Environmental Justice Screening Method:

Integrating Indicators of Cumulative Impact into Regulatory Decision-making

Source: CBE

Source: David Woo

Rachel Morello-Frosch, UC Berkeley
Manuel Pastor, USC
Jim Sadd, Occidental College

Purpose of Screening Methodology

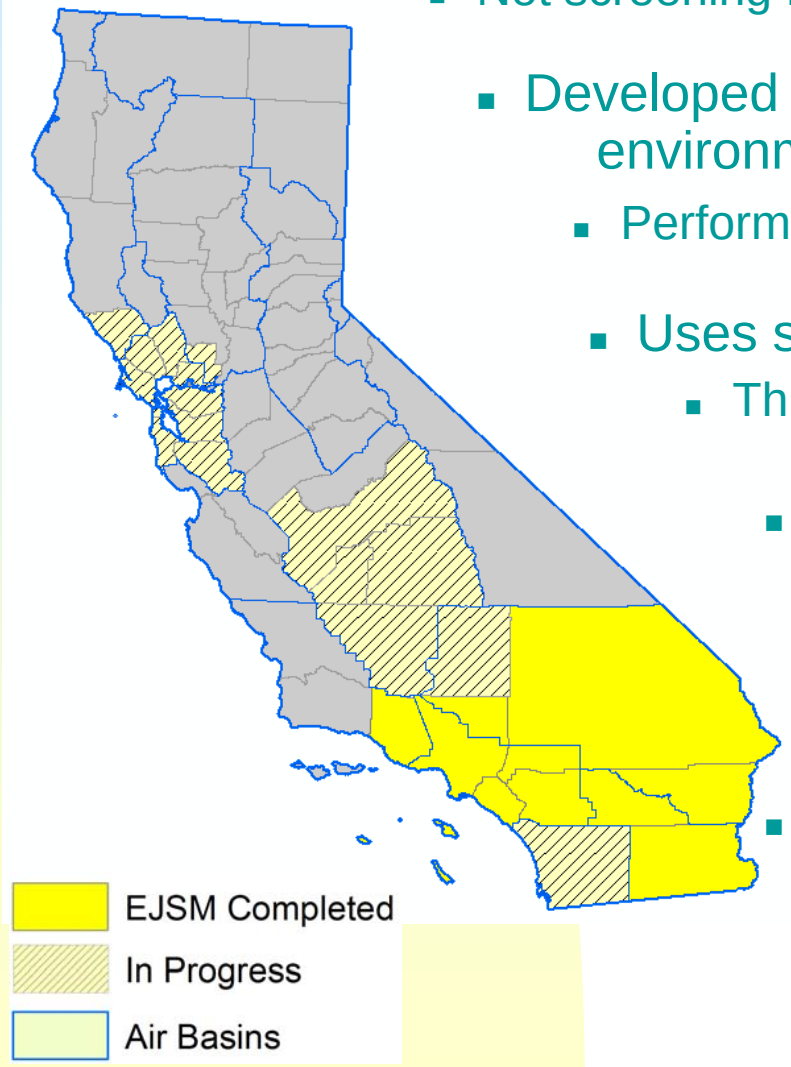
- Developed under research contract with California Air Resources Board (CARB) and Calif. Energy Commission to identify most impacted and most vulnerable communities

- Develop Indicators of cumulative impact that:
  - Reflect research on air pollution, environmental justice, and health
  - Transparent and relevant to policy-makers and communities
  - Reviewed by community EJ groups, California Air Resources Board (CARB), academic peers and other agencies

- Apply EJ "screening method" to multiple uses:
  - Regulatory decision-making and enforcement
  - Community outreach
  - Local land use planning
    - (e.g. Cites of Commerce, Richmond, Los Angeles,)

Focus of Screening Method

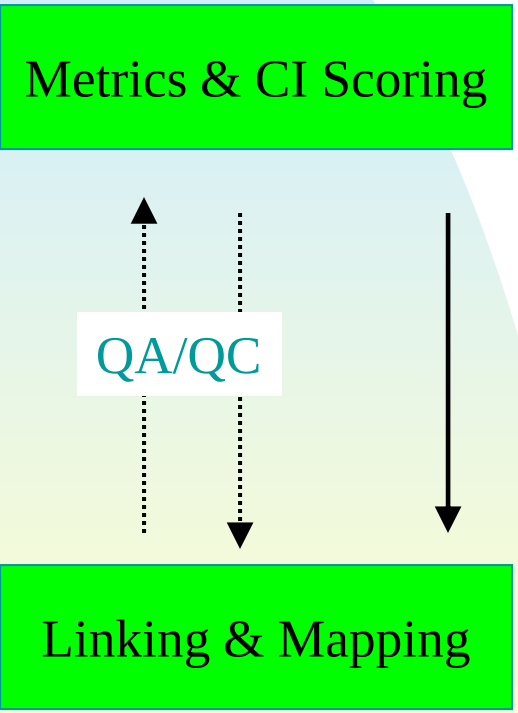
- Developed with specific reference to ambient air quality
  - Not screening for occupational, indoor, water, pesticides.
  - Developed to incorporate land use information into environmental decision-making
    - Performs best with detailed, high resolution land use data.
    - Uses secondary databases
      - This is screening not assessment
    - First applied in So. California
      - high quality land use data
      - 7 Southern California counties – complete
      - Others in progress
    - Map where people are exposed
      - Residential land use
      - Sensitive land use categories (California ARB land use guidelines, 2005)



Categories of Impact & Vulnerability

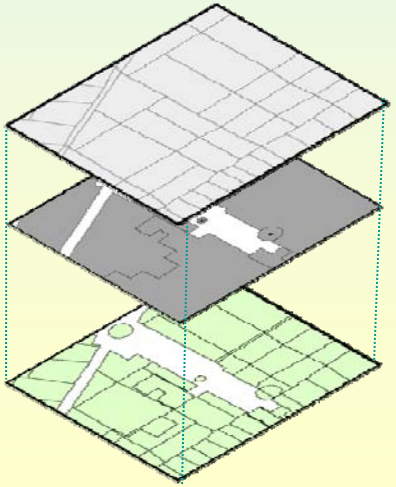
- Proximity to hazards & sensitive land uses
  - Based on EJ literature
  - CARB land use guidelines (sensitive land uses)
  - State data on air quality hazards
- Health risk & exposure
  - Based on EJ and public health literature
  - Available state and national data
  - Modeling from emissions inventories
- Social & health vulnerability
  - Based on epidemiological literature on social determinants of health
  - Based on EJ literature on area-level measures of community vulnerability

