LAND OF RISK

LAND OF OPPORTUNITY





Cumulative Environmental Vulnerabilities in California's San Joaquin Valley

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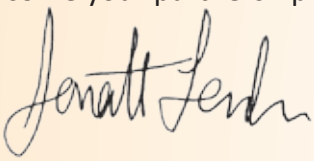
PREFACE

The diverse people and places of California's San Joaquin Valley are a source of great wealth for the state, nation, and world as a whole. Working in collaboration with community leaders from the region's public, private, and civic sectors to inform policies and strategies serving the public good is an important part of the UC Davis Center for Regional Change's mission and reflects our values as a public Land Grant institution.

This report, *Land of Risk/ Land of Opportunity*, is the product of an extensive partnership of mutual teaching and learning between the Center for Regional Change and community leaders from throughout the region, organized as the San Joaquin Valley Cumulative Health Impacts Project. In it, we employ innovative analyses of environmental and social inequities in the San Joaquin Valley that serve as the basis for a set of recommendations on how to protect the health and well-being of the region's most vulnerable populations.

Our intention is that the report will be used by policy makers, regulators, foundations, and community leaders as a factual basis for constructive dialogue on how to resolve some of the region's most vexing problems.

Thank you for your interest in the well-being of California's heartland, the San Joaquin Valley. We welcome your partnership in this important work.



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The UC Davis Center for Regional Change is a solutions-oriented research center dedicated to informing the development of regions that are healthy, prosperous, sustainable, and equitable. We pursue this through engaged scholarship that is collaborative, multi-disciplinary, and applied to solving pressing issues in UC Davis' home regions of California's Central Valley, Sierra Nevada regions, and beyond.

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FOREWORD

Some years ago, I was invited – well, called out really – by a Fresno-based environmental justice activist to attend a meeting in the San Joaquin Valley. I showed up to find a group of fifty other activists, all deeply concerned about the environmental and social inequities in California's heartland and wondering why so few academics and agencies had given the area the environmental analysis it deserved.

They had a point. While environmental justice researchers, including those with whom I have worked closely, have done a good job demonstrating disparities in coastal California, including Los Angeles, San Diego, and the San Francisco Bay Area, very few have ventured inland with their studies. This relative lack of research has persisted even as California itself has changed with rapid population growth in the Valley suggesting that this is where the state's action is and will be.

The gap between where the state is going and where research has been conducted is paralleled by another contradiction. With its rich earth and productive labor, the Valley consistently offers a bounty of produce that contributes to the nutrition and health of the nation. But as those activists in that initial meeting were rightly suggesting, in the Valley itself poverty is high, pesticides are prevalent, and problematic air and water quality contribute to the ill health of local residents.

This report seeks to close these gaps by providing research, documenting disparities, and highlighting the conditions of those most affected. Best yet, it offers a way out, a new forward-looking approach that takes into account cumulative exposure and social vulnerability, and a new set of policies that seek to stress prevention, maximize inter-agency coordination, and enhance the participation of community members in decision-making processes.

This is the first report of its kind done for the San Joaquin Valley – and UC Davis's Center for Regional Change has honored the historic nature of this research by adhering to the highest standards of scientific rigor and best practices in community collaboration. The result is both remarkable and timely, and policy makers in both the Valley and Sacramento would do well to pay close attention to the recommendations offered by the authors.

After all, the Central Valley – with its rich farmland, hard-working people, vibrant businesses, and beautiful vistas – is the newest frontier of the California Dream. And if that Dream is to include economic opportunity and good health for all, then the call to action included in this report is exactly what we need to help us get there.

Manuel Pastor, Ph.D.
Director, University of Southern California,
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Action Principles:

- ***Strive for environmental justice.*** Actions should reduce cumulative health impacts on the most affected and vulnerable communities.
- ***Action should be precautionary, not reactive.*** Agencies should act to introduce this type of precautionary, not reactive approach into decision making.
- ***Break out of silos and build bridges.*** Public agencies must work collaboratively across institutional boundaries.
- ***Residents speak for themselves.*** Agencies must engage with residents of the affected communities in a climate of mutual respect and shared learning.

Josefina Miranda of Earlimart – who once miscarried after exposure to workplace pesticides – shows her daughter how she protects herself when she works in the fields.

California's San Joaquin Valley is a place of contradictions. It contains some of the most productive and wealth-generating agricultural lands on the planet. At the same time, many of the people who produce this bounty live in poverty and often face health risks due to toxic by-products of the region's economy. The San Joaquin Valley is also a land of opportunity where California can learn important lessons on how to solve these most pressing problems to fulfill its promise as the Golden State.

This report is based on a three year study by the UC Davis Center for Regional Change, in affiliation with the Environmental Justice Project of the John Muir Institute of the Environment and with funding from the Ford Foundation. It highlights the places and populations in the San Joaquin Valley that are challenged by high levels of environmental hazards and high levels of social vulnerability that can lead to poor health conditions. It is intended to assist policy makers and public agency leaders to better prioritize actions to protect the health of the region's residents and to build healthy communities. In particular, the analysis in this report supports the recommendation that public policies must address these hazards in a coordinated way rather than the segmented approach of the current regulatory system.

Our analysis demonstrates:

- Nearly one-third of the nearly four million people in the region face both high degrees of environmental risks (for example, toxic air and water pollutants) and high degrees of social vulnerability (poverty, low levels of formal education, and low English literacy). Other research has shown that such social vulnerability increases susceptibility to environmental hazards and increases risks of health problems.

- There are many more environmental hazards identified by area residents than are documented in state and federal regulatory inventories.
- The combined conditions of environmental hazards and social vulnerability are not randomly distributed across the region but are concentrated in a range of urban and rural communities.
- These areas of high environmental vulnerability deserve special attention from regulators and policy makers to protect the health and well-being of area residents.

Our methodology integrates multiple factors into three holistic indices: a Cumulative Environmental Hazards Index (CEHI) a Social Vulnerability Index (SVI), and a Health Index (HI). Together these indices form what we call a Cumulative Environmental Vulnerability Assessment (CEVA). The areas with medium to high CEHI and SVI are called Cumulative Environmental Vulnerability Action Zones (CEVAZ). Residents in many of these CEVAZ also contend with health conditions far worse than the region as a whole.

Using the CEVA, in combination with community members' environmental knowledge derived from participatory mapping workshops with the San Joaquin Valley Cumulative Health Impacts Project, this report provides the factual basis for comprehensive and innovative environmental protection as well as public health policies for the San Joaquin Valley and beyond. Using these methods, leaders and communities can be self-empowered to create innovative strategies to address common problems for the good of the region and the state as a whole. Based on the analysis of the report's data, the authors recommend that policy makers and regulators create ways to adopt CEVA in decision-making processes on rule-making, permitting, oversight, funding, and enforcement.

Action Framework:

1. ***Build on existing strengths of demonstrated methods of cumulative impacts analysis*** developed by a range of academic and agency experts.
2. ***Integrate CEVA into existing policy and planning frameworks.*** The state of California should create an annual Cumulative Environmental Vulnerability Report Card overseen by a Cumulative Impacts coordinating body.
3. ***Move from analysis to coordinated action.*** The state of California should designate Cumulative Environmental Vulnerability Action Zones (CEVAZ) qualifying for enhanced protection, increased interagency coordination, investments, and community engagement.
4. ***Improve meaningfulness of community participation.*** Public agencies implementing CEVA should engage with affected communities as full partners and incorporate, respect, and compensate community knowledge.
5. ***Enhance resources for continued improvements in CEVA.*** California governments should invest in continued improvement of data sources relevant to CEVA, such as bio-monitoring, water quality, and longitudinal analyses.

WHY CUMULATIVE IMPACTS MATTER

The San Joaquin Valley is the heartland of California. It is an elongated bowl stretching 300 miles through the center of the state, bounded by the Sierra Nevada to the east, the coastal range to the west, and the Tehachapi Mountains to the south. Home to nearly four million people, the San Joaquin Valley contains three of the nation's top value-producing agricultural counties (Fresno, Kern, and Tulare), the state's major north-south transportation arteries (Interstate 5, Route 99, and lines of the South Pacific railroad), and California's water systems infrastructure. Sometimes called the "other California" and compared to Appalachia, the San Joaquin Valley is a land of "poverty amidst prosperity"[1] with concentrated poverty and associated social ills despite the wealth of its agricultural and natural resource industries.

Populations of largely low-income immigrants from around the world (with a predominant representation from Mexico, including significant numbers of indigenous and undocumented persons) along with African Americans, Southeast and East Asians, and others comprise the vibrant majority-minority population of the region. Many of these residents are highly mobile on a daily and yearly basis, following agricultural harvests and other jobs through and beyond the region, and commuting long distances between home and work, out of economic necessity. At the same time, contrary to their "migrant" label, many immigrants have laid down deep roots in communities across the San Joaquin Valley, where they invest in a better life for themselves, their children, and the region. The ability of these Californians to achieve success will affect the long-term success and sustainability of the region, state, and nation as a whole.

The region's booming economy – driven by agriculture but also including non-agricultural industries, such as transportation logistics, manufacturing, power generation, and prisons – produces the undesirable consequences of air and water pollution that have significant negative impacts on residents' health. The San Joaquin Valley is also the site of six of the last ten prisons built in California, prompting some to call the region the "Golden Gulag."[2]

As a result of air pollution generated by stationary agricultural and industrial sources coupled with the automobiles and diesel trucks that stream through the region's highways, residents of the San Joaquin Valley suffer from high rates of asthma and other respiratory ailments.[3],[4] Madera, Fresno, and Kings Counties for example, have rates approximately twice that of the state as a whole for asthma-related emergency room visits by young children (ages 0-4).[5] According to one recent study, the economic benefits of the region meeting air quality standards for ozone and particulate matter would top $6 billion per year in reduced health,

Figure 1: Regional Map

Nearly 1 in 5 children in the San Joaquin Valley have been diagnosed with asthma.

missed work and school, and premature death; this is equivalent to a payment of $1,600 per person per year.[6] The region's ground water is also polluted by the extensive applications of nitrogen-based fertilizers, which a recent study found disproportionately affects Latinos served with small and outdated drinking water systems.[7]

Living near freeways and rail lines, working in outdoor occupations with inadequate safety precautions, drinking polluted water, and lacking access to affordable and healthy food, health insurance, and quality medical care together create what has been described as a "riskscape."[8] These multiple factors disproportionately disadvantage those with the least means to protect themselves and their families. Moreover, a large number of the most vulnerable residents live in unincorporated communities and therefore lack direct local representation to address these issues and to hold policy makers accountable.[9]

Drawing inspiration and organizing tactics from the United Farm Workers, the civil rights movement, environmental movements, and related struggles, the environmental justice movements in the San Joaquin Valley have linked campaigns on issues ranging from pesticides exposures, diesel exhaust impacts, access to clean drinking water, and toxic waste dumps to air and water contamination from industrial dairies and other agricultural production, and more recently climate justice.[10] Activists have mobilized across and beyond the region – linking local struggles with regional, statewide, national, and even global justice movements.[11] While there are strong issue-based organizations and networks focused on problems such as health threats from pesticides, much of the environmental activism addresses multiple environmental concerns. For example, the Central Valley Air Quality Coalition (CVAQ) networks organizations working together around issues such as asthma, pesticides, prisons, dairies, transportation, labor, and land use.[12]

The stories of two communities with very high degrees of environmental hazards and social vulnerability – Monterey Park in Stanislaus County and Earlimart in Tulare County – illustrate both the challenges and the ways in which residents and advocates are mobilizing to protect the environment and their own health.

Agricultural workers face hazardous working conditions, including exposures to pesticides, dust, heat, and workplace injuries.

Monterey Park - *"Safe drinking water should be a human right, not a constant struggle."*

Regional water samples collected by the Community Water Center illustrate the limitations to the basic human right to clean water.

Monterey Park is a small, unincorporated community of about 50 homes south of Ceres in Stanislaus County. It is a diverse community of historically African American residents mixed with an increasing Latino population. The community is ringed by agriculture, with a working dairy within 100 feet of some homes and cornfields. Corn cultivation requires extensive nitrogen inputs, often using manure from area dairies, which can result in high levels of nitrogen run-off into surface and groundwater.

