Draft
California Communities Environmental Health Screening Tool (CalEnviroScreen)

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CIPA WORK GROUP &
2nd PUBLIC REVIEW DRAFT

California Environmental Protection Agency
Office of Environmental Health Hazard Assessment

PREFACE

The California Environmental Protection Agency (Cal/EPA) recognizes that many Californians live among multiple sources of pollution and that some people and communities are more vulnerable to the effects of pollution than others. It is important to identify disadvantaged communities that face multiple pollution burdens so programs and funding can be targeted appropriately toward raising the economic and environmental status of the most affected communities. For this reason, Cal/EPA's Office of Environmental Health Hazard Assessment (OEHHA) developed a science-based tool for evaluating multiple pollutants and stressors in communities, the California Communities Environmental Health Screening Tool (CalEnviroScreen). This document describes CalEnviroScreen.

This tool is the next step in the implementation of the Agency's 2004 Environmental Justice Action Plan and will be important for achieving the Agency's environmental justice goals. The EJ Action Plan called for the development of guidance to analyze the impacts of multiple pollution sources in California communities. This will help the Agency comply with statutory mandates to conduct its activities in a manner that ensures the fair treatment of all Californians, including minority and low-income populations. In addition, this tool will assist Cal/EPA in complying with Senate Bill 535 (De León, Chapter 830, Statutes of 2012), which requires the Agency to identify disadvantaged communities in California for purposes of allocating revenue to those communities from the Greenhouse Gas Reduction Fund.

CalEnviroScreen shows which portions of the state have higher vulnerabilities and burdens as compared to other areas, and therefore are most in need of assistance. In a time of limited resources, this tool will provide significant insight into how decision makers can focus available time, resources, and programs to improve the environmental health of Californians, particularly those most burdened by pollution. Potential uses of the tool at the state level include administering environmental justice grants, promoting greater compliance with environmental laws, prioritizing site-cleanup activities, and identifying opportunities for sustainable economic development in heavily impacted neighborhoods. Other government entities and interested parties may identify other uses of this tool and the information it provides. However, the screening tool is not intended to create a legal obligation to conduct additional detailed cumulative analyses for the staff reports written for individual rulemaking.

The CalEnviroScreen uses existing environmental, health, demographic and socioeconomic data to create a screening score for communities across the state. An area with a high score would be expected to experience greater pollution-related impacts (because of pollution burden combined with vulnerability), as compared to areas with low scores. The tool presents a broad picture of the burdens and vulnerabilities different areas face from environmental pollutants. It is not intended to be a substitute for a focused risk assessment for a given community or site, and it cannot predict or quantify specific health risks or effects associated with cumulative exposures identified for a given community or individual. It should be noted that the statutory definition of "cumulative impacts" contained in the California Environmental Quality Act (CEQA), is substantially different than the definition of "cumulative impacts" used to guide the development of this tool. Therefore, the maps generated by this tool cannot be used as a substitute for an analysis of the cumulative impact of any specific project for which an environmental review is required by CEQA.

Transparency and public input into government decision making and policy development are the cornerstones of environmental justice. In that spirit, the framework for the CalEnviroScreen was developed with the assistance of the Cumulative Impacts and Precautionary Approaches (CIPA) Work Group, consisting of representatives of business and non-governmental organizations, academia and government. The CIPA Work Group will also review this report and provide critical feedback and input that will continue to guide the development of this tool. We appreciate the considerable time and effort that the Work Group has devoted to this project since 2008, and we look forward to continuing our productive dialogue with the Work Group and all interested parties.

In addition to the contribution made by the CIPA Work Group, Cal/EPA received input on a previous draft of this document at a series of regional and stakeholder-specific public workshops as well as a day-long academic workshop. (Additional information on these workshops as well as the CIPA Work Group meetings and the development of the tool are available at www.oehha.ca.gov/ej/index.html.) Input from California communities, businesses, local governments, California tribes, community-based organizations, and other stakeholders as well as academia was critical in the development of this project and is reflected in changes in the current document. Changes include reconsidering the model and how public health status is handled; adding indicators for diesel particulate matter and linguistic isolation; removing county-scale data from the analysis and sometimes replacing it with data at a more local scale.

Cal/EPA remains committed to an open and public process. We expect to finalize a version of the CalEnviroScreen in the near future. As the same time, we acknowledge that work in this field continues and refinements of the CalEnviroScreen will also be needed. Thus, over the next several years we plan to update the tool and consider improvements to the indicators used, the geographic scale, the methodology employed and the accessibility of the tool to the public.

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Introduction

Californians are burdened by environmental problems and sources of pollution in ways that vary across the state. Some Californians are more vulnerable to the effects of pollution than others. This document describes a science-based method for evaluating multiple pollution sources in a community, while accounting for a community's vulnerability to pollution's adverse effects. Factors that contribute to a community's pollution burden or vulnerability are often referred to as stressors. The CalEnviroScreen method can be used to identify California's most burdened and vulnerable communities. This can help inform decisions at Cal/EPA's boards and departments by identifying places most in need of assistance. This document is a follow-up to Cal/EPA's and OEHHA's 2010 report, *Cumulative Impacts: Building A Scientific Foundation.*

Purpose of the Statewide Evaluation

A statewide analysis is being conducted:

- To demonstrate the application of a practical and scientifically justified methodology for evaluating multiple pollution sources and stressors that takes into account a community's vulnerability to pollution.
- To provide a baseline assessment and methodology, which can be expanded upon and updated periodically as important additional information becomes available.
- To identify communities in California most burdened by pollution from multiple sources and most vulnerable to its effects, taking into account their socioeconomic characteristics and underlying health status.
- To provide as final output a *relative*, rather than absolute, measure of impact.

Community impact assessment from multiple sources and stressors is a complex problem that is difficult to approach with traditional risk assessment practices. Chemical-by-chemical, source-by-source, route-by-route risk assessment approaches are not best suited to the assessment of community-scale impacts, especially for identifying the most impacted places across all of California. Also, while traditional risk assessment may account for the heightened sensitivities of some groups, such as children and the elderly, it has not considered other community characteristics that have been shown to affect vulnerability to pollution, such as socioeconomic factors or underlying health status.

Given the limits of traditional risk assessment, OEHHA developed a workable approach to conduct a statewide evaluation of community impacts. The method emerges from basic risk assessment concepts and is sufficiently expansive to incorporate the multiple factors that reflect community impacts that have not been included in traditional risk assessments. The tool presents a broad picture of the burdens and vulnerabilities different areas face from environmental pollutants. It is not intended to be a substitute for a focused risk assessment for a given community or site, and it cannot precisely predict or quantify specific health risks or effects associated with cumulative exposures identified for a given community or individual. It should be noted that the statutory definition of "cumulative impacts" contained CEQA, is substantially different than the working definition of "cumulative impacts" adopted by Cal/EPA and used to guide the development of this tool. Therefore, the scores generated by this tool cannot be used as a substitute for an analysis of the cumulative impact of any specific project for which an environmental review is required by CEQA.

This report provides an overall description of the methodological approach used in CalEnviroScreen. It also describes the criteria for the selections of scale of analysis and the selection of indicators. Specific indicators are described, data representing the indicators for the different areas of the state were obtained and analyzed and are presented here as statewide maps. All the indicators for a locale are then combined to score communities. The report concludes by providing scores for the different areas of the state, presented in maps, as well as highlighting communities scoring in the top 5, 10 and 15 percent.

Method

Definition of Cumulative Impacts

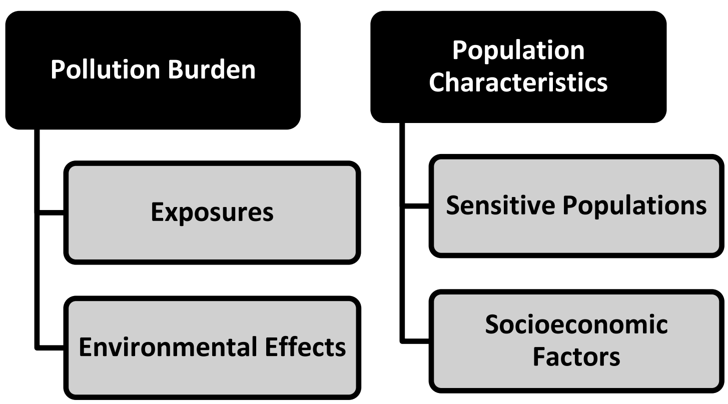
Cal/EPA has a working definition of cumulative impacts[1] adopted in 2005 as follows:

> *"Cumulative impacts means exposures, public health or environmental effects from the combined emissions and discharges, in a geographic area, including environmental pollution from all sources, whether single or multi-media, routinely, accidentally, or otherwise released. Impacts will take into account sensitive populations and socioeconomic factors, where applicable and to the extent data are available."*

CalEnviroScreen Model

The CalEnviroScreen model is based on the Cal/EPA working definition in that:

- The model is place-based and provides information for the entire State of California on a geographic basis. The geographic scale selected is intended to be useful for a wide range of decisions.
- The model is made up of multiple components identified from the definition, which are recognized as contributors to impact. The model includes two components representing pollution burden – exposures and environmental effects – and two components representing population characteristics – sensitive populations (e.g., in terms of health status and age) and socioeconomic factors.



[1] This definition differs from the statutory definition of "cumulative impacts" contained in the California Environmental Quality Act (CEQA). While the term is the same, they cannot be used interchangeably. For example, the data and ranking generated by this tool cannot be used as a substitute for a cumulative impacts analysis in a CEQA document.

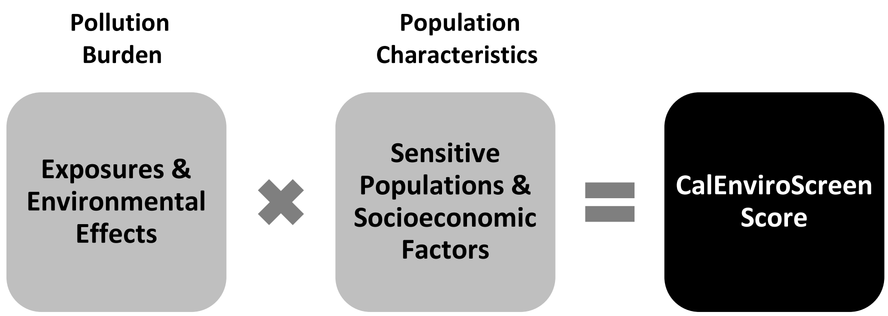
Model Characteristics

The model:

- Uses a suite of statewide indicators to characterize both pollution burden and population characteristics.
- Uses a limited set of indicators in order to keep the model simple.
- Assigns scores for each of the indicators in a given geographic area.
- Uses a scoring system to weight and sum each set of indicators within pollution burden and population characteristics components
- Derives a CalEnviroScreen score in a given place relative to other places in the state, using the formula below.

Formula for Calculating CalEnviroScreen Score

After the components are scored, the scores are combined as follows to calculate overall CalEnviroScreen Score:



Rationale for Formula

The mathematical formula for calculating scores uses multiplication. Scores for the pollution burden and population characteristics categories are multiplied together (rather than added, for example). Although this approach may be less intuitive than simple addition, there is scientific support for this approach to scoring.

Multiplication was selected for the following reasons:

1. *Scientific Literature*: Existing research on environmental pollutants and health risk has consistently identified socioeconomic and sensitivity factors as "effect modifiers." For example, numerous studies on the health effects of particulate air pollution have found that low socioeconomic status is associated with about a 3-fold increased risk of morbidity or mortality for a given level of particulate pollution (Samet and White, 2004). Similarly, a study of asthmatics found that their sensitivity to an air pollutant ranged up to 7-fold greater than non-asthmatics (Horstman *et al.*, 1986). African-American mothers of low-socioeconomic status exposed to traffic-related air pollution were two times as likely to deliver preterm babies (Ponce *et al.*, 2005). The young exposed to environmental carcinogens can be 10 times more sensitive than adults (OEHHA, 2009). Studies of increased risk in vulnerable populations can often be described by effect modifiers that amplify the risk. This research suggests that the use of multiplication makes sense based on the existing scientific literature.

2. *Risk Assessment Principles*: Some members of the general population (such as children) may be 10 times more sensitive to some chemical exposures than others. Risk assessments, using principles first advanced by the National Academy of Sciences, apply numerical factors or multipliers to account for potential human sensitivity (as well as other factors such as data gaps) in deriving acceptable exposure levels (US EPA, 2012).
3. *Established Risk Scoring Systems*: Priority-rankings done by various emergency response organizations to score threats have used scoring systems with the formula: Risk = Threat × Vulnerability (Brody *et al.*, 2012). These formulas are widely used and accepted.

Maximum Scores for Combined Components

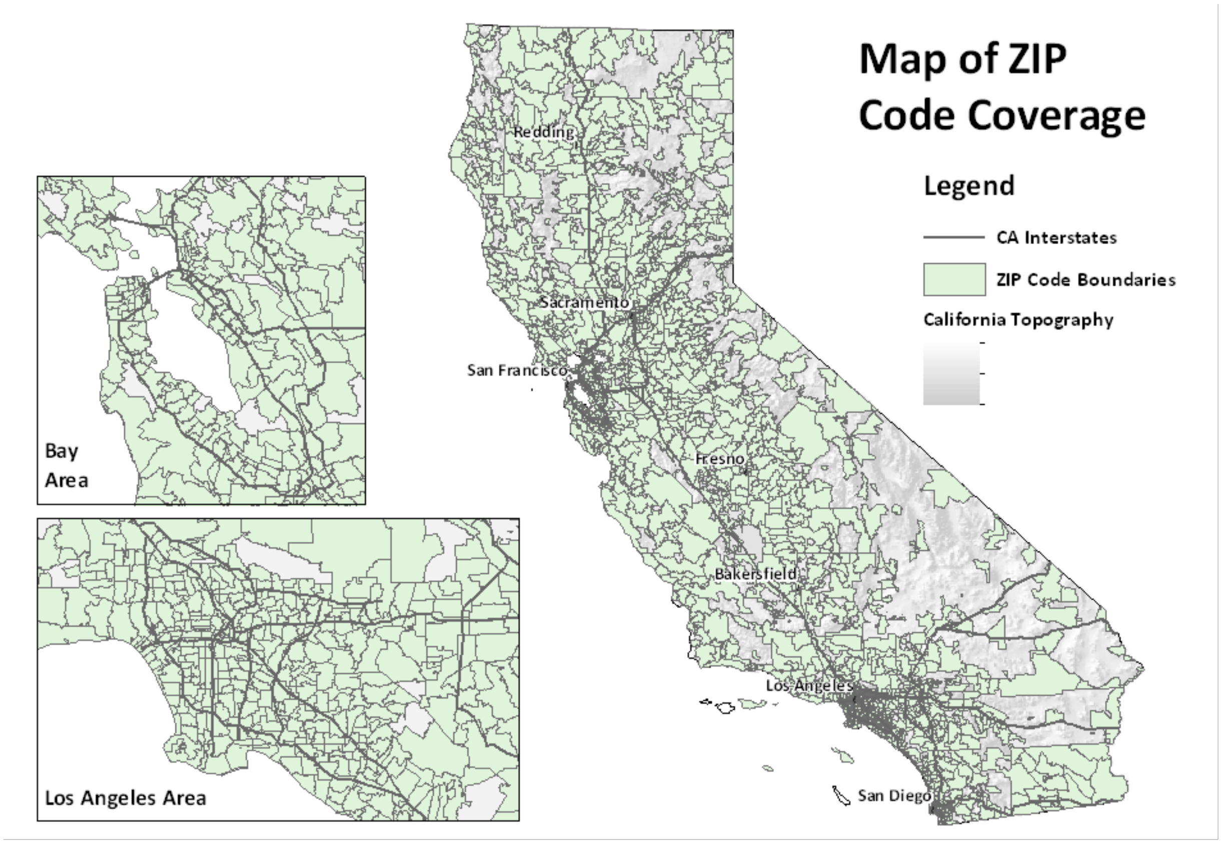
Component	Maximum Score*
Pollution Burden	
Exposures and Environmental Effects	10
Population Characteristics	
Sensitive Populations and Socioeconomic Factors	10
CalEnviroScreen Score	**Up to 100 (= 10 × 10)**

***** The scores for each group were rounded to one decimal place before multiplying to calculate the CalEnviroScreen Score (for example, 6.5 out of a possible 10)

Selection of Geographic Scale

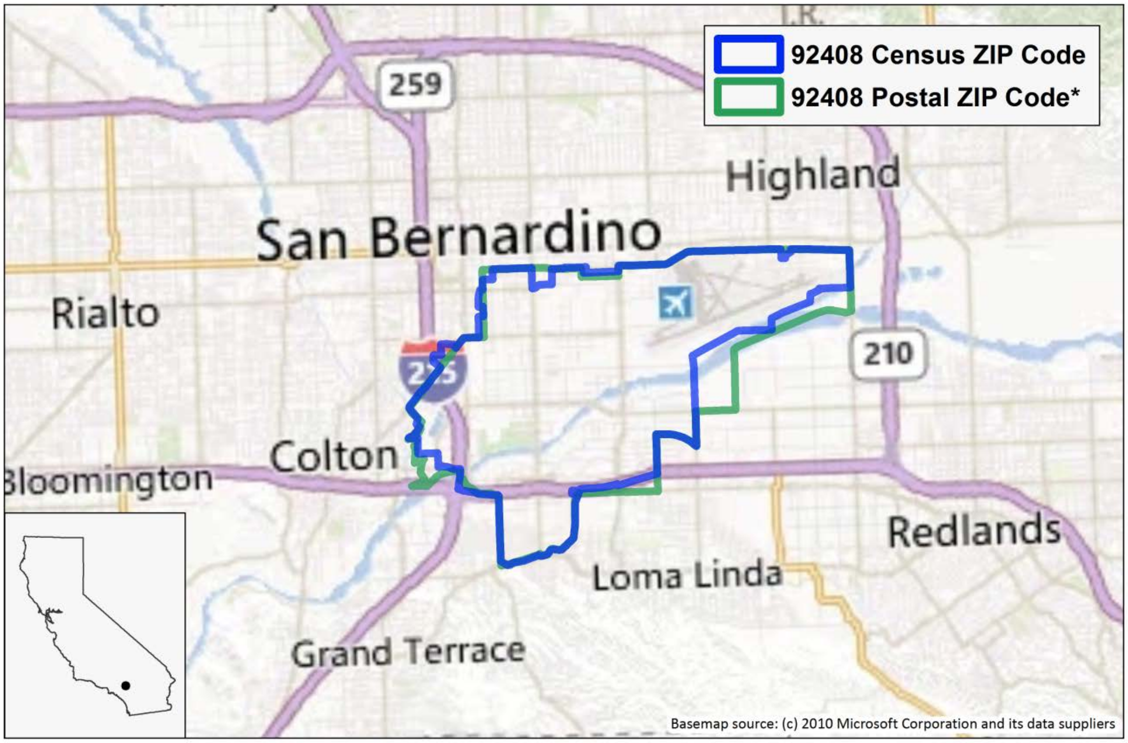
For this version of CalEnviroScreen, the ZIP code scale is the unit of analysis. A representation of ZIP codes, called ZCTAs (ZIP Code Tabulation Areas), is available from the Census Bureau. These were updated in 2010.[2] For simplicity, these areas are referred to as ZIP codes throughout this report.

The census ZIP codes cover areas where people live, but do not include many sparsely populated places, like national parks. There are approximately 1800 census ZIP codes in California, representing a relatively fine scale of analysis.[3]



[2] Additional information on the U.S. Census Bureau's ZIP Code Tabulation Areas may be found on their website: http://www.census.gov/geo/ZCTA/zcta.html.
[3] In a future version of the tool, results will also be available at the census tract scale.

The following map shows the relationship between census-derived ZIP codes (ZCTAs) and approximate postal service ZIP codes for an area in San Bernardino. For many ZIP codes they are similar.



* Postal service ZIP code approximations were obtained from ESRI, Inc.

References

Brody TM, Di Bianca P, Krysa J (2012). Analysis of inland crude oil spill threats, vulnerabilities, and emergency response in the midwest United States. *Risk Analysis* **32**(10):1741-9. [Available at URL: http://onlinelibrary.wiley.com/doi/10.1111/j.1539-6924.2012.01813.x/pdf]. Example: Use in the oil spill emergency response context for priority-setting. "Many organizations use numerical priority-scoring formulas such as Risk = Threat × Vulnerability….Such multiplication is valid when the components of the right side are uncorrelated."

Horstman D, Roger L, Kehrl H, Hazucha M (1986). Airway Sensitivity of Asthmatics To Sulfur Dioxide *Toxicol Ind Health* 2: 289-298.

OEHHA (2009). Technical Support Document for Cancer Potency Factors: Methodologies for derivation, listing of available values, and adjustments to allow for early life stage exposures. May 2009. Available at URL: http://www.oehha.ca.gov/air/hot_spots/2009/TSDCancerPotency.pdf.

Ponce NA, Hoggatt KJ, Wilhelm M, Ritz B (2005). Preterm birth: the interaction of traffic-related air pollution with economic hardship in Los Angeles neighborhoods. *Am J Epidemiol* 162(2):140-8.

Samet JM, White RH (2004) Urban air pollution, health, and equity. *J Epidemiol Community Health*, **58**:3-5 [Available at URL: http://jech.bmj.com/content/58/1/3.full].

US EPA (2012). Dose-Response Assessment [Available at URL: http://www.epa.gov/risk/dose-response.htm]. Example: "The reference dose … is an oral or dermal dose derived … by application of generally order-of-magnitude uncertainty factors (UFs). These uncertainty factors take into account the variability and uncertainty that are reflected in possible differences between test animals and humans (generally 10-fold or 10x) and variability within the human population (generally another 10x); the UFs are multiplied together: 10 x 10 = 100x. If a LOAEL is used, another uncertainty factor, generally 10x, is also used. In the absence of key toxicity data (duration or key effects), an extra uncertainty factor(s) may also be employed."

Indicator Selection and Scoring

The selection of specific indicators to characterize components of the CalEnviroScreen requires consideration of both the type of information that will best represent statewide pollution burden and population characteristics, and the availability and quality of such information at the necessary geographic scale statewide.

Overview of the Process

1. Identify potential indicators for each component.
2. Find sources of data to support indicator development (see Criteria for Indicator Selection below).
3. Select and develop indicator, assigning a value for each geographic unit.
4. Assign a percentile for each indicator for each geographic unit, based on the rank-order of the value.
5. Generate maps to visualize data.
6. Derive scores for pollution burden and population characteristics components (see Indicator and Component Scoring below).
7. Derive the overall CalEnviroScreen score by combining the component scores (see below).
8. Generate maps to visualize overall results.

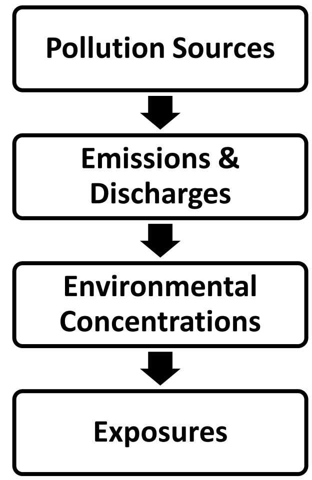
Criteria for Indicator Selection

- Indicators should provide a measure that is relevant to the component it represents, in the context of the 2004 Cal/EPA cumulative impacts definition.
- Indicators should represent widespread concerns related to pollution in California.
- The indicators taken together should provide a good representation of each component.
- Pollution burden indicators should relate to issues that may be potentially actionable by Cal/EPA boards and departments.
- Population characteristics indicators should represent demographic factors known to influence vulnerability to disease.
- Data for the indicator should be available for the entire state at the ZIP code level geographical unit or translatable to the ZIP code level.
- Data should be of sufficient quality, and be:
    - Complete
    - Accurate
    - Current

Exposure Indicators

People may be exposed to a pollutant if they come in direct contact with it, by breathing contaminated air, for example.

No data are available statewide that provide direct information on exposures. Exposures generally involve movement of chemicals from a source through the environment (air, water, food, soil) to an individual or population. For purposes of the CalEnviroScreen, data relating to pollution sources, releases, and environmental concentrations are used as indicators of potential human exposures to pollutants. Six indicators were identified and found consistent with criteria for exposure indicator development. They are:



- Ozone concentrations in air
- PM2.5 concentrations in air
- Diesel particulate matter in air
- Use of certain high-hazard, high-volatility pesticides
- Toxic releases from facilities
- Traffic density

Environmental Effect Indicators

Environmental effects are adverse environmental conditions caused by pollutants.

Environmental effects include various aspects of environmental degradation, ecological effects and threats to the environment and communities. The introduction of physical, biological and chemical pollutants into the environment can have harmful effects on different components of the ecosystem. Effects can be immediate or delayed. In addition to direct effects on ecosystem health, the environmental effects of pollution can also affect people by limiting the ability of communities to make use of ecosystem resources (e.g., eating fish or swimming in local rivers or bays). Also, living in an environmentally degraded community can lead to stress, which may affect human health.

Statewide data on the following topics were identified and found consistent with criteria for indicator development:

- Toxic cleanup sites
- Impaired water bodies
- Groundwater threats from leaking underground storage sites and cleanups
- Solid waste sites and facilities, and hazardous waste facilities

Sensitive Population Indicators

Sensitive populations are populations with biological traits that may magnify the effects of pollutant exposures.

Sensitive individuals may include those undergoing rapid physiological change, such as children, pregnant women and their fetuses, and individuals with impaired physiological conditions, such as the elderly or people with existing diseases such as heart disease or asthma. Other sensitive individuals include those with lower protective biological mechanisms due to genetic factors.

Pollutant exposure is a likely contributor to many observed adverse outcomes at the population level, and has been demonstrated for some outcomes such as asthma, low birth weight, and heart disease. People with these health conditions are also more susceptible to exacerbation from pollution. With few exceptions, adverse health conditions are difficult to attribute solely to exposure to pollutants. High quality statewide data related to these and other health conditions that can be influenced by toxic chemical exposures were identified and found consistent with criteria for development of these indicators:

- Prevalence of children and elderly
- Asthma
- Low birth-weight infants

Socioeconomic Factor Indicators

Socioeconomic factors are community characteristics that result in increased vulnerability to pollutants.

A growing body of literature provides evidence of the heightened vulnerability of people of color and lower socioeconomic status to environmental pollutants. For example, maternal exposure to particulate pollution is associated with reduced birth weight; this effect is greater among African-American mothers compared to white mothers. Here, socioeconomic factors that have been associated with increased population vulnerability were selected.

