

UrbanSim and The Urban Data Science Toolkit

CP 255

Paul Waddell
Eddie Janowicz

<https://github.com/udst>

Urban Data Science Toolkit

The screenshot shows the GitHub repository page for the Urban Data Science Toolkit. At the top, there's a navigation bar with the GitHub logo, a search bar, and links for Pull requests, Issues, and Gist. To the right are notifications, a plus sign for creating new repositories, and a user profile icon.

The main header features a blue icon depicting a 3D cityscape and the repository name "Urban Data Science Toolkit". Below the name is a subtitle: "A collection of projects for urban spatial analysis and simulation". It also shows the location "San Francisco, CA", the website "http://www.udst.org/", and the email "udst@autodesk.com".

Below the header, there are tabs for Repositories (selected), People (41), Teams (18), and Settings. There are also filters, a search bar ("Find a repository..."), and a green button for "+ New repository".

The repository list includes three items:

- urbansim**: Python, 75 stars, 40 forks. Description: "New lightweight version of UrbanSim, a tool for modeling metropolitan real estate markets". Updated 16 minutes ago.
- bayarea_urbansim**: PRIVATE, Python, 2 stars, 5 forks. Description: "UrbanSim implementation for the Bay Area". Updated a day ago.
- demographic_data**: PRIVATE, Python, 0 stars, 0 forks. Description: "ETL demographic data".

On the right side, there's a "People" section showing 41 members. Each member is represented by a small profile picture and a pixelated letter icon (e.g., W, H, I, T, L, D). Below this is a "Invite someone" button.



Open source, transparent model system to project the outcomes of city and metropolitan land use, transportation and environmental plans and policies

Funded mainly by grants from NSF

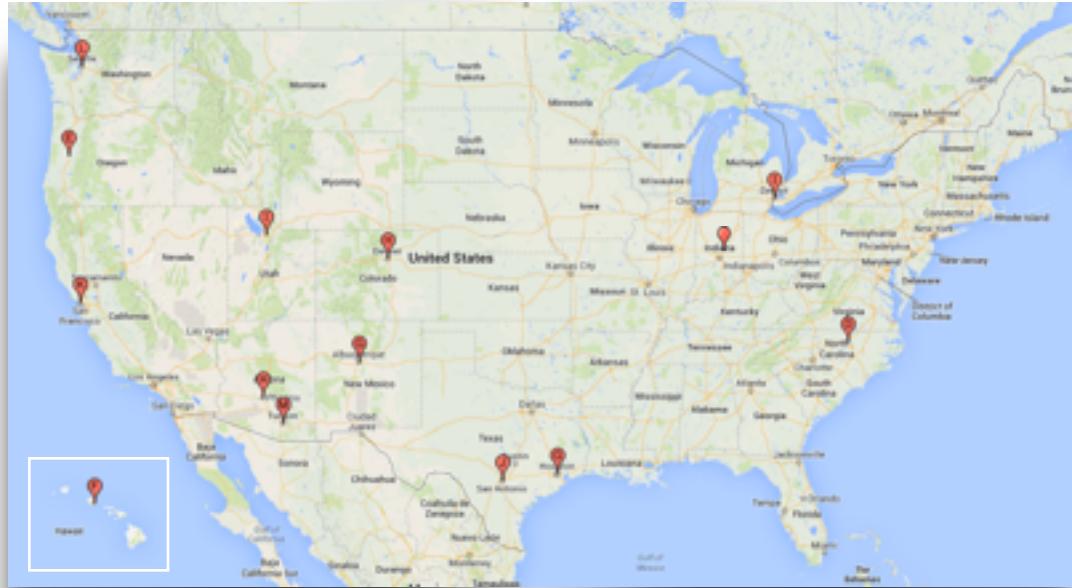
Most widely used land use model system by Metropolitan Planning Organizations (MPOs) in the United States

Research papers and general information at www.urbansim.org, which now redirects to www.udst.org

Code: <https://github.com/udst/urbansim>

Documentation: <http://udst.github.io/urbansim/>

UrbanSim



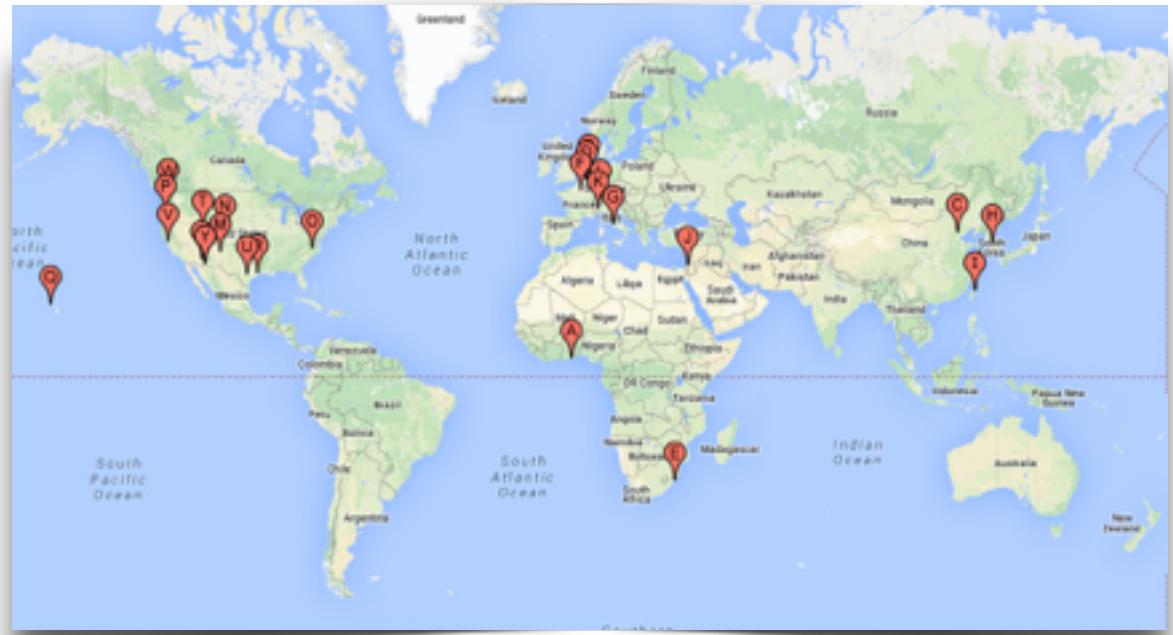
Albuquerque, NM
Denver, CO
Detroit, MI
Durham, NC
Eugene-Springfield, OR

