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Analytical Methods for Assessing the Environmental Justice Implications of Environmental Regulations: Seminar Summary Report

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List of Abbreviations and Acronyms

Abbreviation	Description
BART	Bay Area Rapid Transit
BCA	Benefit-Cost Analysis
CAA	Clean Air Act
C-FERST	Community-Focused Exposure and Risk Screening Tool
DOT	Department of Transportation
ECHO	Enforcement and Compliance History Online
EJ	Environmental Justice
EJSEAT	EJ Strategic Enforcement Assessment Tool
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
HUD	Housing and Urban Development
IEUBK	Integrated Exposure Uptake Biokinetic
IGEMS	Internet Geographical Exposure Modeling System
NAAQS	National Ambient Air Quality Standards
NATA	National-Scale Air Toxics Assessment
NEPA	National Environmental Policy Act
NHANES	National Health and Nutrition Examination Survey
NPL	National Priorities List
OAQPS	Office of Air Quality Planning and Standards
OAR	Office of Air and Radiation
OCSPP	Office of Chemical Safety and Pollution Prevention
OECA	Office of Enforcement and Compliance Assurance
OPEI	Office of Policy, Economics, and Innovation
OPPT	Office of Pollution Prevention and Toxics
OSWER	Office of Solid Waste and Emergency Response
RCRA	Resource Conservation and Recovery Act
RIA	Regulatory Impact Analysis
RSEI	Risk-Screening Environmental Indicators
SIP	State Implementation Plan
SWF	Social Welfare Function
TRI	Toxics Release Inventory
TSCA	Toxic Substance Control Act
VSL	Value of Statistical Life

Executive Summary

While tools used for conducting an efficiency analysis of environmental regulations are rigorous and well understood among economists, those for carrying out an equity analysis are not as well developed. The US EPA has committed to incorporating environmental justice (EJ) analyses into Agency decision making processes. There is thus a strong need to devise appropriate analytical tools to conduct an analysis of the equity, or EJ, implications of regulatory activities.

The purpose of this workshop was to gather a small group of economists, regulatory experts, and EJ community leaders to discuss methods for incorporating EJ analyses into EPA's regulatory process. Each session of the workshop consisted of an overview of EJ activities within an EPA program (e.g., Air, Water, Solid Waste, etc.) and a technical presentation on an EJ methodology appropriate to that program, followed by an evaluation of that methodology. Each session concluded with a moderated open discussion of the technical details of the methodology presented, appropriate uses, data needs, analytical requirements, and merits and limitations. The workshop also included a panel discussion with EJ community leaders in which they outlined the types of questions they would like to see addressed by the EJ analyses.

The workshop began with opening remarks by Lisa Heinzerling, the Associate Administrator of EPA's Office of Policy, Economics and Innovation, highlighting the importance of EJ and the challenge of addressing it in EPA's rulemaking activities. Addressing EJ concerns has officially been required of federal agencies since 1994 (i.e., Executive Order 12898), but has for the most part been handled relatively superficially with boilerplate language. Addressing EJ concerns in broad national level rulemaking is particularly challenging, because EJ concerns developed historically from site-specific decisions and analyses of impacts on nearby communities. Nevertheless, EPA is committed to change along three fronts: substantive changes in the rules being adopted to address EJ concerns, procedural changes that allow greater participation by EJ communities, and institutional changes to ensure that EJ concerns are incorporated into all stages of the rulemaking process.

Session 1 of the workshop provided a broad overview of the evidence for EJ concerns and the issues and challenges facing EJ analysts, and explored how EJ might be incorporated into benefit-cost analyses. The overview (by Manuel Pastor) presented both quantitative analyses and graphs that showed associations between vulnerable communities (poor, minority, linguistically isolated, rapidly transitioning demographics) and greater exposure to environmental hazards. In the discussion of how EJ concerns might be incorporated into benefit-cost analyses, the participants discussed the social welfare function (SWF), which provides a theoretical framework for asking how society might choose between different distributions of environmental quality, with differences in both inequality and overall levels. Although the technical issues concerning such social decisions can be quite complex, a useful analogy is a "leaky bucket," and we can ask, at what level of leakage (costs of redistribution) would society decide that an improvement in equality is no longer worth pursuing? Answering this question is difficult, but "social weights" of some sort applied to a SWF might be used to incorporate EJ concerns into the standard benefit-cost analysis (BCA). Focus group research suggests that it may be possible to develop valuations of distributional outcomes, but we are just at the beginning stages of such development to derive valuations for actual decision-making.

Sessions 2 through 5 of the workshop addressed approaches for EJ analyses of rulemakings for different media or EPA programs: water, air, waste, and toxics. The EPA participants charged with providing an

Agency perspective on EJ concerns noted that their respective offices are committed to incorporating EJ analysis, but that there is considerable uncertainty about what that analysis should include, so better guidelines are needed. Without guidelines, different teams, even within the same office, may devote very different resources to EJ analysis, follow different approaches, and sometimes rely on the earlier boilerplate EJ language.

Researchers presented and discussed papers covering a range of EJ analyses of environmental hazards. Some of these were proximity-based analyses, focusing on the characteristics of the populations living near hazards, to see if vulnerable populations were disproportionately exposed to hazards, but without an explicit model of how people were exposed. Others were exposure and health risk analyses. The paper on air pollution, for example, presented an exposure-based analysis using a GIS-based model for air pollution benefits analysis to estimate population exposures to air pollutants by EJ groups. The analysis of lead dust exposures incorporated a model of the effects of lead exposures on cognition.

The open discussions following the presentations yielded several useful observations. It was noted that it may not be appropriate to extend the exposure modeling to modeling personal exposures, since people taking "averting actions" to avoid exposure (e.g., staying indoors or using filtered air or water) would not count as "exposed" but would nevertheless have had the costs of the potential for exposure imposed upon them. It was also noted that bioaccumulative hazards, interactions among multiple chemical exposures, and/or variations in dose-response relationships across EJ groups will complicate many EJ analyses. For many hazards, the existing data and exposure modeling tools are insufficient to carry out a quantitative EJ analysis of exposures, so proximity-based tools will continue to be used, and in many cases provide reasonable identification of differences in exposures across groups; however, improvements in data and models would be helpful.

The importance of developing EJ screening tools that can help identify EJ concerns early in the rulemaking process was also noted, both to allocate more resources to EJ analyses for those rules and to assess whether some modification of the rule or its options is warranted on the basis of EJ concerns. Combining demographic information on vulnerable populations with data on exposures to a range of environmental hazards, these tools could help to identify "hotspots" – areas with both high hazard levels and vulnerable populations. Some of these tools might therefore be more generally applicable in benefits analyses. The EJ Strategic Enforcement Assessment Tool (EJSEAT) developed by Office of Enforcement and Compliance Assurance (OECA) provided an example of such a screening tool with national coverage; in Session 1 Manuel Pastor showed a more detailed screening tool covering one city. It was noted that, because of the level of detail required, these tools may be most applicable to rules or activities whose effects are relatively localized, to see if the affected location is a vulnerable one (an EJ hotspot). For national rules, tools such as the Environmental Benefits Mapping and Analysis Program (BenMAP), which focus on a particular pollutant, could assess how the aggregate impacts of a rule would affect people from different vulnerable groups. These tools could also be made available to EJ communities to help them participate in the process.

The participation by EJ community leaders, both in their panel discussion and in their comments on other sessions, contributed an important perspective. The EJ community leaders suggested that EJ considerations should be included in the rulemaking process, rather than being "tacked on" at the end. They noted too that involvement of EJ communities in the rulemaking process has implications for EJ analyses. Adopting quantitative EJ analyses that are too complex to be understood by non-experts, for example, will tend to discourage participation of EJ communities in the rulemaking process and reduce

their acceptance of analysis results. The EJ community leaders also noted that EJ concerns arise from exposures to multiple environmental hazards (in conjunction with other disadvantages) over a long period of time, so incorporating EJ concerns into a rulemaking on a particular hazard may require addressing exposures to other hazards and other sources of vulnerability.

Session 6 of the workshop discussed the importance of addressing EJ concerns when implementing EPA regulations. It was noted that concerns about implementation are increased by the federalism of the U.S. regulatory system, since most rules are set at the federal level but implementation and enforcement typically take place at the state or local level. This could in theory improve responsiveness to EJ concerns, with decisions happening closer to local communities; in practice, however, it may frustrate EJ concerns if local decision makers are not responsive to the concerns of EJ communities. In the open discussion following the presentation in this session, ways in which the Federal EPA could play a greater role in encouraging and/or mandating greater responsiveness to EJ concerns by state regulators were discussed. It was suggested that creative implementation of rules could help address long-standing EJ concerns -- for example, firms seeking to locate new emissions sources within non-attainment counties could be required to buy all their offsets from existing sources in EJ communities, thus ensuring gradual reductions in emissions at EJ hotspots. In this way, the rulemaking process could incorporate considerations of implementation into the rule's design, helping ensure that EJ concerns are addressed in ways that are both substantive and procedural.

The workshop concluded that, moving forward, a combination of clearer definitions and guidelines for EJ analyses and "demonstration" examples would make it easier to ensure consistency across rule-writers in the types of EJ analyses being applied to final rules. Development of better EJ screening methods would allow better targeting of analytical effort to rules that raise particular EJ concerns, and doing this earlier in the rulemaking process to influence options and rule selection would be advisable. While various EJ analysis methods were discussed during the workshop, data challenges and model choice issues were identified. Creative application of EJ concerns to new rulemaking could help reduce the existing burden of exposures faced by some EJ communities. The participants in the workshop agreed that these are important issues to be considered in the rulemaking process.

1. Summary of the Workshop Sessions

1.1. Opening Session by Lisa Heinzerling

Lisa Heinzerling, the Associate Administrator of EPA's Office of Policy, Economics and Innovation, opened the workshop by noting that environmental justice is one of Administrator Lisa Jackson's top priorities and that she intends to incorporate it into every step of the rulemaking process. She mentioned two challenges facing EJ analysis. First, EJ arose from a concern about site-specific decisions, specifically the siting of a hazardous waste facility in NC. This presents a challenge for extending EJ analytical methods to national-level rules. Second, although federal agencies have been required to address EJ concerns since 1994 (E.O. 12898), this has, for the most part, been done relatively superficially, with boilerplate language ("everyone benefits from this rule, so there cannot be any EJ problem"). The challenge is to change the expectations of rule-makers and get them to incorporate EJ concerns at all stages of the decision-making process. In addition, EJ advocates have high expectations, which generates pressure on EPA to make progress quickly.

Associate Administrator Heinzerling identified three types of changes to be incorporated in EPA's rulemaking:

1. *Substantive.* EJ concerns may affect the rules that have been adopted. For example, in the NO_X National Ambient Air Quality Standards (NAAQS) Regulatory Impact Analysis (RIA), there were EJ concerns about the impact of the rule on particular communities. It was decided to "set aside" 40 of the air monitoring stations to be placed in the EJ communities of critical importance. However, in general it may be challenging to incorporate EJ concerns in a national rulemaking process for a specific pollutant, especially given the holistic, community-focused approach that generally characterizes EJ concerns.

2. *Procedural.* EPA is committed to improving transparency and collaboration in the rulemaking process to encourage greater participation by EJ communities and outside experts. For example, EPA has developed a portal – the EPA Rulemaking Gateway – where anyone can look up the status of various rules (starting from the proposal stage).[1] This will allow "outsiders" to see what rules are upcoming, and identify whether they have EJ implications, before the rules reach the final comment stage.

