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A Focus on Risk: States Reconsider Their Environmental Priorities

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Three political forces are colliding in most of the northeastern states like so many continental plates: tighter state budgets, weaker business conditions, and expanding public expectations for environmental protection. The collision is shaking the status quo and leading some policy makers co use the "comparative risk process" as a tool to manage change. This article will explain "comparative risk" and show how focusing on risk can help states build a more appropriate and resilient set of environmental priorities and create more effective strategies to address them. The article will illustrate its points with the results from state projects in Vermont, Louisiana, and Washington, and from national and regional projects conducted by the U.S. Environmental Protection Agency (EPA).

So far, the record is good. Over the last five years, the EPA and the states have shown that the comparative risk process can raise the quality of environmental policy-making - at any level from the household to the federal government - by replacing crisis management, inertia, and conventional wisdom with informed judgment.

Comparative risk and public policy

Seeking the best use of scarce resources

Information and judgment are the basic components of comparative risk. The process starts with a quest to gather and to understand the best information available about the causes and consequences of a range of environmental problems. By sticking to a fairly rigorous, systematic approach to gathering and presenting data, participants are able to make useful comparisons among the problems. These judgments usually take the form of a comparative ranking of the problems in the order of the risks they pose. Figure 1 shows the final rankings of such a project in Vermont. These rankings usually conclude a project's first phase: the comparative risk analysis. Typically, the second phase focuses on setting priorities for action: risk management. This article includes both phases in its definition of the comparative risk process.

Figure 1: Public Advisory Committee Ranking of Environmental Problems: 19 November 1990

	PUBLIC ADVISORY COMMITTEE RANKING OF ENVIRONMENTAL PROBLEMS: 19 NOVEMBER 1990			
	ECOSYSTEMS	HEALTH	QUALITY OF LIFE	COMBINED RANKING
HIGHER RISK TO VERMONT AND VERMONTERS	1. alteration of Vermont's ecosystems	1. indoor air pollution	1. alteration of Vermont's ecosystems	A. alteration of Vermont's ecosystems global climate change indoor air pollution
	2. global climate change	2. toxics in the household toxics in the workplace	2. global climate change	B. air pollution ozone depletion
	3. ozone depletion	3. ozone depletion	3. air pollution pollution of lakes, rivers and streams visual and cultural degradation of Vermont's built and natural landscape	C. drinking water at the tap pollution of lakes and ponds toxics in the household toxics in the workplace
	4. air pollution	4. air pollution	4. hazardous waste solid waste	D. hazardous waste pollution of rivers and streams solid waste visual and cultural degradation of Vermont's built and natural landscape
	5. pests (exotic species)	5. drinking water at the tap	5. drinking water at the tap groundwater pollution, other than drinking water loss of access to outdoor recreation ozone depletion toxics in the workplace	E. food safety groundwater, other than drinking water loss of access to outdoor recreation pesticides and pests, excluding exotic pests
	6. pollution of lakes and ponds	6. food saftey	6. indoor air pollution pests and pest management	
	7. pest management	7. pollution of lakes, ponds, rivers and streams	7. food safety toxics in the household	
	8. pollution of rivers and streams	8. hazardous waste		
LOWER RISK TO VERMONT AND VERMONTERS	9. hazardous waste	9. solid waste		
	10. solid waste	10. pests and pest management		
	11. groundwater pollution			

Note: Problems of equal rank are listed alphabetically within their group.

Every project to date has estimated and ranked risks to human health and to the health of ecosystems. Most projects have also tried to estimate and rank the problems' economic impact, or, more broadly, their impact on people's quality of life.

Rarely, however, is the available information complete enough or well enough understood to be taken as indisputable scientific fact. Thus the analysis inevitably ends with personal judgments based on the data and shaped by the participants' values. In other words, the process starts with hard science and ends with something far more value-laden and political.

Some people dismiss the utility of comparative risk when they discover that it isn't and can't be purely scientific. Others charge that the very notion of comparing environmental problems, ranking risks, and setting priorities for action is somehow immoral and counterproductive. Government should be solving all problems, they say. These objections miss the point: decision-makers at every level set priorities every day. Too often, they do so without much information and without carefully choosing the criteria they use to make judgments. The results can be misdirected and wasteful policies.

