October 8, 2021

VIA ELECTRONIC MAIL (permits_hwm@dtsc.ca.gov)

Dr. Meredith Williams
Director
Department of Toxic Substances Control
1001 I Street
Sacramento, CA 95814

RE: Comments on Cumulative Impacts and Community Vulnerability Draft Regulatory Framework

Dear Director Williams:

We submit these comments on behalf of Clean Air Coalition of North Whittier and Avocado Heights (CAC), Del Amo Action Committee (DAAC), and Physicians for Social Responsibility-Los Angeles (PSR-LA) (collectively referred to as "Community and Health Advocates"). CAC is comprised of volunteers committed to defending the environment and quality of life in their community. Part of CAC's efforts have focused on stopping the expansion of and cleaning up contamination from, and eventually shutting down Quemetco, a RCRA-permitted secondary lead smelter. Formed in 1994, DAAC is dedicated to addressing contamination and improper hazardous waste disposal from current and past industrial sources in their community, including the adjacent Del Amo Superfund Site. PSR-LA's work focuses on health, the environment, social justice, and public policy. PSR-LA advocates for policies and practices that improve public health, eliminate nuclear threats, and address health disparities.

The Department of Toxic Substances Control (DTSC or Department) asserts that its mission is, in part, "to protect California's people, communities, and environment from toxics substances." To protect California's people, and to comply with the law, DTSC must focus on taking steps that protect communities that live, work, learn, play, and worship where facilities that generate, treat, or store our state's most hazardous wastes are located. DTSC must develop a methodology that establishes an absolute barrier to adding new, or approving modified or renewed hazardous waste permits in communities already facing extensive cumulative exposures to environmental assaults—especially when that community has increased vulnerability to the impacts of those exposures.

Background

Signed into law in 2015, SB 673 "directed the Department to update its criteria to consider 'the vulnerability of, and existing health risks to, nearby populations' when deciding whether to issue new or modified permits or permit renewals of hazardous waste facilities."[1]

Although the law directed DTSC to complete this update by January 2018, DTSC failed to meet that deadline and instead issued the "SB 673 Cumulative Impacts and Community Vulnerability Draft Regulatory Framework Concepts" in October 2018 and this SB 673 Cumulative Impacts and Community Vulnerability Draft Regulatory Framework (Framework) in May 2021. While releasing this Framework is a sign of progress, we remain deeply concerned

[1] DTSC, SB 673 Cumulative Impacts and Community Vulnerability Draft Regulatory Framework, at iv (revised May 2021) (hereinafter, "Framework").

by DTSC's lack of urgency in approaching this important task. Every day, community members are unnecessarily exposed to harms from California's currently permitted hazardous waste facilities. The legislature directed DTSC to act with haste; DTSC has failed to do so.

DTSC's Pre-Regulatory Framework Fails to Deliver on the Directives of SB 673

We note that Governor Brown signed SB 673 on October 8, 2015—exactly six years prior to the date of these comments. And now, more than a half-decade after that signature, DTSC is working on a project fundamentally different from that set out in the law. The Legislative Counsel's Digest[2] summarized SB 673 as:

> This bill would require the department, by January 1, 2018, to establish or update criteria for use in determining whether to issue a new or modified hazardous waste facilities permit or a renewal of a hazardous waste facilities permit, and to develop and implement, by July 1, 2018, programmatic reforms designed to improve the protectiveness, timeliness, legal defensibility, and enforceability of the department's permitting program.[3]

However, DTSC describes the Framework document as:

> Provid[ing] a more detailed draft methodology for integrating potential facility impacts and community vulnerabilities into the Department's permitting process for hazardous waste facilities and for determining facility actions to enhance community protection.[4]

SB 673 called for "criteria for use in determining whether to issue a new or modified hazardous waste facilities permit or a renewal of a hazardous waste facilities permit;"[5] DTSC is "integrating potential facility impacts and community vulnerabilities into the Department's permitting process."[6] The difference between these two ideas is vast. The first directs DTSC to grapple with *whether* to issue permits; the second seeks to add steps *when* issuing permits. The methodology DTSC sets out in the Framework explores a path toward the second idea[7]—but completely ignores the first.[8] As a result, DTSC is not on track to accomplish what the legislature directed and communities are demanding. Further, we note that DTSC is not free to adopt regulations that are inconsistent with the terms or intent of the authorizing statute.[9]

Based upon a straightforward reading of the plain language of SB 673, Community and Health Advocates call upon DTSC to reframe the regulations it seeks to adopt and focus on the direction given by the legislature: establishing when DTSC will decline to issue or renew a hazardous waste facilities permit in communities experiencing exposures to high levels of pollution.

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[2] The State of California Office of Legislative Counsel "prepares the Legislative Counsel's Digest, which is printed on the first page of each bill and contains a brief summary of the effect of the bill." State of California Office of Legislative Counsel, *Legal Services*, https://legislativecounsel.ca.gov/legal-services (last accessed Oct. 8, 2021).
[3] Legis. Counsel's Dig., Sen. Bill No. 673 (2015–2016 Reg. Sess.).
[4] Framework at v.
[5] Legis. Counsel's Dig., Sen. Bill No. 673, *supra*, note 2.
[6] Framework at v.
[7] Although the 7-element Framework is deeply problematic in many ways and fatally flawed in others.
[8] While DTSC acknowledges that siting decisions are made at the local level, DTSC also notes—correctly—"The Department makes decisions regarding whether facilities are permitted to operate, and issues permits that require facilities to operate safely and in compliance with relevant laws and regulations." Framework at v.
[9] *See, e.g., Cal. Assn of Psychology Providers v. Rank* (1990) 51 Cal.3d 1, 11.

Although DTSC uses a reasonable definition for "cumulative impacts," it selects an unreasonable path to identify cumulative impacts.

According to DTSC, cumulative impact

> refers to exposures, public health or environmental effects from the combined emissions and discharges, in a geographic area, including environmental pollution from all sources, whether single or multi-media, routinely, accidentally, or otherwise released. Impacts will take into account sensitive populations and socio-economic factors, where applicable and to the extent data are available.[10]

Key to this definition is that cumulative impacts includes "pollution from all sources." To assess cumulative impacts, DTSC proposes to use CalEnviroScreen as an "initial screening tool."[11] CalEnviroScreen seeks to "help[] identify California communities that are most affected by many sources of pollution, and that are often especially vulnerable to pollution's effects."[12] It is not, however, a tool to assess neighborhood-level pollution sources; rather, its purpose is to provide "a relative measure of burden experienced by a given community compared to the rest of the state."[13] For this reason, CalEnviroScreen should not be used as an "initial screening tool"[14] which results in communities below a certain threshold receiving "no further action"[15] to identify or address cumulative impacts the community is experiencing.

CalEnviroScreen "[p]resent[s] a relative, rather than an absolute, evaluation of pollution burdens and vulnerabilities in California communities by providing a relative ranking of communities across the state of California."[16] CalEnviroScreen does not, and cannot, provide the whole picture of community experiences of pollution. DTSC must undertake the work of identifying all sources of pollution to which communities with hazardous waste handling facilities are exposed. An important example of a relevant gap in the CalEnviroScreen data is its limited visibility into exposures resulting from industrial facilities. While it is clear that emissions from a range of industrial facilities cause exposures to a range of pollutants, "[s]tatewide information directly measuring exposures to toxic releases has not been identified."[17] CalEnviroScreen relies, instead, on information from the EPA's Toxic Release Inventory (TRI) as a surrogate for local information. While this may be helpful when considering relative cumulative impacts at the statewide level, this provides limited help at the local level. Importantly, facilities are required to report to the TRI system only if they have 10 or more full-time employees, operate in certain sectors, and "manufacture more than 25,000 pounds or otherwise use more than 10,000 pounds of any listed chemical during a calendar year."[18] These criteria miss large swathes of the industrial facility landscape. Further, relying on these data to understand community-level exposures for the purposes of permitting individual facilities is deeply problematic.

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[10] Framework at 13.
[11] Framework at vi.
[12] OEHHA and CalEPA, CalEnviroScreen 3.0 Factsheet, https://dtsc.ca.gov/wp-content/uploads/sites/31/2015/09/CalEnviro-Screen-Fact-Sheet-English-accessible.pdf (last accessed Oct. 8, 2021).
[13] Framework at 58.
[14] Framework at vi.
[15] *Id.*
[16] CalEPA and OEHHA, Update to the California Communities Environmental Health Screening Tool: CalEnviroScreen 4.0, Public Review Draft, at 6 (Feb. 2021), https://oehha.ca.gov/media/downloads/calenviroscreen/document/calenviroscreen40reportd12021.pdf (hereinafter, "CES 4.0 Review Draft").
[17] CES 4.0 Review Draft at 85.
[18] CES 4.0 Review Draft at 85.

Instead of relying only on CalEnviroScreen, a valuable model that can be used to gather important information about cumulative impacts on a local level is "ground-truthing."[19] Ground-truthing is "a form of [community-based participatory research], in which community partners, supported by researchers, gather data about pollution sources and their proximity to 'sensitive receptors.'"[20] It is essential to incorporate community members' knowledge into the process in order to accurately assess cumulative impacts, especially since screening tools have been shown to produce errors and inaccurate results.[21] It is critical that DTSC ensure that this information is collected.

CalEnviroScreen provides important insight into which communities are facing high levels of exposure to a range of environmental assaults. This makes it a powerful tool for deciding how to best focus money and other resources meant to reduce environmental assaults. It is not, however, proper to use this tool for excluding communities from protections envisioned by SB 673.