3. *Institutional.* EPA is in the process of revising the guidance for rule development in the agency. This will require that EJ questions be asked at the various stages of the rule making (initiation, option selection, and final agency review). This may sound bureaucratic, but the effect will be to make EJ considerations pervasive in the agency. Every office will need EJ experts, and they will become accustomed to incorporating EJ concerns in all their processes. This will serve to make the changes durable within the institution. A useful example is National Environmental Policy Act (NEPA) which requires environmental impact statements. To comply with NEPA, federal agencies hired environmental experts and considered the environmental effects of their decisions during their planning processes, and this has had a major impact.

[1] http://yosemite.epa.gov/opei/RuleGate.nsf/

Associate Administrator Heinzerling asserted that EPA is committed to taking action on EJ concerns. There is a need for more analytical help, she noted, to examine whether economic analysis (which is as important as ever) is adequately taking equity concerns into account. She said she is eager to get started.

1.1.1. Questions to Lisa Heinzerling and Answers:

Q1: Through interactions at your level, have you seen evidence that other agencies are focusing on EJ concerns?

Lisa: Not specifically – There have been lots of interagency projects, but none of them focus on EJ, although some address EJ issues. [Charles Lee: Department of Transportation (DOT) does have an EJ policy, and even revoked a $50 million grant to bay area rapid transit (BART) for lack of an appropriate EJ analysis.]

Q2: Has the new Rulemaking Gateway been successful in collecting more comments from a wider range of participants?

Lisa: They do not have any data on that yet. They are trying to measure its impact on comments received. Currently the comments they get are very predictable - industry wants weaker standards, environmental groups want stricter standards, and few others respond. EPA hopes that the Gateway will expand the diversity of comments they receive during the rulemaking process.

Q3: Are there intra-agency definitions of EJ?

Lisa: There has been a general discussion of how to define EJ, but there is no consistency across (or even within) agencies.

1.2. Session 1: Environmental Justice and Equity

1.2.1. Al McGartland

Dr. McGartland observed that the current situation with EJ analysis is similar to the situation with BCA when it was first introduced in rulemaking. EPA has become familiar with BCA, and uses it extensively in RIAs. An EJ analysis presents its own complications, he noted, but we have better data and better tools for measuring environmental impacts, and a substantial EJ literature to work with. Therefore he expressed cautious optimism. He noted that it may be desirable to think about how to best leverage methods developed for BCA for EJ analyses. He added that it is worthwhile to think about ways of incorporating EJ analyses into the existing BCA framework (or at least to try not to depart from it too much).

1.2.2. Manuel Pastor

Dr. Pastor noted that there is not much doubt that poor and minority communities face disproportionately greater risks along many dimensions, but there is some doubt about the cause(s). Explanations include clustered land uses, markets for labor and housing, and the effects of politics and power on facility location. Dr. Pastor is currently working on a more nuanced view of EJ for a project in the San Francisco Bay area, considering factors including linguistic ability and political power, and using a combination of

maps, regressions, and spatial autocorrelations. He noted that properly accounting for distance is important, since facilities are often sited on Census boundaries and affect neighboring blocks. He found major effects for being linguistically isolated as well as "ethnic churning" (rapid demographic transition, which could weaken social cohesion).

Dr. Pastor emphasized that definitions of EJ communities should go beyond residential location to include school, hospital, and work exposures, and should consider all hazards faced by the community – i.e., we should focus on the analysis of the cumulative risks faced by communities. He presented his new method, environmental justice screening method, where he used block-level data weighted by exposure, aggregated up to the Census tract level, and looked for the combination of high exposures and vulnerable populations. The results show the expected EJ communities (i.e., this is, in principle, a screening analysis for the San Francisco Bay area). Interestingly, the results also show locations where the community faces substantial cumulative risks, but has not yet organized to take action. He noted that the kind of analysis he undertook may be useful for encouraging those communities to organize to address EJ concerns.

Finally, Dr. Pastor observed that economists tend to focus on multiple regressions, looking at the impact of race or income "holding all else equal," but that may not be appropriate for an EJ analysis. People of color have disadvantages along many dimensions which can interact with each other, and a "causal" analysis that identifies income rather than race as the causal variable does not negate the disproportionate risks. Returning to the influence of political power, he suggested that the inequality of risks may reduce the pressure to clean up pollution if the risks do not affect those with political power.

1.2.3. Maureen Cropper

Dr. Cropper addressed the following question: Is it appropriate to include in a benefit-cost analysis individuals' willingness-to-pay for changes in the distribution of risks in a population? Her answer: Yes, if altruistic values are allowed in a benefit-cost analysis, and if people are paternalistically altruistic – i.e., if they value risk reductions for others rather than simply increases in others' utilities. Buying a protective device for somebody, rather than giving that person money (presumably to buy such a device), is an example of paternalistic altruism.

Dr. Cropper then described a focus group she conducted with Dr. Alan Krupnick to see if they could operationalize the process of eliciting values for changes in risk to others. This turned out to be tricky, especially communicating the difference between baseline risk and changes in risk due to a policy. She noted, however, that the focus group participants seemed to understand the questions and were generally more willing to contribute to reduce others' environmental risks than simply to provide money. This is just a first step, she said, but suggests this sort of analysis is possible. She identified a benefit-cost analysis of water quality improvements, which has some of the same aspects of evaluating a public good, as a likely candidate for incorporating this approach. Finally, she expressed the opinion that people should be asked to value the change in the overall distribution of risks, rather than valuing the change in a measure of the inequality of risk, because welfare depends on *absolute* risk levels in a population and inequality measures only describe the distribution of risks (or incomes) *relative* to the mean, so they cannot capture changes in overall welfare.

1.2.4. Matt Adler

Social welfare functions (SWF) provide a theoretical way of approaching social decision-making and can be connected to inequality measures. After reviewing different SWFs and their properties, Dr. Adler

discussed ways that the SWF approach could provide insights for practical applications. The utilitarian SWF is similar to the usual benefit-cost analysis approach of adding up everyone's benefits and costs, while an "equity regarding" SWF places greater weight on those who are worse off, tilting society's decisions in favor of more equitable results. Dr. Adler noted that implementing SWFs would require solving some difficult problems (e.g., deriving interpersonally comparable measures of individual utility, using lifetime utility vs. slices of time, and dealing with uncertainty in policy outcomes). He suggested that a less demanding approach may be to normalize by income, after setting non-income attributes at a specific level. (Basically, this would mean putting normalized incomes into the income-utility function.)

He proposed a "leaky bucket" analogy – moving dollars from rich to poor could be worth doing, even if some are lost in the transfer. A measure of society's preferences for equality is how much leakage has to happen before the transfer is undesirable. He noted that inequality metrics can be used to decompose the SWF into two pieces, one for the total utility and the other for the inequality component, which is similar to doing benefit-cost analysis with distributional weights. We could use the leaky budget example to identify the strength of people's preferences for equality, and use those preferences to develop the appropriate distributional weights.

1.2.5. Open Discussion

The open discussion among workshop participants focused on both of the approaches described by Drs. Cropper and Adler, as well as the interface between analysis approaches and EJ communities. Below is a synopsis of the thread of the conversation:

Inequality analysis could be done on survival rates, perhaps decomposing them into the mean survival rate times an inequality measure (e.g., Atkinson index), avoiding the need to assign dollar values to risks, and focusing on tradeoffs between mean risk reduction and improvements in risk equality. The SWF approach suggests that we should also consider inequality in individual exposures within groups as well as between groups.

However, given the fact that some population groups face not only multiple survival risks but also poorer quality of life in general, a more holistic/integrated approach would be to work in the space of individual utilities rather than individual attributes. The SWF approach allows balancing equality and overall change brought about by various policy options, without the need for gathering paternally altruistic WTPs for inclusion in benefit-cost analysis. Nevertheless, eliciting paternally altruistic WTPs may be a more practical approach for including equity considerations in benefit-cost analysis.

The focus on SWFs could address EJ concerns with distributive justice (by defining an appropriate inequality metric, but would not address procedural justice. In fact, the more sophisticated models preferred by academics may be incomprehensible to EJ community groups, and could raise concerns that the experts are trying to "cover up" the true situation with fancy techniques. There is thus a tradeoff researchers should be aware of between (analysis) complexity and communication. It was also noted that an aspect of procedural justice could be captured by multiple regressions in a retrospective analysis (asking, e.g., whether minorities have been exposed to greater risks than others, even after controlling for lower income or less political clout).

EJ methodologies were originally developed to address site-specific issues, which may be difficult to connect to national rulemaking, and concerned with group and community actions, rather than summing up individual utilities. On the other hand, the EPA Office of Environmental Justice was originally called

the "environmental equity" office, and changing the name did not change what they did. There is also the possibility that experts should be trying to change society's valuation of equity issues by providing EJ information in a way that community leaders can use to raise awareness of EJ issues.

1.3. Session 2: Methods for Analyzing Environmental Justice for Disperse Pollutants: Application to Water

1.3.1. Kelly Maguire

Dr. Maguire introduced this session, the first of the four sessions looking at different EJ methodologies and their connections to particular media or EPA programs. She is co-chairing an EPA workgroup charged with developing technical guidance on how to conduct EJ analyses, for which these topics are quite relevant.

1.3.2. William Swietlik

Mr. Swietlik gave an overview of EJ activities in EPA's Office of Water and office's perspective on the challenges they face in incorporating EJ concerns in their rulemaking process. Most major rulemaking in the past, he said, did not pay much attention to EJ issues, but they do more now. A review of the EJ sections in past rulemaking efforts finds a wide range of approaches, from qualitative statements to site-specific analysis using EJ indices. The Office of Water's current action plan includes two programs with major EJ components – "water safe to drink" and "fish and shellfish safe to eat" – and they are doing EJ analysis for all priority actions. They need data for this analysis, he noted, including data on plant location, hydrology, drinking water sources, and subsistence fishing, as well as demographic data. Finally, he noted that they also need a better screening methodology to determine where EJ analysis is needed, better guidance on EJ analysis to ensure that different teams apply similar standards, and guidance on what constitutes "disproportionate impact," the appropriate scope of the community, and how extensive an EJ analysis is needed in different settings.

1.3.3. Spencer Banzhaf

Like some other speakers, Dr. Banzhaf noted that the history of EJ analysis started in specific sites, often connected with hazardous waste, with a second wave connected with toxics release inventory (TRI) facilities. EPA's response has also been site-specific, related to brownfields and permitting. It is less clear, he observed, how to address EJ issues for diffuse pollutants such as pollutants in water.

He noted that the traditional approach to EJ analysis is to define a "community" around a "site" and a "reference community" and look at the groups who live in each. He expressed his sense that EJ analysis at EPA is mostly focused on this approach of examining sites and communities, and that it typically offers "negative assurance" – i.e., it is more likely to assert that there is no reason to think a policy will harm EJ communities disproportionately, rather than trying to craft policies to positively benefit EJ communities.

Instead, he suggested, for diffuse pollutants it makes sense to start with the groups of interest and look at the effect of a regulatory action on them, regardless of where they may live – i.e., to reverse the categories. Essentially, then, EJ analysis becomes a special case of distributional analysis. That is, in addition to computing the aggregate benefits and costs of an action, RIAs should compute the benefits and costs of the action for specific demographic groups. While the importance of adopting this approach

is most obvious for dispersed pollutants, he noted, it is applicable to the environmental justice considerations in any RIA.

Dr. Banzhaf then asked: If EPA sought to positively promote equity through EJ activity, what would it be promoting equity of? One could use policy to try to equalize cancer risk from arsenic, for example, or total environmental risks, or overall well-being. Dr. Banzhaf expressed his preference for the latter approach, which suggests the possibility of using environmental policy to improve the relative position of EJ communities (noting that such a policy would not necessarily be "equitable" in isolation, since it gives preference to the EJ community, but could still be equitable in terms of overall well-being). He noted too that it is important in this process to think about the costs of a policy as well as its benefits, since costs can also disproportionately impact an EJ community. Also important are "general equilibrium" effects (e.g., environmental gentrification in an EJ community raising rents and forcing out current residents).

