Community-Based Science
A Strategy for Achieving Environmental Justice and Improving Environmental Knowledge
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Abstract

Many residential areas are also home to industrial facilities that emit toxic chemicals and other forms of pollution. On issues of environmental quality and health in these communities, scientists and residents often talk past one another: residents’ claims about the harms of industry tend not to meet the standards of scientific study, while scientists’ studies tend not to address residents’ complaints. Community-based science—defined as studies conducted by residents and scientists working in collaboration—is seen as one possible solution. This paper outlines the characteristics that make community-based science effective and summarizes major challenges to creating successful scientist-community collaborations. It recommends ways to overcome those challenges, in large part by meeting obstacles at the structural or institutional level.
The Problem of Science in Environmental-Justice Communities

Environmental regulators, scientific researchers, and residents of industrialized areas share a common interest: at least in principle they all want to address the health and environmental impacts of industrial pollution. But these groups often talk past one another, in part because they differ in their approaches to understanding the effects of pollution on community members' health and quality of life.

Community members observe and experience pollution in their local environments—soot settling on their windowsills, chemical smells pervading the community, flares burning at nearby industrial facilities. They connect symptoms they feel or illnesses they observe among their neighbors with their experiences: a resident of an industrial area has a sore throat whenever she's home but not when she's at work, for example; a teacher at the local elementary school notices more children every year carrying inhalers for their asthma. They want to know how they can stop the pollution and keep people from getting sick. They turn to science as a valuable tool for proving that pollution is making them sick—and for convincing decision makers to clean up their community.

Scientific experts accept that industry emits pollutants into the environment. To protect community health, they want to know at what levels pollutants make people sick. Are residents of nearby communities actually being exposed to levels that can make them sick? And is there at least a 95% certainty that the illnesses community members experience are a direct result of living in an industrialized area? Not all scientists do the same kind of science or approach these questions in the same way: at government agencies scientists focus on producing knowledge that can inform policy and enforcement decisions, which is known as regulatory science. University research, in contrast, may be focused on application and testing new knowledge in the context of real-world problems, or both. But regardless of whether scientists are doing regulatory science or research science, focused on discovery or application, they all design studies to answer questions methodically, in a way that will be recognized as rigorous by their peers and contribute to a body of knowledge about the links between health and the environment in general.

From a scientist’s point of view the community approach has flaws.

- Community groups often start out with a conclusion, arrived at through their experiences, for which they want to find supporting evidence. They may, for example, want to prove they are sick because of pollution. In contrast, responsible scientists should (though admittedly do not always) start out with a hypothesis, or a conjecture about what they will find, and design their studies so that they can prove or disprove their conjecture.

- The quality of the data that community members collect is questioned by scientists, who wonder, for example, do residents' measurements of air quality really reflect what is in the ambient air, or could they be tainted with cigarette smoke, auto exhaust, or fumes from household cleaners? Might community-health surveyors influence their neighbors' answers to questions about their symptoms by mentioning local environmental concerns?

- Community studies usually cannot prove causation. That is, the data communities collect about health symptoms and environmental exposures usually are not sufficient to show that toxins in the environment caused health problems. At best, they show correlation: that people most exposed to toxins are also most likely to report certain health symptoms. While this is true of many scientific studies as well, a community group may feel that a strong correlation should warrant some kind of action on environmental issues, whereas many regulatory scientists will insist that it is up to the community to prove that community health problems were caused by environmental problems before action can be taken.

From a community point of view, the scientific approach is lacking.

- Studies are limited in scope. In order to be rigorous most scientific studies ask about, for example, the health effects of a single chemical,
the presence of particular chemicals in the air or water, or the rate at which a group of people suffers from a set of illnesses or symptoms. As a result the studies usually do not represent the real conditions in industrialized areas, where people encounter a mix of many chemicals in their air and water (and food and …) that may have synergistic effects; where people may have been exposed over a long period and be suffering from the cumulative effects of exposures; and where age, illness, or other factors may make people’s health particularly vulnerable to environmental factors. An individual scientific study also typically will not cover the whole chain of questions (what chemicals are residents exposed to?; how do those affect health?; is residents’ health affected in that way?) that would be necessary to link illness in a community to pollution from local industry.

One way that people may be exposed to hazardous chemicals is through their diet. Fish in particular accumulate toxins, making eating fish from polluted waterways a potentially significant health risk. So when environmental agencies like the Environmental Protection Agency (EPA) conduct environmental-risk assessments, they include fish consumption in their calculations.