Conclusion

Community and Health Advocates urge DTSC to act with all possible haste to refocus and revise its Cumulative Impacts and Community Vulnerability Draft Regulatory Framework in a manner that delivers on the direction provided by the legislature six years ago. The current proposal, though complex, misses the critical goal to "adopt regulations establishing or updating criteria used for the issuance of a new or modified permit or renewal of a permit, which may include criteria for the denial or suspension of a permit."[22] Further, DTSC must develop a regulation that results in a real understanding of the small universe of communities that are on the front lines of California's permitted hazardous waste. Simply acknowledging that communities face significant exposures and vulnerabilities is not enough—DTSC must determine when too much is enough.

This is a critical matter which requires DTSC's urgent attention. DTSC must develop a meaningful approach to reducing cumulative exposures experienced by communities.

Respectfully submitted,

Angela Johnson Meszaros

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[19] *See*, *e.g.*, James Sadd, et. al, *The Truth, the Whole Truth, and Nothing but the Ground-Truth: Methods to Advance Environmental Justice and Researcher–Community Partnership*, 41 Health Education & Behavior, no. 3, 2014, at 281–290, https://escholarship.org/content/qt7hm4r98d/qt7hm4r98d.pdf.

[20] *Id.* at 282.

[21] *See, e.g.*, James L. Sadd et al., *Ground-Truthing Validation to Assess the Effect of Facility Locational Error on Cumulative Impacts Screening Tools*, Geography Journal, Aug. 2015, at 5-7, https://doi.org/10.1155/2015/324683.

[22] Health and Safety Code § 25200.23 (as added by Stats. 2015, ch. 611, § 2 (Sen. Bill No. 673)).

APPENDICES TO COMMENTS ON CUMULATIVE IMPACTS AND COMMUNITY VULNERABILITY DRAFT REGULATORY FRAMEWORK

Appendix	Description
A	James Sadd, et. al, *The Truth, the Whole Truth, and Nothing but the Ground-Truth: Methods to Advance Environmental Justice and Researcher–Community Partnership*
B	James L. Sadd, et al., *Ground-Truthing Validation to Assess the Effect of Facility Locational Error on Cumulative Impacts Screening Tools*

APPENDIX A

Title
The Truth, the Whole Truth, and Nothing but the Ground-Truth: Methods to Advance Environmental Justice and Researcher-Community Partnerships

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The Truth, the Whole Truth, and Nothing but the Ground-Truth: Methods to Advance Environmental Justice and Researcher–Community Partnerships

James Sadd, PhD[1], Rachel Morello-Frosch, PhD, MPH[2], Manuel Pastor, PhD[3], Martha Matsuoka, PhD[1], Michele Prichard, MA[4], and Vanessa Carter, MA[3]

Abstract

Environmental justice advocates often argue that environmental hazards and their health effects vary by neighborhood, income, and race. To assess these patterns and advance preventive policy, their colleagues in the research world often use complex and methodologically sophisticated statistical and geospatial techniques. One way to bridge the gap between the technical work and the expert knowledge of local residents is through community-based participatory research strategies. We document how an environmental justice screening method was coupled with "ground-truthing"—a project in which community members worked with researchers to collect data across six Los Angeles neighborhoods—which demonstrated the clustering of potentially hazardous facilities, high levels of air pollution, and elevated health risks. We discuss recommendations and implications for future research and collaborations between researchers and community-based organizations.

Keywords

air pollution, community-based participatory research, environmental justice

For nearly three decades, community organizing and advocacy by a variety of organizations has transformed California into a leader in environmental justice activism and policy. Environmental justice initiatives now range across multiple programs within the California Environmental Protection Agency (Cal-EPA), and there is even a direct mandate to address environmental justice concerns within the landmark state climate change law ("Global Warming Solutions Act," 2006).

In engaging with the regulatory system, environmental justice organizations sought to document the disproportionate burden of poor air quality on people of color and the poor and/or the likely impacts of hazards on mortality and morbidity. Although academics have helped inform this work, some of the resulting research is highly technical and often less accessible to the affected publics. Also, because some researchers may not provide timely research results back to the community or collaborate with community partners to disseminate the work in ways that promote policy change, there is sometimes tension between academics and activists (Minkler, 2004; Morello-Frosch et al., 2011).

The Los Angeles Collaborative for Environmental Health and Justice (the Collaborative) is a joint enterprise between community organizers and researchers that has developed a different model (Morello-Frosch, Pastor, Sadd, Prichard, & Matsuoka, 2012). Specifically, the Collaborative has sought to combine scientific evidence and residents' firsthand knowledge about the elevated risk and incidence of asthma, cancer, and respiratory illnesses in areas near major pollution sources, such as factories, freeways, and ports. For over a decade, the Collaborative's advocacy work has leveraged research demonstrating a regional pattern of clusters of polluting facilities, high concentrations of toxic air pollution, and high health risks in low-income communities of color (Gauderman, 2004; Hricko, 2008; Morello-Frosch & Pastor, 2002; Pastor, Sadd, & Hipp, 2001). In recent years, the Collaborative's advocates and scientists have also sought to move past documenting disparities and instead develop transparent and scientifically valid tools to identify local

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areas that might need targeted regulatory strategies to address environmental justice concerns.

Working with the Collaborative, our research team developed an environmental justice screening method (EJSM) that is built on secondary data sources and examines issues of pollution exposures and estimated health risks, hazard proximity, and social vulnerability (Sadd, Pastor, Morello-Frosch, Scoggins, & Jesdale, 2011). While advocates, agency scientists, and academic peer-reviewers have provided substantive input in the development of the EJSM and embraced it as a valid screening method for identifying communities of concern for cumulative impacts from environmental and social stressors, the technical and data-intensive nature of this effort has posed a challenge to collaboration: by its nature, it can seem like a distant tool that is the province of university researchers and regulators, and less geared to community advocates.

To partially address this problem, we launched a "ground-truthing" effort using community-based participatory research (CBPR) methods. CBPR entails academic and community collaboration in selecting research questions, designing studies, collecting data, interpreting findings, and disseminating results to policy makers for the purpose of protecting public health and improving public policy (Israel, Checkoway, Schulz, & Zimmerman, 1994). Ground-truthing is a form of CBPR, in which community partners, supported by researchers, gather data about pollution sources and their proximity to "sensitive receptors"—concentrations of people, such as the elderly, young children, and people with chronic health conditions, who are most vulnerable to pollution. Ground-truthing data document the cumulative environmental impacts in these neighborhoods that research teams can map and compare against regulatory agency databases.

While we first developed our ground-truthing method at a site in East Oakland (Community for a Better Environment, 2008), we expanded the practice to include multiple sites in Los Angeles as we were furthering the development of the EJSM. The findings from the process confirmed community residents' concern that regulatory databases were incomplete and sometimes inaccurate and that the level of cumulative environmental burden was often higher than a regulator might assume using agency data alone. In addition, the ground-truthing process itself proved valuable as community members developed working relationships with academic researchers, gained an understanding of how more complicated data sets and analyses were constructed, and learned to trust the more complex EJSM being developed at the same time (Matsuoka, Pritchard, & Sadd, 2010; Morello-Frosch et al., 2012).

We begin with a discussion of CBPR that highlights the challenges of "data disconnect" between researchers and the community. We then provide a description of the Los Angeles Collaborative for Environmental Health and Justice, including its work on the EJSM, and how this led to ground-truthing. We discuss the methodology of ground-truthing and briefly summarize the results. We close with a discussion of how community knowledge completes and complements "official" knowledge in improving environmental outcomes and environmental justice research.

Community-Based Participatory Research

Disparities in environmental hazard exposures and health by race and class have been the subject of a significant body of research. While there are some methodological disputes (Foreman, 1998; Lester, Allen, & Hill, 2001; Mohai & Saha, 2006), there is a prevailing consensus that minority and poorer communities experience disproportional environmental hazards. Although statistical research on disparities has tended to dominate the academic debate, CBPR has also emerged as an important part of the work. CBPR is defined as "a collaborative approach to research that engages academic and community partners in both knowledge generation and intervention strategies that benefit the communities involved" (Freudenberg, Israel, & Pastor, 2010, p. S126). Minkler's (2004) framing of CBPR is more politicized:

> Explicit throughout the CBPR process are the deconstruction of power and the democratization of knowledge such that the experiential knowledge of community members is valued and knowledge that previously was the purview of scholars is accessible physically and intellectually to community participants, as well as being relevant to their needs and concerns. (p. 686)

CBPR is also useful because local communities have important insights about environmental hazards that affect their health which researchers and data sets might miss (Freudenberg et al., 2010), a factor that can lead to more effective solutions in environmental health (Corburn, 2005; Morello-Frosch et al., 2006). Although high levels of social capital and community capacity are needed to carry out CBPR, this approach itself can strengthen social ties and increase civic engagement capacity through the research process (Freudenberg et al., 2010).

The Los Angeles Environmental Health and Justice Collaborative

The Los Angeles Environmental Health and Justice Collaborative was formed in 1996 to study and address community-defined environmental justice issues in this metropolitan region (Morello-Frosch et al., 2012). Initially anchored by Communities for a Better Environment, a California-based environmental justice organization with strong organizing roots in Southern California, and the Liberty Hill Foundation, a Los Angeles-based community foundation specializing in grant-making, technical assistance, and capacity building for community-based organizations, the Collaborative has grown significantly since its inception and now includes several environmental health and justice organizations.

