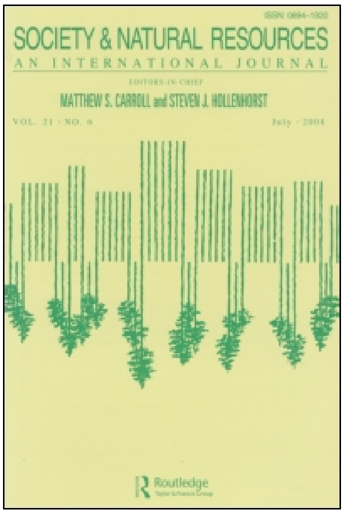

Society & Natural Resources
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713667234

Parsing “Participation” in Action Research: Navigating the Challenges of Lay Involvement in Technically Complex Participatory Science Projects

Jill Lindsey Harrison[a]
[a] Department of Community & Environmental Sociology, University of Wisconsin-Madison, Madison, Wisconsin, USA

First published on: 09 March 2011

To cite this Article Harrison, Jill Lindsey(2011) 'Parsing “Participation” in Action Research: Navigating the Challenges of Lay Involvement in Technically Complex Participatory Science Projects', Society & Natural Resources, 24: 7, 702 — 716, First published on: 09 March 2011 (iFirst)

To link to this Article: DOI: 10.1080/08941920903403115

URL: http://dx.doi.org/10.1080/08941920903403115

Society and Natural Resources, 24:702–716

ISSN: 0894-1920 print/1521-0723 online
DOI: 10.1080/08941920903403115

Routledge
Taylor & Francis Group

Parsing "Participation" in Action Research: Navigating the Challenges of Lay Involvement in Technically Complex Participatory Science Projects

JILL LINDSEY HARRISON

Department of Community & Environmental Sociology, University of Wisconsin–Madison, Madison, Wisconsin, USA

Participatory action research (PAR) is widely recognized for its potential to improve environmental problem solving. However, PAR proponents and observers have paid relatively little attention to the ways in which lay participation complicates the research process. In this article, I examine the challenges presented by lay participation in the case of the Drift Catcher, a participatory air monitoring program in which community residents in the United States work with scientists from an environmental nongovernmental organization (NGO) to sample their own air for pesticides and then to use those data to press for social change. My findings suggest the need for a more nuanced understanding of "participation," one that accounts for the technical complexity of a PAR project, other challenges, and the participants' organizational capacity. Successfully executing a participatory research project, especially one that produces politically controversial data, may require substantial capacity building to weather the political and technical challenges that arise.

Keywords agriculture, air monitoring, environment, participatory action research, pesticide drift, public participation in science

Participatory action research (PAR) is now widely recognized for its potential to improve environmental problem solving. Including lay participants and democratic deliberation into the value judgments that exist within scientific research sets PAR projects apart from "expert research" (Greenwood et al. 1993), which is criticized for its lack of concern for public needs and its bias against nonscientific knowledge (Brown 2007; Corburn 2005; Jasanoff 1987; Kroll-Smith et al. 2000; NRC 1996; Reason 2001).

However, PAR proponents and observers have paid little attention to the ways in which participants negotiate the terms of "participation"—a particularly

Received 12 November 2008; accepted 21 May 2009.

This research was funded by Frederick H. Buttel professorship funds and a Wisconsin Alumni Research Foundation faculty grant. Phil Brown, David Goodman, Randy Stoecker, and three anonymous reviewers generously provided constructive and detailed feedback on earlier iterations of this article. The author would like to extend special thanks to representatives of Pesticide Action Network and all of the participating organizations for their candid reflections.

Address correspondence to Jill Lindsey Harrison, Department of Community & Environmental Sociology, University of Wisconsin–Madison, 1450 Linden Drive, Madison, WI 53706, USA. E-mail: harrison@dces.wisc.edu

important task when research projects are technically complex and thus not readily amenable to public participation. In this article, I examine these challenges in the case of the Drift Catcher (DC), a PAR air monitoring program in which community residents in the United States work with scientists from an environmental nongovernmental organization (NGO) to sample their own air for pesticides and then to use those data to press for social change. Because the technically sophisticated nature of this program presents many special potential barriers to lay participation, the case offers an exemplary opportunity to learn how various participants negotiate the challenges of bringing non-"experts" into scientific research. Though the Drift Catcher has to date been used only in the United States, the discussion here is relevant to similar programs (e.g., Bucket Brigade 2008) and antitoxics activism that flourish throughout the world in response to inadequate regulation of toxic pollution.

My findings suggest the need for a more nuanced understanding of "participation," one that accounts for the technical complexity of a PAR project, the other challenges that may ensue, and the organizational capacity of the participants. Successfully executing a participatory research project, especially one that produces politically controversial data, may require substantial capacity building to weather the political and technical challenges that will arise.

Public Participation in Participatory Action Research

Environmental monitoring is widely recognized as an important part of natural resource management. "Adaptive management" proponents argue that monitoring data should continually drive changes in environmental policy and regulations in the face of scientific uncertainty (Lee 1993). Recently, observers have voiced concerns about the extent to which adaptive management projects meaningfully facilitate interdisciplinary collaboration and public participation (Gerlak 2008).

