Empowering Communities Affected by Sediment Contamination with Collaborative, Science-based Risk Communication Tools

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Abstract
Complex sediment contamination pervades Puget Sound and the Georgia Basin. Cleaning up contaminated areas should involve affected parties, technical specialists and decision-makers in early, active and continuous dialogue. Unfortunately, deficiencies in this dialogue have led to high levels of distrust among communities, government agencies and potentially responsible parties. Complexities of understanding exposure and risk are often barriers to community participation. In addition, it is difficult for decision-makers to show communities how the communities' perspectives have affected decisions. Improving participation in risk-based dialogues is essential for empowering affected parties to be more active in the cleanup process and to ensure that decisions are sustainable. The dialogue should be both analytic and deliberative—i.e., use analytic procedures to inform decision conversations and frame analyses with outcomes from deliberation. In this paper we argue that transparency is essential for understanding how analysis *informs* the deliberation, and, likewise, that considering the values of affected parties is critical for understanding how deliberation *frames* the analyses. The potential of these approaches to enhance community participation in decisions about complex sediment contamination issues and cleanup processes is explored.

Introduction
Sediments in the Puget Sound are contaminated with a wide variety of compounds arising from smelters, wood-product manufacturing, general industrial use, ports, landfills, and military facilities associated with shipyards, submarine bases, and airfields. Specific contaminants found in sediments above regulatory levels include heavy metals, volatile organic compounds, poly chlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), etc. (see http://www.epa.gov/superfund/sites/npl/wa.htm). Although maximum discharge of contaminants occurred during the 1960s, Superfund sites and other highly contaminated areas in Puget Sound continue to have concentrations of contaminants that raise risk and regulatory concerns. Concentrations are highest near former point sources, but many of the contaminants have spread throughout the Sound, and the patterns of historical deposition of contaminants are often found at distances up to 30 miles from the point sources and Superfund sites (Lefkovitz et al 1997).

These complexities suggest that communication issues about contaminated sediments are particularly challenging. As with any Superfund cleanup, affected parties may not understand how risk assessment and regulations are used in cleanup decision processes, or why some contaminants are left in place while others are removed. The large geographic scale of the problems complicates communication because nearly three million people could be affected by Puget Sound sediment contamination. Moreover, due to cultural behavior patterns (e.g. much higher fish and shellfish consumption in Tribal and Asian/Pacific Islander communities) some groups may require unique forms of communication to understand the issues faced by their communities.

Involving affected parties (broadly defined as all parties interested in or affected by contaminated sediment cleanup activities, including potentially responsible parties, contractors, regulators, activists, community representatives, and Tribal, state and local government officials) at all major phases of a cleanup decision is an important component of nearly all risk management paradigms (Federal Risk Commission 1997; National Research Council 1996; National Research Council 2000). Affected parties should be allowed to express their own needs and to help shape objectives for cleanup. However, involvement is challenging. One barrier to effective participation is not involving affected parties early enough in the process, which is a problem in current CERCLA decision processes (National Research Council 2000). Another difficulty is that often, participation is focused on one-way communication—that is, information flows from responsible agencies to affected parties but not from affected parties to agencies. Lack of information and understanding is also a barrier. Experience, skills, scientific training, local knowledge and values can vary considerably among participants working on a decision process, and agencies may not have access to important local knowledge, understand what affected parties care about, or be aware of behaviors that affect exposure to contamination (such as patterns of fish consumption). Despite

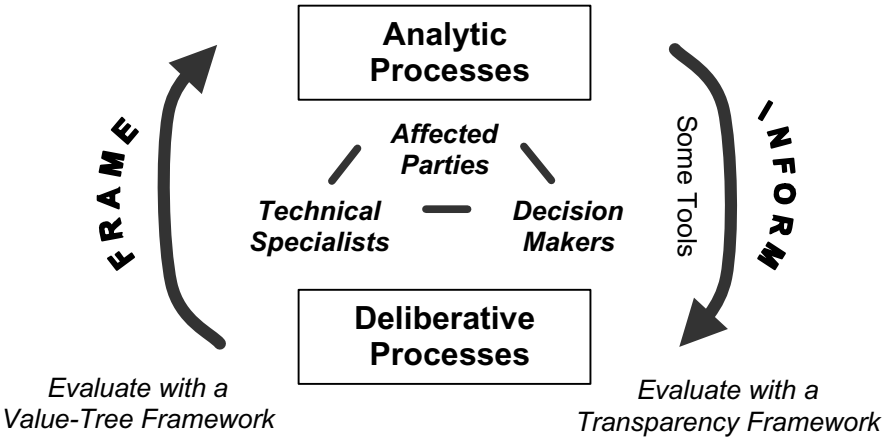

Figure 1. Informing analysis and framing deliberation

making great progress in recent years to involve affected parties (e.g. EPA 2000), tools to help agencies like EPA incorporate information from affected parties, and to show how that information has affected decisions, do not exist.