But how much fish does a population consume? This question became crucial when the EPA in 1994 tried to assess cumulative exposure to toxins in the Greenpoint/Williamsburg neighborhood of New York City. The EPA would have assumed that residents ate a standard “urban diet,” in which locally caught fish did not play a significant role. But community members asserted that fish caught from the polluted East River were an important part of the diets of many families, especially immigrant families.

Although initially skeptical of residents’ anecdotal claims, EPA scientists ultimately agreed to have community members survey local anglers to find out how much of what species of fish they caught and ate. Drawing on scientists’ suggestions about what questions to ask and how to ask them, community surveyors found that families of local anglers ate nearly ten East River fish per person per week, demonstrating that fish consumption was a far larger contributor to cumulative exposure than the EPA’s default “urban-diet” assumptions would have acknowledged.

The EPA subsequently modified its exposure assessment to include risks from local fish consumption—thus making the assessment more accurate by incorporating Greenpoint/Williamsburg residents’ local knowledge of dietary exposures.

Source: Jason Corburn, Street Science: Community Knowledge and Environmental Health Justice, chap. 3 (Cambridge, MA: MIT Press, 2005).

- **Scientific research does not take into account what community members know.** Scientific hypotheses, research design, and conclusions rely on models and assumptions developed to work for the most general circumstances. But they often do not apply very well to the specific conditions of a community—conditions on which residents, not scientists, are the experts. Without the benefit of residents’ unique knowledge of local contexts, scientists may misestimate exposures or fail to include important social factors that intersect with environmental factors to impact health. Thus, scientific studies may end up being partial, skewed, or just plain wrong (see “How much fish?”).

- **Science is limited in its diversity.** Communities affected by environmental hazards are often made up of people from “minority” racial, ethnic, and cultural backgrounds; they are likely to be urban or rural; they include the very young and very old and people of both sexes. Yet the models and assumptions used in environmental-health science have historically been based on the lifestyles of Caucasian suburbanites and the physical characteristics of a healthy adult male. Scientists themselves are also highly likely to be white men. Without direct experience of diversity, many scientists may not consider how cultural, racial, and other differences in populations affected by pollution may demand modified approaches to doing science.

- **Science is cautious in its conclusions.** In order to be considered rigorous a scientific study usually must demonstrate a conclusion—for example, that a chemical causes health problems or that a community has an unusually high asthma rate—to a very high degree of certainty. In fact, in most cases scientists would rather err by not seeing connections that are there than err by seeing connections that are not there. In contrast, for most communities even shaky evidence that their health was in peril would be convincing enough to demand that something be done.

- **Research is not directly linked to action.** Regardless of the other questions that scientific studies might address, they almost never answer the one most important to people who are not scientists: what should be done about this finding? Moreover, because science is not, as a rule, concerned with policy action, scientific studies are designed without regard to whether their conclusions will be actionable—which leads scientists to choose
research questions that may not have a great deal of significance from a community point of view and allows them to accept or even expect inconclusive results.

Because of these characteristics, scientific studies tend not to account for the symptoms and illnesses that residents of industrialized areas experience and link to industrial pollution. Nor can they usually be of much help in residents’ efforts to see pollution reduced and community health better protected.

Community-Based Science as a Solution

One possible way to overcome the limitations of the approaches of scientific experts and community groups to understanding the effects of industrial pollution is through collaboration between scientists and communities.

Community groups have been forming alliances with scientists since the beginning of the anti-toxics and environmental-justice movements in the early 1980s. Since then a small number of organizations, such as Harlem-based WE ACT for Environmental Justice (see www.weact.org), have made collaborations with scientists central to their organizing strategies; organizations like Campus-Community Partnerships for Health (www.ccph.info) have developed extensive resources for communities and scientists interested in developing collaborative research projects; and scientist-community collaborations have at least to some extent been institutionalized in programs like the National Institute of Environmental Health Sciences’ Environmental Justice and Community-Based Participatory Research Program. The nature of these now widespread scientist-community alliances varies greatly. In one of the earliest documented examples of a community-initiated health study—a strategy dubbed “popular epidemiology” by sociologist Phil Brown—residents of Woburn, Massachusetts, noticed an apparent cluster of leukemia in their community and hypothesized that trichloroethylene and tetrachloroethylene in their drinking water was to blame. To prove the connection the community group teamed with biostatisticians from Harvard’s School of Public Health, who helped them design and

1 Indeed, perhaps the biggest problem with science from a community point of view is that so little is done on the issues that most concern the community.
conduct a formal community-health survey.  