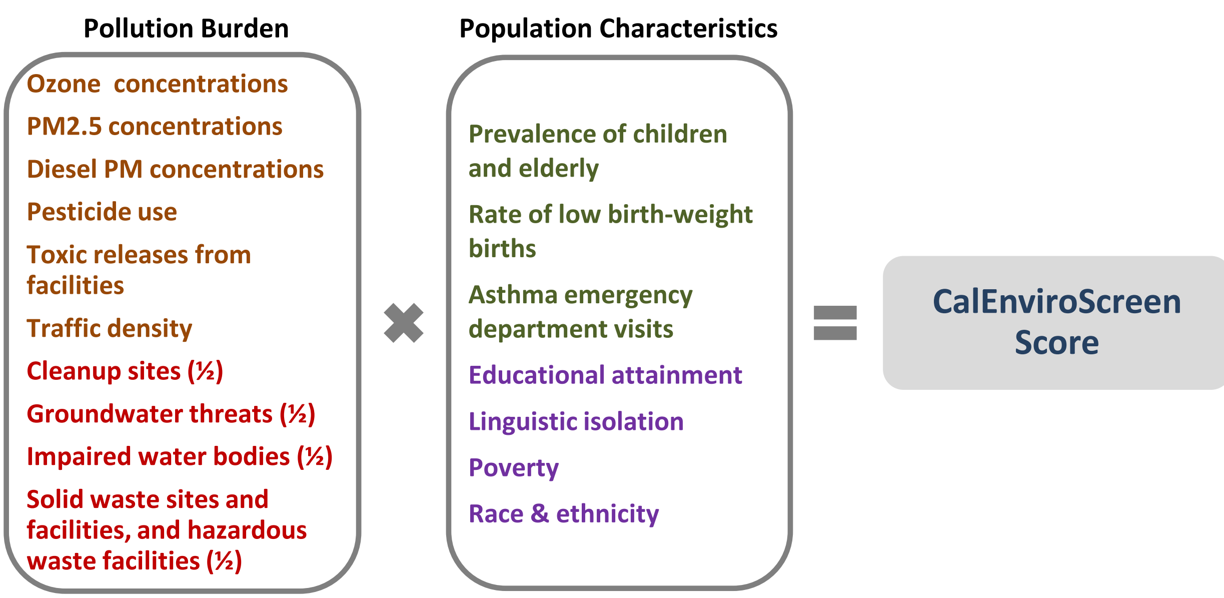
Data on the following socioeconomic factors were identified and found consistent with criteria for indicator development:

- Educational attainment
- Linguistic isolation
- Poverty
- Race & ethnicity

Indicator and Component Scoring

- Each indicator has a value for each geographical area. These values for every geographical area are ordered from highest to lowest. A percentile is then calculated from the distribution of indicator values for all areas that have a value. Thus each indicator's percentile in a specific place is relative to the scores for the indicators in the rest of the places in the state. *
- Indicators from Exposures and Environmental Effects components were grouped together to represent Pollution Burden. Indicators from Sensitive Populations and Socioeconomic Factors were grouped together to represent Population Characteristics (see figure below).
- Scores for the Pollution Burden and Population Characteristics groups of indicators are calculated as follows:
  - First, the percentiles for all the individual indicators in a group are averaged. Indicators from the Environmental Effects component were each weighted half of those indicators from the Exposures component. This was done because the contribution to possible pollutant burden from the Environmental Effects indicators was considered to be less than those from sources in the Exposures indicators.
  - Second, Pollution Burden and Population Characteristics groups are assigned scores from their defined ranges (up to 10) based on these averages.

* When a geographic area has no non-zero indicator value (for example, no facilities with toxic releases are present), it is excluded from the percentile calculation and assigned a value of zero. Thus the percentile score can be thought of as a comparison of one geographic area to other localities in the state where the hazard effect or population characteristic is present.



CalEnviroScreen Score and Maps

- The overall CalEnviroScreen score is calculated from the Pollution Burden and Population Characteristics groups of indicators by multiplying the two scores. Since each group has a maximum score of 10, the maximum CalEnviroScreen Score is 100.
- The scores for every geographical area are ordered from highest to lowest. A percentile is then calculated from the distribution.
- Maps are developed showing the percentiles for all the zip codes of the state. Maps are also developed highlighting the zip codes scoring the highest.

Uncertainty and Error

There are different types of uncertainty that to likely to be introduced in the development of any screening method for evaluating pollution burden and population vulnerability in different geographic areas. Several important ones are:

- The degree to which the data that are included in the model are correct.
- The degree to which the data and the indicator metric selected reflect meaningful contributions in the context of identifying areas that are impacted by multiple sources of pollution and may be especially vulnerable to their effects.
- The degree to which data gaps or omissions influence the results.

Efforts were made to select datasets for inclusion that are complete, accurate and current. Nonetheless, there are uncertainties that may arise because environmental conditions change over time, large databases may contain errors, or there are possible biases in how complete the data sets are across the state, among others. Some of these uncertainties were addressed in the development of indicators. For example:

- Clearly erroneous place-based information for facilities or sites has been removed.
- Low incidences or small counts (e.g., health outcomes) have been excluded from the analysis.
- Highly uncertain measurements (for example, >50 kilometers from an air monitor) have been excluded from the analysis.

Other types of uncertainty are more difficult to measure quantitatively, such as those related to how well indicators measure what they are intended to represent in the model. For example:

- How well data on chemical uses or emission data reflect potential contact with pollution.
- How well vulnerability of a community is characterized by demographic data.

Generally speaking, indicators are surrogates for the characteristic being modeled, so a certain amount of uncertainty is inevitable. That said, this model comprised of a suite of indicators is consided useful in identifying places burdened by multiple sources of pollution with populations that may be especially vulnerable. Places which score highly for many of the indicators are likely to be identified as impacted. Since there are tradeoffs in combining different sources of information, the results are considered most useful for identifying communities that score highly using the model. Using a limited data set, an analysis of the sensitivity of the model to changes in weighting showed it is relatively robust in identifying more impacted areas (Meehan August *et al*., 2012). Use of broad groups of areas, such as those scoring in the highest 5, 10, or 15%, is expected to be the most suitable application of the CalEnviroScreen results.

Reference

Meehan August L, Faust JB, Cushing L, Zeise L, Alexeeff, GV (2012). Methodological Considerations in Screening for Cumulative Environmental Health Impacts: Lessons Learned from a Pilot Study in California. *Int J Environ Res Public Health* **9**(9): 3069-3084.

Individual Indicators:

Description and Analysis

Air Quality: Ozone

Exposure Indicator

Ozone pollution has been shown to cause numerous adverse health effects, including respiratory irritation and lung disease. The health impacts of ozone and other criteria air pollutants (particulate matter (PM), nitrogen dioxide, carbon monoxide, sulfur dioxide, and lead) have been considered in the development of health-based standards. Of the six criteria air pollutants, ozone and particle pollution pose the most widespread and significant health threats. The California Air Resources Board (CARB) maintains a wide network of air monitoring stations that provides information that may be used to better understand exposures to ozone and other pollutants across the state.

Indicator

Portion of the daily maximum 8-hour ozone concentration over the federal 8-hour standard (0.075 ppm), averaged over three years (2007 to 2009).

Data Source

Air Monitoring Network,
Air Resources Board (CARB)

CARB, local air pollution control districts, tribes and federal land managers maintain a wide network of air monitoring stations in California. These stations record a variety of different measurements including concentrations of the six criteria air pollutants (particulate matter, ozone, lead, sulfur dioxide, nitrogen dioxide and carbon monoxide) and meteorological data. In certain parts of the state, the density of the stations can provide high-resolution data for cities or localized areas around the monitors. However, not all cities have stations.

The information gathered from each air monitoring station audited by the CARB includes maps, geographic coordinates, photos, pollutant concentrations, and surveys.

http://www.arb.ca.gov/aqmis2/aqmis2.php
http://www.epa.gov/airquality/ozonepollution/
http://www.niehs.nih.gov/health/topics/agents/ozone/

Rationale

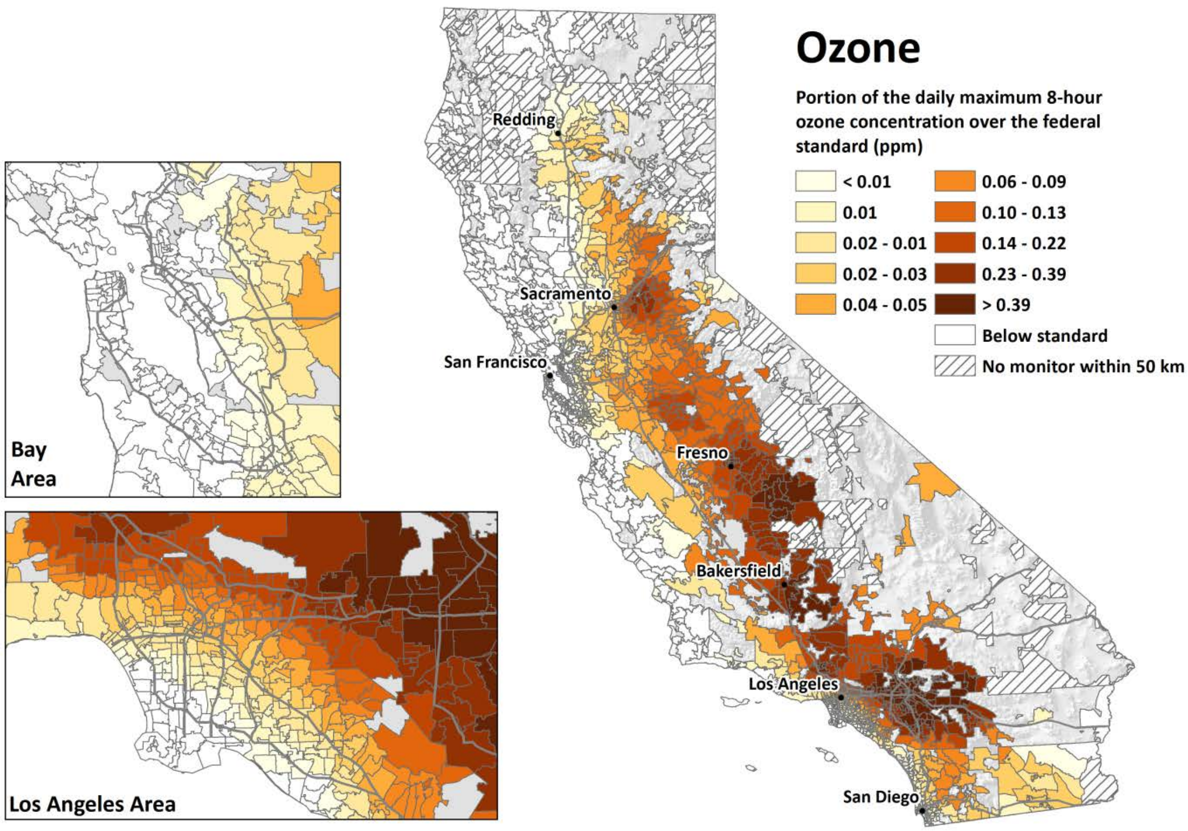
Ozone is an extremely reactive form of oxygen. In the upper atmosphere it provides protection against the sun's ultraviolet rays. Ozone at ground-level is the primary component of smog. Ground-level ozone is formed from the reaction of oxygen-containing compounds with other air pollutants in the presence of sunlight. Ozone levels are typically at their highest in the afternoon and on hot days (NRC, 2008).

Adverse effects of ozone, including lung irritation, inflammation and exacerbation of existing chronic conditions, can be seen at even low exposures (Alexis *et al.* 2010, Fann *et al.* 2012, Zanobetti and Schwartz 2011). A long-term study in southern California found that rates of asthma hospitalization for children increased during warm season episodes of high ozone concentration (Moore *et al.* 2008). Increases in ambient ozone have also been associated with higher mortality, particularly in the elderly, women and African Americans (Medina-Ramon, 2008). Together with $PM_{2.5}$, ozone is a major contributor to air pollution related morbidity and mortality (Fann *et al.* 2012).

Method

- Daily maximum 8-hour average concentrations for all monitoring sites in California were extracted from CARB's air monitoring network database for the years 2007-2009.
- The federal 8-hour standard (0.075 ppm) is subtracted from the monitoring data to arrive at the portion of the 8-hour concentration above the federal standard. Only concentrations over the federal standard from 2007-2009 were used.
- For each day in the 2007-2009 time period, the 8-hour ozone concentrations over the standard were estimated at the geographic center of the ZIP code using a geostatistical method that incorporates the monitoring data from nearby monitors (ordinary kriging).
- The estimated daily concentrations over the standard were then averaged to obtain a single value for each ZIP code.
- ZIP codes were ordered by the ozone concentration values and assigned a percentile based on the statewide distribution of values.

Indicator Map Note: Values at ZIP codes with centers more than 50km from the nearest monitor were not estimated (signified by cross-hatching in the map below).



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Fann N, Lamson AD, Anenberg SC, Wesson K, Risley D, Hubbell BJ (2012). Estimating the National Public Health Burden Associated with Exposure to Ambient PM2.5 and Ozone. *Risk Analysis* **32**(1):81-95.

Medina-Ramón M, Schwartz J (2008). Who is more vulnerable to die from ozone air pollution? *Epidemiology* **19**(5):672-9.

Moore K, Neugebauer R, Lurmann F, Hall J, Brajer V, Alcorn S*, et al.* (2008). Ambient ozone concentrations cause increased hospitalizations for asthma in children: an 18-year study in Southern California. *Environ Health Perspect* **116**(8):1063-70.

NRC (2008). National Research Council Committee on Estimating Mortality Risk Reduction Benefits from Decreasing Tropospheric Ozone Exposure (2008). *Estimating Mortality Risk Reduction and Economic Benefits from*

Controlling Ozone Air Pollution. The National Academies Press.

Zanobetti A, Schwartz J (2011). Ozone and survival in four cohorts with potentially predisposing diseases. *Am J Respir Crit Care Med* **184**(7):836-41.

Air Quality: PM2.5

Exposure Indicator

Particulate matter pollution, and small particle (PM2.5) pollution in particular, has been shown to cause numerous adverse health effects, including heart and lung disease. PM2.5 contributes to substantial mortality across California. The health impacts of PM2.5 and other criteria air pollutants (ozone, nitrogen dioxide, carbon monoxide, sulfur dioxide, and lead) have been considered in the development of health-based standards. Of the six criteria air pollutants, particle pollution and ozone pose the most widespread and significant health threats. The California Air Resources Board (CARB) maintains a wide network of air monitoring stations that provides information that may be used to better understand exposures to PM2.5 and other pollutants across the state.

Indicator

Annual mean concentration of PM 2.5 (average of quarterly means), over three years (2007-2009).

Data Source

Air Monitoring Network,
Air Resources Board (CARB)

CARB, local air pollution control districts, tribes and federal land managers maintain a wide network of air monitoring stations in California. These stations record a variety of different measurements including concentrations of the six criteria air pollutants (particulate matter, ozone, lead, sulfur dioxide, nitrogen dioxide and carbon monoxide) and meteorological data. The density of the stations is such that specific cities or localized areas around monitors may have high resolution. However, not all cities have stations.

The site information gathered from each air monitoring station audited by CARB includes maps, locations coordinates, photos, pollutant concentrations, and surveys.

http://www.arb.ca.gov/aqmis2/aqmis2.php
http://www.epa.gov/airquality/particlepollution/

Rationale

Particulate matter (PM) is a complex mixture of aerosolized solid and liquid particles including such substances as organic chemicals, dust, allergens and metals. These particles can come from many sources, including cars and trucks, industrial processes, wood burning, or other activities involving combustion. The composition of PM depends on the local and regional sources, time of year, location and weather. The behavior of particles and the potential for PM to cause adverse health effects is directly related to particle size. The smaller the particle size, the more deeply the particles can penetrate into the lungs. Some fine particles have also been shown to enter the bloodstream. Those most susceptible to the effects of PM exposure include children, the elderly, and persons suffering from cardiopulmonary disease, asthma, and chronic illness.

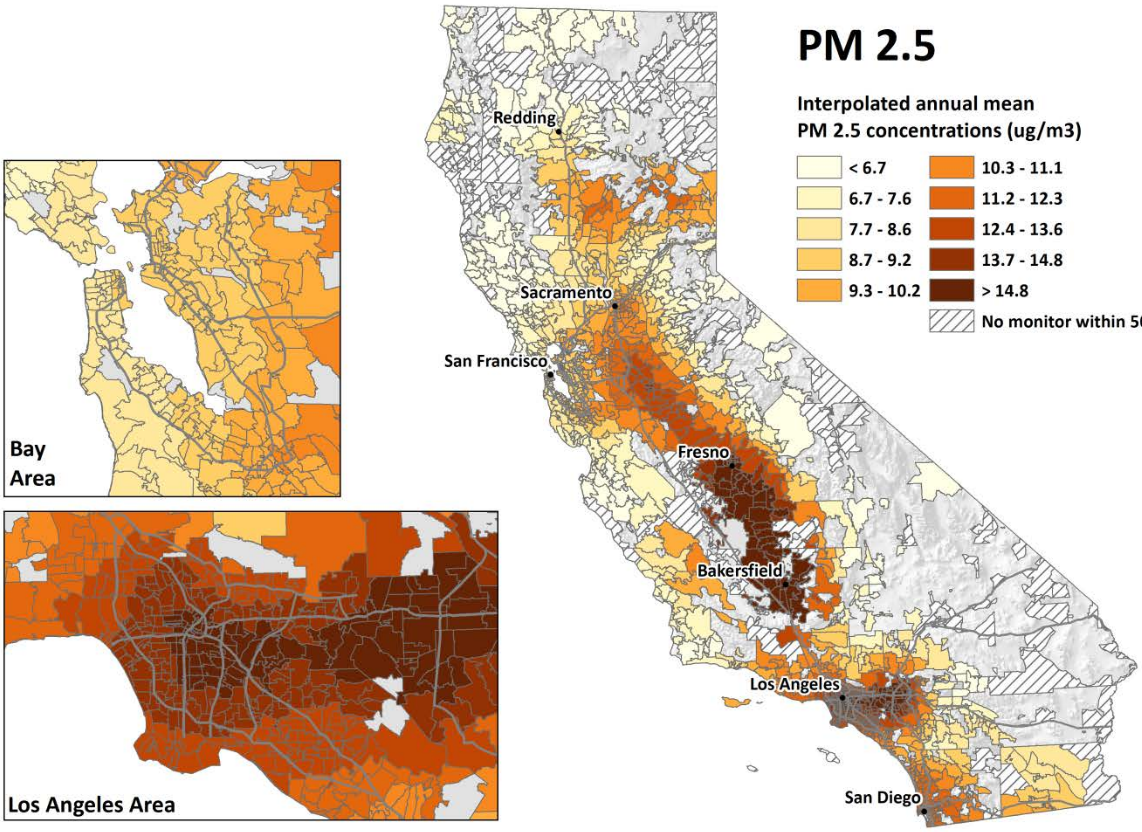
PM 2.5 refers to particles that have a diameter of 2.5 micrometers or less. Particles in this size range can have adverse effects on the heart and lungs, including lung irritation, exacerbation of existing respiratory disease, and cardiovascular effects.

In children, exposure to ambient levels of PM2.5 in Southern California resulted in adverse effects on lung development (Gauderman *et al.* 2004). Another study in California found an association between components of PM2.5 and increased hospitalizations for several childhood respiratory diseases (Ostro *et al.* 2009). In adults, studies have demonstrated relationships between daily mortality and PM2.5 (Ostro *et al.* 2006), increased hospital admissions for respiratory and cardiovascular diseases (Dominici *et al*. 2006), premature death after long-term exposure, and decreased lung function and pulmonary inflammation due to short term exposures (Pope, 2009). Exposure to PM during pregnancy has also been associated with low birth weight and premature birth (Bell *et al.*, 2007; Morello-Frosch *et al.* 2010).

Method

- Monitoring data for the years 2007-2009 was obtained from air monitoring network recordings across the state.
- Monitors that reported fewer than 75% of the expected number of observations, based on scheduled sampling frequency, were dropped from the analysis
- For all measurements in the time period, the quarterly mean concentrations were estimated at the geographic center of the ZIP code using a geostatistical method that incorporates the monitoring data from nearby monitors (ordinary kriging).
- Annual means were then computed for each year by averaging the quarterly estimates and then averaging over the three year period.
- ZIP codes were ordered by the PM2.5 concentration values and assigned a percentile based on the statewide distribution of values.

Indicator Map



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Diesel Particulate Matter

Exposure Indicator

Diesel particulate matter (diesel PM) occurs throughout the environment from both on-road and off-road sources. Major sources of diesel PM include trucks, buses, cars, ships and locomotive engines. Diesel PM is concentrated near ports, rail yards and freeways where many such sources exist. Exposure to diesel PM has been shown to have numerous adverse health effects including irritation to the eyes, throat and nose, cardiovascular and pulmonary disease, and lung cancer. The California Air Resources Board (CARB) has conducted health risk assessments of diesel PM for major ports and railyards throughout the state. Information on diesel PM emissions from many on- and off-road sources is available through the U.S. Environmental Protection Agency's (US EPA) National-Scale Air Toxics Assessment (NATA) program.

Indicator

Diesel PM concentrations from major ports and railyards plus diesel PM concentrations from on-road and off-road sources in NATA.

Data Source

The CARB has conducted health risk assessments for diesel PM emissions for the three major ports and 18 major railyards in California. Diesel PM emissions were calculated for activities at the Ports of Los Angeles and Long Beach; calculations for the Port of Oakland also included other sources of diesel PM emissions in the West Oakland area; and diesel PM emissions were calculated within and near 18 railyards. The emissions were used to estimate the concentrations of diesel PM in the air, which were expressed as cancer risk. In the port and railyard risk assessments, cancer risks are mapped as isopleths, or contour lines on a map that are associated with specific levels of cancer risk.

The 2005 National-Scale Air Toxics Assessment (NATA) compiles emissions estimates for mobile and stationary sources of many air toxics, including diesel PM. Modeled ambient concentrations of diesel PM derived from the emissions estimates are available for all census tracts in the U.S. On-road sources of diesel PM include vehicles found on roads and highways, such as cars and trucks. Off-road sources of diesel PM include recreational marine vehicles; farm and construction machinery; logging, lawn and garden equipment; airport and rail support vehicles; and machinery related to underground mining and oil fields.

Health Risk Assessments for the Ports of Los Angeles and Long Beach, and West Oakland, CARB:
http://www.arb.ca.gov/ports/marinevess/documents/portstudy0406.pdf
http://www.arb.ca.gov/ch/communities/ra/westoakland/westoakland.htm

Health Risk Assessments for select railyards, CARB:
http://www.arb.ca.gov/railyard/hra/hra.htm

2005 National-Scale Air Toxics Assessment, US EPA:
http://www.epa.gov/nata2005/

Rationale Diesel PM is the particle phase of diesel exhaust emitted from diesel engines such as trucks, buses, cars, trains, and heavy duty equipment. This phase is composed of a mixture of compounds, including sulfates, nitrates, metals and carbon particles. In urban areas, diesel PM is a major component of the particulate air pollution from traffic (McCreanor *et al.*, 2007). As particle size decreases, the particles have increasing potential to deposit in the lung (Löndahl *et al.* 2012). Sensitive populations such as children, the elderly, and those with existing respiratory and cardiovascular disease are particularly susceptible to the harmful effects of exposure to airborne PM, including diesel PM (Sacks *et al.* 2011).

Those who experience the greatest levels of exposure include truck drivers and railroad, construction and port workers. A study of U.S. workers in the trucking industry found an increasing risk for lung cancer with increasing years on the job (Garshick *et al.*, 2008). The same trend was seen among railroad workers, who showed a 40% increased risk of lung cancer (Garshik *et al.*, 2004). In children with asthma who attend school in areas of heavy truck traffic, studies have found strong associations between diesel particulate exposure and exacerbation of asthma symptoms (Patel *et al.* 2010, Spira-Cohen *et al.* 2011). Studies of both men and women demonstrate cardiovascular effects of diesel PM exposure, including coronary vasoconstriction and premature death from cardiovascular disease (Krivoshto *et al.*, 2008).

Exposure to diesel PM, especially following periods of severe air pollution, can lead to increased hospital visits and admissions due to worsening asthma and emphysema-related symptoms (Krivoshto *et al.*, 2008). Diesel exposure may also lead to reduced lung function in children (Brunekreef *et al.*, 1997). Studies have shown that diesel PM exposure during pregnancy can result in low birth weight, birth abnormalities, and infant mortality (Parker *et al.*, 2005).

Method Diesel PM concentrations from ports and railyard health risk assessments were calculated as follows:

- Isopleths (contours) of diesel PM cancer risk from individual port or railyard health risk assessments were provided by CARB (some of the isopleths were updated from the original health risk assessment to reflect current diesel PM emissions).
- The isopleths of diesel PM cancer risk were converted to concentrations (in micrograms per cubic meter) using the OEHHA cancer potency for diesel PM.
- Isopleths of diesel PM concentrations were allocated to ZIP codes in ArcMap using a weighted average where the proportion of the isopleth intersecting a ZIP code was used as the weight.

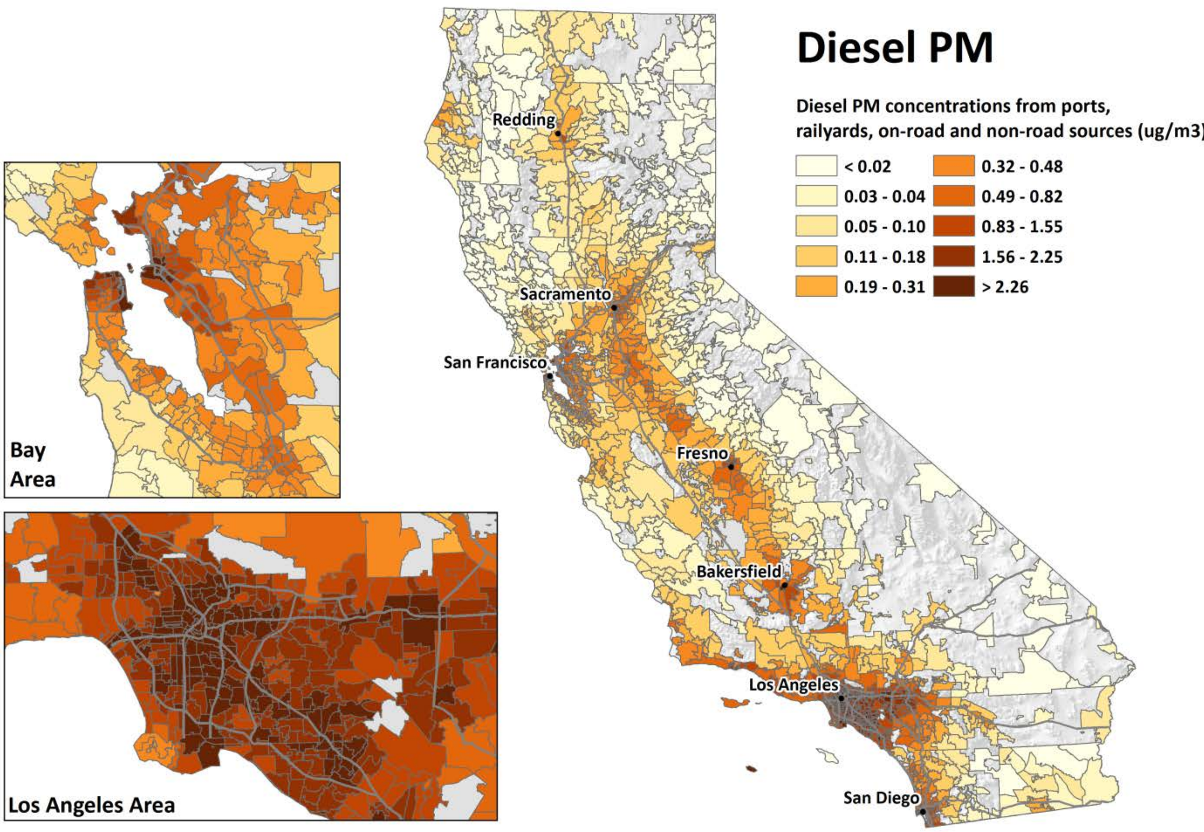
Diesel PM concentrations from the 2005 NATA were obtained as follows:

- Total diesel PM concentrations, or the sum of on-road and off-road modeled concentrations, for California 2000 census tracts were downloaded from the US EPA's NATA website (http://www.epa.gov/nata/).

- Concentrations were allocated from census tracts to ZIP codes in ArcMap using a weighted average where the proportion of a ZIP code that was captured by the area of the census tract within the ZIP code was used at the weight (areal apportionment).

Concentrations from the port and railyards by ZIP code were summed with the concentrations from NATA (road and non-road) by ZIP code and assigned a percentile based on the statewide distribution of values.

