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Environmental Justice, Local Knowledge, and Risk: The Discourse of a Community-Based Cumulative Exposure Assessment

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ABSTRACT / While risk assessment continues to drive most environmental management decision-making, its methods and assumptions have been criticized for, among other things, perpetuating environmental injustice. The justice challenges to risk assessment claim that the process ignores the unique and multiple hazards facing low-income and people of color communities and simultaneously excludes the local, non-expert knowledge which could help capture these unique hazards from the assessment discourse. This paper highlights some of these challenges to conventional risk assessment and suggests that traditional models of risk characterization will continue to ignore the environmental justice challenges until cumulative hazards and local knowledge are meaningfully brought into the assessment process. We ask whether a shift from risk to exposure assessment might enable environmental managers to respond to the environmental justice critiques. We review the US EPA's first community-based Cumulative Exposure Project, piloted in Brooklyn, NY, and highlight to what extent this process addressed the risk assessment critiques raised by environmental justice advocates. We suggest that a shift from risk to exposure assessment can provide an opportunity for local knowledge to both improve the technical assessment and its democratic nature and may ultimately allow environmental managers to better address environmental justice concerns in decision-making.

This paper asks whether the discourse of cumulative exposure assessments responds to critiques of more traditional risk assessment raised by environmental justice advocates. Environmental justice activists have long criticized risk assessment on at least two fronts. First, they claim that traditional risk assessment has focused on individual contaminants from one source—with an overwhelming emphasis on carcinogenisis—while ignoring the multiple hazards that uniquely face low-income populations and communities of color. Second, activists state that the institutionalized risk discourse—often termed risk communication and management—has systematically excluded local, non-expert knowledge by creating hard boundaries between scientific analysis and political values and between expert and lay judgments. In response to these criticisms, both regulators and activists are calling for cumulative exposure assessment to replace the traditional risk models. Cumulative exposure assessment considers multiple hazards, effects, pathways, and populations and, when focused on communities, demands local knowledge in order to capture the particular exposures of the place.

KEY WORDS: Environmental justice; Risk assessment; Local knowledge; Exposure assessment

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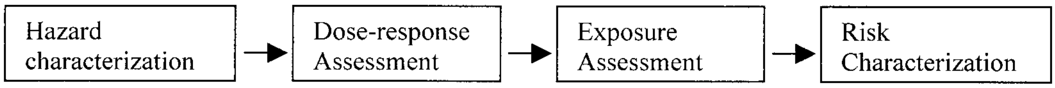
One claim of community cumulative exposure assessment is that by relying on local, contextual information for key data inputs, the assessment process may shift the risk discourse away from an expert-only model of analysis and decision-making toward a more democratic model—where local knowledge can improve both the technical assessment and procedural fairness in policy-making.

This paper examines whether community-based cumulative exposure assessment can live up to these claims by reviewing EPA's first neighborhood-based assessment—the Cumulative Exposure Project (CEP). Piloted in Greenpoint/Williamsburg (G/W), New York, the CEP combined modeling air toxins with local knowledge of hazard exposures, such as diet and where children play, to generate a cumulative hazard exposure for neighborhood residents. This paper examines the CEP effort and highlights the extent to which its risk characterization process addressed the environmental justice critiques of traditional risk assessment. As risk assessment is increasingly used to drive environmental policy decisions it may simultaneously be ignoring the conditions and concerns facing communities seeking environmental justice. This paper investigates whether cumulative exposure assessment can offer a better model for communities seeking environmental



Source: *Risk Assessment in the Federal Government*. National Research Council, National Academy of Science, 1983.

Figure 1. Four stages of risk assessment.

justice and the regulators managing the decision-making process.

The first section of the paper reviews the traditional risk assessment process, focusing on EPA's carcinogenic risk assessment procedures. The conventional process involves four steps—hazard identification, dose-response function, exposure assessment, and risk characterization—and I will briefly review the methodology and assumptions behind each step. The second section raises some of the weaknesses of this traditional process, specifically highlighting the challenges raised by environmental justice advocates. The third section reviews a recent policy shift by EPA, which emphasizes cumulative risk assessment and improving the public discourse surrounding assessments, largely in response to claims from environmental justice advocates. The fourth section recounts the CEP in G/W, highlighting how local knowledge of hazards was treated in the assessment process. While not answering all the environmental justice critiques of traditional risk assessment, I show that the pilot project did begin to shift the hazard characterization process from one primarily the domain of experts to a process that meaningfully considered local knowledge.

Quantitative Risk Assessment

Societal risk is traditionally defined as the probability that an outcome will occur multiplied by the impact, should that outcome occur. One of the first National Research Council (NRC) reports on risk analysis methodology characterized risk analysis as two distinct processes, risk assessment and risk management (NRC 1983). Risk assessment is "the characterization of the potential adverse health effects of human exposures to environmental hazards" while risk management is "the process of evaluating alternative regulatory actions and selecting among them (NRC 1983)." The scientific assessment stage was intended to lend an air of legitimacy to a process that, in the end, only produced probabilities and was laden with uncertainty. The risk management process was supposed to apply to policy-making. Yet, by emphasizing the scientific objectivity of the procedure, risk assessment offered policy-makers a means to persuade the public that regulatory decisions were based on a core of rational analysis. One intention of risk assessment was to enhance public confidence in the impartiality of regulatory agency decisions (Lash 1994: 76).

While raising skepticism almost as soon as it was used for policy-making, these assumptions behind risk assessment have lasted, more or less, through today. Quantitative risk assessment methods and techniques have become so institutionalized that the critics call its weaknesses an "open secret" (Finkel and Golding 1994). Yet, challenges to the assessment process specific to environmental justice are not as well understood.

Quantitative risk assessment remains the framework around which policy discussions over human health hazards occur. Human health risk assessment is a discipline based on toxicological data, which are used to make predictions about potential health effects associated with exposure to hazardous substances. As defined by EPA, the process is designed to identify an environmental hazard; describe the potential adverse effects of exposure to a hypothetical individual; and to understand the scope of adverse effects to a given population (EPA 1986). The process includes the hazard identification, followed by the dose-response evaluations and the exposure assessment. All of which is combined in the end to generate a risk characterization. The characterization is then used to inform the risk management and communication processes (Figure 1).

Hazard Identification

Hazard identification is a process where analysts use available evidence to determine whether a substance is linked to a particular human health or environmental effect. This generally involves EPA scientists reviewing respected health studies to determine whether a chemical or other substance poses a threat to human health. This is largely a qualitative review of quantitative studies that base their findings on three different types of data: human epidemiology, long-term animal bioassay, and short-term mutagenicity tests. Epidemiology data are derived from health effects observed in humans. However, data based on how chemicals affect humans is hard to develop in part because it is difficult to know when an observed health problem can be linked to exposure from a particular substance. In the case of carcinogens, making such links is further complicated because it often takes many years after initial exposure for cancer to develop. Human data also are in short supply because it is simply not feasible (or ethical) to administer doses of suspected carcinogens to people in order to see what health effects may result.

