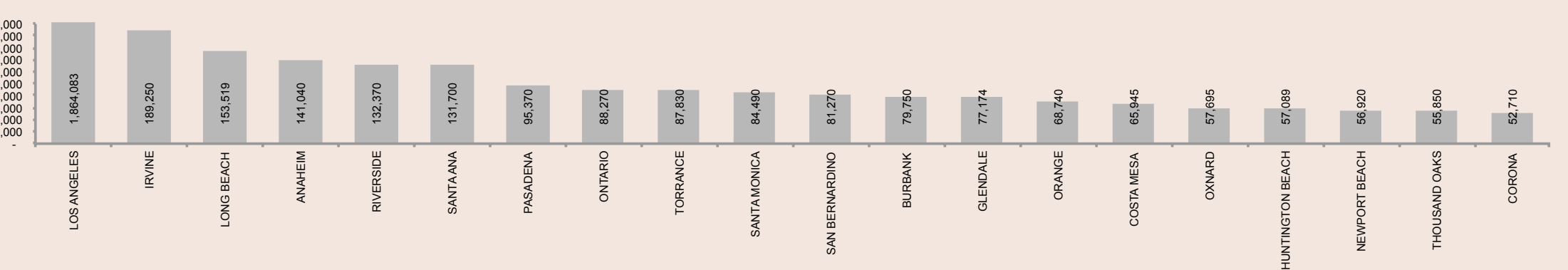
Source: Census Transportation Planning Products (CTPP) - American Community Survey (ACS) 2006-2010



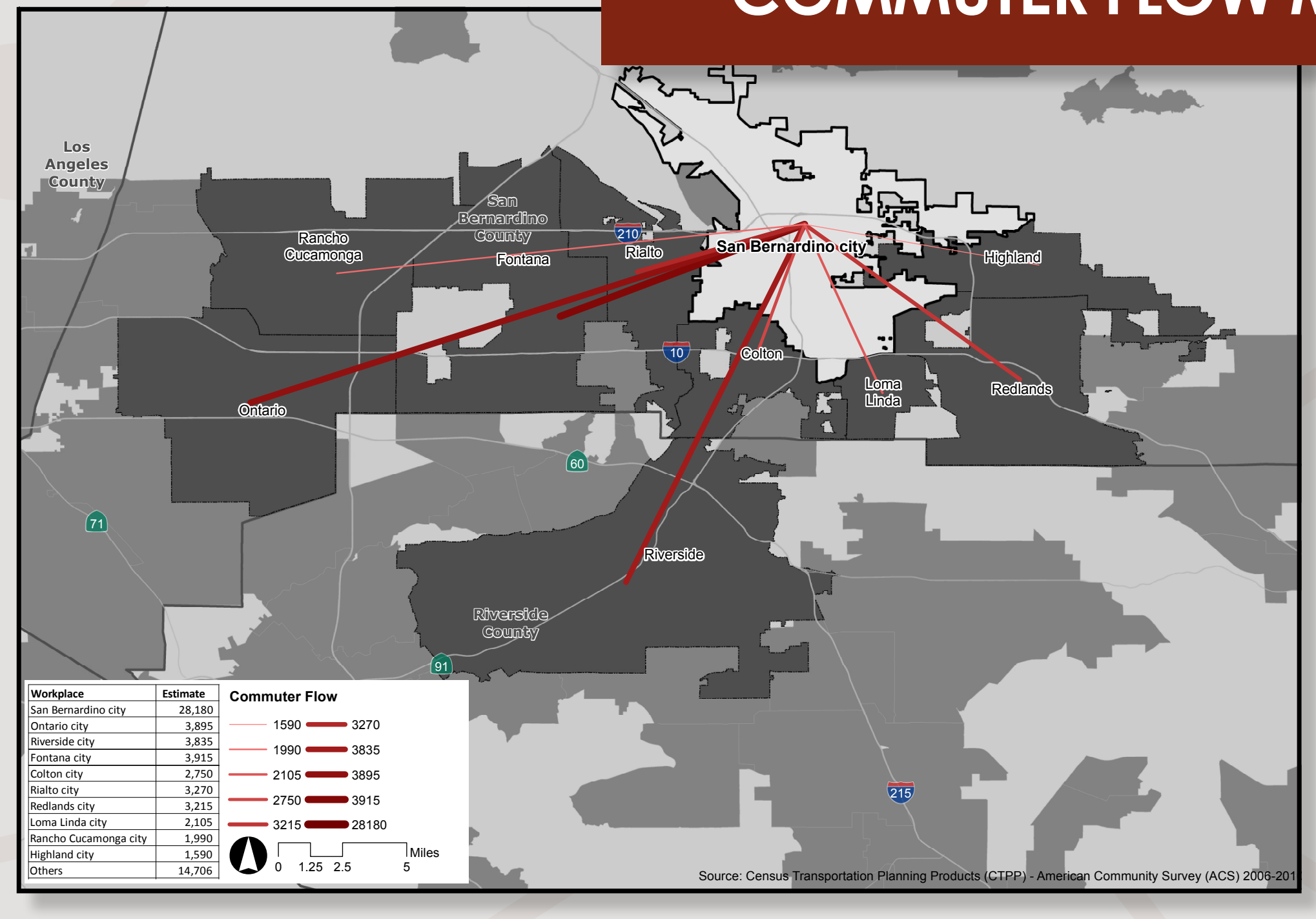
TOP 20 COMMUTING DESTINATIONS IN SCAG REGION



