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

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## 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

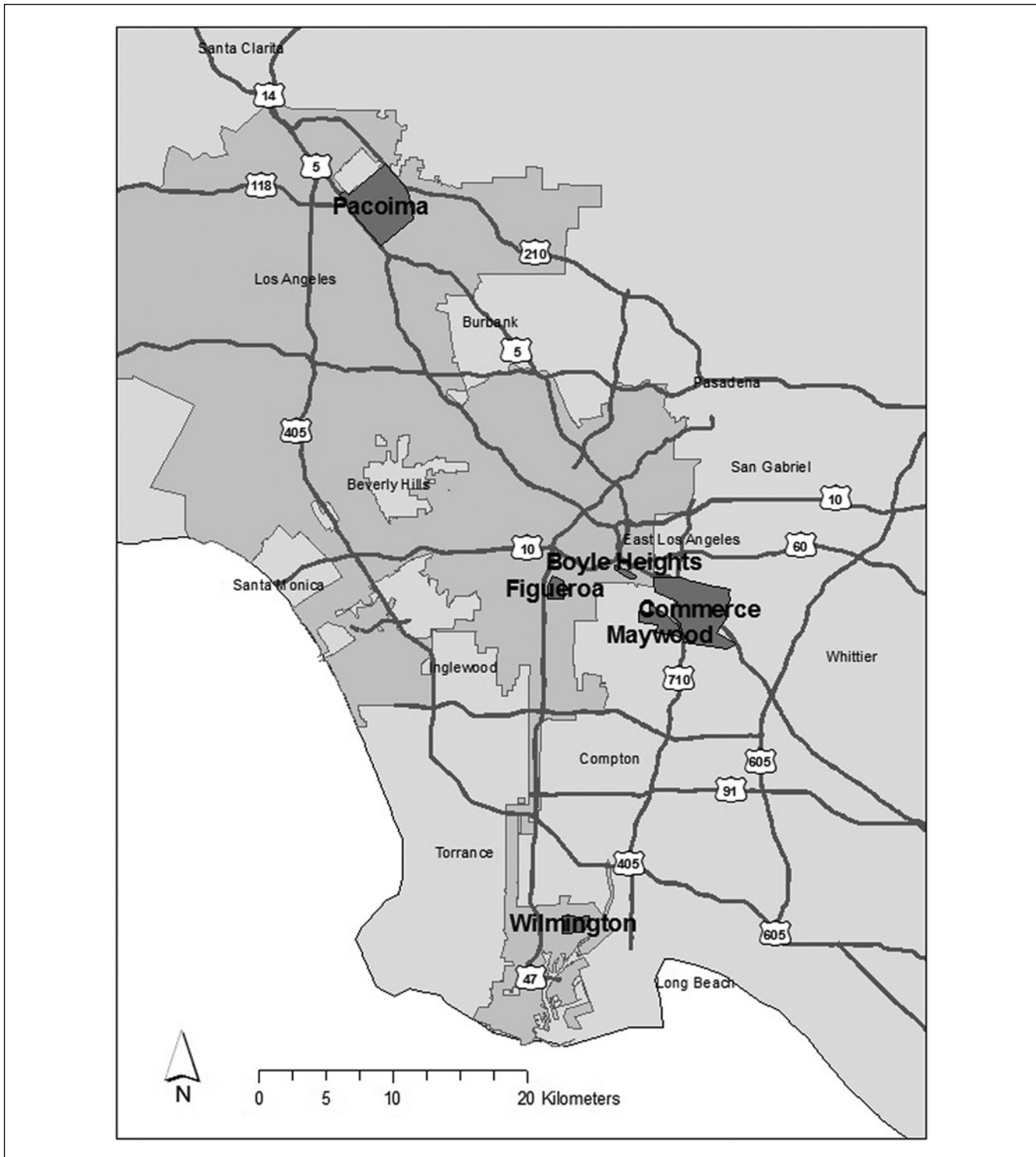
The term *ground-truthing* emerged from the field of cartography, in which aerial imagery or remote sensing data used to map surface features such as vegetation or land use are checked, or validated, using observations "on the ground" (Sharkey & Horel, 2008). Ground-truthing in the context of this project 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 than 2.5 microns in size) levels using handheld