The goals of the Collaborative are twofold: to improve environmental health in low-income communities of color in Southern California by conducting research on air quality and environmental justice and to build the capacity of community-based environmental justice organizations by linking research to policy advocacy and organizing at the local and statewide levels. Decision making over research topics prioritizes community interests: any partner (the researchers, Liberty Hill, or the community organizers) can bring a research idea to the table, but community partners shape project priorities and timing, with a particular eye to policy campaigns they may be seeking to launch (Morello-Frosch et al., 2012).

The Collaborative's research team (consisting of the first three authors of this article) ensures the scientific rigor and objectivity of its work by subjecting research results to peer-review by scientific colleagues (through professional conference presentations and through publishing in the environmental health and social science literature) as well as periodic presentations to regulatory scientists at state and regulatory agencies. The research team has traditionally used secondary data collected by regulatory authorities such as the U.S. Environmental Protection Agency, the California Environmental Protection Agency, the California Air Resources Board, and others to document Southern California's environmental health "riskscape." The Collaborative took this route in the belief that analyzing the government's own data to assess racial and other disparities would be a powerful way to draw regulatory attention to environmental justice issues.

Study results have been used to inform important policy campaigns, including efforts to change local air district regulations on permissible facility emissions, motivate the California Environmental Protection Agency to consider the combined health impacts of environmental and social stressors in decision making, improve air quality near schools, and regulate diesel truck emissions from the ports of Los Angeles and Long Beach (Petersen, Minkler, Vásquez, & Baden, 2006). The research team has also worked to improve decision making on air quality regulation and land use planning at the municipal and regional levels by developing an EJSM that integrates a set of 23 health, environmental, and social vulnerability area-level measures into three categories—hazard proximity and land use, estimated air pollution exposure and health risk, and social and health vulnerability—and then maps and scores the combined impacts at the neighborhood level within the Southern California region (Sadd et al., 2011).

The Collaborative has sought to integrate the EJSM, which is based on secondary data, with the knowledge of community residents regarding the location and local effects of environmental stressors and sensitive land uses. The basic concept is that community residents observe the day-to-day activities of emission sources and may find hidden hazards that are not recorded in government databases. We wound up calling this process "ground-truthing": community residents take the secondary data being used in the EJSM, verify and supplement it with community-based mapping and air monitoring, and use the study results to draw regulatory attention to environmental justice issues.

Method

Ground-Truthing

The term *ground-truthing* emerged from the field of cartography, in which aerial imagery or remote sensing data used to map surface features such as vegetation or land use are checked, or validated, using observations "on the ground" (Sharkey & Horel, 2008). Ground-truthing in the context of this project entailed verifying whether hazards indicated in regulatory databases really existed and whether there were additional hazards identified by residents on the ground that are not captured by these databases. The Collaborative's ground-truthing exercise involved a range of communities in the Southern California region. Of the communities that participated, four lie within the boundaries of the City of Los Angeles—Boyle Heights, the Figueroa Corridor, Pacoima, and Wilmington—whereas two others are bordering municipalities—Commerce and Maywood (Figure 1).

Training Community Researchers

The ground-truthing process began with workshops during which community members were trained on the concepts and science of air pollution hazards, cumulative impacts, and social vulnerability, as well as the state and federal databases that keep locational and other records of air quality hazards that require permits and report emissions. Community members were also made aware of the kind of land uses that the state of California lists as "sensitive receptors" (such as schools, day care centers, health centers, recreational areas and parks) as well as those it considers sources of "hazardous air emissions" (such as chrome platers, rail yards, dry cleaners, ports, refineries, and industrial facilities).

Because the training as well as the research was participatory, residents were also asked to generate their own lists of hazards and sensitive receptors to consider in ground-truthing. Many hazards identified by community members are systematically included in the state's databases (e.g., refineries, chrome plating facilities, dry cleaners), but community participants also generated a more inclusive list that included some hazards and sensitive receptors that are not included in these data sources (e.g., auto body shops and locations where trucks routinely idle and emit diesel pollution, and sensitive receptors like home-based day care sites, churches, and senior centers).

Community members then did a trial run at data collection: they were given preliminary maps and walked through the surrounding community with researchers to check the accuracy of site locations. Community members then defined the geographic boundaries of their neighborhood for the actual ground-truthing exercise and researchers developed

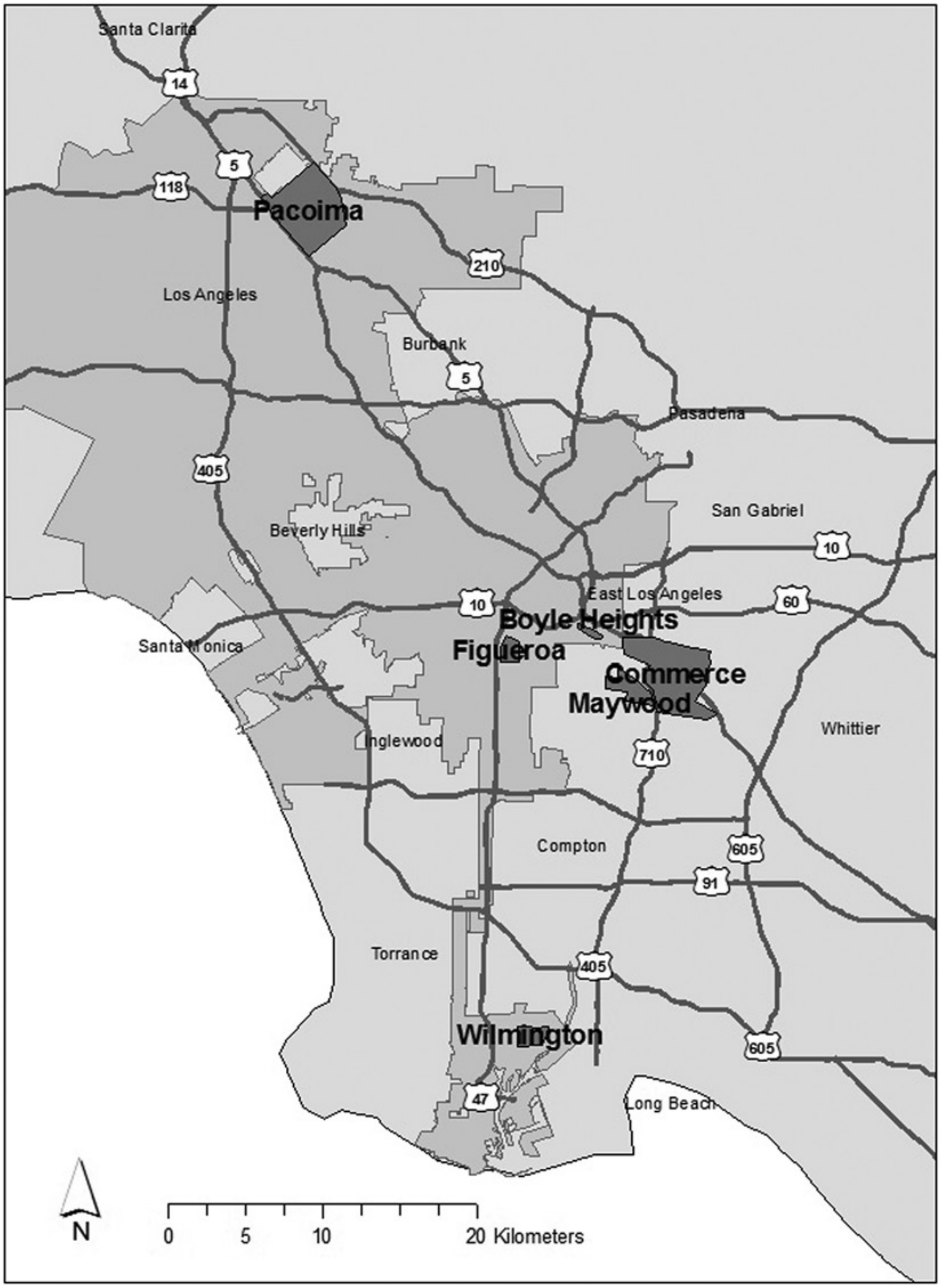

Figure 1. Location of six ground-truthing locations in the Los Angeles metro area.

maps for those areas that included hazardous facilities and land use information derived from regulatory databases from agencies such as the Southern California Association of Governments, the California Air Resources Board, California Environmental Protection Agency, California Department of Education, California Spatial Information Library, and publicly available commercial data sources, such as the Dun and Bradstreet Business Information Service.

Mapping the Neighborhood

To ground-truth their community, participants were equipped with notebooks containing maps, aerial photos, data entry forms, and step-by-step instructions on data collection. Community leaders organized participants into teams of two, with each team trained and responsible for conducting street-by-street assessments of their portion of the study area, identifying, and locating both hazards and sensitive receptors of concern. One block overlaps at the boundaries were included to ensure that the mapping was complete.

Teams were tasked the following:

- Verify the location and correct information of all air quality hazards recorded in regulatory agency databases
- Verify the location and correct information of all sensitive receptor land uses as defined by the California Air Resources Board (schools, child care centers, playgrounds and urban parks, and health care facilities)
- Locate and map any additional air quality hazards and sensitive receptors not included in the regulatory agency databases

Community residents recorded locations on aerial photos, either using portable GPS receivers and/or by writing the street address (or street intersection) of hazard and sensitive land use locations. Participants also recorded the name, type of business or activity, and other notes about the land use on a field notes template sheet. Teams also recorded observations about types of hazards not necessarily tied to land use, that is, idling trucks, trucks passing through residential streets, and large containers on sites that may be filled with chemicals. The data collected by community participants was transferred to a GIS spatial database using geocoded addresses. Duplicates were identified and eliminated, and researchers subsequently visited and documented the location of each site recorded in state regulatory agency databases using GPS to verify location accuracy.