Source: Census Transportation Planning Products (CTPP) - American Community Survey (ACS) 2006-2010

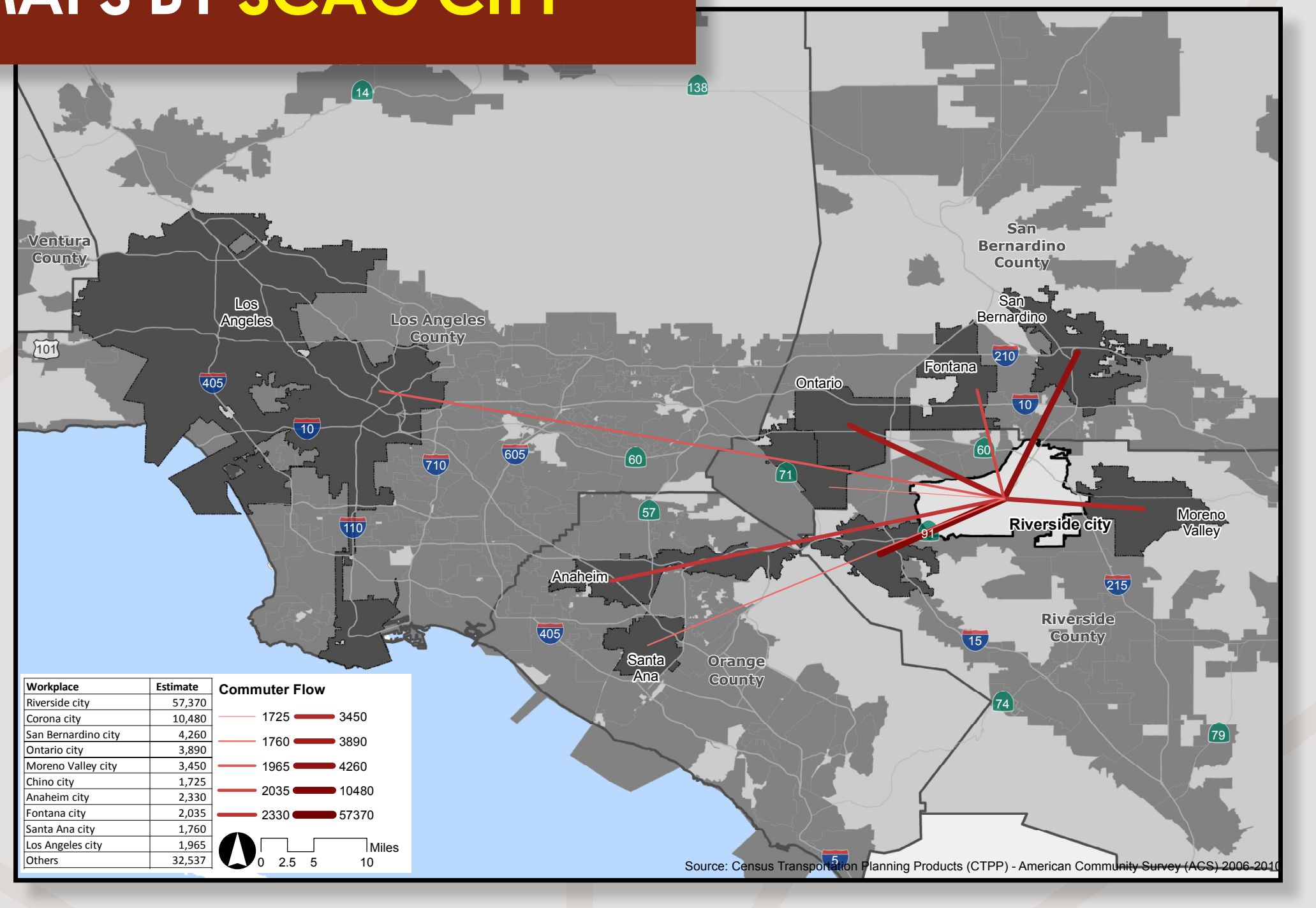