Since the study’s release in 1984 close collaborations between public-health researchers and community groups have become relatively common (see “What am I exposed to?”). In contrast, community-based studies of air quality may involve scientists only peripherally. Next door to oil refineries in southeastern Louisiana—as in many other communities adjacent to petrochemical facilities worldwide—residents use a simple, homemade air sampler called a bucket to measure concentrations of toxic gases in the air. Although the buckets were designed in the mid-1990s by an engineering firm and samples collected with them are analyzed by a commercial laboratory, community members operate the buckets independently of scientists, deciding for themselves when and where to take samples. In Louisiana communities, the noted local chemist Wilma Subra and community groups operate the buckets independently of scientists, deciding for themselves when and where to take samples. In Louisiana communities, the noted local chemist Wilma Subra and community groups use a simple, homemade air sampler called a bucket to measure concentrations of toxic gases in the air. Although the buckets were designed in the mid-1990s by an engineering firm and samples collected with them are analyzed by a commercial laboratory, community members independently operate the buckets. Decision-making for when and where to take samples is left to community members rather than scientists.

Over the last 25 years of community collaboration with scientists, environmental-justice advocates and researchers have paid careful attention to how, why, and under what circumstances such collaborations work in order to facilitate scientist-community partnerships and maximize their impact.

Participants’ experience shows that the most effective collaborations...  

• **Incorporate local knowledge.** Residents of industrialized communities have insider knowledge of on-the-ground environmental conditions and the social contexts in which they interact with them, both of which are important to accurately assess the impacts of pollution on community health. In effective community-based science, scientists work with communities to incorporate residents’ knowledge of local conditions and contexts into the scientific models and hypotheses in order to come up with a better understanding of the hazards and harms that industrial pollution poses to community members (see “How much fish?”).

• **Start from community questions.** The questions that environmental regulators and scientific researchers are trained to ask (e.g., does air quality comply with federal standards?), are quite different from what residents of industrialized communities want to know (e.g., what are the chemicals I smell in the air doing to my lungs?; why are so many of us suffering from a rare disease?). Rather than using local knowledge to help answer scientists’ questions, community-based science takes community questions as a starting point. Scientists and community members work together to figure out how to formulate and address those questions in a way that will be regarded credible by other experts. In doing so, they take care to distinguish between questions and issues that can be addressed by science and issues that cannot be—including racism, economic disparities, and political values—leaving the latter for the community to pursue through means other than scientific study.

• **Advance scientific methods.** Often the methods, protocols, and standards of proof accepted by scientists are not well suited to answering community questions. For example, the official method for measuring particulate matter in the air generates a 24-hour average concentration but cannot show how those concentrations fluctuate over the course of the day—an issue of great interest to many communities. Similarly, the criteria for establishing statistical significance of a disease cluster are nearly impossible to meet when the population being studied is very small, as the communities most affected by industrial pollution often are. As a result, scientists collaborating with community groups modify established protocols or invent new ones—adopting different kinds of monitoring equipment, proposing new tests for determining whether a result is significant, or taking a new approach to research ethics (see “What am I exposed to?”). In doing so, they do not abandon their commitment to rigorous science; rather, they work to expand the meaning of scientific rigor and broaden the range of methods that can be considered credible. Indeed, in part as a result of collaborations with community members, a wide range of new tools and methods are now being used to understand community environmental and health issues, including geographical information systems, multilevel modeling, and biomonitoring.

• **Generate information that community members can use.** Unlike many scientists, community groups do not see knowledge as an end in itself. Rather, they see improved knowledge of chemical exposures and disease rates as a means to their goals of improving the environment and protecting their health. Therefore, studies that offer information with no clear route to making change are a frequent source of frustration for communities, which may even feel taken advantage of by scientists who conduct studies in the

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3 Community-Campus Partnerships for Health features a complementary set of principles for good partnership, with real-world examples to illustrate each, on their Web site: http://ccph.info/.
community with the primary purpose of discovering new knowledge. The most effective community-based science is application oriented rather than discovery oriented; that is, it is undertaken with an eye toward how it will be applied to concrete social problems and result in better outcomes.

In planning a study community members and scientists consider the following questions: what information will it generate? What will that information enable the community to say, do, or ask for? How will it further the community’s overall goals?