Particulate Matter (PM) Monitoring

Facility mapping indicates proximity but community members were sensitive to past experiences of being told that proximity does not necessarily demonstrate exposure or poor air quality. For this reason, community leaders decided to conduct air monitoring in locations of concern and asked the researchers for help and advice. We contacted staff at the California Air Resources Board who had assisted in the aforementioned East Oakland study and who then lent air monitoring equipment to the Collaborative for this study and provided advice on sampling protocols. Over the course of 6 weeks, community members systematically monitored $PM_{2.5}$ (fine particulates less that 2.5 microns in size) levels using handheld TSI Model 8520 DustTrak Aerosol Monitors, which are nephelometers that measure levels of ambient $PM_{2.5}$ by sensing particle scattering of a laser beam and converts signals into a particle concentration (NIST SRM 8632; Sabin et al., 2005).

Table 1. List of Air Quality Hazards and Sensitive Receptors Located and Mapped by Ground-Truthing.

Air quality hazards	
Auto paint and body	9
Auto/truck repair	149
Dry cleaners	5
Manufacturing using air toxics	69
Metal plating	3
Printing	10
Recycling	9
Superfund site	1
Idling trucks (chronic)	8
Sensitive receptors	
Church	61
Community center	7
Daycare	24
Health facility	27
Park	3
School	13
Senior	9

Five communities (Figure 1) participated in outdoor air monitoring: Pacioma, Wilmington, Boyle Heights, Figueroa Corridor, and Maywood (Commerce had recently completed their own independent air monitoring project with similar results, but used a different protocol and thus these data are not reported here). To characterize variations in $PM_{2.5}$ levels, each community member identified a series of sampling sites that they felt represented both the worst and best air quality, as well as locations where large numbers of residents were likely to be exposed to outdoor air pollution. Community members developed a plan to repeatedly monitor these sites at six identical times between 6 a.m. and 10 p.m. each day for a full week, including both low and high “rush hour” traffic periods. During each monitoring session, community members used the DustTrak monitors to collect data for 5 to 10 minutes to derive a time-weighted average $PM_{2.5}$ concentration. Monitoring was done during the winter months.

Results

The Collaborative model is based on the collective sharing, interpretation, and dissemination of research results. Thus, when the spatial analysis was completed and the results verified, researchers reported back to participants in subsequent workshops. Community members compared their maps with those created using only state regulatory agency data and discussed the results.

Community data on locations of hazards and sensitive receptors was generated in six communities. Table 1 shows

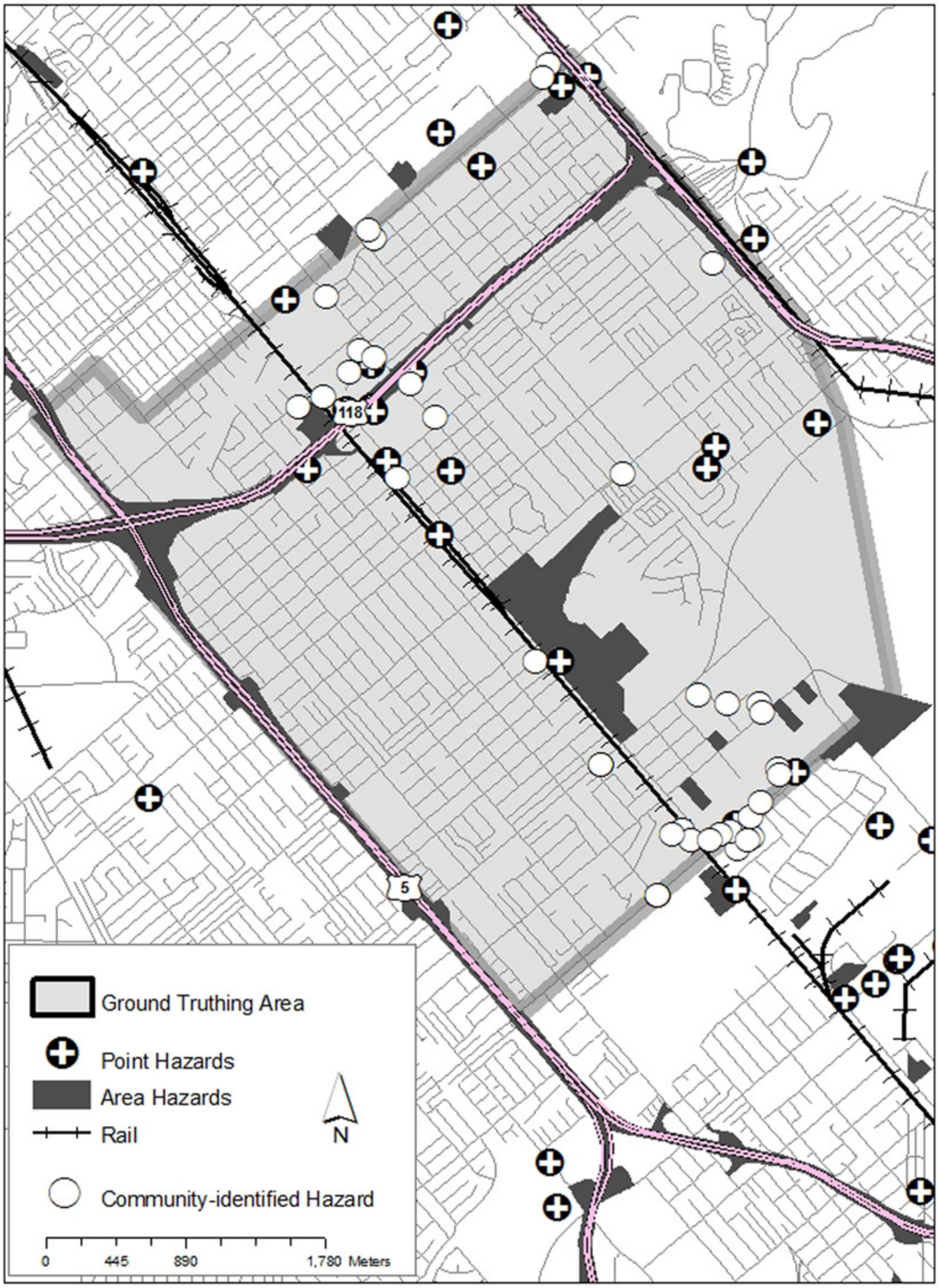

Figure 2. Air quality hazards identified in regulatory databases and by community ground-truthing—Pacoima.

the aggregated hazards across all source types for all ground-truthed areas. While the same data were collected for all six neighborhoods, we show results for our site in Pacoima, CA; additional results for other communities appear as Supplementary Material (available online at heb.sagepub.com/supplemental).

Figure 2 shows ground-truthing results for Pacoima with the shaded areas indicating the community-identified boundaries of their neighborhood. In Pacoima, community members identified almost 50 sites that they considered environmental health hazards that were not included in regulatory databases. These facilities tended to be auto paint and

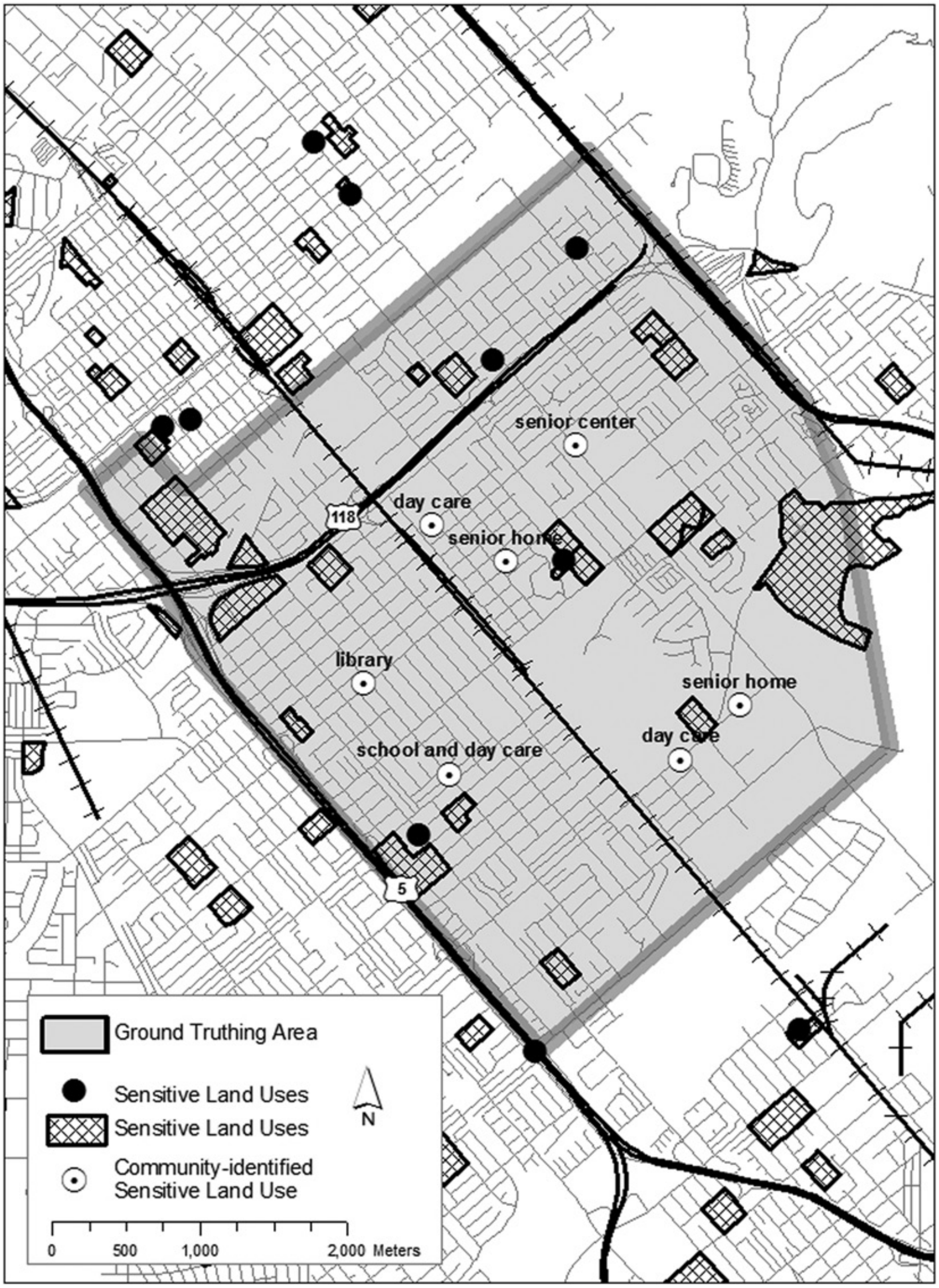

Figure 3. Sensitive receptors identified in regulatory databases and by community ground-truthing—Pacoima.