COMMUTER FLOW MAPS BY SCAG CITY



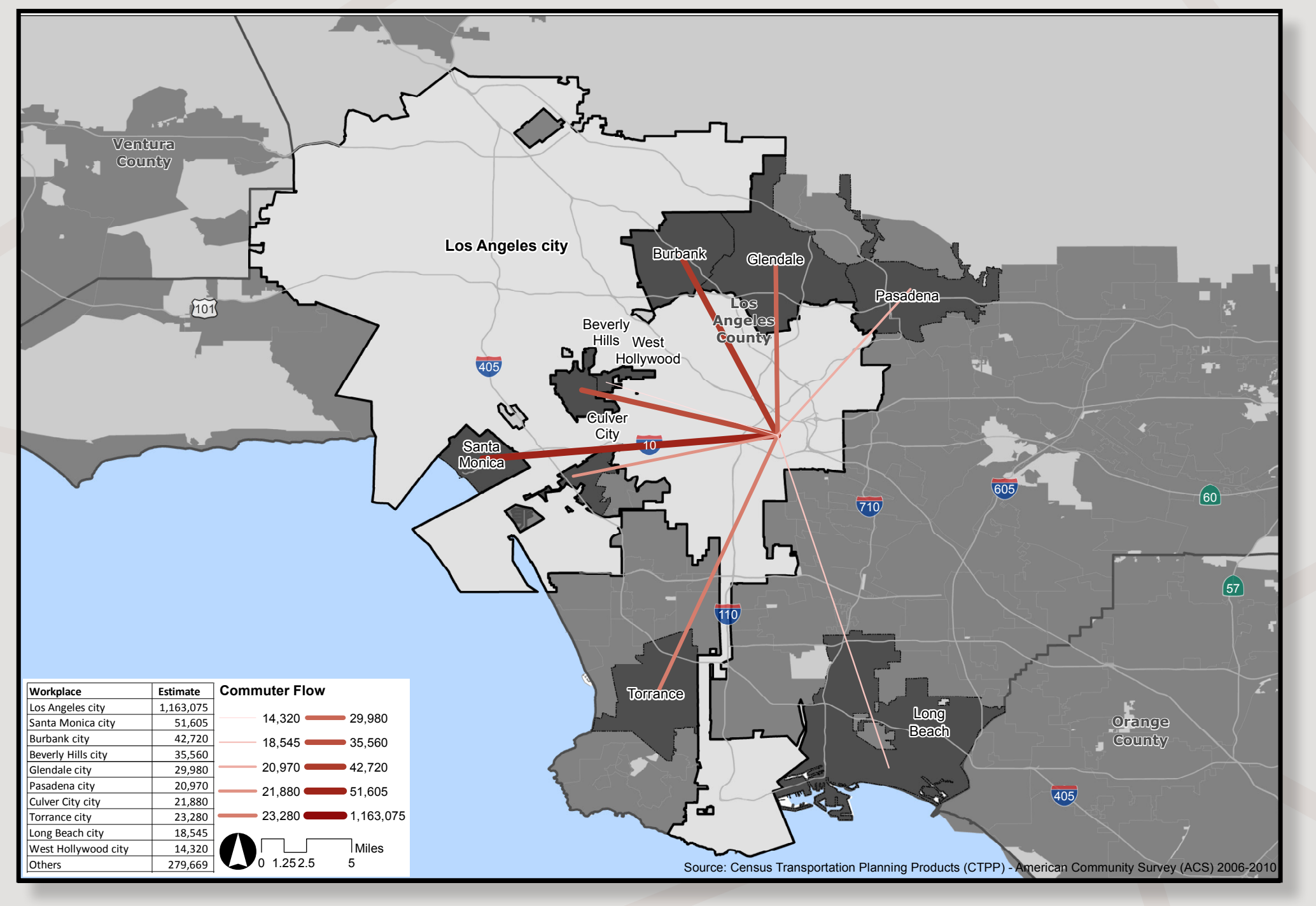
Source: Census Transportation Planning Products (CTPP) - American Community Survey (ACS) 2006-2010