Monterey Park Tract obtains its drinking water from two wells: one exceeds the drinking water standard for nitrates and arsenic, and the second contains high levels of nitrates and also exceeds the drinking water standard for arsenic. High manganese levels result in a foul taste and color to the water, leading many residents to purchase bottled water at a high cost. Small communities typically cannot afford the ongoing costs of treating contaminated water; so, with funding from the California Department of Public Health and Stanislaus County, the local water district is conducting a feasibility study of drilling a new well or connecting to Ceres's water system. Virginia Madueño of Clean Water Action (and mayor of nearby Riverbank) laid out the challenge in stark terms: "Safe drinking water should be a human right, not a constant struggle."

Earlimart - *"Breathing clean air is a human right."*

Teresa DeAnda stands on the narrow strip of dirt and road that divide her home from the fields next door. Pesticide drift from these fields has sickened area residents.

Spurred into action by an acute incident of pesticide drift that sickened dozens of residents, the predominantly low-income, Latino farmworker families of the Tulare County town of Earlimart led by United Farm Workers joined with partners across the county to protect their health. Dozens of residents experienced burning eyes, shortness of breath, severe nausea, vomiting, and diarrhea when fumigant pesticides were sprayed on agricultural land bordering their homes. Despite the cold November night and the pleas for privacy, residents were ordered to disrobe and be sprayed down by high-pressure fire department hoses. In the following days, community members began organizing and filed over 100 illness reports with the Tulare County Agricultural Commissioner and the California Department of Pesticide Regulation.[13] After two more similar pesticide drift incidents in Arvin in 2002 and Weed patch/Lamont in 2003, local residents and members of the statewide coalition Californians for Pesticide Reform worked with Senator Dean Florez to pass Senate Bill 391 to require counties to develop procedures to address pesticide drift as part of their emergency response plans. It also ensures the pesticide applicator responsible for the drift pay the victims' medical costs.

In a further victory in 2008, residents from Tulare County joined together with Californians for Pesticide Reform members, including Center on Race, Poverty & the Environment, to advocate that the County Agricultural Commissioner establish protection zones preventing certain pesticide applications within ¼ mile of schools, homes, and labor camps. Following Tulare County, Kern, Stanislaus, and Madera counties also established pesticide protection zones in 2010. "Breathing clean air is a human right," said Irma Medellin, Director of El Quinto Sol de America, a community group in Lindsay. "We need to protect the health of our children and our communities by making sure that pesticides are not applied right next to where we live, work and play." For their part, growers in Kern County have organized a Spray Safe campaign to encourage communication among growers and to prevent workers in one field from being affected by neighboring growers' pesticide applications.[14]

Environmental justice and health advocates march to call for clean air for all San Joaquin Valley residents.

In contrast to the advocacy sector, the local, regional, state, and federal agencies charged with protecting the environment and health of the San Joaquin Valley's residents tend to work in institutional silos. Innovations such as the Community Air Risk Evaluation (CARE) program developed by the Bay Area Air Quality Management District and the Los Angeles Environmental Enforcement Collaborative led by U.S. EPA have not been implemented in the San Joaquin Valley.

Representative of the deeper challenges of cross-agency collaboration include the unsuccessful attempts of environmental justice advocates to encourage the California Department of Pesticide Regulation (DPR) to better coordinate its work with the California Department of Public Health.[15] Likewise, despite advocacy and litigation by environmental justice organizations, the San Joaquin Air Pollution Control District, California Air Resources Board, and DPR have achieved limited success in collaboration on the issue of smog-producing pesticide applications in the region.[16]

While the San Joaquin Valley Air Pollution Control District has made important progress in identifying "environmental justice communities" through its environmental justice map, its limited criteria of income and race/ethnicity have resulted in a map that includes nearly the entire region.[17] This is not to say that the entire region is not deserving of dedicated efforts to protect environmental and public health, but simply to say that such maps do not provide the finer-grained analysis needed to inform strategic action.

To address these shortcomings, a number of recent innovative methodologies have highlighted the ways in which multiple socio-economic and political factors of vulnerability and environmental hazard exposures occur in layered and interactive ways. Pioneering work by researchers such as Amy Kyle, Rachel Morello-Frosch, Manuel Pastor, and Jim Sadd offers a sophisticated set of environmental justice indices and screening methods to map and target vulnerable communities for interventions to improve current conditions and prevent future harm.[18] Some of these innovations have been adopted by public agencies at the state and federal levels.[19] These approaches offer the analytical basis to increase the transparency and accountability of environmental and health protection regulation.

Research on public health risks and health promotion has shown the value of considering environmental hazard data along with social vulnerability data.[20] Recent innovations in the assessment of factors shaping health conditions have highlighted the value of constructing multi-indicator indices to provide a more comprehensive and understandable approach. This study gathered the latest available public data sets for the San Joaquin Valley and compiled them into two indices: a Cumulative Environmental Hazards Index (CEHI) and a Social Vulnerability Index (SVI). Together, these two indices form the basis of a Cumulative Environmental Vulnerability Assessment (CEVA). We also developed a Health Index (HI), which integrated indicators that other research has shown to be correlated to environmental hazard exposures and exacerbated by social vulnerability factors.[21] (The Technical Appendix provides more detail on the study methods.)

Cumulative Environmental Hazards Index (CEHI)

The Cumulative Environmental Hazards Index (CEHI) was developed by integrating six environmental data sets to identify the places bearing the highest potential environmental burdens.

Four data sets identify point source pollution sites, utilizing the most recent available (2006) data reported to the U.S. Environmental Protection Agency (U.S. EPA): toxic release inventory (TRI) sites, hazardous waste treatment, storage and disposal facilities (TSD), chrome platters, and refineries. Toxic release inventory (TRI) and hazardous waste treatment, storage, and disposal facilities (TSD) sites are widely used in research to assess regional pollution. We incorporated data on chrome platters and refineries, which are sometimes not included in TRI and hazardous waste TSD data, to provide a fuller measure of pollution sources. It is important to note that these data identify only the location of pollution point sources, not the actual exposure or the toxicity of the pollutant.

Health risks are added to these point sources through the National-Scale Air Toxics Assessment (NATA), which estimates total cancer risk associated with inhaled hazardous air toxics. The CEHI uses the most recent 2005 NATA data on the total risk of cancer: integrating point and nonpoint cancer risk, road and non-road cancer risk, background cancer risk and secondary cancer risk. NATA also includes non-cancer risk from diesel emissions. NATA also takes into consideration wind flow and other factors when calculating air toxic travel and cancer risk by census tracts.

Because pesticides are a significant pollution source in the region, we also included the most recent data available (2007) on the total amount of active ingredient per square mile to represent pesticide density reported by the DPR. However, we did not have data to include the impact of pesticide drift, which would have likely increased the hazard rating for pesticides.

Social Vulnerability Index (SVI)

The Social Vulnerability Index (SVI) measures two dimensions of vulnerability: sensitivity of residents and the availability of social and economic resources to prevent or mitigate impacts. The Social Vulnerability Index is composed of six data sets.[22]

Sensitive receptors are identified by the presence of in-patient health care facilities and the percent of population younger than five or older than 60. Children, senior citizens, and people with health conditions have been shown to be more sensitive to various pollutants. We used locations of health care facilities as a proxy for the presence of people with health conditions that may be exacerbated by environmental contaminants (for example, hospital patients whose immune systems may be suppressed).[23]

The level of social and economic resources available to minimize the potential health impacts of environmental hazards is measured by percent of households below the federal poverty rate, percent of people older than 25 without a high school degree, percent of households with no members older than 14 with English fluency, and percent of people of color (those other than non-Hispanic Whites). We selected these data sets based on existing studies of social vulnerability[24] as factors that affect the ability to effectively respond to hazardous conditions. For example, without a fluent English-speaker in the household, it would be very challenging to effectively engage with policy makers and regulators who tend to operate in English-only settings. Likewise, low levels of formal education in a population can often result in a limited capacity to interpret, comment upon, and even produce alternative analyses of environmental documents.

Health Index (HI)

A Health Index (HI) was constructed from data on rates of low birth weight, years of potential life lost before age 65, and rates of asthma hospitalization rate for people 0-19 years old. These factors have been correlated with a range of environmental hazards.[25] For each zip code, the maximum value of the three health indicators was assigned as the value of health index.

Community Mapping

Residents of Kettleman City, including environmental justice advocate Maricela Mares Alatorre (right) documented multiple environmental hazards not accounted for in public data.

Based on the preliminary maps and indices, UC Davis researchers and partners with the San Joaquin Valley Cumulative Health Impacts Project (SJV CHIP) selected a range of places to hold community-mapping workshops. In particular, communities selected were characterized by high CEHI and SVI scores, located in a diverse range of the region's rural and urban areas, incorporated and unincorporated areas, and were also places where the SJV CHIP had strong grassroots networks that would help facilitate effective community engagement and ensure application of results to community organizing.

The goals of the community mapping workshops were to: (1) facilitate participants' active discussion of the pollution sources that impact them; (2) capture location and descriptors of specific pollution sites not accounted for in public data sets; (3) further develop university-community partnerships with SJV CHIP; and (4) create maps and reports that members can use in their efforts to reduce, remove, or prevent the burdens of multiple sources of pollution in their communities.

SJV CHIP hosted four community mapping workshops in the urban neighborhood of West Fresno; the rural communities of Wasco, Arvin, and Lamont (Kern County); Matheny Tract (Tulare County); and Kettleman City (Kings County). At each workshop, UC Davis researchers shared maps on social vulnerability and pollution sources based on public data at the regional and community scale. SJV CHIP members facilitated a process through which participants documented pollution sources on large aerial images, focusing on sources that might not be captured in official data. UC Davis researchers then incorporated the local data into digitized maps.

Community mapping helped enhance the analysis of environmental hazards and social vulnerability in the region, especially in those areas where publically-available data tell only part of the story. One example of the value of community engagement in environmental and health research is that of Kettleman City in Kings County. Because the one major toxic waste facility in the area is located outside the formal boundaries of Kettleman City, and because the area of Kettleman City is only one tenth of the total area of its surrounding block group, the severity of its environmental hazards and social vulnerability are also not easily captured in the publically-available data.

Kettleman City - *Community mapping workshops documenting environmental hazards have highlighted multiple health risks in the area.*

Kettleman City sits next to the largest hazardous waste landfill in the western United States.

Kettleman City in rural Kings County is a community of 1,500 residents, 97% of which are Latino, and the majority are monolingual Spanish-speaking farmworkers. Residents live near diesel emissions from passing trucks on Interstate 5 and Highway 41, pesticides exposure from surrounding fields, water contaminated with arsenic and benzene, air emissions from benzene, old oilfield operations, and the largest hazardous waste landfill in the western United States. Residents report ongoing health concerns such as asthma, cancer, miscarriages, infant deaths, and birth defects, including at least 5 with cleft palate (3 of whom died in infancy) between 2007 and 2010.

El Pueblo Para El Aire y Agua Limpio/People for Clean Air and Water of Kettleman City, with the support of Greenaction for Health and Environmental Justice, Center for Race Poverty & the Environment, California Rural Legal Assistance, Inc., and other organizations, have launched several campaigns to protect Kettleman City residents' health, including the campaign that stopped what would have been California's first toxic waste incinerator in the late 1980s. More recently, these organizations have advocated for a reduction in air, water, and land-based pollution sources in the area, including opposing the proposed expansion of the hazardous waste landfill. Community mapping workshops documenting environmental hazards, coupled with resident-mobilized community health surveys, have highlighted multiple health risks in the area.

CUMULATIVE HEALTH IMPACT ACTION ZONES: PROTECTING PEOPLE AND PLACES AT RISK

Our **Cumulative Environmental Vulnerability Assessment (CEVA), using the data described above, affirms what many community members and advocates suspect: that environmental hazards tend to be clustered around populations with high and very high levels of social vulnerability.** In addition, there are many people with high degrees of adverse health conditions living in these challenging social and environmental conditions that deserve special attention from policy makers and regulators.

Cumulative Environmental Vulnerability Action Zones (CEVAZ) are identified as the neighborhoods (census block groups) with the highest degrees of both Cumulative Environmental Hazards and Social Vulnerability. These areas have the fewest social resources to address the most extreme concentration of environmental hazards. They are therefore deserving of special attention for environmental and health protections, investments, capacity-building, and other resources. We call these "Cumulative Environmental Vulnerability Action Zones" to call out the need for immediate and coordinated action to protect the health of residents in these areas.