Good information and good intentions do not guarantee success in public policy. If government managers or scientists neglect to match their policies with the public's understanding and wishes, the policies will fail and the public's disenchantment with government will grow. Hence the constant repetition of the word "process" in this article: involving the public in the comparative risk process is both important and possible.

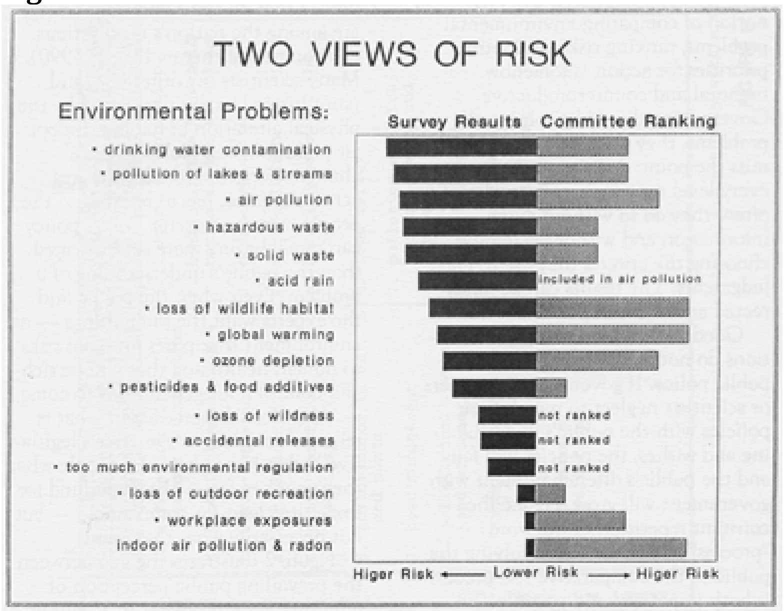
By conducting a scientific inquiry in a public forum with lay participants who exercise significant control over the process, states can build something approaching a consensus on environmental issues, a coalition that includes scientists, politicians, diverse interest groups, and the general public. By making it possible for almost anyone to participate in the science and analysis, the comparative risk process can take politics beyond the normal constraints of public fads and fear.

Risk and public perception: the political context

One of the problems the comparative risk method seeks to solve is deep and difficult: there is a large gap between the public's perception of environmental problems and the scientists'. Most Americans are convinced that oil spills and toxic wastes are among the nation's most serious environmental threats (Roper 1990). Many scientists say otherwise, and point instead to the risks posed by the physical alteration of habitat, indoor air pollution, and global climate change. Congress, like legislatures across America, has to respond to the people, not the experts. Public policy can rarely be any more sophisticated than the public's understanding of a problem. Even when the public and the experts want the same things - an environment that poses minimal risks to human health and that will be rich and bountiful for generations to come - they often disagree about what is required to attain it. America's legislative bodies have given the people what they've asked for - the Superfund for toxic site clean-up, for example - but not necessarily what they want.

Figure 2 illustrates the gap between the prevailing public perception of environmental problems in Vermont and a smaller group's more informed judgment. The Vermont comparative risk project did some informal survey work to find out what environmental problems Vermonters worried most about and why. The results of the survey appear on the left side of the graph. The respondents' top fear was of contaminated drinking water. Their smallest worry was indoor air pollution and radon. The right side of the graph shows the conclusions of the Vermont project's Public Advisory Committee, a diverse group of citizens who spent a year learning about and comparing the risks posed to Vermont and Vermonters by the state's environmental problems. The committee concluded that indoor air pollution and radon are among the highest-risk problems in the state; drinking water contamination is somewhere in the middle. Not surprisingly, the state's budget priorities are much more closely aligned with public perception than with the advisory committee's informed judgment.

Figure 2: Two Views of Risk



Similar results have been found around the country. A Roper poll (1990) demonstrated the divergence between the national opinion and the findings of EPA's Science Advisory Board. The gap between the two views of risk suggests that many of America's environmental programs may be missing the target.

When too little money and political capital is available to solve all environmental problems, it is essential that governments select priorities as carefully as possible. The comparative risk process is designed to help identify those priorities.

