Environment & Society

White Horse Press

Full citation: Gregory, Robin S., "Incorporating Value Trade-offs into Community-Based Environmental Risk Decisions."
Environmental Values 11, no. 4, (2002): 461-488.
http://www.environmentandsociety.org/node/5867

Incorporating Value Trade-offs into Community-Based Environmental Risk Decisions

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ABSTRACT

Although much attention has been given to the role of community stakeholders in developing environmental risk-management policies, most local and national initiatives are better known for their failings than their successes. One reason for this continuing difficulty, we contend, is a reluctance to address the many difficult value trade-offs that necessarily arise in the course of creating and evaluating alternative risk-management options. In this paper we discuss six reasons why such trade-offs are difficult and, for each, present helpful techniques from the decision sciences along with case study examples of successful applications.

KEY WORDS

Risk management, values, trade-offs, decision making

1. INTRODUCTION

Policies for managing environmental and health risks increasingly are developed in response to the expressed values and opinions of lay and expert citizens. These values in turn are used to inform policy makers about the concerns of their constituents in the context of proposed health or environmental risk-management options.

A blueprint for helping community members to become involved effectively in risk management initiatives has been outlined by the United States National Research Council in two well-received publications, *Improving Risk Communication* (1989) and *Understanding Risk* (1996). Both reports advocate a mix of technical analyses and stakeholder-based deliberations as the foundation for

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successful community participation in risk decision making. Supplemented by a rich professional literature drawn from economics, behavioural decision making, psychology, sociology and policy analysis, there is no shortage of thoughtful suggestions for how to join technical analyses with stakeholder participation in the context of developing solutions to community-based environmental risk management problems.

With so much attention given to community participation in risk-based deliberations, an obvious question is: Why do there remain so many stalled, unpopular, or otherwise problematic environmental risk-management initiatives? We believe that a primary reason is the inability of most community-based risk initiatives to deal effectively with the difficult value trade-offs that emerge over the course of nearly all risk policy consultations. The source of this difficulty is twofold and fundamental: a refusal to recognise the complexity of the value dimensions typically at issue, and an inability to provide appropriate techniques for addressing trade-offs that might help community stakeholders to make sense of their own, and others', conflicting values.

Many definitions and conceptual approaches exist for organising environmental values (e.g, Stern and Dietz, 1994; Satterfield, 2001). In this paper we refer to values as an expression of concerns or interests about what matters to individuals, in terms of both their preferences for different goods or activities and the underlying moral or ethical beliefs that give rise to these choices. Values also tell us something about the relative strength of competing preferences, in terms of the observed (through behaviour) or expressed (through surveys or questionnaires) trade-offs made across the many different things that individuals value. Trade-offs occur whenever getting more of one thing of value requires giving up something else that also is desirable: more jobs resulting in less environmental protection, a higher quality output also requiring more time, or more habitat for a rare animal species leading to fewer opportunities for recreationists. There are many reasons for such trade-offs, relating not only to people's choices and beliefs but also to limits on resources, including time, that are available for producing technologies and products or for engaging in activities. Unless these reasons are carefully expressed and disentangled, policy makers can be left with frustrated stakeholders and long lists of issues and concerns that provide little guidance for how to develop, prioritise, or communicate appropriate risk-management responses.

A prime example is the U.S. initiative to safely store and dispose of low-level radioactive wastes. Beginning with the 1980 passage of the Low-level Radioactive Waste Policy Act, a cornerstone of federal policy has been that long-term storage of commercial low-level radioactive wastes can be managed effectively by states through regional compacts. A great deal of money (more than $600 million) has been spent to encourage these new arrangements, and numerous suggestions have been made about how to organise and promote public consultation processes addressing the compacts so as to encourage their broad-based

acceptance (Department of Energy, 1993). However, none of the efforts to establish a regional compact has been successful, and most wastes continue to be stored on-site or sent to temporary storage facilities. Overall, most researchers and policy analysts agree that the current lack of more permanent storage options represents at best a partial solution and at worst a serious, and dangerous, failure of public policy.

Numerous other examples of only partially successful or failed community-based environmental risk initiatives are well known, ranging from estuary protection (e.g., the EPA's National Estuary Program) to new forest practices (e.g., the adoption of ill-defined 'ecosystem management' approaches by the USFS) to cleanup of hazardous wastes (e.g., the U.S. EPA's Superfund program). A common lament is that these processes often stall because of the unwillingness (or inability) of participants to 'see the broader picture' and move beyond single-interest concerns. This leads to frequent clashes between community residents and outside technical consultants, with experts (e.g., from DOE or EPA) feeling they haven't been listened to and their knowledge has been disregarded. More broadly, the observed community reluctance appears to be at odds with much of the normative utility theory underlying modern economics and decision making, which assumes a compensatory structure under which changes in the satisfaction derived from one source of value (e.g., a reduction in water flows in a river, or an increase in vehicular traffic and noise) can be compensated by changes in some other value (e.g., an increase in agricultural outputs and jobs provided through irrigation, or a reduction in local health risks due to a new landfill).

This paper provides some suggestions for using structured decision processes to address difficult value trade-offs in the context of improving the quality of stakeholder input to environmental risk-management decisions. Addressing trade-offs is rarely an end in itself: in most cases, a focus on trade-offs is recommended because it leads to a better definition of the risk-management problem, a more open discussion and better understanding of the fundamental values of participants, and an improved and more broadly accepted set of recommended risk-management alternatives. We believe that many of the current processes for encouraging deliberation and analysis fail because they do not address stakeholders' value trade-offs in ways that are either meaningful or defensible. In the next sections we review some of the reasons why trade-offs are difficult and discuss several case-study examples of structured decision techniques that have been used successfully to address difficult value trade-offs. Our main source of ideas is the rich body of research on constructed preference approaches to decision making, which in practice joins with the techniques of decision analysis and the use of adaptive approaches to the management of ecological risks. Together, these three innovative perspectives shed substantial light on a range of techniques that, in many policy contexts, can appropriately encourage community stakeholders to consider complex choices and to face,

rather than delay or avoid or obscure, difficult value trade-offs. Among those who may thereby gain are the many community-based stakeholders who otherwise would be left out of the decision making process as well as, ultimately, both their larger society and the natural world within which they live.

2. WHY TRADE-OFFS ARE DIFFICULT

A myriad of sources describe the existence of difficult trade-offs: it is probably fair to say that much of the world's literature and many of the world's religions deal in some way with this potent topic. From the disciplinary perspective of the social sciences, there are at least four major relevant strands of thought. Economists, from Adam Smith to Becker, have contributed to the essential notion of scarcity and emphasised that difficult exchanges and trade-offs frequently are encountered because opportunities are lost whenever an individual or society decides to use scarce funds (e.g., money) or resources to purchase or provide one thing rather than another. Psychologists (e.g., Kahneman, Tversky and Slovic) have helped to identify the cognitive complexity of choices (in terms of the multiple dimensions of value) and the types of responses to stresses that may arise when individuals attempt to make sense of difficult choices (e.g., the work of Festinger on cognitive dissonance). Sociologists and anthropologists (including Durkheim, Douglas and Goffman) have written eloquently about the balancing of moral and ethical considerations and the labelling of individuals or things that can occur (e.g., the phenomenon of stigmatisation) when societal taboos are broken. Finally, decision scientists (e.g., Raiffa, Keeney and von Winterfeldt) and policy analysts (e.g., Friedman) have developed tools for addressing trade-offs in policy decisions which emphasise the gains in clarity that can occur when problems are disaggregated to expose their underlying dimensions, thus facilitating choices that reflect explicit trade-offs across weighted attributes.