Dr. Banzhaf suggested that the best analysis would incorporate heterogeneity in willingness to pay (WTP) across groups as well as distributional effects. He observed that differences in WTP across groups could be offset (or more than offset) by using distributional weights or an inequality index to favor disadvantaged groups. This approach would be more flexible than simply imposing the same WTP.

Finally, he noted that even simple tabulations of the distributional effects of a rulemaking in a benefit-cost analysis may facilitate equity considerations and inform the policy makers about the existing tradeoffs.

1.3.4. Tauhidur Rahman

Dr. Rahman, who was asked to be a discussant for Dr. Banzhaf's paper, observed that while the paper does provide a way to think about incorporating distributional effects in RIA, the approach seems to be mostly theoretical, and may be intractable. Many of the potential costs and benefits are difficult to quantify, indirect effects such as market effects may be important, group-specific heterogeneity in responses would be difficult to measure, and non-use or existence values could complicate the process. The incorporation of the distributional objective into the efficiency objective of a benefit-cost analysis by using distributional weights on net benefits requires deciding on the appropriate distributional weights for different groups, which could be quite complicated. Moreover, he added, the proposed method may work for observable dispersed pollutants, but not for unobservable dispersed pollutants.

1.3.5. Open Discussion

The open discussion among workshop participants focused on differential values of statistical life as well as overall versus constrained optima in achieving environmental justice. Below is a synopsis of the thread of the conversation:

Several workshop participants commented on the political pitfalls associated with assigning different value of statistical life (VSL) to groups based on differences in willingness to pay (based on differences in income levels), however theoretically appealing the combination of heterogeneous VSLs and distributional weights might be, since any such attempt could easily be defeated by sound bites (e.g., "the lives of the rich are twice as important as the lives of the poor"). The data requirements would be high (even without different VSLs), but perhaps not much higher than doing a good benefit-cost analysis. The distributional EJ analysis suggested by Dr. Banzhaf needs to be supplemented with a procedural analysis that looks for possible failures of institutions to provide equal protection in EJ communities.

Some "theoretical" first-best analyses of policy changes assume that it would be possible to change the tax code to offset any adverse distributional effects of the policy, so that policy makers can focus on maximizing efficiency. However, since EPA does not have the power to change the tax code, it must make policy decisions in a "second-best" world, where it needs to consider distributional issues. This suggests that EPA could try to incorporate extra benefits for disadvantaged communities when making new rules, as partial compensation for their higher overall baseline risks. We should also be concerned about possible inequity in the implementation of regulations, although this could go both ways. One concern is that facilities in EJ communities might receive less enforcement activity, reducing the benefits of the regulation (so more enforcement would be better). Alternatively, if the cost of compliance differs greatly across facilities, it might be socially optimal to have incomplete implementation at high-cost facilities (i.e., the older facilities located in older industrial areas which are often near EJ communities). In the long run, we need to see whether there is any connection between EJ concerns and EPA's decisions – i.e., what difference does considering EJ make in the final rules being adopted?

There is a sense that examination of the distributional effects of a rule may not be equivalent to an EJ analysis. An EJ analysis is about multiple environmental risks that burden specific communities, whereas distributional analysis is about how (net) benefits of a certain rule are divided up across various socio-demographic groups. Can one inform the other? Also, if inequalities are detected in a distributional analysis, what kinds and/or magnitudes would imply disproportionate impact (i.e., injustice)?

1.4. Discussion with Panel of EJ Community Leaders

1.4.1. Mark Mitchell

Dr. Mitchell is the founder and president of the Connecticut Coalition for Environmental Justice. He noted that a map of Connecticut clearly shows a strong correlation between percent minority and numbers of air pollution sources. The EJ notion of "disproportionate impact" is clearly met in the aggregate, he said, but may be missed by regulators who treat each facility as a separate case or fail to recognize that EJ communities may be more susceptible because they are exposed to more pollutants or because of unique pathways (e.g., subsistence fishing). Dr. Mitchell highlighted the importance of multiple and cumulative exposures to environmental hazards, pointing to public health research on multiple stressors in the environment that make people in EJ communities disproportionately more vulnerable. He also noted the importance of institutional issues, such as the inability to participate in the decision making process or failure to coordinate across agencies (e.g., building a public school on top of a brownfield).

1.4.2. Jose Bravo

Jose Bravo, Executive Director for the Just Transition Alliance, noted that EJ communities are commonly defined by race and income but can also be affected by education and political clout. He observed that while economic analyses often focus on willingness to pay, EJ communities have been "paying" in terms of higher environmental risks for many years, and these higher risks have sometimes been driven by government decisions. Most EJ communities, he noted, have mixed (industrial + residential) zoning; in the case of San Diego, EJ groups were "encouraged" to live near jobs (i.e., in industrial areas) by city ordinances until the 1960s. Even recent decisions, he said, have shown adverse EJ consequences. He gave several examples: (1) California is moving from methyl bromide to methyl iodide to reduce greenhouse gas emissions, but this increases health risks for the farm workers who apply it. (2) A floor

stripper was given a "Green Seal" because less water was used in its production, despite higher risks for the cleaning people using it. (3) Lead-containing toys are banned in the mainstream stores and instead end up in dollar stores (more likely to be frequented by low income individuals). He suggested that rulemaking could help reverse this history of greater (legacy) risks in EJ communities. This is not just "NIMBY" ("not in my backyard"), he said; the idea is not to just push the risks to other areas, but to get them cleaned up everywhere.

1.4.3. Cecil Corbin-Mark

Mr. Corbin-Mark, Deputy Director of WE ACT, noted that his organization is concerned about several environmental issues, including global warming and the potential impacts on native populations (e.g., Alaska), cap-and-trade systems that allow higher emissions at high-cost plants, which tend to be older plants in EJ areas, and the longer term issue of avoiding the perpetuation of past pollution differentials due to the concentration of multiple polluters and pollutants in EJ areas. As others before him had observed, Mr. Corbin-Mark noted that benefit-cost analyses focus on effects of individual policies and ignores the cumulative and multiple-risk setting that is always been the basis for EJ concerns (the "hot spot" concept). EJ activists, he said, hope to influence policy in a way that stops "escalation of the ecological debt" – i.e., stops the "piling up" of the environmental stressors on specific communities. They recognize, however, that the EJ movement has to move out of the "local" and "site-specific" activities and start working at a broader level. There is also an idea, he said, that an arbiter for what happens in society should be the community rather than the individual.

1.4.4. Open Discussion

The open discussion among workshop participants focused on the tradeoffs EJ communities may face as well as the rulemakers' tradeoff between producing more rules versus addressing EJ concerns in every rule. Below is a synopsis of the thread of the conversation:

EJ communities are aware of the tradeoffs affecting them, but often they have not participated in the decision-making process, and the final outcomes often involve costs to EJ communities and benefits to others. They are also aware of the possibility of environmental gentrification - a proposed waterfront park in one community, for example, was opposed by an EJ community for that reason. Can we identify which rules raise particular EJ concerns with some type of screening analysis, given the large number of rules being proposed and the limited resources to process them? It might be possible to structure the communication – i.e., to develop a decision matrix to help with the planning and scoping of rules – to see which need EJ attention. However, this question raises the larger question of EPA's mission and priorities. Is it more important to produce many rules, or to address EJ concerns fully in every rule? Consideration also needs to be given to the time line and the resources that EJ communities need to participate in the regulatory process. Perhaps EPA should try to identify existing hotspots, based on cumulative exposures to multiple pollutants, and then put effort into cleaning up those areas. Workshop participants liked the idea of hotspot cleanup, since they do not want to simply shift pollution to other areas. In considering the benefits of jobs versus community health, health appeared to be the key concern. There is also an understanding that not every job is a good job. In fact, in many cases community was first and then came the industry. Some of these issues may be addressed through proper re-zoning.

1.5. Session 3: An Exposure and Health Risk Environmental Justice Analysis Method: Application to a National Air Quality Rule

1.5.1. Neal Fann

Dr. Fann leads the Office of Air and Radiation health benefits team and is the project manager for the Environmental Benefits Mapping and Analysis Program (BenMAP). He noted that EPA has had practice doing the aggregate analysis required in benefit-cost analysis, but less practice doing distributional analysis. He noted too that air rules cover a wide range of scales, from local or regional to national and that the air office's experience so far suggests that the resolution and scale of a distributional analysis can make a difference, but there is no clear sense as to what are the appropriate resolution and scale.

1.5.2. Tamara Saltman

Ms. Saltman, a policy analyst in the Office of Policy Analysis and Review (OPAR) in EPA's Office of Air and Radiation (OAR), noted that OAR is experimenting with different approaches to addressing EJ issues in rulemaking, that it is very much "a work in progress." OAR can see some communities facing problems, she said, but regulators have a limited toolset to work with, and air pollution comes from many different sources. Given that agency resources are limited, there is an interest in understanding how the existing tools can be used (perhaps, with modifications) to carry out distributional analyses. She noted that the Clean Air Act (CAA) emphasizes a national approach, with minimum standards for air quality to be met everywhere. OAR also deals with a range of different types of rules: standard-based vs. technology-based, sector-based vs. broad rules, rules targeting mobile vs. stationary sources, rules for new vs. existing sources. All of this, she said, implies varying degrees of relationships with the affected communities. EJ concerns could be helpful, she noted, in laying out the agenda, prioritizing rules based on their impact, encouraging multi-pollutant analyses, collecting data on affected communities, thinking about enforcement, and holding meetings with people from affected EJ communities. She identified the current basic concerns as a terminology gap, effective outreach to EJ communities, data for carrying out vulnerability analysis, and a lack of opportunities for the EJ communities to participate in the regulatory process.

1.5.3. Ellen Post

Dr. Post described an individual-based method that Abt Associates developed to carry out EJ analyses of national air rules using BenMap. BenMAP is the tool used by EPA's Office of Air Quality Planning and Standards (OAQPS) to carry out benefits analyses for NAAQS and other national and regional criteria air pollution rules and regulations. It combines data on ambient air pollution concentrations with Census data on location-specific populations, health impact functions, baseline mortality and morbidity incidence rates, and valuation of morbidity and mortality health endpoints to derive estimates of monetized health benefits. Dr. Post noted that an EJ analysis would use EJ group-specific inputs (e.g., EJ group-specific baseline incidence rates) where they are available. Baseline air quality (in the absence of a regulation) and control scenario air quality (in the presence of the regulation) are inputs to BenMAP. In benefit-cost analysis, BenMAP is typically run for the entire population. In the method Dr. Post described for EJ analysis, a BenMAP analysis is effectively carried out separately for each of the population sub-groups of interest. The results of the BenMap runs are then post-processed to derive, for each population sub-group of interest, distributions of individual-level air quality exposures in the baseline and in the control scenario, as well as distributions of air pollution-related health effects. These EJ group-specific distributions can then be compared.

Dr. Post also described how decomposable inequality indices (such as the Atkinson index) can be used to examine the extent to which an EJ factor (e.g., race or ethnicity) explains the inequality (e.g., in baseline exposures) observed across individuals, in the same way that an analysis of variance decomposes total variability into within-group versus between-group variability. She noted that inequality indices can be used to estimate whether an air pollution rule or regulation will increase or decrease the inequality in exposures and/or air pollution-related health effects across EJ groups. In a case study of the Heavy Duty Diesel Rule she presented, decompositions of inequality indices showed that most inequality in exposures to particulate matter air pollution in the US population is due to within-group rather then between-group heterogeneity in exposures.