body shops that are often clustered together, representing a cumulative hazard that may be comparable to a larger industrial facility. The results for Pacoima are not anomalous: in each ground-truthing neighborhood, residents located significantly more hazards than were enumerated in state regulatory databases.

Ground-truthing revealed a similar pattern with regard to sensitive receptors (Figure 3): field teams found seven sensitive receptor land uses in Pacoima that are not included in state databases. Four of these sensitive land uses are located within 1,000 feet of an environmental hazard, placing them within the buffer the California Air Resources Board (2005)

Table 2. Facilities in Pacoima Found to Have Location Inaccuracies in State Agency Databases.

Facility Name	Distance Error (feet)	Direction of Error
Price Pfister, Inc.	1,311	SW
Anthony, Inc.	1,137	SW
Price Pfister, Inc.	746	SW
Anthony International	739	SW
California Technical Plating Corp.	626	NW
All American Asphalt	626	NW
Valley Region High School No. 5	618	N
Whiteman	544	NW
USARC Pacoima	461	SW
Holchem, Inc.	415	NE
Precision Dynamics Corp.	247	NE
Sequoia Shutters	235	NE

recommends for not siting or building of such land uses near certain air quality hazards.

Ground-truthing also revealed that environmental hazard locations in agency databases were often incorrect—sometimes by significant distances. Table 2 shows facilities in Pacoima with locational errors of more than 200 feet—note that a few have a locational inaccuracy that exceeds the recommended buffer. This is not atypical: every community has a similar number of serious locational errors and a full list from the six ground-truthed communities would show that most (77 of 122) of these facilities are inaccurately located by at least 200 feet.

$PM_{2.5}$ air monitoring in locations of concern identified by community partners revealed that particulate matter levels often exceeded California EPA standards. Figure 4 shows measurements from five monitoring locations in Pacoima. Each point represents one measurement of $PM_{2.5}$ at a given location, with a red horizontal line showing the California EPA health protective standard for $PM_{2.5}$ of 0.012 micrograms per cubic meter ($\mu g/m^3$) of air; points that plot above the red dashed line exceed this standard. In all five communities where air monitoring was done, the results were similar: $PM_{2.5}$ levels exceeded the State health standard about half the time. Particulate air pollution concentrations tended to peak midday between 9 a.m. and 3 p.m., corresponding with morning rush hour and busy traffic during the period when children are playing at school and many residents are outside at work or play. In each community, the highest values were five to six times the standard.

Conclusion

CBPR seeks to enhance the rigor, relevance, and reach of the scientific enterprise. Rigor refers to the practice of good science in terms of the analytical design and interpretation phases of research. Relevance refers to whether science is asking the right questions and elucidates opportunities for action. Reach encapsulates the degree to which knowledge is disseminated to diverse audiences and translated into useful tools for the scientific, regulatory, policy, and lay arenas (Balazs & Morello-Frosch, 2012).

The ground-truthing experience sought to achieve rigor, relevance, and reach by uncovering gaps in regulatory agency data, raising important air quality issues at local scales, and providing fuel for proactive policy initiatives. In particular, ground-truthing supplemented regulatory data, which can be riddled with significant geographical inaccuracies and gaps. It also documented and made real the concept of cumulative impacts, or the extent to which communities are overburdened by multiple environmental hazards and social stressors. Most important, ground-truthing empowered community members to explore, verify, and critique government data sources that serve as inputs into the EJSM, which in turn promoted productive scientific dialogue and engagement with both researchers and regulatory officials. As such, ground-truthing of the EJSM became an activity in which community organizations trained members on basic concepts in environmental health and highlighted opportunities for regulatory and policy change.

Specifically, the Los Angeles Environmental Health and Justice Collaborative leveraged its ground-truthing work to support a new policy campaign called "Clean Up, Green Up," which advocates specific steps that the City of Los Angeles should take to address the cumulative impacts of environmental and social stressors in vulnerable neighborhoods. Using this research and effective organizing, the Clean Up, Green Up campaign has been successful in convincing the City of Los Angeles to designate three communities involved in the ground-truthing exercise—Wilmington, Boyle Heights, and Pacoima—as "Green Zones" that will eventually offer special incentives to remove hazards and better enforce regulations, to assist existing businesses in conversion to cleaner operation, and to attract new and "greener" businesses.

This study demonstrates that CBPR approaches to validating the use of secondary data can be a powerful strategy for policy change while also enhancing the scientific rigor of the analytical work. Just as important, ground-truthing can help bridge the gap between increasingly technical research, including GIS mapping, and community knowledge (Corburn, 2005). Ground-truthing helped make a highly technical EJSM more transparent to community stakeholders by meaningfully engaging residents in the structured and rigorous validation of the data inputs. Conversely, advocates showed regulatory and academic scientists how to effectively leverage the EJSM, in conjunction with their local knowledge of environmental health problems, to promote innovative strategies to reduce the impact of environmental hazards in diverse neighborhoods. Overall, ground-truthing proved to be an effective and relatively inexpensive way to

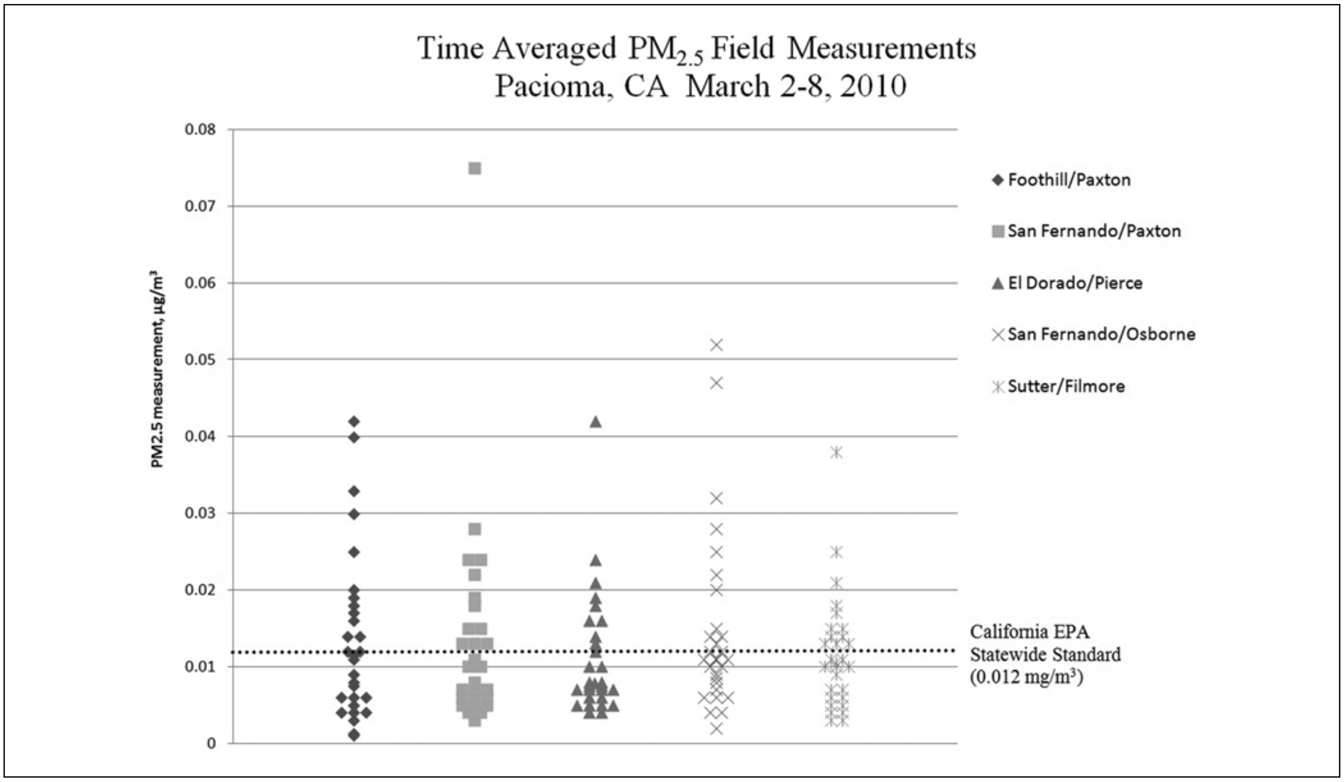

Figure 4. $PM_{2.5}$ monitoring results for five locations in Pacoima.

shine the twin spotlights of good science and community wisdom on real environmental justice concerns.

