POLLUTION MANAGEMENT
In Focus
DISCUSSION NOTE NUMBER 2 FEBRUARY 1999

Comparative Risk Assessment

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In an imperfect world of finite resources, decisionmakers everywhere are faced with difficult choices about how to deal with environmental problems. Comparative risk assessment (CRA) can help. CRA is a tool for comparing and ranking risks to health and ecosystems and identifying strategies for managing these risks, on the basis of both scientific data and public values. Recent experience in the United States and in other countries worldwide shows how CRA can assist in setting environmental priorities, promoting coordination between agencies, building consensus, and giving expression to the environmental concerns and preferences of the community.

Comparative risk assessment is a planning tool for evaluating environmental problems and choices that affect human health and ecosystems. It can be applied in very specific situations to rank risks associated with groups of pollution sources. Or it can be understood in a broader sense, as a participatory process that can help incorporate public views into decisionmaking and promote better public understanding of environmental issues. It is the second use of CRA that is discussed here, particularly as it has been applied in the United States.

Typically, in a CRA process representatives from government, business, environmental groups, and the general public work together with scientists and technical specialists to identify the most pressing environmental problems, assess the risks, and develop priorities for control and prevention strategies. This note presents a brief description of the technical methodology used in CRAs and the public participation activities recommended.

Scope of CRAs

CRAs, in the broader sense, usually analyze three categories of risks: those to human health, ecosystems, and quality of life. The list of issues analyzed can be as narrow as a specific set of toxic and hazardous chemicals. At the other end of the range, they can include global concerns (for example, climate change and emissions of ozone-depleting substances) or matters outside the jurisdiction of environmental agencies such as food safety and patterns of development.

1) *Health risks* are evaluated using the standard risk assessment process: hazard identification, dose-response assessment, exposure assessment, and risk characterization. In a CRA, the set of issues examined is broad, extending to cancer risks, noncancer risks (for example, reproductive, neurological, developmental, or immunologic health effects), and, as appropriate, other health problems, such as vector-related diseases. In some cases, all the effects are combined into a single risk ranking; in others, the risk categories

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are kept separate, and decision-makers implicitly combine and rank them to prioritize problems.

2) *Ecological risks* include risks to ecosystems or to all ecological receptors, from a single species to the functional or structural integrity of an ecosystem.
3) *Quality of life risks* include such nonhealth issues as effects on commercial activities, recreation, property values, and aesthetic values.

Although ecological and quality-of-life analyses attempt to incorporate all the quantitative information available, they have been less uniform and more qualitative than the more established methodologies for assessing health risks.

Experience to Date

Risk assessment has been used during the past decade in a number of industrial countries, developing countries, and transition economies. In the United States, risk assessment has been used to set national environmental priorities, to guide legislation, and to choose among regulatory approaches. Almost every environmental program within the U.S. Environmental Protection Agency (USEPA) now uses risk assessment in deciding regulatory priorities, performing cost-benefit analysis, or targeting enforcement activities. Risk assessment has been used, for example, to decide which air pollutants to control, which pesticides to allow and which to ban, and to what degree hazardous waste sites should be cleaned up. In Western Europe, both the European Union and individual countries are working to adapt risk assessment techniques to their own contexts.

The USEPA has promoted the use of CRA and related environmental planning tools by states, regions, cities, and Native American tribes to help communities address their environmental concerns, using the best scientific information available (see Box 1). Among the reasons for initiating CRAs in the United States is that the transfer of many responsibilities from the federal government to states and local governments makes it imperative for the latter to set priorities for action. Other motivations are a desire to remedy the fragmentation of environmental responsibilities among various government agencies and to include the views of community groups.

CRA is being used in other settings worldwide, although with limited public participation in many cases. In Bangkok and Cairo, for example, CRAs were used to identify specific antipollution measures, such as reducing lead in gasoline and managing traffic to decrease particulate emissions. Other places where CRAs have been applied include Zlatna (Romania), Zilina (Slovakia), Radom, Starogard Gdanski and Chelm (Poland), Lima, Quito, and various sites in Central America. CRA was also used in the preparation of the 1993 Environmental Action Programme for Central and Eastern Europe. Box 2 presents an application of the CRA methodology in a World Bank project in Bolivia.

Benefits of a CRA

CRAs have effects that go beyond the compilation of data and the analysis and ranking of environmental risks and management strategies. They have led to new state legislation dealing with issues that the analysis identified as posing high risks. In addition, they have provided the impetus for internal budgetary reallocations in government agencies, for strategic use of federal grants, and for the creation of public environmental education programs aimed at reducing the gap between perceived and actual risks faced by communities.