Indicator Map



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Pesticide Use

Exposure Indicator

Communities living near agricultural fields, primarily farm worker communities, may be at risk for exposure to pesticides. Drift or volatilization of pesticides from agricultural fields can sometimes be a significant source of pesticide exposure. Complete statewide data on actual human exposures to pesticides do not exist. The most robust pesticide information available statewide are data maintained by the California Department of Pesticide Regulation (DPR) showing where and when pesticides are used across the state. Pesticide use, especially use of volatile chemicals that can easily become airborne, can serve as an indicator of potential exposure. Similarly, unintended environmental damage from the use of pesticides may increase in areas with greater use.

Indicator

Total pounds of selected active pesticide ingredients (filtered for hazard and volatility) used in production-agriculture per square mile.

Data Source

Pesticide Use Reporting
California Department of Pesticide Regulation

In California, all agricultural pesticide use must be reported monthly to county agricultural commissioners, who report the data to DPR. California has a broad legal definition of agricultural use—production agricultural is defined as pesticides used on any plant or animal to be distributed in the channels of trade and non-production agricultural includes pesticide applications to parks and recreational lands, rights-of-ways, golf courses, and cemeteries for example. Non-agricultural control includes home, industrial, institutional, structural, vector control, and veterinary uses. Production agricultural pesticide use is publicly available for each Meridian-Township-Range-Section (MTRS) in California and was used to create this indicator. An MTRS is roughly equivalent to one square mile. Data are available statewide except for some areas that are exempt from reporting, such as some military and tribal lands.

Non-production agricultural and non-agricultural pesticide use data is only available at the county scale and was not included in the indicator due to its large geographic scale.

http://www.DPR.ca.gov/docs/pur/purmain.htm

Rationale

To understand if pesticide exposure is potentially occurring as a result of agricultural use, DPR established a pesticide air monitoring network for select agricultural areas of California. Preliminary results have shown that the majority of pesticides sampled were detected, although most were well below health screening levels (DPR, 2012). Unfortunately, the pesticide air monitoring is only available for a few communities and cannot be extrapolated statewide.

High use of pesticides is, however, correlated with exposure and with pesticide-related illness. Pregnant, low income, Latina women residing in an agricultural area of California showed pesticide metabolite levels in their urine up to 2.5 times higher than a representative sample of U.S. women (Bradman *et al.*, 2005). Some new research indicates that proximity to agricultural fields is correlated with measured concentrations in homes (Bradman *et al.*, 2007; Harnly *et al.*, 2009). A recent study found that agricultural pesticide use was significantly correlated with pesticide concentrations in carpet dust (Gunier *et al.*, 2011).

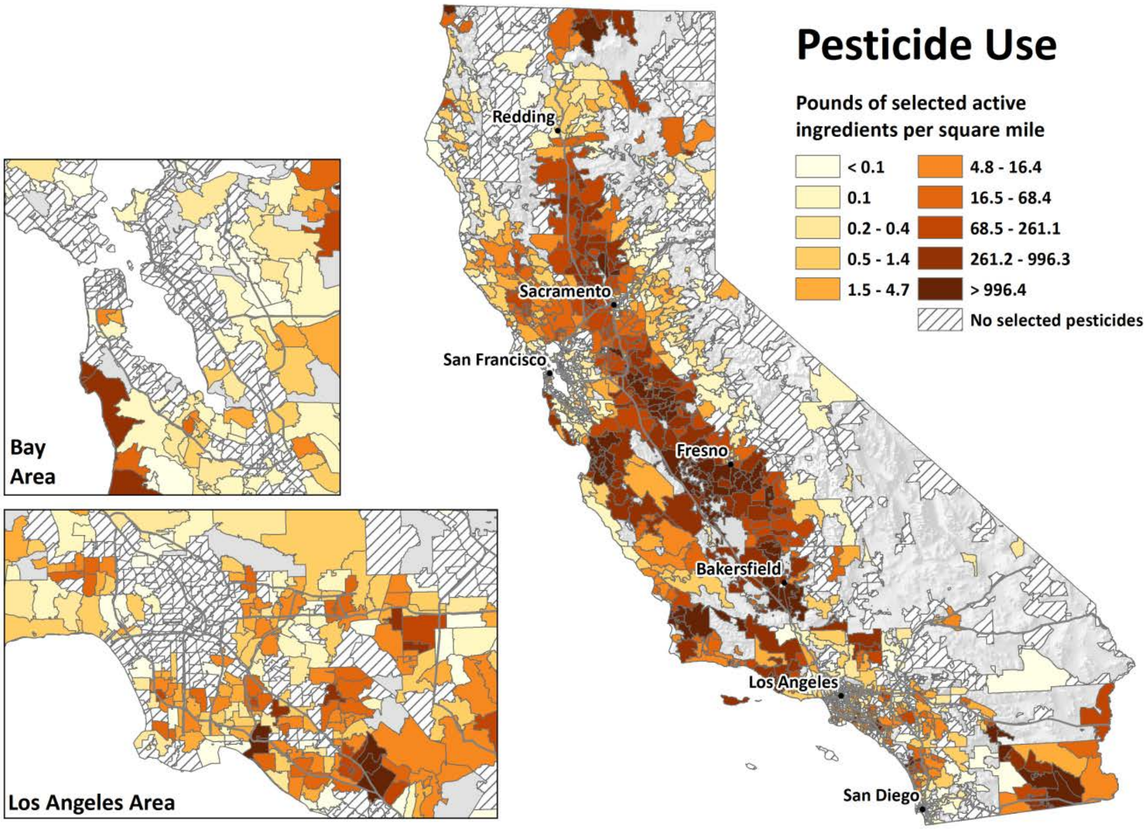
An examination of national pesticide illness data concluded that agricultural workers and residents near agriculture had the highest rate of pesticide poisoning from drift incidents (Lee *et al.*, 2011). Soil fumigation accounted for most of the cases (Lee *et al.*, 2011). DPR has also documented numerous pesticide drift incidents in California which have led to illness in the community (O'Malley *et al.*, 2005). Not all pesticides are likely to drift, but fumigants and other volatile and hazardous pesticides are most likely to be involved in pesticide drift exposure incidents and illnesses.

Method

Specific pesticides included in the measure of pesticide use were narrowed from the list of all registered pesticides in use in California to focus on a subset of 65 chemicals that are filtered for hazard and volatility. Volatility is indicative of higher likelihood of drift and exposure (See Appendix).

- Production agricultural pesticide use records were obtained for the entire state for the years 2009 and 2010.
- Production pesticide use (total pounds of selected active ingredient) for MTRS records were matched to ZIP Codes using a match file created in the GIS software ArcMap.
- Production pesticide use for each ZIP code was divided by each ZIP code's area.

Indicator Map



Appendix

Pesticide Use – Filter for Hazard and Volatility

Specific pesticides included in the measure of pesticide use were identified from the list of all registered pesticides through consideration of both hazard and likelihood of exposure.

The more hazardous pesticides were identified using a list generated under the Birth Defect Prevention Act of 1984 (SB 950) and the Proposition 65 list (Safe Drinking Water and Toxic Enforcement Act of 1986). As part of a review process of active ingredients under the SB 950 program, pesticides are classified as "High", "Moderate", or "Low" priority for potential adverse health effects using studies of sufficient quality to characterize risk. The prioritization of each pesticide is a subjective process based upon the nature of potential adverse effects, the number of potential adverse effects, the number of species affected, the no observable effect level (NOEL), potential human exposure, use patterns, quantity used, and US EPA evaluations and actions, among others. Proposition 65 requires the state to maintain a list of chemicals that cause cancer or reproductive toxicity. For the purpose of developing an exposure indicator, pesticides that were prioritized as "Low," not prioritized under SB 950, or not on the Proposition 65 list were removed from the analysis.

The analysis was further limited to pesticides of high or moderate volatility. Higher volatility was considered to increase the likelihood of exposures. A list of pesticide volatilities was obtained from DPR. Pesticides not appearing on this list were researched for chemical properties in the open literature. Pesticides with volatility less than 10^{-6} mm Hg were removed from the indicator analysis.

The filtering of pesticides for both hazard and volatility resulted in a list of 65 pesticides that were included in the analysis here. The pesticides that are included in the indicator calculation are identified below.

- *1,3-Dichloropropene*
- *2,2-Dibromo-3-nitriloprionamide*
- *Acephate*
- *Acrolein*
- *Aldicarb*
- *Azinphon-methyl*
- *Bromoxynil heptanoate*
- *Bromoxynil octanoate*
- *Buprofezin*
- *Carbaryl*
- *Carbofuran*
- *Chloropicrin*
- *Chlorothalonil*
- *Chlorpyrifos*
- *Chlorthal-dimethyl*
- *Clomazone*
- *Cycloate*
- *Cyprodinil*
- *Dazomet*
- *DDVP*
- *Diazinon*
- *Dichloran*
- *Dimethoate*
- *Endosulfan**
- *EPTC*
- *Ethalfluralin*
- *Ethoprop*
- *Fenamiphos*
- *Fenpropathrin*
- *Fenthion*
- *Fludioxonil*
- *Flumioxazin*
- *Hydrogen cyanamide*
- *Imazalil*
- *Linuron*
- *Malathion*
- *Metalaxyl*
- *Metam-sodium*
- *Methamidophos*
- *Methidathion*
- *Methomyl*
- *Methyl bromide*
- *Methyl isothiocyanate*
- *Methyl parathion*
- *Molinate*
- *Myclobutanil*
- *Naled*
- *Oxydemeton-methyl*
- *PCNB*
- *Phosphine*
- *Potassium N-methyl-dithiocarbamate (Metam-potassium)*
- *Propetamphos*
- *Propoxur*
- *Propylene oxide*
- *Pyrimethanil*
- *S,S,S-Tributylphoshoro-trithioate (DEF)*
- *Sodium cyanide*
- *Sodium tetrathiocarbonate*
- *Sulfur dioxide*
- *Sulfuryl fluoride*
- *Thiram*
- *Triclopyr, butoxyethyl ester*
- *Triclopyr, triethylamine salt*
- *Truiflumizole*
- *Trifluralin*
- *Ziram*

** Added based on its designation as a Toxic Air Contaminant (AB 1807 Program).*

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Toxic Releases from Facilities

Exposure Indicator

There is widespread concern regarding exposures to chemicals that are released from industrial facilities. Statewide information directly measuring *exposures* to toxic releases has not been identified. However, some data on the *release* of pollutants into the environment is available and may provide some relevant evidence for potential subsequent exposures. The U.S. Environmental Protection Agency (US EPA) maintains a toxic substance inventory of on-site releases to air, water, and land and underground injection of any classified chemical, as well as quantities transferred off-site. The data are reported by each facility.

Indicator

Total hazard-weighted pounds of chemicals released on-site to air or water from all facilities within the ZIP code, or within one kilometer of the ZIP code.

Data Source

Toxics Release Inventory (TRI) and
Risk Screening Environmental Indicators (RSEI),
U.S. Environmental Protection Agency (US EPA)

TRI is a database of self-reported disposal or other releases and waste management activities for certain listed toxic chemicals. It is updated annually. The TRI program was created by the Emergency Planning and Community Right-to-Know Act (EPCRA) and Pollution Prevention Act (PPA). The chemicals included in the database are those on EPCRA:

- Chemicals identified in EPCRA Section 313 (593 individually listed chemicals and 30 chemical categories including 3 delimited categories containing 62 chemicals); and
- Persistent, Bioaccumulative and Toxic (PBT) Chemicals (16 specific chemicals and 4 chemical classes).

Facilities are required to report if they have 10 or more full-time employees, operate within a set of industrial sectors outlined by TRI, and manufacture more than 25,000 pounds or otherwise use more than 10,000 pounds of any listed chemical during the calendar year. Lower reporting thresholds apply for PBT chemicals (10 or 100 pounds) and dioxin-like chemicals (0.1 gram).

RSEI is a computer-based chronic health screening tool developed by US EPA. It applies chemical-specific toxicity weights to TRI emissions data to produce a hazard-weighted result. These weights are drawn from various programs with US EPA, Cal/EPA, and the Agency for Toxic Substances and Disease Registry. For each facility, individual chemical weights are multiplied by the pounds of the chemical reported released. These are summed across all chemicals reported by the facility for the total hazard-weighted pounds. Using this metric helps to incorporate toxicity considerations into the emissions data.

http://www.epa.gov/tri/index.htm

http://www.epa.gov/oppt/rsei/

Rationale The Toxics Release Inventory provides public information on emissions and releases into the environment from a variety of facilities across the state. TRI data do not, however, provide information on the extent of public exposure to these chemicals. That said, US EPA has stated that "[d]isposal or other releases of chemicals into the environment occur through a range of practices that could ultimately affect human exposure to the toxic chemicals. They may take place at a facility as an on-site disposal or other release to air, water, land or an underground injection well; or they may take place at an off-site location when a facility transfers its waste containing TRI chemicals as an off-site disposal or other release." (US EPA, 2010).

Air monitoring data at hundreds of locations across the United States have identified over a dozen hazardous air pollutants at concentrations that exceed California cancer or non-cancer benchmarks (McCarthy *et al.*, 2009). Many of the locations with elevated levels in this study are near major industrial sources, and many of the chemicals monitored are the same as those that are emitted from these facilities. In California, a study that modeled concentrations of air toxic chemicals found significant levels of risk (Morello-Frosch, 2000). Although this study found that mobile sources accounted for a major portion of the risk, the authors pointed out that for some communities, local industrial sources were a major contributor.

In addition to routine chemical releases, communities located near some TRI facilities are at risk from exposure to accidental chemical releases. A study of self-reported accident rates at U.S. chemical facilities over a five year period reported that 1,205 facilities (7.8% of facilities in the database) had at least one accident during the reporting period, and an additional 355 facilities (2.3%) had multiple accidents during the reporting period (Kleindorfer *et al.*, 2003). Associated with these events were a total of 1,987 injuries and 32 deaths among workers, and 167 injuries among nonemployees, including public responders. There were 215 total hospitalizations and 6,057 individuals given other medical treatments. Over 200,000 community residents were involved in evacuations and shelter-in-place incidents over that five year period.

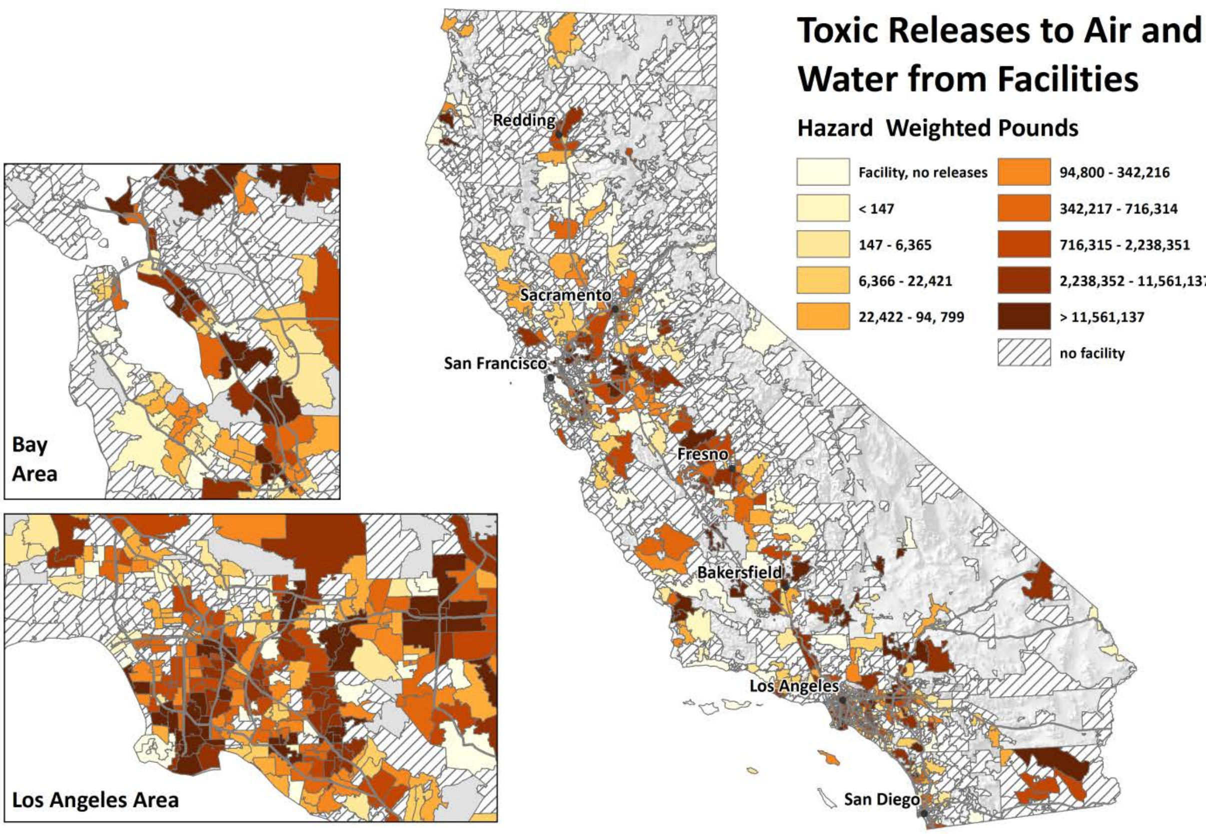
Several studies have examined the potential for health effects from living near TRI facilities. For example, some increase in risk for diagnosis of brain cancer in children of mothers living within a mile of a TRI facility that releases carcinogens was reported in a case-control epidemiological study (Choi *et al.*, 2006). In another set of studies, TRI air and water concentrations were associated with infant, but not fetal, mortality rates (Agarwal *et al.*, 2010).

Multiple studies have observed greater emissions in low-income and disadvantaged areas (as reviewed by Szasz & Meuser, 1997). Additionally, race and ethnicity have been correlated with the presence of toxic release facilities. People of color in studied regions of southern California were found to have a greater likelihood of living in areas with higher toxic releases (Morello-Frosch *et al.*, 2002; Sadd *et al.*, 1999).

Method

- Data on location and hazard-weighted emissions data for facilities in California, or within one kilometer of California, were downloaded from TRI/RSEI (TRI.NET).
- Facility locations were mapped or geocoded (ArcMap).
- Each ZIP code was scored by adding the hazard-weighted pounds of emissions for all facilities within the ZIP code or within one kilometer of the ZIP code.
- A 3-year average of the hazard-weighted emissions for each ZIP code was calculated for the years 2008-2010.
- Scoring:
  - ZIP codes without a TRI facility were assigned a percentile of zero.
  - All other ZIP codes were assigned a percentile based on their location in the distribution of the remaining ZIP codes.

Indicator Map



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Traffic Density

Exposure Indicator

While California has the strictest auto emissions standards in the U.S., the state is also known for its freeways and heavy traffic. Traffic is a significant source of air pollution, particularly in urban areas, where more than 50% of particulate emissions come from traffic. Exhaust from vehicles contains a large number of toxic chemicals, including nitrogen oxides, carbon monoxide, benzene, and particulate matter. Traffic exhaust also plays a role in the formation of photochemical smog. Health effects of concern from these pollutants include heart and lung disease, cancer, and increased mortality.

Indicator

Traffic density, vehicle-kilometers per hour, within 150 meters of the ZIP code boundary.

Data Source

Traffic Volume Linkage Tool,
California Environmental Health Tracking Program
Environmental Health Investigations Branch,
California Department of Public Health

Data on the amount of traffic traveling on major roadways statewide are available. Traffic data are compiled under the California Department of Transportation's (Caltrans) Highway Performance Monitoring System (HPMS) every four years. The data consist of traffic volumes along various pre-defined segments of roadways across the state. Locally maintained roads are not included in the data.

A Traffic Volume Linkage Tool developed under the California Environmental Health Tracking Program (CEHTP) uses the annual average daily traffic (AADT) volumes from the 2004 HPMS data to calculate traffic-related metrics within a circular buffer of any geographic coordinate in California.

For this analysis, CEHTP used the 2004 HPMS data and the Traffic Volume Linkage Tool to calculate traffic density with a 150 meter buffer of the ZIP code boundary. Traffic density was calculated as the sum of all road length-adjusted traffic volumes per hour within 150 meters of each ZIP code. The most recent year for which data are available for use by this tool is 2004.

http://www.ehib.org/page.jsp?page_key=136

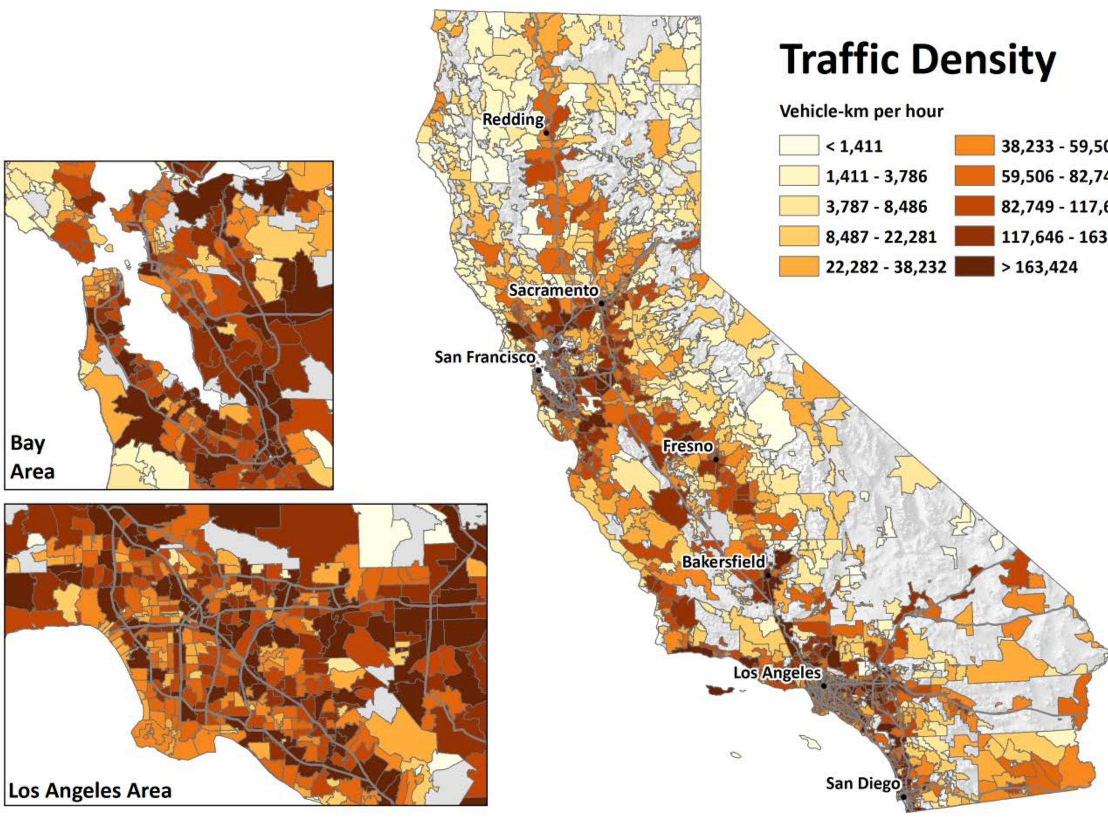
Rationale

Traffic density is used to represent the number of mobile sources in a specified area, resulting in human exposures to chemicals in vehicle exhaust that are released into the air. Studies have shown that non-white and low income people make up the majority of residents in high-traffic areas (Gunier *et al.* 2003) and that schools that are located near busy roads are more likely than those farther away to be in poor neighborhoods (Green *et al.* 2004). In addition, children who live or attend schools near busy roads are more likely to suffer from asthma and bronchitis than children in areas with lower traffic density (Schultz *et al.* 2012). The residents and school children in these areas are therefore likely to be exposed to traffic-related pollutants and to suffer the health effects that may result. Exposure to air pollutants from vehicle emissions has been linked to adverse birth outcomes, such as low birth weight, premature birth and certain birth defects (Ritz *et al.* 2007). Also, motor vehicle exhaust is a major source of polycyclic aromatic hydrocarbons (PAH), which can damage DNA and may cause cancer.

Method

- A 150 meter buffer was placed around each of the census ZIP codes in California. A buffer was chosen to account for roadways near ZIP code boundaries. Specifically, 150 meters or about 500 feet, come from the California Air Resources Board Air Quality and Land Use Handbook recommendations which cite that most particulate air pollution from traffic drops off after about 500 feet (CARB, 2005).
- The buffered boundaries were input into the Traffic Volume Linkage Tool.
- Traffic density estimates (vehicle counts per roadway length) within the 150 meter buffer of each ZIP code were obtained.
- ZIP codes were sorted by traffic density and assigned percentiles based on the distribution.

Indicator Map



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Cleanup Sites

Environmental Effects Indicator

Sites undergoing cleanup actions by governmental authorities or by property owners have suffered environmental degradation due to the presence of hazardous substances. Of primary concern is the potential for people to come into contact with these substances. Some of these "brownfield" sites are also underutilized due to perceived cleanup costs or concerns about liability. The most complete set of information available related to cleanup sites and brownfields in California is maintained by the Department of Toxic Substances Control.

Indicator

Sum of weighted sites within each ZIP code.

Since the nature and the magnitude of the threat and burden posed by hazardous substances vary among the different types of sites as well as the site status, the indicator takes both into account.

Data Source

EnviroStor Cleanup Sites Database,
Department of Toxic Substances Control (DTSC)
Agency for Toxic Substances and Disease Registry (ATSDR) Hazardous Waste Site Polygon Data with CIESIN Modifications, v1 (2008)

EnviroStor is a public database that provides access to information maintained by DTSC on site cleanup. The database contains information on numerous types of cleanup sites, including Federal Superfund, State Response, Corrective Action, School Cleanup, Voluntary Cleanup, Tiered Permit, Evaluation, Historical, and Military Evaluation sites. The database contains information related to the status of the site such as required cleanup actions, involvement/land use restriction, or "no involvement."

The Columbia University Center for International Earth Science Information Network (CIESIN) maintains and distributes the dataset for National Priorities List (NPL) Superfund sites nationwide. The data come in polygon format and generally represents the parcel boundaries of the site. The data represents a subset of the larger Hazardous Waste Polygon Database, originally developed by the Center for Disease Control's Geospatial Research, Analysis, and Services Program (GRASP).

http://www.envirostor.dtsc.ca.gov/public/
http://sedac.ciesin.columbia.edu/data/set/superfund-atsdr-hazardous-waste-site-ciesin-mod-1996

Rationale

Contaminated sites can pose a variety of risks to nearby residents. Hazardous substances may leave the site and impact surrounding communities through volatilization, groundwater plume migration, or windblown dust. Studies have found levels of organochlorine pesticides in blood (Gaffney *et al.* 2005) and toxic metals in house dust (Zota *et al.* 2011) that were related to residents' proximity to contaminated sites.

