Categorizing Risks for Risk Ranking

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Any practical process of risk ranking must group hazards into a manageable number of categories. Defining such categories requires value choices that can have important implications for the rankings that result. Most risk-management organizations will find it useful to begin defining categories in terms of environmental loadings or initiating events. However, the resulting categories typically need to be modified in light of other considerations. Risk-ranking projects can benefit from considering several alternative categorization strategies and drawing upon elements of each in developing their final categorization of risks. In principle, conducting multiple ranking exercises by using different categorizations could be interesting and useful. In practice, agencies are unlikely to have either the resources or patience to do this, but other groups in society might. Done well, such additional independent rankings could add valuable inputs to democratic risk-management decision making.

KEY WORDS: Risk ranking; risk categorization

1. INTRODUCTION

The past decade has witnessed growing interest in risk ranking. The U.S. Environmental Protection Agency (EPA) has been especially active, running three ranking exercises at the agency level8–10 and supporting almost 50 local and regional “comparative risk” ranking projects through its Regional and State Planning Bureau.8–10 In an effort to gauge priorities of nonexperts and nonstakeholders, many of these exercises have involved laypersons. Elsewhere in the U.S. government, the Occupational Safety and Health Administration has recently undertaken a broad priority-setting exercise that involves considerable input from stockholders in labor and industry, as well as from the scientific community.9 In addition, the Federal Aviation Administration has launched an effort to prioritize its safety initiatives.8 Some foreign governments have also pursued ranking of national environmental priorities.8,9

Several choices must be made when preparing to rank risks. Risk-management agencies are typically responsible for thousands of specific hazards. Comparing and ranking such large numbers of risks systematically is infeasible, especially for lay groups. Therefore, one must first group risks into a manageable number of categories. Then, because risk is a multiattribute concept, one must choose a set of risk attributes against which to evaluate each category. Finally, one must develop descriptions of each category of risks in terms of the attributes. These descriptions, which we refer to as risk summary sheets, are needed to provide concise and systematic information on each risk to those who perform the ranking.

This paper addresses the problem of grouping risks into categories.2 We begin with a brief critique of the categorizations used in past risk-ranking exercises in the environmental domain. We then review selected literature on the general subject of categorization. From this review, it will become apparent that

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2 In other writings, we address the issues of choosing attributes, preparing risk summary sheets, and methods that individuals and groups can use to rank risks.12
tions between routine and accidental events. Others do not. Finally, RCRA and Superfund hazardous waste sites are distinguished from each other, presumably because each is covered by a different administrative program, even though other characteristics of the risks from RCRA and Superfund sites are very similar. EPA’s guidebook on comparative risk does not offer a rationale for choosing these particular categorizations, nor are alternative schemes explored. A survey of participants in past comparative-risk projects revealed criticisms that “problem areas were too broad, lacked common measurement criteria, and failed to distinguish past and present activities.”

The lack of attention to the implications of alternative risk categorizations in past risk-ranking exercises is a problem because the results of risk-ranking efforts can be very sensitive to the way that risks are divided up in the first place. In addition, using mixed criteria for defining categories (e.g., affected resource in some cases and human health endpoint in others) can result in biases of inclusion and exclusion, as well as double counting. This may not be a problem if, as noted by Minard, agencies that sponsor comparative-risk exercises “are putting a higher premium on using the list as a risk-communication tool rather than on its intellectual consistency” or are using ranking as a vehicle to promote stakeholder interaction. However, if an agency wants to use the results of a risk-ranking project as input to risk management, explicit analysis of the basis for choosing risk-categorization schemes is clearly needed.

3. CATEGORIZATION IN THE PSYCHOLOGY, NATURAL SCIENCE, AND RISK LITERATURES

The substantial psychological literature on categorization is primarily concerned with how people learn existing classification schemes and how they develop classifications for sets of objects or concepts. Most of the work prior to the late 1970s adopted a tradition that Komatsu has termed the similarity-based view. This tradition holds that the inclusion of a particular instance in a category is based upon the similarity of that instance to some abstract specification. As originally formulated, the similarity-based view “held that all instances of a concept share common properties, and that these common properties were necessary and sufficient to define the concept.” Later literature in this tradition adopts less restrictive, sometimes probabilistic, formulations in
which (1) individual instances bear a “family resemblance” to an idealized category member referred to as a “prototype,” (2) categories are constructed on the basis of similarity comparisons among the individual instances or “exemplars,” or (3) categories result from the use of a cognitive “schema” that often includes both the prototype and the individual exemplars.\(^{(22,23)}\)