With the recent growth of public participatory processes (including opinion polls, contingent valuation surveys, citizen advisory committees and community-based stakeholder groups), information about the values of citizens is increasingly being asked for as an input to evaluating a broad range of environmental- and health-risk management decisions. In most cases, however, the weighing or balancing of conflicting values, which is the essence of clarifying trade-offs, is ignored or partial. Instead, it is seen as sufficient from a process standpoint that public values are expressed, generally in the form of goals or concerns or long lists of issues that might be aired as part of small-group discussions or raised in larger, town-meeting formats. After interviewing stakeholders active in U.S. watershed planning initiatives, for example, Duram and Brown (1999: 462) reported that 'fewer than 50% noted that participation was useful in clarifying the issues'. This is not surprising, given that the general

objective is to afford opportunities for involvement; one of the two 'guiding principles' cited by Webler (1997: 250), for example, in his review of public participation initiatives, is 'empowerment', defined as 'open participation' so that 'any individual or group that feels itself potentially affected should be able to participate on a par with all the other parties'. Although this criterion would help to ensure that concerns are voiced, the critical next steps of helping participants to think through their own values or to deal effectively with conflicts (within their values or across their concerns and those of others) are typically omitted. And in the few cases that trade-offs are addressed, it is usually not in terms of clarifying the fundamental values but rather in terms of setting out alternative priorities for action (e.g., restoring wetlands as opposed to providing municipal drinking water), which are unlikely to provide an accurate window into the underlying value structures.

One reason for this omission is that addressing value trade-offs explicitly is cognitively demanding. Consider the simple example of an individual's choice between two sandwiches. This is a familiar type of private-goods decision, involving well-known commodities and little uncertainty, and with only minor consequences. The costs and benefits implied by this trade-off are relatively easy because, even if the 'wrong' choice is made, the individual will only spend a little too much money and/or eat a relatively less tasty or healthy lunch. Trade-offs quickly become more difficult, however, once we move from this simple case to one involving public goods (e.g., community parks or water purification or banning trade in elephant ivory), less familiar types of decisions (e.g., vaccinations for new flu strains or paying for visibility improvements), less well-known commodities (e.g, rare types of influenza or uncertain impacts of global-climate change), or more significant consequences (e.g, human fatalities or the potential extinction of a species). Some of the most difficult trade-offs involve novel choices, such as arise in the context of formulating policies to address GMOs, or competition between very unlike outcomes, as occurs when a decision to protect ecological services results in fewer jobs or a loss of cultural opportunities.[1]

This characterisation captures only one aspect of why trade-offs are difficult, however, because not all trade-offs involve a cognitive balancing or weighing of costs and benefits. Many trade-offs, particularly in the domain of environmental and health risks, are difficult to address because they bring up emotional, moral, or ethical issues that are fundamentally hard for individuals to think about and do not easily lend themselves to resolution. Examples include questions asking about a person's willingness to increase a present benefit in return for decreasing their own or others' future health, or their willingness to forgo an economic development option to protect habitat essential to an endangered species of animal. In some cases, people may be uncomfortable addressing the relevant trade-offs because they feel they lack the information required to make an informed or responsible choice. In other situations, individuals may be deeply offended by being asked to consider the choice of options or activities, because

they feel it is not their place to do so (instead, elected officials should take on the responsibility) or because a norm that is protected or regarded as sacred (e.g., the health of children) is perceived as being violated. At such times, individuals may refuse to answer the trade-off question that is being asked or they may provide a meaningless response that gives little insight into their underlying values (e.g., responses that show an insensitivity to the amount or geographic extent of the harm, as exemplified by the embedding phenomenon in contingent valuation responses; see Fischhoff et al., 1993).

There are many examples of such proscribed trade-offs, as outlined in the provocative work by Fiske and Tetlock (1997) on *taboo trade-offs* and by Baron and his colleagues (Baron and Leshner, 2000) on *protected values*. The presumed existence of such taboo or protected values raises the question of whether it is correct, in both a professional (analytical) and an ethical sense, to seek to elicit certain difficult trade-offs because people may consider they are being asked to violate or transgress an absolute standard or rule that they have established.

In Tetlock's view, taboo trade-offs arise because of the request to express one thing of value in terms of a fundamentally different metric (or, using Tetlock's term, a 'disparate relational model') which is not seen as simply bizarre or illegitimate but as threatening to the organisation of society. Because the models underlying social relationship do not provide a resolution in such cases, Tetlock predicts that political decision makers will often attempt to avoid making identifiable recommendations about such trade-offs, conceal their own participation, or seek to delay the required choices. His model of 'value pluralism' helps to identify 'the conditions under which people are likely to treat trade-offs as taboo' and explores strategies that decision makers might use to formulate effective policies in the face of taboo trade-offs.[2]

A related research effort, linked most closely with work of the psychologist Jonathan Baron (Baron and Spranca, 1997), focuses on the concept of protected values as those that 'resist trade-offs with other values, particularly economic values'. In such cases, Baron maintains, people will be concerned about the application of absolute rules governing actions (rather than impacts), rules that are deontological in the sense that they apply irrespective of predicted consequences (e.g., 'do not modify genetic information'). Baron's work examines three related properties of protected values: quantity insensitivity (one abortion is as bad as 100 abortions), agent relativity (it matters who is asked to make the trade-off), and moral obligation (entailing a social, as well as a personal, necessity and reference). Although individuals may recognise the existence of multiple value dimensions, the concept of protected values asserts that in some cases they will feel that one value is 'infinitely more important' (Baron and Spranca, 1997: 2) than others. Even if individuals acknowledge the reality that their behaviours imply trade-offs, such as not wanting to contribute to global warming but still driving cars to the corner store or not wanting to reduce their

savings but still travelling to exotic locations for vacations, they are 'not happy with themselves for doing so' and experience that they are caught in an uncomfortable and troubling bind.

In our opinion, these cognitive and emotional and moral barriers translate into six main reasons that, collectively, help to explain why the consideration of value trade-offs by community stakeholders charged with developing environmental risk management alternatives is so often difficult. As discussed in the following section, we believe that techniques drawn from the decision sciences and behavioural psychology can be used in ways that help to clarify value trade-offs without transgressing the emotional, moral, or cognitive bounds of individuals. The key is to gain permission to use the approaches explicitly: only by addressing people's concerns head-on is it possible to develop new management approaches equal to the challenging task of incorporating value trade-offs into controversial risk-management choices.