Honolulu, HI
Houston, TX
Madison County, IN
Phoenix, AZ
Salt Lake City, UT

San Antonio, TX
San Francisco, CA
Seattle, WA
Tucson, AZ

Most widely used modeling platform by Metropolitan Planning Organizations

UrbanSim



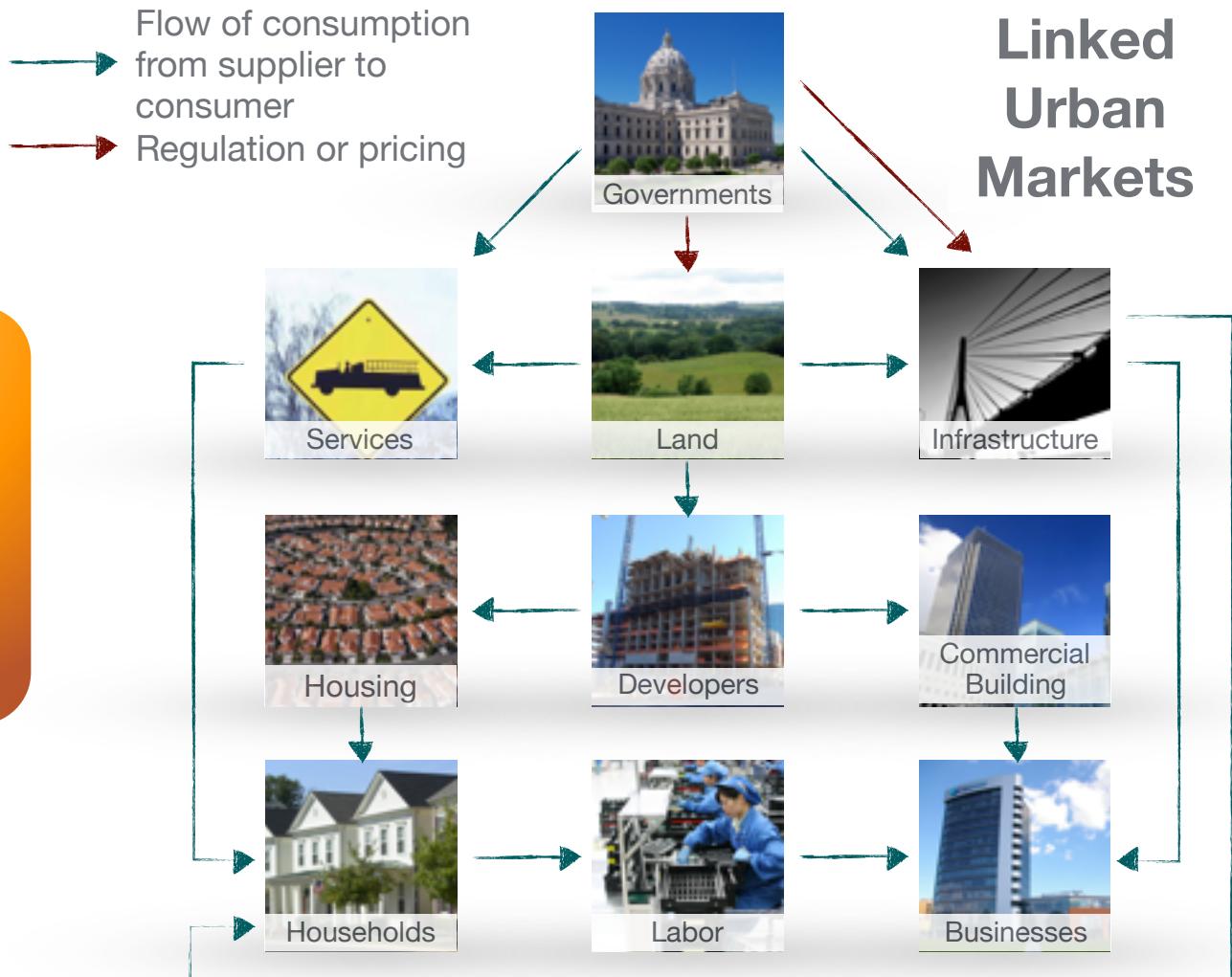
Accra
Amsterdam
Beijing
Brussels

Durban
Paris
Rome
Seoul

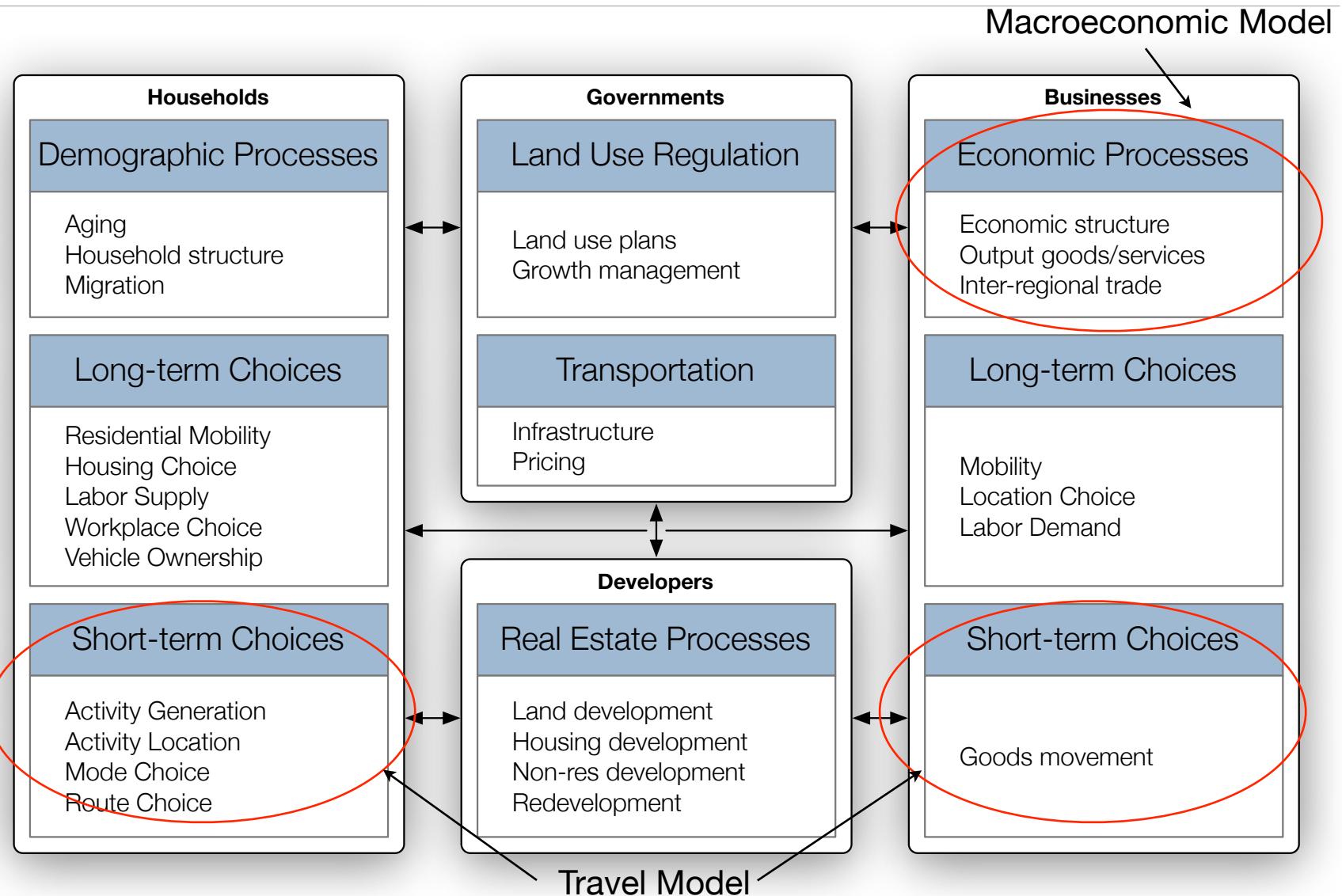
Taipei
Tel Aviv
Turin
Zürich

Users in 70+ countries

UrbanSim

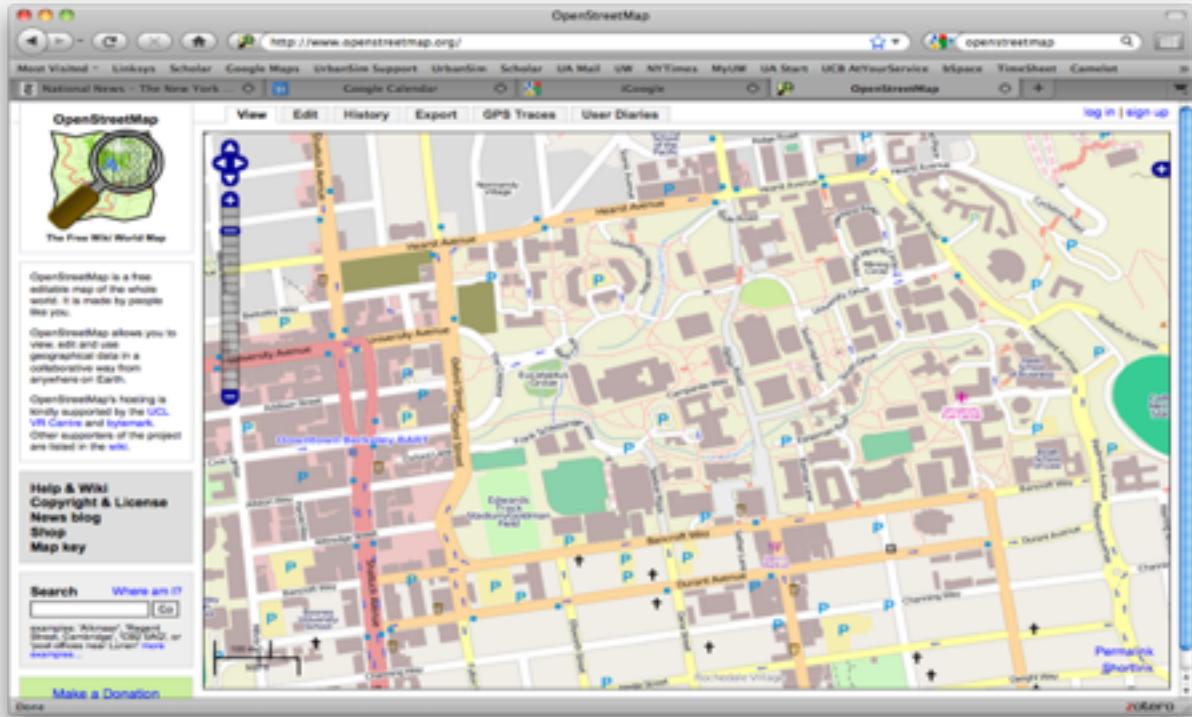


UrbanSim Models Choices of Agents in Urban System



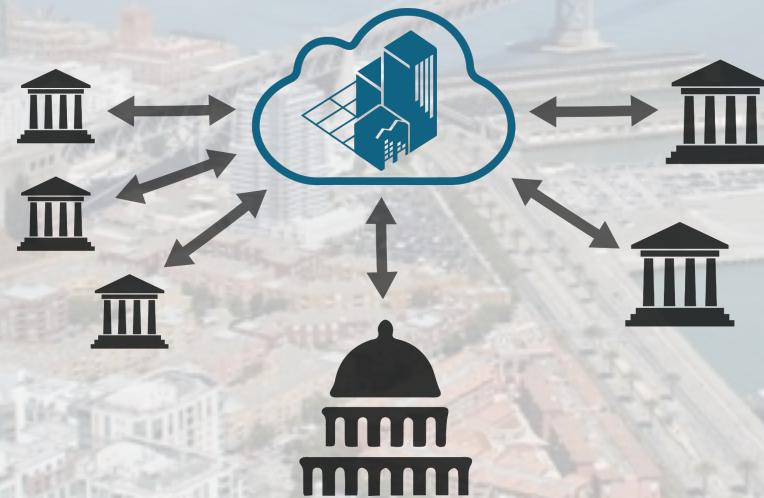
UrbanSim Data Sources

- Digital terrain models
- Digital orthophotos
- Street Network
- Parcels
- Property sales transactions
- Building attributes
- Google buildings where available and of good quality
- Zoning