Greenwood et al. (1993, 176) describe research as existing on a continuum between two idealized endpoints: "expert research" (where "all authority and execution of research is controlled by the expert researcher") and "participatory action research" (PAR; where "authority over and execution of the research is a highly collaborative process between expert researchers and members of the organization under study"). Reason (2001) argues that "action research," by combining a constructivist reflection upon the ways we understand the world with a commitment to active social change, operationalizes a worldview distinct both from modernist, positivist science and from unapplied constructivist critiques. In so doing, it can "increase the validity, the practical significance, and the transformational potential" of science (Reason 2001, 1). The NRC (1996) proposes that increasing democratic deliberation at the many points of *value judgments* in the research process can strengthen the science and make it more responsive to current problems.

PAR principles have been applied toward many environmental efforts around the world, including facilitating already-existing resource management efforts (Chuenpagdee et al. 2004), educating communities and individuals about managing or mitigating the health effects of contamination (Quigley et al. 2005), contesting specific development projects (Phadke 2005), and investigating the links between pollution and illness (Allen 2003; 2004; Brown 1987; 2007; Corburn 2002; 2005; O'Rourke and Macey 2003; Ottinger 2010; Shepard et al. 2002). Social scientist observers widely praise participatory science projects for their ability to address "research silences" (Brown 2007, 261–265), facilitate new or better scientific methodologies, identify missing variables, shift research attention to upstream environmental and political causes of illness, boost civic engagement, illuminate the value judgments upon which scientific standards (e.g., statistical significance) are based, and help citizens influence environmental and health policy, pollution levels, and industry accountability.

However, involving lay participants can clearly complicate the research process. Some researchers have noted that participation can inhibit action where "boundary work" by elites (Gieryn 1999; Allen 2004) or scientific standards (Ottinger 2010) challenge the legitimacy of research involving lay participants. Lee (1993) asserts that political conflict can be very time-consuming and thus must be "bounded" to protect the action goals of adaptive management.

It is not difficult to imagine that PAR projects involving very technically complex scientific research might present some additional challenges to public participation. As the technical complexity of a project increases, so can the costs, difficulty, required precision, and specialized nature of the required knowledge. These factors have not impeded the development of these types of projects, yet social scientists have scarcely elaborated on how participants negotiate the terms of "participation" under such challenging circumstances. Instead, observers of PAR projects (of the full range of technical complexity) typically gloss over the process in which the terms of participation are negotiated (e.g., characterizing the "expert" and lay participants as "equal partners" in all aspects of the research process; Corburn 2002, 241).

Because technically complex projects contain so many different potential barriers to lay participation, they offer an exemplary opportunity to learn about how various participants negotiate these challenges. How does the technical complexity of a participatory science project generate conflicts between various participants? How do the project participants resolve these conflicts? How, in turn, do these findings inform our understanding of "participation" within participatory science projects? The Drift Catcher participatory air monitoring program offers an illuminating case for investigating these questions, and I focus my discussion on those points where the technical complexity of the project presented special challenges to lay participation.

Data and Methods

My work on pesticide politics draws on 6 years of academic research on political conflict over pesticide drift in the United States, including confidential, in-depth, semistructured interviews I conducted with DC participants during 2007. I sought to interview as many participants as possible from completed DC projects and succeeded in gaining access to at least one participant from all but one of the eight DC projects that had been completed by that time. My interviews include five representatives of Pesticide Action Network North America (PANNA; the lead NGO); the local leaders from seven DC projects (two each in California and Florida, and one each in Washington, North Carolina, and Minnesota); and 10 other community participants from the two California projects.

The five interviews with PANNA representatives were recorded and transcribed; I took detailed notes during the other interviews.[1] Most of the California interviews were conducted in Spanish with the assistance of a bilingual translator. All

California interviews were conducted in person in a private setting of the participant's choosing, and the others were conducted by telephone. Interviews typically lasted 1 to 2 hours and addressed the following questions: What initially compelled you to participate in the Drift Catcher project? What has your role been in the project? In what ways were you satisfied and dissatisfied with this project? What other sorts of pesticide activism do you engage in, and how does the DC work relate to those?

My interview work is augmented by follow-up e-mail correspondence with many of the interviewees, as well as ethnographic observation at activist events (including a 2-day DC training retreat in 2005). I also reviewed published materials from all of the four DC projects for which such materials were publicly available as of May 2008 (one each in Washington, Florida, Minnesota, and California), including press releases, technical reports, comment letters, op-eds, and other results reports. I analyzed all of the interviews and other materials for the ways in which DC participants negotiated the terms of participation. It should be noted that these findings represent a snapshot of reflections on some of the early DC projects; PANNA's approach has evolved since that time to address many of the issues discussed here. All quotations without references come from my own interviews and e-mail communication with DC participants.