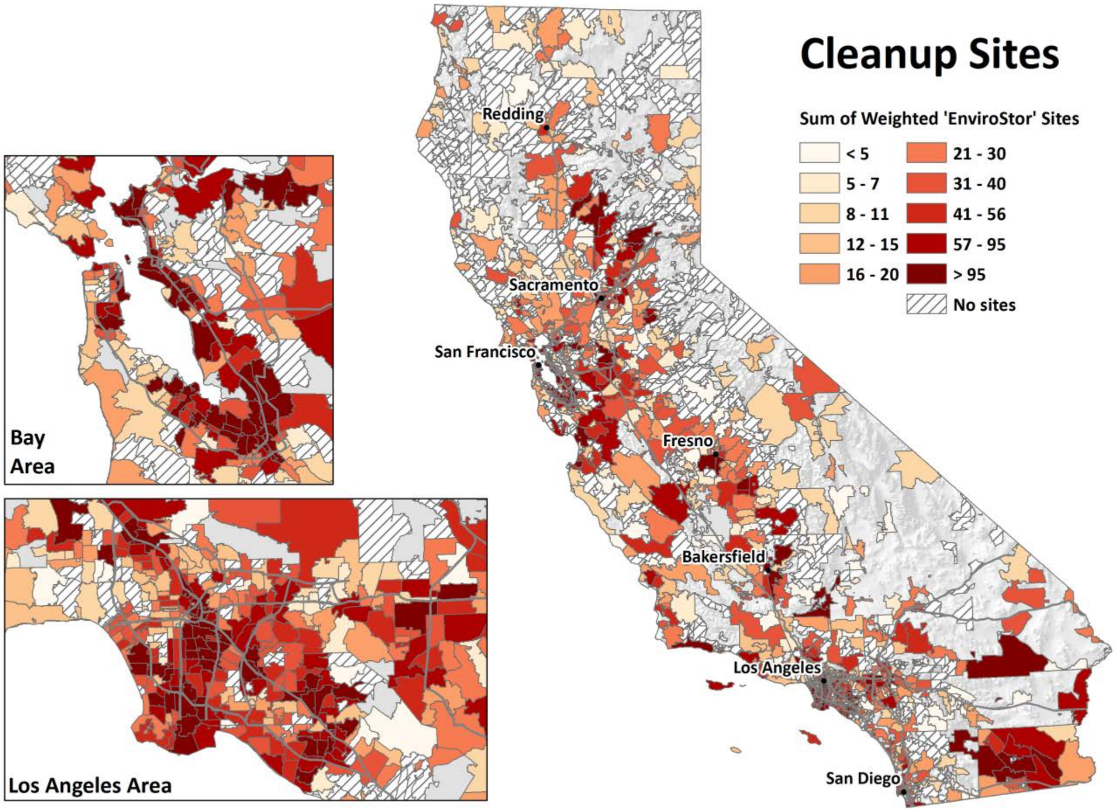
A study of pregnant women living near Superfund sites in New York state found an increased risk of having a low birth weight male child (Baibergenova *et al.* 2003). A later study in New York City found an association between prevalence of liver disease and the number of Superfund sites per 100 square miles (Ala *et al.* 2007).

It may take many years for a site to be certified as clean, and cleanup work is often delayed due to cost, litigation, concerns about liability or detection of previously unrecognized contaminants. Contaminated sites also have the potential to degrade nearby areas, resulting in potential ecological impacts as well as threats to human health.

Method

- Data on cleanup site type, status, and location (coordinate or address) for the entire state were downloaded from EnviroStor Cleanup Sites database.
- Several types of sites were excluded from the analysis (school investigations and border zone/hazardous waste evaluations).
- Each remaining site was scored on a weighted scale of 2 to 12 in consideration of both the site type and status (See Appendix). Higher weights were applied to Superfund, State Response sites, and cleanups compared to evaluations, for example. Similarly, higher weights were applied to sites that are undergoing active remediation and oversight by DTSC, relative to those with little or no involvement.
- Site locations were mapped or geocoded (ArcMap).
- ATSDR Hazardous Waste Site polygon data were downloaded from the CIESIN website.
- Polygon sites in California on the NPL were identified. Sites were assigned a score of 12 (as a federal Superfund site).
- EnviroStor sites with a NPL polygon representation were replaced.
- All sites, including NPL polygon sites, were assigned a 250-meter buffer.
- Each ZIP code was scored based on the sum of the weighted sites it contains and the buffers that it intersects.
- Summed ZIP code ranks were assigned percentile scores.

Indicator Map



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Appendix

Weighting Matrix for Cleanup Sites

Cleanup Sites from the EnviroStor Cleanup Sites database were weighted on a scale of 2 to 12 in consideration of both the site type and status. The following table shows the weights applied for each site type and status. For a given ZIP code, the weighted scores of all facilities in the area were summed. Definitions used in the table are defined below.

	Status		
Site Type	**Low** • Certified • Completed • No Further Action	**Medium** • Inactive-Needs Eval. • Certified O&M	**High** • Active • Backlog • Inactive- Action Required
Low • Evaluation	**2**	**4**	**6**
Medium • Corrective Action • School Cleanup • Voluntary Cleanup	**5**	**7**	**9**
High • State Response • Superfund	**8**	**10**	**12**

Definitions*

- *Active*: Identifies that an investigation and/or remediation is currently in progress and that DTSC is actively involved, either in a lead or support capacity.
- *Inactive - Needs Evaluation*: Identifies inactive sites where DTSC has determined a Preliminary Endangerment Assessment or other evaluation is required.
- *Certified O&M*: Identifies sites that have certified cleanups in place but require ongoing Operation and Maintenance (O&M) activities.
- *Certified*: Identifies completed sites with previously confirmed releases that are subsequently certified by DTSC as having been remediated satisfactorily under DTSC oversight.
- *Corrective Action*: Identifies sites undergoing "corrective action", defined as investigation and cleanup activities at hazardous waste facilities (either Resource Conservation and Recovery Act (RCRA) or State-only) that either were eligible for a permit or received a permit. These facilities treat, store, dispose and/or transfer hazardous waste.
- *Evaluation*: Identifies suspected, but unconfirmed, contaminated sites that need or have gone through a limited investigation and assessment process.
- *Inactive – Action Required*: Identifies non-active sites where, through a Preliminary Endangerment Assessment (PEA) or other evaluation, DTSC has determined that a removal or remedial action or further extensive investigation is required.
- *No Further Action*: Identifies completed sites where DTSC determined after investigation,

generally a PEA (an initial assessment), that the property does not pose a problem to public health or the environment.

- *School Cleanup*: Identifies proposed and existing school sites that are being evaluated by DTSC for possible hazardous materials contamination at which remedial action occurred.
- *State Response*: Identifies confirmed release sites where DTSC is involved in remediation, either in a lead or oversight capacity. These confirmed release sites are generally high-priority and high potential risk.
- *Superfund*: Identifies sites where the US EPA proposed, listed, or delisted a site on the National Priorities List (NPL).
- *Voluntary Cleanup*: Identifies sites with either confirmed or unconfirmed releases, and the project proponents have requested that DTSC oversee evaluation, investigation, and/or cleanup activities and have agreed to provide coverage for DTSC's costs.

* EnviroStor Glossary of Terms
(http://www.envirostor.dtsc.ca.gov/public/EnviroStor%20Glossary.pdf)

Groundwater Threats

Environmental Effects Indicator

Many types of activity can pose a threat to groundwater quality from hazardous substances. These include the underground storage and disposal of hazardous materials on land and in underground storage tanks in various types of commercial, industrial, and military sites. Thousands of storage tanks in California have leaked petroleum or other hazardous substances, degrading soil and groundwater. Storage tanks are of particular concern when drinking water supplies are affected or threatened. These sites can also pose potential exposure risks through contact with contaminated soil and the inhalation of vapors. In addition, the land surrounding these sites may be taken out of service due to perceived cleanup costs or concerns about liability. The most complete set of information available related to sites that may impact groundwater and require cleanup is maintained by the State Water Resources Control Board.

Indicator

Sum of weighted sites within each ZIP code.

The nature and the magnitude of the threat and burden posed by sites maintained in GeoTracker vary significantly by site type (e.g., leaking underground storage tank or cleanup site) and status (e.g., Completed Case Closed or Active Clean up). Thus, the indicator takes into account information about both the type of site and its status.

Data Source

GeoTracker Database,
State Water Resources Control Board (SWRCB)

GeoTracker is a public web site where the SWRCB, regional boards and local agencies can oversee and track projects on cleanup sites impacting groundwater. The GeoTracker database contains information on locations and water quality of wells that could be contaminated, as well as potential sources of groundwater contamination. These include leaking underground storage tanks (LUSTs), cleanup and land disposal sites, military underground storage tanks (USTs) and cleanup sites, industrial sites, airports, dairies, dry cleaners, and publicly owned sewage treatment plants. For each site, there is additional information on the status of cleanup activities. Groundwater quality data are extracted from monitoring and records maintained by SWRCB, the Department of Water Resources, Department of Public Health, Department of Pesticide Regulation, U.S. Geological Survey and Lawrence Livermore National Laboratory. The database is constantly updated and sites are never deleted from the database, where they may ultimately be designated ‘clean closed.’

A separate GeoTracker database contains information on the location of underground storage tanks (not leaking), which was not used.

http://geotracker.waterboards.ca.gov/

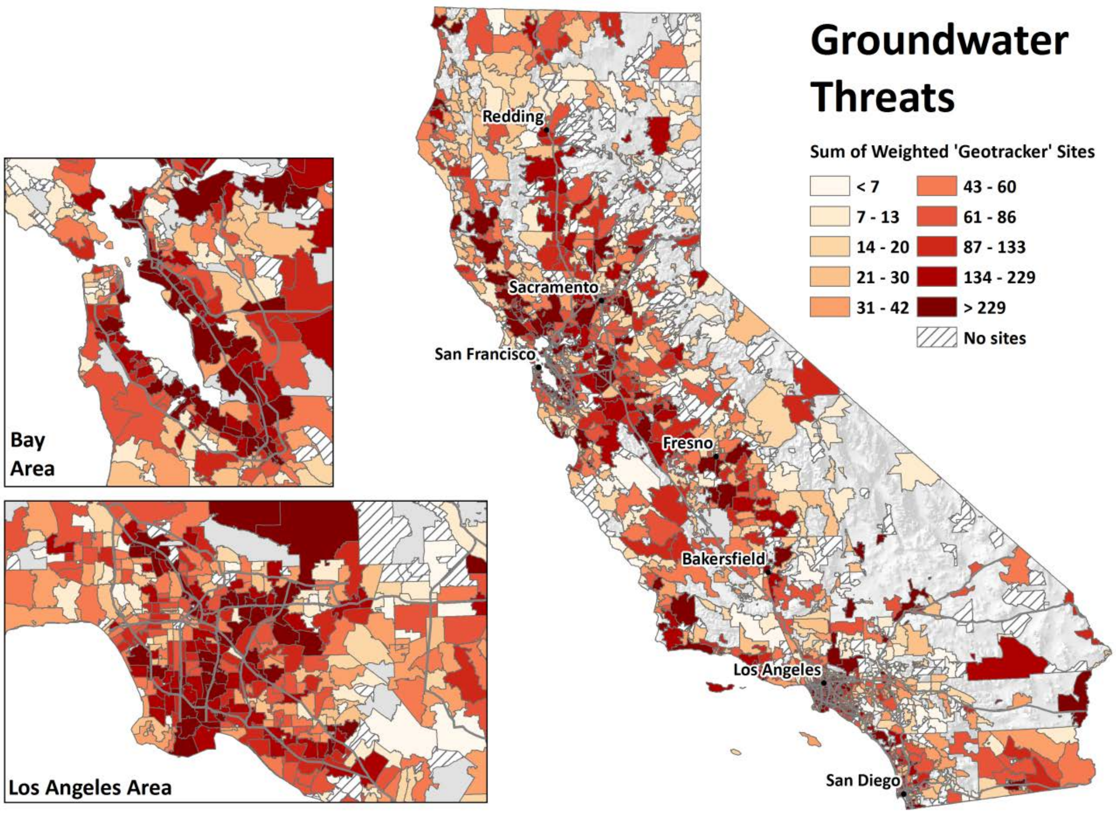
Rationale

Some of the common groundwater threats found at LUST and cleanup sites in California include gasoline and diesel fuels, chlorinated solvents and other volatile organic compounds (VOCs) such as benzene, toluene, and methyl tert-butyl ether (MTBE); heavy metals such as lead, chromium and arsenic; polycyclic aromatic hydrocarbons (PAHs); persistence organic pollutants like polychlorinated biphenyls (PCBs), dioxin; DDT and other insecticides; and perchlorate. The occurrence of storage tanks, leaking or not, may provide a good indication of potential concentrated sources of some of the more prevalent compounds in groundwater. For example, the detection frequency of VOCs found in gasoline is associated with the number of UST or LUST sites within one kilometer of a well (Squillace and Moran, 2007). The occurrence of chlorinated solvents in groundwater is also associated with the presence of cleanup sites (Moran *et al*., 2007). Several of these cancer-causing compounds have in turn been detected in drinking water supplies in California (Williams *et al*., 2002). People who live near shallow groundwater plumes of VOCs may also be exposed via the intrusion of vapors into indoor air.

Method

- Data on cleanup site type, status, and location (coordinate or address) for the entire state were downloaded from GeoTracker.
- Certain types of sites were not included in the analysis (e.g., referred sites).
- Each remaining site was scored on a weighted scale of 3 to 15 in consideration of both the site type and status.
- Sites locations were mapped or geocoded (ArcMap).
- Sites were assigned a 250-meter buffer.
- Each ZIP code was scored based on the sum of the weighted sites it contains and the buffers it intersects.
- Summed ZIP code scores were assigned percentiles.

Indicator Map



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Appendix

Weighting Matrix for Groundwater Threats

Groundwater threats from the GeoTracker database were weighted on a scale of 3 to 15 in consideration of both the site type and status. The following table shows the weights applied for each site type and status. For a given ZIP code, the weighted scores of all facilities in the area were summed.

	Status	
	Low • Inactive Open • Verification Monitoring	**High** • Remediation • Reopen • Site Assessment • Site Assessment & Remedial Action
Low • LUST Cleanup Program • Military UST	3	5
Medium • Land Disposal Site	6	10
High • Cleanup Program Site • Military Privatized Site • Military Cleanup Site	9	15

Impaired Water Bodies

Environmental Effects Indicator

Contamination of California streams, rivers, and lakes by pollutants can compromise the use of the water body for drinking, swimming, fishing, aquatic life protection, and other beneficial uses. When this occurs, such bodies are considered "impaired." Information on impairments to these water bodies can help determine the extent of environmental degradation within an area.

Indicator

Summed number of pollutants across all water bodies designated as impaired within the area.

Data Source

303(d) List of Impaired Water Bodies,
State Water Resources Control Board (SWRCB)

The SWRCB provides information relevant to the condition of California surface waters. Such information is required by the Federal Clean Water Act. Every two years, State and Regional Water Boards assess the quality of California surface waters. Lakes, streams and rivers that do meet water quality standards, or are not expected to meet water quality standards, are listed as impaired under Section 303(d) of the Clean Water Act.

http://www.swrcb.ca.gov/water_issues/programs/#wqassessment

Rationale

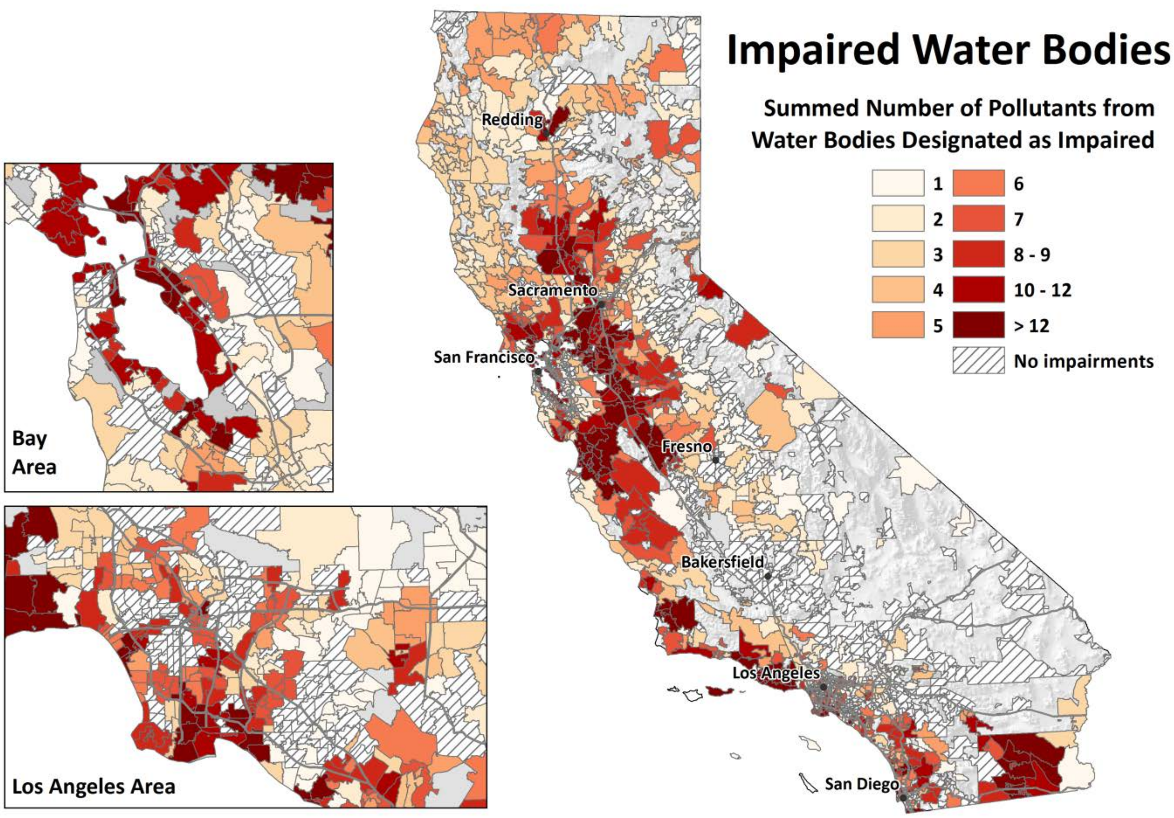
Many rivers, lakes, estuaries and marine waters in California are important for many different uses. Water bodies used for activities from recreation subsistence fishing are important for the quality of life for nearby residents (Cal/EPA and the California Resources Agency, 2002). Water bodies also support abundant flora and fauna. Changes in aquatic environments can affect biological diversity and overall health of ecosystems. Aquatic species important to local economies may be impaired if the habitats where they seek food and reproduce are changed. Marine wildlife like fish and shellfish that are exposed to toxic substances may potentially expose local consumers to toxic substances as well (Cal/EPA and the California Resources Agency, 2002). Excessive hardness, unpleasant odor or taste, turbidity, color, weeds, and trash in the waters are types of pollutants affecting water aesthetics (Cal/EPA and the California Resources Agency, 2002), which in turn can affect nearby communities.

Various communities relying on resources provided by nearby surface waters have populations of lower socioeconomic status than the general population. For example, certain fishing communities along California's northern coast have lower educational attainment and median income than California as a whole (Pomeroy *et al.*, 2010). Various low-income communities in California relying on fishing and waterfront businesses have been affected by a recent decline in the fishing community (California State Lands Commission, 2011). Socioeconomic factors in communities have been associated with the level of pollutants contaminating nearby surface waters. Lower per capita income has been associated with increased levels of certain surface water pollutants, as have a higher percentage of minorities and people of color (Farzin & Grogan, 2012). Communities of color, low-income communities, and tribes generally depend on the fish, aquatic plants, and wildlife provided by nearby surface waters to a greater extent than the general population.

Method

- Data on water body type, water body ID, and pollutant type were downloaded in Excel format, and GIS data showing the visual representation of all water bodies was downloaded from the SWRCB website.
- All water bodies were identified in all ZIP codes in the GIS software ArcMap.
- The number of pollutants listed in streams and/or rivers that intersected a ZIP code were counted.
- The number of pollutants listed in lakes, bays, estuaries and/or shoreline that intersected or bordered a ZIP code were counted.
- The two pollutant counts were summed for every ZIP code.
- Each ZIP code was scored based on the sum of the number of individual pollutants found within and/or bordering it.
- Summed ZIP code scores were assigned percentile scores.

Indicator Map



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Solid Waste Sites and Facilities, and Hazardous Waste Facilities

Environmental Effects Indicator

There are widespread concerns for both human health and the environment from sites that serve for the processing or disposal of solid and hazardous waste. Many newer landfills are designed to prevent the contamination of air, water, and soil with hazardous materials. However, older sites and sites that are out of compliance with current standards may degrade environmental conditions in the surrounding area and pose a risk of exposure. Other types of facilities, such as composting, treatment and recycling facilities raise concerns about odors, vermin, and increased truck traffic, among others. While data are not available that describe environmental effects from the siting and operation of all types of solid waste facilities, the California Department of Resources Recycling and Recovery maintains data on facilities that operate within the state, as well as sites that are no longer in operation, abandoned, or otherwise illegal. The Department of Toxic Substances Control maintains data on permitted facilities that are involved in the treatment, storage, or disposal of hazardous waste.

Indicator

Sum of weighted solid waste sites and facilities and permitted hazardous waste facilities within each ZIP code.

Data Source

Solid Waste Information System (SWIS),
California Department of Resources Recycling and Recovery (CalRecycle)
http://calrecycle.ca.gov/SWFacilities/Directory/

EnviroStor Hazardous Waste Facilities Database
Department of Toxic Substances Control (DTSC)
http://www.envirostor.dtsc.ca.gov/public/data_download.asp

Rationale

The potential health effects of living near disposal sites, including those that handle hazardous waste have been examined in a number of studies (Vrijheid, 2000). Such studies generally suffer from limited information on exposures that are occurring among nearby populations, though some studies have found differences in health effects, especially self-reported health symptoms.

Solid waste sites may have multiple types of impacts on a community. Potentially hazardous gases like methane can be released from such sites (US EPA, 2011). Fires, although rare, can pose another hazard (CalRecycle, 2010; US Fire Administration, 2002). Odors and the presence of solid waste may impair a community's perceived desirability.

Although most sites are regulated, CalRecycle has recorded a number of facilities that are not adequately monitored, or not monitored at all. Such sites are of greatest concern to State and local enforcement agencies. For these sites, environmental issues like pollution from exposed burn ash have been documented.

Solid waste sites in communities remain an environmental justice issue in

California. For example, a recent study on 82 hazardous waste treatment, storage, and disposal facilities in Los Angeles County found that communities most affected by the facilities are composed of working-class and ethnic-minority populations located near industrial areas (Aliyu et al, 2011). A 1997 study correlated race/ethnicity to the location of hazardous waste treatment, storage and disposal facilities for both African-American and Latino populations in Los Angeles County (Boer *et al.*, 1997).

Method: Closed, Illegal, and Abandoned (CIA) sites:

- CIA data were obtained from CalRecycle.
- Unconfirmed and non-solid waste sites were not included in the analysis.
- Each remaining site was scored on a weighted scale in consideration of CalRecycle's prioritization categories (See Appendix).
- Site locations were mapped or geocoded (in ArcMap).

Active SWIS sites:

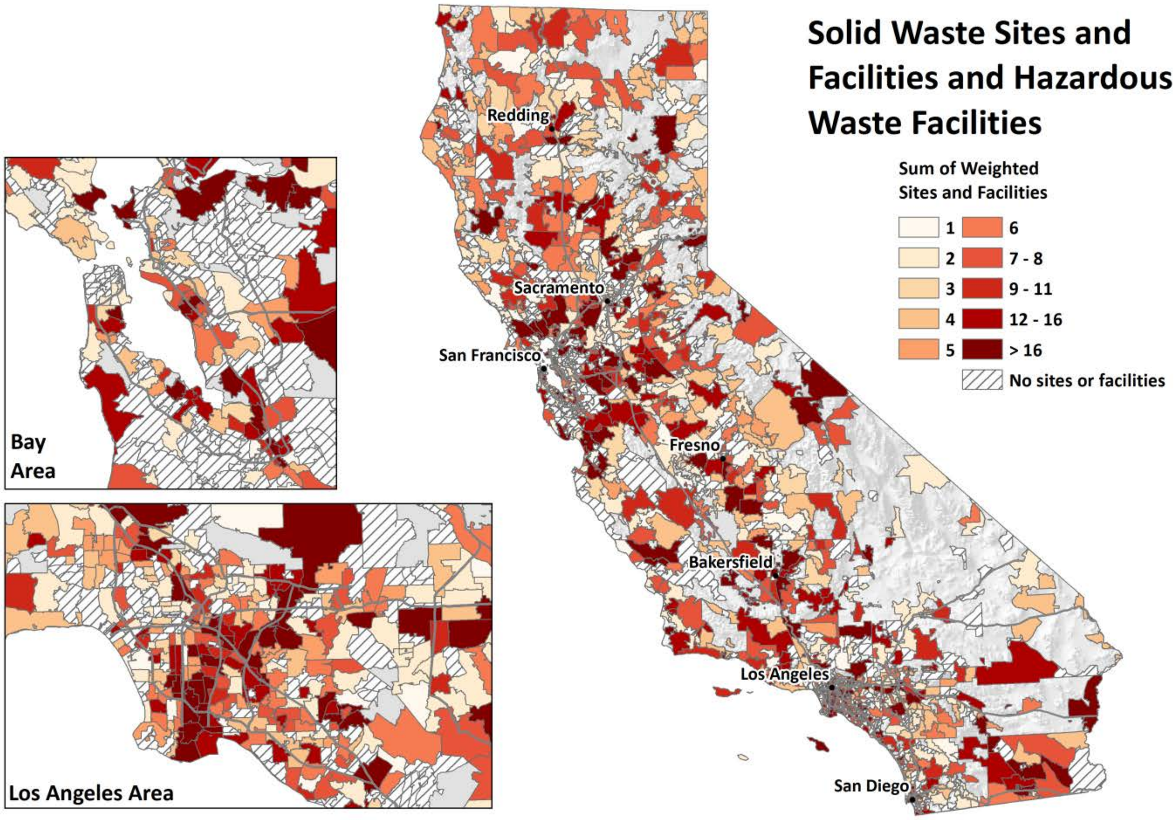
- SWIS data was obtained from the CalRecycle website.
- CIA records were filtered from the database because SWIS contains an inventory of both active and CIA sites.
- Of the non-CIA sites, Clean Closed, Absorbed, Inactive and Planned sites were not included.
- Each remaining site was scored on a weighted scale in consideration of the category type of solid waste operation (See Appendix A4).
- Site locations were mapped or geocoded (in ArcMap).

Permitted hazardous waste facilities:

- Permitted facility data were obtained from the DTSC website.
- Facilities were scored on a weighted scale in consideration of the type and permit status for the facility (See Appendix A4).
- Site locations were mapped or geocoded (in ArcMap).

All sites (CIA, SWIS, permitted hazardous waste) were assigned a 250-meter buffer and ZIP codes were scored based on the sum of weighted sites contained in its boundaries or buffers that it intersected (in ArcMap). Summed scores were assigned percentiles.

Indicator Map



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Appendix

Weighting Matrix for Solid Waste Sites and Facilities, and Permitted Hazardous Waste Facilities

Solid Waste Sites and Facilities from the Solid Waste Information System and Permitted Hazardous Waste Facilities from DTSC's permitted facilities database were weighted on a scale of 1 to 13 in consideration of both the site type and violation history. The following tables show the weights applied to the facilities and sites. The score for any given Solid Waste Site or Facility represents the sum of its Site or Facility Type and Violations. The score for any given Permitted Hazardous Waste Facility represents the sum of its Facility Activity and Permit Type. For all ZIP codes, the weighted scores of all facilities in the area were summed.