- General Plans
- Planned Developments
- Business establishments
- Synthesized population
- Planning boundaries

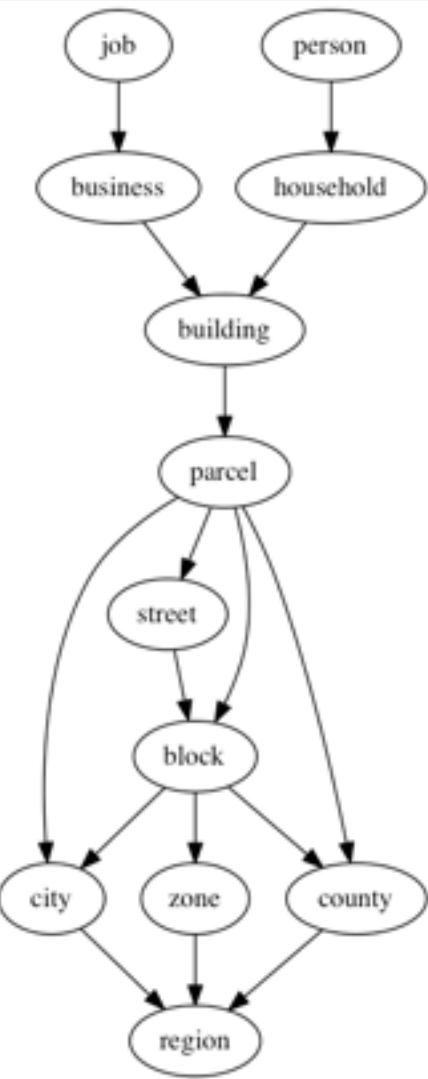


Shared Regional Database

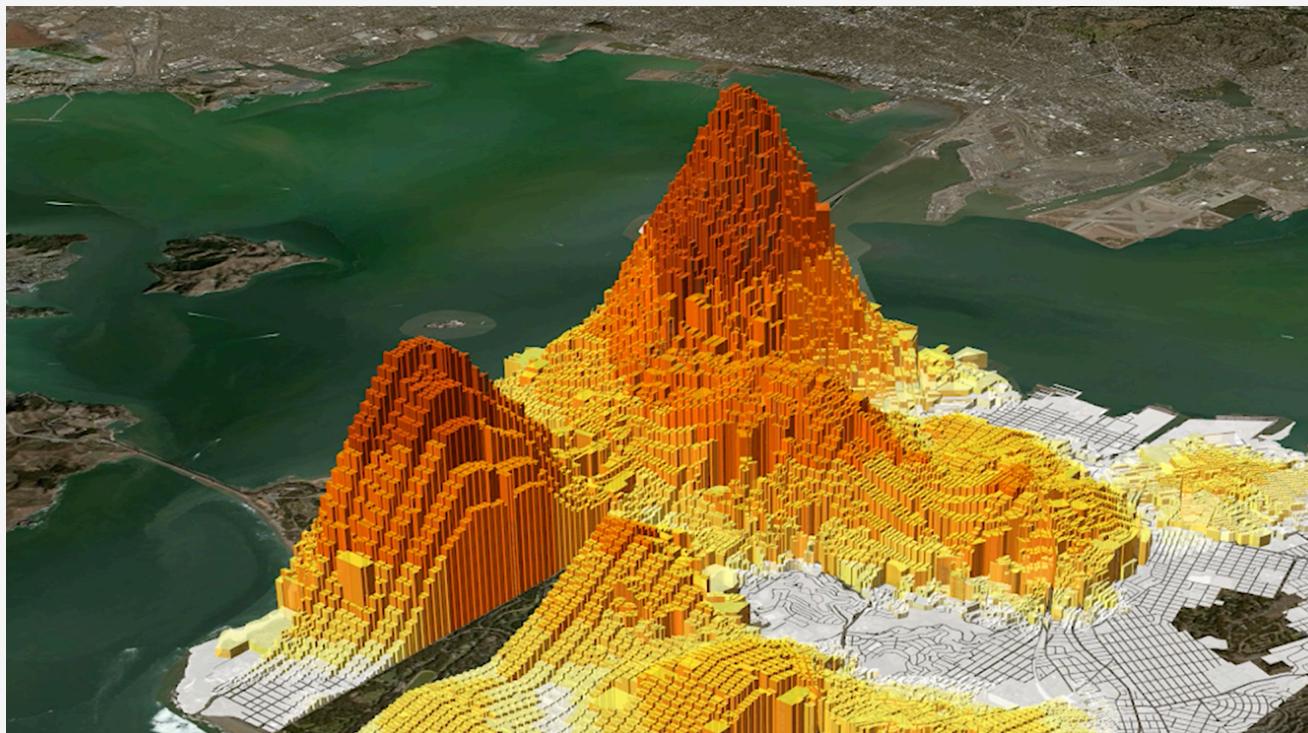
Parcel	Building	Zoning	Development Projects
Parcel Boundaries Zoning/ Land use	Number of Stories Parcel Identifier Footprint Geometry Structure Type	Types Setbacks Density Allowed uses	Geometry or Associated Parcels Residential Units Non residential Square footage Use/ Structure Type



UrbanSim Leverages Big Urban Data: Modeling A Unified Urban Graph of the Metropolis



Micro



Macro

Analyze Development Feasibility

Pencil New Save Browse Report planner@city.gov ~

Parcel Options Mid-rise Generic Parcel

Zone RH-3 - Residential, Multi-family...