Populations with high social vulnerability tend to be the most susceptible to the impacts of cumulative environmental hazards.[26] For example, poor living conditions tend to subject socially vulnerable populations to higher doses of a given pollutant (for example, living and working without air conditioning means no access to air pollutant filtration). In addition, socially vulnerable populations tend to have higher degrees of economic, political, and social stresses on both an individual and community level. For some, this means limited or no access to quality health care and healthy food, exacerbating the impact of pollution on their health. Populations of non-citizens, undocumented residents, and persons who do not speak English fluently tend to have limited access to effective political representation and communication with officials. Together these factors create a mutually reinforcing cycle in which highly vulnerable populations have greater difficulty preventing the siting of new hazardous facilities in their neighborhoods, pushing existing polluting facilities out, and mitigating the health impacts.[27]

The relationship between the Cumulative Environmental Hazards Index (CEHI) and the Social Vulnerability Index (SVI) on a regional scale is illustrated in Table 1, which enumerates the areas with the most elevated environmental hazards and social vulnerability. This table illustrates that there are over 1.1 million people, accounting for 31% of the region's population living in CEVAZ. This table also shows that there are an additional 20% people at risk of cumulative environmental vulnerabilities (medium SVI and medium CEHI), bringing the total vulnerable population to over the half the region's residents.

This population tends to be made up of larger proportions of people in poverty and people of color. For example, we found that those areas with the highest CEHI were comprised of 61% people of color and where 24% live below the poverty line; while those areas with the lowest CEHI were only 47% people of color and 17% lived below the poverty line.

Table 1: Identification of Cumulative Environmental Vulnerability Action Zones

CEHI → \ SVI →			
	Low SVI	**Medium SVI**	**High SVI**
High CEHI	**Low SVI/High CEHI** Population: 17,945 % of Valley Population:<1% % in Poverty: 7% % Non White: 23%	**Medium SVI /High CEHI** Population: 563,780 % of Valley Population: 15% % in Poverty: 16% % Non White: 48%	**High SVI /High CEHI** Population: 369,338 % of Valley Population: 10% % in Poverty: 37% % Non White: 82%
Medium CEHI	**Low SVI/Medium CEHI** Population: 84,579 % of Valley Population: 2% % in Poverty: 8% % Non White: 22%	**Medium SVI/Medium CEHI** Population: 746,720 % of Valley Population: 20% % in Poverty: 16% % Non White: 50%	**High SVI /Medium CEHI** Population: 232,036 % of Valley Population: 6% % in Poverty: 34% % Non White: 82%
Low CEHI	**Low SVI/Low CEHI** Population: 289,153 % of Valley Population: 8% % in Poverty: 7% % Non White: 25%	**Medium SVI/Low CEHI** Population: 1,162,596 % of Valley Population: 31% % in Poverty: 14% % Non White: 44%	**High SVI /Low CEHI** Population: 325,386 % of Valley Population: 9% % in Poverty: 34% % Non White: 79%

CEVAZ are identified as the three categories in the upper right sector of this matrix and characterized by either High CEHI/High SVI, High CEHI/ Medium SVI, or Medium CEHI/ High SVI.

Putting these numbers on a map, Figure 2 illustrates all nine of these CEVA categories across the region. Figure 3 shows only the three categories that make up the CEVAZ: those areas with the highest degrees of cumulative environmental hazards and social vulnerability. The CEVAZ are colored in the dark orange, red, and crimson.

Figure 2: Cumulative Environmental Vulnerability Assessment (CEVA)

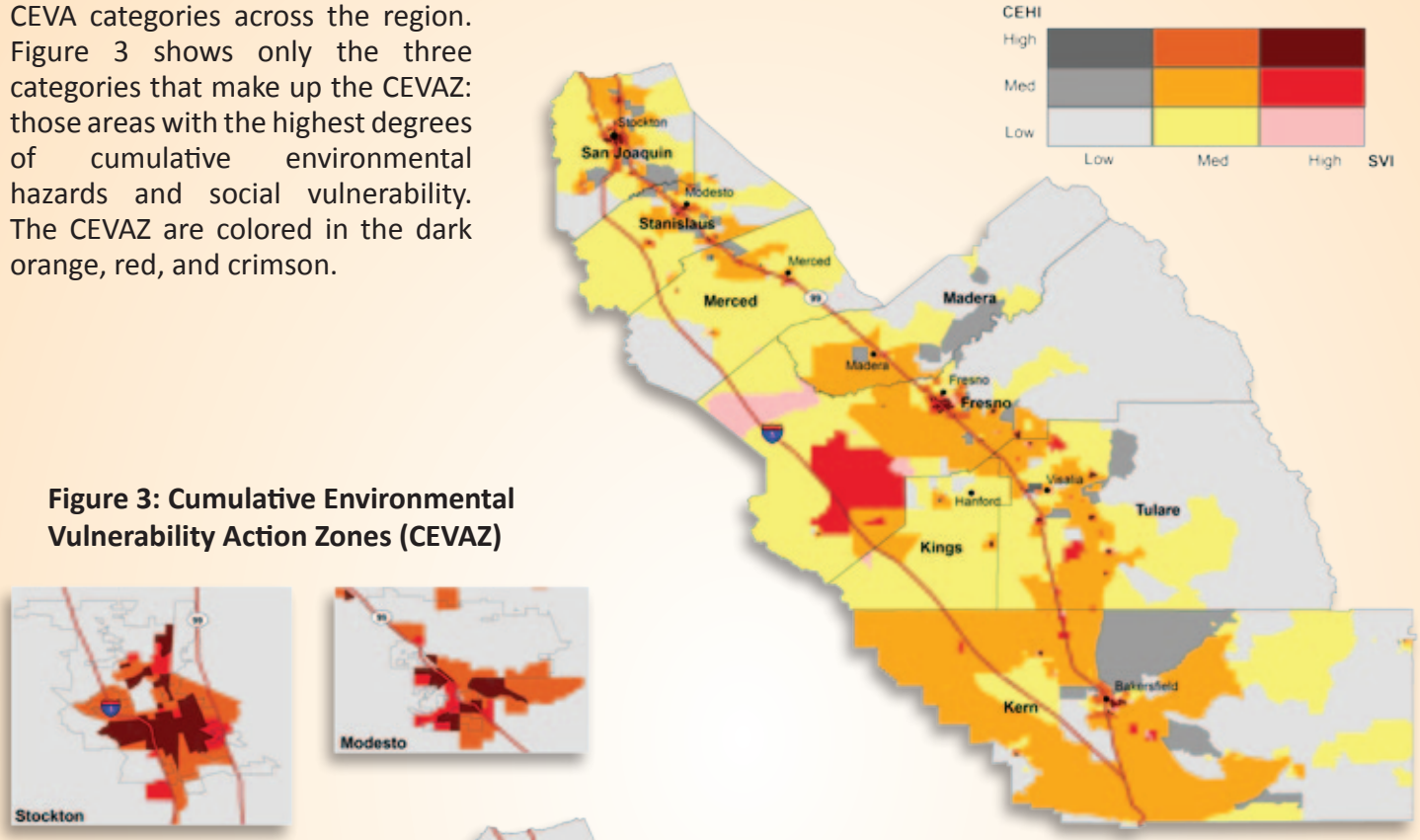
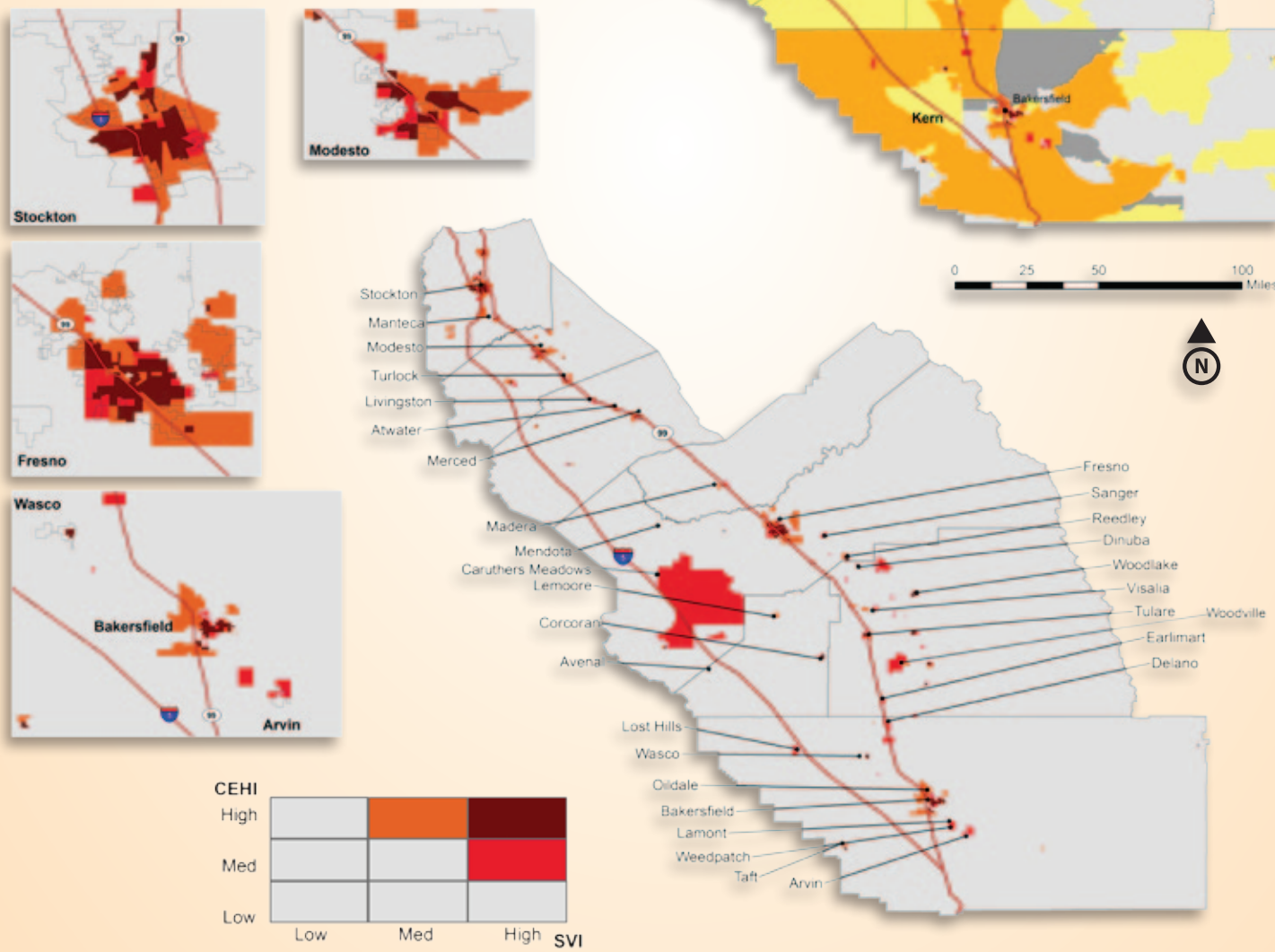