Declaration of Conflicting Interests

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Supplemental Material

The online supplemental material is available at heb.sagepub.com/supplemental.

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APPENDIX B

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Research Article

Ground-Truthing Validation to Assess the Effect of Facility Locational Error on Cumulative Impacts Screening Tools

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Researchers and government regulators have developed numerous tools to screen areas and populations for cumulative impacts and vulnerability to environmental hazards and risk. These tools all rely on secondary data maintained by government agencies as part of the regulatory and permitting process. Stakeholders interested in cumulative impacts screening results have consistently questioned the accuracy and completeness of some of these datasets. In this study, three cumulative impacts screening tools used in California were compared, and ground-truth validation was used to determine the effect database inaccuracy. Ground-truthing showed substantial locational inaccuracy and error in hazardous facility databases and statewide air toxics emission inventories of up to 10 kilometers. These errors resulted in significant differences in cumulative impact screening scores generated by one screening tool, the Environmental Justice Screening Method.

1. Introduction

Over the past three decades, researchers in the fields of environmental justice (EJ) and environmental health have demonstrated the existence of regional- and local-scale differences in exposure to air pollution, as well as calculated health risk and impacts of ambient air quality on the health status of residential populations. The patterns of disparity in cumulative impacts and exposure correlate with several socioeconomic indicators, including race and measures of wealth. Different causal factors contribute to the disparities in health status, but it is probable that differences in exposure to environmental hazards and risk play an important role. In California, there is particularly strong evidence indicating patterns of both disproportionate exposure to air pollution and air toxics and associated health risks among communities of color and lower income groups (e.g., [1–4]). These same highly impacted communities also face challenges associated with social determinants, such as low social and economic status, as well as psychosocial stressors, which make it more difficult to cope with exposure and health disparities.

The problem of cumulative impacts is not fully addressed by current regulatory and permitting practice, in part because of a reliance on traditional methods of risk assessment to decide, for example, whether a specific polluting facility can operate under existing law. Risk is typically calculated using single stressors and is reported on a chemical-by-chemical, medium-by-medium, and source-by-source basis. Each regulatory authority only reviews those projects or facilities within its mandate and jurisdiction, with no integrated enforcement or review action across jurisdictions. A consequence of framing and identifying priorities on single-risk magnitude and single-scope regulation in this way ignores the fact that, in many communities, residents are exposed to multiple environmental hazards and experience the cumulative impact of the attendant risks. The one-dimensional facility-by-facility regulatory approach ignores the reality of the multiplicity of factors that affect these communities and, in doing so, fails to adequately protect public health and safety.

Cumulative Impact Tool Development. The development of tools, approaches, and methodologies for assessing cumulative impacts on vulnerable communities within a cumulative risk framework is rapidly evolving. Several methods, developed by both academic researchers and state and federal regulatory agencies, have been applied in selected regions to aggregate and map the geographic distribution of cumulative impacts and to include consideration of the relative vulnerability of different communities to negative environmental impacts. These cumulative impacts tools are intended to be used by environmental and regulatory agencies for screening-level activities, such as planning and prioritization, and to assist in decision-making on such activities as permitting and determination of environmental remediation actions (i.e., "cleanup" levels). All of these cumulative impacts methods (1) define a set of indicator metrics that track different aspects of exposure, risk, and vulnerability for different geographic units in the region of study; (2) use spatial analysis techniques in a Geographic Information System (GIS) to "screen" areas to characterize their indicator profile; and (3) apply index scores to geographic locations to summarize their relative indicator profile and facilitate mapping and interpretation of the spatial patterns.

Requirements for Cumulative Impact Analysis. A wide variety of health and exposure indicators have been used in various studies. These include proximity to air pollution emissions and hazardous waste sources [1, 3, 5–8], exposure to specific substances such as pesticides and lead [9, 10], exposures to outdoor air pollution and associated health risks [4, 11–13], differences in regulatory enforcement and clean-up [14, 15], body burden measurements [16], and the distribution of environmental benefits due to regulatory implementation (e.g., clean air, water, and access to recreational areas [17, 18]).

Residents in EJ communities point out that inequality in exposure exists for many different pollutants and types of environmental hazards and that the resulting cumulative impacts (CI) have exacerbated health disparities in these communities. Many neighborhoods bear the combined, or cumulative, burden of air pollution emissions from numerous industrial facilities and land uses, as well as emissions from mobile sources on high volume roads and freeways, and emissions associated with smaller facilities that either operate illegally or are not subject to regulatory oversight. This is of particular concern where the exposures affect populations that are, because of age or chronic health conditions, particularly sensitive to air pollution. Areas where these "sensitive receptors" spend much of their time are referred to as sensitive land uses by the California Air Resources Board [19]. Sensitive land uses include schools, childcare centers, urban parks and playgrounds, healthcare facilities, and senior residential facilities.

Support for Cumulative Impact Analysis. The National Environmental Justice Advisory Committee, EJ advocates, and community organizations have long argued that scientists and regulatory agencies should incorporate the cumulative impacts of environmental and psychosocial stressors when ranking the priorities for regulatory enforcement activities instead of using the traditional chemical-by-chemical and source-specific assessments of potential health risks of environmental hazards, which do not reflect the multiple environmental and psychosocial stressors faced by vulnerable communities. These stakeholders have voiced their concern and have called for additional methods to consider and include cumulative impacts in developing regulatory and enforcement priorities. Regulatory agencies have responded to this need by embracing the National Research Council's call for the development of "cumulative risk frameworks" within their scientific programs and enforcement activities.

The consideration of the effects of cumulative impacts originally gave rise to Presidential Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," in 1994, which directed the federal agencies "to identify and address the disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations, to the greatest extent practicable and permitted by law," and to "develop strategies for implementing environmental justice." The lead agency in this effort has been US EPA, through its Office of Environmental Justice and its leadership role in the Interagency Working Group. EPA's Office of Research and Development through its Sustainable and Healthy Communities Research Program and the 10 EPA Regional offices have also developed robust environmental justice initiatives.

EPA Cumulative Impact Tools and Application Domains. EPA Region 9's in-house and externally funded development and application of cumulative impacts screening-level tools, like EJSM, are part of EPA Region 9's urban air toxics strategy, which has a major focus on mobile source air toxics. EPA Region 9's goal is to integrate EJ measures into land use and zoning development planning (i.e., residential, transportational, industrial, etc.). EPA Region 9 has previously applied cumulative impacts screening tools to federally mandated Resource Conservation and Recovery Act actions, and as a result, environmental remediation plans have been modified. A key emphasis area for EPA Region 9 is the SJV, because it is a nonattainment area for $PM_{2.5}$ (i.e., particles less than 2.5 um in diameter) and the high asthma rates. The current projection is that the SJV will not be in $PM_{2.5}$ compliance until 2023. The Interstate Highway 5 and Interstate Highway 99 transportation corridors, along with agricultural pesticides (with particle-bound NH_3), are believed to be the main contributors to the $PM_{2.5}$ nonattainment and high asthma rate problems in the SJV. EPA Region 9 also has a requirement for a methodology to assess if national or regional emissions trading programs are the cause of disparate exposure impacts on vulnerable communities. The EJSM has the potential to address these EPA Region 9 priority areas and assist them in incorporating cumulative impacts screening results into decisions having environmental impacts.

The US EPA developed four cumulative impacts tools: (1) the Environmental Justice Strategic Enforcement Tool (EJSEAT), a pioneering effort from the Office of Solid Waste and Emergency Response to help it prioritize resources; (2) the Census Tract Ranking Tool for Environmental Justice (CenRANK), developed by an EPA contractor, to add data richness and analytical capability to EPA's screening efforts; (3) EJSCREEN, a screening tool released publically in 2015 to identify areas with disproportionately high and adverse environmental health burdens, using nationally consistent data, to identify communities that are potentially overburdened and to help EPA regional offices prioritize permits in these areas; and (4) the Social Vulnerability Index, developed by EPA Region 9, and designed to aggregate and display the social determinants of health as a base map for program-specific environmental information. The SVI uses US Census Tract data to determine where the socially vulnerable populations are located in EPA Region 9, but this tool does not assess the cumulative impact of environmental hazards (air pollution exposures), or their proximity, on those vulnerable populations. The ESJM, initially funded by both CARB and US EPA, was designed to address the need for this type of analysis. This research effort applied EJSM to validate and correct hazard facility locations and to use the corrected data in ESJM and the two other cumulative impacts screening methods (CEVA and CES) to assess the impact of incorrect facility location on cumulative impacts scores.