William Reilly (1991), the Administrator of the U.S. Environmental Protection Agency, described a related management problem that plagues his agency:

"Each time a new issue appeared on the radar screen of public concern, we would unleash an arsenal of control measures in a style reminiscent of the old 'space invaders' video game.... The consequence of this approach is obvious to all our employees: For twenty years we have established goals on a pollutant-by-pollutant and medium-by-medium basis without adequately considering broader environmental quality objectives. Rarely have we evaluated the relative importance of pollutants or environmental media-air, ecosystems and human health. Given the scatter-shot evolution of the Agency and its missions, we were seldom encouraged to look at the total loadings of pollutants deposited through different media from separate routes of exposure at various locations. We have seldom if ever been directed by law to seek out the best opportunities to reduce environmental risks, *in toto*, or to employ the most efficient, cost-effective procedures."

The same is probably true in most states. In Vermont, state government had organized itself along narrowly defined programs to address narrow pieces of environmental problems. The program staffs focused on their pollutant, natural resource, or set of EPA rules, and often failed to notice the consequences their fragmented efforts were having on the complex integrated environment. A desire to change this organizational culture was one of the principal reasons Vermont's environmental secretary initiated the state's comparative risk project.

The Vermont Agency of Natural Resources conducted one of EPA's pilot comparative risk projects. The "Strategy for Vermont's Third Century" ran from September 1989 through September 1991. EPA headquarters had developed the comparative risk methodology in 1986 and published its first comprehensive analysis of the nation's risks in the 1987 volume, *Unfinished Business*. This product of EPA's staff scientists seemed to be such a powerful tool for revising the agency's priorities that the agency's top managers encouraged other levels of government to follow suit.

By 1989, three of EPA's ten regional offices had completed comparative risk projects and the agency's Regional and State Planning Branch was pushing the other seven to do the same. These projects were completed in 1990 and are now being used in strategic planning efforts in the regions. Headquarters is urging the regional staffs to shift their priorities and spending away from lower risk problems and toward higher risk problems.

EPA's independent Science Advisory Board (SAB) examined both the methods and findings of *Unfinished Business* in 1989 and 1990. The SAB gave its strong endorsement to the comparative risk approach to setting priorities in its 1990 report, *Reducing Risks: Setting Priorities and Strategies for Environmental Protection*. The report concludes that the nation's environmental priorities are failing to address many of the most serious risks. William Reilly is using these findings, both within his agency and in Congress, to reshape EPA's agenda.

Meanwhile, EPA has encouraged states to join the movement. Colorado, Washington, and Pennsylvania pioneered the process at the state level starting in 1987. Vermont and Louisiana followed, with projects ending this fall. At this writing, roughly thirteen more states are set to receive EPA grants to start comparative risk projects by the end of the year. The agency wants at least twenty-five states to have engaged in the process by the end of 1992. (Editor's note: Maine has plans to seek funding from EPA for its own comparative risk project. If funded, the project would be expected to begin in 1992.) EPA is also financing comparative risk projects for the Gulf of Mexico and in Eastern Europe.

EPA has at least two motives for spreading the word. First, it has found that one set of priorities doesn't necessarily fit all locales. The biggest environmental risks in Vermont are not necessarily the same as the biggest risks in Louisiana or Colorado, and it makes sense for each region or state to target its resources toward the most locally significant problems. And second, EPA knows that it will only be able to make dramatic changes in federal priorities if the American people and their representatives in Congress are willing to go along. The state projects' aggressive public participation efforts have probably reached more people than EPA's in-house efforts ever will. State projects thus have the potential to improve environmental policy both at home and at the national level.

Reilly (1991) put the challenge this way: "We need to improve the translation of scientific knowledge into the vernacular of politics and public opinion, to make rational risk assessment a part of every citizen's common sense."

The converse is also true: we need to improve the translation of public values, such as a desire for equity, freedom from involuntary risk, aesthetic quality, and a deep commitment to future generations, into the vernacular of the scientists and regulators in order to make the non-quantitative side of the risk equation as powerful a force in establishing standards and priorities as are the probabilities that can be expressed as annual per capita cancer deaths. The comparative risk process's great strength is that it can bring together all the people needed to make more reasonable and durable policy decisions. Although technical information is sometimes difficult to assemble and present in clear, non-technical terms, judgment is in everyone's domain.

Which risks? Which units of measurement? Who decides?