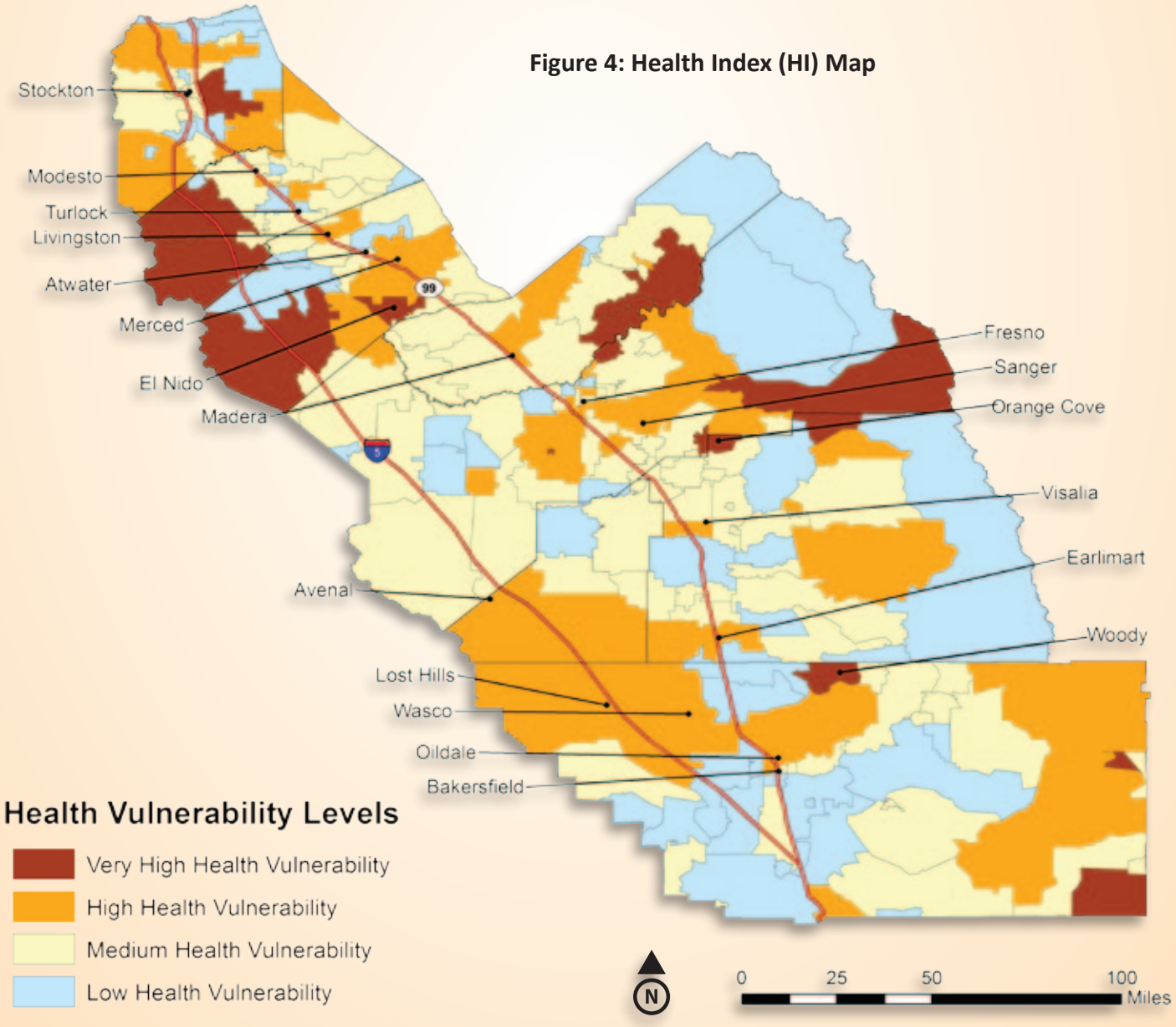
Figure 3: Cumulative Environmental Vulnerability Action Zones (CEVAZ)



The map of CEVAZ reveals two important patterns. First, in urban areas with the highest levels of environmental hazards and social vulnerability, there is a patchwork pattern of separate and unequal places. Second, significant overlap between environmental hazards and social vulnerability also occurs in many small, rural towns throughout the region where low-income communities and communities of color live amidst agricultural fields with intensive pesticide applications and non-agricultural industries such as power plants and waste disposal facilities. Third, many of these CEVAZ also are characterized by high levels of cumulative health problems.

Health conditions are caused by a wide range of factors, including genetics, individual behaviors, health care, and the social and physical environment. This study addresses only the issue of social and physical environment, and therefore does not provide a comprehensive analysis of the causes of health problems in the region. However, using the Health Index, this study demonstrates that there are many thousands of people living in CEVAZ who are contending with a range of health problems that other research has shown to be correlated with environmental and social stressors. The Health Index in the CEVAZ is illustrated in Figure 4.

Figure 4: Health Index (HI) Map



Urban Communities at Risk

An example of an urban CEVAZ, where residents contend with multiple environmental hazards and social vulnerabilities, is West Fresno.

West Fresno - *"The City of Fresno is one body; if one part of the body is ill, the entire body should respond."*

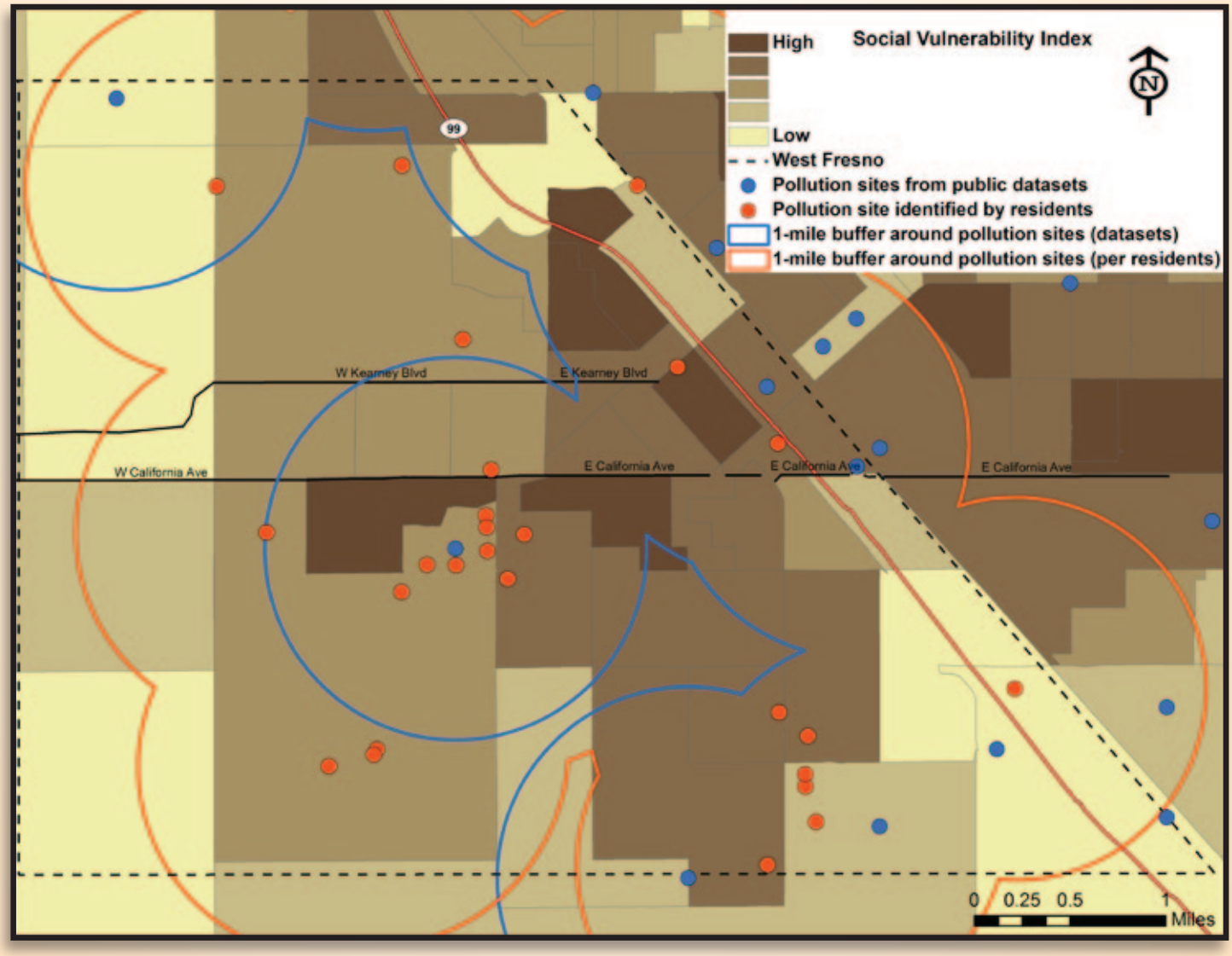
West Fresno area leader, Mary Curry, uses a community-generated map of environmental hazards in a rally calling for the closure of a noxious rendering plant in the neighborhood.

For more than four decades, the predominately African American and Latino residents of West Fresno (who make up 85% of the neighborhood's population) and their allies have opposed the concentration of undesirable facilities in their community. West Fresno bears the burden of the vast majority of the city of Fresno's toxic industrial and environmental stressors (34: counting eight sites identified in public data sets and 26 resident-identified sites as shown in Figure 5), including slaughterhouses and meat processing plants, waste dumps, a wrecking yard, a sewage treatment plant, a biomass processing and recycling plant, and hundreds of contaminated sites designated as potential Brownfields by the U.S. EPA. This pattern of concentrated environmental hazards is shaped by city planning decisions to zone the area for industrial uses and to consistently permit toxic facilities here. The West Fresno area's CEHI is in the highest hazard category in the region. The neighborhood's Social Vulnerability Index is also much higher than the regional average, suggesting that its residents have the fewest formal resources to prevent or mitigate the effects of these hazards. Residents in this area also have among the region's highest hospitalization from childhood asthma (318 for every 10,000 residents); this rate is 2.54 times the regional average.

In response to these burdens, residents have organized to form the Concerned Citizens of West Fresno (CCWF), which successfully fought the unpermitted rendering plant's attempt to expand its operation in 2005 and 2007, as well as pushed for the closing of a hazardous waste facility producing noxious odors in 2008. More recently, residents – working with allies such as Fresno Metro Ministry, California Rural Legal Assistance, Inc., and using the community environmental hazards map produced through this study – have advocated that the City of Fresno require the Darling rendering plant to get a conditional use permit and limit odor and related nuisance impacts on area residents. As Mary Curry, chairwoman of CCWF often states, "the City of Fresno is one body; if one part of the body is ill, the entire body should respond… which is why all Fresnans should care about this issue."

The multiple and often hidden hazards affecting the community of West Fresno can be powerfully illustrated through a map developed by neighborhood residents at one SJV CHIP community mapping workshop (Figure 5). This map demonstrates both the concentration of environmental hazards and the fact that the majority of them are not accounted for in publically-available data sets (blue dots) that agencies depend on for their decisions (orange dots are pollution sites identified by residents).

Figure 5: Pollution Sites in West Fresno



Unincorporated Communities at Risk

Unincorporated communities lacking municipal governments rely on often-distant county seats for their social services and political representation. Many unincorporated communities lack basic services such as potable water, sewers, street lights, curbs, and gutters. These deficiencies can significantly affect the health and well-being of residents. Simultaneously, without a municipal government, many residents consider themselves under-represented in the democratic system.[28] The significance of political status is seen in the case of the Matheny Tract, an unincorporated community adjacent to the City of Tulare.

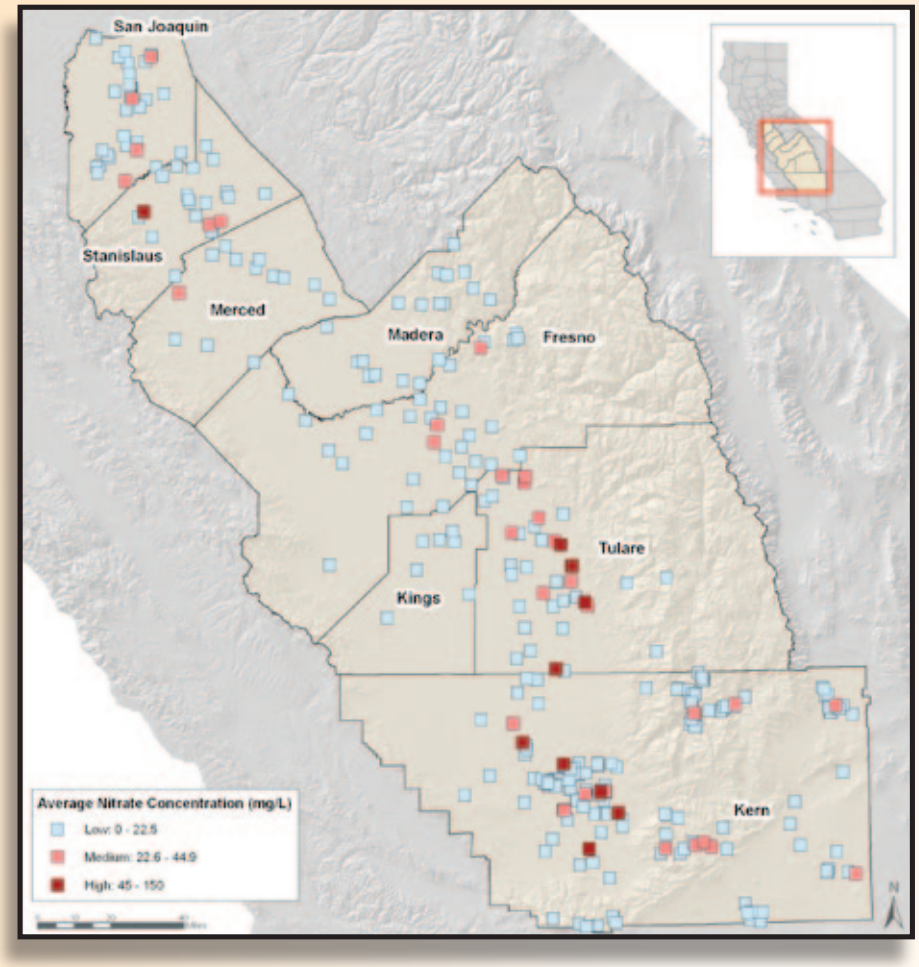
Matheny Tract - *Residents routinely describe suffering from asthma attacks, nausea, headaches, and dizziness.*

The 1,200 residents of Matheny Tract adjacent to the City of Tulare are predominantly Latino, low-income, and with low levels of formal education and English fluency. Matheny Tract also has a high concentration of environmental hazards, a result of county land use policies that concentrate industrial facilities here (in fact, the entire community is zoned for "light industrial" despite its predominant residential land uses). Because the population of Matheny Tract is small relative to that of the census block group that contains it, its high environmental hazards and social vulnerability ratings are masked, affirming the need for place-based analysis using resident knowledge.