Dr. Post noted some issues and challenges. She noted that the method she presented attempts to answer whether there are differences (e.g., in baseline exposures) among EJ groups, but not why there are differences. Perhaps the biggest challenge, she said, is that we cannot really get individual-specific exposures. The case study analysis, for example, used an air quality grid with 36 km x 36 km grid cells, which is much coarser than the usual definition of EJ communities. In contrast, she noted, a recent OAQPS analysis in Detroit used 1 km x 1 km grid cells, which may be too fine a resolution, since people move around rather than staying at their residence. She concluded that it is not clear what the optimal grid cell size is. A next step could be performing a comparative analysis with different air quality modeling resolutions, to determine how sensitive the results of the distributional analysis are to the chosen grid size. The grid structure in general could be problematic for mobile source rules, she said, since a grid would not adequately capture the higher air pollution levels near transportation corridors.

Finally, Dr. Post noted that there will always be some differences across groups. The relevant question, she said, is: Are observed differences between EJ groups *worthy of concern*? That is, we need to be able to decide which differences are large enough to be meaningful.

1.5.4. Chris Timmins

Dr. Timmins, who was asked to be a discussant for Dr. Post's paper, observed that BenMap is comprehensive and relatively easy to use, with the Census data providing highly detailed population information and allowing us to talk about the distribution of effects across population groups for different policy options. He noted, however, that it does not have a way to capture lifetime exposures and that we do not know where individuals spent their childhoods. He noted also that different groups have different degrees of mobility (for example, 80% of high school graduates are living in the same region where they grew up, but this is true of only 50% of college graduates).

He also brought up the broader question of people's locations representing optimizing behavior, and asked, what do people give up to live in a nicer area? While this is easier to think about when the effects do not include mortality, he observed, still we can think about hedonic valuation of non-market characteristics such as environmental quality, perhaps adding heterogeneity in WTP across groups, or inter-urban hedonics including wages and labor markets as well as housing markets, or equilibrium sorting models with endogenous prices. These are complicated models, he acknowledged, but non-optimizing models are equivalent to assuming that people do not know about - or do not value - pollution risks.

1.5.5. Open Discussion

The open discussion among workshop participants focused largely on one of the main challenges of the proposed method: estimating individual-level exposures. Below is a synopsis of the thread of the conversation:

It was noted that some of the challenges identified for the proposed EJ method using BenMAP are challenges for the broader benefit analysis method as well – most notably, air pollution benefit analyses estimate average ambient pollutant concentrations within each cell of a grid, and these average ambient pollutant concentrations get assigned to all individuals living within the grid cell. We do not know the true exposures for individuals, just the ambient air quality within grid cells, which may obscure intra-cell heterogeneity of exposures.

The possibility that averting behavior varies across populations, with more educated people presumably being more able to avoid pollution, was also noted. However, as noted above, the problem is that we do not know true exposures, just the ambient air quality. If different people spend different amounts of time outdoors, they could have different exposures, depending on their access to air conditioning.

It was also noted that, if we are going to apply an inequality metric in BenMap, it is important that it be decomposable, and that it be applied to the levels of pollution before and after the policy change (not just applied to the changes in pollution, which would ignore the differences in baseline exposures which are important in identifying inequities).

Workshop participants discussed whether we should consider differences across other groups, such as gender. It is possible with BenMap, but it would involve moving away from traditional EJ concerns, since gender is not a characteristic that is traditionally associated with environmental justice. It may be more important to provide information to EJ communities based on the groups with which they are already identified. One workshop participant suggested that EJ analysis at EPA is clearly focused on race, class, and power, although there can also be specific groups being defined for particular EJ issues (e.g., substance fishermen in South Florida).

1.6. Recap of Day 1 and Opening Remarks by Wayne Gray

Wayne Gray recapped the main themes that emerged during the first day of the seminar:

- EJ communities experience cumulative exposures to multiple environmental hazards, while the rulemaking process tends to focus on exposures to a single hazard in isolation.
- There seem to be a few different approaches that various EPA offices (or analysts within offices) take to analyze EJ issues.
- There is already a range of tools available (BenMAP, Manuel Pastor's environmental justice screening method, etc.) that can be successfully used for EJ/distributional analyses. There may be other tools that would need to be developed for other analytical contexts.
- There are procedural rulemaking issues: EJ communities for various reasons are unable to fully represent their interests. There is also a problem of clear communication of the modeling/analysis results to the wider public.

- There is a sense that, given the many rules EPA has to produce each year, there may be a need for a screening mechanism for the rules to identify the ones where EJ concerns may be the greatest. Rules with very large net benefits may fall into this category.
- There is a sense of optimism, however, because benefit-cost analysis, which once seemed impossible to do well, is now standard (although analyzing distributions may be somewhat harder).

1.7. Session 4: Proximity-Based Approaches to Analyzing Environmental Justice: Application to Waste

1.7.1. Mark Corrales

Mr. Mark Corrales, of EPA's Office of Policy, Economics and Innovation (OPEI), said that OPEI reviews all proposed rules, so they see a variety of EJ analysis methods early in the rulemaking process. Not many of the methods are quantitative, he noted, nor is it clear what constitutes a quantitative EJ analysis. A number of these rules, he said, come from EPA's Office of Solid Waste and Emergency Response (OSWER), and a lot of the analyses use proximity to hazard as a surrogate for risk in lieu of an exposure analysis using air quality or other modeling. Often enough, air quality modeling is not available and the question is whether proximity analyses may provide useful insights. Problems with modeling exposures, he noted, are not specific to EJ analysis.

Picking up on Manuel Pastor's talk, Mr. Corrales asked whether EJ analyses should focus on trying to explain inequalities (e.g., using multivariate regression) or just document them. A conceptual concern is whether the analysis should focus on the community or individual level. He asked whether EJ analysis should look at impacts (exposure) or also at (health) effects or overall well-being (mentioned by Dr. Banzhaf).

Finally, Mr. Corrales noted that there are at least a dozen upcoming rules with plans for quantitative EJ analysis, yet analysts are not clear about what exactly needs to be done.

1.7.2. Lyn Luben

Mr. Lyn Luben, of EPA's Office of Solid Waste and Emergency Response (OSWER) said that in OSWER they are looking for a measurable benefit to the life of impacted communities, and that they are seeking to incorporate EJ into all aspects of their rulemaking in a meaningful and understandable way, which requires life-cycle assessment. They have been tracking EJ since 1995, he said, and have seen four approaches: boilerplate text, text with speculation on EJ effects, analysis of community demographics, and analysis of community health risks. The only quantitative risk analysis they are aware of, he said, happened in 1992; it looked at the impact of wood treatment runoff on subsistence fishers. For upcoming rules, he noted, they will be using a variety of methods: looking at minority and low-income populations within 1-3 miles, calculating ratios between local and national population percentages (with 1.0 = no differential effect), and looking at other stressors of the community.

He cited several issues which make EJ analyses difficult: (1) there is no overall guidance, including definitions of key terms, e.g., "disproportionate impact" (in one rulemaking they said the impact was "disproportionate" but then realized they could not support the assertion without a definition),

"susceptible populations," "low income," and "proximity"; (2) issues of data availability and appropriate methods; and (3) the waste management hierarchy sometimes conflicts with EJ priorities.

1.7.3. Doug Noonan

Dr. Noonan reported on a literature review of 110 EJ studies, as well as their own analysis, that he and his co-authors conducted. He found that there is considerable "room for guidance" in the way EJ analyses are conducted, both in the scale (unit of analysis) and the scope (geographic study area) chosen for the study, as well as the measured outcome, which can be either discrete (site location) or continuous (emissions or ambient exposures). Typical scopes include national, state, and municipality; typical scales include block, block group, tract, zip code, or county. He reported that the recommendations in the literature are widely varying, as are the "intuitions" about how scale should matter for the results; when different scales are used within the same study, he noted, it often affects the results. Researchers have tried many combinations, he said; something is usually significant, but studies using finer scales tend to have more significant results.

Dr. Noonan reported that, for their own analysis, he and his co-authors looked at 1633 national priority list (NPL) sites, with the dependent variable being a binary variable for whether or not an areal unit has an NPL site. When using national data, he said, it is important to modify the definition of an "area of concern" to something like "an area that has at least 50% within 6 miles of a site," because otherwise the much larger block groups in the West skew the results. He reported that hedonic analysis helped them choose the 6 mile distance as providing the strongest results. In their analysis, the results varied considerably, he said, depending on the scale and the presence of control variables. They also identified issues with assuming linear effects, but while there was evidence of spatial dependence, it did not seem to greatly affect the results. He cited some underlying questions still remaining – for example, disproportionate impact "of what, on what?" The NPL rule did not cause the sites to exist, so it is not obvious how EJ considerations would affect the rulemaking. He noted that E.O. 12898 says that EJ analysis should not "artificially" dilute or inflate the effects, but with so much opportunity for choices to affect the results, and no benchmark for the "true" effects, these are difficult and important issues.

1.7.4. Hilary Sigman

Dr. Sigman, who was asked to be a discussant for Dr. Noonan's paper, observed that it is difficult to get standardized guidance on EJ analyses, given the number of different issues involved. She noted that there has been substantial technological progress over time in EJ analyses, so there may be some "vintage" effects in the range of studies being examined in Dr. Noonan's paper. Newer studies used faster computers, so they include better spatial analysis, more complex models, and better matching to Census data. She said that the scale of the analysis should depend on the rule being examined -- e.g., is it a case of direct contact, surface or groundwater, air pollutants, or urban blight? In addition, community boundaries can be an important part of the analysis, which suggests that Census units (which tend to follow neighborhood boundaries) are preferable to zip codes (which were designed for the convenience of mail delivery). If a larger area is needed for the analysis, Census tracts can be aggregated into larger units. She noted that we might expect smaller areas to give bigger point estimates and more statistical significance. Proximity-based measures are better than point locations, since polluting facilities are often located on or near boundaries.

Finally, she addressed the issue of causality. She suggested that the more sophisticated EJ models that include many controls and test for causality may not be the best choice for rulemaking. We want to give

as much scope as possible for the explanatory variables (race and income) to have an effect, she noted, thus parsimony of controls is essential. We also want the models to be understandable to those in EJ communities, so that they can fully participate in the rulemaking process, which may argue in favor of proximity analysis, which is simpler to explain. The problem, she added, is that peer review pushes researchers towards complicated and novel analyses.

1.7.5. Open Discussion

The open discussion among workshop participants focused on the location versus proximity measures as well as more general issues facing EJ analysis. Below is a synopsis of the thread of the conversation:

It is important to recognize the big variation in the size of Census units across the country, which makes a proximity measure (e.g., all Census block groups which have the majority of their land area within 5 miles of a hazard) better than a location measure (e.g., only those Census block groups which have a hazard within their boundaries) for a national analysis. In a remote rural area, with very large block groups, a location-based measure would count everyone in the block group as being exposed to a hazard located within the block group, even if most of them are many miles away, while in an urban area, with much smaller block groups, a location-based measure would ignore many people located quite close to the hazard, because they happened to be in another nearby block group.

If polluters differ widely in size, that should be considered in the analysis. However, it may be hard to make sense out of (and policy decisions based on) a large number of sensitivity analyses using various proximity measures (multiple buffer sizes, various boundary definitions, etc.). In that sense, a site-specific risk assessment may be a better choice (unless there are too many sites, which would make risk analysis for the rule very expensive).