Screening Method Architecture



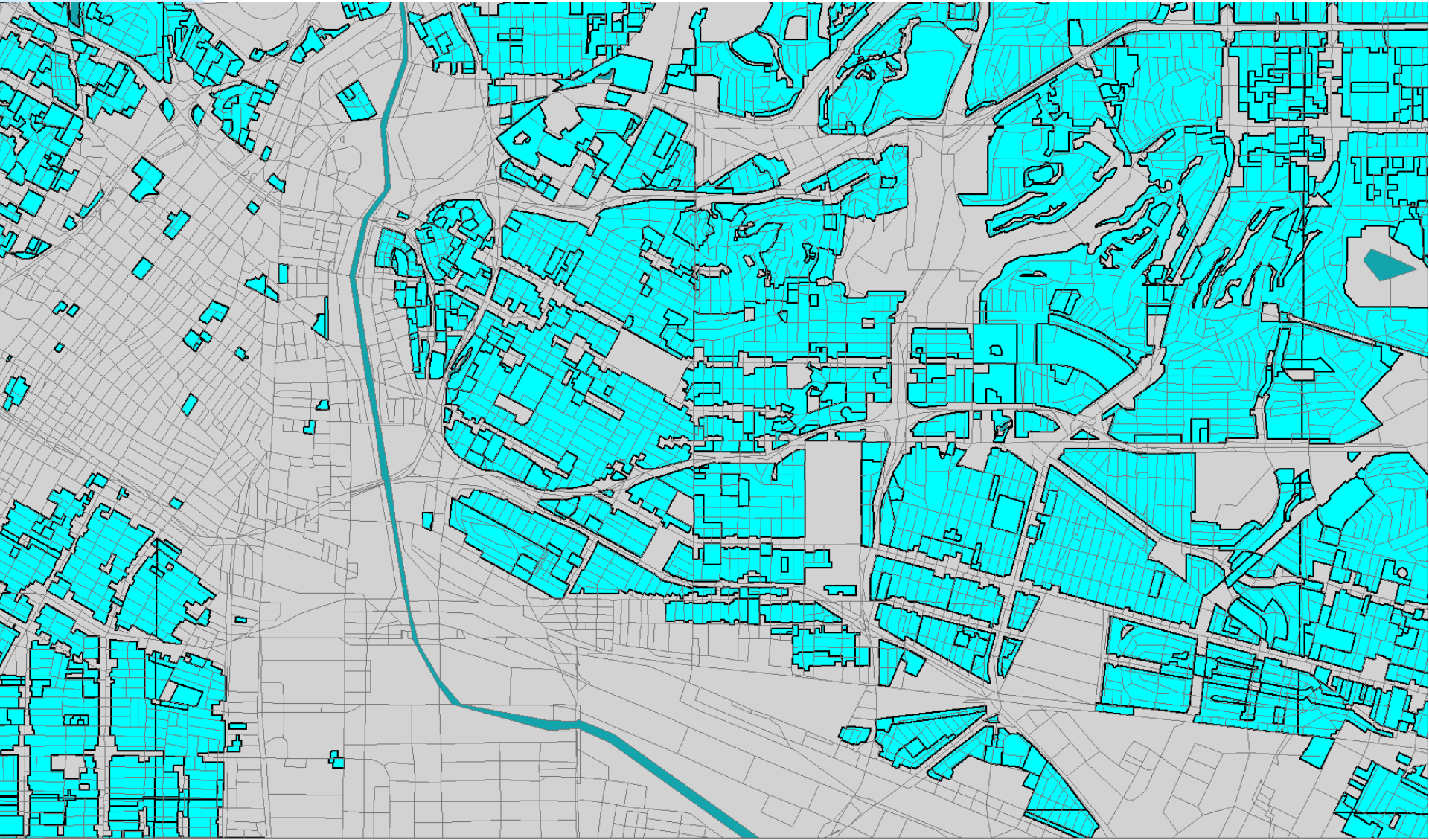
- **Step 1:** GIS Spatial Assessment
  - Derive land use layer
  - Create base map layer (CI polygons)
  - Identify land use and hazard proximity metrics
- **Step 2**: Programming (SPSS)
  - Data processing and cleaning
  - Derive CI scores
  - Analytics
- **Step 3:** GIS Mapping of Results
- Qa/QC essential to Steps 1 and 2:
  - Quality control of data layers
  - Document and verify metrics and scoring