Solid Waste Sites and Facilities

Category	Criteria	Site or Facility Type	Violations (any in previous 12 months) [1]
Solid Waste Landfill *or* Construction, Demolition and Inert (CDI) Debris Waste Disposal (active) [2]	Tonnage	**8** (> 10,000 tpd) **7** (> 3,000 to < 10,000 tpd) **6** (> 1,000 to < 3,000 tpd) **5** (> 100 to < 1,000 tpd) **4** (< 100 tpd)	**3** (gas) **1** (each for litter, dust, noise, vectors, and site security)
Solid Waste Disposal Site (closed, closing, inactive) [3]	Tonnage	**1** (All)	**3** (gas) **1** (each for litter, vector, site security)
Inert Debris: Engineered Fill	Regulatory Tier [4]	**2** (Notification)	**1** (each for dust, noise, vectors, site security)
Inert Debris: Type A Disposal	Regulatory Tier [4]	**3** (Permitted)	**1** (each for dust, noise, vectors, site security)
Composting	Regulatory Tier [4]	**5** (Permitted) **3** (Permitted: Chipping & Grinding, 200 to ≤500 tpd) **2** (Notification)	**1** (each for vector, odor, litter, hazard, nuisance, noise, dust, site security) **1** (fire)
Transfer/Processing	Regulatory Tier [4]	**5** (Permitted: large vol.) **3** (Permitted: medium vol.; direct transfer) **2** (Notification)	**1** (each for dust, litter, vector/bird/animal, fire, site security)
Closed, Illegal, or Abandoned Site [5]	Priority Code [5]	**6** (Priority Code A) **4** (Priority Code B) **2** (Priority Code C) **1** (Priority Code D)	NA

Category	Criteria	Site or Facility Type	Violations (any in previous 12 months) [1]
Waste Tire	Regulatory Tier [4]	**4** (Major) **2** (Minor)	**2** (each for storage, fire) **1** (each for vectors, site security)

[1] Violations: Recurring requirements ensures only facilities that exhibit a pattern and practice of non-compliance receive a higher impact score and reduces point-in-time fluctuations. Explosive gas violations have a greater potential environmental impact than dust, noise, and vectors (from SWIS and the Waste Tire Management System).

[2] Active landfills (other than Contaminated Soil Disposal Sites and Nonhazardous Ash Disposal/Monofill Facilities) are all in the Full Permit tier, so permitted tonnage (from SWIS) is used to scale impact score.

[3] Solid Waste Disposal Site (closed) means the site was closed pursuant to state closure standards that became operative in 1989. Closed sites associated with the CIA Site database were closed prior to 1989 in accordance with standards applicable at the time of closure.

[4] Regulatory Tier used to weight the site or facility. Placement within a regulatory tier accounts for the type of waste and amount of waste processed per day or onsite at any one time. See SWIS for compost and transfer/processing; Waste Tire Management System (WTMS) for waste tire sites.

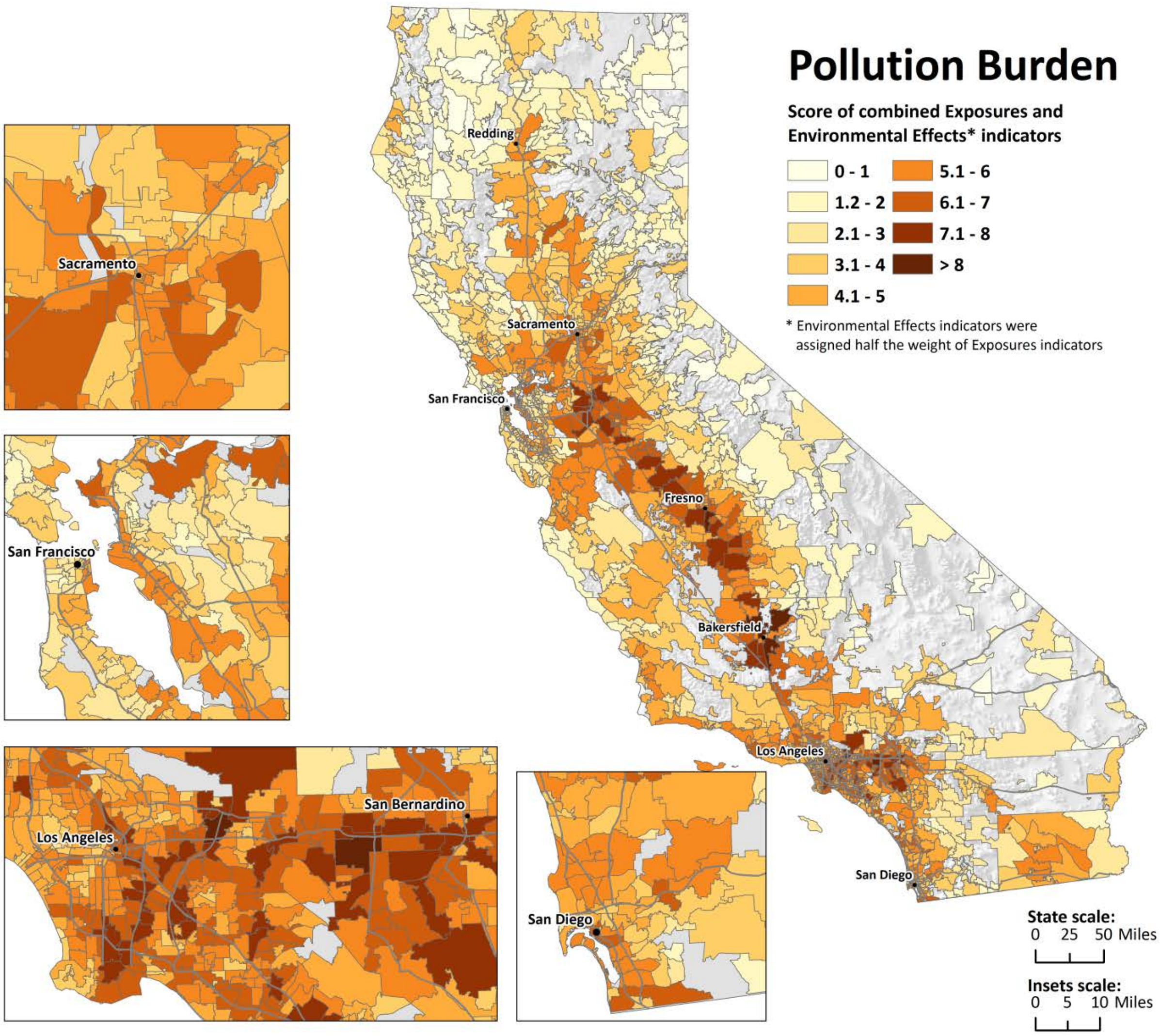
[5] CIA Sites weighted per established CIA Site Priority Code scoring methodology (A through D; additional information available at http://www.calrecycle.ca.gov/SWFacilities/CIA/forms/prioritize.htm).

Permitted Hazardous Waste Facilities

Category	Facility Activity	Permit Type
Permitted Hazardous Waste Facilities	**10** (Landfill) **7** (Treatment) **4** (Storage) **2** (Post-closure)	**1** (Large facilities) **1** (Non-RCRA facilities) **2** (RCRA facilities)

Scores for Pollution Burden (Range of possible scores: 0.1 to 10)

Pollution Burden scores for each ZIP code are derived from the average percentiles of the six Exposures indicators (ozone and PM2.5 concentrations, diesel PM concentrations, pesticide use, toxic releases from facilities, and traffic density) and the four Environmental Effects indicators (cleanup sites, impaired water bodies, groundwater threats, and solid waste sites and facilities and hazardous waste facilities). Indicators from the Environmental Effects component were given half the weight of the indicators from the Exposures component. The calculated average percentile was divided by 10 for a Pollution Burden score ranging from 0.1 -10.



Age: Children and Elderly

Sensitive Populations Indicator

Children may be especially sensitive to the adverse effects of pollutants for many reasons. Children are often more susceptible to the health effects of air pollution because their immune systems and developing organs are still immature. Irritation or inflammation caused by air pollution is more likely to obstruct their narrower airways. Children may have higher background exposures to multiple contaminants from contact with the ground, from breathing through their mouths, and from spending a significant amount of time outdoors. Further, exposure to toxic contaminants in air or other sources during infancy or childhood could affect the development of the respiratory, nervous, endocrine and immune systems, and could increase the risk of cancer later in life.

Elderly populations may be more vulnerable to adverse health effects from exposures to pollutants. This population is more likely to have health conditions that may worsen responses, such as weakened immune systems, and existing cardiovascular and respiratory disease. A history of exposure to the same or other pollutants, or combinations with concurrent pharmaceutical use may influence the response.

Indicator

Percent of population under age 10 and over age 65.

Data Source

U.S. Census Bureau

As part of the 2010 decennial census, the U.S. Census Bureau questionnaire asked all census respondents for the age and date of birth of all members of the household. Datasets describing the number of individuals in different age categories are available for California at different geographic scales. The data are made available using the American FactFinder website.

http://factfinder2.census.gov/

Rationale

Sensitivity of Children

Children's biological differences in comparison to adults account for their enhanced susceptibility to environmental pollutants. Children have smaller airways, a higher oxygen demand, and lower body weight. Children can spend 70% of their time outdoors, where they are exposed to contaminants in outdoor air. Air pollution can contribute to asthma, aggravated by children's high breathing rates and increased particle deposition in their small airways. Because children have low body weights and high oxygen demands, they can also ingest higher amounts of chemicals than adults in relation to their size (OEHHA, 2001).

Children also have a proportionately greater skin surface area than adults. This allows a child's body heat to be lost more readily, requiring a higher rate of metabolism to maintain body temperature and fuel growth and development, resulting in higher oxygen and food requirements. Hence, children can have higher exposures to environmental contaminants in air and food (Cohen Hubal *et al.*, 2000).

The skin of children, especially newborns, is softer than the skin of adults and therefore can be more readily penetrated by chemicals. Infants may have higher exposures to fat-soluble chemicals once the layer of fat underlying the skin develops at approximately 2-3 months of age, continuing through the toddler period (OEHHA, 2001). The percentage of body fat generally decreases with age (Cohen Hubal *et al.*, 2000). Once environmental chemicals have been absorbed, the newborn's immature renal system is unable to eliminate them as effectively as older children and adults are able to do (Sly and flack, 2008).

Sensitivity of the Elderly

The mechanisms of absorption, distribution, metabolism, and excretion change with age. There is a reduction in lean body mass, certain blood proteins, and total body water as we get older. In comparison to younger adult populations, there is more variation in elderly individuals' capacity to metabolize substances. Reduced metabolic rates result in decreases in blood flow, prolonging the process of chemical elimination. In addition, renal function can be reduced by 50% in the elderly (Pedersen, 1997). Heart disease, which is found in the majority of elderly populations, increases susceptibility to the effects of exposure to particulate matter that decreases heart rate and oxygen saturation (Adler, 2003).

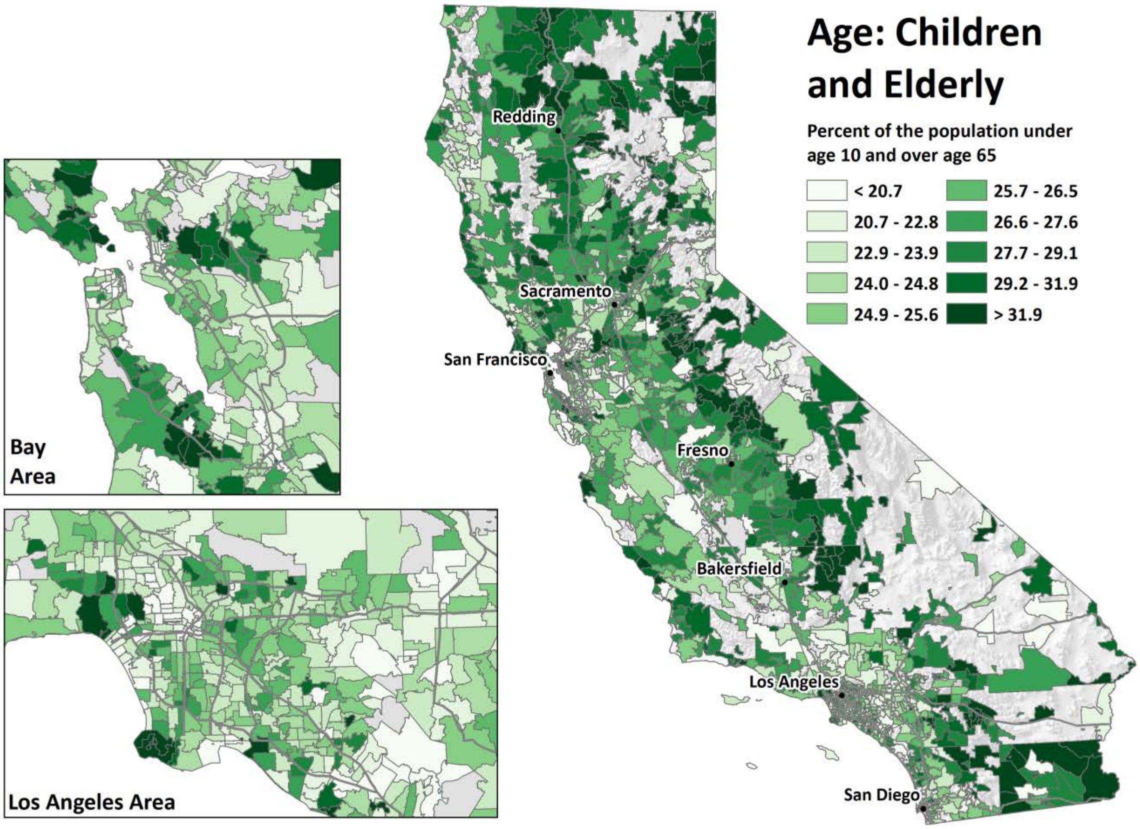
Researchers in Korea in the 1990s noted that an increase in air pollution resulted in an increased risk for stroke in adults over the age of 65 (Hong *et al.*, 2002). Increased prevalence of stroke has also been associated with higher concentrations of carbon monoxide, sulfur dioxide, ozone, and nitrogen oxide (Adler, 2003). A study involving seniors in Denver demonstrated an increased hospitalization rate for heart attacks, atherosclerosis, and pulmonary heart disease on days with high air pollution levels. Sulfur dioxide and carbon monoxide have also been linked to increased hospital stays from cardiac dysrhythmias and congestive heart failure, respectively (Koken *et al.*, 2003).

Water pollutants, such as arsenic, may also pose a threat to the elderly. Arsenic accumulates in cardiovascular tissue and can trigger inflammation of the arteries, increasing the risk of atherosclerosis and vascular disease (Adler, 2003).

Method

- A dataset containing the number of people in different age groups was downloaded by census ZIP codes for the State.
- The percent of children or elderly in each ZIP code was calculated as the total number of children less than 10 years of age and greater than 65 years of age in the ZIP code divided by the ZIP code's total population.
- ZIP codes were ordered by the percentage of children and elderly. A percentile score for a ZIP code was determined by its place in the distribution of all ZIP codes.

Indicator Map



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Asthma

Sensitive Populations Indicator

Asthma is a chronic lung disease characterized by episodic breathlessness, wheezing, coughing, and chest tightness. While the causes of asthma are poorly understood, it is well established that exposure to traffic and outdoor air pollutants, including particulate matter, ozone, and diesel exhaust, can trigger asthma attacks. Nearly three million Californians currently have asthma and about five million have had it at some point in their lives. Children, the elderly and low-income Californians suffer disproportionately from asthma (California Health Interview Survey, 2009). Although well-controlled asthma can be managed as a chronic disease, asthma can be a life-threatening condition, and emergency department visits for asthma are a very serious outcome, both for patients and for the medical system.

Indicator

Annual average, age-adjusted rate of emergency department (ED) visits for asthma (2007-2009)

Data Source

California Office of Statewide Health Planning and Development (COSHPD)

Since 2005, hospitals licensed by the state of California to provide emergency medical services are required to report all emergency department (ED) visits to the COSHPD. Federally-owned facilities, including Veterans Administration and Public Health Services hospitals are not required to report. The ED dataset includes information on the principal diagnosis, which can be used to identify which patients visited the ED because of asthma.

ED utilization does not capture the full burden of asthma in a community because not everyone with asthma requires emergency care, especially if they receive preventative care and undertake disease maintenance. However, there is currently no state-wide monitoring of other indicators, such as planned and unplanned doctor's visits, which might provide a better indication of overall disease burden. Some ED visits result in hospitalization, and COSPHD collects data on hospitalization due to asthma in addition to emergency department visits. However, because the criteria for hospital admittance may vary between facilities, ED visits are thought to provide a better comparative measure of asthma burden.

The Environmental Health Investigations Branch (EHIB) of the California Department of Public Health used COSHPD's data to calculate age-adjusted rates of asthma ED visits for California ZIP codes. These estimates make use of ZIP-code level population estimates from a private vendor and the U.S. 2000 Standard Population to derive age-adjusted rates. Age-adjustment takes the age distribution of a population into account and allows for meaningful comparisons between ZIP codes with different age structures.

http://www.ehib.org/page.jsp?page_key=24

Rationale

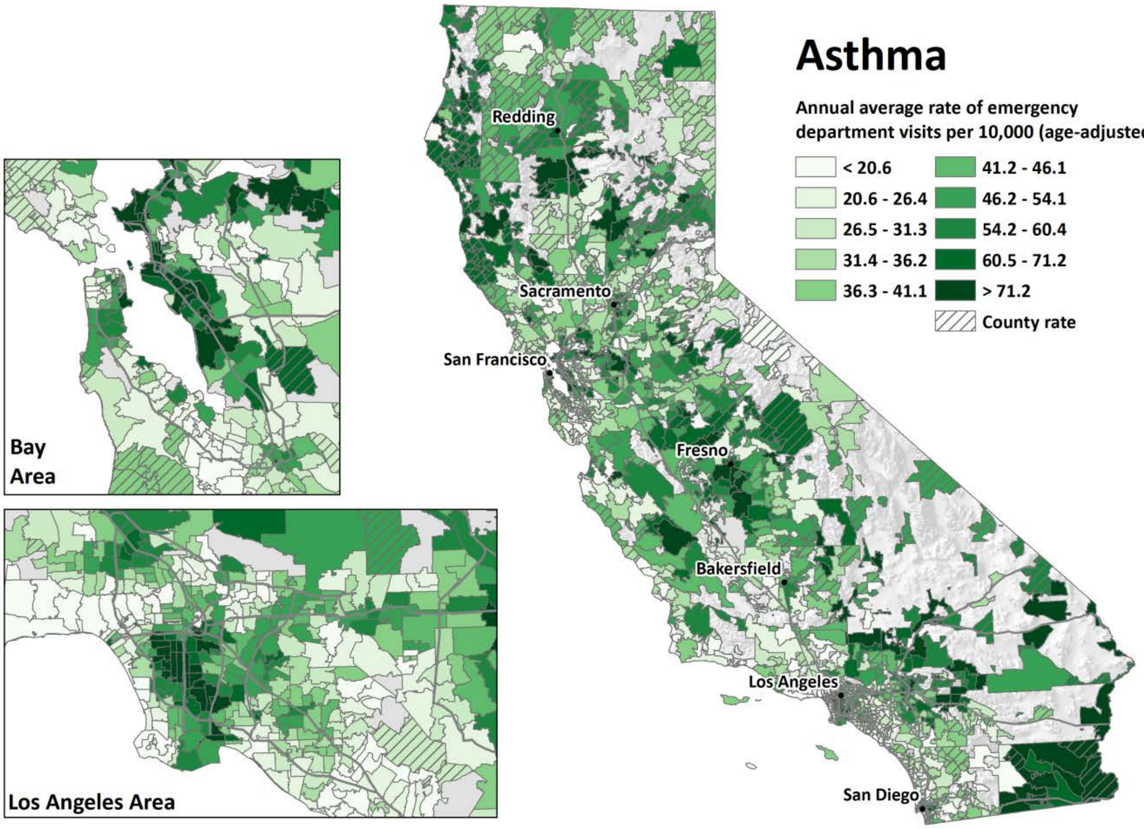
Having asthma increases the sensitivity of one's health to pollutants. Air pollutants including particulate matter, ozone, nitrogen dioxide, and diesel exhaust trigger symptoms among asthmatics (Meng *et al.*, 2011). Children living near major roadways and traffic corridors in California have been shown to suffer disproportionate rates of asthma (Kim *et al.*, 2004). Particulate matter from diesel engines has also been implicated in causing new-onset asthma (Pandya *et al*, 2002). Exposure to certain pesticides can also trigger wheezing, coughing, and chest tightness (Hernández *et al.*, 2011). Asthma can also increase one's susceptibility to other diseases. For example, one study found that when ambient particulate pollution levels are high, persons with asthma have twice the risk of being hospitalized for pneumonia compared to persons without asthma (Zanobetti *et al.*, 2000).

Asthma rates are a good indicator of population sensitivity to environmental stressors because asthma is both caused by and exacerbated by pollutants. The severity of symptoms and the likelihood of needing hospital care decrease with access to regular medical care and asthma medication (Delfino *et al.*, 1998; Grineski *et al.*, 2010). Using an indicator of relatively severe cases, those requiring emergency care, therefore also captures aspects of access to care. As such, asthma emergency department visits are a marker of the cumulative impact of environmental and social stressors.

Method

- An annual average, age-adjusted rate of asthma emergency department (ED) visits was obtained for each ZIP code from EHIB. Estimates derived from places with few ED visits are considered unreliable because they vary greatly from year to year. For this reason, ZIP codes with less than 12 asthma ED visits during the time period considered were excluded. The annual average rate was estimated using three years of data (2007-2009) in order to minimize the number of ZIP codes that had to be excluded. It was assumed that the geographic boundaries of the ZIP codes did not change during these three years.
- Reported ZIP codes were assigned the rate of their corresponding census ZIP code, assuming perfect geographic overlap. Reported ZIP codes that did not correspond to a census ZIP code were excluded from the analysis.
- Census ZIP codes without data were assigned the annual average, age-adjusted rate of their county. For ZIP codes that cross county borders, a weighted sum of the average county rates was calculated based on the proportion of the ZIP code 2010 population within each county. ZIP codes that cross state boundaries were assigned county averages from their California county only. Alpine county, which did not have large enough counts to calculate a statistically reliable rate, was assigned the average of the five counties that it borders: El Dorado, Amador, Calaveras, Tuolumne, and Mono.
- ZIP codes with no population in the 2010 census were given a percentile score of zero, and excluded from the calculation of percentiles for all other ZIP codes. Thus, the percentile score is essentially the comparison among ZIP codes with a resident population in the 2010 census.

Indicator Map



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Low Birth Weight Infants

Sensitive Populations Indicator

Infants born weighing less than 2,500 grams (about 5.5 pounds) are classified as low birth weight (LBW), a condition that is associated with increased risk of later health problems as well as infant mortality. Most LBW infants are small because they were born early. Infants born at full term (after 37 complete weeks of pregnancy) can also be LBW because their growth was impaired during pregnancy. Nutritional status, prenatal care, stress, and maternal smoking are known risk factors for LBW, and studies also suggest links with environmental exposures to lead, air pollution, toxic air contaminants, traffic pollution, pesticides, and polychlorinated biphenyls (PCBs). These children are at risk of numerous other health conditions and may be more sensitive to environmental exposures after birth. Low weight births are more common among African-American women than they are among Hispanic and non-Hispanic white women, even among those with comparable socioeconomic status, prenatal care, and behavioral risk factors (Lu and Halfon, 2003).

Indicator

Annual average low birth weight rate (2005-2009).

Data Source

California Department of Public Health

The Health Information and Research Section of CDPH is responsible for the stewardship and distribution of birth records in the state. Medical data related to a birth, as well as demographic information related to the infant, mother, and father is collected from birth certificates. The residential ZIP code reported by the mother is also included. Birth profiles for California ZIP codes and counties can be accessed by the general public from the CDPH website. Personal identifiers are not released publicly to protect confidentiality.

http://www.cdph.ca.gov/data/statistics/Pages/BirthProfilesbyZIPCode.aspx

http://www.cdph.ca.gov/data/statistics/Pages/CountyBirthStatisticalDataTables.aspx

Rationale

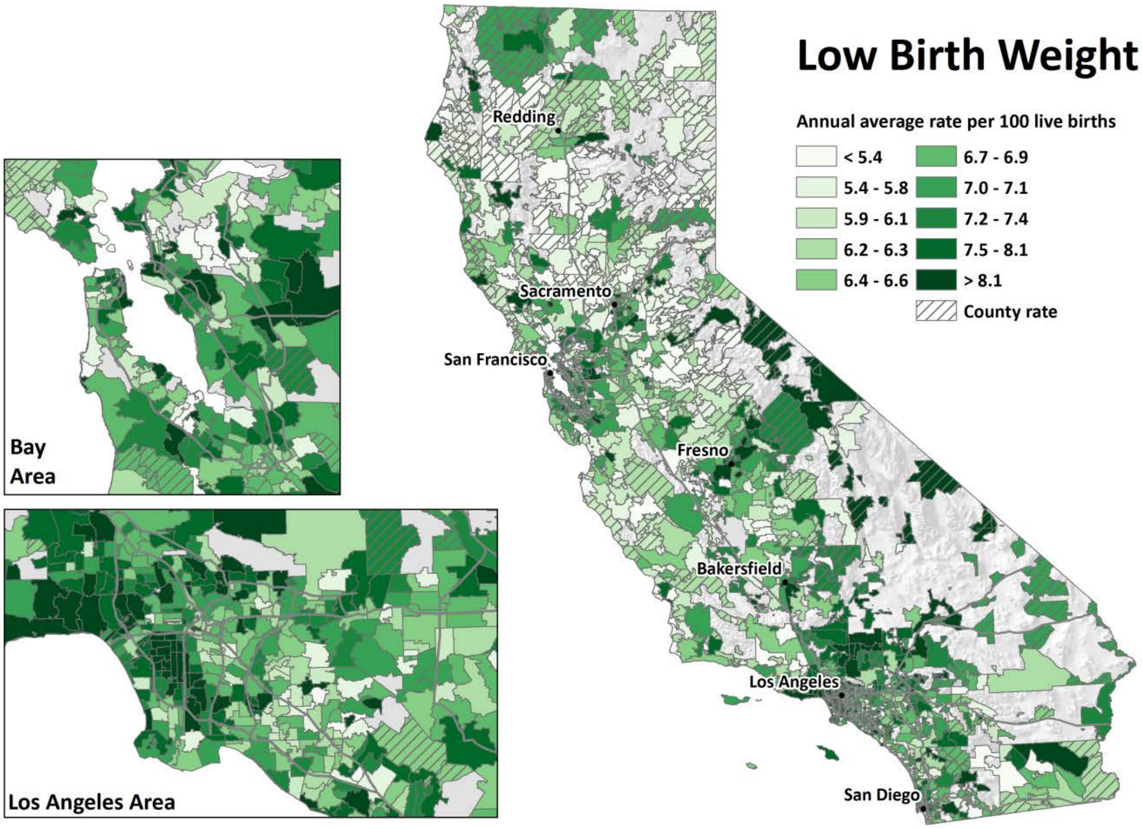
LBW is considered a key marker of overall population health. Being born low weight puts a person at higher risk of health conditions that can subsequently make them more sensitive to environmental exposures. For example, children born low weight are at increased risk of developing asthma (Nepomnyaschy and Reichman, 2006). Asthma symptoms, in turn, are worsened by exposure to air pollution. LBW can also put one at increased risk of coronary heart disease and type 2 diabetes (Barker *et al.*, 2002). These conditions, in turn, predispose one to mortality associated with particulate air pollution or excessive heat (Bateson and Schwartz, 2004; Basu and Samet, 2002). There is also good evidence that children born early have lowered cognitive development and more behavioral problems compared to children born at term (Butta *et al.*, 2002), putting them at disadvantage for subsequent opportunities for good health.

Risk of LBW is increased by several environmental exposures and multiple social factors. For example, exposures to toxic air contaminants (such as benzene, xylene, and toluene), and to traffic, have been linked to LBW in California (Ghosh *et al.*, 2012). Smaller gestational age with smaller head circumference (an indicator of brain development) occurs in babies born to pesticide-exposed Latina women in California, with higher risk in those with certain susceptibility genes (Harley *et al.*, 2011). Low birth weight can therefore also be considered a marker of the combined impact of environmental and social stressors.