Pesticide Drift Activism

> We live in a trailer park in a mobile home, surrounded by orange groves. At night during the spraying season we get sick, with symptoms that wake us up. We have asked the owner of the trailer park to do something about this problem, at least let us know when spraying is going to happen, but the owner always tells us we can leave if we don't like the situation, that we should look for another place to live. But we can't afford to rent a lot in another park. (DC participant; Californians for Pesticide Reform [CPR] 2007, 10)

Part of an international environmental health movement, pesticide drift activists are a network of community groups and NGOs that confronts the airborne movement of agricultural pesticides into residential areas, schools, and other public spaces. Pesticide drift activism has flourished particularly in the United States, likely because its relatively well-developed environmental regulatory apparatus is a mechanism through which activists can leverage change. Exposure to pesticide drift can cause acute illness (vomiting, dizziness, skin/eye irritation, unconsciousness, or, in extreme cases, death) and contribute to many chronic diseases (cancer, reproductive and developmental disorders, asthma and other respiratory diseases, neurological damage, behavioral disorders). All of these relationships are poorly understood and hotly contested.

Activists emphasize that official statistics underrepresent the scope of the problem because of a combination of factors: the marginalized status of many rural populations, the political and economic power of chemical-intensive agriculture, the technical difficulties of medical diagnosis, and the limited amount of air monitoring. Pesticide drift exposures are rarely reported, are frequently handled poorly by emergency responders, and are rarely thoroughly investigated by doctors and/or local regulatory officials. These social inequalities intersect with a highly devolved regulatory structure, neoliberal regulatory reforms, and widespread discursive minimization of the problem as a series of isolated, discrete "accidents"; these intersections render the problem invisible and thus naturalize a minimal regulatory response (Harrison 2006; 2008). These structural supports of the problem make the task of characterizing the scope of pesticide drift a highly contested practice. For example, in California—whose pesticide use and illness data are perhaps the best in the world—estimates of the number of people exposed to agricultural pesticide drift every year range from several hundred (according to state regulatory data) to several hundred thousand (per Lee et al. 2003; see Harrison 2006).

Pesticide drift activism has largely developed separately from today's predominant forms of pesticide activism (notably, the organic food movement), which emphasize market-based strategies such as food labels, privilege the health of relatively wealthy consumers, and effectively sideline the problems of pesticide exposure experienced by people living in agricultural communities. In contrast, pesticide drift activists focus on exposures to agricultural pesticides near the site of production and focus their efforts on demanding greater regulatory protections and increased accountability from the state (Harrison 2008). Pesticide Action Network (PAN), an international NGO with more than 600 participating organizations, institutions, and individuals in over 90 countries, has taken the lead in targeting pesticide drift by helping to coordinate local and regional groups and giving them technical guidance as needed (PAN 2009). PAN North America (PANNA) leads such work in the United States.

In my interviews with pesticide drift activists in the United States, they report that they are frustrated by the limited amount of data they have to back up their convictions. Many pesticide drift victims and other agricultural community residents see themselves as "guinea pigs" living squarely in the middle of scientific practice—rather than outside it—simply by virtue of residing in agricultural communities in a context of scientific uncertainty. In light of these sentiments and observations, sampling their own air typically strikes many pesticide drift activists as an exciting way to validate their suspicions (Clarren 2008). Pesticide drift activists were inspired by the success of the Bucket Brigades, a participatory air-monitoring program initially commissioned by Ed Masry and Erin Brockovich and then further developed and implemented widely throughout the world by Communities for a Better Environment and the Global Community Monitor to document and combat air pollution around oil refineries (Bucket Brigade 2008; O'Rourke and Macey 2003; Ottinger 2010).

The Drift Catcher Program

In 2002, PANNA scientist Susan Kegley developed an air-monitoring device that could assess and document the ambient concentration of specific agricultural pesticides, with help from numerous regulatory agency scientists and researchers at University of California, Berkeley. The primary technical goals for the Drift Catcher device and its accompanying use protocol were that they be relatively inexpensive, easy to implement, functionally equivalent to regulatory agencies' own air monitoring systems, and able to produce data that could stand up in a court of law. The DC device includes a vacuum pump that pulls air through glass sampling tubes filled with a special resin that traps the pesticides. The process includes an elaborate set of quality control procedures and contextual data (e.g., flow rate of the pump) recorded by community participants and later used by PANNA scientists

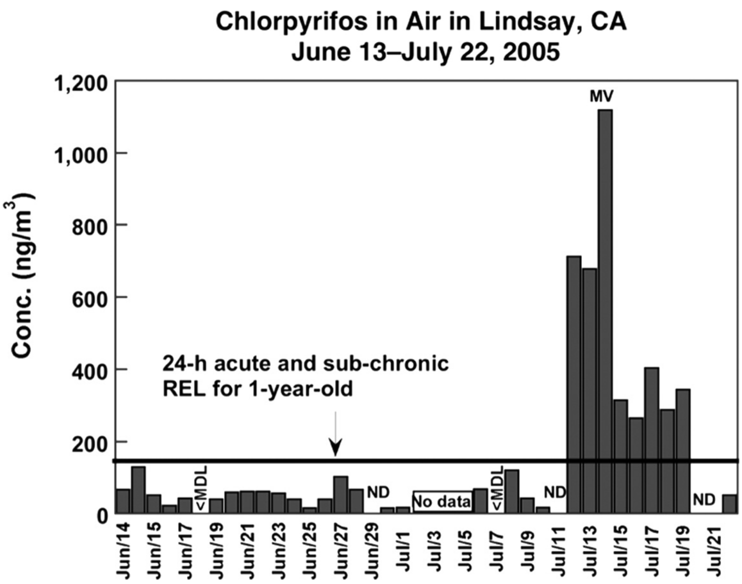

Figure 1. Representation of one Drift Catcher project results. REL indicates the reference exposure level, a health benchmark calculated from the U.S. EPA acceptable daily (24-hour) dose for acute and subchronic exposures. ND indicates no data. MDL indicates that the amount was below the method detection limit (PANNA 2006, 20).

to calculate the overall ambient concentration of specific pesticides during each sampling period at the study site.