Development Type Full Site

Block with Rear Yard Full Site Setback all sides L shaped Tower and Base DevType Preset:

stories: 5 

textures: Shapes layout: none type: flat

Unit Mix Typical Mix

Costs Bay Area Average

Revenues July 2014, San Francisco

Parking Low Parking

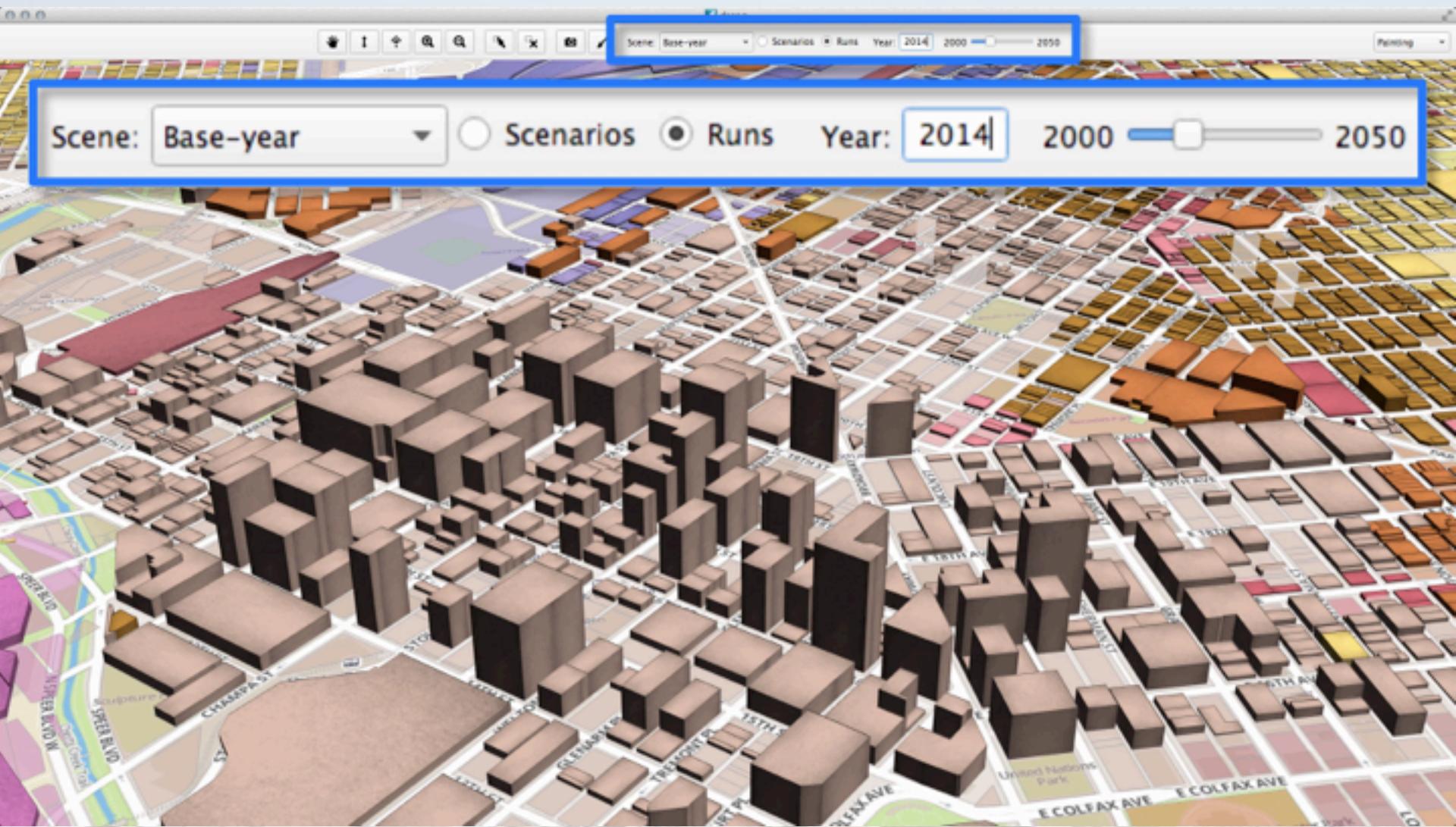
Development Parameters Dev Preset Two



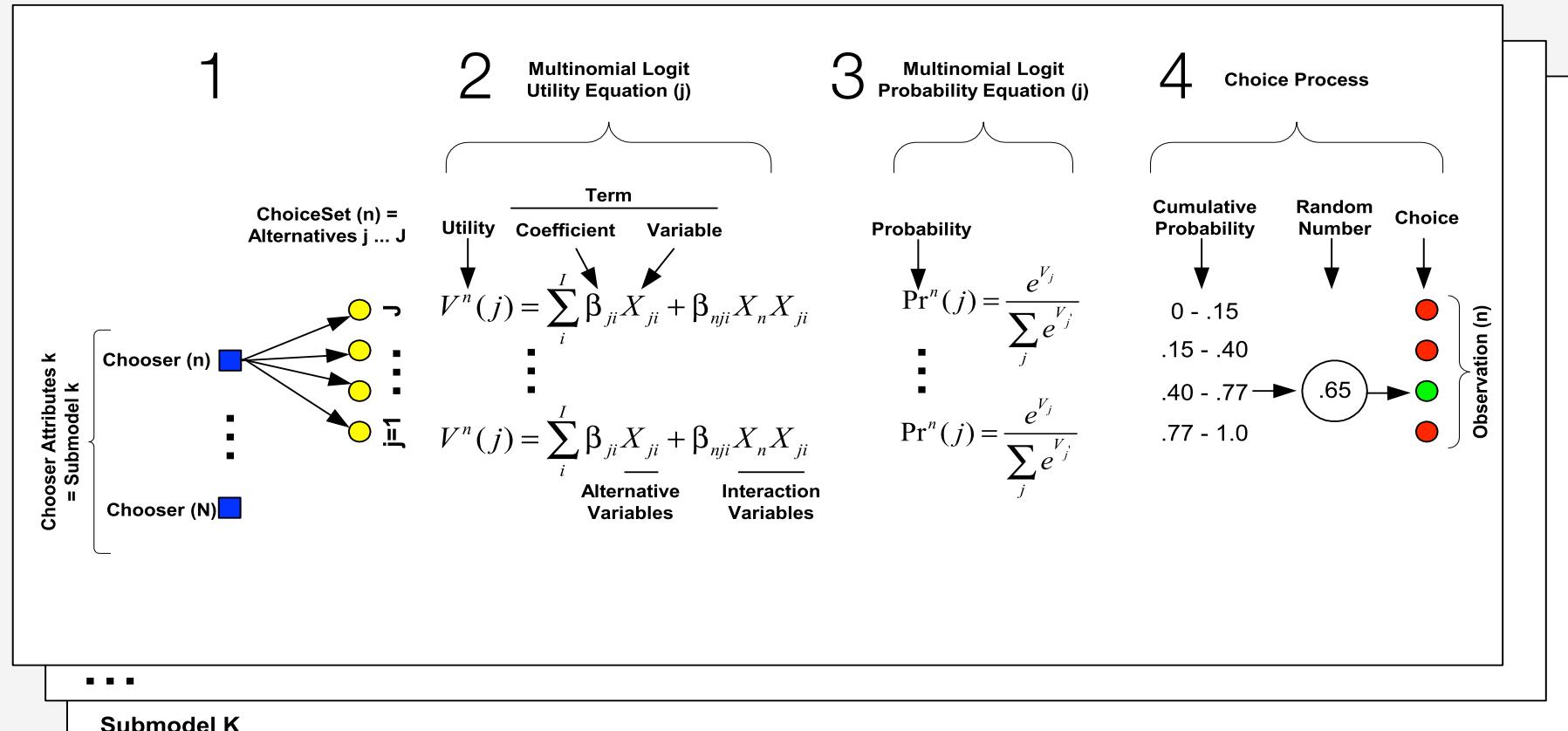
Size & Use		136,179 SqFt	
Area Takeoffs and Zoning Conformity			
	Proposal	Zoning	Compliance
Parcel Area (sqft)	27,236	-	-
Building Footprint (sqft)	27,236	-	-
Building Total Area (sqft)	136,179	-	-
Lot Coverage (%)	100	85 max	No
Stories	6	5 max	No
Height (ft)	72	60 max	No
Floor Area Ratio (FAR)	6	7 max	Yes
Housing		122.0 Units	
Parking		92.3 Spaces	
Revenues		\$106,904,000.00	
Costs		\$46,128,000.00	
Feasibility		1.36	

UrbanCanvas:

Create Scenarios and Visualize Simulation Results

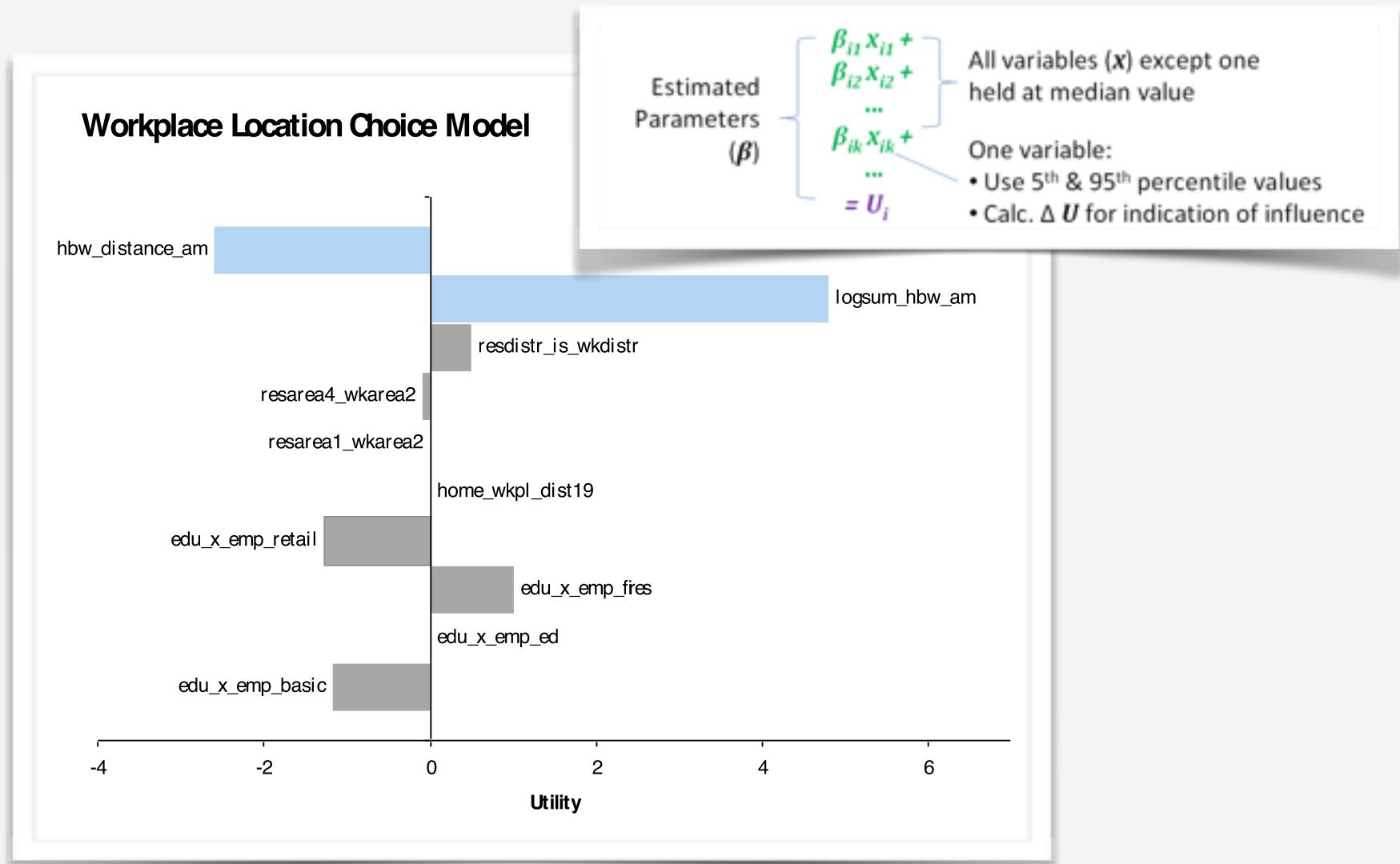


Software Architecture for UrbanSim: Modular Choice Models



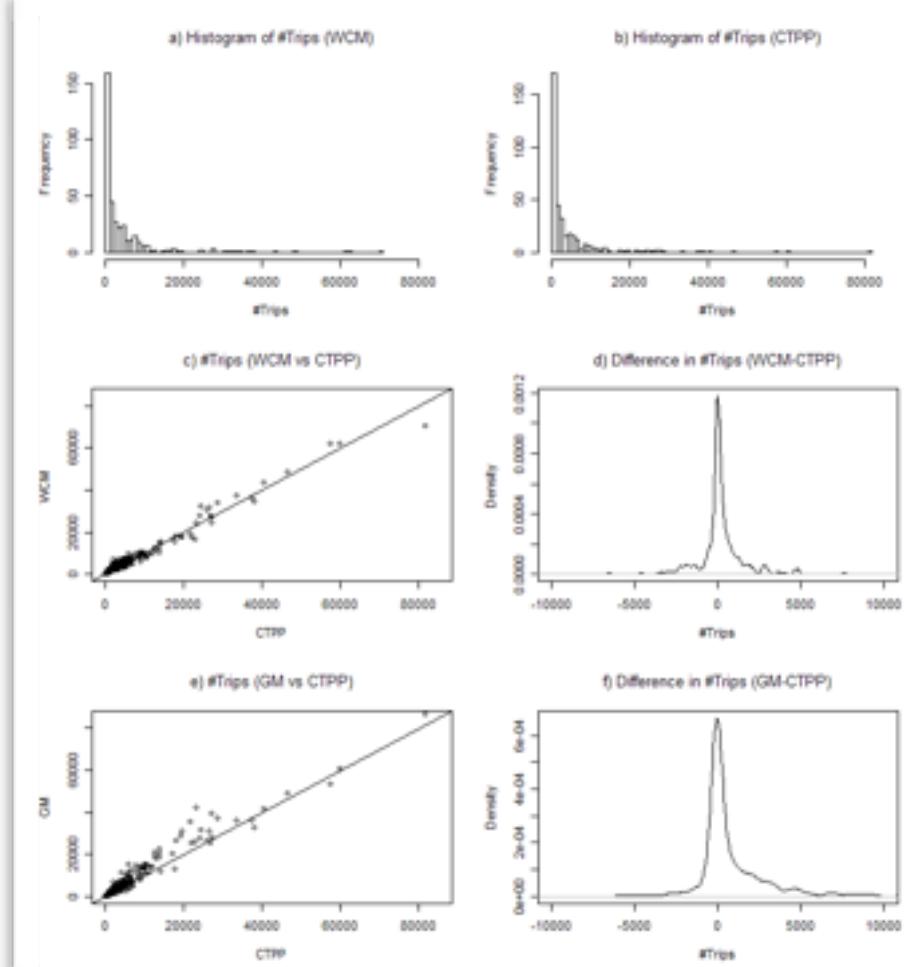
Implementation of a choice model involves selecting options for each step in the model process, and setting its configuration. In most cases, this can be done in the GUI, without the need to edit program code. New models can be created from templates, specified, and estimated interactively.