Method

- The annual average low birth weight (LBW) rate was defined as the percent of live births (including multiple births) weighing less than 2,500 grams occurring in one year.
- Estimates derived from places with few births are considered unreliable because they vary greatly from year to year. For this reason, ZIP codes with less than 5 low weight infants or less than 100 live births during the time period considered were excluded. The annual average was estimated using five years of data (2005-2009) in order to minimize the number of ZIP codes that had to be excluded. It was assumed that the ZIP code geographic boundaries did not change during these five years.
- Reported ZIP codes were assigned the rate of their corresponding census ZIP code, assuming perfect geographic overlap. Reported ZIP codes that did not correspond to a census ZIP code were excluded from the analysis.
- Census ZIP codes with too few births to calculate a reliable estimate were assigned the five year average rate of their county. For ZIP codes that cross county borders, a weighted sum of the average county rates were calculated based on the proportion of the ZIP code's 2010 population within each county. ZIP codes that cross state boundaries were assigned county averages from their California county only. Alpine County, which did not have enough births to estimate a stable rate, was assigned the average of the five counties that it borders: El Dorado, Amador, Calaveras, Tuolumne and Mono.
- ZIP codes with no population in the 2010 Census were given a percentile score of zero, and excluded from the calculation of percentiles for all other ZIP codes. Thus, the percentile score can be interpreted as the comparison among ZIP codes with a 2010 population.

Indicator Map



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Educational Attainment

Socioeconomic Factors Indicator

Educational attainment is an important element of socioeconomic status and is a social determinant of health. Numerous studies suggest education has a partially protective effect against exposure to environmental pollutants that damage health. Information on educational attainment is collected annually in the U.S. Census Bureau's American Community Survey (ACS). In contrast to the decennial census, the ACS surveys a small sample of the U.S. population to estimate more detailed economic and social information for the country's population.

Indicator

Percent of the population over age 25 with less than a high school education (5-year estimate, 2007-2011).

Data Source

American Community Survey
U.S. Census Bureau

The American Community Survey (ACS) is an ongoing survey of the U.S. population conducted by the U.S. Census Bureau and has replaced the long form of the decennial census. Unlike the decennial census, which attempts to survey the entire population and collects a limited amount of information, the ACS releases results annually based on a sub-sample of the population and includes more detailed information on socioeconomic factors such as educational attainment. Multiple years of data are pooled together to provide more reliable estimates for geographic areas with small population sizes. The most recent results available at the census ZIP code are the 5-year estimates for 2007-2011. The data are made available using the American FactFinder website.

http://www.census.gov/acs/www/
http://factfinder2.census.gov/

Rationale

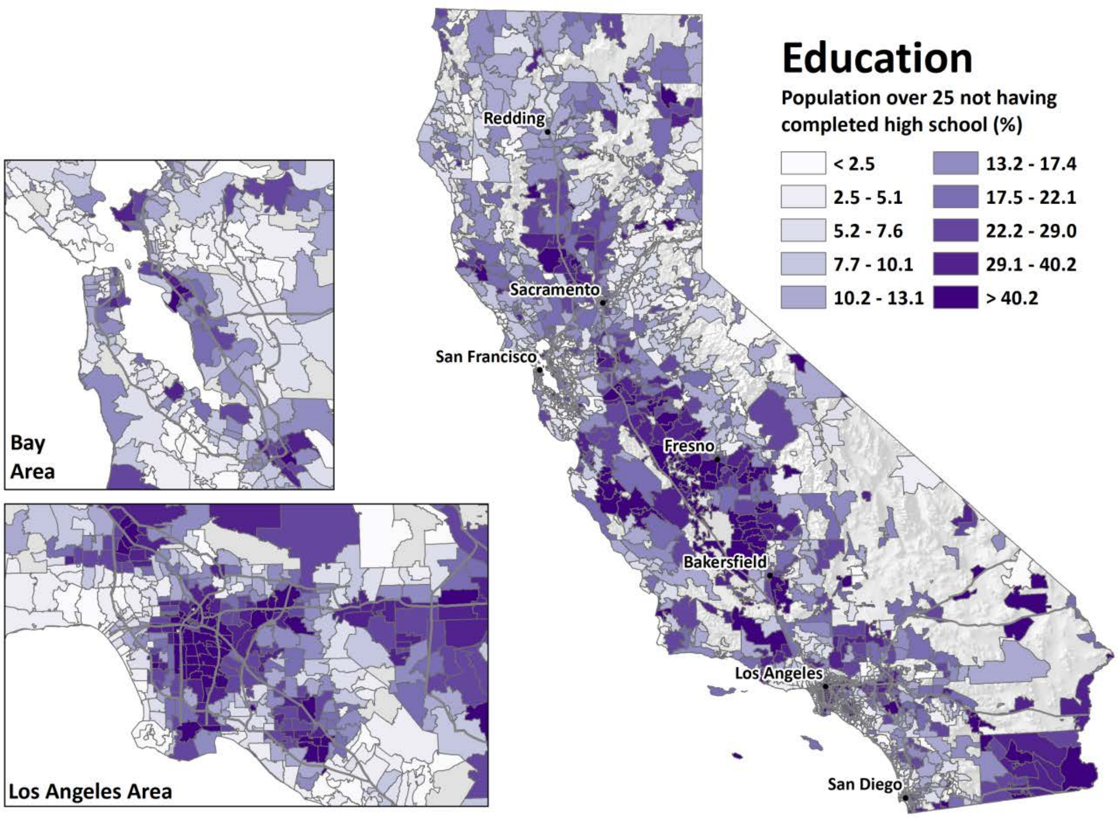
Educational attainment is an important independent predictor of health, and, as a component of socioeconomic status, is often inversely associated with higher exposure to indoor and outdoor pollution. Several studies have associated educational attainment with one's susceptibility to the health impacts of environmental pollutants. For example, individuals without a high school education appear to be at higher risk of mortality associated with particulate air pollution than those with a high school education (Krewski *et al.*, 2000). There is also evidence that the effects of air and traffic-related pollution on respiratory illness, including childhood asthma, are more severe in communities with lower levels of education (Cakmak *et al.*, 2006; Shankardass *et al.* 2009; Neidell, 2004).

The ways that lower educational attainment may decrease health are not understood, but may include economic hardship, stress, occupational opportunities, social support, and access to health-protective resources such as medical care and nutritious food.

Method

- From the 2007-2011 American Community Survey estimates, a dataset containing the percent of the population over age 25 with a high school education or higher was downloaded by census ZIP codes for the state of California.
- This data was subtracted from 100 to obtain the percent of the population with less than a high school education by census ZIP code.
- ZIP codes were ordered by the percent with less than a high school education and percentiles were assigned to each based on the distribution across all ZIP codes.

Indicator Map



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Linguistic Isolation

Socioeconomic Factors Indicator

According to the most recent U.S. Census Bureau's 2007-2011 American Community Survey (ACS), nearly 43% of Californians speak a language at home other than English, about 20% of the state's population speaks English "not well" or "not at all," and 10% of all households in California are linguistically isolated. The U.S. Census Bureau uses the term "linguistic isolation" to measure households where all members have at least some difficulty speaking English. The number of households in the U.S. defined as "linguistically isolated" rose by almost 50% from 1990 to 2000 (Shin and Bruno, 2003). High linguistic isolation among members of a community raises concerns about access to health information, receiving public services, and effective engagement with regulatory processes. Information on language use is collected annually in the ACS. In contrast to the decennial census, the ACS surveys a small sample of the U.S. population to estimate more detailed economic and social information for the country's population.

Indicator

Percentage of households in which no one age 14 and over speaks English "very well" or speaks English only.

Data Source

American Community Survey
U.S. Census Bureau

The American Community Survey (ACS) is an ongoing survey of the U.S. population conducted by the U.S. Census Bureau and has replaced the long form of the decennial census. Unlike the decennial census, which attempts to survey the entire population and collects a limited amount of information, the ACS releases results annually based on a sub-sample of the population and includes more detailed information on socioeconomic factors such as linguistic isolation. Multiple years of data are pooled together to provide more reliable estimates for geographic areas with small population sizes. The most recent results available at the census ZIP code are the 5-year estimates for 2007-2011. The data are made available using the American FactFinder website.

http://www.census.gov/acs/www/
http://factfinder2.census.gov/

Rationale

The inability to speak English well can affect an individual's communication with service providers and their ability to perform daily activities. People with limited English are less likely to have regular medical care and are more likely to report difficulty getting medical information or advice than English speakers. Communication is essential for many steps in the process of obtaining health care, and limited English speakers may delay care because they lack important information about symptoms and available services (Shi *et al.* 2009). Non-English speakers are also less likely to receive mental health services when needed, and because in California non-English speakers are concentrated in minority ethnic communities, limited English proficiency may contribute to further ethnic and racial disparities in health status and disability (Sentell *et al.* 2007).

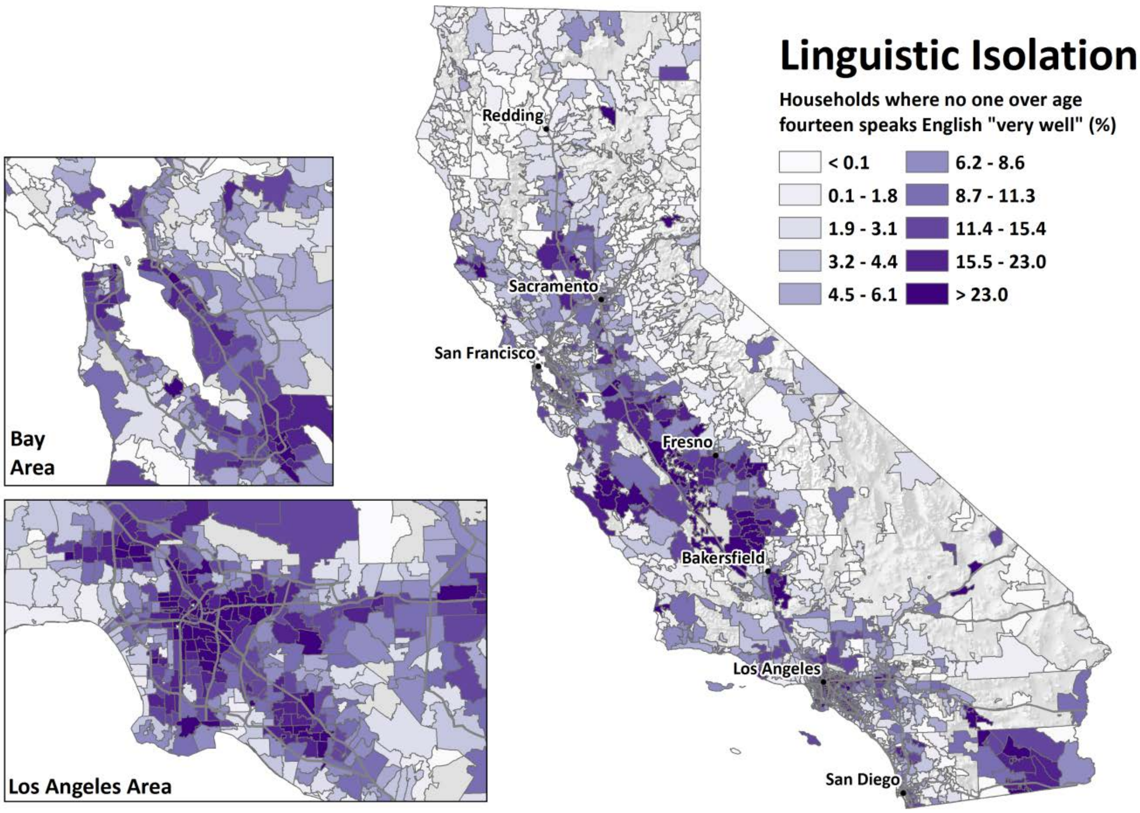
Lack of proficiency in English often results in racial discrimination, while both language difficulties and discrimination are related to stress, low socioeconomic status and reduced quality of life (Gee and Ponce, 2010). Linguistic isolation hampers the ability of the public health sector to reduce racial and ethnic disparities because non-English-speaking individuals participate in public health surveillance studies at very low rates, even when there is translation available (Link *et al.*, 2006).

In the event of an emergency, such as an accidental chemical release or a spill, households that are linguistically isolated may not receive timely information on evacuation or shelter-in-place orders, and may therefore experience health risks that those who speak English can more easily avoid. Additionally, linguistic isolation was independently related to both proximity to a toxic release inventory (TRI) facility and cancer risks from the National-Scale Air Toxics Assessment (NATA) in an analysis of the San Francisco Bay Area, suggesting that linguistically isolated communities may bear a greater share of health risks from air hazards (Pastor *et al,.* 2010).

Method

- From the 2007-2011 American Community Survey, a dataset containing the average percent of household in which no one age 14 and over speaks English "very well" or speaks English only was downloaded by census ZIP codes for the state of California. This variable is referred to as "linguistic isolation" and measures households where no one speaks English well.
- ZIP codes were ordered by the percent linguistically isolated and percentiles were assigned to each based on the distribution across all ZIP codes.

Indicator Map



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Poverty

Socioeconomic Factors Indicator

Poverty is an important social determinant of health. Several studies suggest that impoverished populations are more likely than wealthier populations to experience adverse health outcomes when exposed to environmental pollution. Information on poverty is collected annually in the U.S. Census Bureau's American Community Survey (ACS). In contrast to the decennial census, the ACS surveys a small sample of the U.S. population to estimate more detailed economic and social information for the country's population.

Indicator

Percent of the population living below two times the federal poverty level (5-year estimate, 2007-2011).

Data Source

American Community Survey
U.S. Census Bureau

The American Community Survey (ACS) is an ongoing survey of the U.S. population conducted by the U.S. Census Bureau and has replaced the long form of the decennial census. Unlike the decennial census, which attempts to survey the entire population and collects a limited amount of information, the ACS releases results annually based on a sub-sample of the population and includes more detailed information on socioeconomic factors such as poverty. Multiple years of data are pooled together to provide more reliable estimates for geographic areas with small population sizes. The most recent results available at the census ZIP code are the 5-year estimates for 2007-2011. The data are made available using the American FactFinder website.

The Census Bureau uses income thresholds that are dependent on family size to determine a person's poverty status during the previous year. For example, if a family of four with two children has a total income less than $21,938 during 2010, everyone in that family is considered to live below the federal poverty line. A threshold of twice the federal poverty level was used in this analysis because the federal poverty thresholds have not changed since the 1980s despite increases in the cost of living, and because California's cost of living is higher than many other parts of the country.

http://www.census.gov/acs/www/
http://factfinder2.census.gov/

Rationale

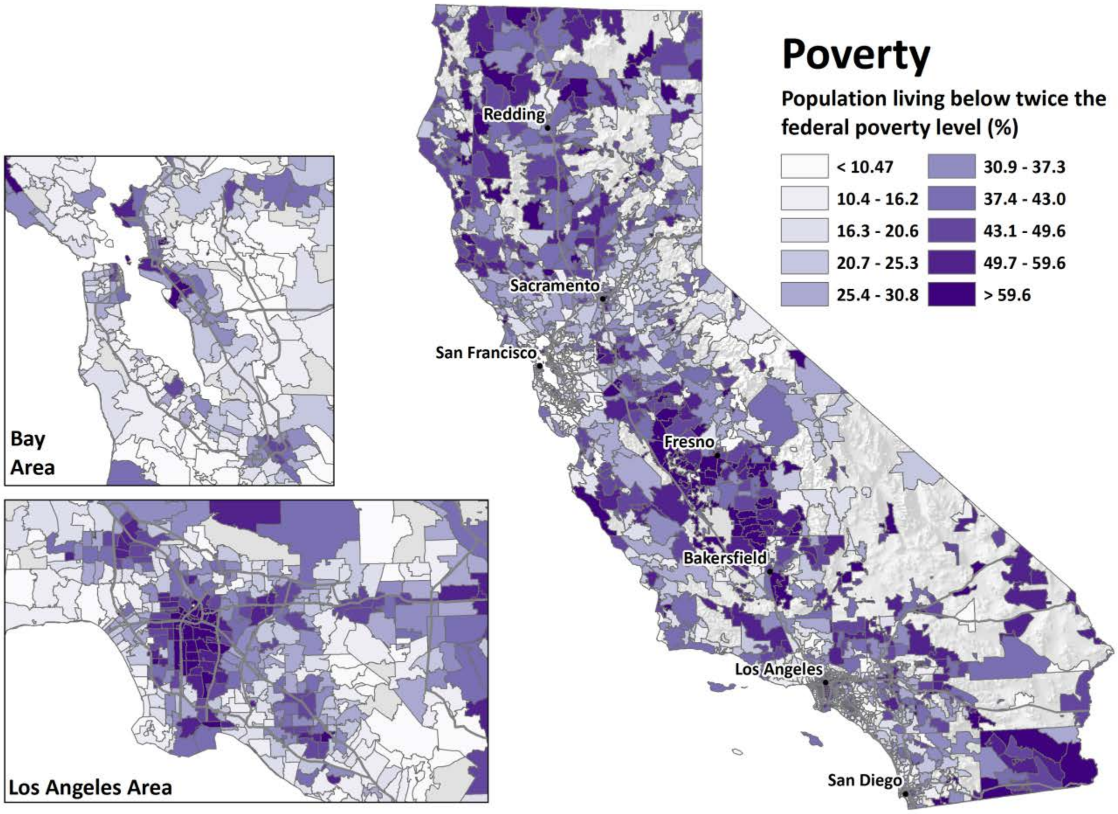
Wealth influences health because it helps determine one's living conditions, nutrition, occupation, and access to health care and other health-promoting resources. There is growing evidence that increased individual wealth as well as the wealth of one's neighborhood can reduce susceptibility to exposure to environmental pollutants. For example, studies have shown a stronger effect of air pollution on mortality (Forastiere *et al.* 2007) and childhood asthma (Lin *et al.* 2004, Meng *et al.* 2011) among low income communities. A multi-city study in Canada has shown that the effect of nitrogen dioxide on respiratory hospitalizations was worsened among lower income households (Cakmak *et al.*, 2006). Other studies have found that neighborhood-level income modifies the relationship between particulate air pollution and preterm birth (Yi *et al.* 2010) as well as traffic and low birth weight (Zeka *et al.* 2008), with mothers living in low income neighborhoods having higher risk.

One way by which poverty may lead to greater susceptibility is from the additional wear and tear chronic stress puts on the body (Wright *et al.*, 1999; Brunner and Marmot, 2006). Differential underlying burdens of pre-existing illness and co-exposure to multiple pollutants are other potential explanations (O'Neill *et al.,* 2003).

Method

- From the 2007-2011 American Community Survey, a dataset containing the number of individuals below 200 percent of the federal poverty level was downloaded by census ZIP codes for the state of California.
- The number of individuals below the poverty level was divided by the total population for whom poverty status was determined to obtain a percent.
- ZIP codes were ordered by the percentage of the population below twice (or 200 percent) of the federal poverty level. A percentile score for a ZIP code was determined by its place in the distribution of all ZIP codes.

Indicator Map



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Race/Ethnicity

Socioeconomic Factors Indicator

Emerging scientific research is showing the relationship between pollutant exposure and health outcomes can vary based on the race and ethnicity of the population. For example, studies have shown that maternal exposure to particulate pollution results in a greater reduction in infant birth weight among African-American mothers compared to white mothers. Similarly, higher mortality has been observed among African-American populations exposed to ozone than other populations exposed to the same levels. The U.S. Census Bureau collects information on race and ethnicity as part of the decennial census and makes this information publicly available.

Indicator

Percent of the population that is non-white or Hispanic/Latino.

Data Source

U.S. Census Bureau

As part of the 2010 decennial census, the U.S. Census Bureau questionnaire asked all census respondents to identify their race and ethnicity (Hispanic or Latino origin) of all members of the household. Other questions asked of all respondents are age and date of birth, household relationship, sex, and home ownership.

Datasets describing the number of individuals in different race and ethnicity categories are available for California at different geographic scales. The data are made available using the American FactFinder website.

http://factfinder2.census.gov/

Rationale

Several studies have provided evidence that race/ethnicity can modify the adverse response to specific pollutant exposures. For example, maternal exposure to particulate pollution (PM 2.5) is associated with reduced birth weight. This effect is greater among black mothers compared to white mothers (Bell *et al.*, 2007). Ozone levels have been shown to be associated with increased mortality. The effect of ozone on the mortality of black populations has been shown to be stronger compared to non-black populations (Medina-Ramon & Schwartz, 2008). Another study has shown that African-American mothers of low socioeconomic status exposed to traffic-related air pollution in Los Angeles County had twice the chances of delivering a preterm baby compared to white low-socioeconomic status mothers (Ponce *et al.*, 2005).

A study of traffic exposure and spontaneous abortion found a greater effect for African-American women than other racial/ethnic groups (Green *et al.*, 2009). In a study of the effects of nitrogen dioxide (NO_2) of children without health insurance in Phoenix, Hispanic children showed twice the risk of hospitalization for asthma from NO_2 exposure as white children. Black children (with and without insurance) showed about twice the risk of asthma hospitalization from NO_2 exposure as Hispanic children (Grineski *et al.*, 2010).

Differences by race have also been observed for the effect of PM2.5

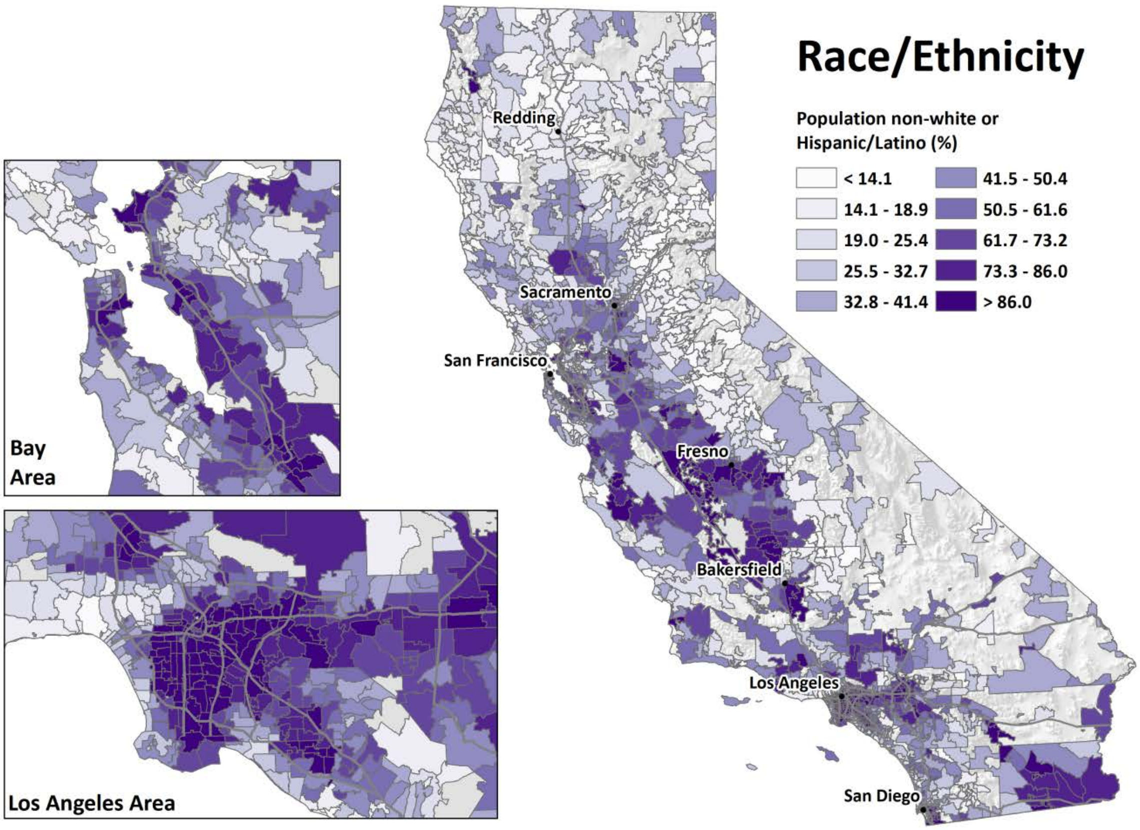
exposure on emergency department visits for asthma in Pittsburgh (Glad *et al.*, 2012). The effect was found to be significant and greater in African American populations compared to Caucasians for the first three days following exposure.

The ways in which differences in race/ethnicity may lead to differences in response to pollutants is not well understood. Some research has explored the relationship between chronic stress and human health. Such stressors can include socioeconomic disadvantage such as residential crowding, noise, poor housing quality, exposure to violence, or the experience of racial discrimination (Evans and Marcynyszyn, 2004; Geronimus, 1996; Williams and Williams-Morris, 2000; Clark *et al.*, 1999; Kwate *et al.*, 2003; Paradies, 2006). Another possible explanation is that there are other differences in exposures that are occurring that are not captured or accounted for in the studies' design.

Method

- A dataset containing the number of people by race/ethnicity was downloaded by census ZIP codes for the State.
- The percent of the population in each ZIP code was calculated as the total number of people identified as non-white or Hispanic/Latino in the ZIP code divided by the total population of the ZIP code.
- ZIP codes were ordered by the percentage of the population that is non-white or Hispanic/ Latino). A percentile score for a ZIP code was determined by its place in the distribution of all ZIP codes.

Indicator Map



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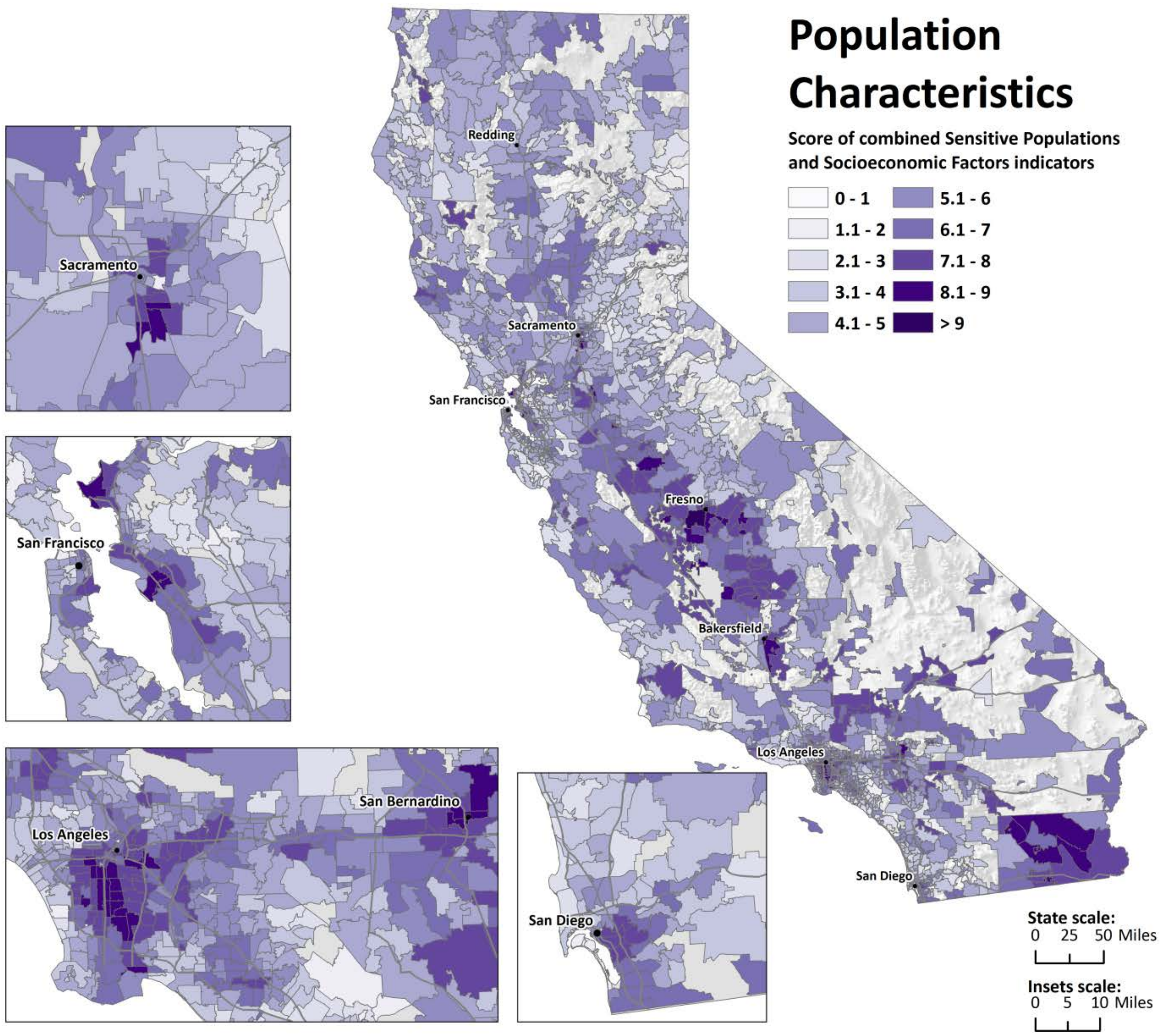
Scores for Population Characteristics (Range of possible scores: 0.1 to 10)

Population Characteristics scores for each ZIP code are derived from the average percentiles for the three Sensitive Populations indicators (children/elderly, low birth weight, and asthma) and the four Socioeconomic Factors indicators (educational attainment, linguistic isolation, poverty, and race/ethnicity). The calculated average percentile divided by 10 for a Population Characteristic score ranging from 0.1 -10.