2.1 Multiple value dimensions

Fundamentally, trade-offs are difficult because it is hard for people to make choices over options that may result in outcomes affecting multiple dimensions of value. In the case of a proposed storage site for low-level radioactive wastes, for example, the multiple dimensions might include human health concerns (as the result of planned or unplanned exposures), economic considerations (relating to facility construction and monitoring costs), environmental impacts, social effects, and moral assessments relating to the ethical and long-term consequences of waste storage (Flynn et al., 1992). In the case of relicensing a hydroelectric dam, the dimensions of the choice might include fisheries benefits, power sales, regional social stability, and changes to government revenues.

Not only are there many different dimensions of value, but their variation is often fundamental: the decision context is not akin to a choice between apples and oranges but, rather, a choice among apples and paper clips and threatened vistas. As a result, people are left feeling like the circus artist asked to juggle a pizza, a balloon and a chainsaw. In these and many other environmental risk contexts, the definition of some key dimensions also can be subject to substantial ambiguity: people may care intensely about protecting biodiversity or reducing respiratory illnesses among children without precisely understanding what these concerns imply. Even if definitions are clear to one individual or stakeholder group, the existence of multiple value perspectives means that others may disagree.

2.2 Uncertainty about consequences

Concern about the negative consequences of a proposed activity is what motivates opposition by some stakeholders. Uncertainty itself imposes costs,

because management responses are typically more difficult to develop when there is imprecision in impact estimates. When the response of ecological, social, or economic systems to a proposed action cannot be predicted with precision, the experts are in the uncommon position of having far less to tell concerned community citizens (about the predicted number of salmon in a river, the anticipated emissions from a hazardous waste site, or the expected effects of an initiative on biodiversity or jobs) than either the scientists or stakeholders would like to know. Evaluations of a proposed management action are frequently made in the face of little baseline data and no comparable (with/without) condition, so there is no effective way to isolate and experimentally test one piece of the system (Morgan and Henrion, 1990). And in most cases, there is no easy cure because the uncertainty has two aspects: in addition to the lack of knowledge (i.e. epistemic uncertainty) about how things work, the system itself is not well behaved (i.e., aleatory uncertainty) due to the dynamic and interlinked nature of the natural, cultural and socio-economic systems involved. As a result, experts can only say that impacts are expected to occur within wide ranges that, in many circumstances, are so broad that the associated trade-offs are hard to think about and, at the extreme, lose all meaning.

Linked to concerns about uncertainty is the fact that surprises (unintended consequences) inevitably seem to occur, which in turn may decrease public trust in both science experts and risk managers. Some surprises are ecological, as in the case of the infamous spruce-budworm outbreak in Nova Scotia's forests (see Gundersen, Holling and Light, 1995). Others are social and economic: An example is the refusal of some communities to participate in Superfund cleanup efforts out of their fear that being labelled as a Superfund site will increase the salience of local environmental problems and, in turn, stigmatise the community in the eyes of potential in-migrant businesses or individuals (Gregory and Satterfield, 2002). Most importantly, all estimates of uncertainty are conditional in the sense that they take place against a background of (typically unstated) assumptions about the larger systems within which they operate. Making these assumptions explicit – for example, through carefully breaking down a larger problem to show its constituent elements – may be actively opposed by some stakeholders, even though such decomposition can help to identify areas of agreement and disagreement among participants.

2.3 Unfamiliar evaluation contexts

A third reason why making value trade-offs is difficult is that most individuals or community groups have little experience making evaluative choices of the type typically encountered in environmental risk-management decisions. Instead, most of our decision making experience comes from repeated choices, such as buying groceries or selecting a movie to see. It's harder to buy a car or

house because of our lack of experience; it's harder still to 'purchase', or to know whether to vote for using tax dollars to fund, a nuclear-waste repository site or a coastal-zone cleanup plan.

In response, individuals typically resort to simplifying strategies such as lexicographic choice processes, whereby alternatives are ranked in terms of a single, most important dimension. At least initially, the favoured context is likely to be one that has been made most salient, for example by recent media reports. Thus, one role of an analyst or facilitator leading a community-based stakeholder group should be to enhance the salience of other, perhaps less sensational decision contexts and, in turn, to ensure attention is given to other, less familiar dimensions of the problem.

The unfamiliarity of a decision context is particularly significant in the case of more consequential policy options, involving either large expenditures of money or long time horizons or adverse health effects – features shared by many environmental risk management initiatives. In such cases, an individual's lack of experience in framing and explaining the proposed exchange can become a source of stress, anger, or frustration. In experiments conducted comparing value elicitation techniques across two groups of approximately fifty adults, for example, those who were given the more complete information on values and trade-offs experienced a higher stress level than those given less encouragement to face difficult trade-offs (Arvai, Gregory and McDaniels, 2001).

2.4 Balancing effort and accuracy: the difficult of thinking carefully

Another consideration is simply that it is hard to get people to think (or feel) carefully: working through the cognitive demands required by the explicit consideration of trade-offs takes effort. Judgement processes, particularly when unaided, are also prone to numerous shortcomings and biases. Researchers from the field of behavioural decision making (BDM) have identified a variety of now widely-recognised simplifying rules-of-thumb (Kahneman, Slovic and Tversky, 1982) which may aid judgement in the context of everyday decisions but can lead to serious errors in the context of more consequential decisions. This research also has shown that scientific training provides no easy cure: decision making biases have been demonstrated in the choices made by physicians (McNeil, Pauker and Tversky, 1988), risk regulators and other technically-trained experts as well as in the judgements of the typical layperson.

In many policy circles, there appears to be a naive assumption that a simple cure for the shortcomings of unaided individual decision making processes is to work with people as a group, thereby ensuring that a wiser choice emerges. There is little support for this idea, however, either in theory or experience (Bone, Hey and Suckling, 1999). Instead, a rich body of psychological literature supports the contrary hypothesis, that group participation often encourages people to con-

form, even if the influence of others leads to erroneous choices (e.g., Allen and Levine, 1968). Policy analysts as well as psychologists have amassed numerous examples of mistakes by groups of highly competent individuals, from the Bay of Pigs invasion to the Watergate scandal, that demonstrate how an unintentional focus on loyalty and maintenance of internal cohesiveness of the group results in a decision making process that fails to explore sufficiently the wisdom of minority views (e.g., Russo and Schoemaker, 1989) or moves prematurely to a consensus. This phenomenon is supported by the well-documented tendency of group discussions to focus on the shared information about a problem and to neglect information that only one or two members may hold (Gigone and Hastie, 1997), with the result that opportunities for incorporating a broader range of values may be missed.

2.5 Incorporating affect and process considerations

Community-based risk choices are accompanied by a history that typically involves both specific (locally-based) and general (society-wide) issues. Trust in government is a common example, with local concerns about government objectives or skills mirroring parallel national concerns. Anger at local resource-management agencies is another common example, with past decisions – often dating back to times when most peoples' value trade-offs were quite different – serving as a source of frustration and worry for some local citizens. Different processes that are used to foster (or stifle) debate and the communication of information can either ease or inflame these judgements about the affective (i.e., positive or negative) and emotional aspects of the decision context.