Looking at community demographics in specific communities may be of value for rulemaking. It may make sense to screen for communities with certain demographic compositions first. We might also consider the cumulative exposures in an area, not just exposures from each polluter in isolation, perhaps by counting the number of polluters or total emissions within a circle around the area. The precise calculations should depend on the pollutant and risk involved. We could focus regulatory attention on those areas with both high exposures and especially vulnerable populations, and perhaps try to write the rules in a way that will provide those populations with greater protection, rather than simply reducing exposures equally from all sources. This may be easier to apply to permitting and implementation decisions than it is to a national rule.

It is not clear how the EJ analysis is supposed to affect the rule. Would an EJ analysis simply justify an existing decision, if the analysis is done too late in the process to affect the number or type of options being considered? (It was noted that this concern about the timing of the analysis also exists for benefit-cost analysis.) We may need screening methods to identify which rules raise the greatest EJ concerns, and try to put more effort into the EJ analysis for those rules (and do the EJ analysis earlier in the rulemaking process). The forthcoming EPA guidance on rulemaking will address these issues.

Another concern is the incentives faced by those making the rules – if they are rewarded based on the number of rules they complete, they will not want to spend extra time doing EJ analysis, so the incentive structure may need modification.

1.8. Session 5: Methods for Analyzing EJ Associated with Pollutants in Household Products: Application to Toxics and Pesticides

1.8.1. Glenn Sheriff

Dr. Sheriff, of EPA's Office of Policy, Economics and Innovation, noted that for household products there is not a perfect overlap between geography and community, so there is a question of the proper unit of analysis. The pollution occurs at the individual household level, e.g., from pesticides or lead paint. He cited formaldehyde as an interesting example of the practical difficulty involved in incorporating EJ in regulatory design for toxics. Much of the EJ pressure for developing the formaldehyde rule came from exposures to formaldehyde of Katrina evacuees living in Federal Emergency Management Agency (FEMA) trailers. It would be impractical for EPA to conduct the monitoring required to enforce regulations on indoor air quality for individual homes. Instead they are regulating the sources of household formaldehyde, specifically the ingredients in the pressed-wood products used in furniture and cabinets. Risk of household formaldehyde exposure is likely to be highest in new, tightly sealed homes with new furniture rather than older drafty homes with old furniture. If EJ populations are concentrated in the latter, they may not be the ones most benefiting from the regulation.

1.8.2. Kaitlin Rienzo-Stack

Ms. Rienzo-Stack, of EPA's Office of Chemical Safety and Pollution Prevention's (OCSPP), Office of Pesticide Programs, noted that pesticide exposures cover a variety of scales, moving from production to field application to processing and transport to consumption; there is therefore some direct exposure, some proximity exposure, and some disperse pollutants. In principle, she said, this calls for a life cycle analysis-inspired EJ analysis. She also raised the issue of multiple exposures – a farmer might use five different pesticides in a season, but the rules are written one pesticide at a time. Much of the EJ effort at EPA's Office of Pollution Prevention and Toxics (OPPT), she said, now focuses on mitigation rather than rulemaking – e.g., outreach to EJ communities and funding of doctors in farm worker areas. She noted that some of their rules are developed for EJ reasons, especially those for worker protection when all the workers are from sensitive/disadvantaged communities. Benefit-cost analysis, she said, could consider the distributions of both costs and benefits – i.e., how both costs and benefits are distributed across large vs. small farmers as well as workers and consumers. She noted, however, that they face serious data issues. Their pesticide data measures applications in particular areas, but workers may move across areas over the course of a year and get multiple exposures. It is also often unclear who would be affected by a particular pesticide. Finally, there is limited information on human health and environmental toxicology for all the different pesticides. Given the lack of guidance, she concluded, it is not surprising that different rulemaking teams make different choices.

1.8.3. Stephanie Suazo

Ms. Suazo, also from OCSPP in the Office of Pollution Prevention and Toxics, briefly discussed the challenges that EPA/OCSPP faces in dealing with the wide range of chemicals on the market. For new chemicals, EPA receives pre-manufacture notice and information on exposure, so they can limit uses or the production process. There are so many existing chemicals, however, that it is difficult for EPA to cover everything. Like pesticides, she said, there are many potential channels of exposure, and it is not known how consumers respond to changes in the market. There are also jurisdictional issues and statutory limitations related to downstream uses of the chemical and imports. She said they are developing the internet geographical exposure modeling system (IGEMS), combining TRI and geographic data, to produce analyses of exposures to specific chemicals.

1.8.4. Matt LaPenta

Mr. LaPenta reported on a method for estimating the EJ implications of revising the Section 403 residential lead dust hazard standards. He noted that EPA is revising these standards after being petitioned to lower the permitted levels. The benefits include cognitive effects (IQ loss avoided), and the affected population tends to be in the EJ community. He considered household poverty status as the "EJ variable," although he noted that his method could be applied to other EJ factors as well. Finally, he focused only on floor dust.

In his method, he estimated baseline levels of lead dust (using data from national health and nutrition examination survey [NHANES]), as well as the dust levels expected if the policy were imposed, separately in each EJ group. He then converted the lead dust levels ($\mu g/ft^2$) in each scenario (baseline and control scenario) to concentrations ($\mu g/g$) to predict lifetime average blood lead levels using the integrated exposure uptake biokinetic (IEUBK) model. Blood lead levels were then translated into an estimate of IQ loss using a relationship estimated in an epidemiological study. Like the baseline levels, these health effects were estimated separately for the high-income population and the low-income population.

Mr. LaPenta said that both the baseline exposure levels and the policy effectiveness (i.e., the likelihood that the hazard will be mitigated if the policy is implemented) should be considered. The latter, he said, will be attempted in a future draft. The current analysis compared baseline exposure levels in the two income-level groups and, assuming full compliance (an unrealistic assumption, Mr. LaPenta acknowledged, for a variety of reasons), compared the impact (in terms of IQ loss avoided) of going from the current standard of 40 $\mu g/m^3$ lead in floor dust to a standard of 10 $\mu g/m^3$. He found a reduction in mean IQ loss for all children, especially for those in low-income households; he noted, however, that the sample size is small (94 individuals) and he has not conducted tests of statistical significance.

Mr. LaPenta emphasized that there are several different reasons why lead dust hazards get mitigated in specific households. Sometimes lead blood level screening identifies exposures and some Housing and Urban Development (HUD)-funded housing requires lead tests. There are, in addition, geographic differences in screening frequency – some states require screening at age one, while other states require annual screening. Medicaid requires screening at ages one and two. The proposed rule would require that lead dust tests be conducted after renovations. If all children were subject to the same screening rules, Mr. LaPenta said, he could use the NHANES data directly to identify differences in lead exposures across different groups for an EJ analysis. Unfortunately, as noted above, blood lead screening requirements affect older children in some states but not in others, and there are different screening requirements for Medicaid recipients; moreover, screening frequency may also differ with the household's access to medical care.

1.8.5. Robin Saha

Dr. Saha, who was asked to be a discussant for Mr. LaPenta's paper, acknowledged that lead exposures are an important EJ concern and noted that it is helpful that the steps in the analysis are clearly explained, using good data and a sensible chronic exposure model. He noted, however, that the sample was small and poverty level is a questionable EJ variable (observing that, although poverty level is convenient, even households at twice the poverty level might be resource-constrained). He observed that better tests and statistical analyses would require more and better data. For example, to improve modeling of hazard

mitigation in accordance with the rule considered, one could conduct a survey of compliance rates, with a stratified sample (both owners and renters), including local agency implementation capacity and policy advocacy to help explain hazard reductions. Questions remain, however, about the quantitative importance of the reductions achieved, other neuro-developmental effects, and effects below threshold levels.

He added that risk communication to the community and involving the community in the rulemaking process are important, and suggested that we should distinguish between predictive analysis (for rulemaking) and retrospective analysis (to evaluate existing policies and the distribution of risks).

1.8.6. Open Discussion

The open discussion among workshop participants focused on some of the difficulties of dealing with the great number of chemicals that EPA regulates, each of which may have its own exposure profile idiosyncrasies. Below is a synopsis of the thread of the conversation:

Dealing with all the legacy chemicals (tens of thousands of them) is difficult. There are blood biomarker testing data in NHANES for about 200 chemicals that could help identify which chemicals are most present in the population, and perhaps also which chemicals show the most inequality in presence across different groups, focusing EJ attention on overlaps between quantity and inequality of exposure. EPA could provide input about which (legacy) chemicals to include in the biomarker testing, and NHANES has been good about responding to such requests. This information could help with priority-setting for which chemicals to regulate next. Pesticides are reviewed every 15 years, along with coverage of specific groups of chemicals. EPA tries to address all chemicals in a product group together (e.g., soil fumigants), so that any restrictions on using one will not simply drive users to switch to an unregulated substitute.

Any given chemical will have idiosyncrasies in its exposure profile that need to be taken into account. EJ communities may be exposed to more sources of lead (e.g., in cookware, medicines, older toys, candy wrappers from Mexico). Higher blood lead levels may affect the EJ analysis if there are nonlinearities in the effects. (These effects may sometimes occur in surprising ways -- e.g., a simulation of lead exposures in children at home and in daycare using a threshold dose-response function found more benefit from reducing exposures in daycare, despite greater exposure levels in the home. This occurred because the home exposure levels were so high that they still exceeded the upper threshold levels for IQ effects even after the rule was adopted, so those exposure reductions were not predicted to result in IQ improvements).

Chemicals can affect distant EJ groups, such as Arctic and Native American tribal groups who do not use the chemicals but are affected by long-range transport and bioaccumulation. We could put more of the burden on industry to gather the information on hazards. Europe follows a different approach to regulation of chemicals which is more precautionary – the regulators must approve a new chemical before it can be used, and manufacturers must provide evidence on hazards as part of that process. Bioaccumulation can affect EJ analyses, if EJ populations have long histories of high exposures.

There is also considerable uncertainty about the information going into EJ analysis of chemicals, which may affect our confidence about the significance of observed disparities. Some sources of uncertainty, however, may not affect the relative impacts of the chemical on different groups (e.g., a dose-response function could be uncertain, but be the same across groups, so it would not affect the relative impacts of exposures). Finally, a technical point was raised: if a dose-response function comes from a study that

controls for EJ variables (e.g., demographics, income), the EJ analysis may need to adjust for those variables.

1.9. Session 6: Environmental Justice Considerations in the Implementation of Regulations

1.9.1. Ann Wolverton

Dr. Wolverton, of EPA's Office of Policy, Economics and Innovation, introduced this last session looking at EJ considerations in the implementation of regulations.

1.9.2. Loan Nguyen

Ms. Nguyen, of EPA's Office of Enforcement and Compliance Assurance (OECA), gave a brief overview of how OECA has addressed EJ concerns in implementation and enforcement of regulations: They have emphasized EJ concerns when working on the Toxic Substance Control Act (TSCA). They have developed a training course in writing enforceable regulations, which provides draft guidance on the rulemaking process incorporating EJ concerns on topics such as record keeping and community monitoring (which aids enforcement). They are working on improving transparency of the implementation process. She mentioned Enforcement and Compliance History Online (ECHO), an online information system that provides information on compliance and enforcement action at specific sites. They have also developed tools, she said, to screen EJ populations, helping inform enforcement activity and communicate EJ benefits.

1.9.3. Andrew Schulman

Mr. Schulman, also of OECA, gave a brief overview of EJSEAT, which is designed to provide a nationally-consistent tool for EJ screening assessments. He said that EJSEAT was originally developed in 2005-2006 and incorporates 18 indicators in 4 areas: social demographics, environmental exposures, baseline health, and enforcement. It uses only nationally available and federally managed data sources. The indicators are scaled from 0-100 and are combined across the 4 areas, with the scales calculated separately for each state, allowing state program independence, while looking at the allocation of resources across facilities within the same state. Because of privacy concerns, he noted, the health indicators are available only at the county level (he noted that some reviewers had suggested removing the health indicators from the model for that reason). He said that the model only goes down to the Census tract level and may not be measured well in tribal areas, but it can be a useful screening tool to see where "environmentally disadvantaged" populations might be located. Its relative simplicity, he noted, can also make it a useful tool for EJ communities to participate more in the rulemaking process. Testing in Region 3 and Region 5 showed that EJSEAT does reasonably well in prioritization of the communities according to EJ concerns. He said, however, that EJSEAT is not yet available to the general public.