Challenges for Community-Based Science

Decades of experiments in community-based science have helped us understand what makes an effective collaboration between scientists and residents of industrialized communities. But successful partnerships remain difficult to construct.

The obstacles to effective community-based science include:

- **Expert acculturation.** Scientists (as well as engineers and other technical professionals) are often taught that there is one best way to do science, and they may regard alternative ways of looking at problems as misguided or ill-informed; the problem is exacerbated by the lack of diversity among scientists themselves, which helps insulate scientists from other perspectives. Many scientists are socialized to value the discovery of new knowledge over application or engagement. And in mainstream scientific cultures “lay” perspectives may be considered to have value only insofar as they speak to the social issues that surround experts’ technical work. To be sure, many scientists can and do appreciate alternative perspectives and recognize that no clear line can be drawn between the “social” and “technical” aspects of knowledge production. However, for scientists wishing to collaborate with community groups, these deeply ingrained ideas can prove a stumbling block in efforts to establish successful partnerships.

- **Communities’ scientific readiness.** Most residents of industrialized communities do lack extensive scientific and technical training, regardless of how much they may value science and understand the importance of solid evidence. While they are well able to identify issues of concern to them, they may be less likely to be able to be full participants in translating those concerns into questions that can be answered through scientific studies. As a result, even scientists dedicated to using communities’ questions as a starting place may end up dominating the processess of problem definition and research design.

- **Missing frameworks for interpretation.** Data collected in industrialized communities become meaningful in context—that is, through comparison to data from other communities, or legal limits, or levels known to be harmful. Unfortunately, appropriate contexts for interpreting data from community-based studies frequently do not exist. Ambient-air concentrations of most toxic gases, for example, are regulated neither by the U.S. government nor by the majority of states; further, the exposure levels at which those chemicals pose a threat to human health are uncertain and contested. Communities working with scientists to measure air quality thus have a hard time saying what their results mean—a difficulty shared by many community-based science initiatives, including community-health surveys.

- **Unclear pathways to action.** Only rarely does community-based science find a “smoking gun”—a demonstrable legal violation or an elevated disease rate with a clear connection to a toxin known to be in the local environment. When it does, the actions that follow can be relatively clear: sue for enforcement of the law, for example, or demand that people be moved away from the cause of disease. But where the conclusions of community-based studies are less obvious—often owing in part to the lack of useful frameworks for interpreting data—the actions to be taken may be far from clear. Communities working in partnership with scientists thus run the risk of creating data that they have little more ability to act on than when scientists were designing the studies themselves.

- **Scarce resources.** Doing community-based science is expensive: it requires time from highly skilled (and highly paid) professionals; the dedication of community volunteers whose own jobs, families, and churches demand their attention; and money to pay for scientific instruments and laboratory analysis. Money for this kind of work is hard to come by. The foundations that fund
community organizing through grants to nonprofit environmental-justice support organizations are often less interested in science and technology projects than in more traditional, direct organizing initiatives; perhaps more important, the grants they offer may be small in comparison to the costs of experts and equipment. The funding sources available to scientists usually prioritize new discoveries in the laboratory over applied research in communities. The combination leaves communities and their scientist allies scrambling to find ways to do research on the cheap.

These challenges create the risk that community-based science will suffer from the same shortcomings that collaborations among the steps they can take to foster effective community-based science:

• Invest in expert education. In the course of their technical training, scientists, engineers, and other technical professionals are not typically offered tools for understanding the disproportionate effects of environmental hazards on communities or community perspectives on environmental issues. Even more rarely does their training equip them to understand how residents’ perspectives might inform their own practices. Service-learning courses that give undergraduate and graduate science and engineering students supervised practice in answering community questions and solving community problems would help counter this trend. Recruiting more members of traditionally underrepresented groups into scientific professions that could help by diversifying the range of perspectives available within the scientific community. Continuing-education opportunities to help established professionals understand community issues and perspectives would be valuable as well. Regulatory agencies, professional societies, and accreditation boards are all well positioned to institutionalize such opportunities for established and aspiring experts; however, they should expect to look to social scientists (especially science, technology, and society scholars) and environmental-justice professionals to provide the content.

• Create new funding streams and incentives. Environmental grant makers, including environmental regulatory agencies, should make community-based science an explicit priority and provide funding on a scale commensurate with the costs of scientific research. Research universities and agencies that fund research, such as the National Science Foundation and the National Institutes of Health, should create incentives, such as grant programs and fellowships, and remove disincentives like overhead costs for academic investigators to pursue applied, participatory research projects.