GIS Spatial Assessment –
Derive Land Use Spatial Layer

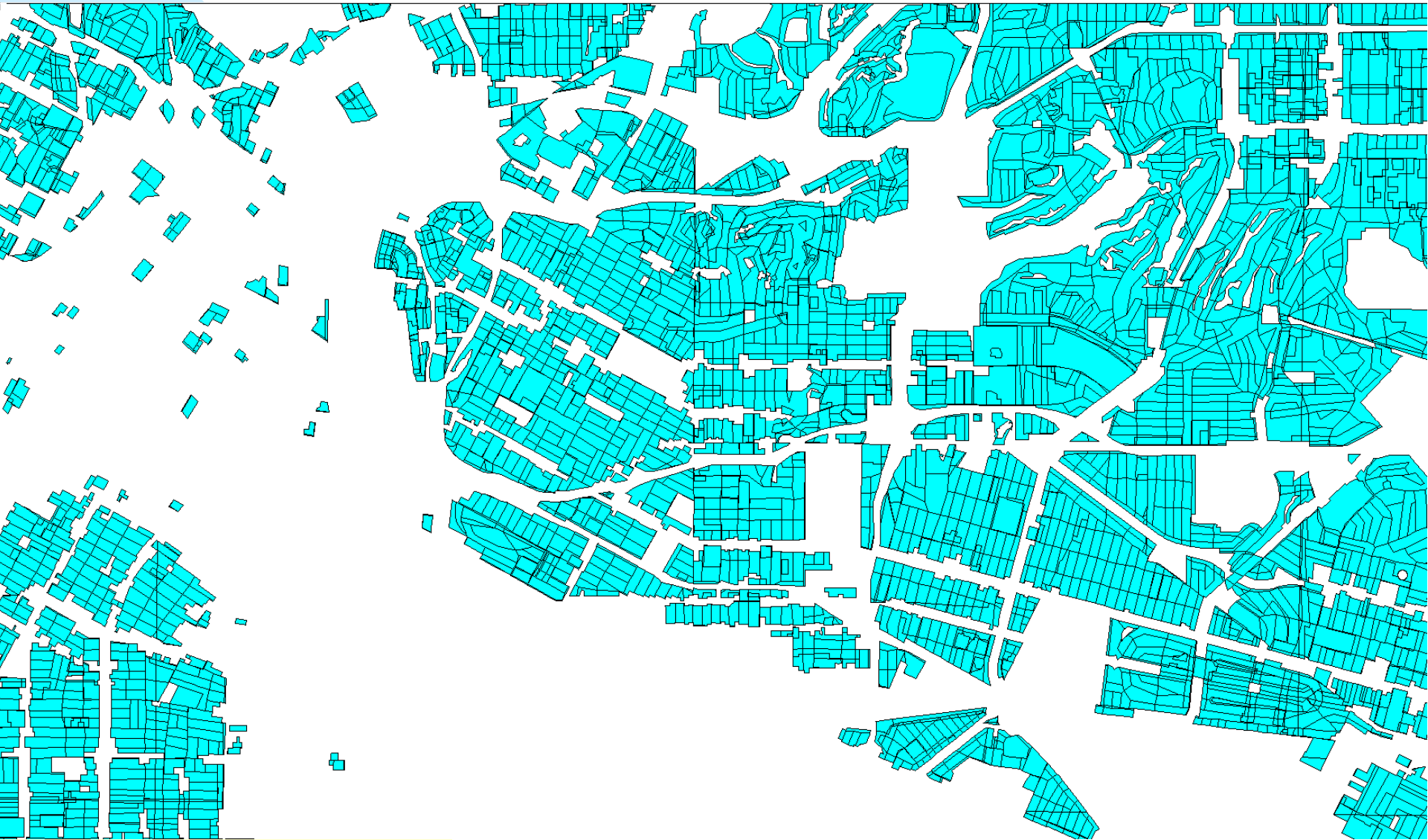


1. Isolate specific land uses from high quality spatial data (SCAG, 2005)
   - "Sensitive land uses" – daycare, schools, medical facilities, urban parks and playgrounds (CARB, 2005)
   - Residential
2. Intersect land use polygons with census blocks
3. Resulting Base Map - CI Polygons
   - Scoring System – each polygon receives "points" related to indicators
   - Final mapping also done using census tracts (discussed later)

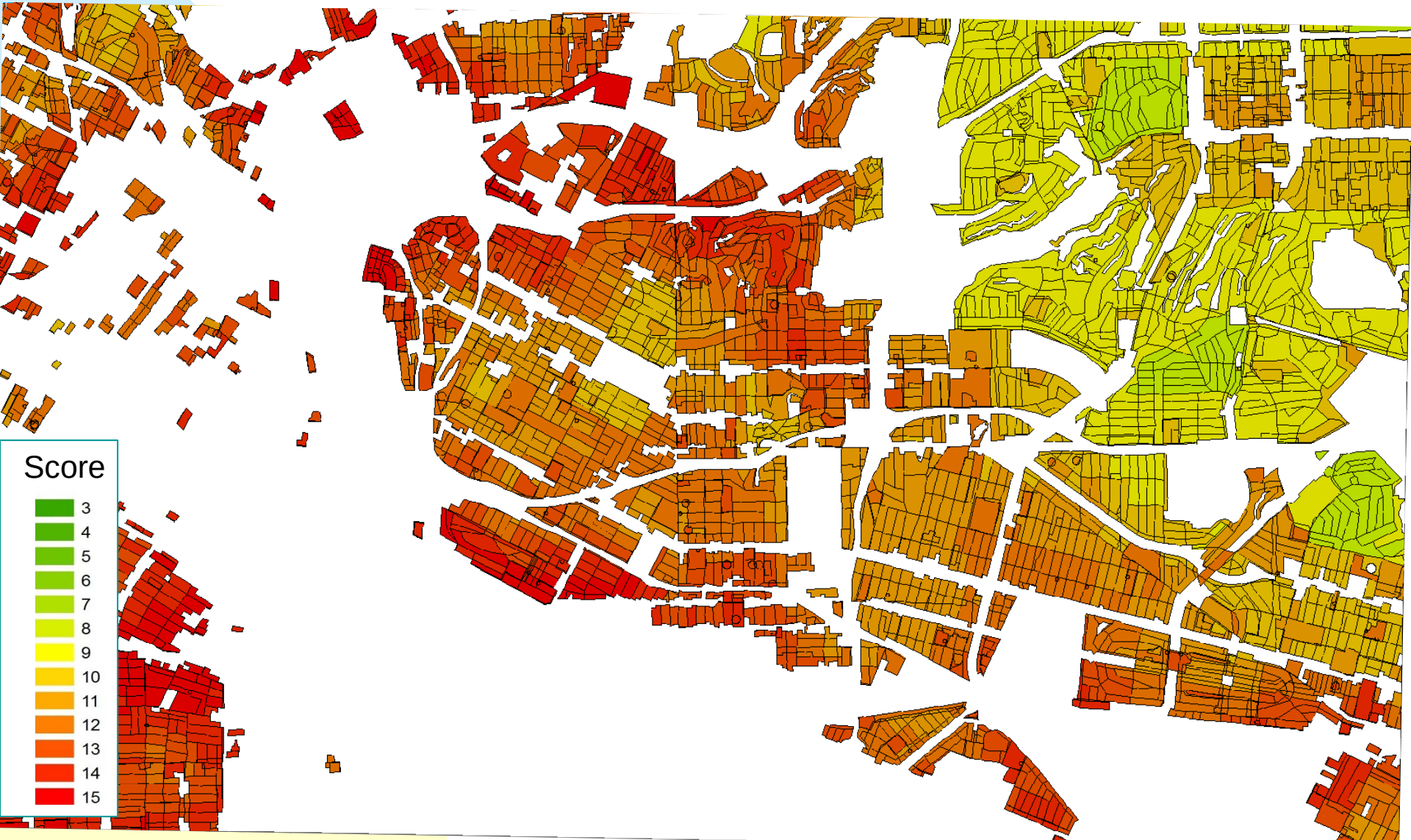
Intersect Land Use Polygons with Blocks



Result: Cumulative Impact (CI) Polygons, each associated with a specific block and land use