**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

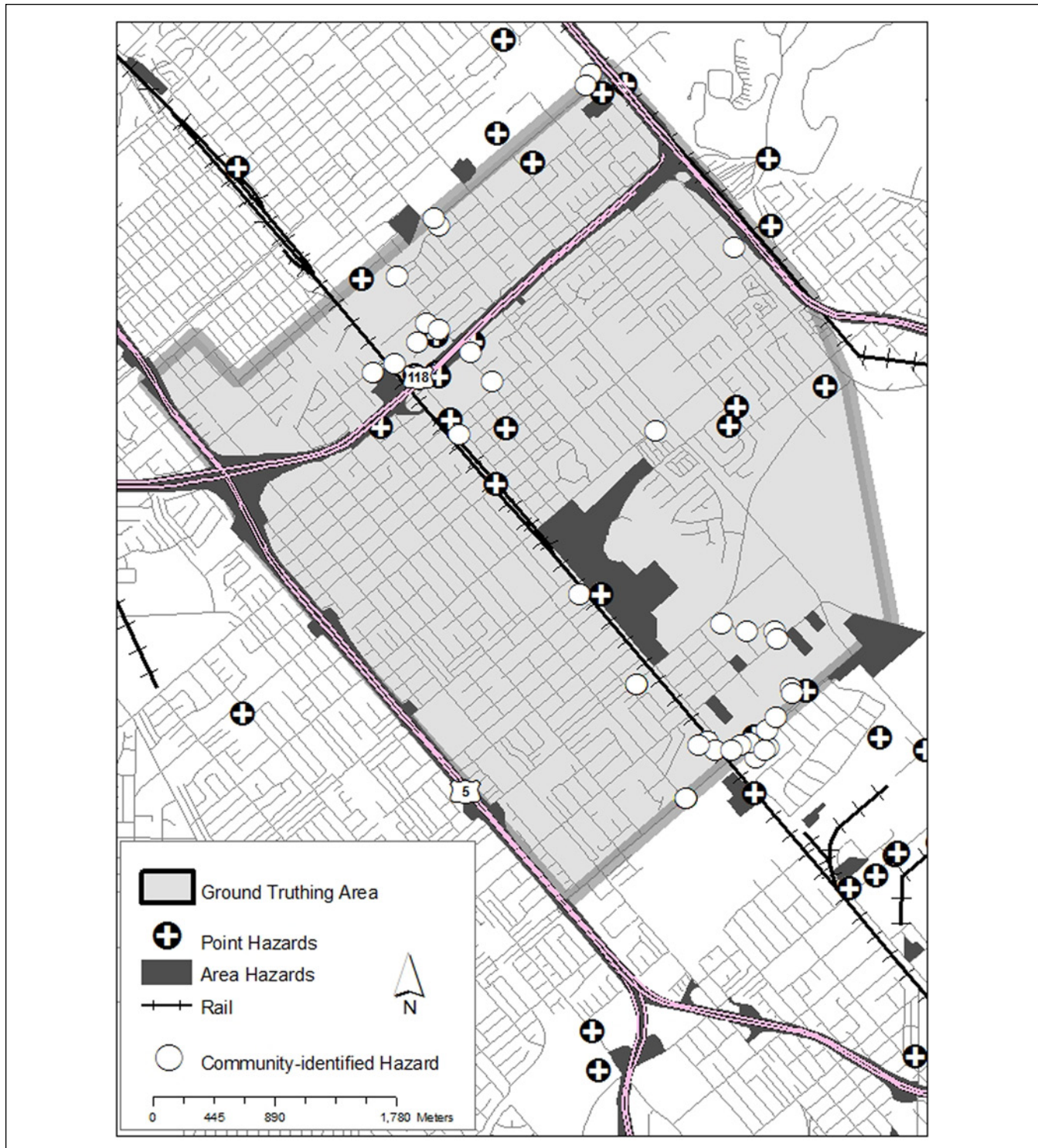
TSI Model 8520 DustTrak Aerosol Monitors, which are nephelometers that measure levels of ambient  $PM_{2.5}$  by sensing particle scattering of a laser beam and converts signals into a particle concentration (NIST SRM 8632; Sabin et al., 2005).