As a result, researchers typically use data from long-term animal bioassays. Bioassay is often a time-consuming and costly process where researchers administer doses of a substance to lab animals in order to induce tumors. The third data source, short-term mutagenicity testing, is less time-consuming and often more cost-effective method where chemical mutagens are used to further flag potential chemical carcinogens.

Evidence used to identify potential hazards tends to vary in quality and results are often conflicting. That is, some studies are better than others due to a number of factors including sample size and the duration of the experiment. Furthermore, some studies may illustrate a positive association between a dose of some chemical and a health effect, where others may fail to demonstrate a link.

When confronted with conflicting information, EPA must decide how much weight to place on the available evidence. EPA typically deals with such issues by choosing a uniform, or default set of assumptions, which are applied to each substance assessed. So, for example, when assessors are confronted with evidence that shows both a positive and negative association between a substance and a health effect, guidelines might instruct analysts to err on the side of caution and favor studies that show a positive link between exposure and an observed health effect. In the end, the hazard identification is often a judgement call on behalf of EPA and its science advisory board (SAB). Risk assessors generally use these judgements as the default "toxicity weightings" for chemicals they are studying (Wilson and Crouch 1987).

Dose-Response Function

The second step in risk assessment, the dose-response function, is a way to estimate the relationship between exposure to a harmful substance and the resultant harm. Because data on the human health effects due to exposure are in short supply, dose response assessment typically requires researchers to employ sophisticated mathematical techniques to extrapolate health effects observed in rodents administered relatively high doses to effects which could be observed in humans exposed at low doses. Such techniques are known as low-dose extrapolation models (Wildavsky and Levenson 1995). According to Marcus (1988), in order to "determine with 95 percent accuracy that the carcinogenic response to a substance is one in a million, over six million rodents would be required for controlled laboratory experiment, lasting eighteen to twenty-four months." Since this is impractical, scientists must test fewer animals at significantly higher doses, and then extrapolate to approximate the low-dose rates associated with human exposure.

Of the four steps, dose response assessment may contain the most uncertainty in the risk assessment process because it is difficult to know whether it is realistic to assume that effects observed in animals administered high doses will accurately reflect what people encounter in their everyday environment. Related to the extrapolation problem is the fact that humans differ so significantly in size, weight, and metabolic function from lab animals. In the context of carcinogens, establishing links between suspected substances and tumor development is further complicated because scientists still do not fully understand all the mechanisms that may trigger cancer. To deal with these uncertainties, EPA uses a variety of "safety features" to arrive at conservative estimates. For carcinogens, EPA assumes rats and humans metabolize similarly and the default assumption is to adjust one-to-one for the difference in body weight (EPA 1986). To further extrapolate from animals, EPA makes similar adjustments, assuming that rats live three years and humans on average seventy and that, over a lifetime, sporadic doses react in the body similarly to continuous doses. Finally, in being extra-conservative when it comes to carcinogenesis, EPA recommends that a "linearized multistage" (LMS) model be used. In this model, cancer is assumed to be linear (i.e., more dosage = more cancer) and that there is no threshold level (i.e., all non-zero doses have some positive effect). These modeling assumptions are then used with different confidence intervals to calculate probabilities (Kammen and Hazenzahl 1999).

Animal studies present particular difficulties since animals used in studies are bred to be homogeneous to eliminate genetic diversity and ensure stability between the test and control groups. Test animals are given a constant equivalent dose, as opposed to a more sporadic uneven dose more typical of environmental exposure. A major challenge to the EPA assumption is that the threshold effect, the dose where disease is first observed, could be dramatically different for different animals receiving the same cumulative dose (Ames and Gold 1989). A further challenge to EPA's conservative assumptions comes from Bruce Ames and Lois Gold, who claim that the chronic wounding caused by delivering heavy doses of a chemical *promotes* cancer by inducing cell division, a process called mitogenesis.

Once the animal is injured, it grows replacement cells, increasing the chances of mutation and hence cancer (Ames and Gold 1989).

A final issue with animal tests concerns the interaction of multiple toxins. There is increasing evidence that many toxins may have additive effects. For example, radon and cigarette smoking both contribute to lung damage and in combination are much more potent than either alone (NRC 1996). Similarly, the ability of the human body to tolerate some amount of toxic exposure individually may be overwhelmed by a similar amount of multiple toxins when exposed at the same time. However, the additive and synergistic effects of chemicals are almost never considered in risk modeling (Ozonoff and Boden 1987).

The methods employed in low dose extrapolation are derived from statistical models and not biological information. When assessors choose different equations the results about plausible effects associated with chemical doses in humans will also differ. This means that the dose-response function is a statistical measurement first, and an estimator of disease second. Epidemiological studies, which might serve to better illustrate actual ways in which exposure to a substance manifests itself in humans, are rarely available. Thus, the predicted incidence of cancer in humans as a result of exposure to a certain substance can vary, depending on the statistical model used.

Exposure Assessment

Exposure assessment is the third stage of a risk assessment. At this stage, analysts attempt to identify how much of a population will receive some exposure to a substance. Exposure assessment methods can vary greatly, depending on the type of pollution source. For example, the exposure assessment for dispersion of air pollution bears little resemblance to the exposure assessment for the dispersion of pollutants from a landfill (EPA 1986). The facts relevant to exposure assessment consist of information that is usually well known or readily knowable—the concentration of a chemical at a pollution source, the nature of migration from the source and the location of the surrounding people. The difficulties arise in choosing a concentration to model (i.e., daily, monthly, yearly averages) key fate and transport assumptions (i.e., meteorological data) and which receptors to include (i.e., what distance from source, sensitive populations, treat all people the same, etc.).

Epidemiological studies are one way to estimate exposures. These studies are often descriptive or analytic, the former looking at existing populations while the latter isolate a specific exposure in a forward looking study (Kammen and Hassenzahl 1999: 163). Descriptive studies look at existing populations, isolate past exposures and relate these to suspected effects. Estimating historical exposures is the major challenge in these studies. A double-blind test for new medicines is an example of analytic studies.

Epidemiological studies, like animal studies, are fraught with uncertainties. Recall bias, where people remember exposures to the things they *think* cause disease, is a major challenge in gathering retrospective exposure information. Epidemiological studies face the additional problems of isolating confounding factors, imperfect measurements, representativeness of the analyzed population, and interpreting small effects. Confounding factors arise because epidemiological studies are natural and not controlled, and the population under study is generally exposed to other stresses. When elevated rates of disease are found, confounding factors make it difficult to determine which factor or combination of factors is the cause. Measurement errors are also a result of natural experiments, because exposure levels and rates for each member of the analyzed group is not available. Average levels and rates must be used and what average to use becomes an additional point of judgement and potential controversy. Representativeness issues arise when workers and occupational exposures are studied and the results are extrapolated to the general population. Certain worker populations have been shown to be less healthy and have particular characteristics that significantly differentiate them from the general population (Paustenbach 1989).