Sensitivity Analysis: Relative Influence of Variables

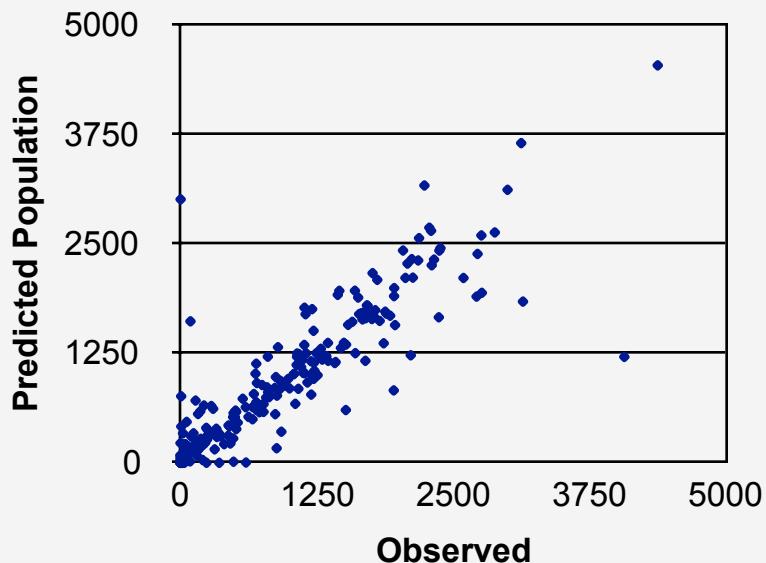


Calibration and Validation of Workplace Choice Model

- Model predicts individual workplace (attaches a job to a person) at parcel and building level
- Comparison of predicted values (commute trips) to observed values from CTPP to compute errors
- Calibration: Adding variables to specification to reduce errors.
- Errors compared to previous HBW Trip Distribution Model (gravity model)
 - RMSE Gravity Model = 2558.65
 - RMSE New Model = 1440.01



Longitudinal Validation of Full Model System



	Cell	Zone	1-Cell
Employment	0.805	0.865	0.917
Population	0.811	0.929	0.919
Nonreside	0.799	0.916	0.927
Housing	0.828	0.927	0.918
Land	0.830	0.925	0.908

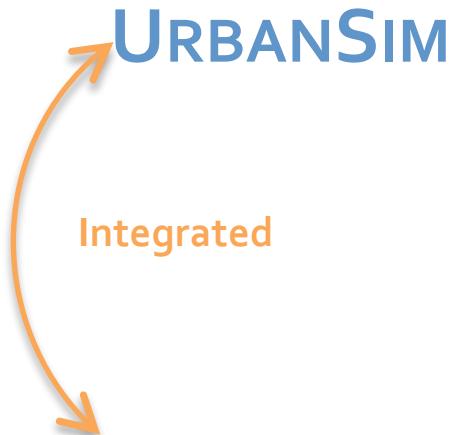
Comparison of predicted to observed values in Lane County, Oregon, from 1980 to 1994



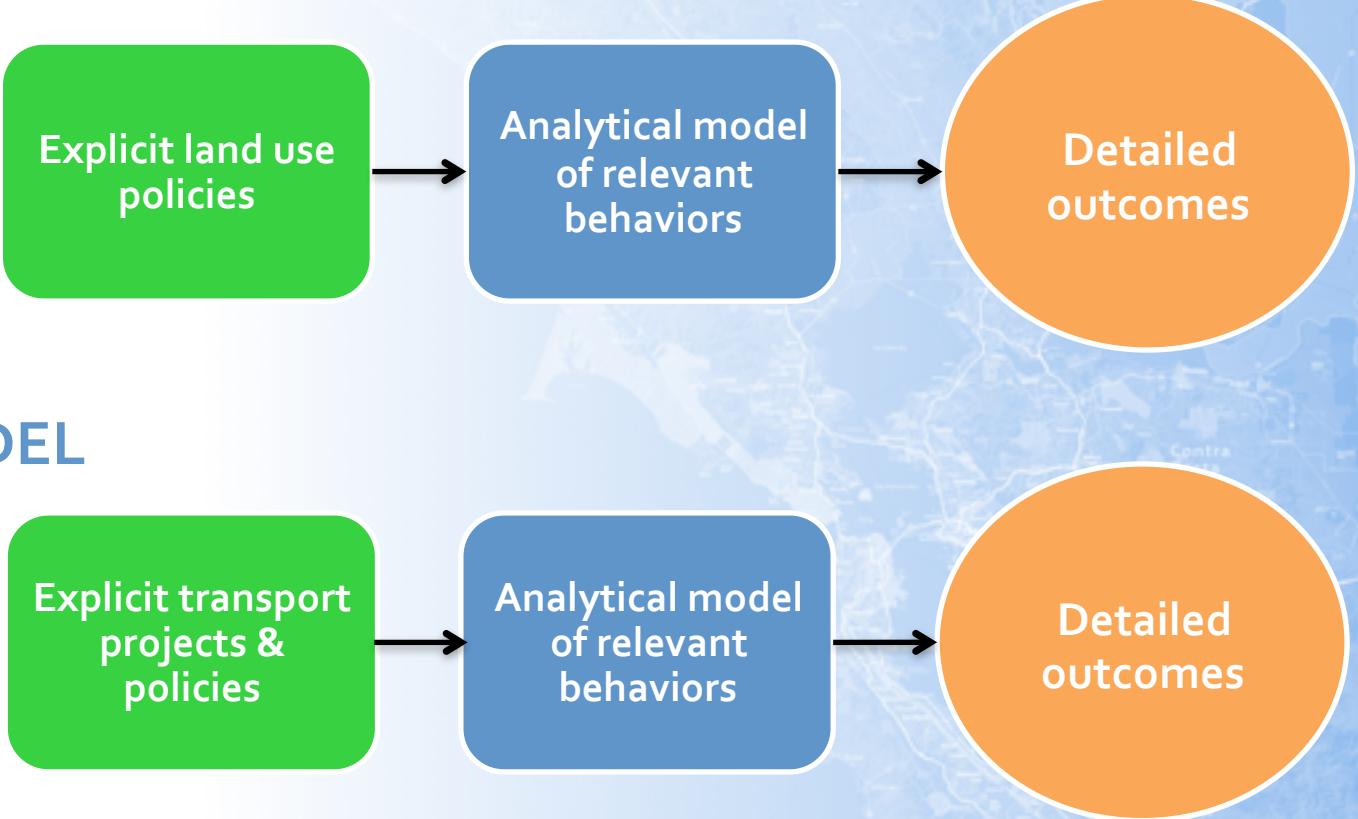
PT BayArea Plan

- First regional plan to integrate transportation, land use, and housing (*Sustainable Communities Strategy*)
- Initiated by California Senate Bill 375