Five communities (Figure 1) participated in outdoor air monitoring: Pacima, 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

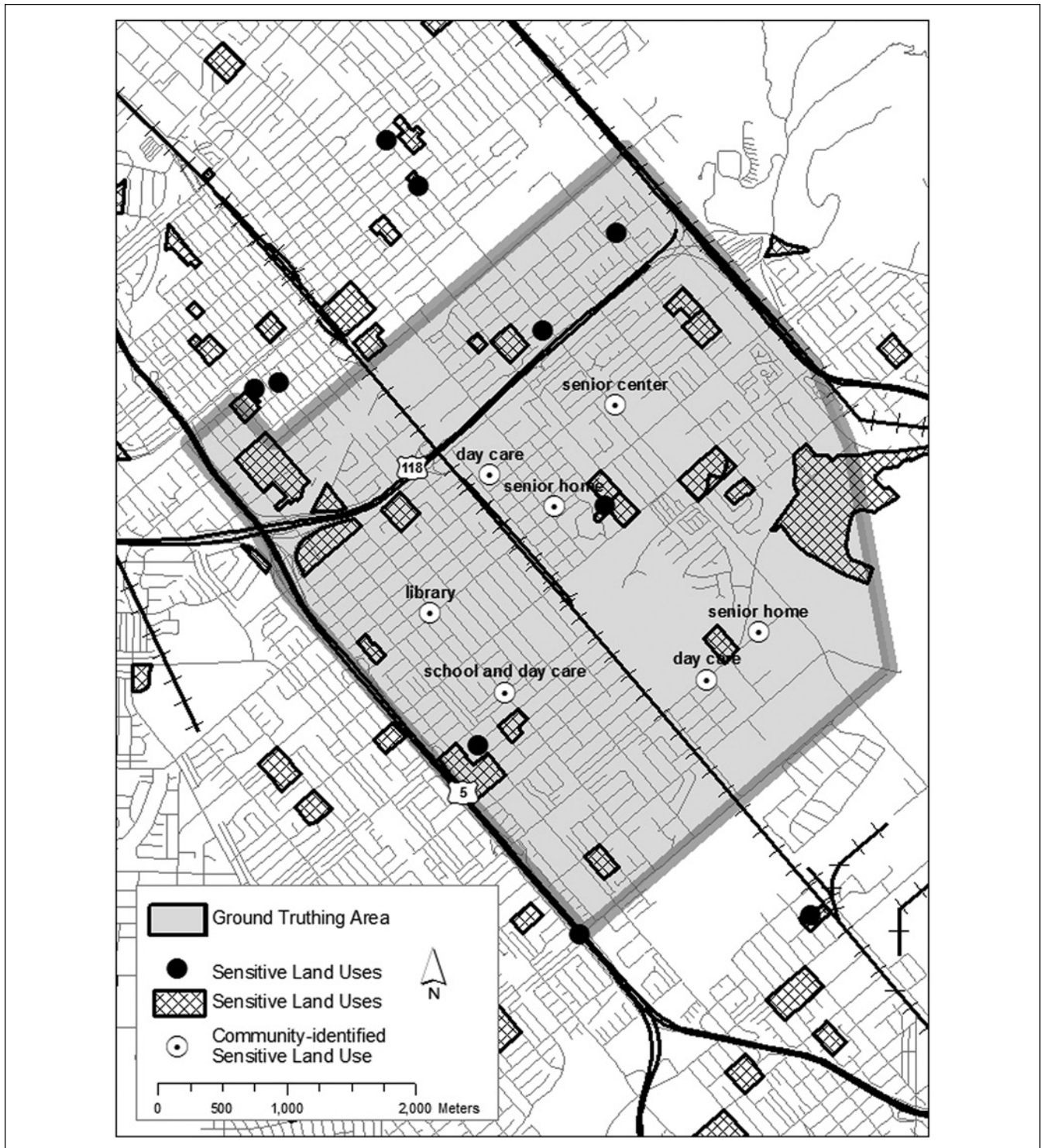


**Figure 2.** Air quality hazards identified in regulatory databases and by community ground-truthing—Pacoima.

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](http://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<sub>2.5</sub> 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<sub>2.5</sub> at a given location, with a red horizontal line showing the California EPA health protective standard for PM<sub>2.5</sub> of 0.012 micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ) 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<sub>2.5</sub> 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