Each CI Polygon receives a Cumulative Impacts Score



Scoring – Land Use and Hazard Proximity

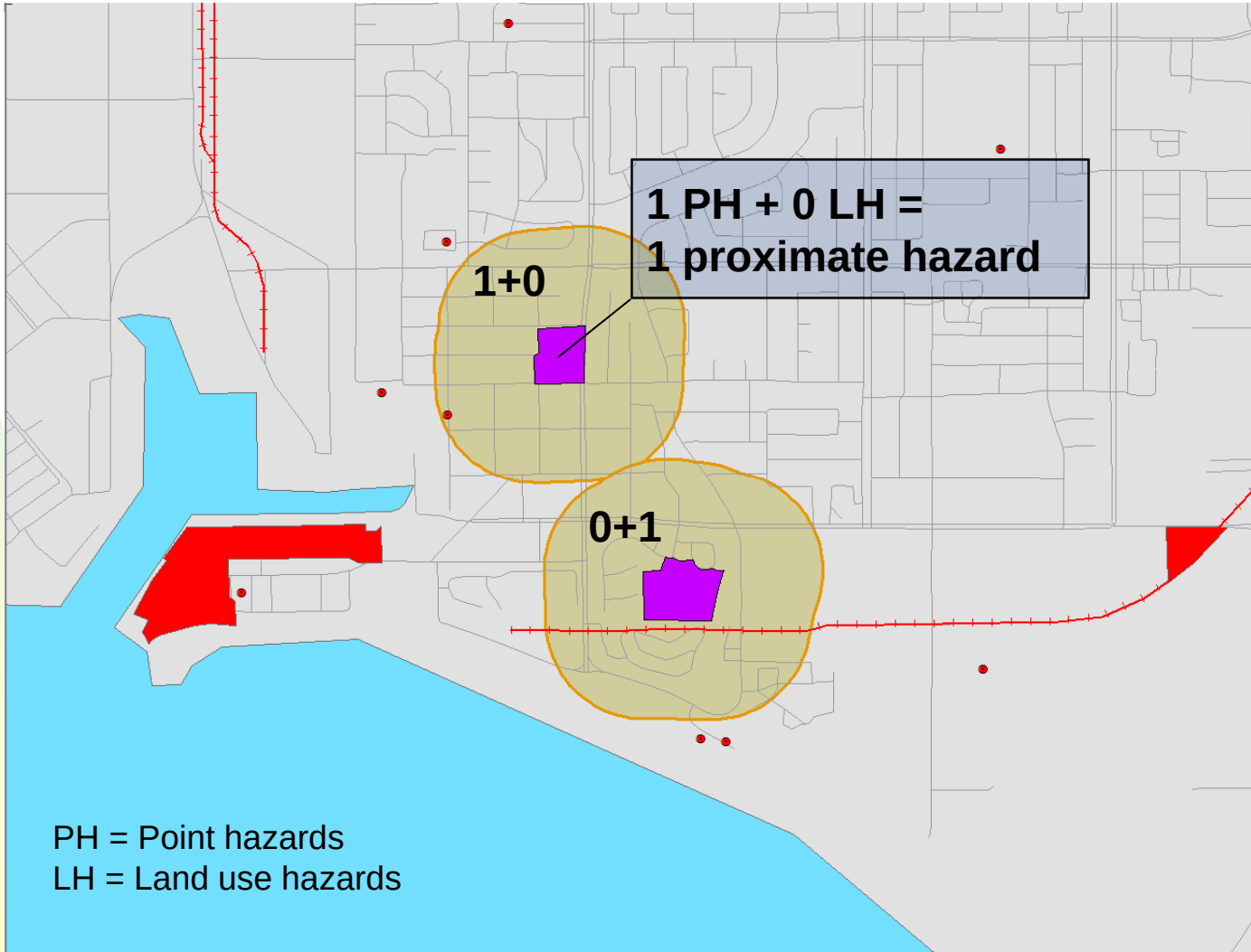
Screening score is based on a "points" system

- CI polygons receive 1 "point" if they are a sensitive land use category
- Hazard proximity points
  - CHAPIS (Priority emitters from California emissions inventories)
  - Chrome Platers
  - Hazardous Waste TSDs
  - Land Uses associated with high levels of air pollution
    - Rail, Ports, Airports, Refineries, Intermodal Distribution Facilities
- Proximity analysis using CI polygons
  - Number of sites within distance of CI polygon boundary
  - Distance-weighted approach to address locational inaccuracy
  - Aggregate these counts to census tracts using a population-weighting procedure