• Develop skilled intermediaries. The inevitable asymmetry between the ability of scientists and community members to participate in research design can be ameliorated by the involvement of professionals who can recognize and articulate the differences in the groups’ perspectives, effectively translate between them, and teach (formally or informally) members of both groups what they need to know to work together effectively. Currently, a small cadre of individuals, mostly academics, trained in science, technology, and society is well equipped to serve this function. With the help of these individuals environmental-justice support organizations and regulatory-agency environmental-justice offices should...
cultivate these skills among their staff members as well, and should develop programs to help selected community members acquire skills to be able to speak across the two groups. Further, as part of funding community-based science, provisions should be made to hire not only scientists but also the skilled intermediaries (including appropriately trained members of the community) who can help scientists and communities collaborate more effectively.

- **Design frameworks for interpretation into community-based science.** Rather than gathering a single set of data that will ultimately be difficult to make sense of, community-based studies should, where appropriate, generate additional data sets to help provide context for the information that the community seeks. For example, air monitoring in an industrialized community could be conducted in tandem with air monitoring in an area relatively free of industrial pollution; the results could then be used to demonstrate the impact of industry on community exposures to chemicals. Similarly, environmental monitoring could be conducted in tandem with health-symptom monitoring as a way of connecting fluctuations in, say, air quality with residents’ health—without relying on regulatory standards that may or may not be adequately protective.

- **Work for rules and regulations that expand pathways for action.** The legal frameworks through which communities can use their studies to get action are limited, but they can be changed. Advocates of community-based science should lobby for regulations that cover the environmental conditions of particular concern to communities, including ambient-air levels of toxic chemicals and peak concentrations of gases and airborne particulates, among others. Communities and their allies should also demand that local facilities’ operating permits be contingent on specified markers of environmental quality—*as measured in the community*—being met.

Overcoming the challenges to community-based science requires action not just at the level of individual communities but also at the institutional and structural levels. Regulatory-agency administrators, program officers, university leaders, and national-level environmental-advocacy groups all need to be enlisted as allies for communities and their scientific collaborators in order to make their partnerships most effective.
For Further Reading

The Problem of Science


Wing, Steve. “Objectivity and Ethics in Environmental Health Science.” Environmental Health Perspectives 111:14 (2003), 1,809–1,818.

Gaps in knowledge


Uncertainty and proof in environmental health research


Importance of local knowledge


Examples


Changing research practices


Morello-Frosch, Rachel; Phil Brown; Julia Green Brody; Rebecca Gasior Altman; Ruthann A. Rudel; Ami Zota; and Carla Perez. “Experts, Ethics, and Environmental Justice: Communicating and Contesting Results from Personal Exposure Science.” In Technoscience and Environmental Justice: Expert Cultures in a Grassroots Movement, edited by G. Ottinger and B. Cohen, 93–118. Cambridge, MA: MIT Press, 2011.


Overcoming Obstacles

Expert Cultures and “Lay” Participation


Wing, Steve. “Social Responsibility and Research Ethics in Community-Driven Studies of


**Frameworks for Interpretation and Action**


About the Chemical Heritage Foundation

The Chemical Heritage Foundation (CHF) fosters an understanding of chemistry’s impact on society. An independent nonprofit organization, we strive to

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About CHF’s Center for Contemporary History and Policy

The Center for Contemporary History and Policy offers historically grounded perspectives on issues related to the molecular sciences and technologies. The Center’s programmatic initiatives draw on diverse historical and contemporary source materials to provide knowledge, perspective, and advice to stakeholders from industry, academia, government, and citizen groups.

About the Series

The Studies in Sustainability series serves as a forum for discussion about the unique challenges and opportunities that exist in transforming chemistry into a tool for sustainability. The series, which highlights the intersecting roles played by emerging science, innovation, regulation, standards, and civil action, aims to publish dynamic new research examining the links among chemistry, sustainability, and pressing environmental and human health concerns.

About the Author

Gwen Ottinger received her Ph.D. from the Energy and Resources Group at the University of California, Berkeley, and is currently an assistant professor at the University of Washington-Bothell, where she teaches environmental studies and science and technology studies (STS) in the Interdisciplinary Arts and Sciences Program. She is co-editor of Technoscience and Environmental Justice: Expert Cultures in a Grassroots Movement (MIT Press, 2011).