California-Based Cumulative Impacts Tools. In California, the Office of Environmental Health Hazard Assessment (OEHHA) maintains a Cumulative Impacts and Precautionary Approaches Work Group, which has advised the California Environmental Protection Agency (CalEPA) in its efforts to develop guidelines for consideration of cumulative impacts within the different CalEPA programs. Academic researchers in California have developed two cumulative impacts tools to assist in screening-level analysis in overburdened communities in California, the Environmental Justice Screening Method (EJSM) [8], and the Cumulative Environmental Vulnerability Assessment (CEVA) screening tool [20]. EJSM is a screening-level cumulative risk assessment tool, which is an analytically robust and procedurally transparent method to assess and compare the cumulative impact of environmental and social stressors across neighborhoods within a region. EJSM has an emphasis on air pollution impacts and vulnerability according to the specific recommendations of the California Air Resources Board [19] but also includes impact and vulnerability with respect to poor drinking water quality and adverse climate change effects. CEVA is a screening tool used to identify concentrations of cumulative environmental hazards in areas with low social, economic, and political resources, to help these communities prevent, mitigate, or adapt to these conditions; it has been applied to selected areas in California. CalEPA OEHHA has developed an additional cumulative impacts screening methodology called the California Communities Environmental Health Screening Tool (CalEnviroScreen or CES) [21], which is used to identify communities that experience disparate health impacts from multiple sources of air pollution. These three cumulative impacts screening methodologies differ significantly from each other in analytical approaches, model algorithms, and other details (e.g., the geographic unit for analysis, some indicator metrics used, and methods of index scoring), but they share many common features, including use of standard data sources, primarily databases, maintained by California state regulatory agencies for permitting and analysis, augmented by land use or business information from municipalities and private companies. These data sources are not only used in cumulative impacts screening, but they are fundamental components in the processes through which regulators and policy developers assess and characterize "place-based" environmental exposure and risk.

Use of Ground-Truthing in Cumulative Impacts Screening. One critique of EJ-based cumulative impacts screening focuses on concerns that the resultant output data is flawed due to locational inaccuracy, lack of completeness, and errors from infrequent updating of the input data sources and that the use of the flawed input data for cumulative impacts screening introduces significant error into screening results. To address this criticism, "ground-truthing" was used to validate these data. The term *ground-truthing* was introduced into EJ parlance from the field of cartography, where aerial imagery or remote sensing data, used to map surface features such as vegetation or land use, is checked or validated using observations "on the ground" [22]. Ground-truthing in the context of this research project entails verifying whether hazards indicated in regulatory databases are active, accurately described, and actually located at the reported location [23].

We used ground-truthing techniques to (a) validate the locational accuracy of established facilities and land uses from standard business/facility and regulatory databases as a way to check their accuracy before use in cumulative impacts screening tools and (b) determine the impact on cumulative impacts screening scores using unchecked/nonvalidated (with respect to locational and other errors) hazard and facility data as a test of EJSM's susceptibility to identifying false positives (i.e., recorded locations of environmental hazards that are incorrectly shown to be concentrated in a given area and falsely indicate that an area has a high air pollution "loading" or impact). After ground-truthing, the screening results were then compared using both the *uncorrected data* (i.e., data obtained from original source(s) "as-is") and the *corrected data* (i.e., data obtained from original source(s) with (i) subsequent correction applied to facility location(s) and/or (ii) removal of nonexistent facilities or addition of new facilities based on visual confirmation and GPS location) to determine the degree to which the results are affected. For example, if standard databases erroneously indicate that hazards are located or concentrated in a given area, that location might be falsely interpreted as an area of high pollution impact, or a "false positive," distorting

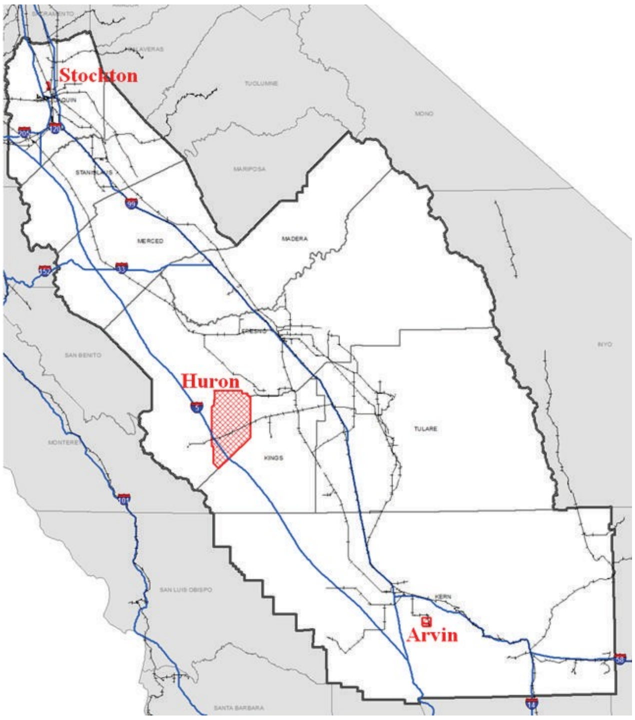


Figure 1: Map of San Joaquin Valley (SJV) region. Labeled are the three cumulative impacts analysis areas, where field-based ground-truth validation was completed. Counties are labeled by name.

the screening results and focusing attention on the wrong locations.

2. Methods

This cumulative impacts analysis was performed using the three cumulative impacts screening tools (ESJM, CEVA, and CES) in the San Joaquin Valley (SJV) region of Central California, comprising eight counties and 71,161 square kilometers (km^2) in area (Figure 1). Two different methods of validation were accomplished. Field-based ground-truthing was completed in three cumulative impacts analysis areas, Arvin, Huron, and Stockton (Figure 1), which were selected to represent the very large and diverse San Joaquin Valley region with reasonable geographic variation and on the basis of the divergence in screening scores among the three methods in these areas. These analysis areas differ from one another, but all have a high number of reported environmental hazards. Arvin, with an area of 24 km^2, is located southeast of population and commerce center, Bakersfield. Huron, with an area of 816 km^2, is a somewhat isolated community almost completely dependent on agriculture and is a historically persistent environmental justice community. Central Stockton with an area of 3.4 km^2 is also an EJ community. Field-based ground-truthing validation of all facility information for the three test areas was conducted in which all reported facilities were visited and validated for locational accuracy and operational status.

Additional field-based ground-truthing in the three cumulative impacts analysis sites was carried out in a systematic search by driving the public roadway network, to locate and validate facility locations not included in the regulatory databases. The facility information for those sites was built in the field as geospatial data layers using ArcMap GIS software, running on a laptop computer in the vehicle and using an external high-accuracy GPS receiver. Software allowed the receiver location to position the cursor in the ArcMap session so that observer location could be tracked on the display and the GPS position could be used to correct these locations or add new features (new facilities), as needed. In each case, locational accuracy was verified and corrected if necessary. In addition, the name and type of each field-identified facility were compared to the information recorded in the standard regulatory or business/facility database. Facilities were also checked for activity to determine whether they were closed or relocated, and duplicate facility records were removed.

As a separate validation test, the reported locations of all hazardous facilities for the entire eight-county SJV region were mapped using best-known location: geographic coordinates reported in the standard regulatory or business/facility databases or the geocoded address of the facility provided by the applicable regulatory agency. Each facility location was then evaluated for locational accuracy using Google Earth Pro using the available aerial imagery, geocoding capability, and real estate tax parcel information to review and correct all facility data, verify correct location, and correct locations as needed.

3. Results and Discussion

Several of the hazard facility databases and all sensitive land use types used in California EJ cumulative impacts screening tools were validated including the following:

(i) CARB Facility/Facilities of Interest (CARB FOI) that are industrial and commercial facilities from the California Emission Inventory Development and Reporting System (CIEDARS) statewide air toxics emissions inventory of greatest concern to CalEPA regulators because of amounts, toxicity, and possible impacts of emissions,

(ii) facilities reporting to the California AB2588 air toxics "Hot Spot" inventory,

(iii) California Department of Toxic Substances Control (DTSC) permitted hazardous waste handling facilities and generators

(iv) autopaint and body shops from the Dun and Bradstreet Business Locator Service,

(v) gas stations as reported by the California Department of Food and Agriculture Division of Measurement Standards,

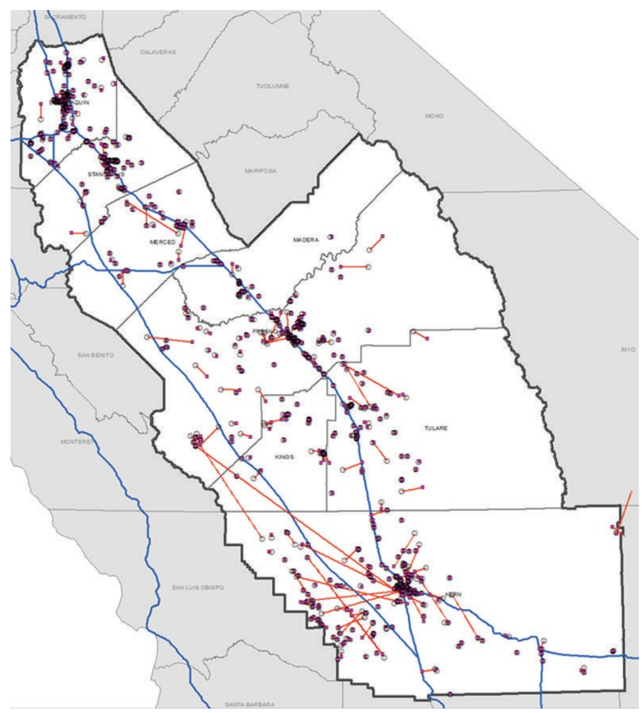
(vi) sensitive land uses: schools, childcare centers, urban parks and playgrounds, healthcare facilities, and senior residential facilities [19]; locations obtained from State agencies, permit databases, county real estate tax parcel information, and the Cal-Atlas Geospatial Clearinghouse.

Table 1: Location errors discovered in field validation in Arvin, Huron, and Stockton by facility type. Note: this is a summary of the number of facilities reported in the standard regulatory or business/facility databases (uncorrected) and facilities found during ground-truth validation (corrected), as well as the number of facilities located inaccurately by at least 100 meters for each cumulative impacts analysis site.