Defining Hazard Proximity

Distance-weighted Approach - 1000 foot buffer

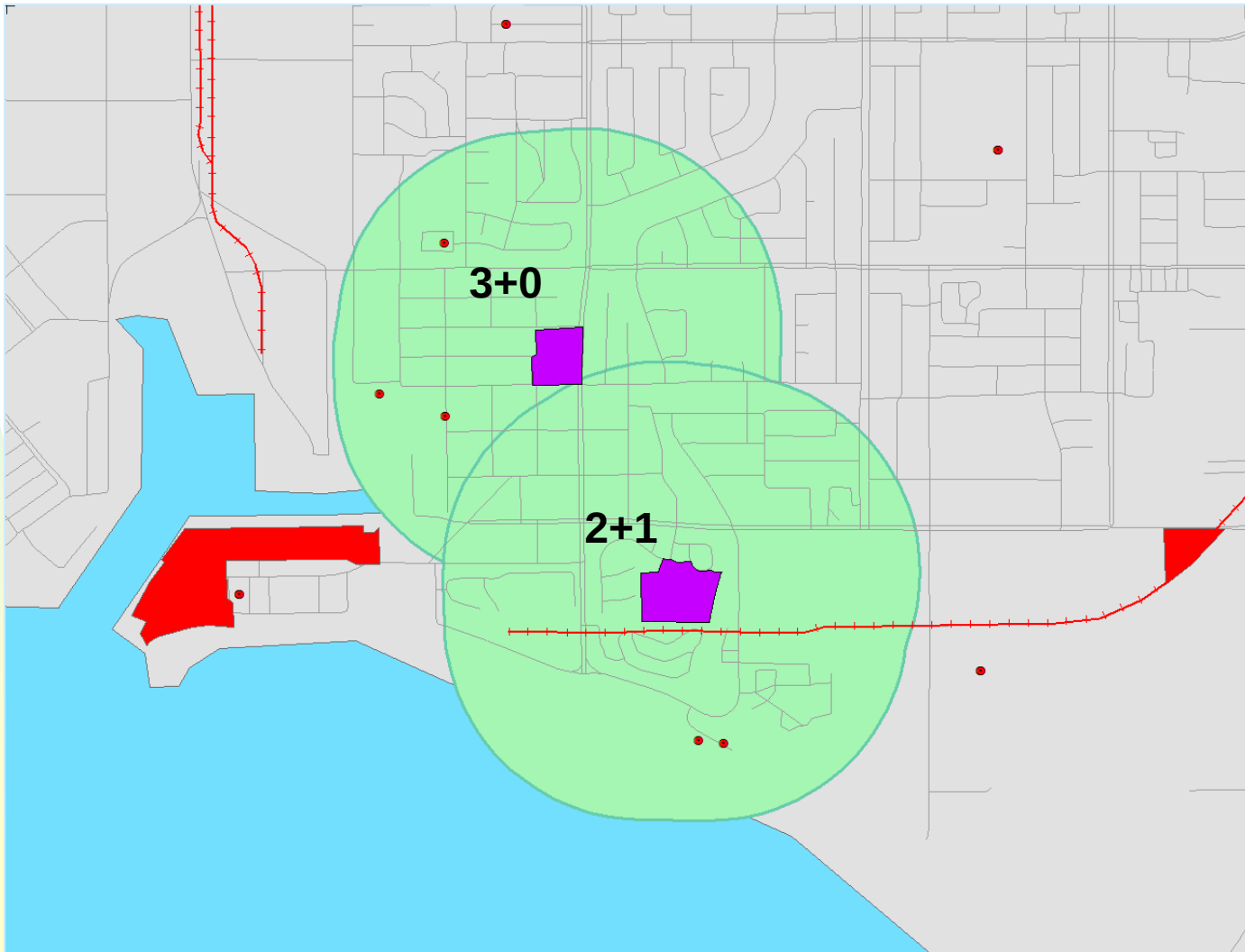
- Buffer CI polygon boundaries at different distances
- Hazard proximity based on number of facilities (point-sources) and hazardous land uses inside the buffer



Defining Hazard Proximity – Distance Buffers

2000 Foot Buffer

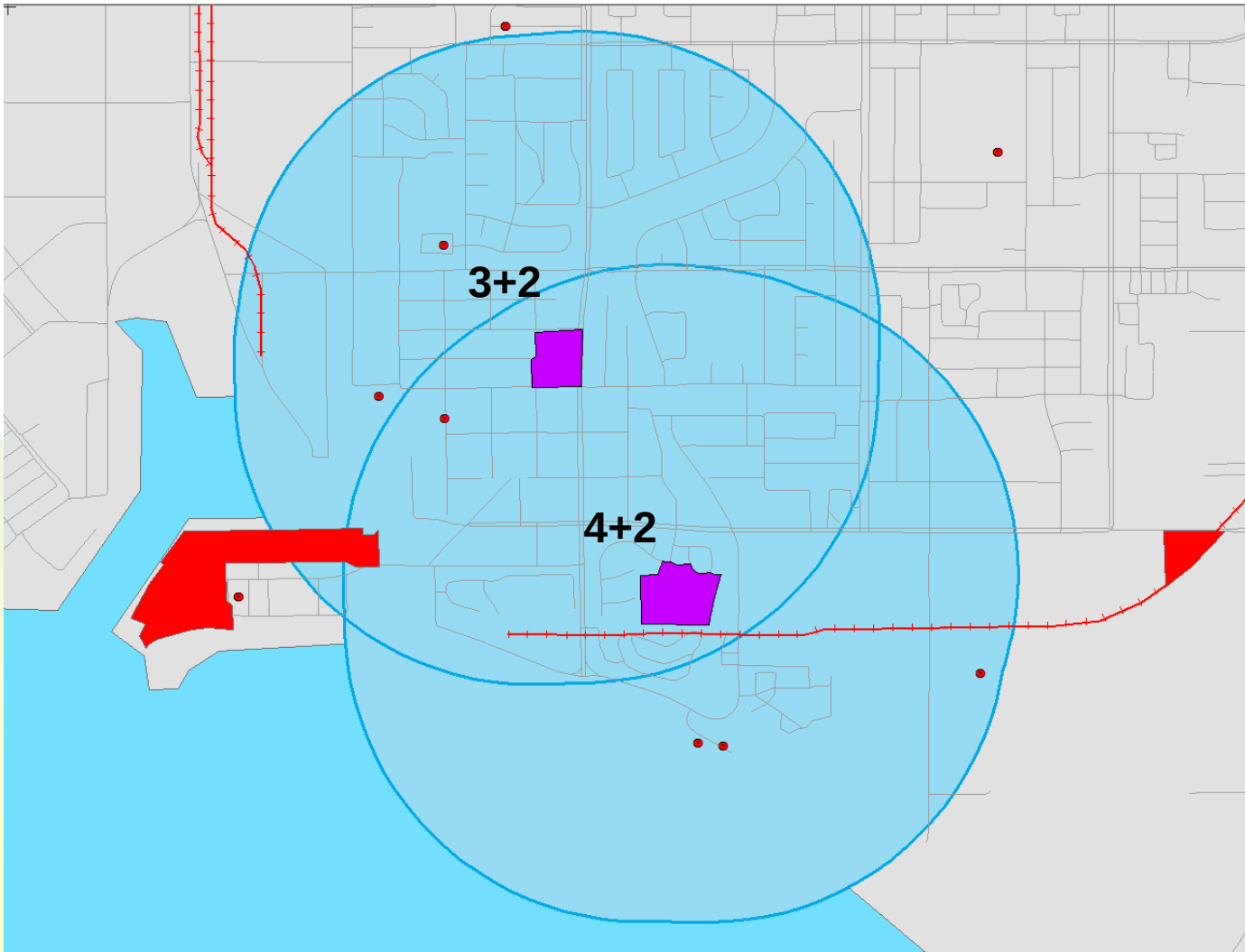
- Buffer CI polygon boundaries at different distances
- Hazard proximity based on number of facilities (point-sources) and hazardous land uses inside the buffer