Matheny Tract is the site of a large sewage treatment plant, a particular irony, given the fact that the City of Tulare has never extended potable water or sewers to serve the area. Residents must contend with the odors of the plant wafting over their homes. Residents routinely describe suffering from asthma attacks, nausea, headaches, and dizziness. A major canal bypasses the community to send high quality surface water south, while area residents rely on ground water contaminated with by-products of the large-scale dairies and intensive applications of pesticides and herbicides.[29]

In 2010, the City of Tulare sought to annex 500 acres adjacent to Matheny Tract (but not the community itself) as part of an effort to site a large industrial park there. No public notice was provided to area residents of either the proposed annexation or project siting. Residents mobilized with the support of advocates from organizations such as California Rural Legal Assistance, Inc. and successfully petitioned the Local Area Formation Commission (LAFCO) – which adjudicates annexation proposals – to condition annexation on the extension of potable water and sewer services to Matheny Tract residents. In addition, LAFCO ruled that the City of Tulare must inform all residents of future development proposals in the new industrial park (not only those within 300 feet as required by law) and to allow for an annexation bid if requested by 25% or more of property owners (not the 50% required by law). This episode also prompted the Tulare LAFCO to consider cutting in half annexation fees for low-income communities such as Matheny Tract.[30] Together, these events demonstrate both the severity of cumulative environmental hazards when layered with social vulnerability and the power of community action combined with responsive governance that takes these cumulative factors into account.

Figure 6: Average Nitrate Concentration of SJV Community Water Systems. *Source: Balazs et al. 2011.*



Residents in Madera protest the proposed placement of a new prison near neighborhood schools and parks and instead advocate for more funding for education.

The combination of high social vulnerability and environmental hazards such as drinking water contamination is not an isolated phenomenon, but is found in a large number of communities in the region. A recent study of San Joaquin Valley water systems found 10 community water systems with high levels of nitrate contamination and another 24 communities with medium levels of contamination (above the safety standard).[31] These results are likely a vast undercount because they rely on an uneven and inconsistent monitoring system for drinking water from county to county.

A third notable characteristic of rural communities with high CEHI and SVI are that many also house state and federal prisons. More than two-thirds of the state's prisoner population (70,000) is incarcerated in the San Joaquin Valley, and six of the last ten prisons built in California are located here. Several towns such as Mendota, Corcoran, Chowchilla, Delano, and Wasco host multiple prison facilities within or adjacent to their boundaries. While there is debate about the environmental and social impacts of area prisons, many community members and advocates perceive the concentration of such Locally Unwanted Land Uses (LULUs) in the region as part of a pattern of the valley serving as the dumping ground for the rest of the state's unwanted people and pollutants.

One example of a rural town confronting multiple sources of environmental hazards and social vulnerability – including prisons – is Wasco, a town of 25,000 in Kern County.

Wasco - *"Our purpose and current work is to improve the environment and to have healthier food by creating green and sustainable jobs."*

Community leaders associated with the Center for Race, Poverty & the Environment's Power to the People campaign, promote green jobs and economic justice.

On the east side of Wasco, cut off from the rest of the community by a heavily used railroad line, is a farm labor camp. Here residents contend with high occupational exposures to pesticides, substandard housing, food insecurity, and air pollution from sources including the rail line, an adjacent coal storage facility, a fertilizer plant, large-scale rose nurseries, and truck traffic servicing the 12 nearby correctional facilities. The vast majority of the people here has lower incomes, lower levels of formal education, less English language fluency, and is more likely to be people of color than the regional average. Therefore, they score high on the Social Vulnerability Index.

In 2006, the Wasco Housing Authority proposed closing the farm labor camp and building a new industrial park to include two ethanol plants, industrial facilities, and distribution warehouses across the street. Residents mobilized to fight their eviction and the siting of the industrial park on their doorsteps by forming Comité Pro Derechos de los Niños (Committee for the Rights of Children), which evolved into Comité ROSAS (Residents Organized at the Service of a Healthy Environment). Residents began participating at Housing Authority Board meetings and demanded translation, fair notice, and time to secure alternative housing arrangements. As a result of their engagement, one resident of the camp was appointed to the Housing Authority's Board and currently holds a position that allows her to make decisions in support of her neighbors.

Comité ROSAS along with the Center on Race, Poverty & the Environment's "Power to the People Campaign" proposed an alternative economic development strategy based on worker-owned agricultural cooperatives and community-supported agriculture for a "triple-bottom line" that would benefit the local economy, the environment, and social equity.[32] One Comité ROSAS member, Reyna Alvarado, described this ongoing community action by saying, "Our purpose and current work is to improve the environment and to have healthier food by creating green and sustainable jobs."

We have seen how applying a CEVA can uncover patterns of overlapping environmental hazards, social vulnerability, and poor health conditions. The CEVA of the San Joaquin Valley highlights a wide range of places and populations at risk: from inner city neighborhoods to small rural communities. This analysis provides the factual basis to prioritize action to protect the health of residents in these communities. The examples above demonstrate that a coordinated and collaborative approach bringing together residents and public agencies can achieve important successes in transforming the San Joaquin Valley from a landscape of risk to a land of opportunity. The following section lays out an action agenda to make this vision a reality.

This report provides evidence to argue that the questions are no longer whether or when to implement CEVA – the answers are "yes" and "now" – but instead, the question is how?

By identifying CEVAZ in need of immediate and coordinated action to protect residents' health and well-being, this report provides the basis for developing strategic and prioritized action. To take action on the findings of the study, we recommend that CEVA be further developed and implemented at all relevant policy levels including local, regional, state, and federal agencies.

Grassroots coalitions like the San Joaquin Valley Cumulative Impacts Project (SJV CHIP) have taken the lead on defining the path forward. Through a participatory process between the UC Davis research team and the community partners in SJV CHIP, we considered both the analysis above as well as promising practices on cumulative impacts from elsewhere in California and the nation, and we have developed the following action framework:

Principles for Action

- *Strive for environmental justice.* Actions should reduce cumulative health impacts on the most affected and vulnerable communities.
- *Action should reduce risk, with the burden of proof on those proposing the potential hazards.* Agencies should act to introduce this type of precautionary – not reactive – approach into decision making.
- **Break out of silos and build bridges.** Public agencies must work collaboratively across institutional boundaries.
- *Residents speak for themselves.* Agencies must engage with residents of affected communities in a climate of mutual respect and learning.

To help transform the San Joaquin Valley in line with these principles, we offer the following action steps:

Build on existing strengths

Public agencies should draw on the robust base of science and policy frameworks on cumulative impacts. Some notable examples include the U.S. EPA's Environmental Justice Strategic Enforcement Screening Tool (EJSEAT), the California Environmental Protection Agency's (Cal/EPA) Office of Environmental Health Hazard Assessment Cumulative Impacts analysis guidelines, and the California Department of Toxic Substances Control's (DTSC) Environmental Justice Task Force. This last example includes a DTSC official tasked as an "Environmental Justice Problem Solver" to encourage collaboration between agencies and area residents to identify and respond to a wide range of environmental hazards.[33]

These public agency innovations have been informed by cutting edge research, such as that by Amy Kyle, Manuel Pastor, Rachel Morello-Frosch, and Jim Sadd[34] including the latter three scholars' recent Environmental Justice Screening Method (EJSM) developed in collaboration with the California Air

Resources Board and the Cal/EPA, and supported in part by U.S. EPA research funding. These precedents should serve as an affirmation of the legitimacy of this approach and a catalyst for other agencies to adopt and implement CEVA.

Active engagement with residents and advocates representing the most affected communities has greatly enriched this research through the "ground-truthing" of local conditions. This approach of complementing academic science with what is sometimes called "civic science" has been shown to improve the rigor and the relevance of the results.[35] This approach of complementing academic and regulatory science with civic science can build the capacity of community members and advocates to understand the impacts they face, to work effectively with public agencies, and to develop innovative methods for preventing or mitigating impacts. Promising practices of civic science in the San Joaquin Valley, such as the use of pesticide drift catchers and mobile air monitors should be expanded and applied to implementation of CEVA in the region.[36]

The bottom line: there are excellent models for CEVA: these should be adapted and implemented immediately.

Integrate CEVA into existing policy and planning frameworks

As an overarching strategy, California state environmental and health agencies should produce an ***annual comprehensive CEVA Report Card.*** The CEVA Report Card would track progress towards improving conditions for the most vulnerable communities and populations, identify CEVAZ needing special consideration and resources, and document promising practices to adapt to other areas of the state. The development and monitoring of this report card could be coordinated by a ***new cumulative environmental impact entity*** – perhaps associated with the Governor's Office of Planning and Research – that would have authority to direct all state department heads to implement collaborative strategies associated with the Cumulative Environmental Vulnerability Action Zones. This entity could also convene public agencies at the local (for example, Metropolitan Planning Organizations) and national level (for example, U.S. EPA) in a ***cumulative impacts policy collaborative*** that could share promising practices, leverage resources, and increase inter-agency cooperation.

CEVA should be integrated into several other policy frameworks already in place or in active development. For example, California's visionary ***"Health in All Policies,"*** spear-headed by the Strategic Growth Council promoting alignment of California state government agencies around a holistic approach to health, could incorporate CEVA as a guiding framework. The analytical tools of the CEHI and the SVI could be used as part of the social equity criteria in evaluating proposals for Strategic Growth Council funding and as a way to track progress in meeting regional health and environmental goals. These indices could also be incorporated into the promising practice of ***"Health Impact Assessments,"*** that analyze the comprehensive effects of policies and projects on the environmental conditions that shape health outcomes.[37] The recent funding from the Strategic Growth Council to the counties and cities in the San Joaquin Valley to design a ***sustainable planning "toolbox"*** could be enhanced by incorporating CEVA as one tool.

At the regional level, the CEVA should be integrated into the ***environmental justice strategy of the San Joaquin Regional Air Pollution Control District,*** enhancing its current environmental justice map to better highlight CEVAZ deserving special consideration in District policies and actions, in addition to guiding the activities of the local air district's Environmental

Justice Advisory Group. At the level of metropolitan planning organizations (MPO) and Council of Governments (COGS), the CEVA can be used in the ***environmental justice analysis of Metropolitan and Regional Transportation Plans,*** such as those currently being pioneered by the Sacramento Area Council of Governments through a Sustainable Communities Partnership grant from the U.S. Department of Housing and Urban Development.[38] At the local level (city and county), the CEVA could be integrated into the ***environmental justice analysis of General Plans,*** including the integration of social vulnerability and environmental hazard indices. Two immediate opportunities for land use planning in the San Joaquin Valley would be the City of Fresno's General Plan update and the regional Smart Valley Places initiative under the federal Sustainable Communities Partnership.[39]

Move from analysis to coordinated action

Public agencies should focus on mechanisms to incorporate CEVA into their decision-making processes. While CEVA cannot provide the level of specificity to serve as the sole basis for permitting decisions (for example, it is not a formal health risk assessment), the profile of a community characterized as having high cumulative environmental hazards and high social vulnerability ought to raise the bar for permitting additional environmental hazards.[40]

Identifying ***Cumulative Environmental Vulnerability Action Zones*** would serve to prioritize support for specific areas within the region most burdened by environmental hazards and with the fewest social and economic resources to mitigate these hazards. Such supports could include enhanced pollution abatement and mitigation funding, additional environmental and health monitoring, and special consideration in permitting decisions and enforcement actions. Enhanced community engagement of the populations most at risk in these areas should be a priority.[41]

Agencies could be further encouraged to adopt and implement the CEVA through a series of ***financial and policy incentives*** for working collaboratively with other agencies to reduce and mitigate cumulative environmental hazards. For example, the California Legislature could establish a special fund to be allocated for cross-agency collaboration in CEVA. Agencies that engaged in such collaborations and adopted CEVA could get added funding for science and policy personnel to implement these innovations and could receive additional evaluation points in allocations of funds (such the State Revolving Loan Fund for drinking water infrastructure and Community Development Block Grants).