A second tradition, which Komatsu terms the explanation-based view of categorization, developed in the 1980s. In this literature, which draws upon cognitive schemas and knowledge-based representations of the world, categorizations are viewed as constructed on the basis of relationships that exist between instances and categories. In the words of Keil,\(^{(24)}\) “coherent belief systems, or ‘theories,’ are critical to understanding the nature of concepts and how they develop.” Arguing in this tradition, Medin and Ortony\(^{(25)}\) suggest that “people act as if their concepts contain essence placeholders that are filled with ‘theories’ about what the corresponding entries are” and that “these theories often provide or embody causal linkages to more superficial properties.” These authors suggest that “organisms have evolved in such a way that their perceptual (and conceptual) systems are sensitive to just those kinds of similarity that lead them to the deeper and more central properties.” They term this formulation psychological essentialism, arguing that although real physical objects may not have Aristotelian essences, people’s cognitive models of such objects do.

One general characteristic of the explanation-based view of categorization is that objects, which on superficial consideration have little or nothing to do with each other, may be linked to form a category by some underlying scenario or knowledge structure. Medin and Ortony\(^{(25)}\) illustrate this point by describing whales as mammals that look like fish. Barsalou\(^{(26)}\) gives an example of a category consisting of children, pets, photo albums, family heirlooms, and cash—the set of things one should grab on leaving the house in the event of a fire. Clearly this is a category that takes on meaning only because of an underlying set of knowledge and beliefs. Indeed, it is a category that is meaningful only in a particular decision context that clearly defines the actor’s goals for categorization. Komatsu\(^{(22)}\) notes that “the explanation-based view casts doubt on the assumption that concepts can be understood independently of the inferences they enter into. It may even cast doubt on the assumption that concepts are stable representations. Abandoning these two assumptions makes the study of concepts enormously more complicated.”

In the natural sciences, the objective of classification has frequently been to develop a “natural system” that is “believed to be in accord with nature.”\(^{(27)}\) However, here too issues arise regarding the features that should be used to form the categories, whether these features are directly observable (e.g., similarity in bone structure), or depend upon some deeper structure (e.g., similarity in genetic code). Sokal\(^{(27)}\) draws attention to the distinction between monothetic classification systems, “in which the classes established differ by at least one property that is uniform among the members of each class” and polythetic systems in which “individuals or objects that share a large portion of their properties … do not necessarily agree in any one property.” Note that this distinction has strong parallels with the development of the similarity-based view mentioned previously.

Cvetkovich and Earl\(^{(28)}\) have identified two motivations for classification in environmental psychology. The first, which they term essentialist, aims to “devise systems that accurately reflect categories of phenomena (taxa of animals or plants for example) as they exist in nature.” The second motivation, which they term constructivist, is based upon human decisions constrained by knowledge of the world. This approach “considers classification systems as aids to thinking and communicating and assumes that there is no single generally best classification system. The quality of a classification system depends upon how well the functions of analysis and communication are performed. Thus, whether one system is better than another depends upon the specific aims of its user.”\(^{(29)}\)

Cvetkovich and Earl review a large number of alternative systems that have been proposed by different authors for classifying hazards. Three things are apparent from this review: (1) As with the explanation-based psychological approaches described by Komatsu, risk classification schemes can vary greatly depending upon the underlying perspective and knowledge used in their construction; (2) different objectives are best served by different classification schemes; and (3) given the inherent multivariate nature of risk, virtually all classification schemes that have been proposed are, in Sokal’s terms, highly polythetic.

\(^1\)Note the confusion in nomenclature. What Cvetkovich and Earl term “constructivist” is very similar to what Medin and Ortony term “essentialist,” whereas what Cvetkovich and Earl term “essentialist” is very similar to what Komatsu terms the “similarity-based view.”
4. CRITERIA FOR EVALUATING CATEGORIZATIONS

Although experts may be able to describe a risk objectively in terms of specified attributes, deciding which of two hazards is more risky requires value judgments. For example, in our middle-school test bed, commuting to and from school by private car, bicycle, or on foot produces the largest expected number of annual deaths, whereas transporting hazardous materials over nearby rail and road corridors produces a much lower expected number of annual deaths. On the other hand, in the unlikely event that it happened, a catastrophic hazardous material transportation accident could kill many more students than the largest imaginable commuting accident. Which of these risks someone is more concerned about depends in large part on a value judgment about the relative importance of annual expected mortality versus large numbers of fatalities in low probability accidents.4

4 In our middle-school test bed, hazardous material transport yields roughly $10^5$ fewer expected annual fatalities than commuting. The largest plausible hazardous material accident kills roughly 10 times as many students as the largest plausible commuting accident. In risk-ranking exercises that we have run, commuting is ranked as one of the risks of greatest concern, whereas hazardous materials transport receives low rankings.