Defining Proximity – Distance Buffers

3000 Foot Buffer

- Buffers on CI polygon boundaries
- Hazard proximity based on number of facilities (point-sources) and hazardous land uses inside the buffer



Distance Weighting the Hazard Count

Because of the potential for inaccurate hazard locations, a distance weighted approach is used to get the hazard count for each CI polygon:

Distance Weighted Hazard Count =

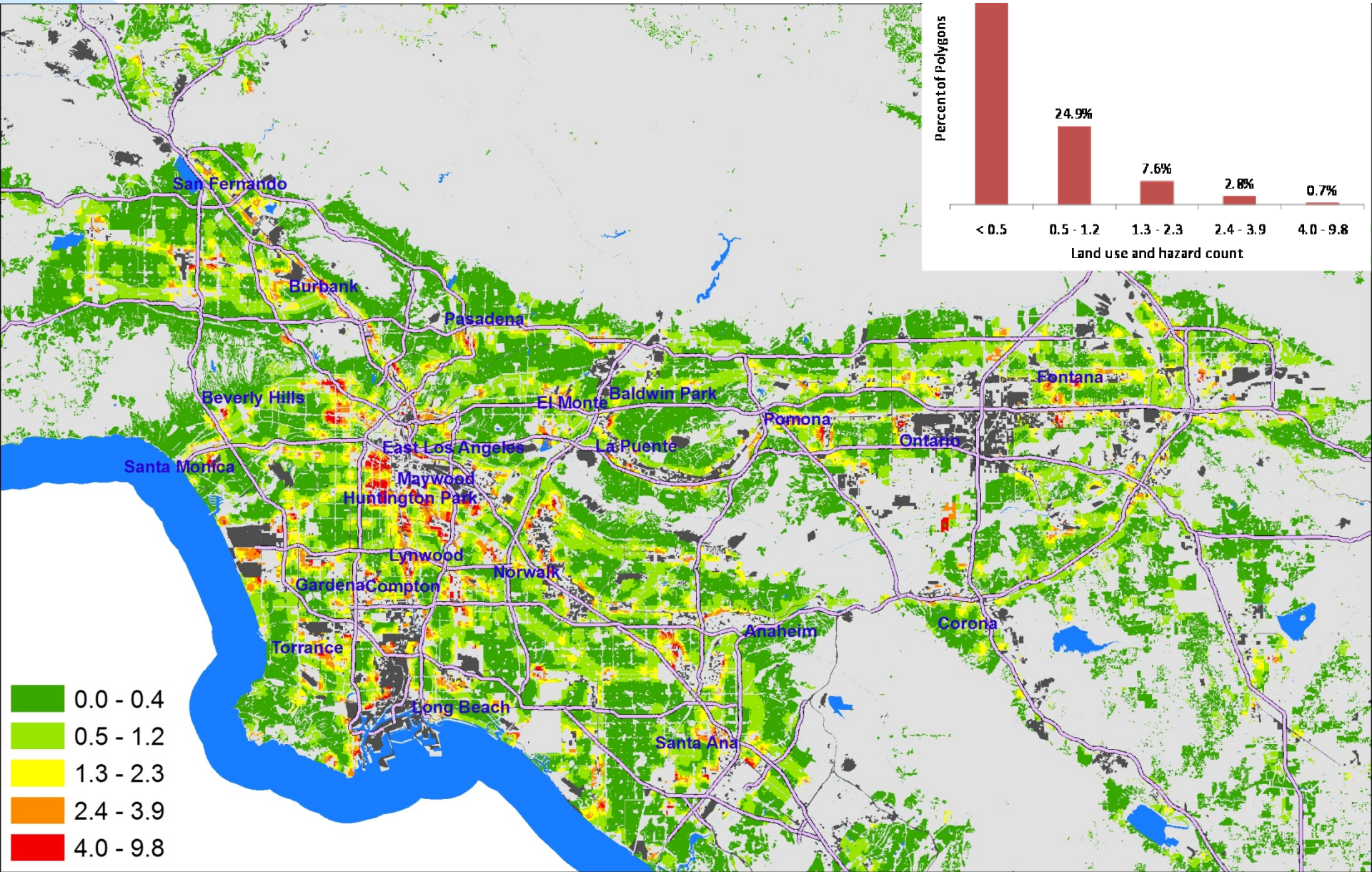
(1 x #Hazards within 1,000ft) +

(**0.5** x #Hazards 1,000-2,000ft) +

(**0.1** x #Hazards 2,000-3,000ft)

** The above weights can be set to any desired value*

Distance weighted hazard count around CI Polygons (Jenks natural breaks)



Calculating Hazard Proximity & Sensitive Land Counts at the Tract Level

Why?