PANNA scientists then compare the DC results with the target pesticide's "reference exposure level" (REL)—a health benchmark, or the point below which no adverse health effects would be expected. The REL is as crucial a component of the program as the air monitoring results are, since the relationship between the two (i.e., whether the levels in the air exceed a level of public health significance) is what is ultimately of concern to the public and to regulatory decision makers.[2] Figure 1 illustrates a typical representation of DC results.

As of late 2008, the DC had been used to sample for pesticides in 15 locations in nine U.S. states, and participants represent a wide range of demographic groups: Latino farmworkers (Washington, Florida, several California sites), middle-class high school students (Florida), Native Americans (Minnesota), and other residents of agricultural communities (Indiana, Maine, North Carolina, Minnesota, Colorado, Oregon). In comparison to many environmental health PAR projects whose first priority is education, the DC is a fundamentally political endeavor to show that current pesticide regulations do not prevent airborne pesticides from exceeding levels of health concern. The objective is for local participants and PANNA to collectively integrate DC data into other long-term, ongoing political campaign work to limit the use of the most toxic and drift-prone pesticides. PANNA and local organizations have used the DC data to raise public awareness in the local participants' communities about pesticide drift through community meetings, press releases, television and newspaper coverage, and letters to the editors of local newspapers. Local participants have drawn upon their data to strengthen their testimony in legal, legislative, and regulatory hearings about the human impact of pesticide exposure. Local organizations in California used their data to successfully press for new county-level, health-protective buffer zones around schools and residential areas (CPR 2008). The Farm Worker Pesticide Project, the NGO in Washington State that coordinated a DC project, used its DC results to successfully lobby the state legislature to secure funds for a Washington State air monitoring program for pesticides. Additionally, PANNA and many local organizations have used DC data in comment letters and other technical documents to influence state and federal re-registration decisions for specific pesticides.

Throughout the DC process, lay and "expert" participants collectively make many of the significant value judgments embedded within the research process, and lay involvement was often integrated quite smoothly into the research. This was particularly the case in the problem formation phase of the research and in the framing of the findings (as presented to the public and regulatory officials). In contrast, I describe next how the technical sophistication of the program complicated the inclusion of lay participants in several key stages of some DC projects—research design, data collection, communication of results to lay participants, and application of results. Though the complications yielded conflicts, they are not necessarily unresolvable, and they yield insights into the nature of "participation" in participatory science projects.

Research Design

Lay participants play a crucial role in the design of DC projects, as they weigh in on a wide variety of seemingly technical decisions (e.g., which neighborhoods to sample in, which chemicals to target) that contain value judgments about who the research should serve and which problems it should investigate. Lay participants also can provide knowledge about the typical timing, types, and spatial patterns of pesticide applications in a particular region; knowledge about appropriate monitoring locations; and insights into local political opportunities associated with the various pesticides. PANNA representatives use this information, along with their own understanding of the cost and feasibility of analyzing various pesticides, to shape the research design.

However, the inclusion of lay participants sparked some disagreement among PANNA staff members about how fully to share decision making with lay participants in the design phase of DC projects. Some PANNA staff members worried that PANNA's authority in decisions about research design strays from the democratic ideal of PAR, or that it diminishes local participants' sense of ownership over the process and the findings. One PANNA scientist raised a concern that the decision-making authority that PANNA maintains during the research design phase contradicts the "participatory" appearance of the program: "We've got the power. We [say that we] want you [local groups] to come in and work with us on this, we think it's good for you, we think you'll like it. But we're calling the shots. So it's not, by no means, a grassroots effort."

Other PANNA scientists argued, in contrast, that formally trained scientists need to maintain some decision-making authority over research design in order to ensure that the results can stand up to the inevitable political scrutiny and that all of the efforts of data collection are not squandered:

> You can't do a lousy science experiment just so you [do not] inconvenience the community. Because a lousy science experiment still takes up their time and you've done nothing! It's useless! … The scientific

> method requires you to start with a hypothesis and test it rigorously to see if it holds up to scrutiny. If you lose the rigor, you have not adequately tested your hypothesis, and your "results" will merely be guesswork and/or wishful thinking. That is not science. That is a waste of everyone's time.

The DC's technical complexity thus makes it difficult for scientists to agree on the best ways to include lay participants in research design. That said, none of the community participants and local organizers I interviewed stated they felt micro-managed by PANNA during the research design phase, and all stated that they appreciated PANNA's guidance and leadership on technical issues. One local DC organizer emphasized the importance of the DC program's careful research design, noting that an air monitoring project she participated in several years earlier with a different NGO lacked such adherence to standard scientific protocol and subsequently fell apart under EPA scrutiny.