Increase meaningful community engagement

To ensure that CEVA matches the lived realities of residents, "ground-truthing" of the publically-available data used to generate the maps is needed. This incorporation of resident knowledge has been validated in many settings around the state, country, and world as providing important and unique information to enrich academic and regulatory science. CEVA implementation and application should include meaningful opportunities for residents in affected communities to inform specific indicators used, contribute local knowledge of environmental hazards, and participate in the decisions acting upon the analyses produced.

Resources supporting resident involvement are also needed. Key resources could include

- ***Stipends for civic scientists and community-based organizations*** to compensate them for their valuable knowledge and time;

- ***Funding*** for culturally-relevant community engagement (with simultaneous interpretation, childcare, transportation, skilled facilitation, and accessible times and locations);
- ***Training for residents in scientific monitoring techniques*** (such as the use of personal and portable air quality monitors, and water quality testing methods) to ensure rigorous civic science methods and data; and
- ***Forums for data sharing and mutual learning*** between academic, agency, and civic scientists.

Public agencies should work in mutually-beneficial partnership, not conflict, with community-based organizations and intermediaries with expertise in civic science. The results of validated civic science should be seriously considered by agency boards in decision-making processes (such as permitting and rule making).

Enhance resources for continued improvement in CEVA

The science of CEVA, while based on sound science, is still in its formative stages. Public and philanthropic funding for continued innovation in CEVA methods and applications is needed. Some promising scientific directions include:

- Integration of air quality and water quality analysis, pesticide drift and toxicity data for a more comprehensive CEVA;
- Incorporation of bio-monitoring and health condition data to move beyond exposure to actual health impacts;
- Attention to especially vulnerable populations such as children, seniors, prisoners, and undocumented residents.
- Longitudinal studies to track the relationships between environmental hazards, social vulnerability factors, and health conditions over time; and
- Methods to track individual mobility and behaviors to better account for the multiple exposure pathways.

Investments in regulatory and academic science to further enhance, disseminate and apply CEVA would pay great dividends in better-informed and more democratic public policy. Processes to ensure the rigor and reliability of the civic science by community organizations and the complementing of civic science with academic and agency science will enhance the overall quality of CEVA. Finally, financial and institutional support for an intensive pilot program developed through a collaboration between academic partners, community organizations, and public agencies focused on a specific area and/or environmental health issue could help field test the CEVA methodology for real-time improvement.

California's heartland, the San Joaquin Valley, has the potential to serve as a model for a sustainable and healthy California.

California's heartland, its San Joaquin Valley, embodies many of the contradictions of the Golden State. At once a place of tremendous wealth based on its natural resources and agricultural bounty, a place of poverty and deprivation, and the birthplace of powerful social movements of the dispossessed, the San Joaquin Valley offers an exciting opportunity to shape the course of the future of California.

Will the Valley become a place where healthy people and communities contribute to the prosperity and sustainability of the region, the state, and the nation as a whole? Or, will this future be jeopardized by overlapping environmental, economic, and social crises? This is the choice confronting all of us who care about the people and places of the San Joaquin Valley. **The Cumulative Environmental Vulnerability Assessment is a potent way to understand and, most importantly, to inform action on behalf of the health of our communities.**

The Cumulative Environmental Vulnerability Assessment (CEVA) was constructed through three indices: the Cumulative Environmental Hazards Index (CEHI) Social Vulnerability Index (SVI) and the Health Index (HI). The data sets used in these indices are summarized in Table 2.

Table 2: Summary of CEVA Data Sources

Index	Dataset		Source
Cumulative Environmental Hazards Index	Point source pollution emission sites	Toxic release inventory sites	U.S. EPA, 2006
		Petroleum refineries	U.S. EPA, 2006
		Hazardous waste treatment, storage and disposal facilities	U.S. EPA, 2006
		Chrome platters	U.S. EPA, 2006
	Pesticide application	Total amount active ingredient of pesticide application per square mile.	CA Dept. of Pesticide Regulation, 2007
	Cancer risks from inhaled air toxics	National Air Toxics Assessment	U.S. EPA, 2005
Social Vulnerability Index	Sensitivity of receptors	Percent of people younger than 5 or older than 60 in census block group	American Community Survey 2005-2009
		Locations of health care facilities	Cal-Atlas, 2010
	Availability of social/ economic resources	Percent of linguistically isolated households	American Community Survey 2005-2009
		Percent of population in poverty	American Community Survey 2005-2009
		Percent of people ofcolor	American Community Survey 2005-2009
		Percent of people older than 25 without a high school diploma	American Community Survey 2005-2009
Health Index	Health condition	Low birth weight rate	CA Dept. of Public Health, 1999-2007
		Years of potential life lost before age 65	CA Dept. of Public Health, 1999-2007
		Asthma hospitalization rate ages 0-19	CA Office of statewide health planning and development, 1999-2007

Sources for data sets used in this study

US Census

We used census block group as the unit of analysis. Census block group is the smallest geographic unit based on which socioeconomic data was collected. According American Community Survey 2005-2009, San Joaquin Valley has 2240 census block groups. More information on Cartographic Boundary Files Descriptions and Metadata for census block group can be found on the website of US Census Bureau. http://www.census.gov/geo/www/cob/bg_metadata.html

We used American Community Survey 2005-2009 data for poverty rate, education, linguistic isolation, race/ethnicity and age when calculating SVI. This is the most recent dataset available. More information on the American Community Survey can be found on their website. http://www.census.gov/acs/www/

Toxic release inventory, hazardous waste treatment, storage and disposal facilities, refinery and chrome platter sites

The TRI is a publicly available database containing information on toxic chemical releases and other waste management activities in the United States. More information on TRI can be found at United States Environmental Protection Agency (U.S. EPA)'s website. http://www.epa.gov/tri/

Locations of hazardous waste treatment, storage and disposal facilities were provided by U.S. EPA. Through the Resource Conservation and Recovery Act, Congress directed U.S. EPA to regulate all aspects of hazardous waste. As a result, U.S. EPA developed strict regulations for the treatment, storage, and disposal of hazardous waste. More information on Hazardous waste treatment, storage and disposal facilities can be found at USEPA's website. http://www.epa.gov/osw/hazard/tsd/

Pesticide applications

Pesticide application data was provided by California Department of Pesticide Regulation. We used total amount of active ingredient per square mile of pesticides application for agricultural use based on 2007 pesticide use reporting data. More information and databases on agricultural pesticide application and regulation can be found on their website. http://www.cdpr.ca.gov/dprdatabase.htm

Pesticide application data was based on the public land survey system, which divided land into sections with an approximate1-square-mile area. More information and data regarding public land survey system can be found on the website of National Atlas at the U.S. Geological Survey.
http://www.nationalatlas.gov/articles/boundaries/a_plss.html

Health Data

Birth weight data for the years 2000-2007 and data for Years of Potential Life Lost was obtained from the CA Department of Public Health. http://www.cdph.ca.gov/data/statistics/Pages/default.aspx.

Asthma hospitalization rates (2000-2007) were obtained from the CA Office of Statewide Health Planning and Development http://www.oshpd.ca.gov/HID/Dataflow/index.html.

Original data sources were generously provided by the Central Valley Health Policy Institute at California State University, Fresno. http://www.csufresno.edu/ccchhs/institutes_programs/CVHPI/index.shtml

Calculating the Indices

Cumulative Environmental Hazards Index (CEHI)

The CEHI is a relative measure of environmental hazards in and around each block group and scores between 0 and 1. The higher the value is, the more environmental hazards are within or around the block group.
The Cumulative Environmental Hazards Index (CEHI) was calculated at the census block group level from the following six datasets: toxic release inventory sites, refineries, hazardous TSDs and chrome platters, pesticide, and NATA. The first four datasets, toxic release inventory sites, refineries, hazardous TSDs and chrome platters, are all point source data, indicating the specific location of the pollution sites. These four datasets were merged into one file and a 1-mile buffer zone was drawn around the points in ArcGIS 9.3™. The percent area of each block group that falls within the 1-mile buffer was calculated, to be incorporated into the CEHI.

Calculating the Indices

Pesticides density was based on the public land survey system, which divided land into sections with an approximate1-square-mile area. To break down this large-spatial unit to a scale in line with potential individual exposures, we divided each section in ArcGIS 9.3TM into 16 units with an approximate size of 100m x 100m and assigned each unit the pesticide density from the section where the unit was located. Then we calculated pesticide density for each block group as the mean value of that from all the units within or including at least 50% coverage of the block group.

National-scale air toxic assessment (NATA) estimates the risk of different kinds of cancer and other serious non-cancer health effects from inhaling air toxics. This study used the total cancer and non-cancer risks from the NATA dataset. We used the latest available data from the 2005 NATA in this study. NATA uses Census tracts, which is one level higher than block group as the unit of analysis. In the San Joaquin Valley, one census tract contains an average of 5.5 block groups. We assigned the total risk of cancer of a tract to all the block groups that were contained within it.

Lastly, we normalized the percent area of each block group within 1-mile buffer of point source pollution, pesticides density and total risk of cancer by dividing each value by the maximum value of the dataset, and calculated as the mean value of the three normalized datasets. In order to have the scores spread out widely and range between 0 and 10, we normalized the mean values by dividing its maximum value and multiplying the entire data set by 10 to generate the CEHI value for each block group. $CEHI_{max}$

The formula of calculating $CEHI_{Norm}$ is shown below in two steps.

$$CEHI_i = \frac{\left(\sum_{j=1}^{3} \upsilon_{ij}\right)}{3} \qquad CEHI_{Norm} = 10 * \frac{CEHI_i}{CEHI_{max}}$$

Where $CEHI_i$ is the Cumulative Environmental Hazards Index score for block group *i*;
v_{i1} is the percent area of block group *i* that falls in the 1-mile buffer of point source pollution sites, normalized by dividing by the highest value in the dataset.;
v_{i2} is the normalized total risk of cancer for block group *i* from NATA;
v_{i3} is the normalized pesticide application for block group *i*.

Social Vulnerability Index (SVI)

The SVI is a relative measure with values between 0 and 1: the higher the value, the more vulnerable the residents of a block group are to the effects to environmental hazards. The Social Vulnerability Index (SVI) was calculated at the census block group level from the following six datasets: locations of health care facilities, poverty rate, education, linguistic isolation, race/ethnicity, and age. We retrieved the dataset of locations of health care facilities from the Cal-Atlas website. In ArcGIS 9.3™, we drew a 1-mile buffer zone around each health care facility and then calculated the percent area of each block group within the buffer zone.

We calculated the mean value of the percent area of each block group within the buffer zone, percent population in poverty, percent people older than 25 without a high school diploma, percent household that are considered linguistically isolated (defined as without a member older than 14 speaks English fluently), percent people of color (other than non-Hispanic White) and percent population older than 60 and younger than 5. Finally, we normalized the datasets by dividing its maximum value and multiplying by 10 to generate the SVI value for each block group.

The formula of calculating SVINorm is shown below.

$$SVI_i = \frac{\left(\sum_{j=1}^{3} \upsilon_{ij}\right)}{6}$$

$$SVI_{Norm} = 10 * \frac{SVI_i}{SVI_{max}}$$

Where SVI*i* is the Social Vulnerability Index score for block group *i*;
v_{i1} is the percent area of block group *i* that falls in the 1-mile buffer of health facilities;
v_{i2} is percent population in poverty for block group *i*;
v_{i3} is percent people older than 25 years old without a high school diploma for block group *i*;
v_{i4} is percent linguistically isolated households for block group *i*;
v_{i5} is percent people of color for block group *i*;
v_{i6} is percent people older than 60 or younger than 5 for block group *i*;

Health Index (HI)

A cumulative health index (CHI) was constructed from data in low birth weight rate, years of potential life lost before age 65 (YPLL65) and asthma hospitalization rate ages 0-19. Due to data availability, health data is based on zip code. Low birth weight rate and YPLL65 were from California Department of Public Health, and asthma hospitalization rates were from CA Office of Statewide Health Planning and Development. All health data were aggregated from 1999-2007.