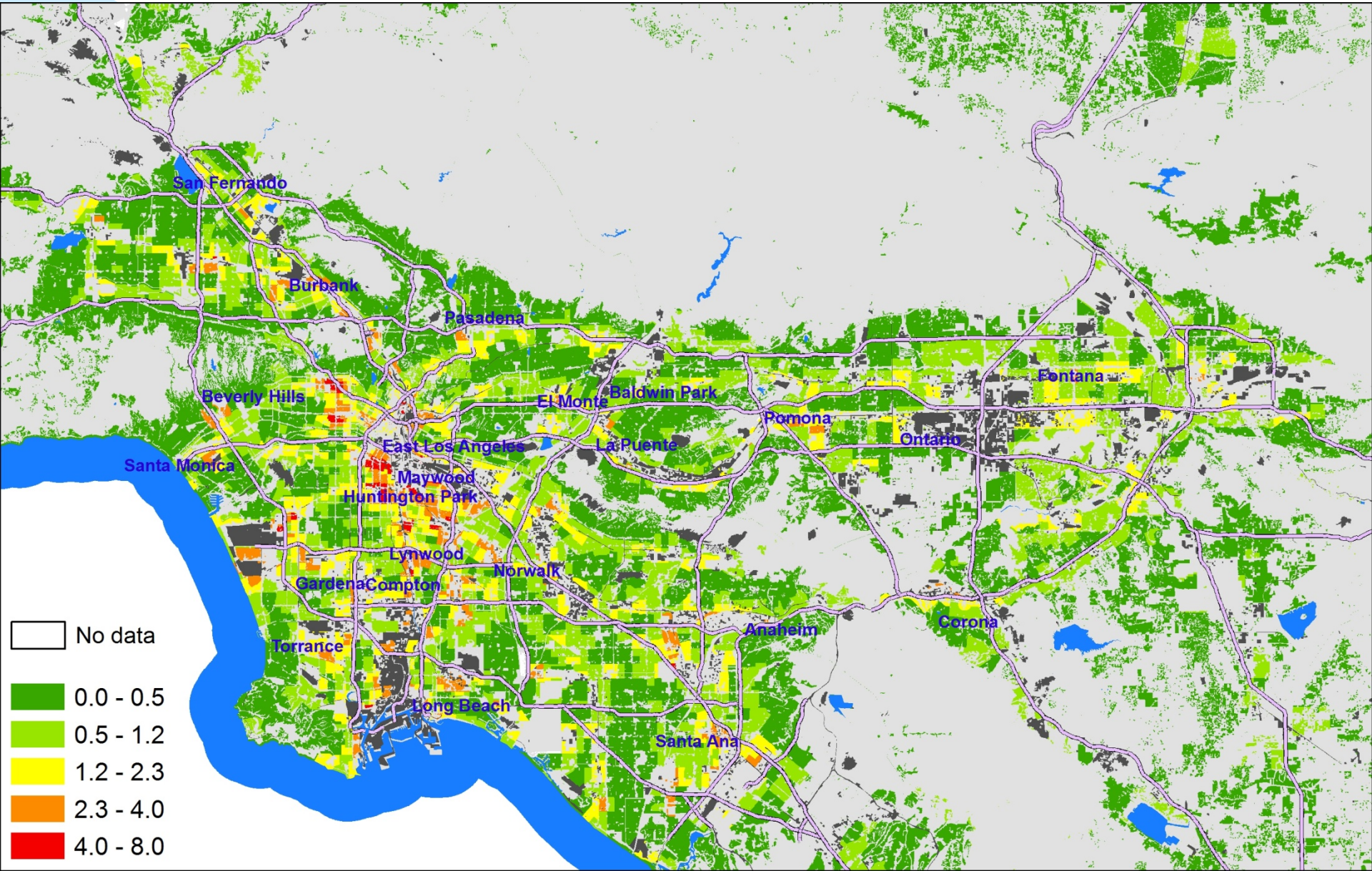
- Tracts are a consistent level of geography for many sources of data; avoid misrepresenting precision
- All of the health risk and social vulnerability measures (discussed later) are available at the tract level

How Calculated:

- Estimate population in each CI polygon (area-weighting)
- Calculate population-weighted average of the hazard and sensitive land use counts across all CI Polygons within each census tract

Hazard Proximity & Sensitive Land Use Count at the Tract Level

Distance weighted hazard count (+1 if sensitive land use), population weighted to the tract level, mapped on CI Polygons (Jenks natural breaks)



Scoring: Hazard Proximity & Sensitive Land Use

- Tract-level counts are ranked into quintiles (1-5) across all tracts in the region to produce the final hazard proximity and sensitive land use **score**

- Quintile distribution is used throughout the EJ Screening Method because it is an easily understood and normal ranking procedure

  - No “right” distribution to follow (magnitudes of hazards unknown)

  - Other distributions could easily be applied

Health Risk & Exposure Indicators
(Tract Level)

- RSEI (Risk Screening Environmental Indicators)
  - (2005) toxic conc. hazard scores from TRI facilities
- NATA 1999 (National Air Toxics Assessment)
  - Respiratory hazard from mobile & stationary sources
- CARB Estimated Inhalation Cancer Risk 2001
- CARB estimated $PM_{2.5}$ concentration
- CARB estimated Ozone concentration

Scoring for Health Risk & Exposure

Scoring:

- Each indicator is ranked into quintiles (1-5) across all tracts in the region
- Quintile rank values are summed for each tract
- These sums are ranked into quintiles (1-5) across all tracts in the region
- The resulting quintile rank is the health risk and exposure score for each tract

Social & Health Vulnerability Indicators

Census Tract Level Metrics (2000)

- % residents of color (non-White)
- % residents below twice national poverty level
- Home ownership - % living in rented households
- Housing value – median housing value
- Educational attainment – % population > age 24 with less than high school education
- Age of residents (% <5)
- Age of residents (% >60)
- Linguistic isolation - % pop. >age 4 in households where no one >age 15 speaks English well
- Voter turnout - % votes cast among all registered voters in 2000 general election
- Birth outcomes – % preterm or SGA infants 1996-03

Social & Health Vulnerability Scores

- Each social and health vulnerability metric is ranked into quintiles (1-5) across all tracts in the region

- Final score is derived by taking average ranking (across all metrics) for each tract, and ranking the average once again into quintiles (1-5)

A note on missing values:
To help ensure that the social and health vulnerability scores are reliable, we exclude tracts with less than 50 people, and those with 5 or more missing values among the 10 metrics considered. To account for missing values in tracts with 1 to 4 missing metrics, the average quintile ranking is taken across only the non-missing metrics.