The objective of this paper is to describe a proposed tool to improve dialogue and engagement about sediment contamination issues in the Puget Sound Region (note this proposal is currently under review with U.S. EPA). First we review our general approach to engaging interested parties in sediments issues, next we discuss existing tools for dialogue; and finally we describe the proposed sediments tool.

Approaches for engaging people in complex cleanup issues

Our approach for involving people in sediments issues is derived from the risk management perspective and literature, as well as our own research and outreach experiences. In 1996, the U.S. National Academy of Sciences developed a framework to describe risk assessment processes (NRC 1996). The framework describes three distinct groups that participate in risk-related decision making, such as cleanup of contaminated sediments, including public officials, natural and social scientists, and interested and affected parties. It also shows a series of decision steps during which parties analyze the situation and deliberate on the options. After a decision is made, further evaluation and review occurs, and a feedback mechanism is present throughout. The NRC calls this the "analytic deliberative process." Analytic processes include what people generally think of as "science," i.e., the theories, studies, hypotheses and reports that provide information about the issues relevant to the problem being addressed. Deliberative processes are the discussions and interactions that occur, including public meetings, interagency discussions, emails, hearings etc.

Figure 1 highlights several key aspects of the Academy's framework, specifically the interplay among the analytic and deliberative processes. According to the Academy, analytic processes are meant to INFORM deliberative processes, and deliberations are meant to FRAME the analytic processes (NRC 1996). But, there are some problems when we really try to look at this in detail. First, it is unclear exactly how these processes work, and what information is needed to assess the effectiveness of these processes. Second, in our experience, little attention has been paid to the information needs inherent to the analytic-deliberative process (Drew 2002; Drew 2003; Griffith et al. 2002; Kern 1998, 1999). Often, analytic tools that have been used in deliberative processes were not designed in collaboration with communities, and therefore cannot answer the questions raised in the deliberative process (Griffith et al 2002; Kern 1998, 1999; Judd et al 2003a, 2003b). In addition, more attention has been given to the informing aspects than the framing aspects and more tools have been developed to support the analytic aspects of the processes than the deliberative aspects. Examples of tools that help inform are geographic decision support systems, analytical software programs, and the like. A value tree is an example of a tool that frames analysis.

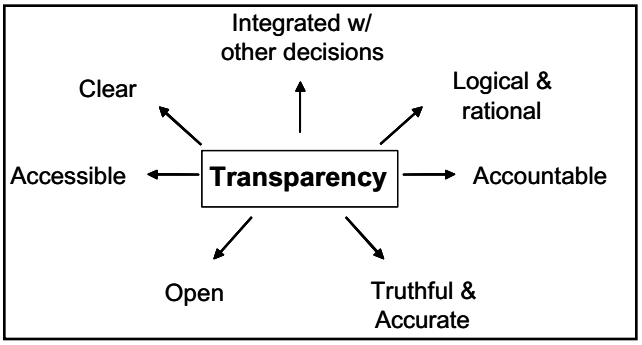

Figure 2. Seven Objectives for a Transparent Decision (Drew and Nyerges 2003)

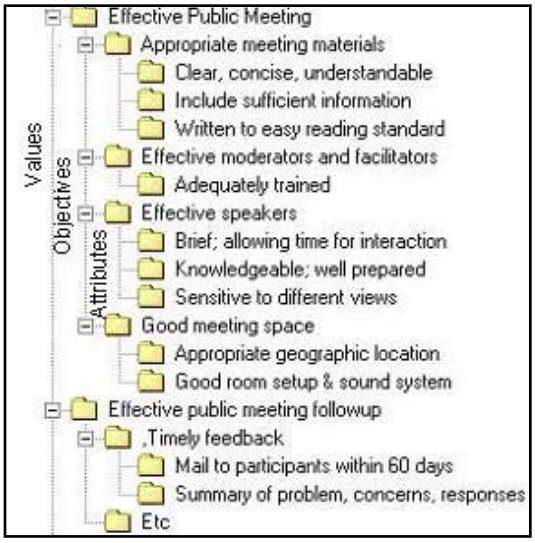

Figure 3. Example value tree for evaluating aspects of a public meeting (Extracted from Kern 1999, Appendix 14)