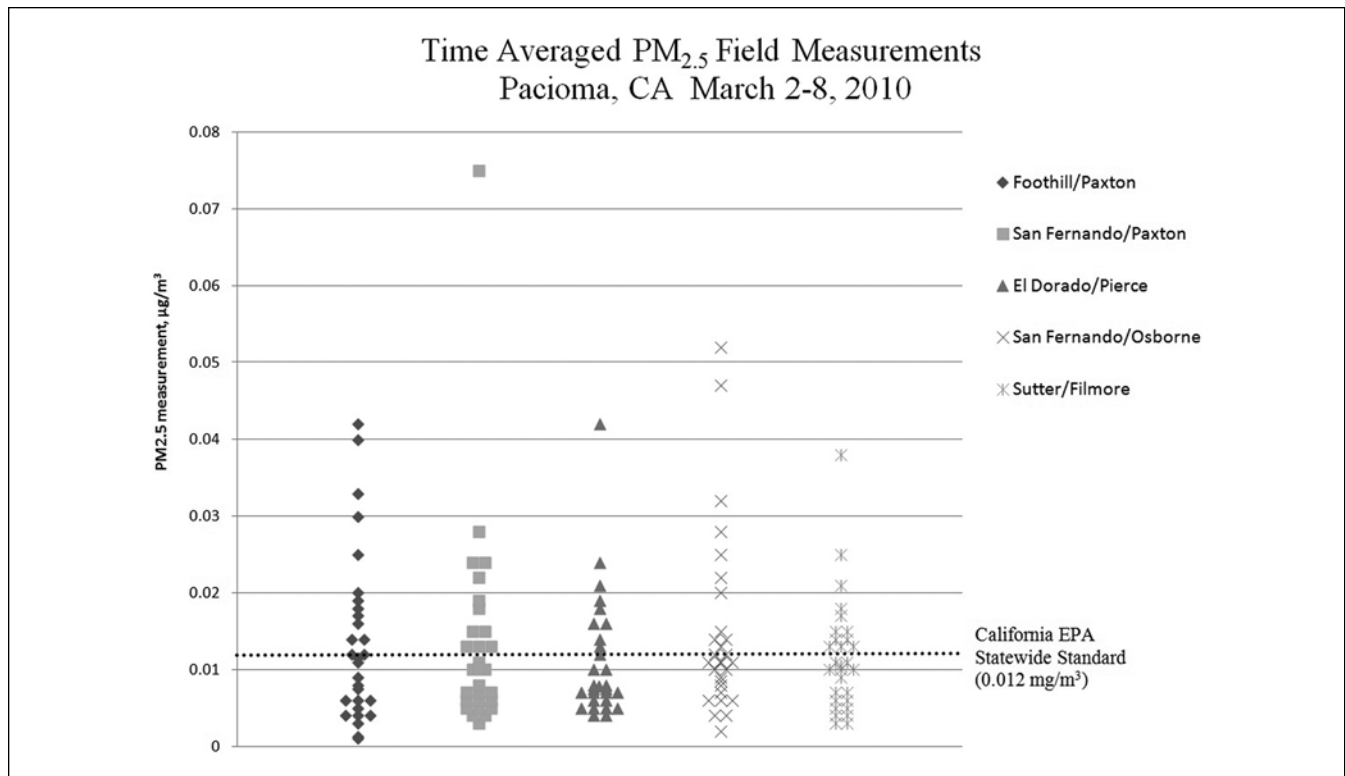
CBPR seeks to enhance the rigor, relevance, and reach of the scientific enterprise. Rigor refers to the practice of good science in terms of the analytical design and interpretation phases of research. Relevance refers to whether science is asking the right questions and elucidates opportunities for

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<sub>2.5</sub> monitoring results for five locations in Pacoima.

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

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### Supplemental Material

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