Judgments about the relative importance of different attributes are not the only value judgments required in risk ranking. The process of categorizing a large number of hazards into a manageable number of categories also requires value judgments. Because different people and organizations have different concerns about risks, there can be no entirely value-free way to classify risky phenomena.5 In the case of the school, should commuting in school buses be combined in the same category with commuting in private cars, bicycling, and walking? Should the common cold be included in the same category as more serious infectious diseases such as pneumonia and meningitis? Should risks from chlorine transport on the nearby railroad be combined with risks from on-site chlorine gas, which is stored in pressure tanks at the school for treatment of the water in the swimming pool?6 The choices one makes about such options can have important consequences for the rankings that result.

5 In our middle-school test bed, school-bus accidents (which yield, on average, about 0.0002 deaths per year) are categorized separately from private commuting (which yields about 0.03 deaths per year). The risks associated with driving, walking, and bicycling are reported separately in the risk summary sheet. Chlorine is not treated separately from other hazardous material accidents, although it is singled out as a major contributor to risk in the discussion in the risk summary sheet. Risks from chlorine used to treat swimming pool water are included in a separate risk summary sheet that describes “accidents.”

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of facility that creates the environmental loading (power plant, steel mill, etc.), one might consider the facility's organizational or legal status (profit, non-profit, cooperative, municipal, etc.). In addition to the age, sex, and race of the persons affected by the pollutant, one could consider more complex historical and relational social factors (families, economically depressed areas, culturally unique artifacts, etc.).

Risks differ in terms of where along the chain of risk processes management intervention is most commonly or efficiently applied. Interventions might focus on modifying human activities, reducing inventories, limiting the release of hazardous materials, shielding or otherwise protecting those who could be exposed, ameliorating damage once it has occurred, or compensating victims. Because most risk-management organizations devote most of their attention to the early stages of the chain, in most cases it makes sense for them to begin the process of categorization by sorting risks according to human activities, environmental loadings, or initiating events.

However, categorization that is based only on these early steps in the chain will probably not incorporate all the attributes that regulators and the public find important. Having begun categorization in terms of environmental loadings or initiating events, one will typically need to modify categories in light of other considerations. The revision process that we went through to categorize the 22 risks in our middle-school test bed is described in Florig et al. figure 2 illustrates how such logic might apply to the categorization of risks associated with air pollution.

The final list of categories in Fig. 2 looks fairly standard, and it is tempting to stop at this stage. However, we believe that developing several alternatives before settling on a final categorization is useful. Figure 3 illustrates the logic that could be used in developing such alternative categorizations for the case of air pollution.

In addition to the factors illustrated in Figs. 1 and 2, various other considerations, including agency administrative organization and regulatory statute, may sometimes be relevant. These and other considerations are discussed in the next section.

Careful consideration of several alternative categorizations encourages broad systematic thinking about what is important about the risks that are to be categorized and ranked. In choosing a final categorization, it is typically desirable to draw upon elements of several of the alternatives that have been considered.

Fig. 2. Illustration of how consideration of various factors along the chain of risk processes can modify an initial categorization on the basis of a choice of loading (or initiating event).

Fig. 3. Several alternatives to the categorization shown in Fig. 2. Although it is less likely that an organization responsible for managing air-pollution risk would want to use any of these categorizations in place of that developed in Fig. 2, they might well wish to refine the categorization of Fig. 2 in light of insights gained by considering these alternatives. Private organizations, with different agendas, might wish to conduct their own ranking exercises by using such alternative categorizations.
In principle, conducting multiple ranking exercises by using different categorizations could be interesting and useful. In practice, agencies are unlikely to have either the resources or the patience to engage in multiple rankings. But of course, there is no reason why careful, well-executed risk rankings should be the sole domain of risk-management agencies. Although risk-management agencies will probably want to operate with categories that are derived from an initial consideration of loadings and initiating events, organizations that are more concerned with equity or the distribution of social and economic power may wish to commission rankings that are performed by using very different classification schemes. If done well, such rankings could add valuable inputs to democratic risk-management decision making.