We first normalized low birth weight rate, YPLL65 and asthma hospitalization rate ages 0-19 by dividing the data sets by its maximum value. For each block group, the maximum value of the three health indicators was assigned as the value of health index. In this way, the health index was designed to reflect high value (i.e. health problems) from any indicator.

Then we converted the unit of analysis from zip code to block group. We generated a raster file in ArcGIS 9.3™ with a cell size of 100m x 100m. Each cell was assigned the value of HI from the zip code where the cell was located within. Second, we calculated the mean value of the HI from the raster file for each block group.
The formula of calculating HI is shown below.

$$HI_i = \max(v_{i1}, v_{i2}, v_{i3})$$

Where HI_i is the Health Index score for block group *i*;
v_{i1} is normalized incidence of low birth weight for block group *i*;
v_{i2} is the normalized YPLL65 block group *i*;
v_{i3} is the normalized hospitalization rate for asthma (ages 0-19) for block group *i*.

Cumulative Environmental Vulnerability Assessment (CEVA)

Census block groups were used as the unit of analysis. Each block group was assigned to one of nine categories based on their scores on the CEHI and the SVI. Block groups were classified as low, medium or high on both indices. We determined breakpoints using selection tools in ArcGIS 9.3™ . The analysis indicated breakpoints at the 33% and 66% percentiles was appropriate, but we also adjusted the breakpoints so there would be sufficient block groups in each of the nine categories.

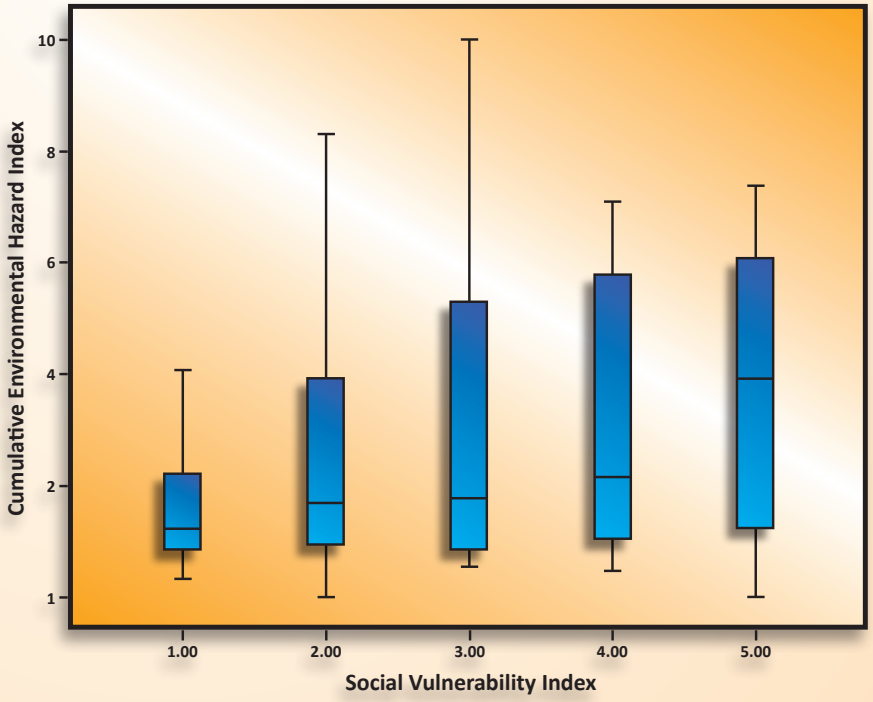
Table 3: Descriptive Statistics for CEVA

CEHI ↑ / SVI →			
	Low SVI/High CEHI Mean CEHI: 5.45 (4.45, 7.99) Mean SVI: 1.87 (1.58, 2.70) Block groups = 9	**Medium SVI /High CEHI** Mean CEHI: 5.86 (4.82, 10) Mean SVI: 4.50 (2.48, 10) Block groups = 373	**High SVI /High CEHI** Mean CEHI: 6.05 (5.14, 10) Mean SVI: 7.50 (5.62, 10) Block groups =257
	Low SVI/Medium CEHI Mean CEHI: 2.543 (.94, 8.05) Mean SVI: 1.703 (.96, 5.90) Block groups = 49	**Medium SVI/Medium CEHI** Mean CEHI: 2.60 (.96, 8.61) Mean SVI: 4.17 (2.09, 10) Block groups =392	**High SVI /Medium CEHI** Mean CEHI: 2.77 (.94, 8.71) Mean SVI: 7.37 (5.60, 10) Block groups =135
	Low SVI/Low CEHI Mean CEHI: .9300 (.36, 3.85) Mean SVI: 1.666 (.88, 5.88) Block groups = 153	**Medium SVI/Low CEHI** Mean CEHI: .9378 (.43, 3.95) Mean SVI: 4.203 (2.06, 10) Block groups = 694	**High SVI /Low CEHI** Mean CEHI: .9896 (.47, 3.95) Mean SVI: 7.350 (5.63, 10) Block groups =179

Each cell in Table 3 includes the mean of the CEHI and SVI, the 95% confidence intervals, and number of census block groups represented in each category. The CEVAZ are the three categories in the upper left set of cells: those with medium or high SVI and CEHI. These colors match those used in Figures 2 and 3 above that map the CEVAZ across the region.

A boxplot was generated to present the distributions of CEHI within the five quintile groups of SVI (Figure 7). The boxplot presents the five statistics (minimum, first quartile, median, third quartile and maximum) within each category. Each category contains about 450 cases. The results show an increase of the median CEHI when the SVI increases across the five social vulnerability index categories.

Figure 7: Box Plot for SVI and CEHI



Using the Pearson's statistic, we determined that the CEHI is significantly correlated with the SVI (0.296) and, to a lesser degree with the HI (0.092). This statistic also shows that the SVI is significantly correlated with the HI (0.231).

Table 4: Pearson's Correlation Matrix of CEHI, SVI, and HI

		CEHI	SVI	HI
CEHI	Pearson Correlation	1	.296**	.092**
	Block Groups (n)	2237	2237	2237
SVI	Pearson Correlation	.296**	1	.231**
	Block Groups (n)	2237	2241	2241
HI	Pearson Correlation	.092**	.231**	1
	Block Groups (n)	2237	2241	2241

** Correlation is significant at the 0.01 level (2-tailed).

Limitations

It is important to note that the CEHI is not a risk assessment that quantifies the specific pollution exposures. This is because the data include those metrics that measure emissions and potential exposures, as well as some that do calculate health risks. Therefore, the CEHI should be understood as a screening method, helping to identify places with higher relative degrees of environmental hazards compared to the region as a whole. It should also be noted that there are a range of other data sets that were not included in this index because of challenges of data availability at the appropriate spatial scale, with a region-wide scope, or with reliable sources.[42] While it is difficult to know for sure, it is very likely that including these data sources would show a more extensive pattern of environmental hazards. Therefore, the CEVA should be considered as an underestimate.

Our model for the three indices – CEHI, SVI, and HI – has some inherent limitations. To begin, while the multi-indicator indices are a powerful approach they have the challenge of selecting the appropriate indicators to represent the intended issue. They also make analysis of the individual factors less explicit and visible. Furthermore, their outputs are highly sensitive to the ways in which the indices are constructed.

A second limitation is that our model is only as accurate as the available data sets. All the data sets we used are generated either on national or state scale and publicly available, which allows our model to be replicated. These data sets are the most reliable ones in their field. However, restricted by time and other resources, these data sets all have their own limitations, which are published along with the data sets.

Third, there are certain issues – including those correlated with severe health conditions – that lack data sets that are reliable and comprehensive in geographic scale. Water quality, for example, has long been an issue in the San Joaquin Valley region and could potentially have very important health impacts on residents. While there is some water quality data available, it is not available at the census block group for the region as a whole, and therefore is not possible to incorporate this data into the Cumulative Environmental Hazards Index.

Fourth, the indices use data sources that cover a range of stages in the emissions, potential exposures, toxicity, and health risk process. For example, the point source data (e.g., TRI, TSDs) indicate only the presence of an emitting facility, but not the amounts, the fate or the toxicity of the pollutants. The emissions data (e.g., pesticide application) indicates the amounts, but not the fate, exposures or toxicity of the substances. The NATA data does estimate exposures and health risks from air toxin exposures (inhalation). As a result, it is important to emphasize that the CEHI is not a formal risk assessment method:

it is best used as a screening method to identifies communities of concern for enhanced regulatory attention and investments.

Lastly, our model is limited by its geographic unit of analysis: the census block group, which is the smallest geographic unit that the U.S. Census Bureau aggregates certain demographic data. Therefore, CEHI and SVI calculated from our model only work at the scale of block groups and cannot provide much reference to areas smaller than a block group. Instead, the indices are mostly likely to be accurate when we look at areas that are larger than a block group.
Because the indices are relative to the region as a whole – and not absolute measures – the analysis may categorize some communities who face significant environmental and social vulnerabilities as moderate or low risk. Because the San Joaquin Valley faces high incidence of environmental and social problems, the relative "low" or "medium" score of some areas can mask vulnerabilities due to the severity of conditions in the region as a whole. Relative indices also preclude being able to track progress over time, as conditions in individual places or the entire region may have declined.

As described in the recommendation section above, the authors have identified a number of future refinements to the indexes that would enhance the comprehensiveness and precision of the indices. Please see the section *"Enhance resources for continued improvement in CEVA"* above.

REFERENCES AND NOTES

[1] Cole, L.W., & Foster, S.R. (2001). *From the Ground Up: Environmental racism and the rise of the environmental justice movement.* New York: New York University Press.

Congressional Research Service. (2005). *California's San Joaquin Valley: A region in transition* (December 12, 2005). Tadlock Cowan, Coordinator.

Haslam, G.W. (1994). *The Other California: The Great Central Valley in Life and Letters.* Reno: University of Nevada Press.

Martin, P.L., & Taylor, J.E. (1998). Poverty Amid Prosperity: Farm employment, immigration, and poverty in California. *American Journal of Agricultural Economics, 80*(5), 1008-1014.

Pulido, L. (1996). *Environmentalism and Economic Justice: Two Chicano struggles in the Southwest.* Tucson: University of Arizona Press.

[2] Gilmore, R.W. (2007). *Golden Gulag: Prisons, surplus, crisis, and opposition in globalizing California.* Berkeley: University of California Press.

[3] Ngo, M.A. & Pinkerton, K.E., et al. (2010). Airborne Particles in the San Joaquin Valley May Affect Human Health. *California Agriculture*, 64(1), 12-16.

[4] American Lung Association (ALA). (2011). American Lung Association State of the Air. New York, NY: American Lung Association.

[5] Madera County's age-adjusted rate of asthma-related emergency room visits by young children, (ages 0-4) is 235 per 10,000 residents, compared with 109 per 10,000 residents in California as a whole. Fresno County and Kings County follow closely at 216/10,000 and 196/10,000 respectively. Source: California Environmental Health Tracking. Retrieved from http://www.ehib.org/page.jsp?page_key=124

Capitman, J.A., & Tyner. T.R. (2011). *The Impacts of Short-Term Changes in Air Quality on Emergency Room and Hospital Use in California's San Joaquin Valley.* Sacramento: Central Valley Health Policy Institute. Retrieved from http://www.csufresno.edu/ccchhs/institutes_programs/CVHPI/publications/AQR_web.pdf

[6] Hall, J., and Brajer, V. (2008). *The Health and Related Economic Benefits of Attaining Healthful Air in the San Joaquin Valley.* Fullerton, CA: Cal State Fullerton Institute for Economic and Environmental Studies.

[7] Balazs, C., Morello-Frosch, R., Hubbard, A., Ray, I. (2011). Social Disparities in Nitrate Contaminated Drinking Water in California's Central Valley. *Environmental Health Perspectives.* June 2011.

[8] Morello-Frosch, R., Pastor, M. & Sadd, J. (2001). Environmental Justice and Southern California's "Riskscape": The distribution of air toxics exposures and health risks among diverse communities. *Urban Affairs Review,36*(4), 551-578.

[9] Anderson, M.W. (2008). Cities Inside Out: Race, Poverty, & Exclusion at the Urban Fringe. UCLA Law Review, 55, 1095-1060.

Rubin, V., Chandler, A., Bernabei, E. & Lizardo, R. (2007). *Unincorporated Communities in the San Joaquin Valley: New Responses to Poverty, Inequity, and a System of Unresponsive Governance*. Oakland, CA: PolicyLink.