Collecting the Data

Although the "expert research" model holds that data collection must be conducted by objective, unbiased scientists, PAR argues that lay participants should help make value judgments that emerge during the data collection process. Budgeting priorities that restrict the amount of air monitoring conducted by regulatory agencies constitute value judgments about public needs, and DC participants who collect that data are effectively making a different judgment about those needs and priorities.

Community residents and their local coordinators typically do all of the DC data collection themselves, and PANNA scientists or a local leader help manage the process. Data collection usually takes several weeks, during which time the community participants change the filter once or twice per day (a process that takes about half an hour). The participants collect the completed sampling tubes in an ice chest, transfer them to a freezer, and ultimately ship them overnight to PANNA offices in San Francisco. The data collection process reportedly proceeded without major hitches in many of the DC projects, and several of the lay participants I spoke to found the process to be "fun" and "exciting." One local organizer related that her participants seemed to use the scientific process to be role models for their children; two of them (both men) brought their teenage children to the trainings, eager for the teens to see the Drift Catcher and to do a science project with their parents.

In contrast, several other participants found the process to be very challenging, and bringing lay participants into the data collection was problematic at times in different ways. One local organizer lamented that the gauges are hard to read, the glass tubes could easily cut the data collector (since the ends of these must be broken open for each sampling period), there are "a million steps to follow," some steps are difficult for participants with shaky hands (due to neurological poisoning or old age), and the equipment was very heavy.

Several DC groups got unusable data because of data collection errors made by local participants or equipment malfunctions that were not adequately reported and/or resolved. One PANNA scientist, while recognizing that community participants are collecting data on top of myriad other personal responsibilities, lamented the tendency of one local organizer to dismiss scientific protocol: "She's very understanding of her people, and if they say, 'I've got to go take care of my mother this week, I won't be able to do it,' [she] will say, 'Oh, that's okay, you can just do it next week.' No, not okay!" In this case, the participant made a judgment about the timing of the data collection that ultimately compromised the quality of the data. In another DC project, one data collector was unsure of how to read and document the flow rate of the pump. Afraid to admit this, she recorded inaccurate numbers, which ultimately made the data unusable.

The highly technical nature of the DC program thus increases the risk of zero results relative to less technical participatory projects whose need for precise adherence to detailed research process is not so crucial. Several participants emphasized that getting "zero results" (for whatever reason) can be incredibly deflating and disempowering, given how time-consuming and resource-intensive DC projects are. Local NGOs that coordinate the projects devote considerable resources (time, money, energy) to training, coordinating, trouble-shooting, preparing shipments, and managing the data collection process. Training often had to happen multiple times, since the DC's elaborate use protocols are challenging for residents who lack a formal education, do not speak English, and/or are unfamiliar with scientific research. These issues of technical and scientific guidance were less an issue for DC participants whose local coordinator had scientific training. A notable example is the project that was run by a high school science teacher and two of her students in Hastings, FL; there, the teacher possessed the scientific knowledge and decision-making authority needed to easily manage the technical requirements of the project.

Communicating the Research Results to the Community Participants

PAR observers widely emphasize that one of the key ways in which participatory research projects improve upon the "expert" model of scientific research is by communicating the results back to the lay participants. The decisions about whether and how to share the findings with the lay participants are a series of value judgments about ownership of the results and scientists' obligations to their research "subjects." However, a few researchers have recognized that this can be especially difficult in technically sophisticated PAR projects. Morello-Frosch et al. (2009) problematize the fact that scientists' abilities to detect toxicants often outpace their ability to interpret the results. As Quandt et al. (2004) show, this communication challenge can be compounded by the limited formal education and language differences in many participating communities, gender and culture dynamics that inhibit active learning, and the various time and transportation constraints that make it difficult for community participants to attend informational meetings.

The politically oriented and technically complex dimensions of the DC program complicate this task further, since community participants need to understand the scientific data not simply for some abstract notion of "sharing," but also because they will need to present and defend the results repeatedly and under conditions of considerable scrutiny. To communicate the results after the DC data have been analyzed, PANNA scientists hold one or more meetings (of up to several hours each) with the local participants. These are done in-person or, for "fairly tech-savvy groups," via e-mail and conference calls. PANNA states that these meetings are done "usually once to present the data and at least one more time to plan what they will do with the data. Often, if the plan is complex, we work with an organizing team throughout the course of the community's project to help them present the data in the best way and help with the media release of the results (if applicable)." PANNA also prepares fact sheets that present the data in relatively simple and engaging terms (see PANNA 2008), in multiple languages where appropriate.