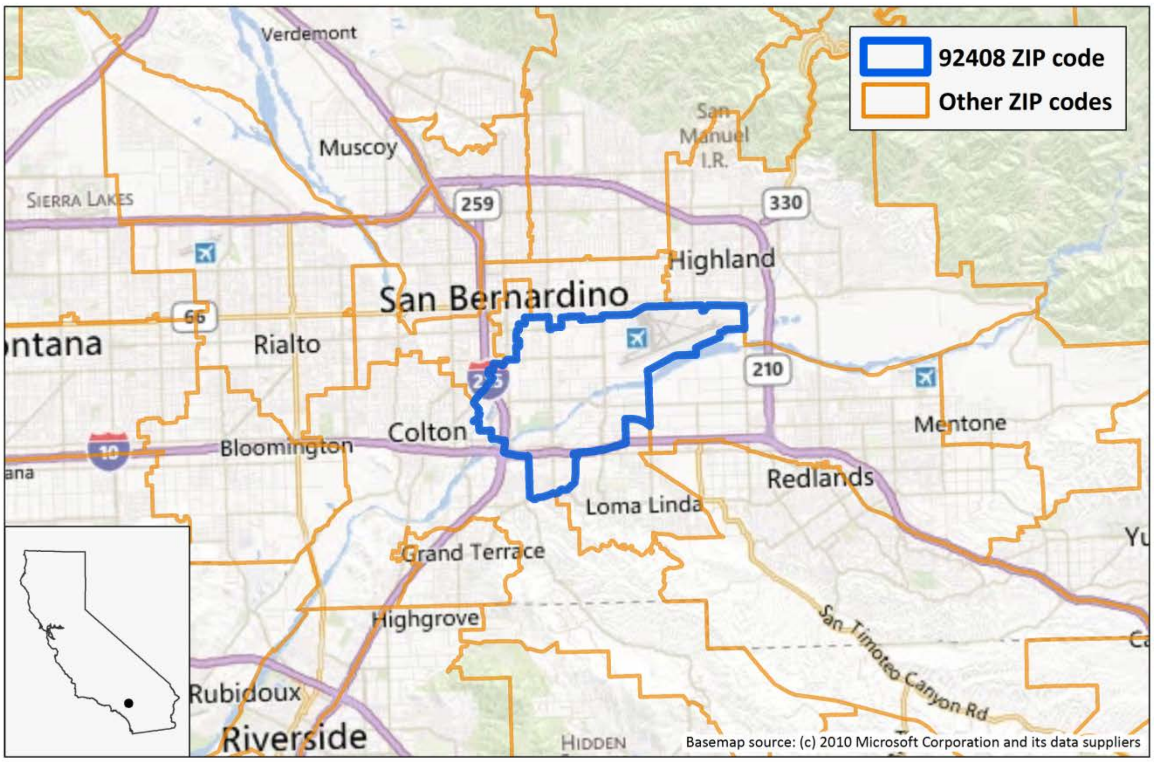
Example ZIP Code

Indicator Results and CalEnviroScreen Score

Example: 92408, San Bernardino
Population 15,271

One example ZIP code was selected to illustrate how an overall CalEnviroScreen score is calculated using the California Communities Environmental Health Screening Tool. Shown below are:

- An area map for the ZIP code and surrounding ZIP codes.
- Tables for the indicators of Pollution Burden and Population Characteristics with percentile scores for each of the indicators.
- A table showing how a CalEnviroScreen score would be calculated for the example area, based on the data in this report.



Exposure Indicators						
Indicator	Ozone (concentration)	PM2.5 (concentration)	DieselPM (concentration)	Pesticide Use (lbs/sq. mi.)	Toxic Releases (weighted lbs)	Traffic (density)
Raw Value	0.81	14.0	1.44	0.35	577,026	140,765
Percentile	98.26	83.28	78.52	29.88	68.13	85.87

Environmental Effects Indicators				
Indicator	Cleanup Sites (weighted sites)	Impaired Water Bodies (number of pollutants)	Groundwater Threats (weighted sites)	Solid Waste Sites and Facilities (weighted sites and facilities)
Raw Value	82	1	110	24
Percentile	89.46	14.50	75.08	95.92

Sensitive Population Indicators			
Indicator	Children (<10) and Elderly (>65) (percent)	Asthma (rate)	Low Birth Weight (rate)
Raw Value	23.2	69.6	8.53
Percentile	23.14	89.48	93.86

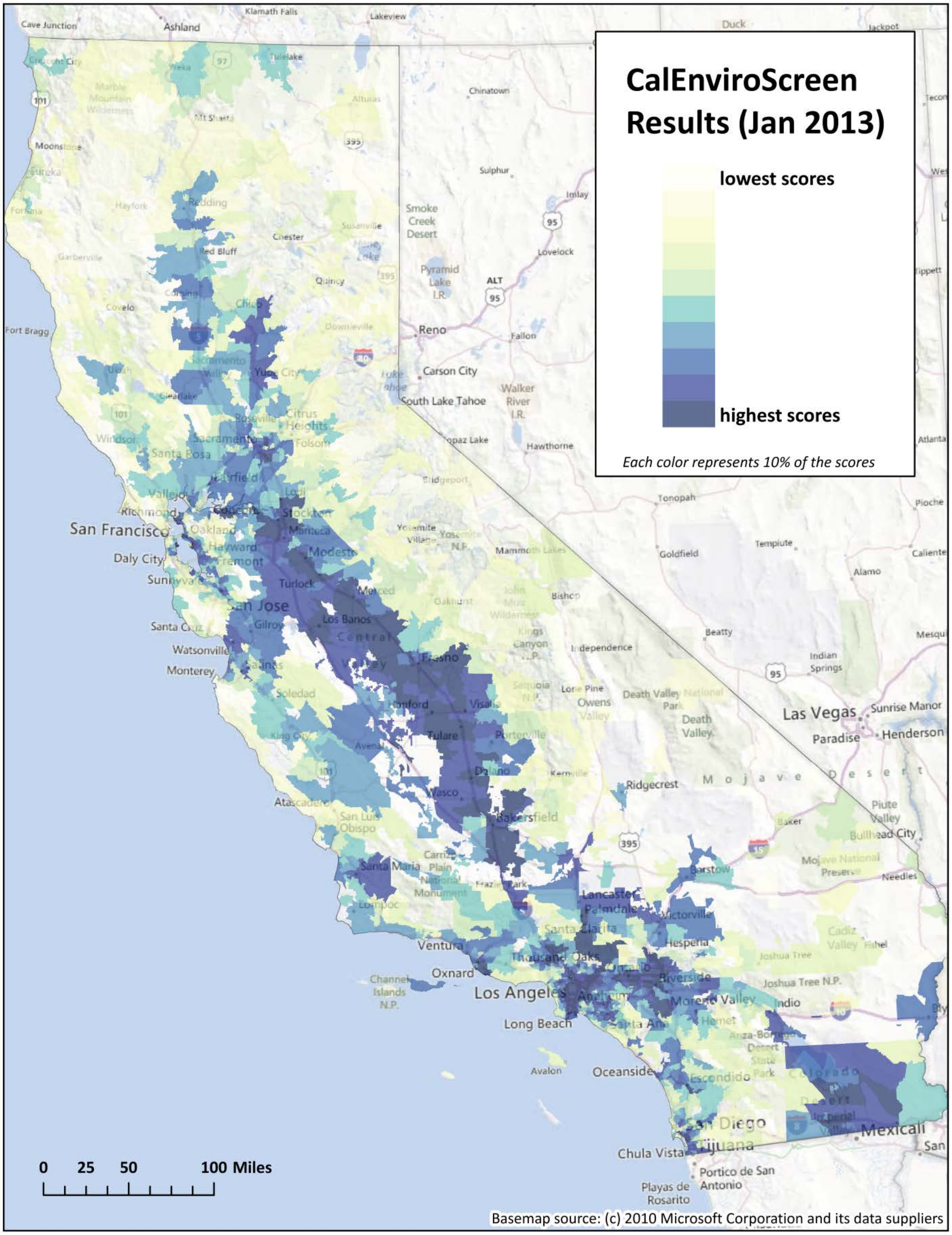
Socioeconomic Factor Indicators				
Indicator	Educational Attainment (percent)	Linguistic Isolation (percent)	Poverty (percent)	Race and Ethnicity (percent)
Raw Value	31.5	18.5	55.4	83.6
Percentile	83.60	87.77	85.94	87.89

Calculation of CalEnviroScreen Score

	Pollution Burden		Population Characteristics	
	Exposures *(6 indicators)*	Environmental Effects* *(4 indicators)*	Sensitive Populations *(3 indicators)*	Socioeconomic Factors *(4 indicators)*
Indicator Percentiles	98.26 +83.28 +78.52 +29.88 +68.13 +85.87	+ (0.5 × 89.46) + (0.5 × 14.50) + (0.5 × 75.08) + (0.5 × 95.92)	23.14 + 89.48 + 93.86	+ 83.61 + 87.77 + 85.94 + 87.89
Average Percentile	581.42 ÷ (6 + (0.5 × 4)) = **72.68**		551.69 ÷ 7 = **78.81**	
Score (Range 0.1 – 10)	72.68 ÷ 10 = **7.3**		80.27÷10 = **7.9**	
CalEnviroScreen Score	7.3 × 7.9 = **57.67**			

* Indicators from the Environmental Effects component were given half the weight of the indicators from the Exposures component

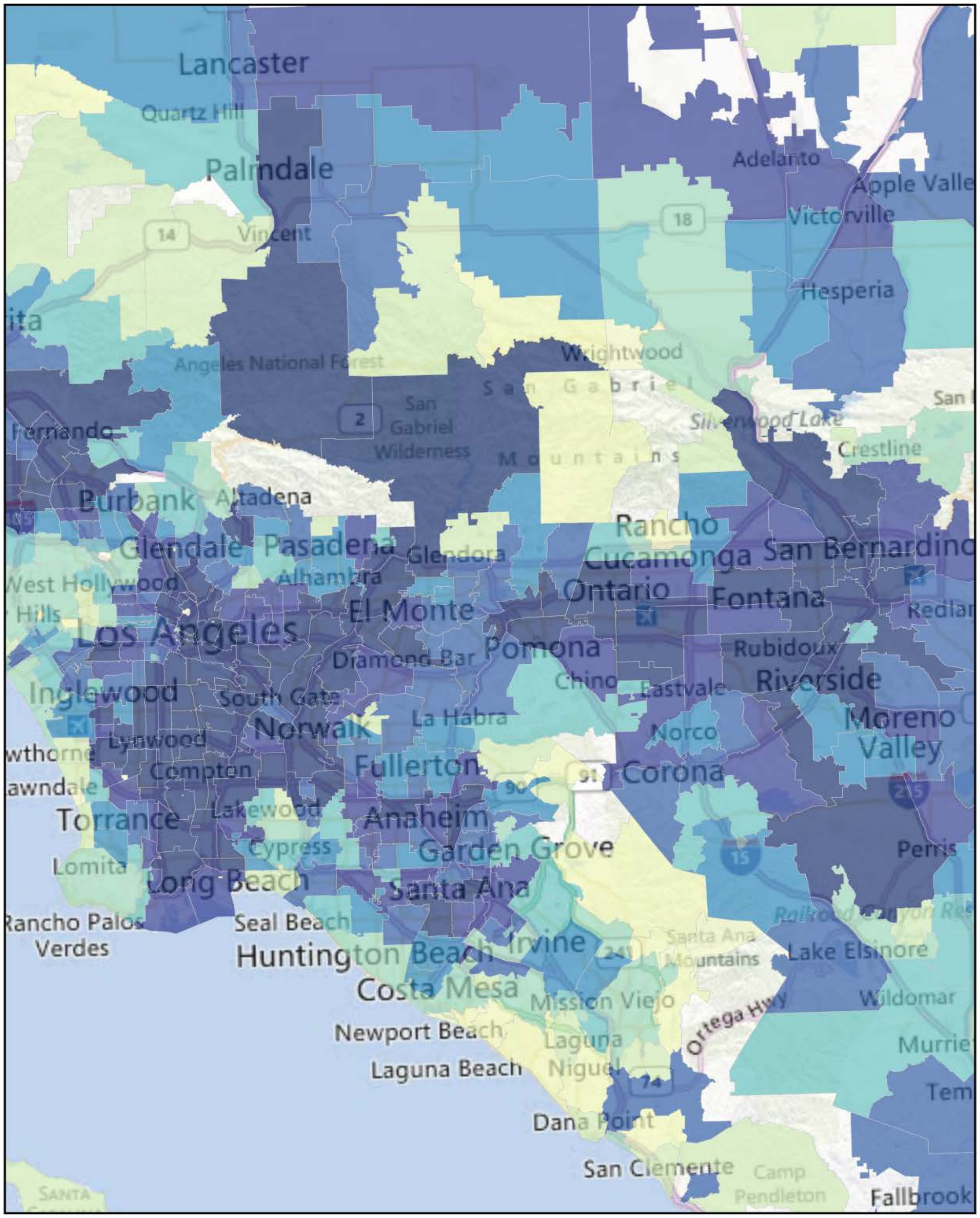
CalEnviroScreen Statewide Results


CalEnviroScreen Results (Jan 2013)
lowest scores
highest scores
Each color represents 10% of the scores
0 25 50 100 Miles
Basemap source: (c) 2010 Microsoft Corporation and its data suppliers
Ashland
Reno
Carson City
South Lake Tahoe
San Francisco
Daly City
Oakland
San Jose
Stockton
Modesto
Fresno
Bakersfield
Santa Maria
Ventura
Oxnard
Los Angeles
Long Beach
Oceanside
Riverside
Lancaster
Victorville
Las Vegas
Henderson
Paradise
Sunrise Manor
Ridgecrest
San Diego
Tijuana
Chula Vista
Mexicali
Monterey
Watsonville
Santa Cruz
Fort Bragg
Mojave Desert

CalEnviroScreen Results (Jan 2013)

lowest scores — **highest scores**

Each color represents 10% of the scores



Los Angeles Area

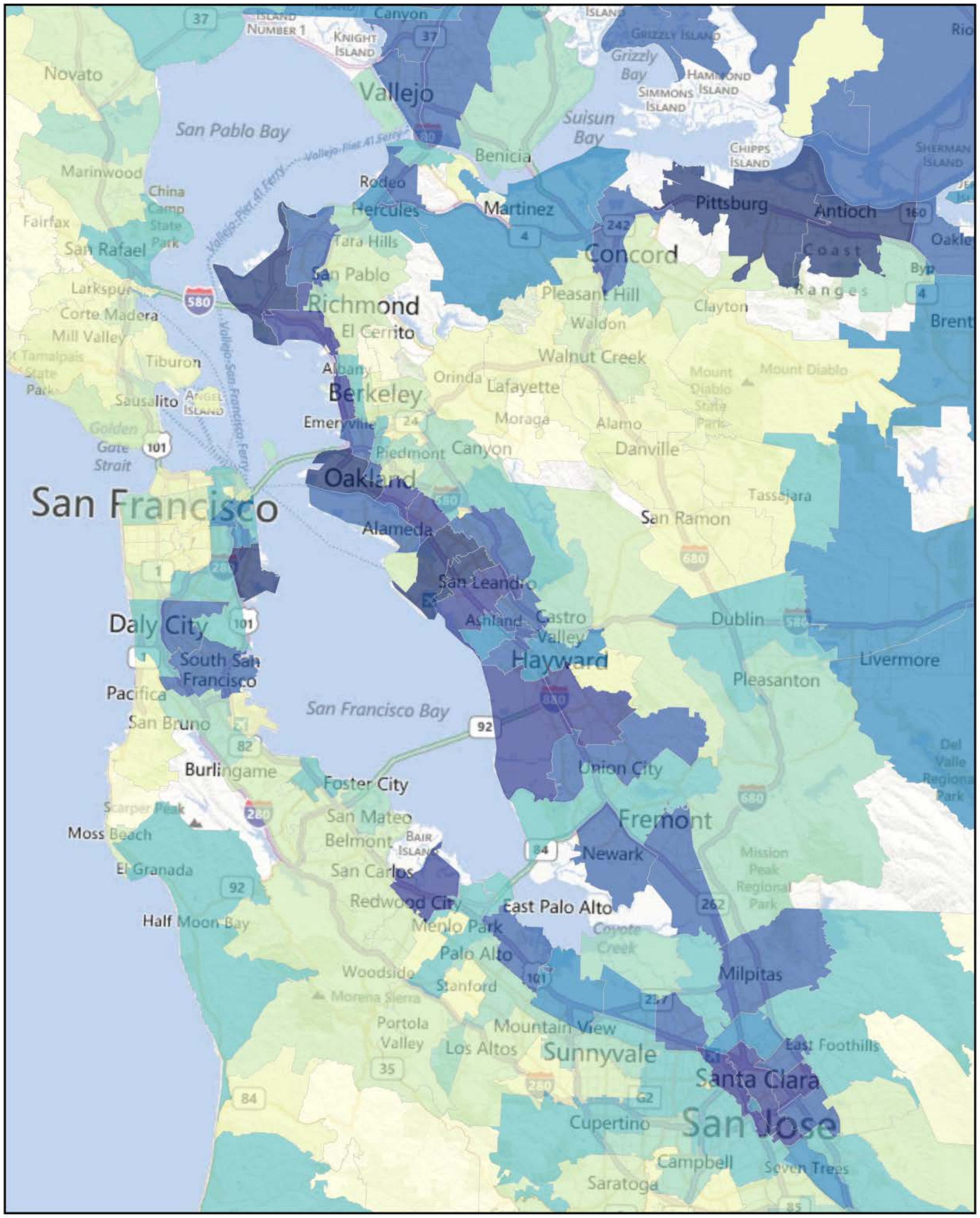
0 5 10 20 Miles

Basemap source: (c) 2010 Microsoft Corporation and its data suppliers

CalEnviroScreen Results (Jan 2013)

lowest scores **highest scores**

Each color represents 10% of the scores



San Francisco Area

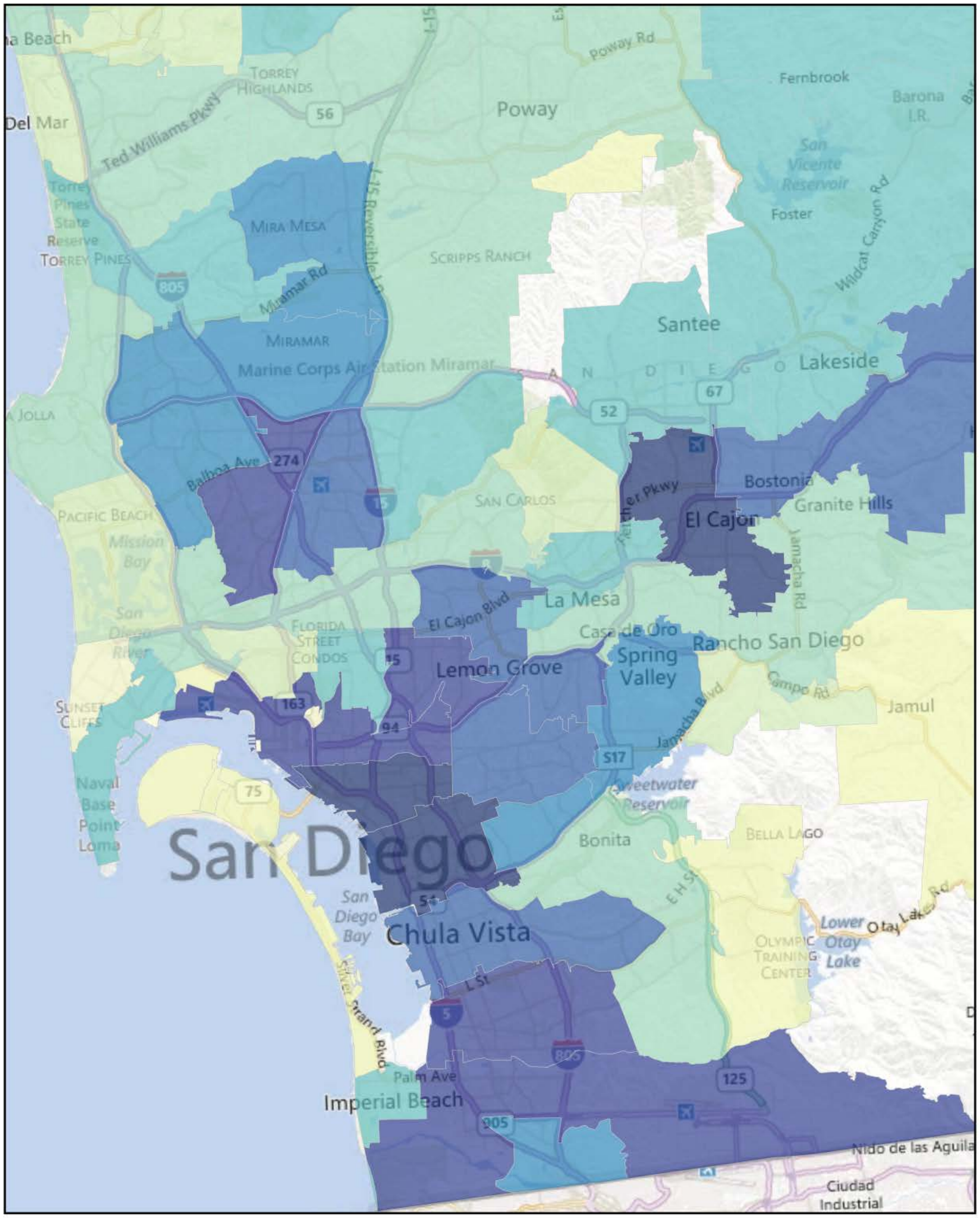
0 2.5 5 10 Miles

Basemap source: (c) 2010 Microsoft Corporation and its data suppliers

CalEnviroScreen Results (Jan 2013)

lowest scores — highest scores

Each color represents 10% of the scores



San Diego Area

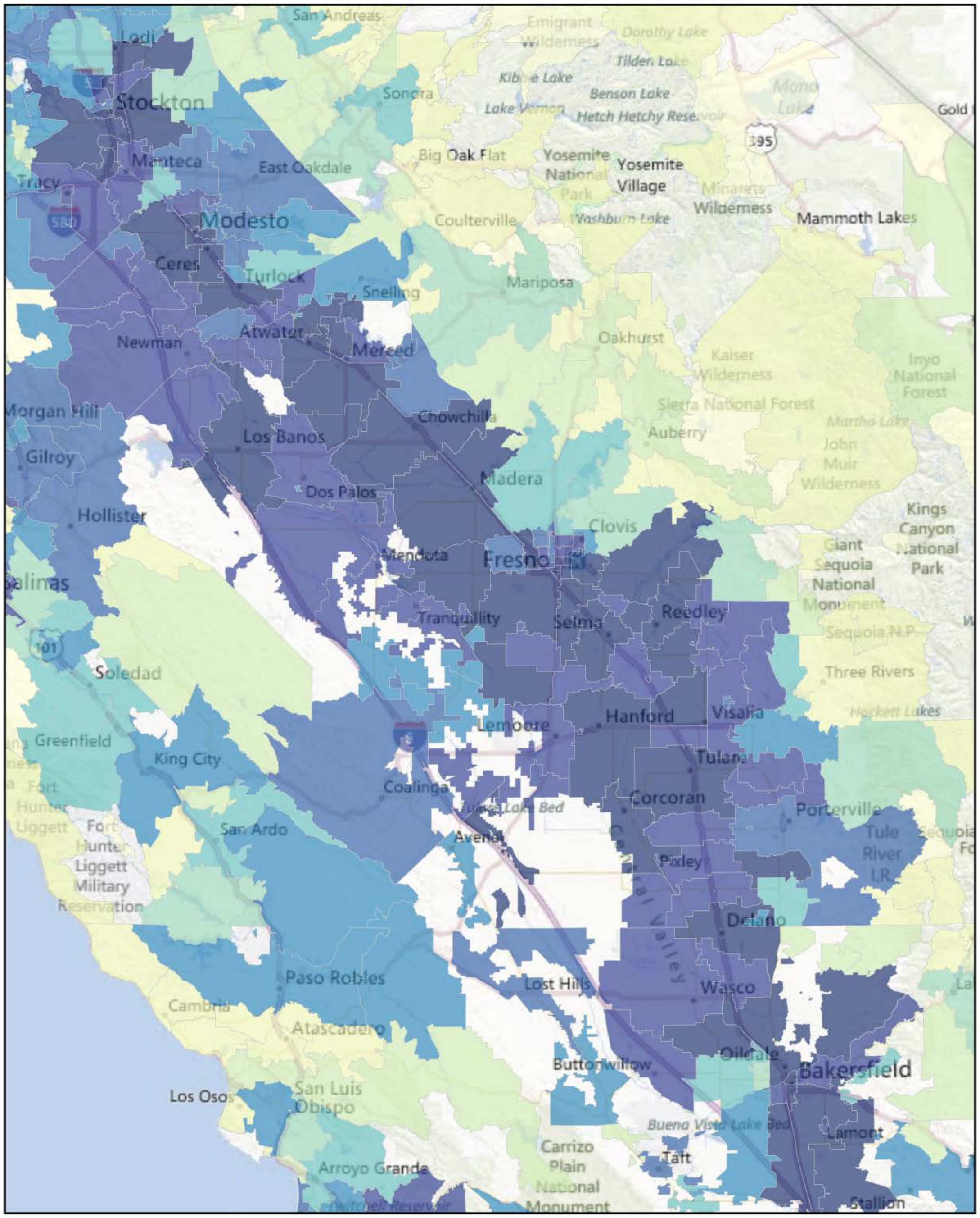
0 2.5 5 10 Miles

Basemap source: (c) 2010 Microsoft Corporation and its data suppliers

CalEnviroScreen Results (Jan 2013)