Modeling Scenarios Regionally for EIR



TRAVEL MODEL

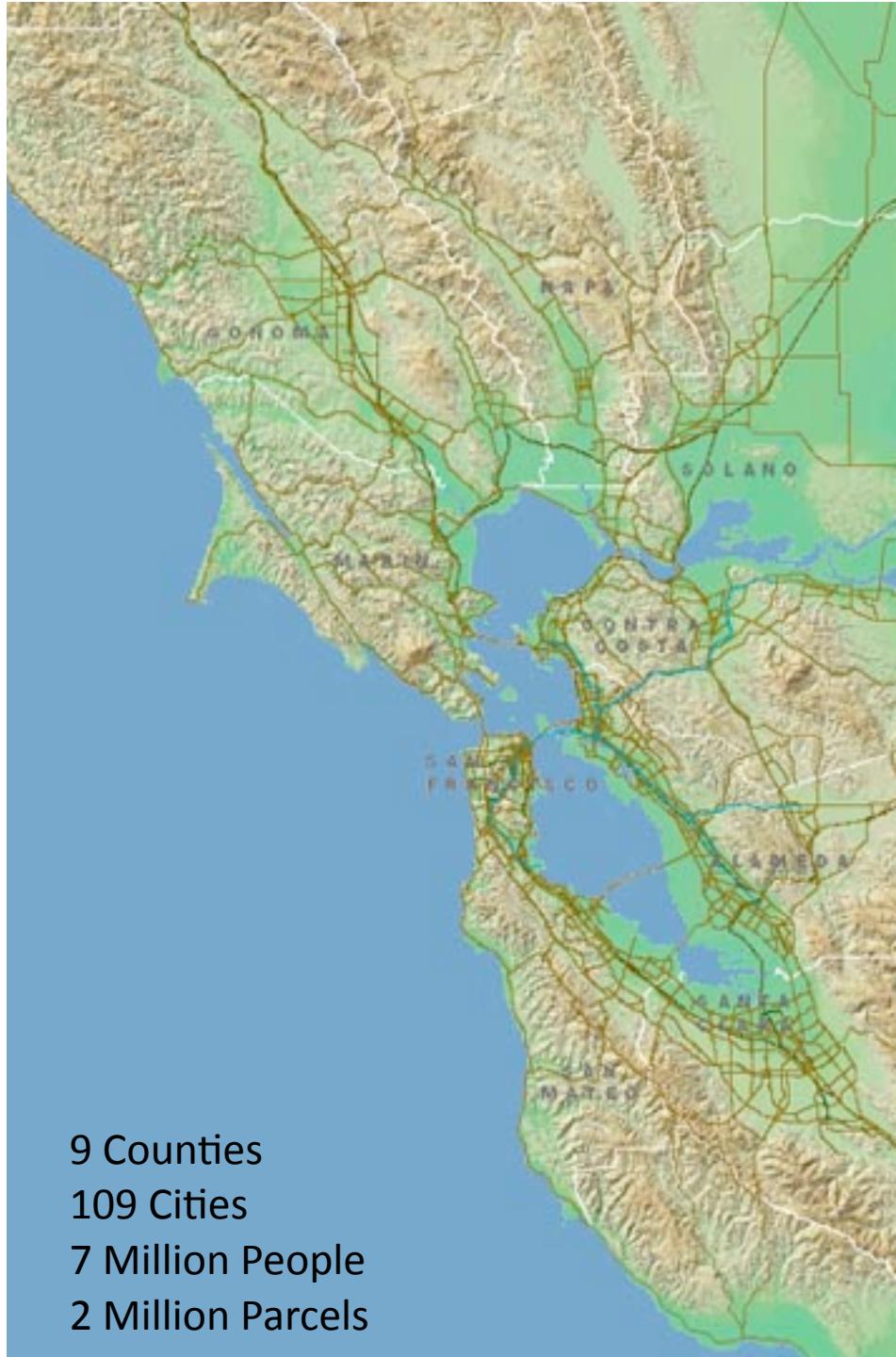
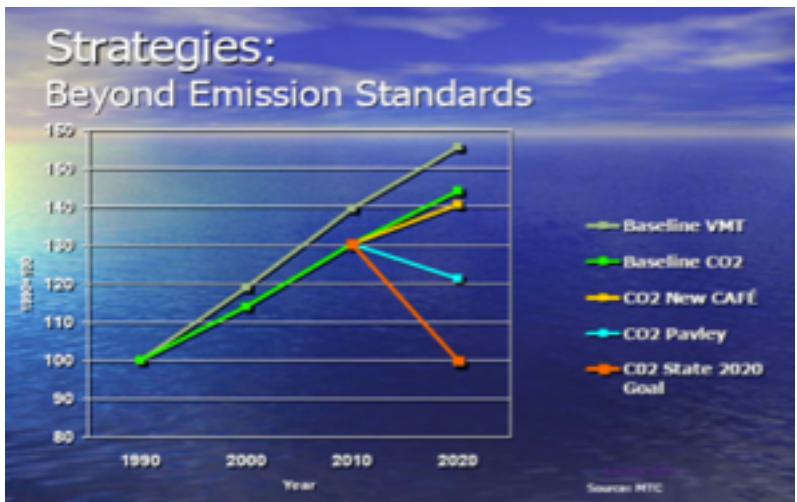


Largest MPOs should “build formal microeconomic land use models, as soon as is practical, so that they can be used to analyze and evaluate the effects of growth scenarios on economic welfare (utility), including land prices, home affordability, jobs-housing fit, the combined housing-transportation cost burden, and economic development (wages, jobs, exports).”

Source: *California Transportation Commission's 2010 RTP Guidelines*

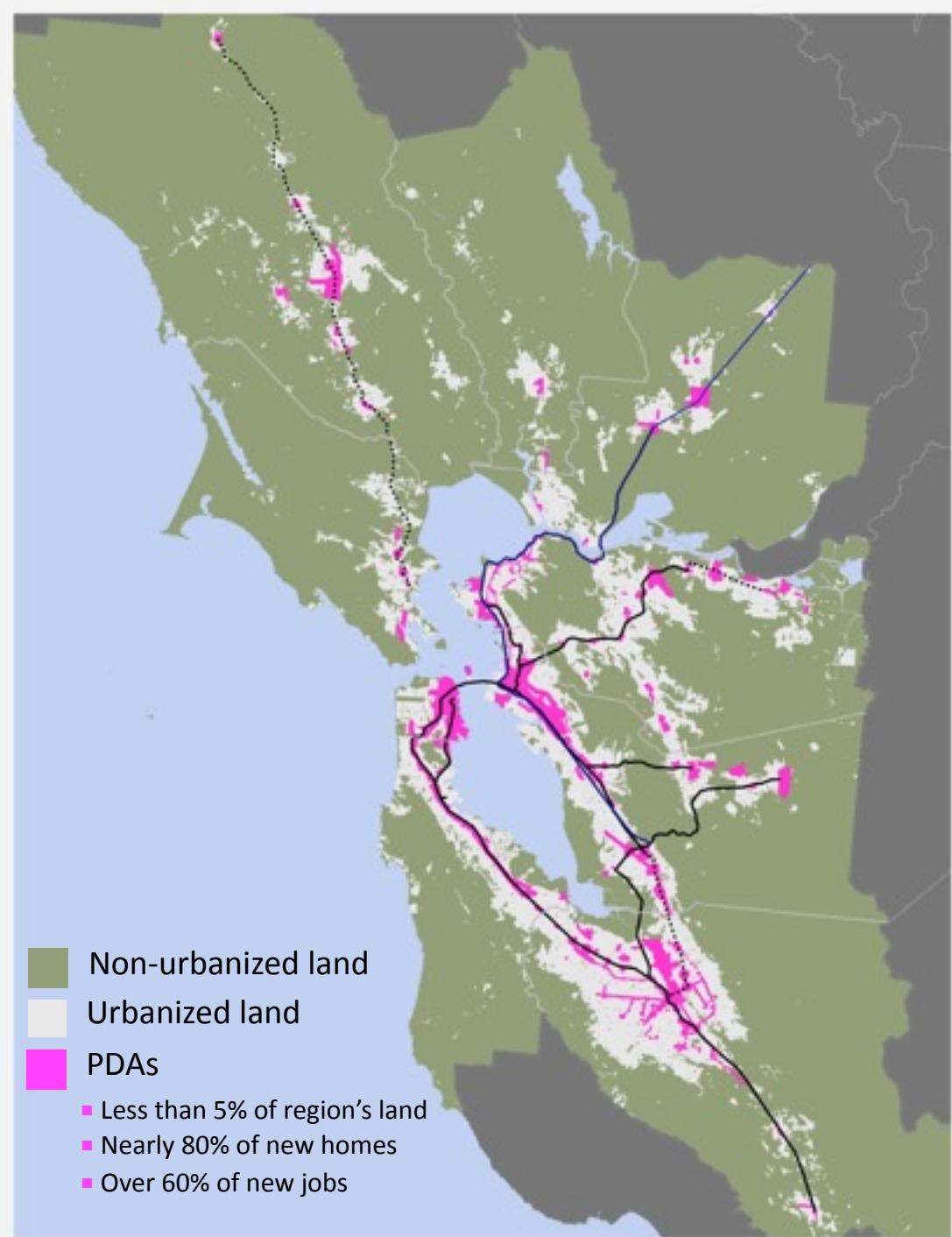
The Regional Task

- Reduce per capita greenhouse gas emissions by 15% from 1990 levels by 2035
- House the region's population at all income levels
- Embody local visions
- Stretch tax revenues through smart investments
- Increase economic competitiveness
- Preserve the natural environment
- Sustain a healthy, vibrant region for our children and grandchildren



9 Counties
109 Cities
7 Million People
2 Million Parcels

Regional Growth Strategy: Focused Growth



Policy Inputs to Model System

- **Transportation**

- Transit investments (Rail, Bus)
- Roadway investments (GP, HOV, HOT, Bike, Pedestrian)
- Pricing (Tolls, Congestion)