However, several of the local participants I interviewed indicated that they neither understood their DC results nor could present them with confidence in a political setting. PANNA's efforts to share the results have been hindered by the fact that the DC data are tricky to accurately interpret and communicate. For example, results such as those presented in Figure 1 do not conclusively show, as many lay participants assume, that "we are being exposed to illegal levels of pesticides" or that "this pesticide is causing the health problems in my neighborhood." Rather, to accurately characterize Figure 1, a person would include many caveats and qualifications, stating something like the following: "Figure 1 shows that during this particular sampling period, our monitor found that chlorpyrifos levels in the air exceeded the health benchmark for a 1-year-old child on eight of the 39 days sampled." Additionally, as noted in DC technical reports, the results "may or may not represent worst-case exposure scenarios," the results do not represent actual exposures, and the health effects are determined by innumerable environmental, behavioral, and bodily variables (PANNA 2007, 9). Moreover, in cases where PANNA's REL differs from the standard health benchmark used by the U.S. Environmental Protection Agency (EPA), the activist may have to explain and defend that variation. Fully conveying the implications of the results would also require explaining all of the limitations of *any* REL—explaining that so little is known about most pesticides that RELs do not account for chronic effects or for the combined effects of exposure to multiple pesticides. Any person lacking formal training in chemistry or other natural sciences needs considerable help understanding, re-learning, effectively communicating, and applying such results—particularly if the person aims to present them in the contentious policy, regulatory, or media arenas.

Using the Data

One of the hallmarks of PAR is that the research is designed to solve actual problems—not to just produce knowledge for knowledge's sake—thus problematizing a common value judgment made in "expert research" about the purpose of scientific study. The lay DC participants I interviewed described their primary goals for joining the DC program in terms of shaping the research topic (getting research to address the unanswered questions about the risk of pesticide exposure in their neighborhoods) and using the results to achieve social change. Specific stated social change goals include raising neighbors' awareness about the effects of pesticides in their communities, encouraging more people with suspected pesticide illness to insist to their doctors that their case be reported as such, and encouraging farmers to "use something healthier" or "at least reduce what they apply."

PANNA staff and community participants discuss potential political applications of the results early in the process—during the research design phase—to ensure that the project results will coordinate with the community participants' goals. PANNA's general approach thus far has been to provide some assistance to the local participant groups but generally to allow them to take the lead on applying the results in their local communities.

Lay participation in the project can, however, bring about some problems during this final stage of the research. Elites engage in "boundary work" (Gieryn 1999; Allen 2004) to challenge the legitimacy of data collected by lay participants who lack formal scientific credentials. For example, a local official publicly rejected some DC findings because "the drift catchers were manned by lay people with no scientific backgrounds" (Burgin 2006). Kegley and other DC designers anticipated such boundary work—hence the reason for designing a device and its elaborate set of use protocols that are rigorous and functionally equivalent to the regulatory agencies' own air monitoring practices. Kegley conceptualizes this scientific rigor as fundamental to the political credibility that this program can bring: "You have *power*! You come in with *power*! Data! It's not like people can dismiss you out of hand. They try, but we've dotted enough of the i's and crossed the t's that they have a little bit of trouble doing that."

Additionally, lay participants are not always adequately prepared to utilize the DC results. Although one PANNA representative claimed that the program gives participating groups "the tools to take that data and make change," several of the local participants received insufficient guidance in using the data to effect local or regional change. In the case of one California DC project, a local NGO that had served as a liaison between PANNA and the Spanish-speaking community participants effectively disappeared during the data analysis period due to staffing shortages. PANNA was thus unable to sufficiently communicate the results to local participants (only after a very long time, and to some participants not at all), and those community participants were not linked together in any way aside from the DC project. As a result of these various factors, the participants did not fully understand the DC findings or have the capacity needed to politically apply them.

Although PANNA has been reluctant to micro-manage its community partners in this final stage of the research process, many community participants in confidential interviews stated that they felt stranded the most when they were given results but insufficient assistance with utilizing and applying them. This is particularly problematic in highly technical and political PAR projects, where scientist involvement would help community groups grapple with complex technical results throughout long-term, contentious campaigns. PANNA scientists express considerable concern about their participating organizations' needs for organizing assistance but explain that PANNA

> knew from the start that we did not have the capacity to provide both technical assistance and organizing assistance, and so the availability of organizing expertise in participating groups was one of the criteria we used for selecting projects.... This worked well when we were working with groups with some organizing expertise, and not so well when working with groups without this expertise.

Given PANNA's limited community organizing capacity, the DC seems best suited to groups with some formal scientific training and organizing capacity. The DC project that secured the most dramatic outcome is the one from Washington State, where the participating NGO was highly organized, technically skilled, and had an ongoing political campaign that was bolstered by the strong data it collected but did not depend on the DC findings. Without adequate organizing and scientific assistance, the DC could end up serving the needs of PANNA much better than those of the community participants.

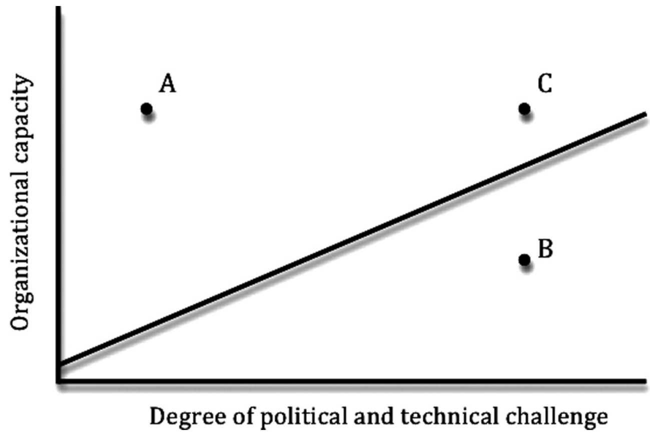

Figure 2. Relationship between two key variables that influence the process and outcome of a given PAR project: participants' organizational capacity, and the degree of political and technical challenge. Below the line, the project participants are unlikely to be able to manage the challenges that arise.