The CRA process usually brings about better understanding among stakeholders in government programs and initiatives and encourages improved coordination among agencies with overlapping jurisdictions. In general, CRAs at the local level have been more effective than those at the national level in developing focused

Box 1. Experience with CRA at the State and City Level in the United States

More than 30 states, 32 cities, and Native American tribes in the United States have used the CRA methodology to establish environmental priorities in their jurisdictions, with varying degrees of success. Here are a few highlights:

California. Clearly differentiated environmental topic lists were developed to avoid overlap between categories of risk. The CRA included (in addition to the usual technical groups on human health, ecological, and quality-of-life risks) working groups on education, environmental justice, economic perspectives, and interagency cooperation. Simple quantitative criteria were used to rank risks.

New York. The state CRA, currently under way, limited its focus to the evaluation of risks associated with 14 categories of toxic and hazardous chemicals.

Maine. The technical groups were organized by environmental media (outdoor air, land and agricultural resources, surface water and sediments, and groundwater). The risk-ranking analysis included trend analyses and evaluations of the quality of information.

Ohio. The CRA included extensive public participation and outreach activities—for example, interviews with environmental professionals, focus groups, telephone polls, participation in fairs, and distribution of fact sheets and newsletters.

Hawaii. The CRA resulted in the establishment of an indoor air program, a program to test blood lead levels in children, new legislation to implement the recommendations, and a cabinet-level committee to oversee progress.

Box 2. Setting Priorities for Remediation of Environmental Contamination: Bolivia's Mining Sector

The World Bank Environment, Industry, and Mining project in Bolivia included a CRA to identify how best to use financial resources specifically targeted for remedying environmental contamination associated with mining. The study first compared mine sites according to the risk that they posed to people, to the economic infrastructure, and to ecosystems through heavy metals contamination, acid generation, and physical hazards. The goal was to make informed decisions on which sites to clean up first, how much to clean them up, and how to do the job. In the second part of the study, the set of actions analyzed was expanded beyond those directly related to the remediation of mine waste. The study identified the most cost-effective measures for dealing with problems resulting from contamination—for example, repairing water supply pipes affected by acid drainage, sealing playgrounds built on mine waste, and paving dust roads.

Source: Ayres, Anderson, and Hanrahan (1997).

environmental action plans because the information tends to be of higher quality, the management strategies are within the jurisdiction and capabilities of those involved in the CRA process, and the results are more tangible.

The CRA Process

A CRA project generally has two stages: risk comparison and ranking, and strategic analysis and priority setting. The project tasks are commonly divided among three committees: (a) technical work groups or consultants in charge of research and analysis of risks; (b) a broadly representative public advisory committee that serves as a liaison between the government and the general public and has varied responsibilities, ranging from definition of risk issues to be analyzed up to the final ranking of risks and strategies; and (c) a steering committee that oversees the process and the delivery of products.

The scope of the CRA depends on the purpose of the analysis and may be as narrow as a comparison of risks across industries or other groups of pollution sources or as broad as a national ranking of environmental problems. Among the first steps in the CRA process is the selection of an issues list. The USEPA's guidebook on CRA contains a comprehensive list of health and ecological risks that has been used by various states and cities after public consultation.

Once the issue list is defined, the technical work groups collect and analyze the best data available and describe the level of risk for each issue. Next, the technical groups, the public advisory committee, or both together compare and rank the risks on the basis of criteria specific to each risk category (health, ecosystems, or quality of life). Finally, the public advisory committee integrates all the issues into a single ranked list.

The first stage—analysis and ranking of health risks—commonly has two steps. First, the stressors or sources of risks are grouped to facilitate the analysis, and estimates are made of the population exposed to each stressor and the concentration of the particular stressor. Second, the risks to typical exposed individuals are estimated, using either cancer potency factors for carcinogens and a reference dose for noncarcinogens, or relative risk ratios and other dose-response coefficients from epidemiological studies. By multiplying the individual risks by the number of people assumed to be similarly exposed, a population risk estimate can be obtained. In some CRAs, the technical groups have made a special effort to identify subpopulations of special concern, such as children.

The comparison of population risk estimates is not the final step in ranking health risks. The risks are diverse (cancer, gastrointestinal problems, and so on); they affect different age groups; and they may be fatal, permanent, or short-term. Next, society's values and choices have to be integrated into the ranking. These preferences and values are transmitted through the public advisory committee, which should have a diverse and representative makeup, or through public participation in forums or polls.