1.9.4. Ron Shadbegian

Dr. Shadbegian, of EPA's National Center for Environmental Economics, provided some general thoughts on environmental justice and the implementation of regulations. He first observed that EPA's RIAs do not always consider implementation issues, which can raise EJ concerns. There is not much

academic literature addressing this area, he noted, so there are no firm conclusions to point to, and EPA is also just getting started in this area.

He identified several issues of EJ concern regarding implementation. One of the key issues is regulatory federalism, with federal EPA rules typically being implemented and enforced by state and local regulators, so that the stringency of enforcement activity may affect the overall regulatory stringency applied in different areas. He noted that EPA generally assumes that all states will achieve 100% compliance, adding that there is fairly good data available on compliance and enforcement activity for air and water pollution, so we could conduct some retrospective assessments of enforcement activity of existing rules to see whether an assumption of equal enforcement across different communities is reasonable.

Another EJ issue he discussed is the permitting process, which tends to focus on single plants but could consider existing vulnerabilities due to multiple and cumulative impacts, and engage the EJ community more fully in permit writing.

He noted that most rulemakings are national in scope, but some include regional features and some have geographic variability (the most widely studied being county non-attainment status for enforcement stringency on air pollution), so the results could differ across groups. While rules incorporating allowance trading have enabled more efficient reductions in emissions, he observed that there may be local hotspots and an inequitable distribution of benefits if there is a local impact of the pollution.

He also acknowledged a "lack of voice" for EJ communities in the allocation of pollution reductions across sources, since the allocations are driven by market outcomes, not by negotiations over permit conditions. He suggested that we could try an ex-post analysis of actual trades, to see whether they tended to shift pollution towards or away from EJ communities. Given the long time needed for implementation of new rules, however, the socioeconomic characteristics of particular areas can change before the rules take effect (and such changes could be affected by the rules).

Finally, he observed that technological change can result in long-run reductions in pollution, so if plants in different areas have different rates of adoption of technological change – and if these differences are related to location near EJ communities -- this could affect the long-run exposure trends for different groups.

1.9.5. Randy Walsh

Dr. Walsh discussed two kinds of equity relevant to EJ concerns: (1) process equity (i.e., are all communities treated equally, are regulators "demographically blind" in their decisions, and do all communities have equal access to the process?) and (2) exposure equity. He said that regulatory behavior and implementation of rules get at the heart of process equity – e.g., is there sufficient auditing and oversight of those allocating enforcement activity to ensure equal treatment of all groups? This is a complicated analysis, he said, because if regulators are less stringent in some areas in an absolute sense, but companies take advantage of that lower stringency to lower their compliance efforts, this may induce additional enforcement activity (based on non-compliance), offsetting the initially lower enforcement activity in those areas. EPA could help encourage process equity, and allow EJ communities to play a greater role in influencing state and local decisions, he said, by creating EJ analytical tools (such as EJSEAT) and training communities in their use.

Even if there is process equity, he noted, there could still be exposure inequity. Suppose, for example, that there is generally a spatial pattern to the location of air polluters, so that some areas have higher exposures than others. Air regulations seek to ensure some baseline level of air quality, he said, but that just moves up the air quality at the lower part of the distribution – it does not completely catch up with the higher air quality in some areas before regulation. This unequal distribution of exposures is likely to lead to hotspots and to EJ correlations –lower environmental quality in an area results in lower land rents, attracting polluting facilities and poor renters. This can be exacerbated by a combination of housing discrimination and a taste for living with similar people to increase the tendency for poor and minority communities to exist where there is lower environmental quality.

These EJ concerns could be addressed, he said, by incorporating cumulative exposures into regulatory implementation, including crediting the community for its past exposures. He suggested that there could be increased enforcement, tighter standards, and other creative approaches for facilities located in hotspots. For example, people in Alleghany County, PA (an EJ area where he does some work) could require new facilities to buy offsets from plants located in EJ communities, ensuring that the cleanup would be targeted spatially to reduce hotspots. The ways to reduce the correlation between EJ communities and poor environmental quality, he noted, are to move the pollution or move the people. One possibility would be to allow local hotspots, but not allow people to live nearby (although displacing current residents might not be considered an appropriate outcome by the community).

Finally, he identified environmental gentrification as a concern. If environmental quality in an area improves, among the chief beneficiaries will be the owners of land in the area. If most of the residents are renters, they would tend to be left out – i.e., displaced when rents rise to reflect the quality improvement. He suggested that perhaps it would be possible to work with other government agencies in areas like low income housing and zoning rules to try to give low-income renters a stake in the benefits of environmental quality improvements. He acknowledged, however, that this will be difficult, because market forces will tend to push in the other direction.

1.9.6. Open Discussion

The open discussion among workshop participants focused on the difficulties in addressing EJ concerns when it comes to the implementation and enforcement of environmental regulations. Below is a synopsis of the thread of the conversation:

Analyzing differences in compliance or enforcement across areas can be very difficult. Observing bigger penalties for violations in a minority community could be interpreted as good ("regulators being especially protective of the EJ community") or bad ("violations being much worse in the EJ community"). This could be addressed, at least in part, by controlling for the seriousness of violations, although there could also be variation across areas in how compliance is measured.

Environmental federalism raises some EJ concerns. It does not have to in theory – it allows the decision-making process to be "closer to" the affected community – but in practice state-level regulatory decisions tend to be driven more by the unequal distribution of power and resources within the state (except for a few unusually progressive states). Despite its practical drawbacks, however, there is no escaping federalism. For example, under Resource Conservation and Recovery Act (RCRA) legislation, implementation must devolve to the states. The implementation is paid for with grants to the states, which could in theory be taken back if the state did not properly implement the rules (but no grant has ever been taken back). Similarly, achievement of air quality regulations is supposed to happen through

State Implementation Plans (SIP), where EPA can review the plans to either accept or reject them, but the state regulators have the primary role of designating which facilities are making the largest emissions reductions. EPA also has oversight responsibility for enforcement activity and can conduct its own inspections, which can help support state regulators facing local political opposition. There needs to be enough federal oversight, however, to ensure reasonably equitable implementation at the state level – if not, all the good EJ intentions during rulemaking could be undone at the implementation stage. This is important if the goal is protecting EJ communities rather than just writing nice-sounding regulations. It was suggested that perhaps state agencies could be evaluated based on the "EJ-friendliness" of their regulatory activity, in either a retrospective study or in ongoing oversight. One workshop participant noted that some of these concerns about federalism call to mind the difference between state and federal responses to implementing civil rights legislation, with the federal government taking a much more active role in enforcing regulations despite state reluctance.

EJSEAT, or some other screening program, could be quite useful for EJ communities to gather information and participate in the rulemaking process. The concern about health data being available only at the county level may not matter so much if it is designed to capture local vulnerabilities, rather than being a direct measure of differences in environmental hazards. It might also be possible to get some health data with more spatial detail, but such data tend to show that most of the geographic variation in health outcomes occurs within the county, rather than between counties. EJSEAT also includes information on compliance levels and inspection rates, which can be subject to the concerns about controlling for differences in regulatory attention across areas.

It would be helpful to conduct a "litmus test" on EJSEAT or other screening models. We could begin by identifying 20 well-known EJ communities, based on existing qualitative information and feedback from EJ community leaders. We could then see if those communities are near the top as ranked by the screening model. If the model identifies other communities as being of high EJ concern, we could look carefully at those communities to see whether they are worthy of consideration (i.e., can we believe the model's results and learn something from them?). It can be difficult to test the model quantitatively, since we do not have an existing "true" measure of EJ communities to compare it with. In fact, OECA did a validation study of EJSEAT in EPA Region 3, and the tool seemed to get pretty close to what was known about the EJ communities.

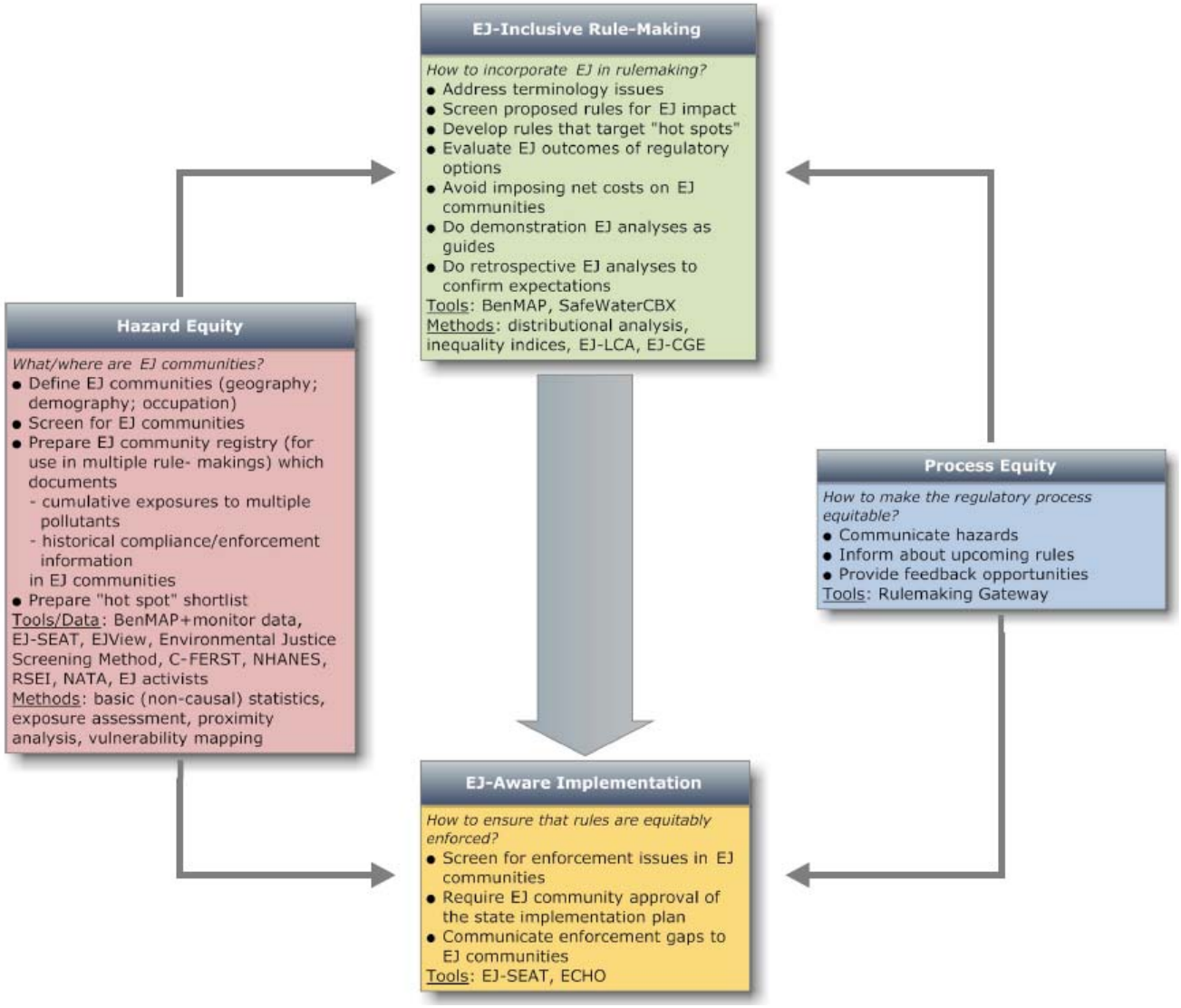
One problem with any analysis of compliance and enforcement is that it depends on datasets that focus on the large and well-known polluters found in EPA regulatory databases. The worst cases of violations are often found at small plants operating without permits (e.g., small metal-plating shops), either because they are exempt from reporting due to their size, or because they are concealing their existence from regulators. Enforcement is technically possible at such plants, but their absence from regulatory datasets makes them difficult targets.