Informing deliberative processes: Looking at the process of informing a deliberation with analytic information raises questions, for example: Is translation or interpretation of analytic results necessary? What information is most important? What format works best? How does the process of "informing" get measured to determine its effectiveness? To date, little research has been done on exactly what information affected parties, especially those with limited risk-science training, need to participate in complex regulatory decision processes (Drew et al. 2003, Gilbert et al. 2003). A decision transparency framework we recently developed (Drew and Nyerges 2003) is particularly helpful in understanding this process. We have proposed that the concept of transparency be expanded into a series of objectives, i.e., that a transparent decision be clear, accessible, integrated within a broader context, logical, truthful and accurate, open to the public, and accountable (Figure 2). Sub-objectives for each of these have been developed (in the interests of brevity only one is described in detail here; additional details may be found in Drew 2002). For example, to be clear, the framework states that information should be readily comprehensible, contain no hidden meanings, contain minimal jargon and be precise and simple. We recently used the framework to evaluate the transparency of decisions in a particular context—soil cleanup at the Hanford site (Drew 2002), but it has yet to be evaluated in other situations. The transparency objectives provide a basis for developing a more robust understanding of the informing mechanisms in the analytic-deliberative process.

Framing analytic processes: Questions also arise about how deliberative dialogues frame analytic processes, for example: What do people care most about? What behaviors are relevant to the analytical procedures? What information do decision-makers need? How does framing get measured to determine its effectiveness? Little work has been done to understand or support the transfer of information emerging from a dialogue into an appropriate format for use in analytical processes. We intend to use value trees to help frame and provide feedback to the analytic process. Increasingly, value-trees are used at the outset of interactions with affected parties to build a shared understanding of values, objectives and criteria, and to develop concrete metrics to evaluate results (Dale and English 1999; Edwards and von Winterfeldt 1987; Keeney 1992; Keeney 1996; McDaniels and Thomas 1999; von Winterfeldt 1987). An example, extracted from a tree we helped develop with Hanford Openness Workshop participants (Kern 1999, Appendix 14), identifies some of the values, objectives and attributes associated with evaluating an effective public meeting (Figure 3). Structuring deliberative information this way will allow analysts greater opportunity to use information and to show how it has affected decisions.

Tools to improve dialogue

Many tools to enhance the dialogue have been developed. For example, Geographic Information Systems (GIS), have been used to improve understanding of complex contaminated sites. Using maps is particularly valuable in discussions of risk because they help participants understand the interplay between location and environment. In a review of over 40 studies, (Nyerges et al 1997) found GIS to be useful to manage, integrate and communicate complex spatial data sets at

all phases of a risk management process: including scoping, risk assessment modeling and risk communication. More and more, GIS is being used in group settings to enhance public participation in decision processes by structuring problems, employing problem solving techniques, fostering dialogue and building consensus (Carver 2001; Peng 2001; URISA 2002; Weiner et al 2001). Jankowski and Nyerges (2001) have gone so far as to show where and how value trees can be useful, but have not yet developed a value tree tool integrated with a GIS.

Our experience suggests that simple techniques can often go a long way to communicate complex information and stimulate meaningful dialogue among diverse participants. For example, in 1998 we assisted the League of Women Voters in a risk communication dialogue (Drew et al 2003). Previous focus groups about nuclear waste transportation had identified common questions, such as: How much waste exists? What kind of waste is it? What are the hazards of the waste? And, how and where is the waste going to be transported. These questions framed the analyses for a creative exercise that was prepared for the workshop—the "LegoMap." The LegoMap consisted of color-coded Lego blocks placed on a large base map of the United States to indicate relative volumes of various nuclear waste types and simulate waste transportation scenarios with workshop participants. It quickly enabled participants to understand relative volumes of different types of wastes with different hazards at different sites, to use that information to understand the significance of planned transportation routes through densely populated areas with high percentages of non-white populations, and to discuss Environmental Justice issues. The LegoMap was one of the most popular exercises because it provided relevant information in an innovative and fun way. Moreover, it serves as an example of the framing and informing cycle: the earlier focus groups framed the scientific analysis, and then the analysts provided an innovative tool to inform the dialogue. As a GIS-based approach, the LegoMap demonstrates the usefulness of visual and geographic approaches for understanding complex problems.

Another tool that has significantly altered the delivery of information in recent years is the Internet—particularly for government information. Benefits to using the Internet include wide geographic access to information 24 hours a day 7 days a week. This means that any interested party may access information from any computer connected to the Internet at whatever time is most convenient. In addition, Internet technology affords an unprecedented opportunity for linking and integrating information in complex ways that was not possible prior to the arrival of hypertext information linkages (URISA 2002). For these reasons, many argue that the Internet has a large role to play in informing democratic decisions. However, just over 50% of American households have access to the Internet, there are significant wealth and education barriers that affect access, and a wide range of Internet literacy affects usage (U.S. Department of Commerce 2002). These issues dictate that the Internet can never be the only mechanism for risk communication, and that more research is needed to understand its effectiveness. For example, a recent review of Internet sources for understanding reproductive and developmental toxicity found that on the one hand, many sites do not appropriately frame information in order to answer risk based questions that are important to participants; or on the other hand, provide information in a risk context but are not transparent about how the risk assessments are conducted (Polifka and Faustman 2002).