Most stakeholder-based consultation processes give little help to participants seeking to integrate the affective and cognitive aspects of their choices. Instead, emotion is often viewed as being counterproductive to open dialogue and debate. In contrast, current research in decision making points to affective reactions as helping to guide and formulate an effective cognitive response (Slovic et al., in press). Affective responses are seen as central to the perception of risk, for example, as pre-cognitive responses helping to condition and anticipate the influence of cognitive reactions. Helping stakeholders to articulate and to integrate their emotional responses to a proposed action are therefore essential elements in establishing the basis for an informed policy choice.

Affective responses not only influence the judgements that people make; they also influence whether individuals are willing to participate in a stakeholder-based deliberation in the first place. In most cases, society lacks institutions that can build on the emotions and anger and worries of stakeholders to effectively harness politics to conflict through innovative management prescriptions (Lee, 1993). If community stakeholders feel at the outset that their views are unlikely to be heard or will be marginalised as overly emotional, then there is little reason

for them to take the time or make the effort to participate. Successful deliberations about environmental risk-management trade-offs therefore set up new relationships among people to the same degree that they advance new relationships among economic or ecological concerns.

2.6. Learning over time

In many environmental risk-management contexts, the novelty of the decision context combined with the existence of substantial uncertainties makes it hard for stakeholders to do what they consider to be a 'good job' of providing input to the choice of policies. Holling (1978), Walters (1986) and others have developed adaptive management as a means of coping with profound uncertainties in managing complex natural resource systems. The approach explicitly recognises uncertainties (in both the underlying science of the physical environment and in the underlying concerns of the human participants) and, in response, suggests that multiple approaches be tried on a small, reversible scale, with results closely monitored to maximise learning while minimising the occurrence of costly failures. Learning thus becomes an explicit objective of policy initiatives and a consideration in the development of alternatives: a relatively more expensive risk-management option may be chosen, for example, because of its greater flexibility in the light of unknown future conditions or because of the enhanced opportunities for learning provided through adaptive management.

Although classical adaptive management focuses on ecological change, the same concept applies to social, economic and institutional learning (Gunderson, Holling and Light, 1995). Frequently, of course, these dimensions are interlinked, so that progress on one can only be made following new insights into another. Work on the Columbia River system, for example, has helped demonstrate how early success with the operation of hydroelectric dams to maximise economic returns (from power sales and commercial fish catches) served to narrow the range of permissible management options and, over time, created a less flexible system that was unable to respond successfully in the face of rapid ecological and economic changes (Lee, 1993).[3] The incorporation of learning as an explicit concern can help to remind participants of two important sources of uncertainty: the ecological uncertainty which characterises the natural system along with the values-based uncertainty that characterises their own concerns. As a result, value trade-offs made at an early stage of a public-participation process may differ considerably from those made later on, provided that learning about one's own values is considered to be a legitimate (rather than embarrassing) enterprise. In the next section, techniques for encouraging this shift – similarly conceptually to how the negotiations literature (eg, Bazerman and Neale, 1992) characterises a move from positions to interests – are described and illustrated using brief case-study examples.

3. A STRUCTURED APPROACH TO MAKING TRADE-OFFS

A structured decision making approach accepts the need for addressing trade-offs and takes the value elicitation 'problems' noted in Section 2 as givens. It acknowledges that, for many of the choices and judgements required to formulate risk-management policies, most people will have only a vague, imprecise value and, without additional help, will lack the ability to make finer distinctions or defensible trade-offs. The context within which a risk-management question is asked and the cues provided as part of the judgement task therefore create a systematic influence on the expression of a participant's attitudes and choices. In his review of four decades of behavioural decision research, Slovic (1995) concluded that preferences 'appear to be remarkably labile, sensitive to the way a choice problem is described or 'framed' and to the mode of response used to

Decision making challenge	**Useful techniques**
Multiple value dimensions	means / ends networks value hierarchies constructed attributes
Uncertainty of consequences	value of information assessment identification of thresholds expert judgment processes
Unfamiliarity of evaluation contexts	setting priorities (e.g., swing weighting) simplifying the decision (e.g., even swaps) evaluability: increasing ease of comparisons
Effort and accuracy	influence diagrams and knowledge maps impact hypotheses logrolling (to create win-win trades)
Affect and process concerns	broaden legitimate range of concerns use process-based and constructed scales mental models and open-ended elicitations
Learning	multiple (sequenced) decisions multiple methods monitoring and adaptive strategies

TABLE 1. Selected decision making techniques for encouraging the consideration of trade-offs.

express the preference'. Following this constructive line of thinking, Slovic suggests that the way to improve the quality of an expressed preference or attitude is to use a procedure that can build a clear expression of value, one 'that is transparent, logical, and free of arbitrariness'.

If individuals look to available cues for assistance in constructing a response, then how this help is provided is critical. Tools from decision analysis are helpful in operationalising a structured decision framework for making risk trade-offs. In contrast to the conventional, science-based process of risk analysis, a decision-based approach starts with the values of participants and attempts to structure alternatives based on their concerns and expressed trade-offs (Slovic and Gregory, 1999). Following the order in which issues were posed in Section 2 of this paper, there are six critical challenges: responses from a structured, constructive decisionmaking perspective are discussed below and summarised in Table 1.

3.1. Identifying multiple value dimensions

A structured approach to addressing value trade-offs typically begins by asking stakeholders to express all those things that matter to them, including both content and process objectives, in the light of a proposed risk-management context. Identifying and defining values that arise in the context of a novel problem is difficult work and requires both introspection and deliberation on the part of participants. For example, many stakeholders may prefer an alternative that improves biodiversity but each person may disagree as to what is meant by biodiversity and no one may have addressed the trade-offs, for example involving costs or timing or across-species conservation options, that are implied by different management alternatives. Although there are many different ways to elicit these values, including discourse-based techniques (e.g., Norton and Steinemann, 2001) and narrative methods (e.g., Satterfield, 2001), a structured decision making approach is unusually aggressive in its focus on looking behind the casually-expressed concern (e.g., protect biodiversity) to try to understand its essential structure (e.g., is biodiversity linked more closely to species or genetic conservation?) and underlying motivation (e.g., protecting a natural area vs. maintaining local property values vs. increasing the probability of finding a miracle cancer cure).