Public Views

Public participation structured to generate results is one of the most important and valuable features of the CRA process. CRA projects deal with the public on three levels: as participants in the process, as a source and recipient of information, and as a body whose support for the initiatives and proposals resulting from the project is needed. Participation is not limited to representation of stakeholders in the public advisory committee. Outreach and participation activities under the CRA engage all stakeholders in a broad discussion about risks, public values, and potential risk management strategies; allow them to reach consensus on an action plan; educate the public about risks in their communities; gather information on the public's views; and give legitimacy to the CRA process and the proposed risk management plan.

Risk-ranking exercises in state and local CRAs have been criticized for a lack of rigor (due to, among other factors, deficiencies in the supporting data). However, the final ranking of risks and strategies is not the sole result or objective of the ranking process.

Another goal is to promote a structured, fair, and open exchange of ideas among scientists, citizens, and government officials on a broad range of environmental risks, using the best available data. In many cases, the public participation activities have revealed

differences in how the technical work groups and the public perceive risks. Some CRA projects have used the outreach activities to educate the general public about environmental risks and how to reduce or avoid them.

Resources and Requirements

Risk assessment does not necessarily require extensive collection of new data. Reasonable, practical results can be derived from the information available in developing countries, although considerable effort may have to be put into collecting and organizing information from different agencies. In the United States, the time frame for state-level CRAs has ranged between 18 and 36 months. Most CRAs have taken two years to complete—one year for the risk-ranking phase, and one year for the management strategies phase. The budget for CRA projects (not counting in-kind and voluntary contributions) has ranged from $70,000 for a city project to $700,000 for state projects with substantial public participation components. The USEPA has provided federal seed funds—usually $100,000 for two-year projects but up to $300,000. State agencies have provided staff time and support, and most of the work of scientists, technical specialists, and citizens in the technical work groups and public advisory committees has been voluntary.

For developing countries, the United States Agency for International Development (USAID) has suggested a typical schedule of between four to six months. Some CRAs have taken up to one year to prepare, depending on the difficulty of data gathering and the extent of public involvement. Rapid evaluations of a broad set of risks yield less certain results, but they do give an idea of the magnitude of the problems associated with pollution sources, provide a means of incorporating public views into the decisionmaking process, and illustrate the importance of pollution problems. Even a fairly rough CRA, without extensive public participation activities, can be useful as a first step in heightening awareness of environmental issues and indicating priorities for action.

Sources of Information

For a more detailed version of this paper, including highlights of CRAs conducted in the United States, see the World Bank Pollution Management Web site (http://www-esd.worldbank.org/pollution). For additional technical information on CRAs, see the chapter on Comparative Risk Assessment in the *Pollution Prevention and Abatement Handbook* (http://www-esd.worldbank.org/pph/part2/Setting1.html). The USEPA *Guidebook to Comparing Risks and Setting Environmental Priorities* (http://www.epa.gov/opperspd/risk.htm) is an excellent source of information. Two centers set up with USEPA support to assist states and cities with CRAs have prepared numerous publications and case studies, available at http://www.gmied.org/ and http://www.wced.org/. The World Bank's Decision Support System and Industrial Pollution Projection System (http://www.worldbank.org/nipr/polmod.htm) are useful for supplementing pollution and risk data. A key source of information for the evaluation of health risks is provided by the USEPA Integrated Risk Information System (IRIS), which contains a large collection of files on the health effects of individual chemicals (http://www.epa.gov/iris/). Information on ecological risk assessment can be found in http://www.epa.gov/ncea/ecologic.htm. Other useful documents include R. Minard and K. Jones, *State Comparative Risk Projects: A Force for Change* (1993), http://www.epa.gov/docs/futures/risk/crexamples/reviews/change.txt.html; *California Comparative Risk Project Report* (1994), at http://www.epa.gov/docs/futures/risk/crexamples/examples/california.txt.html; the Ohio EPA, *Recommendations to Reduce Environmental Risk in Ohio* (1997); *The Maine Environmental Priorities Project*, at http://www.state.me.us/dep/mepc/index.htm; and *The City of Seattle's Environmental Action Agenda* (1992, 1996).

Note

This PMDN is based on the Comparative Risk Assessment chapter in the World Bank's *Pollution Prevention and Abatement Handbook* and on a review of U.S. experience with comparative risk assessments.

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