City of San Bernardino



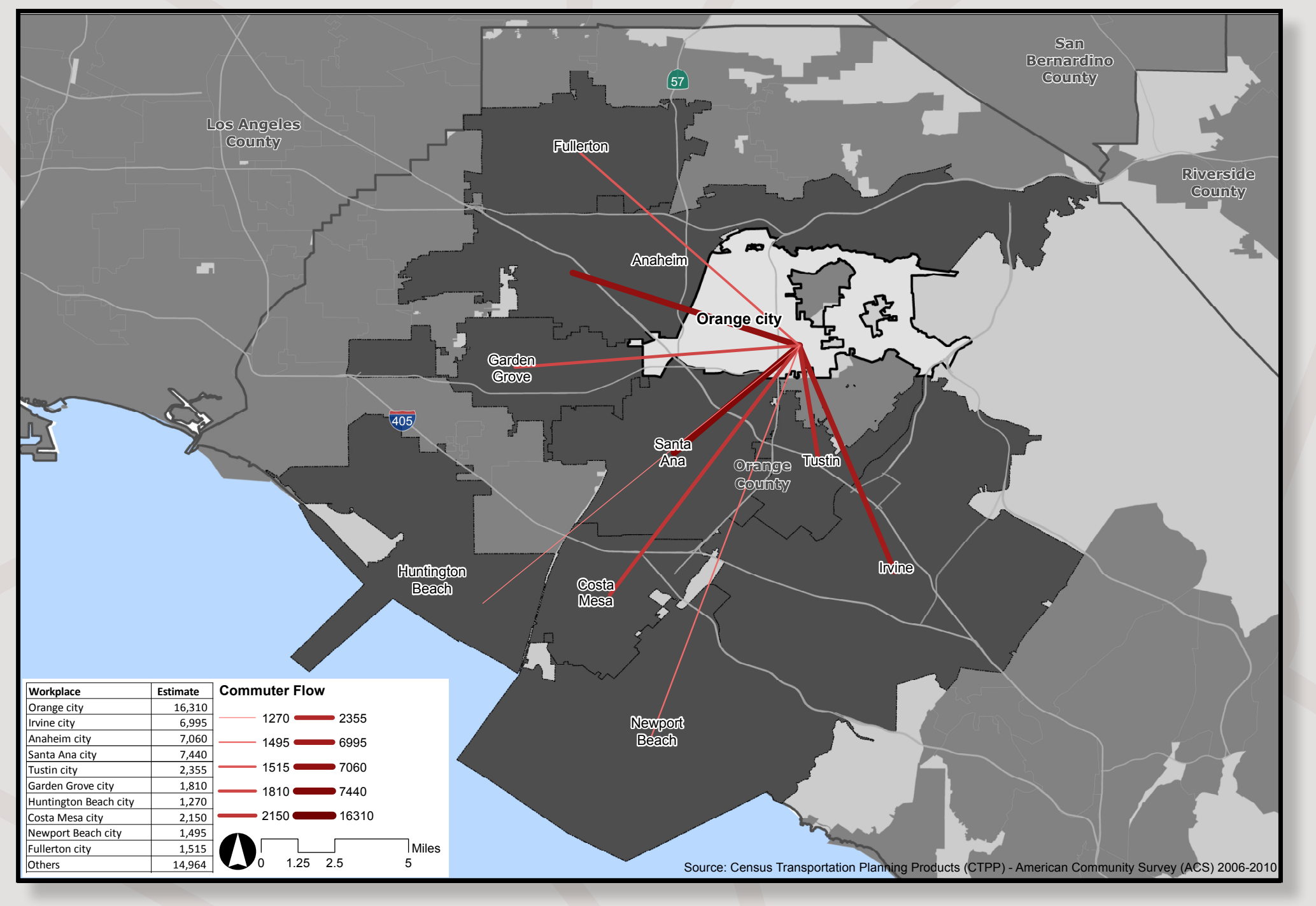
Source: Census Transportation Planning Products (CTPP) - American Community Survey (ACS) 2006-2010