Risk Characterization

Risk characterization is the fourth and final stage of a traditional quantitative risk assessment. Multiplying the harm from incremental doses (the number derived from the dose-response assessment) by the dose a population is expected to receive (the number derived from the exposure assessment) derives the risk characterization. The resulting number is supposed to represent the threat to a population from the concentration of a chemical that might reach them. However, the risk characterization merely consists of a “stacking” of all the uncertainties of the exposure assessment with all the uncertainties of the dose-response function. This stage often masks the uncertainties in the previous steps, thereby inaccurately portraying the potential severity of the risks (NRC 1996). However, policy prescriptions and risk management decisions are often based on these final characterizations (NRC 1996).

The risk assessment, combined with a management and communication phase, comprise the traditional

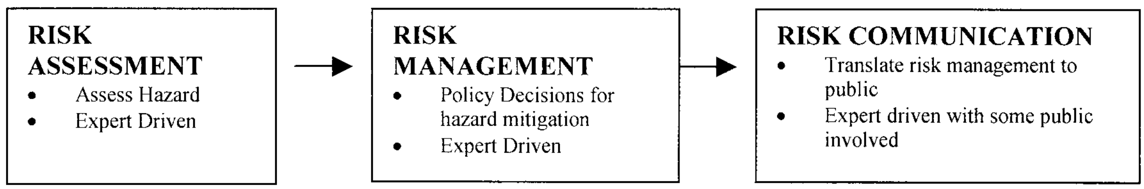


Figure 2. Three stages of conventional risk analysis.

risk analysis process. After the assessment results in a risk characterization, regulators generally determine appropriate management or mitigation measures, often employing cost-benefit analyses to help make these decisions. The public, and generally those populations being asked to bear the risk, are informed of the characterization and management decisions in the communication phase. Public deliberation with experts, if it occurs at all, generally takes place only during the risk communication stage (Figure 2). Clearly, the assessment and management stages require non-objective, value judgments—such as the most likely, most serious, and most irreversible risks—all of which are accompanied by a high degree of uncertainty. As Lash (1994) points out, even expert judgments "inevitably reflect attitudes about uncertainty and the significance of the consequences of errors of underestimation or overestimation." The value judgments during the assessment and management stages are where risk policy is made and these often take place without meaningful public input. Many observers of risk analysis have raised this criticism of risk assessment, suggesting that public deliberation is an essential aspect of risk policy-making (Graham and Wiener 1995). However, which expert assumptions and judgments are open to public debate, at what time in the analysis process should the discourse occur, and what weight should be granted to non-expert knowledge are three of the central tenets of the environmental justice critique of risk-based decision-making.

Environmental Justice Challenges to Risk Assessment

The models and default assumptions used for site-specific risk assessments in the US come from EPA and its science advisory board and are intended to protect public health (NRC 1983, EPA 1986). Yet, many scientists and risk-assessment professionals state that EPA, in its excessive desire to protect human and ecological health, uses assumptions that are too conservative in modeling outcomes, often over-stating the true risks of many chemicals and situations (Zeckhauser and Viscusi 1990, Bryer 1993, Viscusi 1998, Farber 1999). Environmental justice advocates often criticize risk assessment for both underestimating the magnitude of risks for low-income populations and people of color and systematically excluding these populations from the risk characterization discourse.

White Male Bias

Quantitative risk assessments have difficulty distinguishing inter-individual variability in susceptibility to disease. The default assumption generally employed in risk assessment is that humans on average have the same susceptibility as persons in epidemiological studies or as the most sensitive of the animal species tested (EPA 1986). However, Zahm and others (1994) reports that in a survey of occupational cancer epidemiological studies, only two percent of the studies had any analysis of the effects on nonwhite women and only seven percent addressed the effects of nonwhite men. The EPA default "reference man" for developing dose-response predictions has been described as "a seventy-kilogram man with the general biology of a Caucasian" (Kuehn 1996). Yet, genetic, lifestyle, and socio-economic factors have all been shown to influence susceptibility to environmental pollutants (Adler and others 1993, Rios 1993, Lantz and others 1998, Geronimus 1999, Krieger 1999). Additionally, biological differences are suspected of making certain diseases such as hypertension, chronic liver disease, chronic respiratory disease, and sickle-cell anemia more prevalent among minority populations, thereby increasing their risk of adverse outcomes to environmental exposures (Sexton and others 1993). The Federal Centers for Disease Control, Agency for Toxic Substances Disease Registry (ATSDR), has confirmed for over a decade that the percentages of black children with excessive levels of blood lead exceeds the percentages of white children by ten orders of magnitude (ATSDR 1988). According to ATSDR, African-American children have a higher incidence of excessive levels of lead at all income levels (Weisskopf 1992). While EPA acknowledged in its 1992 Environmental Equity Report that health risks differ according to race and class, they continued to rely on the default dose-response assumptions and that all humans are equally exposed and susceptible for risk assessment purposes, "until more data disaggregated by race is available" (EPA 1992). The present practice of excluding information regarding the risks to more susceptible ethnic and racial sub-populations results in an assessment that fails to reflect higher environmental risks to which these groups are subjected.

Ignorance of Socio-Economics

While biological and genetic disease susceptibility differences can be an extremely controversial subject, and one still loaded with uncertainty, poverty, lack of adequate health care, and other socioeconomic factors as primary indicators of disease susceptibility are no longer controversial. There is an increasing consensus that poverty and race drive mortality rates and disease susceptibility, including cancer (Adler and others 1993, Link and others 1995, Lantz and others 1998, Geronimus 1999, Krieger 1999, NIH 1999). For example, African-Americans face the highest excess mortality (particularly low-income urban males) and the highest incidents of liver disease, asthma, hypertension, and all cancers, of any population group in the US (Geronimus 1999). Lack of access to health care or poorer quality care may increase the adverse effects of environmental exposures on low-income, minority, and ethnic communities (Rios and others 1993). Yet, it is not just poverty that drives these figures. As Amartya Sen (1999) recently wrote:

> A related lesson emerges also from the observed fact that in the USA, African Americans as a group-men and women-have a lower chance of reaching advanced age than do men and women born in the immensely poorer economy of the Indian state of Kerala, and (in the case specifically of men) than do the Chinese as well. The shorter lives of African Americans relate not to their low incomes (they are, in fact, very much richer in per-capita income than the Chinese or the Keralite), but to the lack of guaranteed health care (with big gaps in medical insurance), blighted educational arrangements, and other problems of social malaise and disruption. Indeed, the average African American man in New York, or San Francisco, or the District of Columbia has a lower life expectancy than does even the average man in India or Pakistan.