On the housing decision, EPA has been working with HUD in siting low-income housing. To hold down the costs of building such housing, developers often use inexpensive land, which has sometimes led to the housing being built out in the middle of nowhere, far from the jobs and transportation networks available near the city center. The only inexpensive land available in the central city might be remediated brownfield sites, which, according to HUD regulations, cannot be used for such housing. Housing could be an efficient use of brownfield land, assuming the cleanup was effective, but it would be a difficult decision to justify politically.

1.10. Closing Session

The six sessions described above were followed by a "closing session" in which Dr. Gray and other workshop participants synthesized the various strands of the 2-day discussion. The many issues discussed in the course of the 2-day workshop are outlined below. The basic questions the workshop addressed, the suggested approaches to answering these questions, and how they relate to each other, are shown diagrammatically in Figure 1.

Figure 1. A Summary of the EJ Workshop Discussion



1.10.1. What is an EJ Analysis?

Perhaps the most fundamental question that arose in the workshop was: What is an EJ analysis? Most participants considered an "EJ analysis" to be a distributional analysis – i.e., an analysis of how benefits

and costs are distributed among different groups in the population. It was repeatedly pointed out, however, that there are communities whose members tend to be disadvantaged in multiple ways and who experience multiple cumulative environmental exposures. These "EJ communities" are "hot spots" – places with both vulnerable populations and multiple exposures. An alternative answer to the question was, then, that EJ analysis should focus specifically on these "EJ communities." It was not clear, however, how a national rule would do this. It was also noted that, while these EJ communities experience multiple environmental exposures, environmental rulemaking has traditionally focused on one pollutant at a time. The discussion of how to define EJ analysis was acknowledged to be ongoing.

The following key concepts need to be better understood and defined:

- "EJ analysis" vs. "distributional analysis"
- "Disproportionate impact" (how much difference constitutes a "disproportionate impact"?)
- "EJ community" vs. "demographic group" (i.e., is adding up individuals okay, or must they only be considered as a part of a community (which would include some mix of demographics)?)

1.10.2. Suggestions for how EPA could be more proactive/prioritize/screen:

- Identify burdened EJ communities and hotspots (EJ baseline analysis) to provide a baseline of current exposures to identify most vulnerable populations; analyses could also include bioaccumulation of persistent hazards and increased sensitivities; we could identify communities that, more generally, face more stressors.
- Perhaps also consider ways to provide extra help to EJ communities in the rulemaking process (e.g., require offsets for new plants to be bought from facilities in EJ communities).
- Screen upcoming regulations to identify those rules with potential EJ concerns or implications to improve the current EJ baseline.
- Consider the relative magnitudes of effects – for example, $PM_{2.5}$ has huge mortality effects (relative to other air pollutants), so even a small variation in benefits across groups with respect to exposure to $PM_{2.5}$ could have larger consequences than larger variations with respect to other pollutants.
- Use EJ communities themselves as a resource to help test any numerical screening methods.

1.10.3. Benefits from EJ Analyses

- They help EPA in setting overall priorities for rulemaking.
- They help EPA in choosing regulatory options within a given rulemaking.
- They help provide credible measures of benefits of regulation to EJ communities, and communicate those measures to those communities. Even if results do not show disparity, they still provide a "positive assurance" (so that is also a benefit).
- They help to document the current burden faced by EJ communities and support community action to address this burden.

1.10.4. EJ Methodology – Toolkit

Screening tools:[2]

[2] Note that this list is not necessarily comprehensive.

- Proximity analysis – for specific sites, examine characteristics of "nearby populations;" we could use a binary (0/1) metric of EJ community or percentage minority/poor.

- EJSEAT – a national multi-component indicator for EJ assessment; uses socio-demographic, health, environmental, and compliance/enforcement tract-level data (except health, which is at the county level), normalized within state; used for strategic targeting of enforcement.

- Environmental Justice Screening Method – presented by Manuel Pastor. His method can include multiple dimensions of community characteristics (see Section 1.2.2).

- C-FERST (Community-Focused Exposure and Risk Screening Tool) – a user-friendly, web-based tool designed as a "one-stop shop" to help identify and prioritize community environmental issues and to assess human exposures and health risks, using the best available information and science (http://www.epa.gov/heasd/c-ferst/).

- RSEI (the Risk Screening Environmental Indicators) – described by EPA as "a computer tool that analyzes risk factors to put TRI release data into a chronic health context." (see http://www.epa.gov/oppt/rsei/)

- NATA (EPA's National-Scale Air Toxics Assessment) – described by EPA as "a state-of-the-science screening tool for State/Local/Tribal Agencies to prioritize pollutants, emission sources and locations of interest for further study in order to gain a better understanding of risks." (see http://www.epa.gov/ttn/atw/natamain/)

- EJView -- formerly known as the Environmental Justice Geographic Assessment Tool, is a mapping tool that allows users to create maps and generate detailed reports based on the geographic areas and data sets they choose (see http://epamap14.epa.gov/ejmap/entry.html).

Distributional analysis tools:

- BenMap – combines detailed Census block-level socio-demographic information with concentration-response functions for criteria air pollutants estimated in epidemiology studies, baseline incidence rates (for mortality and morbidity endpoints), and modeled or/and monitoring air quality data. BenMAP generates counts of deaths and illnesses avoided as a result of specified changes in ambient air pollutant concentrations and calculates total dollar benefits (using VSL, willingness to pay, and cost of illness estimates of value).

- SafeWater CBX – estimates the costs and benefits of alternative maximum contaminant levels (MCLs) for water contaminants (e.g., arsenic) in drinking water, using test sample data from public water suppliers and information on populations served. (Although it is not currently in the model, more detailed demographic population data could be added.)

In addition to the tools discussed above, workshop participants also mentioned some datasets that are potentially useful for conducting screening and distributional analyses. For example, the NHANES database contains biomarkers for chemicals, which could possibly be used to screen for differential exposures across population groups. (This database contains direct measures of blood concentrations, but for a relatively small selection of chemicals, although EPA can request that specific chemicals be tested.)

1.10.5. Data Challenges

Data availability has been recognized as one of the biggest challenges for conducting EJ analysis. The challenges include:[3]

Lack of data on sources of pollution

- Mobile sources
- Small stationary sources (RCRA), exempt from permit requirements (so not in existing datasets).

Estimation of exposures (given pollution)

- Better models of pollution flows/pathways are needed
- Some media have relatively sophisticated models already (e.g., air pollution with air quality modeling) while others are less well developed (e.g., water pollution, where there are some models of stream flow, but groundwater aquifers are less well modeled). For air, everyone breathes so ambient concentrations provide a reasonable starting point – it is harder to model exposure for water, since that often involves choices (swim/boat/fish).
- Occupational exposures of different groups -- e.g., farm workers for pesticide regulation, subsistence fishing for bioaccumulative toxins – are needed.
- For some contaminants, a life-cycle approach may be needed – e.g., for pesticides, we may need exposures from production and application to consumption; there may also be "trickle-down" exposures – e.g., toys with lead paint removed from shelves at toy store, sent to dollar store.

Issue of personal exposures vs. ambient concentrations

- Although subject to argument, ambient concentration represents a hazard to communities even if people engage in averting behavior to avoid it (therefore it is not clear whether personal exposures or ambient concentrations are the more appropriate metric).
- Epidemiological concentration-response functions (e.g., describing the relationships between criteria air pollutants and population health effects) are based on ambient concentrations rather than personal exposures.

Data on sensitivity for vulnerable populations

- We lack dose-response functions for specific hazards stratified by population groups – or, alternatively, evidence that the response is similar across groups. (It was mentioned that CDC may be working on this.)
- More work is needed to identify data on disease incidence for different EJ groups to establish baseline risk levels.
- We need to take into account the interactions among multiple pollutants, non-linearity and bioaccumulation.

Costs and unintended consequences

- Environmental gentrification is a possible unintended consequence of environmental cleanup in EJ communities; while this could impose costs on EJ communities, this is currently not considered in EJ analysis.

[3] Note that the following list of challenges is not necessarily comprehensive.

- There are sometimes mixed effects of product substitution (e.g., the change of pesticides to reduce greenhouse gases increases hazards to farm workers).

1.10.6. Modeling choices

- In any policy-related analysis that needs to be communicated to non-specialists (in this case, those without expertise in economics or statistics), there is a tradeoff between using sophisticated models and analytical techniques to estimate distributional consequences, on the one hand, and being able to easily explain the methods and results of the analysis to the target audience, on the other hand. The experts doing the analysis prefer using more sophisticated techniques because those techniques are considered superior, and studies using those techniques are far more likely to get published in scholarly journals. This generates a natural research bias towards more complex approaches that are unfortunately more difficult to communicate to others. While they should not sacrifice analytical rigor, researchers should be encouraged to consider whether, in some cases, simpler models might capture the same results as the more complex ones. Whatever analytical approach is used, researchers should also be encouraged to make the effort to explain their results in non-technical language so that others who do not happen to be experts in economics and/or statistics can more easily understand the analyses and participate in the rule-making process.
- Trying to estimate causality, rather than simply correlation – the standard approaches for trying to get at causality may not be appropriate if our focus is on the "excess burden" faced by the EJ community (e.g., even if greater pollution exposure is "explained" by income differentials across groups, that does not make it any less burdensome). The causality analysis may be helpful for something like the analysis of rule implementation, where we are trying to see whether the regulatory activity was distributed equitably among groups, or was lower (or higher) for plants located in EJ communities.

1.10.7. Rulemaking

Current rulemaking

- Consider multiple stressors in vulnerable communities, interactions among pollutants.
- Consider non-linearity in effects, if different baseline exposures.
- Consider implementation effectiveness – will EJ communities see equal enforcement?
- In cases where EJ analysis shows negative distributional consequences, seek to modify rule to avoid EJ problems – or at least be willing to make the negative results public.
- Perhaps add requirements for state implementation plans to "favor" EJ communities (provide extra protection where possible).
- Perhaps require demonstration of "at least equal" enforcement activity.
- Perhaps require consultation with local EJ communities on SIPs, with sufficient time to provide meaningful response.

Retrospective analysis of rules

- Try to discern any differences in implementation of rules across EJ groups
- Examine consequences of rules after adoption to see whether EJ communities show similar outcomes (exposures, costs, etc.)
- Collect information on possible unintended consequences

1.10.8. Possible next steps

- Develop and test screening models to identify EJ communities and characterize the environmental risks they face.
- Do detailed EJ analyses of some rules as "demonstration projects," even if the analysis takes too long to be incorporated in the rulemaking (to learn how to do the analysis for the next time, to describe the baseline risks, and to show it can be done). Alternatively, we could apply EJ analysis to an existing rule, which would remove the time pressure, allow selection of a rule that raises EJ concern, and enable us to compare "*ex ante*" expectations of impact with "*ex post*" resulting impacts.
- Develop capacity for rapid deployment of EJ screening and distributional analysis tools (a "matrix of solutions"), apply it to upcoming rules, and modify as necessary (learning process).
- Possibly consider larger changes in rulemaking, such as requiring companies to get regulatory approval before introducing a new chemical on the market, which is already required for new drugs and is required more generally for new chemicals in Europe. That would put the burden of proof on the company to show the chemical's safety, at the cost of greatly slowing down the introduction of new chemicals.
- Take a more proactive approach to helping EJ communities –e.g., a systematic examination of all the problems they face (community by community) and attempt to address environmental problems simultaneously. This might be similar to current "small business" protections (e.g., create a register of EJ communities to focus attention on them). Use of offsets targeted to EJ communities to improve conditions.