As befits any serious inquiry, a comparative risk project needs to start with questions. Some of the questions relate to process, committee structure, and project management. Others are technical or methodological: Which model for carcinogenesis should we use? How do we measure ecological damage? Should we assume continued exposures at today's rates? How do we deal with incomplete data and uncertainty? Should we estimate risks from problems such as global climate change over which we have no jurisdiction? When calculating human health risks, should we focus on the risks borne by those few who are most directly exposed (to hazardous waste sites, for example) or pay more attention to the average exposures of the general public? How much of the data should we present, and to whom? How will the information be used?

The questions above only hint at the scope of issues that need to be settled before the technical work of a comparative risk project can begin. The questions also illustrate a more important point: very few of the so-called technical issues are devoid of value-laden choices. Even a decision to use EPA's method of estimating cancer risks implies the moral choice to err on the side of overstating risks to human health when the data are uncertain.

These points raise a more fundamental question: Who should decide the various issues? Government scientists? Appointed or elected officials? Interest group leaders?

Each project has to make these decisions for itself. What is most important is that the project organizers approach their challenge with an understanding that the technical questions cannot be divorced from the managerial or structural questions, nor from the broader political context or goals for the project.

A closer look at Vermont's comparative risk project, "The Strategy for Vermont's Third Century," will show how one set of participants wrestled with and resolved these questions.

Steps in a comparative risk project

The Vermont project had two distinct phases completed under three different administrations. Phase 1 (1990) focused on understanding and comparing risks. Phase 2 (1991) focused on managing risks and developing risk reduction strategies.

Setting the goals; designing a process

Vermont's project started in 1988 when Jonathan Lash, then secretary of the Vermont Agency of Natural Resources, decided that Vermont would be able to set a more effective agenda for environmental protection if it conducted a comparative risk project. Lash convened a day-long work session with key officials in his agency, the Governor's Office, the Health Department and other departments with a stake in environmental policy. The meeting demonstrated the need for the project and created enough interdepartmental commitment to proceed. The latter was essential because conducting the risk analysis would require substantial staff support from throughout state government. Lash hired a director (the author of this piece) to work on the project full time in the fall of 1989.

Lash and his colleagues set the project's basic goals:

1. to assess and compare the risks posed by Vermont's environmental problems;
2. to build a broader understanding of environmental risk among the general public; and
3. to use the technical information and public understanding to change stare government's priorities for environmental protection and to encourage sound environmental action outside of state government.

Lash and the director developed the following structure for the project:

1. Three technical work groups would compile and analyze data about the state's environmental problems. The groups would look at the same set of problems from three perspectives: risks to human health, to ecosystems, and to quality of life. The groups would be composed of state employees from all the involved departments.
2. A steering committee, composed of the secretaries and commissioners of the involved departments, would have formal oversight authority.
3. A 20-member Public Advisory Committee would make the most important decisions: selecting and defining the problems to study; approving analytical methods and criteria; and ranking the problems.

The advisory committee's job would have two parts. First, it would have to learn enough about public attitudes and values to be able to rank the problems with confidence. Second, it would have to help the public learn about risks and the state's environmental problems. Lash and the director decided to give the Public Advisory Committee so much control because by creating a strong public advisory committee, the project and its ultimate decisions had a stronger connection with the public and a degree of credibility that could not have been achieved by a purely "government" study. The structure worked well. The official steering committee remained satisfied with the progress of the project and never met. The work groups and advisory committee occasionally felt threatened by the other's power but developed considerable mutual respect by the end of the project.

The structure's principal drawback was that it prevented the project from capitalizing on the publicity and sense of importance that a governor can generate. Its second drawback was that it left all decisions about how Phase 2 would be organized and managed for the new administration to make, weakening the coherence of the project and its ability to inspire political changes.

Two tracks: technical analysis and public outreach

The participants' first challenge was to select and define Vermont's most serious environmental problems for further study. The director and the three work groups created a single set of carefully defined problems with minimal overlap. The work groups presented this list to the advisory committee for consideration.

Meanwhile, the advisory committee had developed and adopted a mission statement and a public outreach plan that included public forums, numerous other smaller events, and distribution of a survey. The events and survey asked the public what environmental problems they were most concerned about and why. By insisting on learning why a problem was considered serious (*e.g.* it threatens the future, it is harmful to children's health, it disrupts the look of the land, etc.), the committee developed a keener sense of Vermonters' values. This information became a vital component of the risk ranking.