Thus, the policy responses, or lack thereof, to racial and economic inequality are as important a determinant of health risk as poverty itself. When risk assessment ignores these facts, they tend to minimize health hazards facing these populations and ignore the unique background risks they already face.

One Exposure at a Time

Risk assessments normally estimate for cancer because it is viewed as a proxy for all other health risks posed by an environmental agent or source (EPA 1986). However, non-cancer health effects, such as respiratory, neurologic, reproductive, and psychologic disorders, along with birth defects, hormonal and immune deficiencies, and endocrine dysfunction are often overlooked in risk characterization. Over-reliance on cancer leaves many other serious diseases and human health problems unaddressed—many of which appear to increasingly fall on low-income and minority communities (Williams and others 1997).

Even when cancer acts as the primary focus for risk assessment, criticism tends to focus on the fact that the assessment identifies single exposures from a single source. Cumulative exposures, where individuals are exposed to numerous chemicals through different media and/or sources, are never part of a risk assessment calculation. The result is that traditional risk assessments may determine that one hazard facing a population is "safe" or acceptable, but the aggregate risk goes unstudied.

One reason cumulative risk is not considered in traditional risk assessment is that the exposures individuals are experiencing before the addition of a new exposure— referred to as the "background exposure" condition—is rarely known. The importance of this information becomes apparent when questions of chemical additivity and synergism are considered. Chemical additivity occurs when chemicals or pollutants mix and result in an exact combination of all their individual effects (i.e., a chemical with a toxicity of two plus another chemical with a toxicity of two might result in a mixture with a toxicity of four). Synergism occurs when chemicals combine for a greater additive effect (i.e., toxicity of two plus toxicity of two combine and results in a toxicity of ten). Conversely, antagonism of chemicals can occur where the combined result is a diminished toxicity. Yet, since toxicology has not developed an accepted method for determining these effects they are ignored in traditional risk assessment.

Because people of color and low-income communities face greater exposures to environmental contaminants, the failure of risk assessment to account for multiple and cumulative exposures may be impacting these subpopulations greatest. The 1992 EPA report on Environmental Equity stated that racial minority and low-income populations have greater than average observed and potential exposures to pollutants because of where they live, where they work and what they consume (EPA 1992). Subsequent federal government reports have confirmed that cumulative exposures are a "significant driving force behind environmental justice issues" (SAB 1999). The higher exposures experienced by these communities mean that risk assessment's failure to take account of cumulative and multiple exposures and its failure to aggregate risks based on race, ethnicity and class, results in risk characterizations that are less accurate and less conservative for low-income populations and people of color.

Beyond the Numbers

Finally, environmental justice advocates criticize risk assessment because it tends to rely on probabilities without considering public perceptions, distributions, and whether the risk characterization process was at all democratic. In the traditional mode of assessment, risk is a number, or probability, of expected deaths or disease for a given population. However the public attitude toward risk can depend on a host of factors beyond rationally derived probabilities, including fairness, distribution, voluntariness, responsibility, control, trust, reversibility, and identifiable victims (Douglass and Wildavsky 1982, Slovic 1987, Beck 1992, Leiss and Chociolko 1994, Finkel and Golding 1994, Adams 1994, Jasanoff 1999). Quantitative analysis often leads to what Tribe (1972) called the "dwarfing of soft variables," or the fact that information that cannot be quantified is not considered and conclusions are biased toward considerations that the quantification process can incorporate. Environmental justice is primarily concerned with the political and ethical questions of risk definition and distribution (Bullard 1994).

Environmental justice advocates are often more concerned with asking who are the persons at risk rather than, for example, whether one-in-a-million is an acceptable risk. While risk implies that the chance of harm in question is accepted willingly in the expectation of gain, many environmental justice activists are concerned about whether they will actually receive any of the "gains." According to Winner (1986), by engaging in debates over risk calculations, the discourse of environmental policy is shifted from talk of hazards and dangers to the notion of 'risk;' "this tends to imply that the chance of harm in question is accepted willingly in the expectation of gain" (1986: 145). Winner continues by stating that as activists:

> adopt risk assessment as a legitimate activity, they tacitly accept assumptions they might otherwise wish to deny (or at least puzzle over): that the object or practice that worries them must be judged in light of some good it brings and that they themselves are recipients of at least some portion of this good (Winner 1986: 149).

When the tradeoffs for gains are health, safety, and environmental quality, Winner suggests this is not the right game for activists to enter. Additionally, in deliberations over risk, "the burden of proof rests upon those who seek to change long-existing patterns" of haphazard use of industrial chemicals. Winner (1986) suggests that before "risk" is selected as a focus in any area of policy discussion, other available ways of defining the question be thoroughly investigated because one's initial definition of the problem shapes who is empowered to dictate the conversation and who will be excluded, deemed inarticulate, irrelevant, or incompetent.

Lois Gibbs echoes some of Winner's concerns. She characterizes risk assessment as describing the "risks that someone else has chosen for you to take" (Gibbs 1994). She states that the people being asked to bear the "risk" have little chance to escape it, so are forced into discussions of appropriate risk with experts whose values and judgements have determined the terms of the debate. The community's values, according to Gibbs, are not perceived as tangible or worthy, "and this translates into a lack of respect when experts define a toxic problem with risk assessments"(1994). The real failure of risk assessment, for Gibbs, is that "the experts have begun to believe that their numbers are more valid than the facts and conditions of a real-life situation and these expert-derived numbers are then used to justify political decisions" (1994). According to Gibbs and other environmental justice activists, even when they have the opportunity to participate in risk management decisions, activists are at a disadvantage in the policy discourse simply because the issue has been framed, analyzed, and understood, a priori, as a "risk" (Austin and Schill 1994).

While quantitative risk assessment has made great strides in the past ten years in its ability to conceptualize and mathematize uncertainty, many of the criticisms raised by environmental justice advocates remain unanswered. While some environmental justice advocates might agree that some form of quantification of hazards is useful for comparison purposes, they might also agree that the traditional modeling—with its white bias, ignorance of highly susceptible populations, and exclusion of those being asked to bear additional risks—represents a form of domination and control that is deeply misleading. The models and quantification processes of risk assessment are often founded on the untenable premise that a perfectly objective, "god's-eye" view of the world can be attained through scientific inquiry. Translating the uncertainties of risk assessment into quantitative language washes out the political and cultural biases, such as the tradition of the "technocrat," which influence the appropriate way to legitimize political decisions.