Appendix A: List of the Participants

Participant	Affiliation
Matt Adler	University of Pennsylvania
Tracy Atagi	U.S. EPA, Office of Solid Waste and Emergency Response
Spencer Banzhaf	Georgia State University
Randy Becker	U.S. Census Bureau
Anna Belova	Abt Associates
Tracy Bone	U.S. EPA, Office of Water
Jennifer Bowen	U.S. EPA, Office of Policy, Economics, and Innovation
Jose Bravo	Just Transition Alliance
Heather Case	U.S. EPA, Office of Environmental Justice
Cecil Corbin-Mark	WE ACT
Mark Corrales	U.S. EPA, Office of Policy, Economics, and Innovation
Jeneva Craig	U.S. EPA, Office of Air and Radiation
Maureen Cropper	Resources for the Future
Bridgid Curry	U.S. EPA, Office of Policy, Economics, and Innovation
Ken Davidson	U.S. EPA, Office of Air and Radiation
Brooks Depro	Rearch Triangle Institute
Neal Fann	U.S. EPA, Office of Air and Radiation
Michael Firestone	U.S. EPA, Office of Children's Health Protection
Lisa Garcia	U.S. EPA, Office of Environmental Justice
Wayne Gray	Clark University
David Guinnup	U.S. EPA, Office of Air and Radiation
Kevin Haninger	U.S. EPA, Office of Solid Waste and Emergency Response
Lisa Heinzerling	U.S. EPA, Office of Policy, Economics, and Innovation
Jin Huang	Abt Associates
Debbie Kemp	Abt Associates
Gerry Kraus	U.S. EPA, Office of Enforcement and Compliance Assurance
Matt Lapenta	Abt Associates
Amanda Lee	Office of Management and Budget
Charles Lee	U.S. EPA, Office of Environmental Justice
Lyn Luben	U.S. EPA, Office of Solid Waste and Emergency Response
Kelly Maguire	U.S. EPA, Office of Policy, Economics, and Innovation
Sarah Mazur	U.S. EPA, Office of Research and Development
Al McGartland	U.S. EPA, Office of Policy, Economics, and Innovation
Mark Mitchell	Connecticut Coalition for Environmental Justice
Loan Ngnyen	U.S. EPA, Office of Enforcement and Compliance Assurance
Doug Noonan	Georgia Institute of Technology
Onyemaechi Nweke	U.S. EPA, Office of Environmental Justice
Manuel Pastor (on phone)	University of Southern California
Ellen Post	Abt Associates
Tauhid Rahman	University of Arizona
Kaitlin Rienzo-Stack	U.S. EPA, Office of Chemical Safety and Pollution Prevention
Robin Saha	University of Montana
Tamara Saltman	U.S. EPA, Office of Air and Radiation

Participant	Affiliation
Andrew Schulman	U.S. EPA, Office of Enforcement and Compliance Assurance
Ron Shadbegian	U.S. EPA, Office of Policy, Economics, and Innovation
Glenn Sheriff	U.S. EPA, Office of Policy, Economics, and Innovation
Hilary Sigman	Rutgers University
Stephanie Suazo	U.S. EPA, Office of Chemical Safety and Pollution Prevention
William Swietlik	U.S. EPA, Office of Water
Chris Timmins	Duke University
Randy Walsh	University of Pittsburgh
James White	U.S. EPA, Office of Air Quality Planning and Standards
Ann Wolverton	U.S. EPA, Office of Policy, Economics, and Innovation

Appendix B: Workshop Agenda

Day 1 – Wednesday	
8:00	Registration, coffee/tea and light refreshments
Opening Session	
8:30	Welcome and Administrative Remarks *Workshop Chairperson – Wayne Gray, Clark University*
8:45	Opening Remarks *Lisa Heinzerling, Associate Administrator, USEPA, Office of Policy, Economics and Innovation*
9:00	Q&A following the Opening Remarks
Session 1: Environmental Justice and Equity	
9:15	Introduction and Overview *Moderator – Al McGartland, USEPA, Office of Policy, Economics and Innovation*
9:20	Environmental Justice: Evidence, Issues and Challenges *Manuel Pastor, University of Southern California*
9:40	Incorporating Willingness-to-pay for Equity into Health Benefits Analysis *Maureen Cropper, University of Maryland and Resources for the Future*
10:00	Equity and Social Welfare Functions *Matt Adler, University of Pennsylvania*
10:20	Open Discussion
11:00	**Break**
Session 2: Methods for Analyzing Environmental Justice for Disperse Pollutants: Application to Water	
11:15	Overview of Theme *Moderator – Kelly Maguire, USEPA, Office of Policy, Economics and Innovation*
11:20	Highlighted Regulatory Activity (EPA perspective) *William Swietlik, USEPA, Office of Water*
11:35	Methods for Analyzing Environmental Justice Effects with Disperse Pollutants *Spencer Banzhaf, Georgia State University*
11:55	Remarks on presentation *Discussant – Tauhidur Rahman, University of Arizona*
12:10	**Lunch (on your own, Panel discussion will begin at 12:45)** *Panel of EJ Community Leaders* *Moderator, Lisa Garcia, USEPA, Senior Advisor to the Administrator for Environmental Justice* *Jose Bravo, Just Transition Alliance* *Cecil Corbin-Mark, WEACT for Environmental Justice* *Mark Mitchell, Connecticut Coalition for Environmental Justice*
1:50	Open Discussion – Disperse Pollutants
2:35	**Break**
Session 3: An Exposure and Health Risk Environmental Justice Analysis Method: Application to a National Air Quality Rule	
2:50	Overview of Theme *Moderator – Neal Fann, USEPA, Office of Air and Radiation*

2:55	Highlighted Regulatory Activity (EPA perspective) *Tamara Saltman, USEPA, Office of Air and Radiation*
3:10	Methodology for Distributional Benefit Analysis of a National Air Quality Rule *Ellen Post, Abt Associates*
3:30	Prepared Remarks on Presentations *Discussant – Chris Timmins, Duke University*
3:45	Open Discussion
4:30	**Adjourn**
5:00	**Group Dinner – Lauriol Plaza, Dupont Circle (participants responsible for own tab)**

Day 2 – Thursday	
8:00	Coffee/tea and light refreshments
8:15	Recap of Day 1 and Opening Remarks *Workshop Chairperson – Wayne Gray, Clark University*
Session 4: Proximity Based Approaches to Analyzing Environmental Justice: Application to Waste	
8:30	Overview of Theme *Moderator – Mark Corrales, USEPA, Office of Policy, Economics and Innovation*
8:35	Highlighted Regulatory Activity *Lyn Luben, Office of Solid Waste and Emergency Response*
8:50	Scales of Justice: A Geographic Bias in Environmental Equity Analysis *Doug Noonan, Georgia Institute of Technology*
9:10	Prepared Remarks on Presentations *Discussant – Hilary Sigman, Rutgers University*
9:25	Open Discussion
10:10	**Break**
Session 5: Methods for Analyzing EJ Associated with Pollutants in Household Products: Application to Toxics and Pesticides	
10:25	Overview of Theme *Moderator – Glenn Sheriff, USEPA, Office of Policy, Economics and Innovation*
10:30	Highlighted Regulatory Activity (EPA perspective) *Kaitlin Rienzo-Stack and Stephanie Suazo, USEPA, Office of Chemical Safety and Pollution Prevention*
10:45	A Proposed Method for Evaluating the Environmental Justice Implications of Revising the Section 403 Lead Dust Hazard Standards *Matt LaPenta, Abt Associates*
11:05	Prepared Remarks on Presentation *Discussant – Robin Saha, University of Montana*
11:20	Open Discussion
12:00	**Lunch** (on your own)
Session 6: Environmental Justice Considerations in the Implementation of Regulations	
1:00	Overview of Theme *Moderator – Ann Wolverton, USEPA, Office of Policy, Economics and Innovation*
1:05	Highlighted Regulatory Activity (EPA Perspective) *Loan Ngnyen and Andrew Schulman – USEPA, Office of Enforcement and Compliance Assurance*
1:20	Implementation and Environmental Justice Considerations

	Ron Shadbegian, USEPA, Office of Policy, Economics and Innovation
1:35	Heterogeneity in Environmental Quality: Environmental Justice Considerations *Randy Walsh, University of Pittsburgh*
1:50	Open Discussion
2:30	**Break**
Closing Session	
2:45	Facilitated session on significant issues, summary points and next steps. *Chairperson and others*
4:30	**Adjourn**

Appendix C: Discussion Questions

The questions and points of guidance below are intended to help inform the workshop discussions and focus the presentations in order to meet the workshop objectives as outlined on the agenda. They are grouped according to the intended recipients and the purpose they are intended to serve.

All Participants:

Questions for all workshop participants to consider throughout the workshop
Purpose: Provide a basic foundation for workshop discussions

1. What is "environmental justice"?
    a. Are there differences between environmental justice, equity, and equality and how should they be treated in an analytical framework?
2. What questions should environmental justice (EJ) analyses try to answer?
    a. Are all questions equally appropriate in all scenarios (e.g., if the pollutant travels in certain media; if the scope of the environmental regulation is relatively local vs. regional or national)?
    b. What are the appropriate baseline(s) to consider?

Questions for participants to bear in mind during each of the methodology sessions
Purpose: Provide guidance to participants during open discussions

1. What EJ questions does the methodology attempt to answer?
2. Are these appropriate questions given the scenario being considered (e.g., the medium in which the pollutants travel; the scope of the regulation)?
3. Does the methodology succeed in answering these questions? If not, what are the limitations of the methodology? Can the methodology be improved so that it is better able to answer the questions?
4. Is the methodology empirically feasible?
5. Is the methodology useful for national environmental regulatory decision-making?

All Presenters and Discussants:

Guidance for presenters and discussants in methodology sessions
Purpose: Provide guidance to presenters on areas to focus on in their presentations

- Paper Presenters:
    1. Please clearly identify the question(s) your analysis is trying to answer.
    2. Please highlight the methodology (rather than specific results).
    3. Discuss advantages and limitations of the methodology, including other approaches that could be used to address your question(s).
    4. Discuss data needs and access.
    5. Identify the timeframe needed to conduct the analysis.

- Discussants:
    1. Please focus on the extent to which the methodology is able to answer the question(s) it was intended to address.
    2. Discuss the strengths and weaknesses of the methodology.
    3. What, if any, other methodology could be used to address these question(s)?

- EPA Highlighted Regulatory Activity Presenters:
  1. Please provide an overview of the EJ activities in your program
  2. Try to address the following questions:
     a. How is EJ being applied in your program?
     b. What are the challenges your program faces in incorporating EJ into regulatory analysis?
     c. What plans does your program have to incorporate EJ into future regulatory analysis?

Session 1 (Environmental Justice and Equity) Presenters:

1. Are there differences between equity, from an economist's perspective, and environmental justice? If so, please elaborate.
2. Please provide thoughts on how to incorporate equity concerns into national environmental regulatory decision-making.

Lunch-time Panelists:

1. What is environmental justice and how is it achieved?
2. What are the most important questions EPA should address by equity or EJ analyses?
3. What are the advantages of quantitative assessment of EJ for national, environmental rule-makings? What are the limitations?