City of Riverside



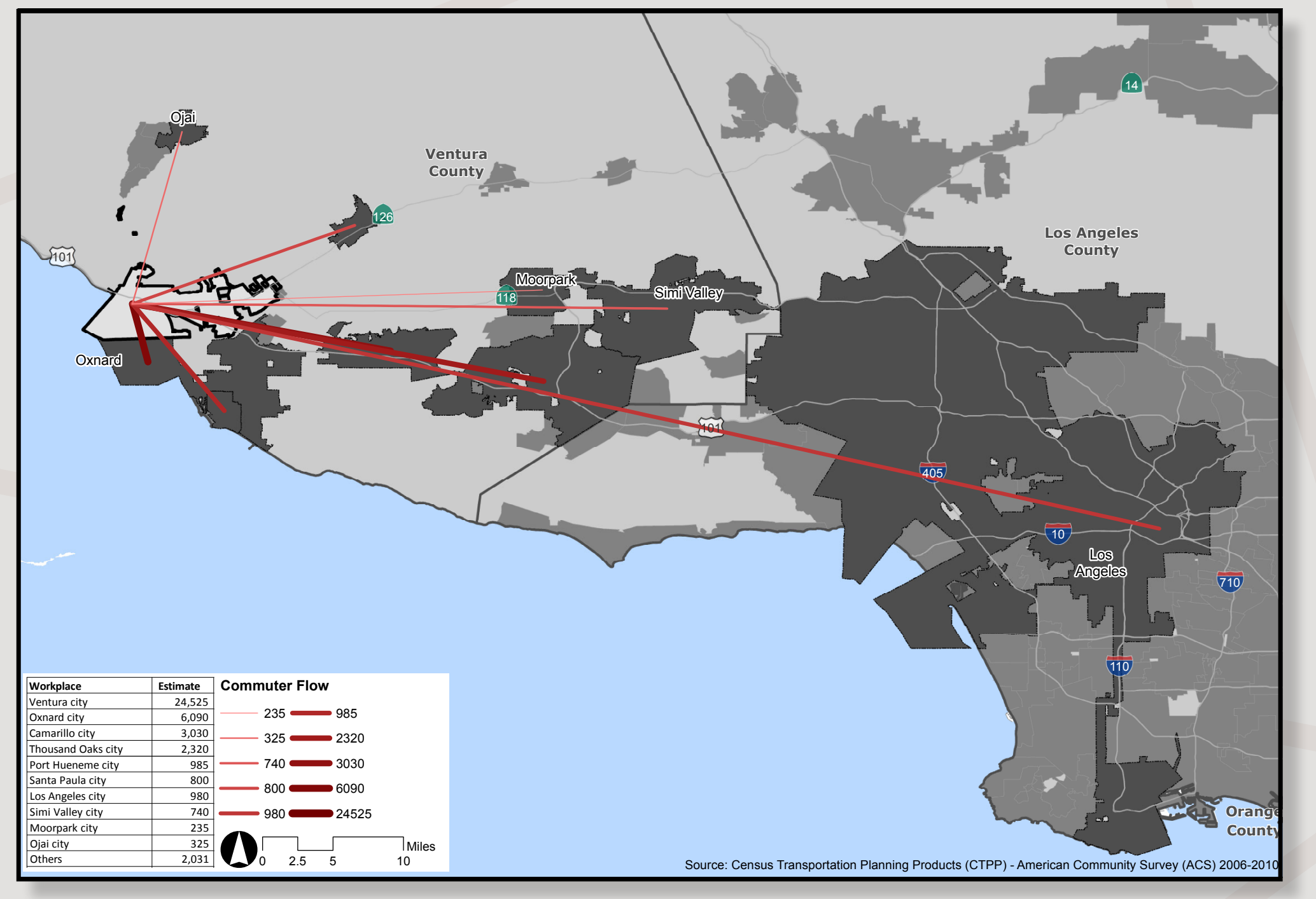
Source: Census Transportation Planning Products (CTPP) - American Community Survey (ACS) 2006-2010