For example, Chief Justice Stephen Breyer recently called for bureaucratically rational risk assessment to be insulated from politics and the public in a federal "superagency" assigned all risk assessment duties (Breyer 1993). Breyer's vision epitomizes the notion that analysis of human health harms can be neutral and apolitical. However, the EPA (1997), the Science Advisory Board (1999), the National Research Council (1996), and the Presidential Commission on Risk Assessment and Management (1997) have all rejected Breyer's suggestion. These agencies recently concurred that traditional risk assessment inadequately addresses issues of justice and they have suggested an alternative methodology where science and politics interact from the earliest stages of the hazard assessment process. According to the NRC (1996), this new process should include constant public feedback and recursion, so that initial problem frames can be revisited and redrawn in the light of new information and experiences, and that decision making should drive analyses, not the search for an ultimate scientific resolution. These suggestions are a radical step from the traditional linear risk assessment and management approach and ultimately call for a cyclical assessment processes grounded in, not separate from, the rhythms of deliberative politics.

Deliberation and Cumulative Assessments

Ultimately, in policy-making, risk assessments are always vulnerable to deconstruction—that is, to being pulled apart so that the underlying assumptions or value judgements are exposed to public review and criticism. Often, environmental values are sharply divided in risk debates, and scientific information and expert discourses alone offer insufficient protection against the skepticism of people representing different social positions or interests. Thus, faced with increasing controversy and dissatisfaction with the expert-dominated risk assessment process, the NRC issued a report in 1996, entitled Understanding Risk: Informing Decisions in a Democratic Society, calling for a end to the separation between risk assessment and management. The NRC recommended a more holistic process which was "decision-driven" and based upon "mutual and recursive analytic-deliberative efforts involving all interested and affected parties" (NRC 1996). The NRC report also emphasized the need for increasing public discourse in risk characterization for the following reasons:

- Clarifying and potentially advancing resolution of issues of fairness (When we use the word "fairness" we are referring to both distributional and procedural equity, two issues that have been concerns of the Environmental Justice movement.);
- Informing multi-dimensional tradeoffs among efficiency, fairness, environmental sustainability, and other concerns;
- Increasing credibility;
- Informing priorities for research. Studies suggest that more data are not necessarily better for organizational decision-making. Deliberation can help determine the research that is most likely to be key to decision-making (SAB 1999).

The NRC report makes explicit reforms to the risk characterization process which respond directly to concerns of many environmental justice advocates.

Following the NRC report, EPA issued draft guidance for cumulative risk assessment, which further responded to the environmental justice critiques of conventional risk models. In the cover letter accompanying the cumulative risk assessment guidance, Carol Browner, Administrator of EPA, stated:

> We are better able in many cases to analyze risk by considering any unique impacts the risk may elicit due to gender, ethnicity, geographic origin, or age of the affected populations . . . We may be better able to determine . . . whether a cumulative exposure to many contaminants, in combination, poses a greater risk to the public . . . Our goal is to ensure that citizens and other stakeholders have an opportunity to help define the way in which an environmental or public health problem is assessed, to understand how the available data are used in the risk assessment, and to see how the data affect decisions about risk management (EPA 1997).

At first glance, this shift from EPA's earlier guidance appears to respond to the weaknesses of risk assessment raised by environmental justice advocates. However, the guidance explicitly omits "the social, economic, behavioral, or psychological factors that also may contribute to adverse health effects," including, "existing health conditions, anxiety, nutritional status, crime, and congestion" (EPA 1997). The new guidance, while limited, does offer a new methodology for risk assessment where the focus is on cumulative exposures and public deliberation among scientists and the affected populations.

The Science Advisory Board (SAB) of the EPA also recently issued draft guidance which attempts to couple the cumulative risk assessment guidance with social and economic factors into an "integrated decision-making process." The SAB report, which began as a review of comparative risk assessment, is entitled Integrated Environmental Decision-Making in the Twenty-First Century (1999), and speaks directly to the cumulative and discourse challenges of traditional assessments. The report begins by acknowledging the major weaknesses of traditional risk-based decision-making, namely the lack of a cumulative focus. The report notes:

> [t]hat making ever smaller reductions in selected single risks may not necessarily be the best policy either for protecting overall environmental quality or for making the best use of society's resources . . . risk reduction efforts should be designed to control more than one kind of human or ecological receptor at a time . . . In short, we need to develop and apply an integrated, out-comes based environmental decision-making process that allows us to reduce aggregate risks, even when those risks are caused by multiple sources and affect multiple receptors, both human and ecological, through multiple pathways (SAB 1999: 2).

The integrated model of environmental decision-making, while still relying heavily on scientific expertise, calls for "values and deliberation at every stage of the cyclical and recursive assessment process" (SAB 1999: 9). The SAB calls for "integrated deliberation" which means "an on-going interaction among experts and stakeholders during problem formation, collection of information and development of options" (SAB 1999: 5–35). The report further specifies that integrated deliberation may also be needed during implementation and performance evaluations stages and "may take the form of adaptive management with stakeholders and experts reviewing the results and suggesting iterative changes" (SAB 1999: 5–36).[1] In the spirit of all the recent agency guidance documents suggesting a shift in the risk discourse, EPA conducted the first community-based cumulative exposure assessment in Greenpoint/Williamsburg, New York. The next section of this paper asks how well the pilot community cumulative exposure project (CEP) lived up to the goal of "recursive deliberation" as suggested by these government agencies and whether the CEP responded to the specific environmental justice critiques of risk assessment.

Greenpoint/Williamsburg, New York: A Profile of Potential Exposures

Community Profile

Greenpoint/Williamsburg, located in Brooklyn, New York, is a historically working-class immigrant community. Today, it remains one the poorest neighborhoods in New York City, with 35.7% of the population living below the poverty line.[2] The median household income for the neighborhood is $16,409, compared to $25,684 for Brooklyn, and $29,805 for New York City generally. Consequently, there is a high level of income dependency in the area, with 25% of all households on public assistance, compared with 15.9% in the borough, and 13.1% in New York City.

The community is comprised of mostly Latinos (40%), Whites (42%), and African-Americans (14%). Three ethnic groups predominate, including Latinos (mostly Puerto Rican and Dominican), Hasidic Jews, and recent Polish immigrants. Greenpoint had the largest influx of immigrants between 1990 and 1994, as a percentage of its total 1990 population, than any other neighborhood in New York City.[3] Education levels in the neighborhood are also very low. Only 43.7% of adults over twenty-four years of age have a high school diploma or higher level of education, compared with averages of 63.7% in Brooklyn and 68.3% in New York City, generally.