The advisory committee used the public input to modify the problem list submitted by the work groups. Because so much depended on the problems that were included for study, the selection required several meetings and ballots, and inspired an appeal for reconsideration by the work groups. Eventually, everyone was sufficiently satisfied to proceed. (Figure 1 shows the problems' titles.)

Analyzing the problems

The director helped the work groups develop their analytical approaches. He turned to earlier comparative risk projects conducted in the states and at EPA, and to the work then being done by the EPA's Science Advisory Board. The latter's innovations in ecosystem risks and economic issues were particularly useful. The director also used the advisory committee's public input to draft a set of criteria for measuring risks to Vermonters' quality of life.

The work groups and advisory committee adopted these methods and criteria before proceeding with the analysis. The work groups assigned individual members to analyze each of the problems. Most of the problems were investigated for risks to health, ecosystems, and quality of life. The work groups agreed to create integrated problem reports combining all three of these issues, something other projects had not tried. This approach encouraged work group members to broaden their perspectives on the problems and to learn more about the ways different programs were dealing with the same pollutants or polluters.

Some of the technical work was beyond the abilities of the Vermont teams, so members turned to consultants selected by EPA for assistance on some problems. The teams focused their original research on problems that required Vermont-specific investigation. On problems affecting most of the country in similar ways, such as ozone depletion, global climate change, and indoor air pollution, the work groups relied heavily on data that had been compiled for other projects. The work groups tried to be as quantitative and thorough as possible. Huge data gaps and limited time and resources for original research prevented the reports from being as rigorous and complete as all would have wished. The work groups used their professional judgment to bridge these gaps.

Preparing the Public Advisory Committee

Because the project would require a non-technical group, the Public Advisory Committee (and eventually the public at large), to make decisions based on the problem reports, the director set up a series of three training sessions. The project brought in nationally recognized experts and teachers to work with the advisory committee, the work groups, and the public, on risks to ecosystems, human health, and economics. The project sponsored risk communication training for the work group members and for the advisory committee to help them better understand technical issues and public perception.

When the work groups had completed their analyses, they spent a full weekend briefing the advisory committee members on their findings. The advisory committee's four regional subcommittees each held another public forum to discuss the results of the technical analysis with the public and to learn how the public would rank some of the problems, once equipped with the technical information.

Ranking the problems

Each of the three work groups ranked the problems and many of their subcomponents for the risks they had studied. The groups did not attempt to combine the three rankings into an integrated ranking. The technical groups were explicit about the criteria they used for ranking the problems, the degree of uncertainty inherent in each ranking, and the values that guided their interpretation of the data. With the help of an outside facilitator, the Public Advisory Committee agreed on a process for making decisions and then made four rankings: risks to human health, risks to ecosystems, risks to Vermonters' quality of life, and finally, an integrated ranking that included all of the risks. (See Figure 1.) The advisory committee selected a subcommittee to work with the director on drafting *Environment 1991: Risks to Vermont and Vermonters*, a summary of the project's findings and recommendations. The report's detailed companion, the *Technical Appendix*, includes the twenty technical reports and supporting documents prepared by the work groups. The Public Advisory Committee also used the report to make several recommendations to state government, including a basic assertion: "The primary goal of Vermont's environmental policy should be to reduce risks to ecosystems, human health, and Vermonters' quality of life."

Strategies to manage risks

Upon taking office in January, 1991, the Snelling administration melded Phase 2 of the comparative risk project into a comprehensive review of all of the Agency of Natural Resource's programs. The review was essentially an internal effort with an emphasis on improving efficiency, eliminating unnecessary programs, and maintaining environmental quality in the face of severe budget constraints. The concepts of risk and the information collected in Phase 1 helped guide the review and decision-making. At this writing, the immediate impact of the risk analysis appears to be positive but still small, as should be expected in any system that tends to make changes incrementally. The ultimate significance of the comparative risk work will be determined in budget and policy decisions made by administrations and legislatures in years to come. Even small annual changes in emphasis can produce significant changes in priorities in just a few years.

The comparative risk process can generate far more dramatic changes than have so far been seen in Vermont. The State of Washington responded to its comparative risk project's high ranking of air pollution by enacting a comprehensive clean air law. Washington and Colorado are working with EPA to target federal grants to address the states' higher risk problems. Vermont will probably commence a similar negotiating process in late 1991.