A variety of techniques can be used to help stakeholders think through and express their multiple value dimensions (and, in turn, communicate this information more effectively to decision makers). For example, one of the key distinctions in structured value elicitations is between the means and ends values identified by stakeholders (Keeney, 1992). Although this distinction is conceptually straightforward – ends are valued in and of themselves, whereas means are valued insofar as they contribute to the availability or amount of some other objective – developing clarity in practice only comes after engaging stakeholders

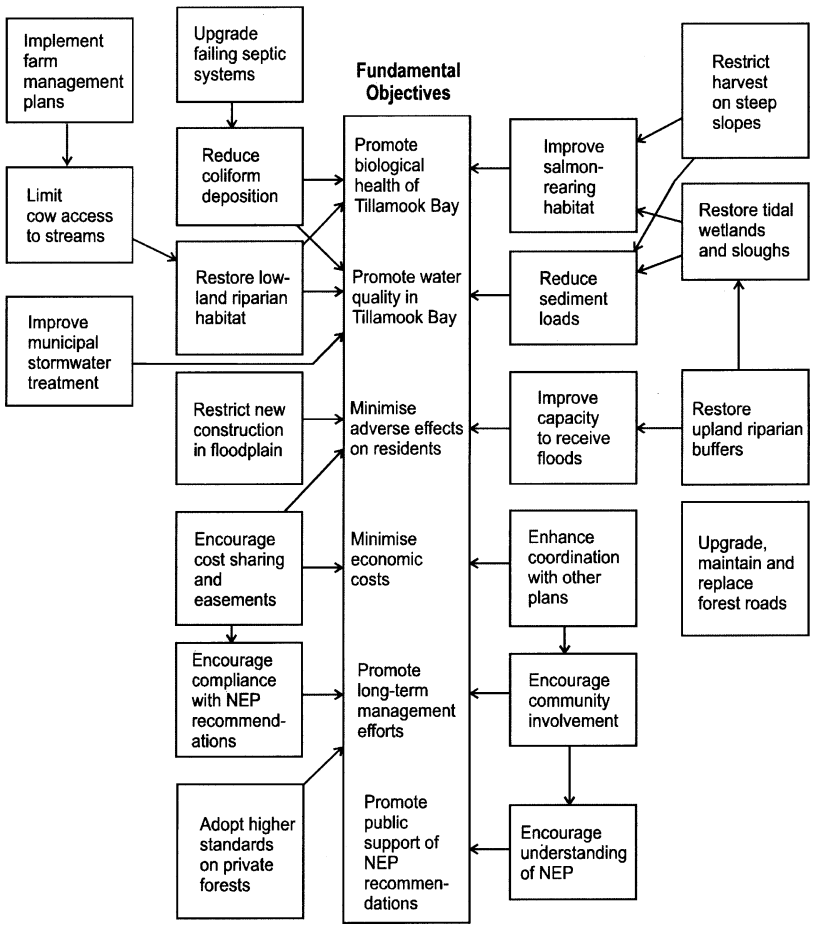

Figure 1: Tillamook Means-Ends Network

in demanding discussions. An example is from a multi-stakeholder, multi-agency consultation charged with aiding cleanup of the Tillamook, Oregon coastal estuary (Gregory, 2000a). Detailed value elicitations with key participants led to the construction of a means-ends network, which visually helped to clarify that a small set of concerns were central to all three of the major stakeholder groups (community residents, state and local management agencies, and technical experts). As shown in the middle portion of Figure 1, we noted explicitly the distinction between the six 'fundamental objectives' of the estuary

management program and the 'means objectives' associated with specific policy initiatives. Even though the weights placed on the fundamental objectives – their relative importance – differed among stakeholders, the knowledge of these relationships helped to focus and give direction to subsequent deliberations.

A second innovative aspect of a structured decision approach involves the development of constructed measures for assessing the performance of policy alternatives. If the objective is to maximise profit, for example, then dollars provide an example of a natural attribute which is in general use and has a common interpretation. At other times, however, a concern is less easy to measure because it is situation-specific (e.g., community pride) or hard to observe (e.g., anger or distrust) or complex (e.g., forest health). In such cases, a constructed measure requires the creation of an index that describes the range of possible impacts for the attribute of concern in the context of the given problem. For example, a constructed scale for ecosystem health might include considerations such as those shown below:

Attribute level	**Description of ecosystem health**
1	no loss of salmon spawning area, additions to riparian zone conifers
2	small loss (<5 acres) of spawning area, no loss of riparian zone conifers
3	moderate loss (5–50 acres) of spawning area, minor (<10%) riparian zone loss
4	significant loss (> 50 acres) of spawning area, moderate (>10%) riparian loss

The same approach to constructing scales works equally well for 'softer' concerns such as a community's lack of trust in risk managers or its frustration with the actions of a management agency. For example, concerns about trust could be addressed through the creation of an oversight committee (with responsibilities for running a facility) that includes community members: a low-scoring component of the trust index might show no community members, whereas a mid-level score would show several community participants and the highest level might include veto powers for community members. Even admittedly imperfect scales might provide an improved basis (compared to current evidence) for the assessment of policy alternatives. For example, as part of a project that sought to compare alternative sites for storing hazardous wastes in Washington state, a local Indian Nation agreed to the use of 'distance from any known sacred sites' as one proxy for the preservation of its culture. Along with several other considerations, this then became the basis for a 'preservation of

cultural identity' objective that was used to rank alternative sites. No one believed that cultural identity had been defined fully, but all participants acknowledged that using a distance proxy was far better than having no attribute at all.

Constructed attributes provide a means for helping community stakeholders to make trade-offs between different levels of a hard-to-define value (e.g., ecosystem health, trust) and other, more easily defined values (e.g. the financial cost of factories with different levels of environmental safeguards). Constructed scales thus provide a possible mechanism for addressing one of the key issues giving rise to taboo trade-offs, which is the perceived incommensurability between value dimensions of the environmental risk-policy issue under consideration. They also provide a mechanism whereby a wide range of ethical and moral and aesthetic concerns can be made legitimate, in the sense that they can be compared directly to concerns such as costs or jobs. (Gregory, Lichtenstein and Slovic, 1993). Individuals then have the option of ranking these different components as more or less important to the overall decision: one person may assign a high weight to jobs and a low weight to cultural or aesthetic concerns, for example, whereas another person may do the opposite. The point is not to reach agreement in value structures, but rather to present the full range of relevant values and to demonstrate the diversity of concerns that any broadly-supported policy alternative will need to address.

Another example of this type of process comes from a stakeholder consultation that involved changes in water flows at a hydroelectric generating facility (McDaniels, Gregory and Fields, 1999) on the Alouette River in British Columbia, involving structured discussions with a 20-member representative stakeholder committee. This required providing technical guidance on clarifying members' objectives, which included the following five objectives

- avoid adverse effects from flooding
- promote recreational activities
- promote the health and biological productivity of the river
- avoid cost increases to provincial residents, and
- promote flexibility, learning and adaptive management

These objectives were then used to identify the pros and cons of selected operating plan alternatives, which in turn enabled the group – which initially had been very discordant – to make a consensus recommendation about preferred water flows and a desired management regime to the provincial regulatory authority.

3.2. Incorporating uncertainty in consequence estimates

Community-based stakeholders often despair unless predictions of impacts can be made with precision. This leads to the need to collect further information so as to reduce the uncertainty associated with key concerns, which can result in significant time delays and costs. In many cases, however, this expenditure will be unnecessary because questions relating to the value of the new information (VOI) have not been asked. Specifically, a structured decision process would ask whether access to the new information is expected to have an effect on the decision at hand; if the new data would improve basic knowledge but not influence the creation of alternatives or the choice among options, then (from the standpont of the current decision) its value is likely to be below a critical decision threshold and considered negligible.