Environmental Profile

Community District 1, which includes both Williamsburg and Greenpoint, is a mixed-use neighborhood where industry often abuts residents. With twelve percent of its land devoted to industrial uses, it ranks first out of New York City's 59 community districts in industrially-used land. The average percentage of industrial land-use for all districts in the city is 1.9%. The neighborhood contains a number of polluting facilities, including: the city's largest sewage treatment plant, 30 solid waste transfer stations where garbage is stored before transport to landfill, the only radioactive waste storage facility in New York City, 30 facilities which store extremely hazardous wastes, 17 petroleum and natural gas storage facilities, and 96 above-ground oil storage tanks. The petroleum storage has led to a 15-

[1] According to Holling (1978) and Lee (1993), the adaptive view of environmental management is a process in which managers choose actions that serve as experiments, where the public and managers work collaboratively to test the experiment and where decisions are constantly adjusted as new information and learning emerges.

[2] All of the following demographic data comes from the 1990 US Census, Population and Income File, Stf3a, unless otherwise noted.

[3] The 1994 population was 19.3% new immigrants in Greenpoint. *The Newest New Yorkers 1990–1994: An Analysis of Immigration to New York City in the Early 1990's.* New York City, Department of City Planning, December 1996. P. 53.

million-gallon oil plume that sits underneath one-quarter of the neighborhood. The Brooklyn Union Gas liquid natural gas tanks, the only such storage in New York City, are located in eastern Williamsburg. With over 1000 industrial uses in only five square miles, there are a number of potential hazardous exposures within the community.

In 1987, a study by Hunter College's Community Environmental Health Center, called Right-to-Breathe, Right-to-Know, revealed that Williamsburg was home to the largest concentration of Toxic Release Inventory (TRI) reporting industries in New York City, most of which were not in compliance (Steinsapir 1987, Kissmen and others 1989). Not much had changed 10 years later. According to a 1997 New York City (NYC) Department of Environmental Protection (DEP) Right-to-Know Report, compared to the city as a whole, the community housed the highest number of facilities storing, using, or manufacturing 10,000 pounds or more of a hazardous substance (60), the largest number of facilities reporting hazardous substances in the Citywide Facility Inventory Database (161), the most TRI facilities (21), the largest number of facilities using or storing extremely hazardous materials with Risk Management Plans (11), and the highest number of hazardous materials emergency responses (NYC DEP 1997). Residents are also exposed to heavy vehicular traffic from the Brooklyn-Queens Expressway (BQE), an elevated roadway which bisects the community. The Williamsburg Bridge and its access ramps also traverse the community. The BQE is a major link in the regional transportation network and has consistently been rated one of the US's most congested roadways. As a result, vehicles frequently idle in the neighborhood, and commercial traffic tends to use local streets to avoid BQE congestion.

The neighborhood is also the home to over 30 waste transfer stations. Trucks that pick up solid-waste on the streets of New York often travel to Williamsburg to transfer the waste to larger vehicles which then haul the waste out of the city. Residents have complained that these facilities have noxious odors, are noisy, attract vermin, and generate air pollution, especially particulates from diesel trucks and fugitive dust. Trucks with uncovered containers often transport waste through the neighborhood, and residents have repeatedly complained of odors, dust, and debris from these vehicles. Additionally, it is not uncommon for idling trucks to queue along neighborhood streets waiting to enter transfer stations.

Finally, a 1998 report by the Regional Plan Association and Environmental Action Coalition, found that only 3.0% of Community District 1 is shaded by trees, the lowest canopy cover in any of the city's 59 districts. By comparison, trees shade 11.4% of Brooklyn and the average coverage for all of New York City's neighborhoods is 16.6% (Perris and Chait 1998). With a lack of green space and an abundance of polluters, the community is suspected of having related public health problems.

Public Health Profile

The health profile of the neighborhood is not as well documented as the environmental conditions. A study performed in 1992 by the NYC Department of Health (DOH) and the Department of Community Health and Social Medicine of CUNY Medical School, reviewed incidents of all cancers, asthma, and childhood lead poisoning in the neighborhood (Kaminsky and others 1992). While the study revealed no "significant findings in the aggregate," it did disclose that "the incidence of certain types of leukemia in children and male adults and stomach cancer among adult males and females was the highest in the city" (Kaminsky and others 1992). Recent data from the NYC DOH suggest that the community has a severe asthma problem (Noble 1999, Stolberg 1999). A survey of Latino residents by El Puente, a local community group, found that the prevalence of self-reported asthma in their sample was 12.4%, more than twice the national rate of 5.4%. They also found that boys between 3 and 12 years old have double the rate of asthma of girls the same age, adult women (over 18 years) are 80% more likely than men to have "active asthma," and over 20% of women between 45 and 64 surveyed reported active asthma (Ledogar and others 1998).[4] The public health data and environmental conditions in G/W lead EPA to choose the area for its first community cumulative exposure assessment.

Cumulative Exposure Assessment: Expert and Local Discourse

Williamsburg's environmental and health profile, its urban characteristics, environmental and health activism, and the availability of agency and academic environmental and health data, all led EPA to choose G/W

[4] The term "active asthma" refers to people who self-report asthma and have been diagnosed by a physician that they have asthma and have exhibited the signs of asthma in the past year. It includes all those who reported one or more symptoms, including wheezing, sleep disturbance, speaking difficulty and/or are taking asthma medication or have been to the emergency room for asthma in the past 12 months.

for its first community cumulative exposure study.[5] EPA's Cumulative Exposure Project (CEP) examined how much toxic contamination residents are exposed to through air, food, and drinking water. The study modeled the local dispersion of 148 hazardous air pollutants (HAPs) and added hazardous food and water ingestion exposures to derive a cumulative community exposure profile. Since the final report of the project, Who Bears the Burden? Cumulative Exposures in Greenpoint/Williamsburg, was not publicly available at the time of this writing, my analysis is based on reviews of draft documents and interviews with key participants.[6]

The CEP was divided into two major tasks. The first task involved generating the EPA's hazardous air pollutant dispersion model entitled, Assessment System for Population Exposure Nationwide (ASPEN), and applying it at the census tract level in the neighborhood. The second task reviewed locally available data sources and included meetings with residents to determine the most prevalent and pressing community hazards. At least three incidents during deliberations between EPA technicians and community members highlight how local, non-expert data changed the conventional risk assessment process. First, the EPA considered data on exposures to indoor perchloroethylene inside homes after they learned from the Watchperson's Office, a community group, that hundreds of families lived above dry cleaning establishments. Dry cleaners are small pollution sources and generally not factored into EPA's human health exposure assessments. However, with knowledge of potential indoor exposures from dry cleaners, EPA was forced to consider incorporating these exposures into the assessment. Second, community-based organizations helped advise EPA over how to structure the process to best respond to community concerns. Through community meetings, local residents convinced the EPA study team to pay particular attention to lead-exposures, a health hazard not originally included in EPA's work plan. Third, after learning from the community that a large number of residents relied on a subsistence diet of fish caught in the East River, EPA relied on two community organizations, the Watchperson's Office and El Puente, to investigate and document these exposures. The community organizations sampled and interviewed anglers, estimated the number of fish being caught, and worked with EPA to estimate the total dietary toxic intake for local families.