- **Land Use Regulations**

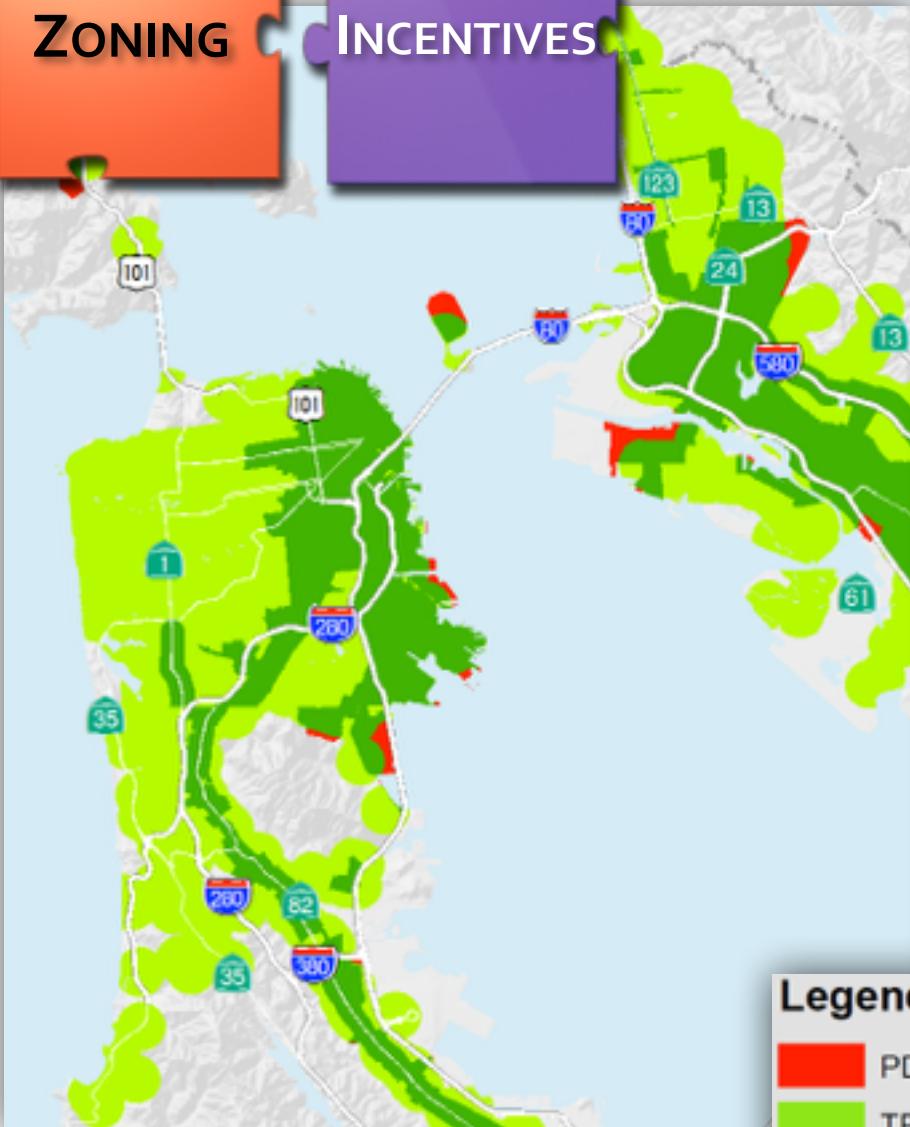
- City comprehensive Plans
- Transit Oriented Development, Urban Villages & Centers
- Subsidies, Impact Fees
- Urban Growth Boundaries
- Protection of Environmentally-sensitive Areas



Comparison of TPPs and PDAs

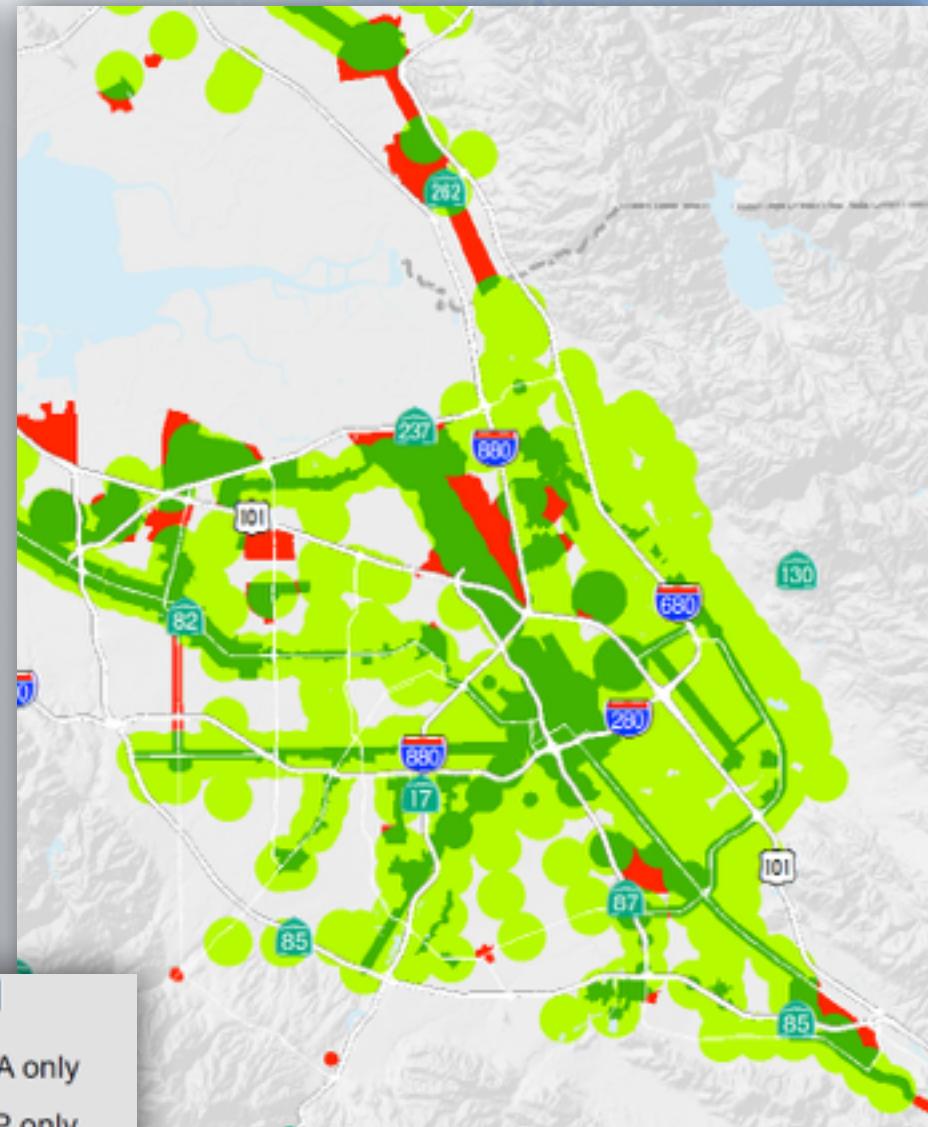
ZONING

INCENTIVES



Legend

- PDA only
- TPP only
- TPP & PDA



ECONOMY



ECONOMIC VITALITY

Increase gross regional product



TRANSPORTATION SYSTEM EFFECTIVENESS

- Increase non-auto mode share
- Reduce VMT per capita
- Maintain the transportation system

ENVIRONMENT



CLIMATE PROTECTION

Reduce per-capita greenhouse gas emissions from cars and light-duty trucks



OPEN SPACE AND AGRICULTURAL PRESERVATION

Direct all non-agricultural development within the urban footprint



HEALTHY AND SAFE COMMUNITIES

Reduce premature deaths from exposure to particulate emissions

Reduce injuries and fatalities from collisions

Increase average daily time spent walking or biking

EQUITY



ADEQUATE HOUSING

House all of the region's projected housing growth



EQUITABLE ACCESS

Decrease housing and transportation costs as a share of low-income household budgets

EIR Alternatives Analysis:

Performance Targets

achieves or exceeds performance target

falls short of performance target

moving in the wrong direction

Target	Goal	No Project	Preferred	Transit Priority Focus	Network of Communities	Equity, Environment & Jobs
1 Reduce per-capita CO ₂ emissions from cars and light-duty trucks	-15%	-8%	-18%	-16%	-16%	-17%
2 House the region's projected growth	100%	100%	100%	100%	118%	100%
3a Reduce premature deaths from exposure to fine particulates (PM _{2.5})	-10%	-71%	-71%	-72%	-69%	-72%
3b Reduce coarse particulate emissions (PM ₁₀)	-30%	-16%	-17%	-17%	-14%	-18%
3c Achieve greater particulate emission reductions in highly impacted areas	Yes	Yes	Yes	Yes	No	Yes
4 Reduce the number of injuries and fatalities from all collisions	-50%	+18%	+18%	+17%	+23%	+16%
5 Increase the average daily time walking or biking per person for transportation	+70%	+12%	+17%	+18%	+13%	+20%