Vermont's approach to Phase 2 of the comparative risk project contrasts with the aggressive outreach efforts that Colorado, Washington, and Louisiana used to explain the risk rankings to the public and to build a consensus for change. Washington and Louisiana hosted large and highly successful "environmental summits" to involve the public in making risk reduction a political priority. Louisiana's project also hosted a series of "town meetings" across the state to bring the public directly into the decision-making.

The analysis and ranking: information and judgment

Still more choices

The comparative risk methodology is still changing, improving through innovation and better understanding of the technical issues, and adapting to new political situations. Because there is no "best" way to analyze environmental problems, the EPA is attempting to catalogue the most useful alternatives in a report called the Road Map to comparative risk. It should be published by the end of 1991. EPA hopes to standardize the process as much as possible without stifling innovation or discouraging states from making their projects fit their own needs.

Despite the variations, a few approaches have achieved something approaching the status of rule. The analyses measure "residual risk," not total risk or hypothetical risk. The residual risk from a problem is that which is left over after existing environmental controls have done their job. Thus, an analysis of the risks that raw sewage poses to the nation's surface water would first note that virtually all sewage is treated before it reaches rivers and lakes. The discharges from the treatment plants and from any remaining straight pipes would be the subject of a residual risk estimate.

The focus on residual risks has benefits and drawbacks. The benefit is that it reflects, as precisely as possible, today's reality. Analysts do not have to hypothesize about what would happen if all those treatment plants broke down at the same time or if someone invented a better technology. The primary drawback is that the analysis may convey the false impression that a problem posing low risks today may be insignificant and somehow undeserving of continued public investments in existing control strategies. It may be that maintaining those controls is the only way to keep the problem's risks so low. A tight focus on residual risk does not require the analyst to pay much attention to risk management: spotting ways to reduce risks or to prevent small risks from getting worse. Of course, a thoughtful analyst will keep a list of these issues on the side.

The other almost-rule of comparative risk relates to time. Projects generally produce a snapshot in time, a picture of the pollution and problems occurring today, rather than a dubious extrapolation way into the future. Whether measuring risks to people or ecosystems, the projects measure the impacts of today's pollution over the lifetime of the pollutant. Several projects have found it useful to bend this rule. For example, most of the projects' health-risk estimates also assume that people are exposed to today's level of pollution for a full seventy years. Most of the projects have also weighed the future risks posed by global climate change and ozone depletion.

Other rules are more flexible still. It is up to each project to decide what problems to look at and how. Some projects have relied exclusively on quantitative analysis; one project even succeeded in using a computerized geographic information mapping system to analyze and display results. Other projects have found rigorous ways to use qualitative analysis when hard data were unavailable, and to underscore the role that judgment and values play in the technical estimation of risks.

Health risks

Estimating health risks from environmental problems is simple in principle, yet highly uncertain in practice. Risk is a function of the toxicity of a pollutant or "stressor," the number of people who are exposed to the stressor, and the size and duration of each exposure. In theory, an analyst would simply tally up all the exposure data and churn out the number of health problems that a given environmental problem would be expected to cause in any year. A quick comparison of the numbers would reveal which problems are most serious.

Unfortunately, the science of health risk assessment is still crude. It simply can't deliver the kind of precision many people expect. Toxicity estimates are usually based on experiments with laboratory animals and so may have little relevance to humans. As tenuous as these estimates are, they don't even exist for most of the chemicals in commerce today. Further uncertainty results from the absence of much good data about human exposures to pollutants. As a result, even the most rigorous health assessments of a specific, well-monitored site can produce only rough estimates of risks of human cancer and non-cancerous health effects. Comparative risk projects must be conducted on a larger, less detailed scale than formal site-specific risk assessments. The generalizations are broader and the degree of precision smaller.

Nevertheless, the results of such a comparison can be credible, surprising, and important. In Vermont, for example, after looking at all the data available about Vermont's hazardous waste sites, indoor air pollution, and surface water pollution, both the technical and lay participants concluded that indoor air pollution is probably a much greater health threat than the other two. Despite the uncertainties, the analysis revealed useful information that few had ever fully considered.