6. WORKING OUT THE DETAILS

Criteria for judging the merits of specific risk categorizations have been mentioned previously,(4,34,35) but these have not been fleshed out to any extent. In addition to reflecting risk-management objectives as argued previously, an ideal risk-categorization scheme should be logically consistent, compatible with administrative systems, equitable, and compatible with human cognitive limitations. Table I elaborates on these objectives. Applying the criteria of Table I to the task of developing categories is complicated because these criteria often conflict. In this section, we draw upon our experience in developing the middle-school test bed and in assisting with risk-ranking exercises in Allegheny County, Pennsylvania, to discuss some of the difficulties and conflicts that can arise and identify some of the subtle ways in which category development can influence how risks are framed and compared.

6.1. Logical Consistency

Risk categories should be exhaustive, encompassing all relevant risks. But to assure that nothing falls through the cracks, category definitions might need to be quite exact. Creating lists of subcategories, and even sub-sub-categories, can be helpful in assuring that inclusion and exactness criteria are satisfied. Note that these subcategory lists would be used only to help define the categories and would not, themselves, be ranked.

Risk categories should be mutually exclusive so that management priorities derived from risk rankings can be unambiguously targeted. Using the subcategory exercise described previously can help identify overlaps between categories. In our middle-school test bed, we identified a number of overlapping risks in the process of preparing the risk summary sheets describing each risk category. For instance, in the process of preparing the risk summary sheets for “Allergens” and “Food Poisoning” in our middle-school test bed, we realized that risks from school cafeteria food containing allergens could fit in either of these categories.

Table I. Desirable Attributes of an Ideal Risk-Categorization System for Risk Ranking

<table>
<thead>
<tr>
<th>Categories for risk ranking should be:</th>
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<tbody>
<tr>
<td><strong>Logically consistent</strong></td>
</tr>
<tr>
<td>• Exhaustive so that no relevant risks are overlooked.</td>
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<tr>
<td>• Mutually exclusive so that risks are not double-counted.</td>
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<tr>
<td>• Homogenous so that all risk categories can be evaluated on the same set of attributes.</td>
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<tr>
<td><strong>Administratively compatible</strong></td>
</tr>
<tr>
<td>• Compatible with existing organizational structures and legislative mandates so that lines of authority are clear and management actions at cross purposes are avoided.</td>
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<tr>
<td>• Relevant to management so that risk priorities can be mapped into risk-management actions.</td>
</tr>
<tr>
<td>• Large enough in number so that regulatory attention can be finely targeted, with a minimum of interpretation by agency staff.</td>
</tr>
<tr>
<td>• Compatible with existing databases, to make best use of available information in any analysis leading to ranking.</td>
</tr>
<tr>
<td><strong>Equitable</strong></td>
</tr>
<tr>
<td>• Fairly drawn so that the interests of various stakeholders, including the general public, are balanced.</td>
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<tr>
<td><strong>Compatible with cognitive constraints and biases</strong></td>
</tr>
<tr>
<td>• Chosen with an awareness of inevitable framing biases.</td>
</tr>
<tr>
<td>• Simple and compatible with people’s existing mental models so that risk categories are easy to communicate.</td>
</tr>
<tr>
<td>• Few enough in number so that the ranking task is tractable.</td>
</tr>
<tr>
<td>• Free of the “lamp-post” effect, in which better understood risks are categorized more finely than less understood risks.</td>
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Sometimes making risk categories distinct is difficult because some risks are coupled in a risk-management sense so that risk-management measures that affect one category can reduce or exacerbate risks in another category. For example, measures to reduce the health and ecological impacts of sulfur dioxide emissions from coal burning can accelerate climate warming by removing fine particles from the atmosphere, thus decreasing the planetary albedo. Such links between categories weaken their independence and complicate the task of deriving risk-management priorities from risk rankings.

Risk categories should be defined so that they can be evaluated on a common set of attributes. Sometimes finding a common set of attributes to describe all risk categories of interest is difficult because the categories are so diverse. For instance, the attributes of behavioral risks such as drug abuse and sexually transmitted diseases are quite different from those of environmental risks such as radon and lead dust from old paint. Yet a school district examining school risks might want to include both behavioral and environmental risks in the same ranking exercise.