lowest scores — highest scores

Each color represents 10% of the scores



San Joaquin Valley

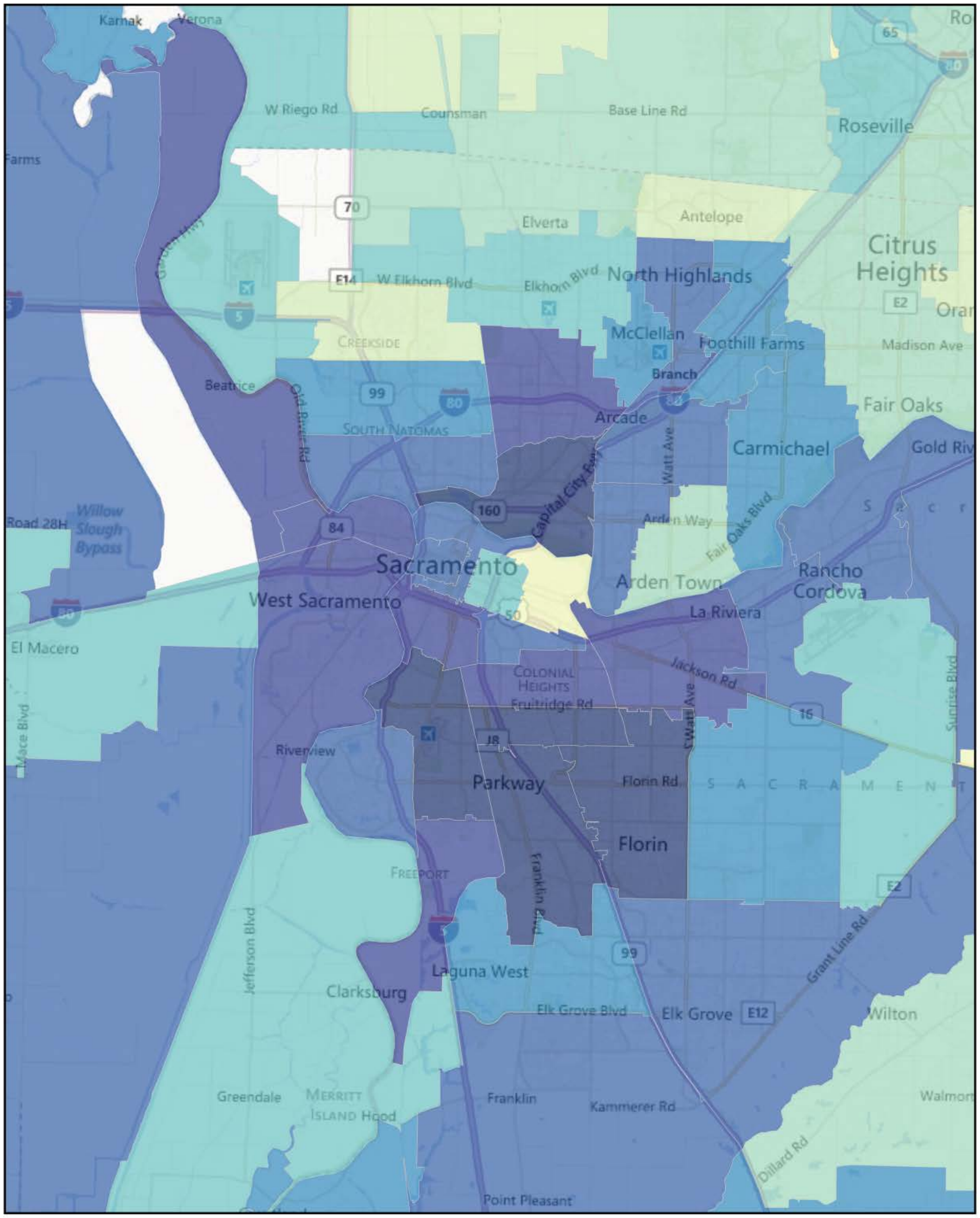
0 10 20 40 Miles

Basemap source: (c) 2010 Microsoft Corporation and its data suppliers

CalEnviroScreen Results (Jan 2013)

lowest scores — highest scores

Each color represents 10% of the scores



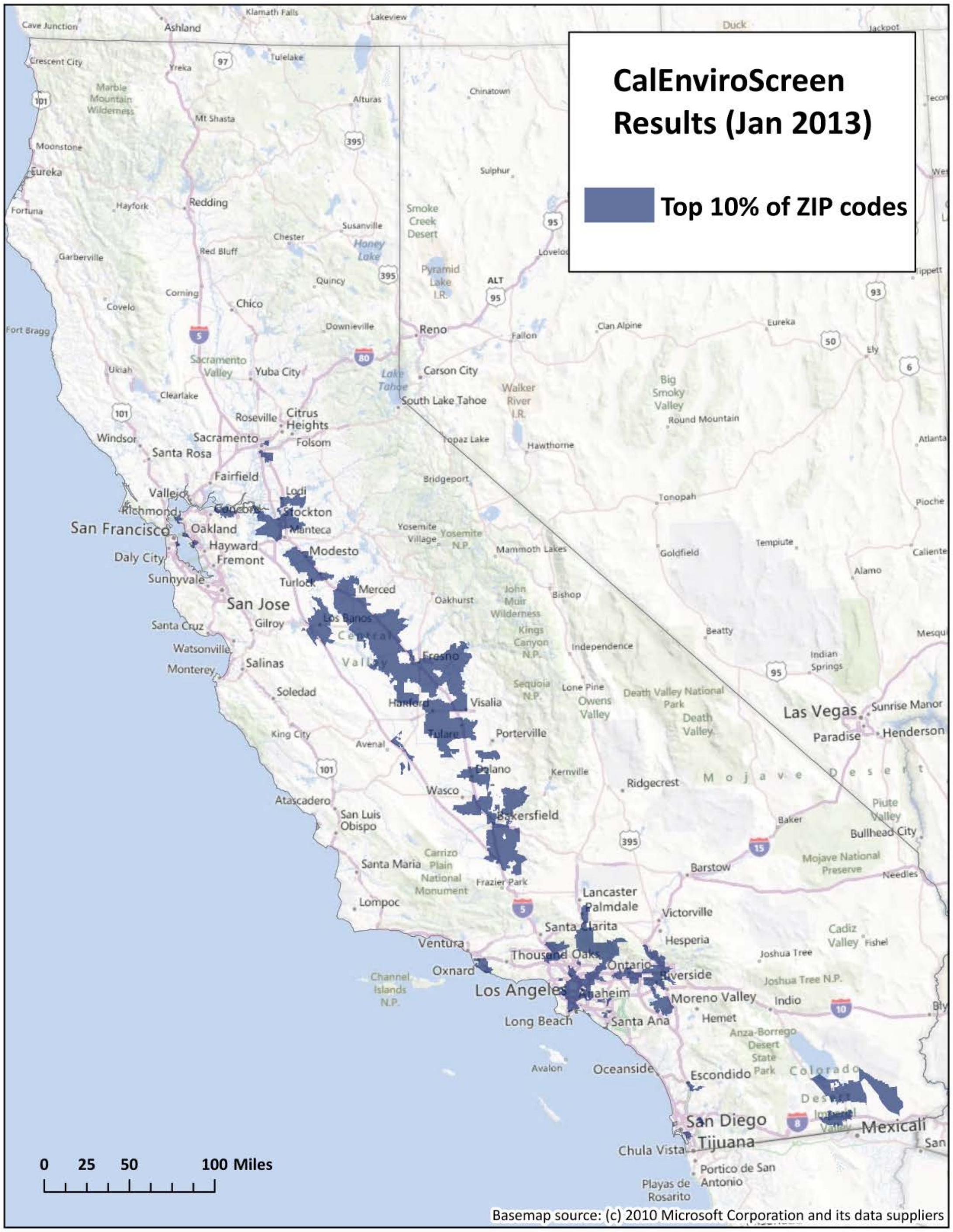
Sacramento Area

0 2.5 5 10 Miles

Basemap source: (c) 2010 Microsoft Corporation and its data suppliers

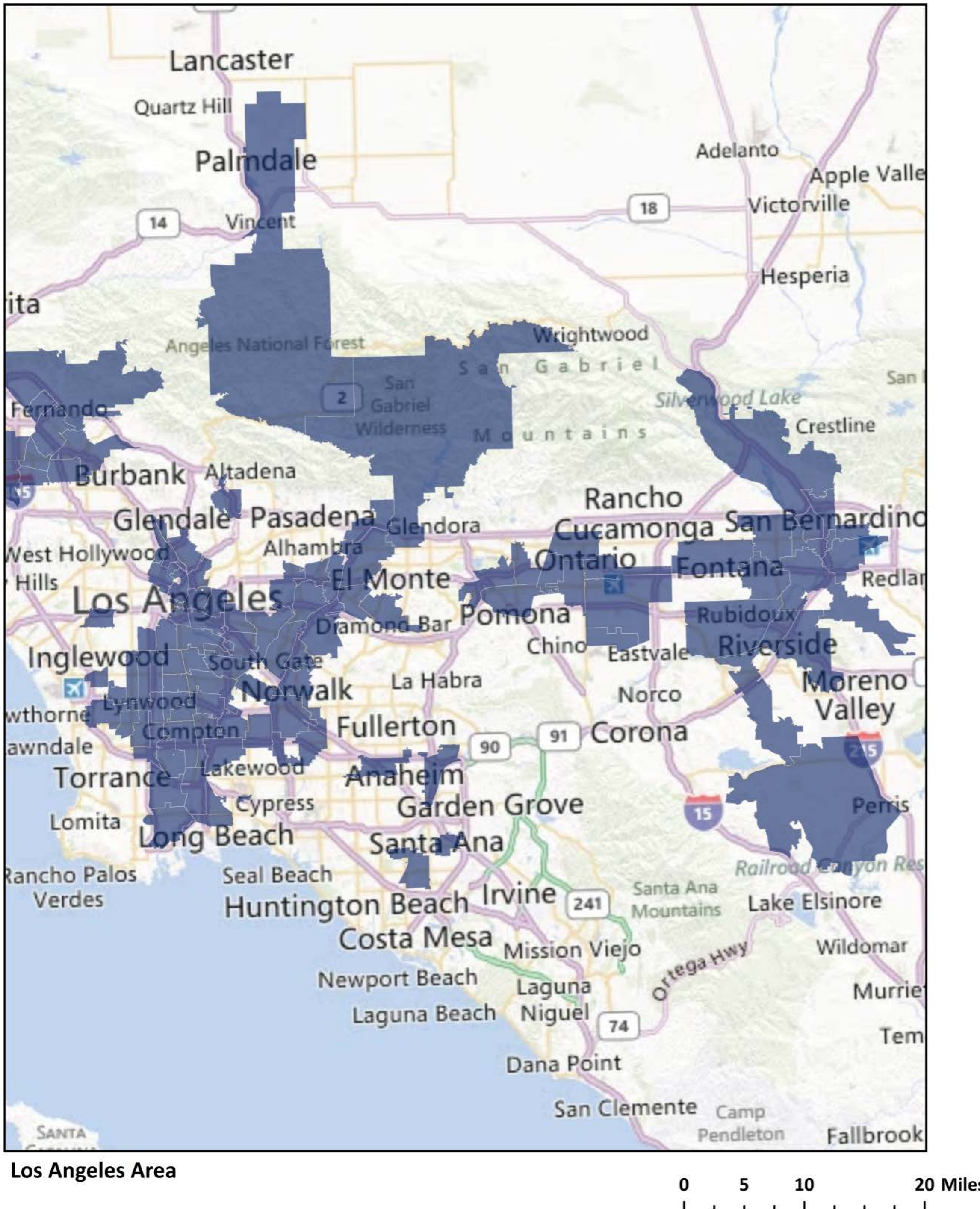
Top 10% Highest Scoring Census ZIP Codes

Using the CalEnviroScreen scores for all the census ZIP codes across the State, the 10% of the ZIP codes with the highest scores were identified. This represents 177 of the 1769 ZIP codes in the State. Because of variation in the number of people living in different ZIP codes, the population represented in these 10% of ZIP codes is about 8 million, or about 21% of the 37 million people living in California.



CalEnviroScreen Results (Jan 2013)

Top 10% of ZIP codes

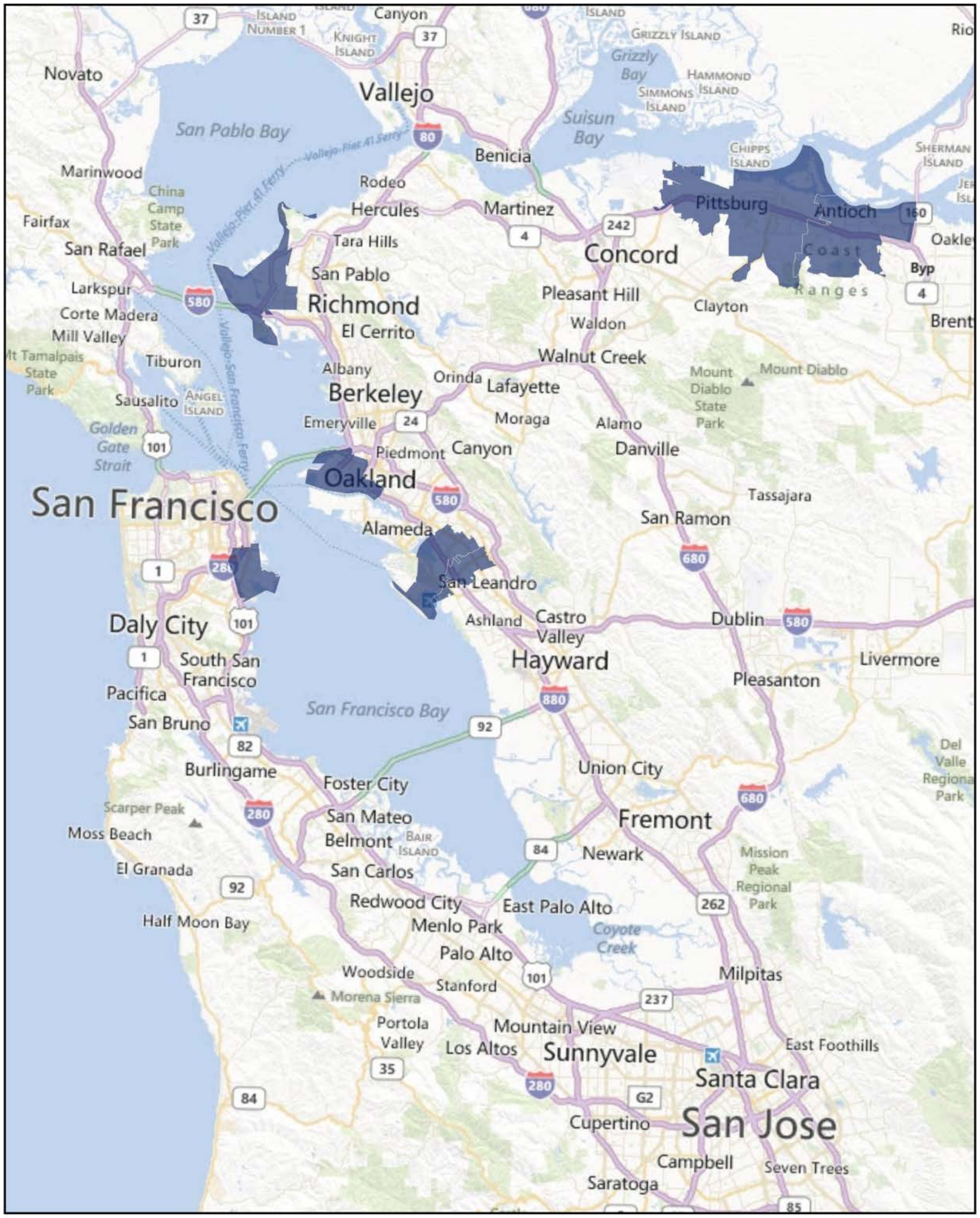


Los Angeles Area

Basemap source: (c) 2010 Microsoft Corporation and its data suppliers

CalEnviroScreen Results (Jan 2013)

Top 10% of ZIP codes



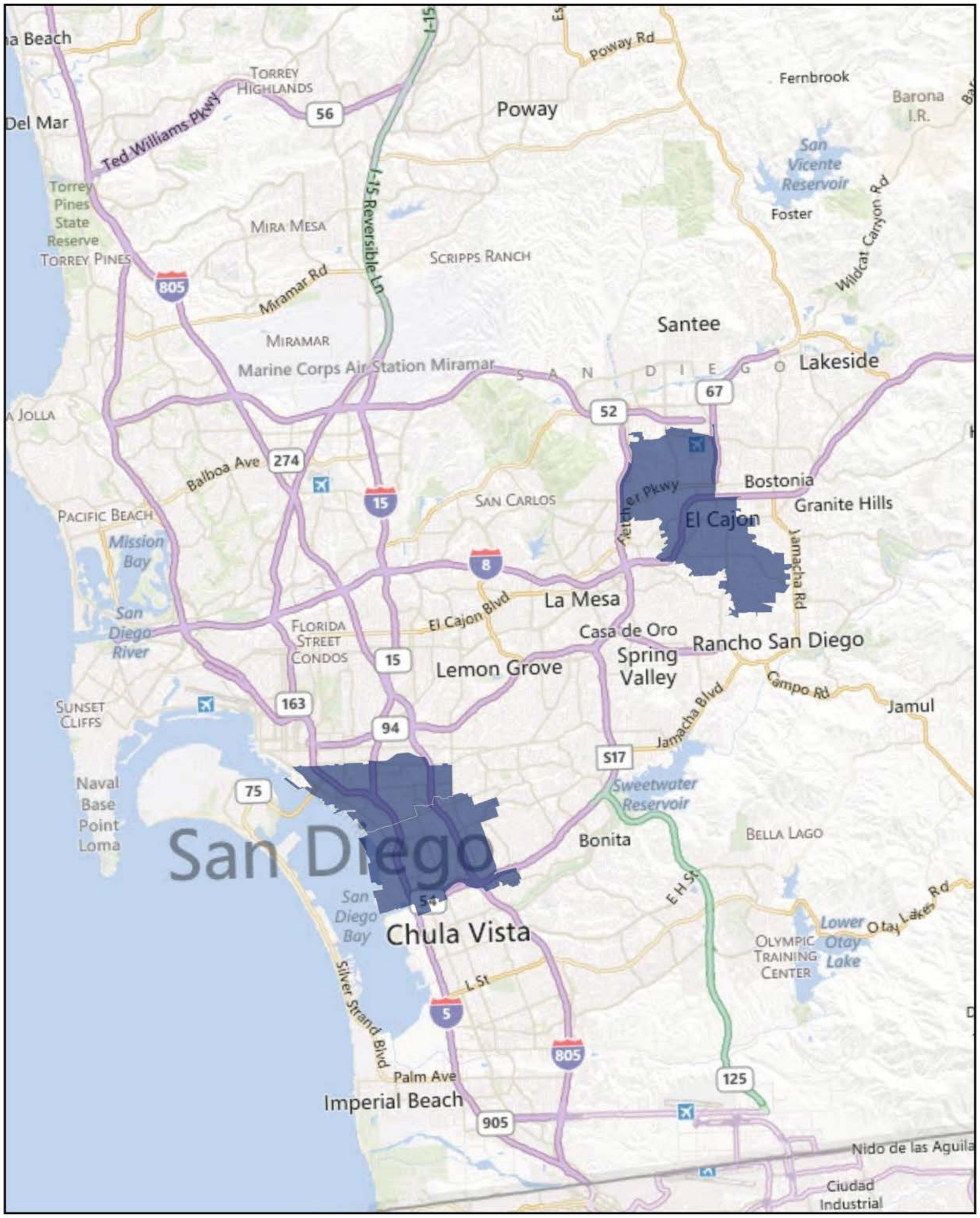
San Francisco Area

0 2.5 5 10 Miles

Basemap source: (c) 2010 Microsoft Corporation and its data suppliers

CalEnviroScreen Results (Jan 2013)

Top 10% of ZIP codes



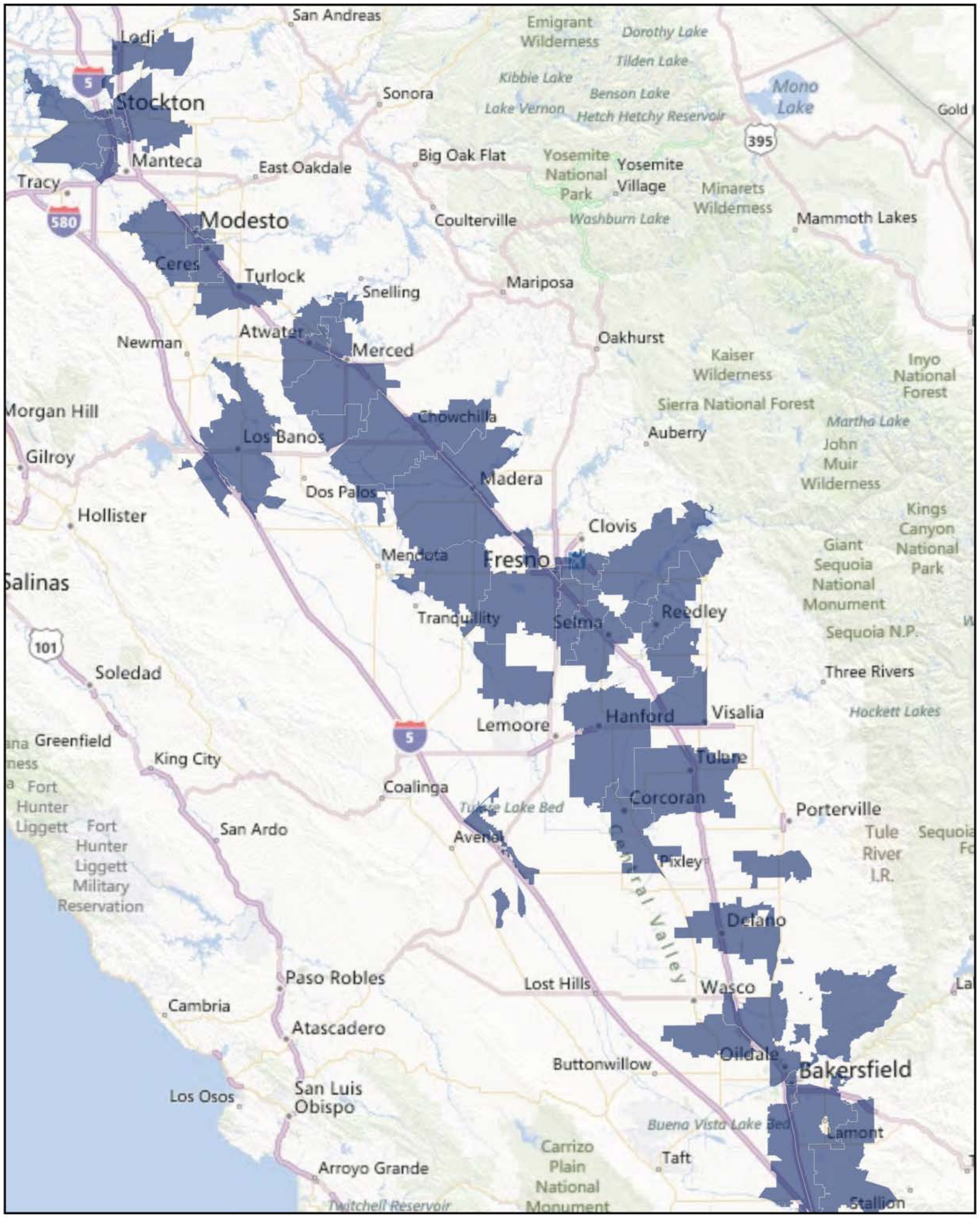
San Diego Area

0 2.5 5 10 Miles

Basemap source: (c) 2010 Microsoft Corporation and its data suppliers

CalEnviroScreen Results (Jan 2013)

Top 10% of ZIP codes



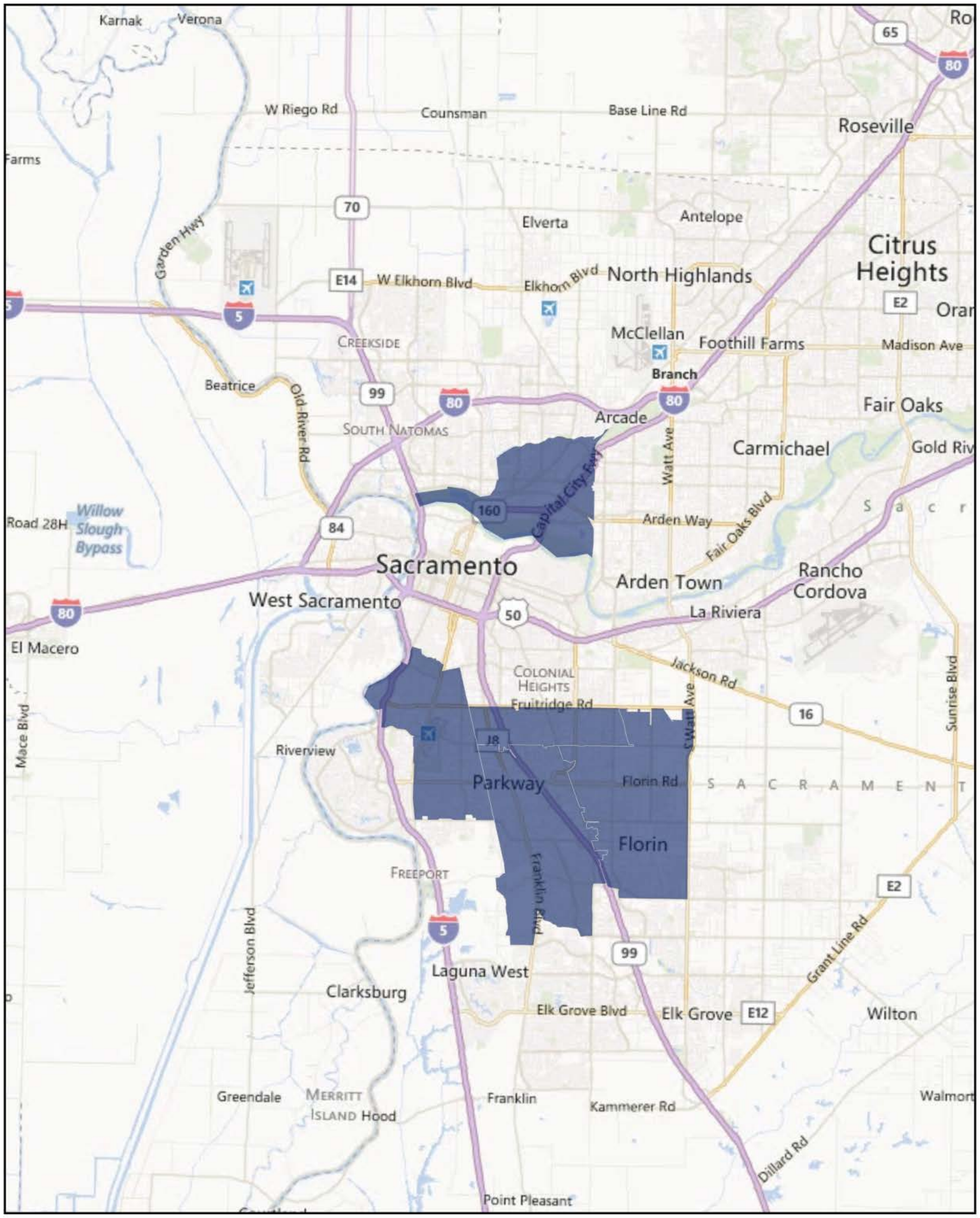
San Joaquin Valley

0 10 20 40 Miles

Basemap source: (c) 2010 Microsoft Corporation and its data suppliers

CalEnviroScreen Results (Jan 2013)

Top 10% of ZIP codes



Sacramento Area

0 2.5 5 10 Miles

Basemap source: (c) 2010 Microsoft Corporation and its data suppliers