Comparing health risks cannot be a completely "scientific" process. Personal or public values must enter into many of the decisions, such as deciding which is more serious: a problem like ground-level ozone that can reduce people's physical abilities or a problem like lead ingestion which can reduce people's mental abilities. The panel that reviewed national health risks for the EPA's Science Advisory Board refused to move from science to policy and make these value-laden decisions. The challenge for state projects is to be as explicit as possible about the values influencing the analysis and ranking. As noted above, the Vermont project's Public Advisory Committee sought out an understanding of the public's values before it made its rankings, an approach which was successful in Vermont.

Ecological risks

The techniques for estimating ecological risks are somewhat newer and fresher than those used for human health. The Science Advisory Board's panel on ecological risk did an extraordinary job in establishing useful criteria for the task.

Space and time are the keys. Analysts start by identifying the most important chemical or physical stressors associated with each environmental problem, and then estimate the stressors' impact on exposed ecosystems. (These steps are analogous to estimating health risks.) Analysts try to determine the size of the area affected by the stressor and how long it would take the ecosystem to recover from the damage if the stress were removed.

Some problems hyped as ecological disasters by the media cause only localized, short-term damage to ecosystems. A typical chemical spill in a river, for example, may radically change the life in and around a few miles of the stream, but leave no trace of damage just a few years later. Ozone depletion or global climate change, in contrast, may change ecosystems worldwide and take centuries to recover from, if recovery is possible at all. Species extinctions are permanent, of course, and some local changes - such as the elimination of migratory waterfowl habitat - can affect ecosystems across an entire continent. The space-time or extent-reversibility criteria provide a solid foundation for more detailed analysis.

Perhaps the biggest challenge in estimating and comparing ecological risks is keeping people and their values out of the picture. Considerations of the relative worth of sport fish versus other less tasty species are inappropriate here and can skew conclusions about environmental health. Natural resources are important to people for many reasons, and each comparative risk project ought to measure risks to resources on which people's jobs and emotional well being depend. These calculations belong in their own section, however. The two most-often-used names for this kind of analysis are "welfare" and "quality of life."

Risks to people's quality of life

Environmental problems that make people sick degrade people's quality of life. So do environmental problems that make it impossible to fish, swim, or hunt. So do problems that degrade the aesthetic quality of the environment by filling the air with haze or odors or eliminating the sound of songbirds. So do problems that put people out of work, or require them to spend their savings to replace water supplies, repaint their houses, or repair flood damage. So do problems that threaten the well being of future generations.

Measuring these costs is probably the most problematic part of the comparative risk process. EPA's own projects have typically either avoided any "welfare" analysis or considered only a handful of direct economic costs, such as the materials damage, crop losses, and health-care costs caused by various pollutants.

This narrow approach leaves out too much to be considered sufficient. It tends to undervalue or ignore anything not currently traded on financial markets - anything without an obvious price. Worse, because the approach usually yields a number preceded by a dollar sign, the damage estimates appear to be precise, concrete and meaningful, when they are none of these. Some projects, including Vermont's, have pushed the scope of the welfare analysis into a more comprehensive, albeit qualitative, analysis. The approach makes scientists and some economists nervous but makes perfect sense to anyone who has dealt with public opinion.

After talking with Vermonters about environmental problems, the project's Public Advisory Committee adopted seven criteria by which it would measure each problem's impact on the quality of Vermonters' lives: aesthetics, recreation, economic well-being, fairness, future generations, sense of community, and peace of mind. The information that supported the analysis ranged from precise numbers, including the number of people-days for which boil-water orders were in effect in a year, to softer polling data showing how intensely Vermonters felt about the quality of their visual landscape.

Perhaps because the analysts did not convey their findings as precise, concrete, or comprehensive, they were meaningful. The analysis of Vermont's solid waste problem, for example, pointed out that the problems with landfills are not so much their impact on human health or the environment, but on aesthetics, fairness, and peace of mind. The project's participants had no trouble ranking the state's problems based on these criteria and analyses. Although much of the information was relatively subjective, it still helped the committees make more informed judgments.

Integrating rankings

Figure 1 shows Vermont's four ranking lists. The last column is the most important: the integrated ranking. Most of the comparative risk projects sponsored by EPA have not produced an integrated ranking because the participants couldn't figure out how to do it scientifically. No formula seemed to work. (Should health be weighted twice as much as ecology, or half as much?) This reluctance to resort to a formula is wise, though the notion that dissimilar risks or priorities "can't be combined" is disproved every time a legislature passes a budget.