### 6.2. Administrative Concerns

Most people would agree that the risks addressed by risk ranking within an agency should include at least the set of risks for which the agency has a legislative mandate. Often, however, agencies reach beyond the minimum set that is required by law. EPA's attention to naturally occurring radon and the Food and Drug Administration’s (FDA's) attention to tobacco are examples of such behavior. In selecting risk categories for risk ranking, one might ask how far outside an agency’s legislative mandate risk categories should be defined. If EPA includes radon in its ranking exercise, should it also include other “natural” environmental hazards such as soil dust particles or natural allergens in the air? Because an important objective of ranking is to examine the adequacy of current agency priorities, we think being more expansive and inclusive is generally wise.

Making categories compatible with technical, regulatory, and organizational elements can sometimes lead to awkward divisions of risks. For instance, indoor tobacco smoke is regulated in public buildings but not in private homes. Radon from industrial sources and mill tailings is regulated, but radon in homes is not. Therefore, risks from indoor air pollution in homes might be placed in a different category than identical risks elsewhere.

What about risks that are currently unknown or poorly understood and therefore not specifically covered by existing legislation or organizations? These might include both risks that are already addressed generically by legislation (e.g., carcinogenic effects from human exposure to new industrial chemicals) and those that are not (e.g., many types of unknown risks to ecosystems). By including a general category of poorly known but suspected risks (e.g., endocrine disrupters, power-frequency electric and magnetic fields), agencies may be able to develop some sense of the value that the public places on exploratory research.

Priorities derived from risk ranking ultimately need to be mapped into risk-management actions. This can be facilitated if risk categories are defined to be management relevant, as described in Section 4.

Some risks have fallen completely off the radar screen because, like boiler explosions, strategies for their adequate management were adopted years ago, or because, like horse manure on city streets, technological or societal changes have made them irrelevant today. Other risks, such as radon, are currently only partially controlled, even though additional management actions would in many cases be cost effective. Still other risks, such as collisions between small cars and sport-utility vehicles, are relatively new and thus may not have been adequately addressed. In defining risk categories, it is important to consider the extent to which uncontrolled, partially controlled, fully controlled, or obsolete risks are to be included in the analysis.

Data on population exposures to risks and risk consequences are often collected by organizations different from those responsible for risk management. Even when data collection and management are done by the same agency, the office responsible for data collection might not use “applicability to risk management” as a strong criteria for designing data collection, preferring instead to focus on criteria such as tradition or convenience. As a result, databases are often mis-aimed, too coarse, or too sparse to permit agencies to divine some risk categories that might be of interest. Risk ranking may offer a useful vehicle for reevaluating an agency’s data-collection practices.

### 6.3. Equity Concerns

Risk categories can carry ethical implications. Categories can be drawn to highlight risks produced
by a particular moral agent (e.g., industry, nature). Categories can be drawn on the basis of some quality of fairness, such as the extent to which those at risk consent to being exposed or the extent to which the benefits of the risky activity accrue to persons other than those at risk. Categories might also be chosen on the basis of specific attributes of a population such as special vulnerabilities or past experience (as in arguments for environmental justice). Even when such factors are not included in the process of categorization, considering them in later stages of risk ranking is still possible by incorporating equity and controllability as attributes of each risk category.

6.4. Cognitive Concerns

The categorization of risks can have powerful effects on the cognitive frames that people use in risk ranking. Particular risks can be made to seem significant or insignificant, simply by shifting the risk bundles presented for ranking. Indoor air pollution, for instance, may seem to have very different health impacts depending on whether radon is included among the pollutants. Similarly, indoor air pollution may seem to be dreaded or not depending on whether asbestos is included. EPA has noted this bundling effect with respect to ground-water:

Ground-water can be contaminated by numerous sources, such as pesticides, leaking underground storage tanks, salt/sand mixtures used to de-ice slippery roads, solid and hazardous waste sites, improper storage of hazardous materials at all sorts of commercial and industrial facilities, and residential septic systems. Questions arise as to how to allocate these risks. At first glance, counting ground-water risks in the problem areas where they occur would seem to be the best approach. For example, ground-water contamination associated with hazardous waste sites would be counted as one of the risks for the hazardous waste problem area. However, it has been found from past comparative risk projects that ground-water risks become “lost” among a number of different problem areas as a result. This has created difficulties in communicating a comprehensive picture of the risks posed by and to ground-water.

Changing the way that issues are categorized can also significantly alter the salience of particular attributes. A categorization example that does not involve risk is instructive. In the 1970s, the federal government’s decision to impose waterway user fees was due, in part, to changes in perception resulting from reclassifying navigable waterways as transportation corridors rather than as natural resources.