Conclusions

Value judgments make democratic participation an important component of scientific research. However, technical complexity made the inclusion of lay participants problematic at several points in the life cycle of the DC projects: research design, data collection, communication of results back to project participants, and application of the findings. At those points, technical challenges and political controversy often overwhelmed the participants' organizational capacity. In follow-up correspondence, PANNA representatives report that they are adapting the DC program to account for these lessons, through carefully selecting potential participants based on PANNA's available resources and regularly soliciting feedback from community participants.

These findings indicate that the "participation" of any one actor in a PAR project is contingent on the *organizational capacity* of the other participants and the expected (and possible) degree of political and technical *challenges* that arise. The relationship between these two variables in a given PAR program is represented in Figure 2.

Organizational capacity refers to many variables, including a group's degree of internal organization, strategic skills, ability to recruit participants, an ongoing and relevant campaign into which the research will clearly fit but that is not dependent on any particular results, adequate resources (time, money, scientific guidance, and, in the case of the Drift Catcher, basic knowledge of math and the scientific method, and decent English language skills), and the ability to effectively respond to challenges. *Challenges* can be political (e.g., discrediting of data or participants by elites) or technical (e.g., equipment malfunctions), and they may be known, likely, or unforeseen. Figure 2 illustrates that, for a given PAR project, organizational capacity becomes increasingly important as political and technical challenges multiply.

The space above the line in Figure 2 represents scenarios in which the participants possess sufficient organizational capacity to smoothly manage the challenges that unfold. In the case of the Drift Catcher, point A would be illustrated most clearly by what are arguably the two most successful DC cases: the DC projects in Hastings, FL, and in Washington. In contrast, lay participation in a given PAR project becomes problematic when participants have low organizational capacity relative to the amount of anticipated or possible challenges they will face (represented as point B). Smoothly and successfully executing a participatory research project in such circumstances would require additional resources or other capacity building so that the participants are equipped to manage the political and technical challenges that arise (point C).

These findings raise an ethical question: Should a host organization involve community participants in a given PAR project if it cannot provide all of the support that will be needed? The DC case casts doubt on the appropriateness of involving community groups who lack sufficient organizational capacity in such a scenario, since a community group's available resources could be stretched further through other, less resource-intensive, organizing tactics. The organizational capacity constraints are not trivial, nor does insufficient capacity simply limit whether a project can be done or not—uncompleted projects can actually compound community participants' sense of distress and disempowerment. This finding is underscored in projects that produce findings that can increase uncertainty and dread about participants' own health or safety, particularly when the participants will face fierce opposition by entrenched industrial interests and fail to find support from regulatory agencies. These observations reinforce Corburn's (2002) recommendation that participatory science projects must be "long-term and iterative, not a 'one-shot deal' " (247).

Notes

1. I did not record the California community participant interviews because the informants did not wish to be recorded.
2. DC reports invariably question one or more of the assumptions that state and federal regulatory agencies use in setting a particular pesticide's health benchmark (REL), and PANNA scientists authoring the reports usually use their own (more health-protective) RELs. The setting of RELs involves numerous calculations to account for multiple uncertainty factors and the available scientific data, spelled out in minute detail in each DC project's technical report (see PANNA 2007, 32–36). Inconsistencies between PANNA's REL and those of the U.S. Environmental Protection Agency or state regulatory agencies emerge in all of the specific printed reports detailing the DC results from Minnesota (PANNA 2008), Florida (PANNA 2007), Washington (Farm Worker Pesticide Project [FWPP] 2006), and Lindsay, CA (PANNA 2006). For this stage of the process that is not directly amenable to lay participation, PANNA scientists report that lay knowledge about residents' lifestyles and pesticide exposures nonetheless informs PANNA scientists' arguments.

References

Allen, B. 2003. *Uneasy alchemy: Citizens and experts in Louisiana's chemical corridor disputes*. Cambridge, MA: MIT Press.

Allen, B. 2004. Shifting boundary work: Issues and tensions in environmental health science in the case of Grand Bois, Louisiana. *Sci. Culture* 13(4):429–448.

Brown, P. 1987. Popular epidemiology: Community response to toxic waste-induced disease in Woburn, Massachusetts. *Sci. Technol. Hum. Values* 12(3):78–85.