	Arvin			Huron			Stockton		
Facility type	Uncorrected	Corrected	>100 m location error	Uncorrected	Corrected	>100 m location error	Uncorrected	Corrected	>100 m location error
CARB-FOI	—	—	—	5	5	2	3	3	0
AB2588 Air Toxics "Hot Spots"	18	10	5	31	27	13	40	32	1
DTSC Hazardous Waste	—	—	—	—	—	—	—	—	—
Auto paint/body	1	1	0	—	—	—	4	3	1
Gas stations	5	5	0	7	10	0	9	6	0
Sensitive land uses	7	7	0	4	4	4	5	5	0

Field-based ground-truth validation of Arvin, Huron, and Stockton revealed that location inaccuracy and error in these databases are substantial (Table 1). Facilities were found which are of the same type as those recorded in agency database. These "new" facilities were mapped and included as well. For example, the field researcher used the road network to confirm presence and activity of an AB2588 "Hot Spot" facility or childcare facility and compared its "real-world" location to the reported location and then corrected/updated the reported location if necessary. If similar facilities were found, their locations and attribute information were added to the geospatial data layer. Ground-truth validation in these areas indicated that the AB2588 "Hot Spot" database is the most locationally inaccurate one and tends to overstate the hazard exposure due to numerous facility location errors and duplicate facilities. Errors in the other regulatory or business/facility databases are significant, but not quite problematic.

The results of validation of all hazardous facility sites in the eight-county SJV area using Google Earth Pro also demonstrated considerable inaccuracy in these databases (Table 2). One-third of CARB-FOI air toxics emitters were mislocated to a degree that would result in inaccurate cumulative impact scores using the screening tools described above (Figure 2). The accuracy of autopaint and body shops and hazardous waste facilities was considerably better but still contribute to inaccurate screening scores. Gas stations appear to be far more accurately located, as estimated by validating a randomly selected subsample.



CARB-FOI facilities
Location correction
CARB-FOI site as reported

Figure 2: Corrected locations of CARB-FOI air toxics sites in the San Joaquin Valley. The red lines connect facility site location as reported in standard regulatory or business/facility databases (pink circles outlined in black) with the accurate location determined by ground-truthing (unfilled circles).

3.1. Effect on Cumulative Impacts Screening Scores. After corrections were made to each geospatial dataset, EJSM hazard proximity metrics and land use scores were recalculated for the SJV region to determine the impact of using nonvalidated (with errors) versus validated (errors corrected) facility information for one screening method. The Environmental Justice Screening Method (ESJM) methodology was applied, using the location corrected facility information to look for differences resulting from using unchecked (error filled) versus validated (errors corrected) information to assess the degree to which cumulative impacts score metrics changed. Any given census tract containing inaccurately located facilities could either have a higher or lower score, depending

Table 2: Summary of the error rate: locational inaccuracy for selected regulatory databases of hazardous facilities in the SJV region. Inaccurate locations were most prevalent in the CARB_Facilities of Interest dataset, where one-third of the facilities would results in misclassified cumulative impacts using screening tools that track hazard proximity.

	Total	>300 m	>600 m	>1000 m	>3000 m
CARB_FOI	730	248 34.0%	199 27.3%	149 20.4%	97 13.3%
Autopaint/body	314	29 9.2%	20 6.4%	16 5.1%	13 4.1%
Gas stations	1640	10% random test <3%			—
Hazardous waste	17	2 11.8%	1 5.9%	1 5.9%	1 5.9%

Table 3: Distribution of EJSM changes in hazard proximity scores resulting from ground-truth correction by census tract (760 total tracts) in the San Joaquin Valley. Positive values indicate that the hazard score increased for that tract, while negative values indicate a decreased hazard score.

Change in hazard score	Number of census tracts
−4	7
−3	32
−2	77
−1	131
0	200
1	135
2	88
3	62
4	27
5	1

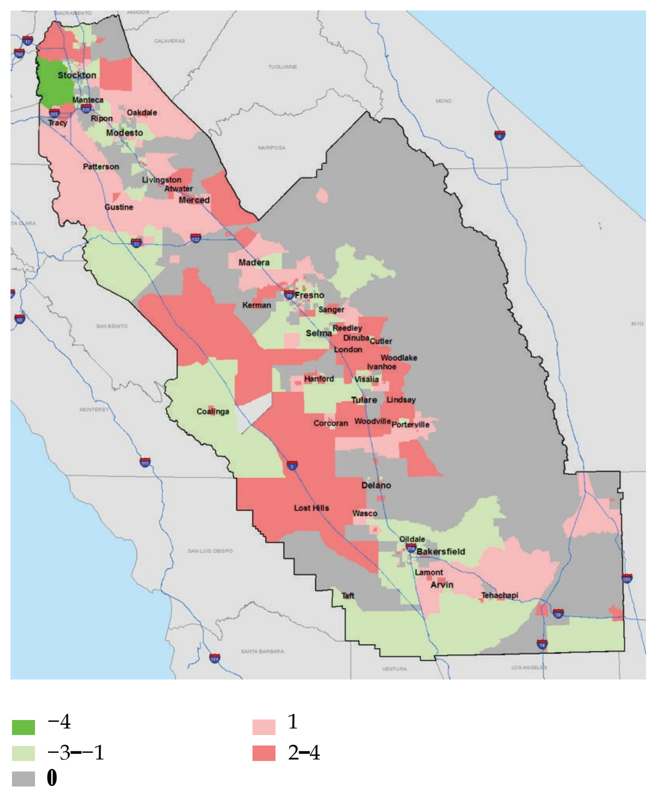


Figure 3: San Joaquin Valley study area showing change in EJSM hazard proximity scores resulting from use of corrected hazard facility data. Color code: (a) gray = no change in score; (b) light pink = 1-point *increase* in score; (c) dark pink = 2–4-point *increase* in score; (d) light green = 1–3-point *decrease* in score; (e) dark green = 4-point *decrease* in score.

on the degree of change in the hazard proximity metrics resulting from correction of facility locations. Table 3 shows the distribution of change in hazard proximity and sensitive land use scores for the 760 census tracts in the SJV region. A significant number of tracts have different scores as a result of error correction, and the distribution of census tracts mapped against the change in *hazard score* (i.e., hazard proximity and sensitive land use score (obtained from hazard proximity metrics and land use information)) is nearly Gaussian. The values from −4 to +4 represent the amount by which the tract-level hazard score changed as a result of correcting the facility database information.

After the appropriate corrections were made to the applicable databases, a total of 247 census tracts received lower hazard proximity and sensitive land use scores. The incorrect data led to overstating the cumulative impacts in those tracts.

Similarly, 313 tracts received higher hazard proximity and sensitive land use scores as a result of error correction, contributing to understating the cumulative impacts in those tracts; there was no change during the rescoring activity in 200 of the 760 census tracts. Figure 3 shows the geographic pattern of change in EJSM scores resulting from using corrected data. The greatest understatement of hazard proximity and sensitive land use scores was in West-Central SJV, a sparsely populated and mostly agricultural region with substantial oil and gas production facilities. Census tracts surrounding population centers in the SJV (e.g., Stockton, Fresno, Modesto, and Bakersfield) were the focus of most tracts with overstated hazard proximity and sensitive land use scores.

4. Conclusions

The primary goal of this study was to evaluate the accuracy of regulatory databases used in cumulative impacts screening, validate and correct the facility-level data used in the screening methodology to characterize hazard proximity, and determine the degree to which errors affect the accuracy of screening scores. Accuracy validation was accomplished using three different methods of validation or ground-truthing: (1) field-based ground-truthing validation of all reported facility information for three selected test areas; (2) finding and recording hazardous facilities in the field that are of the same type as those in the regulatory database, but not included in the database itself; (3) reviewing and correcting all reported facility locations for the entire SJV region using Google Earth Pro. Using the validated and corrected facility data, cumulative impact screening scores were recalculated using the method in the EJSM, which employs a sophisticated approach to characterizing hazard proximity based upon CARB recommendations for land use planning to provide health-protective distances buffers around certain land uses and facility types. Differences in scores resulting from using unchecked (with error) versus validated (errors corrected) information provided a comprehensive test of false positives/negatives in the entire SJV region which were significant, demonstrating the importance of error-checking and database validation in this context. Of the 760 census tracts in the study region, well over one-third ($n = 247$ 36.5%) received lower hazard proximity screening scores; the uncorrected data led to overstating the cumulative impacts in those tracts. Similarly, 313 tracts (41.9%) had higher screening scores, with the use of the uncorrected inaccurate data which understated the cumulative impacts in those tracts.

There is also a geographic pattern to the corrected screening scores. The rural west-central portion of the SJV experienced the greatest increase in score after errors were removed. Tracts in this region tend to be relatively large and sparsely populated, and agriculture and energy production is intense. Areas with lower hazard proximity scores were concentrated in the urban and suburban areas surrounding the population centers of the SJV region: Stockton, Modesto, Fresno, and Bakersfield. The locational error rate tends to be higher, and error distances tend to be greater, in rural regions of California for several reasons. Road networks are less regular and address ranges are not as uniform as in urban areas, so address geocoding accuracy suffers. Many hazard types in these regions are larger in size and, consequently, not as well represented by a geocoded point.

Finally, regulatory reporting practice is often accepting low accuracy or generalized locations, locations are commonly not verified by the government agency, and there is little to no penalty for reporting locations inaccurately or incorrectly. This highlights the need for local, regional, and state governments to maintain accurate data sources and to invest resources into assuring accuracy in order to facilitate reliable and correct cumulative impacts analyses for vulnerable communities, regardless of which screening method is used.

Disclosure

It has been subjected to Agency review and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Conflict of Interests

The authors have no conflict of interests or financial ties to disclose.

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