Several tools using both GIS and the Internet have appeared recently to express complex geographic information. Examples include Scorecard (http://www.scorecard.org); The Epidemiologic Query and Mapping System (EpiQMS) (http://www5.doh.wa.gov/epiqms/); and the Performance Indicators Visualization and Outreach Tools (PIVOT) (http://www.csc.noaa.gov/products/pivot/). These projects offer a good start on understanding certain types of complex information—e.g., distribution of hazards—but generally lack tools to understand other components of the risk assessment paradigm—such as exposure, risk characterizations and decision processes. In addition, many were not developed in a participatory way.

Despite the increasing use of GIS for analytical aspects of risk assessment and the delivery of this information on the Internet, very little research addresses how the use of advanced information technology affects the process or outcome of a decision, or even what information participants in the process need during the deliberative processes, and in what format. One project that has attempted to address these issues was the pilot Decision Mapping System (DMS) (Drew 2002) (http://nalu.geog.washington.edu/dms). We developed this tool as a direct result from working with members of the Hanford Openness Workshops (Kern 1999) who expressed frustrations with understanding cleanup decisions at the Hanford site, a former nuclear weapons facility in Washington State. The complexities of Hanford, including widespread radionuclide and chemical contamination, complicated regulations affecting cleanup processes, a wide range of interested parties with differing values, and the sheer size of the site (nearly 600 square miles), led us to a tool that integrated decision information with GIS and Internet technology.

Our experience with the DMS provides a strong basis for developing similar tools for other cleanup situations, such as contaminated sediments. We engaged affected parties at the outset of the DMS development process to ensure that their

needs and concerns would be addressed. The transparency framework (Drew and Nyerges 2003) also evolved directly from our work with parties affected by Hanford cleanup, and we used it to develop an innovative protocol for evaluating the DMS with a broader group of interested parties. In particular, our focus on regulatory processes (generally CERCLA) as an explanatory framework for decisions led to greater understanding of Hanford cleanup decisions and processes. Although all aspects of the DMS may not be directly translatable to contaminated sediment contexts, our evaluation of the Pilot DMS suggests that these types of tools can increase transparency and should be explored in additional contexts.

Proposed sediments tool

In response to the many challenges and approaches for involving interested and affected parties in complex dialogue about sediments cleanup, we advocate developing and evaluating innovative risk communication tools in collaboration with affected parties, decision-makers and technical specialists. Research questions about the informing and framing processes of the analytic-deliberative dialogue are important to consider. For example: (1) In what way do affected parties understand regulations, risk and other analytical information? (informing); and (2) In what way do decision-makers understand and incorporate community needs and perspectives into deliberative processes? (framing). Answering such questions requires researchers and communities to identify what information is needed (both content and format) to participate in an analytic-deliberative process about cleanup of contaminated sediment sites.

We are developing and evaluating a modular risk communication tool for understanding risks relating to contaminated sediment sources, using the scientific principles of risk analysis. The tool will include several modules and will be implemented primarily on the Internet. We will develop the modules based on the risk assessment framework and focus on understanding principles, hazards, exposure routes, risk characterization, as well as taking action to mitigate risks. We will develop the tool by working with a range of community representatives to help us define what information is required and in what format. Many groups around the Sound are concerned about contaminated sediments. Concerns focus on contaminated seafood harvested from the Sound and skin contact with the sediments that may occur during harvesting. Such groups are the primary audience for this tool, and will be enlisted to participate in the project—thus allowing us to better understand information needs and address them in the tools.

Conclusion

Connecting with exposure and risk models helps stakeholders become more fully engaged in complex environmental decision processes such as sediment cleanup. It helps stakeholders move beyond the "right to know" and into the "right to understand." It also helps scientists to provide information that will inform deliberative processes; i.e. answer the questions most important to participants. Visual and geographic approaches can help with the connection process, but are more meaningful when stakeholders participate and are empowered to take action on a variety of levels. To foster empowerment, emphasis on both the framing and informing processes within an "analytic-deliberative dialogue" is needed. The informing process can be evaluated using a framework based on goals for decision transparency. Dialogue participants will shape the informing process by defining what information is desired for deliberation and in what format. The framing process has been studied less often than the informing process but value trees offer a promising approach to study and evaluate the framing process. They can help participants to develop criteria to evaluate how satisfied participants are that their input has been used in a decision process.

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