Brown, P. 2007. *Toxic exposures: Contested illnesses and the environmental health movement*. New York: Columbia University Press.
Bucket Brigade. 2008. Bucket Brigade introduction. http://www.bucketbrigade.net/article.php?list=type&type=9 (accessed 2 June 2008).
Burgin, A. 2006. Group protests pesticide drift. *Porterville (California) Recorder*, 19 July, p. 1.
Californians for Pesticide Reform. 2007. Pesticides in our air and in our bodies: Profiles of Lindsay residents who participated in the study. http://pesticidereform.org/article.php?id=297&preview=1&cache=0 (accessed 2 October 2009).
Californians for Pesticide Reform. 2008. Press release: Tulare County residents win greater protection from dangerous pesticides. http://pesticidereform.org/article.php?id=316 (accessed 2 October 2009).
Chuenpagdee, R., J. Fraga, and J. I. Euan-Avila. 2004. Progressing toward comanagement through participatory research. *Society Nat. Resources* 17:147–161.
Clarren, R. 2008. Pesticide drift: Immigrants in California's Central Valley are sick of breathing poisoned air. *Orion* July/August:56–63.
Corburn, J. 2002. Combining community-based research and local knowledge to confront asthma and subsistence-fishing hazards in Greenpoint/Williamsburg, Brooklyn, New York. *Environ. Health Perspect.* 110(suppl. 2):241–248.
Corburn, J. 2005. *Street science: Community knowledge and environmental health justice*. Cambridge, MA: MIT Press.
Farm Worker Pesticide Project. 2006. Poisons on the wind: Community air monitoring for chlorpyrifos in the Yakima Valley. *Report by Farm Worker Pesticide Project and Pesticide Action Network North America.* http://www.panna.org/drift/catcher/results/DCYakima06-CP (accessed 2 October 2009).
Gerlak, A. K. 2008. Today's pragmatic water policy: Restoration, collaboration, and adaptive management along U.S. rivers. *Society Nat. Resources* 21(6):538–545.
Gieryn, T. F. 1999. *Cultural boundaries of science: Credibility on the line*. Chicago: University of Chicago Press.
Greenwood, D., W. F. Whyte, and I. Harkavy. 1993. Participatory action research as a process and a goal. *Hum. Relations* 46(2):175–192.
Harrison, J. 2006. 'Accidents' and invisibilities: Scaled discourse and the naturalization of regulatory neglect in California's pesticide drift conflict. *Polit. Geogr.* 25:506–529.
Harrison, J. 2008. Abandoned bodies and spaces of sacrifice: Pesticide drift activism and the contestation of neoliberal environmental politics in California. *Geoforum* 39:1197–1214.
Jasanoff, S. 1987. Contested boundaries in policy-relevant science. *Social Stud. Sci.* 17: 195–230.
Kroll-Smith, S., P. Brown, and V. J. Gunter, eds. 2000. *Illness and the environment: A reader in contested medicine*. New York: New York University Press.
Lee, K. N. 1993. *Compass and gyroscope: Integrating science and politics for the environment*. Washington, DC: Island Press.
Lee, S., R. McLaughlin, M. Harnly, R. Gunier, and R. Kreutzer. 2002. Community exposures to airborne agricultural pesticides in California: Ranking of inhalation risks. *Environ. Health Perspect*. 110(12):1175–1184.
Morello-Frosch, R., J. G. Brody, P. Brown, R. G. Altman, R. A. Rudel, and C. Perez. 2009. Toxic ignorance and right-to-know in biomonitoring results communication: A survey of scientists and study participants. *Environ. Health* 8:6.
National Research Council. 1996. *Understanding risk: Informing decisions in a democratic society*. Washington, DC: National Academy Press.
O'Rourke, D., and G. P. Macey. 2003. Community environmental policing: Assessing new strategies of public participation in environmental regulation. *J. Policy Anal. Manage.* 22(3):383–414.
Ottinger, G. 2010. Buckets of resistance: Standards and the effectiveness of citizen science. *Sci. Technol. Hum. Values* 35(2):244–270.

Pesticide Action Network North America. 2006. Air monitoring for chlorpyrifos in Lindsay, California: June–July 2004 and July–August 2005. http://www.panna.org/drift/catcher/results/DCLindsay04-05 (accessed 4 October 2009).

Pesticide Action Network North America. 2007. Air monitoring for pesticides in Hastings, Florida, December 6–14, 2006: Technical report. http://www.panna.org/drift/catcher/results/hastings (accessed 4 October 2009).

Pesticide Action Network North America. 2008. Pesticides and air pollution in Minnesota: The frequency of detection of chlorothalonil, a fungicide used on potatoes, at 11 sites in 2006–07. http://www.panna.org/drift/catcher/results (accessed 4 October 2009).

Phadke, R. 2005. People's science in action: The politics of protest and knowledge brokering in India. *Society Nat. Resources* 18:363–375.

Quandt, S. A., A. M. Doran, P. Rao, J. A. Hoppin, B. M. Snively, and T. A. Arcury. 2004. Reporting pesticide assessment results to farmworker families: Development, implementation, and evaluation of a risk communication strategy. *Environ. Health Perspect.* 112:636–642.

Quigley, D., V. Sanchez, D. Handy, R. Goble, and P. George. 2005. Participatory research strategies in nuclear risk management for native communities. In *Community research in environmental health: Studies in science, advocacy, and ethics*, ed. D. Brugge and H. P. Hynes, 219–244. Burlington, VT: Ashgate.

Reason, P. 2001. The action turn: Toward a transformational social science. *Concepts and Transformations* 6(1):1–37.

Shepard, P. M., M. E. Northridge, S. Prakash, and G. Stover. 2002. Preface: Advancing justice through community-based participatory research. *Environ. Health Perspect.* 110(suppl. 2):139–140.