Uncertainty always accompanies looking to the future, and neither community residents nor technically-trained scientists are particularly skilled at making predictions about future impacts. Critical data (as identified by VOI studies) are often missing. In addition, research on decision making clearly shows that individuals typically think they know more than they do (ie., they are overconfident) and their opinions are influenced unduly by particularly salient aspects of the problem (Kahneman, Slovic and Tversky, 1982). In such cases, it is generally possible to make a substantially improved decision by working more closely with those having expertise on the topic. Such 'expert judgement' processes (Keeney and von Winterfeldt, 1991) provide a small group of knowledgeable individuals with some training in decision making and help them to understand similarities and differences in how they decompose the problem and how they assess the probability of its constituent parts. Codifying these judgements, in terms of separate assessments and quantitative expressions of probability, makes them explicit (which encourages careful thought) and facilitates dialogue (which helps to understand the reasons for similarities or differences in views). One result is a reduction in the uncertainty associated with predicted consequences of a proposed initiative. Expert judgement processes also may reduce the need for additional studies, thereby saving time and resources, and serve to focus attention on key values of scientists and community residents (which may account for differences in how data are interpreted) as well as their understanding of factual information.

An important element in any successful expert judgement elicitation is the identification of experts who have standing and credibility with stakeholders. As part of the water-use planning process currently underway in British Columbia, for example, participants from four knowledgeable groups are involved in expert judgement elicitations regarding environmental objectives: academic scientists, First Nations (i.e., Aboriginal populations), government resource managers, and community resource users. By stimulating a discussion between a scientist

(familiar with ecosystem biology) and a First Nation elder (familiar with traditional ecological knowledge), for example, new insights about values (e.g., are hatchery and wild salmon the same?) or trade-offs (e.g., is a time perspective of 50 years sufficient?) may help to interpret differences in the perceived uncertainty associated with identified consequences. In addition, identifying representatives from these four groups as 'experts' also has the process advantage of demonstrating an equitable treatment of different points of view.

3.3. Unfamiliar evaluation contexts

Without both analysis and deliberation, it is impossible for group participants to evaluate unfamiliar options defensibly. Both clarifying objectives and defining uncertainty will help to improve peoples' understanding of policy options. However, the act of evaluation – selecting or voting for a preferred option, or assessing the level of individual or social willingness-to-pay for gains or willingness-to-accept compensation for losses – raises new concerns.

One contribution of a structured decision approach is to attempt to simplify the decision at hand by using trade-offs to reduce the number of relevant, distinguishing dimensions. Several straightforward methods – such as swing-weighting techniques and pair-wise comparisons – help participants to order and distinguish the relative importance of their different concerns. These methods thus enable individuals to place more attention on the more important dimensions of value and to reduce the influence of less relevant considerations. Other techniques, such as 'even swaps' (Hammond, Keeney and Raiffa, 1999), make it easier to think about difficult choices by eliminating some dimensions of a complex problem. By determining the change in one objective that just compensates for a reduction in another (e.g., the number of air miles you would give up to get a $100 cost saving on your next ticket, or the number of vacation days you would relinquish to receive a higher salary at work), a decision is simplified because one dimension of value (now the same for the two choices) can be ignored as it no longer helps to distinguish between the options.

Other research points to the need for a display of multiple alternatives in terms of the multiple value dimensions important to respondents, who then are able to make a more informed choice as a result of having comparison-friendly information readily available. Hsee (1996), for example, asked subjects to assume they were music majors looking for a music dictionary. In a joint-evaluation condition, participants were shown two dictionaries (A and B) and asked how much they would be willing to pay for each. Willingness to pay was far higher for Dictionary B, presumably because of its greater number of entries. However, when one group of participants evaluated only A and another group evaluated only B, the mean willingness to pay was higher for Dictionary A. Hsee argues that this reversal provides evidence for the difficulty of making a choice based on the specified attribute for 'number of entries' when the evaluator does

not have a precise notion of how good or bad 10,000 (or 20,000) entries is. Thus, in the independent evaluation, more weight is given to the affective 'defects' attribute, which translates easily into a good/bad response. Only under joint evaluation is the participant able to make an evaluative comparison and thereby see that option B is superior on the more important attribute.

These techniques were used in helping community members living near Oregon's Tillamook Bay to make a choice among estuary cleanup options which were sufficiently unfamiliar that, initially, many stakeholders refused to entertain the possibility of considering trade-offs or, at the extreme, to participate in any discussions. The conceptual solution involved designing a framework whereby the missing sense of value could be constructed through understanding the relationship among value dimensions, much as a residence is constructed through linking different types of rooms (Payne, Bettman and Johnson, 1992). The practical solution involved scoping down the larger problem of estuary cleanup to focus on three critical actions (shown in Figure 1): limiting livestock access to streams (to decrease pollution and damage to riparian habitat), protecting and restoring tidal wetlands (to improve spawning and rearing habitat for salmon), and upgrading forest management roads (to reduce sedimentation in streams, thereby improving habitat and reducing flood risks). These actions were particularly controversial because each implied difficult trade-offs (i.e., every benefit was offset by a cost) and there were significant inequalities in their distribution.

One part of our response was to identify these distributional concerns explicitly and suggest mitigation packages that might address them. In addition, we developed a workbook that presented groups of stakeholders with what are termed 'consequence tables', linking impacts and objectives (Gregory and Wellman, 2001). The workbook summarised the pros and cons of alternative plans, using both natural and constructed scales, and allowed respondents an opportunity to 'vote' directly for their most preferred alternatives and to explain their thinking, using both their pocketbooks (by stating their willingness to pay for an action) and words (by responding in writing to structured and open-ended questions). By providing an accessible evaluation mechanism, most of the community stakeholders changed their minds and agreed to participate; feedback was positive, and several participants noted that their original hesitation was based on a refusal to participate in a process that did not include their concerns rather than, as they initially had stated, an unwillingness to entertain trade-offs or contribute to government-backed policies.

3.4. Balancing effort and accuracy

The application of a structured decision approach emphasises qualitative guidance to help community stakeholders think clearly about the decision problem and make smarter choices, rather than quantitative analysis to make an optimum

decision. This qualitative orientation is particularly relevant in the context of difficult stakeholder trade-offs involving complex initiatives: too often, resources are poured into solving a problem that, in hindsight, turns out to be a minor issue. The primary goal of a structured decision effort should be to improve thinking about key aspects of the problem and sharpen communication about critical concerns.