Tapping Local Knowledge I: Air Modeling

While modeling is traditionally the domain of experts and the ASPEN was no different, at least two experiences suggest that because the investigation was open to cumulative exposures—not just assessing risks—local knowledge was incorporated into the normally expert-only process. The ASPEN model estimated the relative contributions of 148 air toxins from different types of emissions sources, including mobile sources, stationary sources, and area sources (US EPA 2000). The data were aggregated by census tract and the findings suggested that mobile and area sources, not industrial (as measured by TRI facilities) were the most significant source of air toxins in the community. Most significantly, according to the EPA officials who conducted the modeling, G/W residents are exposed to HAPs over two-and-a-half times more than the national average and over half of their exposures can be directly attributable to mobile sources. According to Fred Talcott of EPA, "Over half of the toxicity weighted air concentrations come from mobile sources and about a third come from so-called area sources" (Talcott 2000). Some of the modeling judgments were significantly shaped during community dialogues with the EPA experts.

A GIS project run by the Watchperson's Office turned out to add crucial data for the EPA project. The Watchperson's Office had developed a data set that matched traditional emission information, such as the TRI, with a map of each land parcel in the neighborhood. The land parcel data set was obtained from the NYC Department of Finance and included data on every lot in NYC, often dividing each city block into 30 unique lots. The Watchperson's Office decided to develop this database because the housing density and mixed-use character of the neighborhood meant that land uses change dramatically from block-to-block and even along individual blocks. According to Robert Lewis, Director of the Watchperson's Office GIS project, "to capture data only by census tract or block

[5] This was according to Fred Talcot, US EPA Project Director of the Williamsburg CEP. Interview, February 1, 2000. According to Talcott: "It also seemed like a place where we might expect high levels of toxic exposure, partly because it is so densely populated, there is a lot of ground transportation, and it has more than its fair share of industrial facilities in and nearby it."

[6] Since the document was undergoing review, EPA would not release the final draft to this author. Thus, I reconstruct the events from draft documents and interviews with the following participants: Fred Talcott, US EPA, Project Director; Melanie Melinda Ortiz, US EPA Project Community Liaison Officer; Samara Swanson, Director Watchperson's Office; Robert Lewis, Watchperson's Office GIS Project Director; Analia Penchasadah, Director of Environmental Programs, El Puente; Eva Hanhart, Director, Environmental Benefits Program, NYCDEP; Joe Ketas, Assistant Commissioner, NYCDEP; Daniel Kass, Director, Hunter College Center for Occupational and Environmental Health.

group averages-out significant localized emissions. A data-set that aggregated by census-tract or even block would miss important distinctions between city blocks and even within one block" (Lewis 2000). The Watchperson's Office mapped 15,167 distinct land parcels in the community.

The Watchperson's Office used this parcel-level map and overlaid a city DEP database, similar to the TRI, called BARAMIS. The BARAMIS data set tracks the same data as the TRI plus over 100 additional chemicals and thousands more facilities, from boilers and small incinerators in apartment buildings to artist paint shops. The BARAMIS data set included 3,869 records for properties in G/W while the TRI less than fifty.

The CEP was initially geared toward modeling at the census-tract level, a significant fine-tuning compared to prior EPA models. However, after learning of the BARAMIS data set aggregated by the Watchperson's Office, EPA realized that their ASPEN census tract-level data could only capture "a broad picture of exposures." According to one EPA scientist, the agency struggled with how to treat the local data in their model:

> We struggled for a long time considering the community group's data set. We tweaked the model some but we just couldn't aggregate at that small a level without loosing accuracy in the dispersion model. What we did do, however, was take the area sources we could get enough data for, plot them, and model them as point sources. The final aggregation is still the census tract.[7]

Thus, while the Watchperson's Office data didn't completely alter the ASPEN model, it was considered and forced EPA to re-think their original assumptions.

Another set of data collected by the Watchperson's Office also influenced the EPA modelers. One project run by the community group was to track, map and follow-up on community complaints of air, noise, or odor pollution registered by the city DEP. When the community group started visiting sites in the neighborhood where they had mapped a large number of air and odor complaints, they discovered that a large number of complaints were from residents living in buildings with dry-cleaning establishments on the ground floor. The Watchperson's Office organized high school students to walk the neighborhood and document the location of all the dry-cleaning establishments and the type of buildings where they were located. The group checked the survey data with the parcel-level database from the Department of Finance and confirmed that over fifty dry cleaners in the neighborhood were located in residential or mixed-use buildings.

The complaints data and dry-cleaning establishment survey raised a particular concern to EPA. The EPA was aware of a recent study that found concentrations of Perchloroethylene (perc) inside apartments, at up to three floors above a dry cleaner in the same building, averaging 150 ppm (NYC DOH 1997). Yet, the EPA ASPEN model estimated the expected outdoor concentration of perc at less than 2 ppb, with a maximum-modeled census tract outdoor concentration of 39 ppb. According to Talcott of the EPA:

> The average concentration found in apartments above dry cleaning establishments was on the order of 1000 times higher than the outdoor concentration of "Perc" as predicted by the ASPEN model in G/W. That to me is an illustration of a micro-level problem that would be completely obscured if you only looked at daily walking around concentration. Without the community group data set, we would have missed this (Talcott 2000).

EPA considered running a separate exposure model for this exposed sub-population, but eventually decided to only document the findings in the CEP report. Nonetheless, the fact that EPA considered the dry-cleaning establishment data generated by the community represented a significant change from the traditional expert-driven assessment process.

The deliberations between the EPA and community members reflected, to some environmental activists, a new commitment by EPA scientists and technicians to meaningfully engage local knowledge. According to Samara Swanston, director of the Watchperson's Project:

> The EPA was very open to information that only people from the neighborhood could know. The scientists realized early on that if a community exposure assessment was going to be at all relevant, they better understand local realities. The dry cleaners were something you couldn't know from a database, any database. You'd have to walk around the neighborhood to know that they are located in residential buildings. That's what we did in our survey and they listened to us (Swanston 2000).

The EPA modeling team acknowledged that lived experience is an important factor in understanding exposures and acquiesced to local, non-experts, for this knowledge. The traditional assessment would likely have missed or ignored these data, but because EPA was open to multiple pathways and sources, local realities were acknowledged to some extent in the assessment. Community-generated data, specifically the Watchperson's GIS data and the survey of dry-cleaning establishments, forced EPA to rethink their initial assumptions and set the stage for local knowledge to begin to drive the assessment process.

[7] EPA official, interviewed on condition of anonymity, February 1, 2000.