Final Cumulative Impact Score

Combine three categories of impact and vulnerability to derive final Cumulative Impact Score

Cumulative Impact Score =

Hazard Proximity and Sensitive Land Use Score (1-5) +

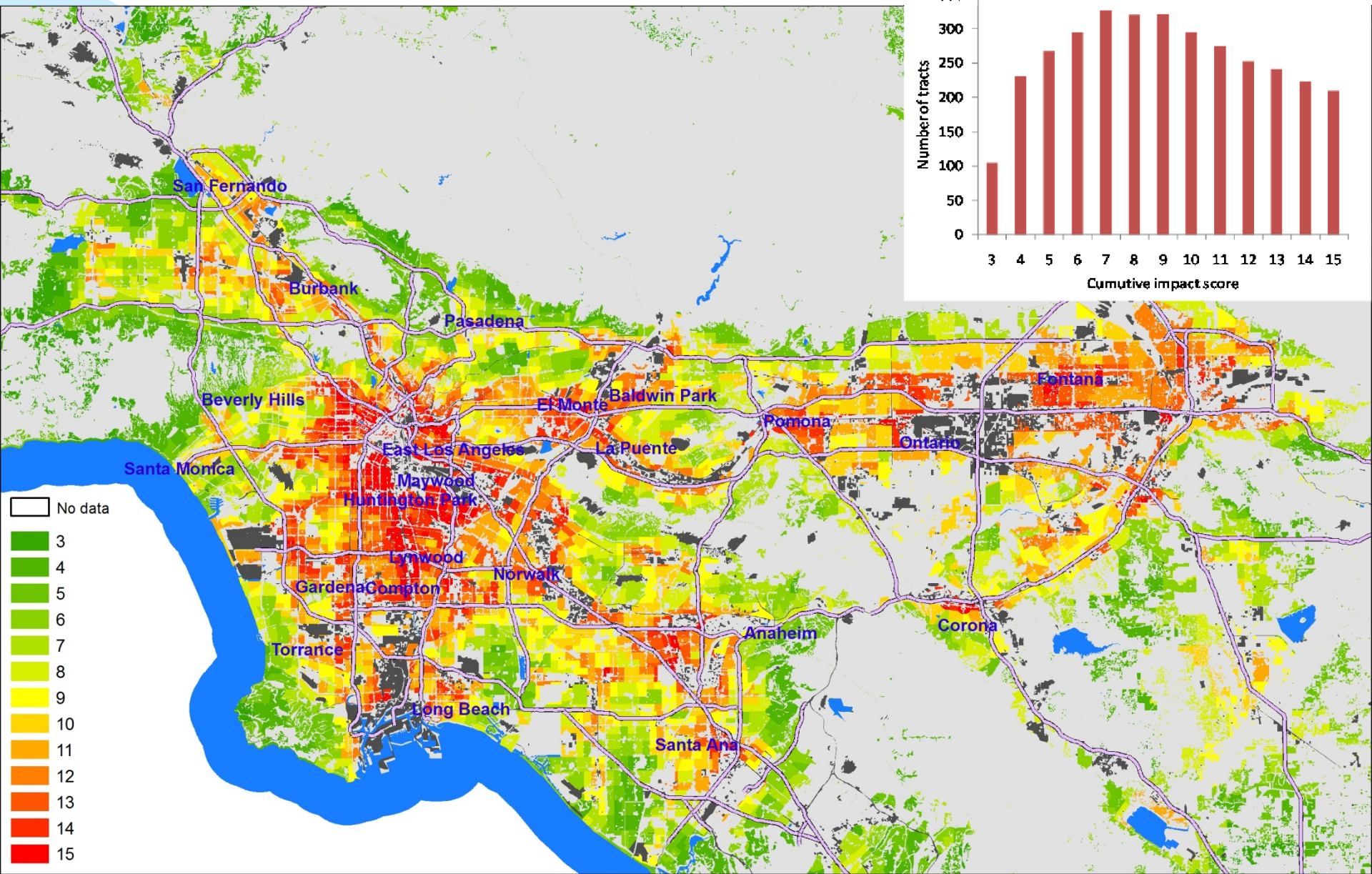
Health Risk and Exposure Score (1-5) +

Social and Health Vulnerability Score (1-5)

- *Final Cumulative Impact Score Ranges from 3-15*

Tract Level Cumulative Impact Score

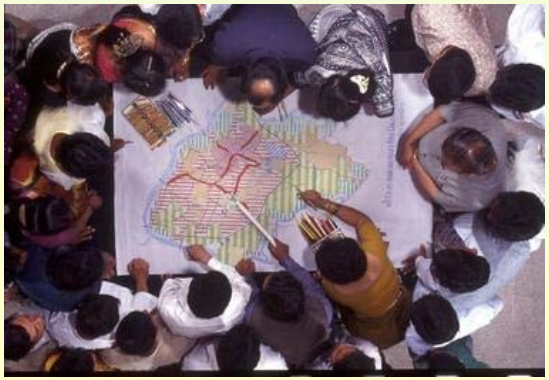
Distance weighted hazard proximity, mapped on CI Polygons



Important Caveats

- Method was developed with specific reference to air quality and does not screen for other concerns (such as water quality or pesticides)
  - Performs best with well-classified, high spatial resolution land use data
    - Currently experimenting with other data types to apply the Screening Method more widely
  - This is screening not assessment, so neighborhood monitoring and ground truth verification is needed.

Potential Contributions



- Screening provides a way to examine the geographic pattern of cumulative impact and vulnerability
  - Can be used to highlight communities of potential regulatory concern
  - Our approach is transparent and all metrics come from publicly available data, so it is not too difficult to implement & update
    - Open to modification by sophisticated users (change weights, indicators, scoring approaches)