City of Los Angeles



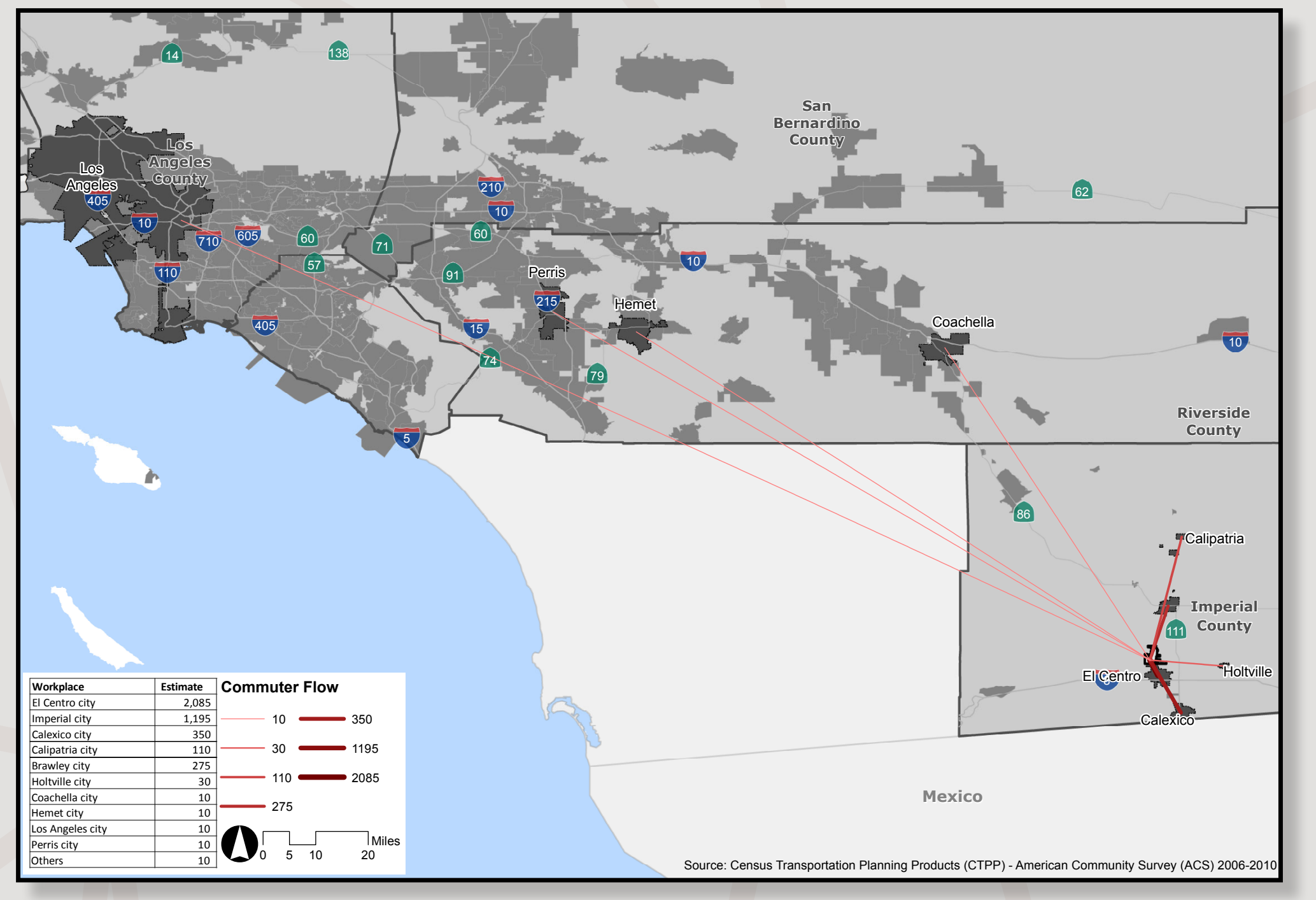
Source: Census Transportation Planning Products (CTPP) - American Community Survey (ACS) 2006-2010

City of Orange



Source: Census Transportation Planning Products (CTPP) - American Community Survey (ACS) 2006-2010

City of San Buenaventura



Source: Census Transportation Planning Products (CTPP) - American Community Survey (ACS) 2006-2010

City of Imperial

ABOUT SOUTHERN CALIFORNIA ASSOCIATION OF GOVERNMENTS

SCAG is the nation's largest metropolitan planning organization, representing six counties, 191 cities and more than 18 million residents. SCAG undertakes a variety of planning and policy initiatives to encourage a more sustainable Southern California now and in the future.

GEOGRAPHIC INFORMATION SYSTEMS (GIS)

The SCAG GIS and Data Service Program was designed as the preferred source for customized demographic and economic studies, data and analysis, Geographic Information Systems (GIS) analysis and mapping for the Southern California region. We maintain data/information and GIS files for the counties of Imperial, Los Angeles, Orange, Riverside, San Bernardino and Ventura.

50 YEARS
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