Tapping Local Knowledge II: The Community Advisory Committee and Lead

In order to establish a working relationship with the community, the EPA established a Citizens Advisory Committee (CAC) consisting of area residents and community-based organizations. One of the most pressing public health concerns for residents was lead poisoning, especially in children. Many residents involved in the EPA project were also aware of the NYC Department of Transportation (DOT) Williamsburg Bridge repainting project. In preparation for bridge repainting, the DOT sandblasted old paint off the bridge without using any screens to capture the blasted paint. The lead-based paint chips fell unobstructed into the community leading many residents to accuse the DOT of causing elevated blood-lead levels in neighborhood children. This event and a history of neighborhood children having elevated blood-lead levels led residents to ask EPA to place a special emphasis on lead exposures in the CEP.

Paying special attention to lead was not part of the original EPA CEP work plan. Lead was a constituent of the air toxics model, but it was not planned as a separate study. According to Talcott, of the EPA, "We heard over and over that lead was a contaminant of concern. We couldn't ignore this" (Talcott 2000). The EPA was aided by a NYC DOH study, which sampled over 1,000 children's blood for lead soon after the Williamsburg Bridge situation. The DOH study revealed that the average blood-lead levels in children under 10 in Health District 30 (Williamsburg) was 6.8 μg/dL (NYC DOT 1998). While this was not cause for immediate concern, residents still felt that special attention should be paid to lead exposures. EPA responded to these concerns with a special section in their analysis on cumulative lead exposures.

The EPA analysis modeled indoor, outdoor and workplace lead exposures in their assessment. According to Talcott, this type of cumulative measurement did not fit easily into established EPA models, but by combining standard models with local blood-lead level measurements: "We were able to get a better sense, through our modeling, of the overall lead exposure picture in G/W. As far as we know, this had never been modeled in this way before and the only reason we tried it was the constant requests from residents" (Talcott 2000). EPA responded to a specific concern in the community that lead was a significant source of disease. The CEP allowed community concerns to shape a special study in the assessment project while a traditional risk assessment would most likely not have responded to these local community concerns.

Tapping Local Knowledge III: Subsistence Diet Analysis

A third aspect of the CEP that represented a significant change from the discourse of traditional risk assessment was it's consideration of toxic food exposures. In particular, EPA discovered through community meetings that the large immigrant and Latino population of G/W were eating fish out of the East River. Driven in part by poverty and cultural practices, many G/W residents were suspected of living off a subsistence diet of East River fish. The EPA recognized that this presented a significant toxicity exposure pathway but one for which they had no data. Two community groups, the Watchperson's Office and El Puente, approached EPA and proposed to survey and interview residents to identify approximately how many people were eating fish out of the river, how much they were regularly consuming and the type of fish they were eating.

The community groups, with the help of EPA, designed a survey and questionnaire and took a stratified random sample of the population. They characterized fish intake by age and ethnic group. The community groups spent over six months at the neighborhood docks interviewing anglers, gathering data on their family's total fish intake. According to Fred Talcott of EPA:

> After we learned from residents that they were eating fish from the East River, we had no choice but to let the community groups gather the data. For a number of reasons, including language and cultural barriers and potential trust issues, we felt the local people could best gather this data. This was one situation where residents raised an issue we hadn't considered, defined the extent of the problem, and provided the data for analysis (Talcott 2000).

In this instance, EPA handed over the exposure assessment process to local people— from the characterization of the hazard, the population at risk, and the gathering of data. This aspect of the CEP represented a significant change from the traditional expert-dominated risk characterization discourse. The community members and organizations were the only "experts" to completely understand and characterize exposures from fish consumption. The EPA scientists took the community gathered data and estimated toxicity values for the different types of fish and extrapolated annual toxicity intake for residents based on their consumption.

Perhaps most importantly, a lack of data did not lead to an assumption of an absence of risk. The traditional expert-driven risk assessment process often rewards ignorance by assigning zero risk where little or nothing is known (Graham and Wiener 1995). The CEP's reliance on local-data was very much in line with the environmental justice principle of not treating ethnic groups like the “average exposed person” when no information is available. A special effort was made by local people to gather exposure data, which then enabled the characterization of food exposures specific to ethnicity where, in the absence of such data, this most likely would have been ignored.

These three examples reveal how a community cumulative exposure assessment process can differ from the traditional risk assessment process. Additionally, the CEP revealed how many of the environmental justice critiques of conventional risk assessment can be addressed. However, a shift from risk to exposure assessment does not produce these outcomes on their own. A commitment from regulators to open up public discourse, to consider local knowledge and well-organized community organizations all contributed to the shift in the hazard characterization discourse.

Conclusions

The shortcomings of traditional quantitative risk assessment, as applied to people of color and low-income populations, are many, and its usefulness in advancing the goals of environmental justice is uncertain. Nonetheless, risk assessment in some form or another is here to stay and, in light of recent regulatory reform efforts and new guidance documents, likely to increase in use. Additionally, risk assessment may provide a systematic, accountable method for evaluating risks, highlighting areas of uncertainty and data gaps, and yielding some evidence of the probability of harm. This paper has shown how a shift from traditional, expert-driven risk assessment toward community cumulative exposure assessment might move the process more toward the goals of environmental justice.

Reacting in part to the critique that risk assessments have become so disassociated from on-the-ground realities, EPA and other governmental bodies have recommended a risk-characterization process that includes cumulative hazards and more meaningful public discourse. Yet, environmental justice is about both distributive and procedural fairness. How questions about risk are decided are often as important as what is decided. Quantitative hazard assessments, whether for risks or exposures, is a highly specialized decision-making tool that few can fully understand. To prepare, no less critique, these assessments takes a sophisticated understanding of complex issues of animal and human toxicology, physiology, epidemiology, mathematical models, exposure measurements, and statistical probabilities. An over-reliance on quantitative risk assessment has resulted in less democratic and more oligarchic environmental policy—it legitimizes policy decisions driven by a few experts. A decision-making process that decides whether something is a problem or not through sophisticated, inaccessible techniques is likely to further alienate groups that have tended to feel left out and cut off from the political process. By acknowledging that local, non-expert knowledge can both improve the hazard assessment process and democratize the process, the EPA’s CEP in Brooklyn may offer an alternative approach for environmental managers.

Of all the challenges to risk assessment, the hidden distributive assumptions that accompany expert-dominated analyses may be the most antithetical to environmental justice. When scientists and technicians claim that their analysis is detached, dispassionate and disinterested, justice is further hindered in the eyes of activists. As local residents, their knowledge and life experiences are meaningfully incorporated into the assessment process and when these same populations have a chance to frame the hazard characterization discourse, environmental justice may be possible. Cumulative exposure assessment appears to be a shift in the right direction—away from the weaknesses of traditional risk assessment and towards a more democratically deliberative hazard characterization process.

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