[10] Pulido (1996); Harrison (2006); Liévanos, R, London J, Sze, J. (2011). Uneven Transformations and Environmental Justice: Regulatory Science, Street Science, and Pesticide Regulation in California. In B. Cohen & G. Ottinger (Eds.), *Engineers, Scientists, and Environmental Justice: Transforming Expert Cultures through Grassroots Engagement.* Cambridge, MIT Press.

[11] London, J.K., Sze, J. & Liévanos, R.S. (2008). Problems, Promise, Progress, and Perils: Critical reflections on

REFERENCES AND NOTES

environmental justice policy implementation in California. *UCLA Journal of Environmental Law & Policy, 26*(2), 255-289.

[12] Central Valley Air Quality Coalition. (n.d.). Retrieved from http://www.calcleanair.org/

[13] Harrison, J.L. (2006). 'Accidents' and Invisibilities: Scaled discourse and the naturalization of regulatory neglect in California's pesticide drift conflict. *Political Geography 25*, 506-529.

Harrison, J. (2004). Invisible People, Invisible Places: Connecting air pollution and pesticide drift in California. In E. M. DuPuis (Ed.), *Smoke and Mirrors: The politics and culture of air pollution* (pp. 288-304). New York: New York University Press.

[14] Minkler, M. (2008). *Promoting Healthy Public Policy through Community-Based Participatory Research: Ten Case Studies.* A project of the University of California, Berkeley, School of Public Health and PolicyLink. Oakland: PolicyLink.

Minkler, M. & Hancock, T. (2003). Community-driven asset identification and issue selection. In M. Minkler & N. Wallerstein (Eds), Community Based Participatory Research for Health (pp. 135 – 154). San Francisco: Jossey-Bass.

[15] London et al. (2008).

[16] London et al. (2008).

[17] The San Joaquin Valley Air Pollution Control District's Environmental Justice map is based on coverage of census tracts with "greater than or equal to 50% of the population either Hispanic, Latino or Non-White, and greater than or equal to 10% of the population below the Federal Poverty Level." https://www.valleyair.org/Programs/EnvironmentalJustice/Environmental_Justice_idx.htm

[18] Morello-Frosch, R., Zuk, M., Jerrett, M., Shamasunder, B., and Kyle, A.D. (2011). Understanding the Cumulative Impacts of Inequalities in Environmental Health: Implications for Policy. *Health Affairs*, 30(5), 879-887.

Su, J.G., Morello-Frosch, R., Jesdale, B.M., Kyle, A.D., Shamasunder, B., Jerrett, M. (2009). An index for assessing demographic inequalities in cumulative environmental hazards with application to Los Angeles, California. *Environmental Science & Technology,* 43(20), 7626-7634.

Pastor, M., Morello-Frosch, R, Sadd, J. (2010). *Air pollution and Environmental Justice: Integrating indicators of cumulative impact and socio-economic vulnerability into regulatory decision- making* (Final Report, Contract No.: 04-308). Sacramento: California Air Resources Board. Retrieved from http://www.arb.ca.gov/research/apr/past/04-308.pdf

[19] Office of Environmental Health Hazard Assessment (OEHHA). (2010). *Cumulative Impacts: Building a Scientific Foundation.* Sacramento: California Environmental Protection Agency. Retrieved from http://oehha.ca.gov/ej/cipa123110.html

U.S. Environmental Protection Agency. (n.d.). *Environmental Justice Strategic Enforcement Assessment Tool* (EJSEAT). Washington, DC: U.S. Environmental Protection Agency. Retrieved from http://www.epa.gov/environmentaljustice/resources/policy/ej-seat.html

California Environmental Protection Agency Air Resources Board. (2005). *Air Quality and Land Use Handbook: A community health perspective.* Sacramento: California Environmental Protection Agency Air Resources Board.

[20] Evans, G.W., & Marcynyszyn, L.A. (2004). Environmental Justice, Cumulative Environmental Risk, and Health Among Low- and Middle-income Children in Upstate New York. *American Journal of Public Health, 94*, 1942-1944.

Office of Environmental Health Hazard Assessment. (2010). *Cumulative Impacts: Building a Scientific Foundation.* Sacramento: California Environmental Protection Agency. Retrieved from http://oehha.ca.gov/ej/pdf/CIReport123110.pdf

Sadd, J., Pastor, M., Morello-Frosch, R., Scoggins, J., Jesdale, B. (2011). Playing It Safe: Assessing Cumulative Impact and Social Vulnerability through an Environmental Justice Screening Method in the South Coast Air Basin, California. *International Journal of Environmental Research and Public Health,* 8, 1441-1459.

Su, J.G., Morello-Frosch, R., Jesdale, B.M., Kyle, A.D., Shamasunder, B., & Jerrett, M. (2009). An Index for Assessing Demographic Inequalities in Cumulative Environmental Hazards with Application to Los Angeles, California. *Environmental Science and Technology,* 43, 7626-7634.

[21] For a peer-reviewed published methodology for the CEVA, see Huang, G. and London, J., in press. Mapping cumulative environmental impacts, social vulnerability and health in the San Joaquin Valley, California. *American Journal of Public Health.*

[22] These data are from the latest available U.S. Census Bureau's American Community Survey (2005-2009), and health care facilities locations are from the Cal-Atlas website.

California Spatial Information Library, Cal-Atlas Geospatial Clearinghouse [data files]. Available from the Cal-Atlas site http://atlas.ca.gov/download.html

[23] There is some disagreement in the public health field over the relevance of placement of health care facilities as a measure of sensitive receptors. Following the work of Morello-Frosch, Pastor, and Sadd , we maintain the value of this measure. See Pastor, M., Morello-Frosch, R., Sadd, J. (2010).

[24] Cutter, S.L., Boruff, B.J., & Shirley, W.L. (2003). Social Vulnerability to Environmental Hazards. *Social Science Quarterly,* 84(2), 242-261.

Oxfam America. (2009). *Exposed: Social Vulnerability and Climate Change in the US Southeast.* Boston: Oxfam America Inc.

[25] O'Neill, M.S., Jerrett, M., Kawachi, I., Levy, J.I., Cohen, A.J.,

REFERENCES AND NOTES

Gouveia, N., Wilkinson, P., Fletcher, T., Cifuentes, L., Schwartz, J. (2003). Health, Wealth, and Air pollution: Advancing theory and methods. *Environmental Health Perspectives , 111*, 1861– 1870.

Evans, G.W., Marcynyszyn, L.A. (2004).

[26] Su, J.G., Morello-Frosch, R., Jesdale, B.M., Kyle, A.D., Shamasunder, B., & Jerrett, M. (2009).

[27] Defur, P.L., Evans, G.W., Cohen Hubal, E.A., Kyle, A.D., Morello-Frosch, R.A., & Williams, D.R. (2007). Vulnerability as a Function of Individual and Group Resources in Cumulative Risk Assessment. *Environmental Health Perspectives, 115*, 817-824.

[28] Anderson, M.W. (2008). Cities inside Out: Race, Poverty, and Exclusion at the Urban Fringe. *UCLA Law Review,* 55(5), 1095-1160.

[29] California Rural Legal Assistance, Inc. (2010). Matheny Tract Wins Critical Victory at Tulare LAFCO. *The San Francisco Bay Area Independent Media Center.* Retrieved from http://www.indybay.org/newsitems/2010/08/05/18655441.php

[30] California Rural Legal Assistance, Inc. (2010).

[31] Balazs, C., Morello-Frosch, R., Hubbard, A., Ray, I. (2011).

[32] The Center for Race Poverty and the Environment "green paper" on their *Power for the People campaign* accessible at http://www.crpe.ej.org/crpe/images/stories/featured/green/j6365_crpe_eng_web.pdf

[33] Office of Environmental Health Hazard Assessment. (2010). *Cumulative Impacts: Building a Scientific Foundation.* Sacramento: California Environmental Protection Agency. Retrieved from http://oehha.ca.gov/ej/pdf/CIReport123110.pdf

California Air Resources Board (CARB). (2010). *Proposed Screening Method for Low-Income Communities Highly Impacted by Air Pollution for AB 32 Assessments.* Sacramento: California Environmental Protection Agency. Retrieved from http://www.arb.ca.gov/cc/ab32publichealth/communitymethod.pdf

U.S. Environmental Protection Agency. (n.d.). *Environmental Justice Strategic Enforcement Assessment Tool* (EJSEAT). Washington, DC: U.S. Environmental Protection Agency. Retrieved from http://www.epa.gov/environmentaljustice/resources/policy/ej-seat.html

Department of Toxic Substances Control. Sacramento: California Environmental Protection Agency. http://www.dtsc.ca.gov/

Imperial Vision Action Network (IVAN). http://www.ivanonline.org/

[34] Pastor, M., Sadd, J., Morello-Frosch, R. (2007). *Still Toxic After All These Years.: Air Quality and Environmental Justice in the San Francisco Bay Area.* Santa Cruz, CA: UC Santa Cruz Center for Justice, Tolerance and Community.

Sadd, J., Pastor, M., Morello-Frosch, R., Scoggins, J., Jesdale, B. (2011). Playing It Safe: Assessing Cumulative Impact and Social Vulnerability through an Environmental Justice Screening Method in the South Coast Air Basin, California. *International Journal of Environmental Research and Public Health, 8*, 1441-1459.

[35] Corburn, J. (2005). *Street Science: Community Knowledge & Environmental Health Justice.* Cambridge: Massachusetts Institute of Technology Press.

Los Angeles Collaborative for Environmental Health and Justice. (2010). *Hidden Hazards: A Call to Action for Healthy, Livable Communities.* A project of Liberty Hill Foundation. Retrieved from http://www.libertyhill.org/document.doc?id=202

Communities for a Better Environment. (2008). *Cumulative Impacts in East Oakland: Findings from a Community-Based Mapping Study;* Communities for a Better Environment: Oakland, CA. Retrieved from http://www.cbecal.org/campaigns/oakland.html

[36] Liévanos, R., London, J.K. & Sze, J. (2011).

[37] Centers for Disease Control and Prevention, Health Impact Assessment. http://www.cdc.gov/healthyplaces/hia.htm

[38] Sacramento Area Council of Governments (SACOG). (n.d.). *Sustainable Communities Planning Process.* http://www.sacog.org/sustainable/

[39] Smart Valley Places information can be retrieved from http://www.sjvpartnership.org/uploaded_files/Doc/ABSTRACT%20Cal%20State%20Fresno%20Found.pdf.

[40] This approach is complementary to the U.S. EPA's new "Problem-Formulation" approach to cumulative risk assessment and aligned with the agency's new Plan EJ 2014 (coinciding with the 20th anniversary of President Clinton's Executive Order on Environmental Justice). Plan EJ 2014 information can be retrieved from http://www.epa.gov/compliance/ej/resources/policy/plan-ej-2014/plan-ej-2011-09.pdf

[41] This recommendation aligns with those by the California Environmental Justice Alliance for the establishment of "Green Zones" in communities facing combinations of environmental hazards and social vulnerability. For more information, see the full report: "Green Zones for Economic and Environmental Sustainability: A Concept Paper from the California Environmental Justice Alliance" at http://caleja.org/documents/2010_0000_green_zones.pdf

[42] Data sources not integrated into the Cumulative Environmental Hazards Index (CEVA) include: air quality monitoring data for criteria pollutants such as ozone and particulate matter, water pollution, pesticide drift and other pollution sources that originate outside the target area. All of these would be useful directions for further improvement of the CEVA.

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San Joaquin Valley Cumulative Health Impacts Project (SJVCHIP)

The San Joaquin Valley Cumulative Health Impacts Project is a collaborative of community, health and environmental justice organizations and coalitions that have joined together to protect the health of our communities. We formed because too many low-income and communities of color in the Valley are impacted and suffer from exposure to multiple pollution sources such as: unhealthy air and water quality, pesticides, toxic waste and garbage dumps, power plants, incinerators, Superfund sites, mega-dairies and diesel pollution. Government agencies who are supposed to protect public health do not yet have mechanisms to take these cumulative impacts into account when making permit and regulatory decisions.

Our goal is to assure better health for residents through the adoption of enforceable measures to reduce cumulative pollution, particularly in communities that are heavily burdened by or especially vulnerable to pollution exposure. We will work to ensure the public's access to information and to build community capacity and the public's right to participate in regulatory decision-making.

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