The only rule that seems appropriate for making an integrated ranking is to be as deliberate and explicit as possible. People should be able to see which values the decision-makers considered most important. The corollary to the rule is also important: the project should not claim that the integrated ranking is wholly "scientific."

Setting environmental priorities

Having completed a comparative risk analysis and ranking, the challenge for state governments is to use the results to achieve their policy goals. A sharp focus on risk can improve the effectiveness of some traditional management tools.

Strategic planning is perhaps the most important tool in the manager's arsenal. The planning process requires managers to be clear about their goals and objectives, to understand their position and options, and then to take steps to achieve their objectives. The final step, monitoring the results and adjusting accordingly, takes the process back to the beginning. The comparative risk analysis can be the intellectual foundation for a strategic planning process. It can show where action is needed and suggest the best ways to accomplish goals. The risks that are measured today can be the monitored indicators that will show success or failure tomorrow.

Enthusiasts of comparative risk presume that most states consider it important to reduce or at least manage environmental risks. Nowhere can risk reduction be the only goal, however. Keeping down taxes, social costs, and government intrusion into private affairs are also widely held goals. So too are economic development, social equity, expanding recreational opportunities, and preserving traditional industries and agriculture. After conducting a comparative risk project, participants may decide to modify those goals. The EPA's Science Advisory Board, for example, concluded its work with a recommendation that EPA start giving risks to ecosystems at least as much attention as it has given risks to human health.

Accomplishing any of these goals requires specific actions, and it is when policymakers get down to details that the comparative risk results become most useful. In addition to the risk ranking, the analysis will have produced an organized, up-to-date body of information about the status of the state's environment and environmental problems. Thus, the analysis can show where to start looking for places to save money without substantially increasing risk, or to spend more money to reduce risks of various kinds. Reference to the analysis can clarify the tradeoffs between conflicting goals, such as aesthetic protection, recreation, and public spending.

The analysis can show where different strategies will be most effective. Problems caused by a small number of polluters will require management strategies different from problems caused by nearly everyone. And problems that the public already understands and wants fixed will demand different treatment from problems, such as radon, to which the public is currently indifferent. Regulation may work best for the former, while education may be the only useful risk-reduction strategy for the latter.

The same conceptual tools and rigor that make it possible to compare risks also can help policymakers compare risk-reduction strategies to determine which are the most desirable to implement. A useful approach is to list a number of alternative approaches to managing a particular risk, and then to compare the alternatives' likely costs and benefits in terms related directly to the risk estimates. There is no magic formula in this process, only informed judgment. The process looks radical only when compared to the more typical approaches to budgeting and problem-solving: hiring freezes and across-the-board spending reductions that treat all people and programs as equals, or tinkering with staffing levels within bureaucratically defined programs. One of the advantages of looking for ways to reduce or manage risks rather than merely adjusting program budgets is that the effort encourages policy-makers to consider the full range of impacts that a policy might have on ecosystems, people, and government.

Another advantage of focusing on risks is that it opens the door to innovative, non-regulatory approaches to environmental protection and risk reduction. Comparative risk projects are showing that many of the big remaining risks facing America are caused by the small environmental insults caused by millions of individuals, rather than by a few large industries. The old "command-and-control" regulatory approaches either will not work against these remaining problems or will prove to be pointlessly inefficient. Relatively new tools, such as market-based incentives, cooperative pollution-prevention strategies, and the aggressive use of public information, can accomplish more good for less.

A useful tool

If cost were no object, no one would need to worry about comparative risk. State legislatures and Congress could simply pass laws requiring society to pay whatever it takes to eliminate all environmental problems once and for all. Because that day will never come, individuals and their governments should try to get as much environmental protection as possible for their money. The comparative risk process can help make that happen.

The process offers no miracle cures, no easy consensus or mass conversion to altruism. The process doesn't even guarantee wisdom or certainty. The process does provide a way to make today's political systems work better: it allows more people access to more information; it encourages more people to debate fundamental issues of equity, safety, and the future; it provides a framework for making judgments, reaching agreements, and turning them into action. In short, the comparative risk process will not replace contentious democracy with a universally accepted Scientific Truth. Rather, the process gives democracy a chance to use scientific understanding for all it's worth.

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