Influence diagrams (Schacter, 1987) and the closely related knowledge maps provide a particularly helpful technique for clarifying thinking about how expressed values relate to the anticipated consequences of actions. An example from a proposed hydroelectric facility relicensing (involving possible changes in water flows on a major river) is shown in Figure 2, with the influence diagram noting linkages from operational parameters to anticipated impacts and fundamental stakeholder objectives. The use of this type of tool helps stakeholders to focus on the more relevant aspects of a choice and to pay less attention (or, at the extreme, to ignore) less consequential aspects. In addition, as participants learn more about the magnitude of expected impacts and how they may vary as part of different options, the relative importance weights placed on specified value

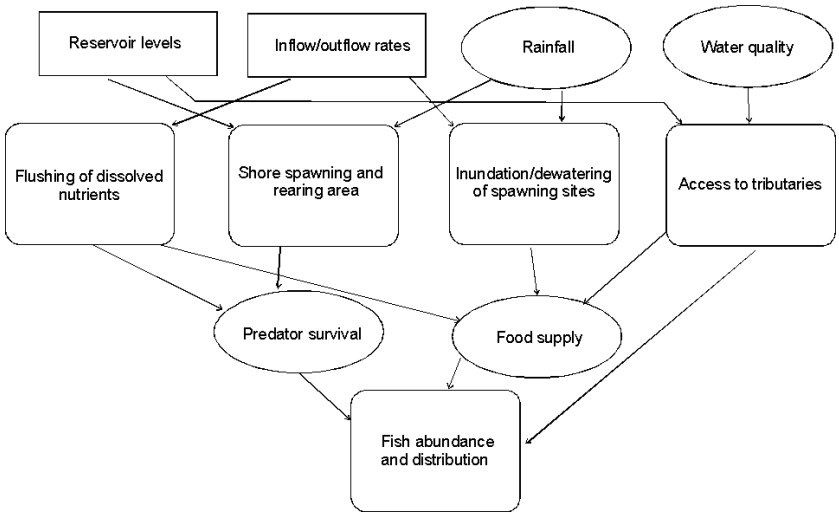

FIGURE 2: Influence diagram for hydroelectric facility relicensing*

* Rectangles represent decisions, ovals represent chance events, and a rectangle with rounded corners represents a consequence. Arrows (arcs) denote a relationship among the nodes.

components may also change. Impact hypotheses play a similar role, in terms of facilitating additional precision in ecological or health effects information that can be used for modelling the more important value-consequence linkages of planned actions.

This balancing of effort and accuracy is aided by the realisation made by many community stakeholders that, if they work hard to define their objectives and create responsive alternatives, they will then 'win' in the sense of getting more of what they most want. The exciting realisation is that others, even those with quite different priorities, also can win. This message should not be lost on the facilitators of stakeholder groups, who often fail to realise the essentially co-operative nature of structured consultations and, as a result, allow an unnecessarily competitive context to develop. The key concept is that, so long as there are different strengths of preference on an issue (i.e., some parties care relatively more about one objective than do others), improved alternatives can be created by trading off more important for less important issues, leading to a higher total (combined) value of the alternative. In the language of negotiations, the ability to engage in such 'logrolling' as part of multi-issue, multi-party consultations enables the group to see beyond the artificial limits imposed by a 'you win, I lose' fixed-pie mentality (Thompson, 1998).

3.5. Incorporating affective and process concerns

Because conflicts are at the centre of the need for making trade-offs, it is important for community stakeholders to be part of an environment in which they can speak freely and evoke emotions as well as logical thought. The omission of individuals who are sufficiently angry or disenfranchised that they refuse to participate in community surveys or other assessments of risk-mitigation and cleanup options will only serve to further these stakeholders' perceptions that they are unrecognised or disenfranchised. In such cases, the focus needs to be on finding new methods that are able to handle the full range of stakeholder concerns, not (as frequently assumed) identifying more docile or better-trained participants.

Recent findings in judgement and choice research acknowledge the importance of emotions and affect – the feeling states that people experience, such as happiness or sadness, and the qualities associated with a stimulus or event, such as its perceived goodness or badness – as key elements in how individuals form judgements and make decisions (Loewenstein, 1996; Slovic et al., in press). Basic to this body of work is the hypothesis that initial affective reactions will often play a significant role in the processing of information and, as a result, can influence subsequent judgements and deliberations.

A structured approach facilitates the incorporation of emotion into stakeholder risk-management deliberations. One way, already noted, is through the construction of scales (e.g., indices for anger or outrage as well as scales for moral

or ethical concerns) and the tracing through of emotions to their source in the specific problem context. In many cases, the incorporation of emotion and affect also can be encouraged by using language that is comfortable and not intimidating, reflecting the manner in which many stakeholders already talk about their values. One possibility is to employ open-ended questions designed to characterise participants' 'mental models' of how a system works (Bostrom, Fischhoff and Morgan, 1992). Another technique is to utilise narrative approaches and encourage participants to simply tell their stories, thereby enhancing stakeholders' access to the full range of emotional, affective and moral considerations (Satterfield, Slovic and Gregory, 2000). These more open-ended forms of dialogue can enable participants to 'get inside' the decision and consider it from their own perspective. Concerns that arise in the course of these discussions can then be used as the basis for developing explicit measures or attributes that help to define key aspects of the concerns. In this way, a less structured dialogue may yield insights into an appropriate constructed scale that can be used to assess the performance of a policy alternative in a subsequent trade-off analysis, for example in terms of its ability to satisfy a strongly affective objective such as 'reducing community anger' or 'retaining a positive community image'.

In deliberations about alternative plans for managing old-growth forests in Oregon (Gregory, 2000b), for example, emotions were very evident in the early stages of the value-elicitation process: responses included frequent disagreements among participants, impassioned speeches and frequent references to historical wrongdoings on the part of management agencies. In hindsight, these responses can be viewed as natural outgrowths of the decades-long battle by some local residents to obtain changes in how harvest decisions were made. Structured analysis techniques, including means-end value networks and the development of constructed attributes for measuring progress in meeting objectives, helped in addressing these concerns. Discussions were also held to develop criteria for assessing alternatives that gave explicit consideration to process concerns such as trust and the capabilities of community members to influence future decisions. Another important element in gaining community trust and participation was an acknowledgement of the need for an iterative and flexible decision process in light of the prevalent scientific and value uncertainties relating to the consequences of proposed management interventions. As noted by Norton and Steinemann (2001: 474), often it is 'necessary to go beyond one-time elicitations ... and to engage community members in a process of further clarification and integration of these values'. In the Oregon case, as in many others, how decisions were to be made over time was often at least as important to community stakeholders as the expected outcomes themselves.

3.6. Help people and institutions to learn

Incorporating learning into community-based discussions of value trade-offs has substantial advantages. Foremost is that an adaptive perspective can turn one-shot management decisions into longer term, iterative, sequential decisions, which then can be revisited (and uncertainty reduced) as new information is derived from management experiments. In addition, it encourages an orientation towards joint problem-solving rather than positional stances among participants. These results are positive steps in any stakeholder-based approach to environmental decision making.