. . . one [Hill staffer] attributed the passage of a waterway user charge partly to a change in categories. As he put it, “Navigation always used to be considered a part of water resources policy. It is only recently that it has come to be thought of as transportation.” This change had an important effect. If waterways are categorized as water resources, then such navigation projects as locks and dams, canals, and dredging would be compared to such projects as reclamation and irrigation. But if waterways are viewed as corridors of transport, then a barge’s use of locks and dredged channels without paying any user fee is unfair when compared to the fuel taxes paid by users that finance highway construction and maintenance, the ticket tax on airline travel that finances airport construction, and the railroads’ own expenditures for right-of-way construction.

Examples in which risk recategorization could greatly affect attitudes toward management include efforts by FDA to reclassify tobacco as a drug rather than as an agricultural commodity and efforts by Mothers Against Drunk Driving and various gun-control groups to frame their respective issues in terms of public health or child safety.

Category definitions should be easy to communicate, but because risks overlap each other in complex ways, finding simple rules for separating them is often difficult. For instance, indoor air pollution would seem to be a risk category that is simple to define. But complications arise when one considers whether or not this category should include radon, direct inhalation of tobacco smoke, infiltration of outdoor pollutants, or other risks that the category label might not obviously subsume. To be accurate, therefore, category definitions often must often contain a number of conditions and caveats. Such complications can make categories more difficult to communicate.

Cognitive limitations restrict the number of risk categories that people can thoughtfully rank to perhaps a few dozen. Yet, typically, regulatory organizations focus at finer levels, with the result that they must set priorities among hundreds of separate risks. One way to deal with this problem is to adopt an iterative hierarchical approach to risk ranking. For example, once “air pollution” has been identified as important in a ranking exercise, one could run a second exercise in which the risks to be ranked are all the different kinds of air pollution. Note that subcategory rankings can be used to set priorities only within a category and not across categories. Some subcategories of high-ranked categories may actually be of less concern than some subcategories of low-ranked categories. Agencies are unlikely to have the resources to do very much hierarchical risk ranking, but a few carefully chosen elaborations could go a
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long way to improving the utility of ranking as an input to an agency’s risk-management decision making.

An agency’s ability to categorize risks depends greatly on the amount of technical knowledge available. There is a natural tendency for agencies (and others) to categorize well-known risks in finer detail than poorly understood risks. At EPA, for instance, risks from carcinogenic chemicals in the environment have been treated in more detail than risks from hazardous but noncarcinogenic chemicals. Similarly, sources of human health risks have been categorized more finely than sources of ecological risks. In selecting a classification system, agencies should ask whether this “lamp-post effect” serves their management needs.

The knowledge of those doing the risk ranking may constrain the types of categories that are most appropriate. Groups of lay persons, for instance, may not find meaning in risk categories that depend on distinctions that are too technical (e.g., primary and secondary particulate air pollutants). Although lay persons may be able to best understand categories based on health endpoints or hazards that most immediately affect them, less salient categories (e.g., based on legislative boundaries, for instance) might still be workable, as long as the categories are understandable. Before finalizing the categories that will be used, having the categories reviewed by representatives of the groups that will use them in ranking would be wise.

7. CONCLUSIONS

Even within a specific domain of risk such as air pollution or airplane safety, the world is filled with numerous known and potential hazards. For this reason, any practical process of risk ranking must group hazards into a manageable number of categories. Defining categories requires value choices. These choices can have important implications for the rankings that result.

Because a similarity-based approach to risk categorization is inherently ambiguous, we believe that it makes more sense for risk-management organizations to categorize risks according to the goals of the organization and the risk-management decisions that they face. In most cases, these organizations will find it useful to begin defining categories in terms of human behavior, environmental loadings, and initiating events. However, before a set of risks will be useful in risk ranking, categories that result from such an approach will almost always need to be modified in light of other considerations.

Agencies or organizations conducting risk-ranking projects would be well-advised to develop several alternative categorizations before settling on a final choice. Careful consideration of several alternative categorizations encourages broad systematic thinking concerning what is important about the risks that are to be categorized and ranked. In choosing a final categorization, drawing upon elements of several of the alternatives considered will typically prove useful.

In principle, conducting multiple ranking exercises by using different categorizations could be interesting and useful. Although government agencies are unlikely to do this, other organizations in the society might. Such additional independent rankings could add valuable inputs to democratic risk-management decision making.

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