Learning can take several forms, including (a) learning about the decision problem and its accompanying constraints, (b) learning about oneself and setting priorities among one's own values in the context of the decision problem, (c) learning about others and what matters to them and why, and (d) learning about the consequences of different management responses. Much of this learning is largely qualitative in nature, despite the typical association of decision science methods with the development of a numeric or quantitative assessment framework. Its implications also extend beyond the immediate participants; for example, the incorporation of learning as part of a risk-management plan also requires and, in turn, fosters institutional flexibility (which represents a key advantage, as well as a potential stumbling block, of many adaptive management initiatives; see Gunderson, Holling and Light, 1995).

In addition, the adoption of explicit learning objectives as part of a structured decision process can help to relieve legitimate fears among stakeholders that 'we don't know enough' to make a decision, or equally legitimate fears that 'the science may change'. Introducing a new objective concerned with fostering adaptive learning over time can lead to the development of improved monitoring strategies and to the selection of an alternative that can respond to a wider range of future conditions. At the Alouette River, for example, the creation of an explicit learning objective lead to the creation of a new element in the water management alternatives, concerned with establishing ongoing studies to monitor the effects of changes in water flows, as well as a management council composed of key community and government representatives to foster (and incorporate) adaptive learning over time (McDaniels, Gregory and Fields, 1999).

An emphasis on learning also frequently serves to encourage the use of multiple methods for addressing difficult trade-offs. This is in contrast to the more usual 'discuss and choose the best option' mode of operation, which can lead to serious errors when the uncertainty associated with ecological, economic, or social responses is high. For example, concerns about the long-term safety of containers proposed for storing a hazardous waste could be addressed by carefully testing three or four of the leading designs and learning over time about trade-offs among objectives such as minimising manufacturing time, reducing

cost, avoiding leakage and meeting monitoring needs. Similarly, choices about the preferred level of water flows on a managed river could be addressed by trying out different regimes over a specified period of time. Of course, there is a cost associated with running multiple trials, and there must be a sufficiently high expected value associated with the information to be learned. In many cases, however, this type of 'multiple methods' approach will help to avoid catastrophic errors and save money over time while also significantly reducing decision making errors such as the 'sunk cost' bias, which refers to managers' natural tendency to retain faith in a proposed action or solution long after its net benefits (relative to alternative courses of action) have become questionable.

4. CONCLUSION: HELPING COMMUNITIES TO ADDRESS VALUE TRADE-OFFS IN RISK MANAGEMENT DECISIONS

Over many years, community-based risk management efforts have provided ample frustration for their clients along with evidence for protected values stemming from the apparent unwillingness of many participants to address value trade-offs. We maintain that this result is not inevitable but, instead, is in large part a predictable product of the flawed decision context within which the environmental and health risk management options are considered. In particular, most risk management public-involvement initiatives provide insufficient help to participants in thinking through their own values, evaluating the quality of impacts information, or assessing the trade-offs that characterise alternatives. In short, they fail to encourage the more deliberative, constructive type of decisionmaking response that is called for. And most survey designs are no better, beginning with a brief factual introduction followed by short, declarative sentences that lead to respondents being asked to 'fill in the blank' or to 'check a preferred alternative' about which they have thought only briefly, without regard for the balancing across multiple objectives that is an indication of careful decision making .

This paper advocates the use of a structured, deliberative process for addressing community-based environmental risk decisions that focuses on decision aiding, both for the participants and for the agency empowered to make the decision. Of course, the adoption of a structured decision making process is not all good. Disadvantages include the additional time and cost required to conduct a responsible assessment and the possibility that adoption of a structured process may reduce the opportunities for a consensus solution (Gregory, McDaniels and Fields, 2001). In our experience, however, the additional costs are typically small in the context of the overall project expenditure, and – so long as decision makers are able to link alternative actions to their values-based sources of support or opposition – the absence of a consensus is not problematic. In fact, one of the key advantages of an approach that focuses on addressing

trade-offs is that it seeks long-term solutions that explicitly reflect (rather than minimise or ignore) the diversity in views among the various community, agency and technical participants.

A different type of cost associated with a structured decision making approach is that it can serve to introduce a new element into the risk-management picture. In the typical case, elected officials and government agencies are charged with making decisions in the broad public interest. The creation of citizen and technical groups, serving in various advisory capacities to these officials, can be viewed as undermining the accountability of public administrators and creating an undesirable sharing of the burdens and responsibilities associated with risk management. We maintain (Gregory, McDaniels and Fields, 2001) that this concern is less worrisome with a structured decision making approach, which has as its goal lending insight to decision makers, than it is with a dispute resolution approach based on unanimous agreement of all participants. However, the concern is real and merits attention; one obvious application is that stakeholder participants should clearly be told at the outset whether achievement of consensus is desirable and how much weight will be given to the official outcome of their participation (i.e., are they making a recommendation or a decision?).

The advantages of a structured approach are often demonstrated by their absence: public participation efforts routinely fail because they give insufficient attention to developing the foundation for making a good decision. This does not mean that extensive analysis is always necessary: once problems are carefully structured and stakeholders' values are clearly articulated, many decisions can be resolved quickly because of the obvious merits of a dominant solution. For less tractable problems, a focus on the identification and refinement of participants' objectives, the probabilistic consequences of alternatives, and an overall process that facilitates learning will provide a solid foundation for resource managers and analysts and provide essential insight for decision makers. Unless the trade-offs underlying procedural and resource use conflicts are brought into the open and addressed explicitly, however, the likely result for community stakeholders is continued frustration and disappointment as they realise that neither their own values nor the full range of possible environmental risk-management options will be explored.

NOTES

Support from the National Science Foundation (Grants SBR-9602155, SES-9876581, and SES-0114924 to Decision Research) and from NSF Award SBR 95-21914 to the Center for the Integrated Study of Human Dimensions of Global Change at Carnegie Mellon University is gratefully acknowledged. However, the views expressed in the paper are those of the author alone and do not necessarily represent the views of the

National Science Foundation. Thanks also to Joseph Arvai, Ralph Keeney, Tim McDaniels and Terre Satterfield for their helpful comments on an earlier draft.

[1] Recent reseach in the decision sciences looks at the question of why certain trade-off decisions are more difficult than others (e.g, Beattie and Barlas, 2001). However, this emerging research has yet to capture the interest of policy analysts or economists, despite its obvious relevance: the difficulty of making trade-offs across goods with unlike attributes, for example, is part of the reason why the classic Economics 101 indifference-curve example of choosing between incremental levels of 'more guns or more butter' is, in fact, an extremely difficult and often confusing type of choice.

[2] Another concern is the public goods nature of many environmental protection initiatives, which means that, just as everyone benefits, so should everyone share in the costs (e.g., of estuary cleanup, waste storage, etc.). Under such conditions, research on the psychological response known as 'crowding-out' suggests that if the state then offers monetary incentives to induce local individuals to participate, this external motivation (via monetary incentives) can undermine the intrinsic motivation of community members to participate.

[3] In the Columbia River case, as in many others, a decision was made to emphasise short-run production gains over the long-term benefits of learning and thereby working to create a more flexible system that would be more responsive to the inevitable surprises.

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