Energy Division

Anthropology and Decision Making about Chronic Technological Disasters: Mixed Waste Remediation on the Oak Ridge Reservation

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Anthropology and Decision Making about Chronic Technological Disasters: Mixed Waste Remediation on the Oak Ridge Reservation

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Abstract
This paper discusses two related case studies of decision making about the remediation of mixed (hazardous and radioactive) wastes on the Oak Ridge Reservation in Tennessee. The three goals of the paper are to (1) place current decision-making efforts in the varied and evolving social, political, regulatory, economic, and technological contexts in which they occur; (2) present definitions and attributes of "successful" environmental decision making from the perspectives of key constituency groups that participate in decision making; and (3) discuss the role of anthropology in addressing environmental decision making. Environmental decision making about remediation is extraordinarily complex, involving human health and ecological risks; uncertainties about risks, technological ability to clean up, the financial costs of clean up; multiple and sometimes conflicting regulations; social equity and justice considerations; and decreasing budgets. Anthropological theories and methods can contribute to better understanding and, potentially, to better decision making.

Introduction

Disasters typically are presumed to be acute events no matter if they are natural events such as hurricanes or earthquakes or technological events such as explosions or airline crashes. However, disasters also can be chronic. Examples include long-term droughts or underground mine fires such as those in Centralia, Pennsylvania (insert Couch and Kroll-Smith refs.). This chapter deals with another kind of chronic technological disaster that is prevalent throughout the world, continuing hazardous and radioactive waste contamination of the ground and water surrounding industrial facilities.

Such contamination problems tend to be extremely complex. Among the factors that contribute to this complexity are the following: industrial contamination often is cumulative—it may be a latent problem whose existence may not be evident for years; similarly, its impacts on humans and the environment may be delayed; the impacts may be dynamic (e.g., due to groundwater flow), multiple (e.g., contributing to an array of medical conditions instead of a single kind of condition), and uncertain (e.g., in the context of multiple contaminants with unknown combined effects); and cleaning up industrial contamination may be technically, economically, or politically infeasible. Further, while the contamination generally is considered "bad," the industries that create the contamination may not be so easily categorized as "bad" or "good." In fact, the current, legally responsible parties frequently are not the parties that created the contamination problem. This chapter focus on situations where the same industries that are responsible for the contamination may be integral to the economic, political, and social fabric of the communities in which they operate.

In these circumstances, chronic technological disasters differ from acute disasters in a number of ways. First, the former build gradually to the level of "a problem" and may not be recognized as disasters by community residents, in stark contrast to events like tornadoes or explosions. Second, acute disasters promote action; chronic disasters promote consideration and uncertainty. Third, while the urgency of acute disasters may unify people and encourage cooperation (at least in the near term), chronic industrial contamination typically prompts diverse, frequently conflicting reactions. Decisions about how to respond to chronic industrial contamination increasingly are made in accordance with formalized processes that include public participation. Public participation can reveal and exacerbate conflicting cognitive models of the problems and of acceptable solutions. Fourth, acute disasters typically cannot be prevented from happening, but there are some clear-cut responses when they do occur (e.g., evacuating, tending to the wounded, putting out fires). There frequently are no obvious responses to chronic industrial contamination. Fifth, acute disasters are recognizably different; they can be considered in terms of "before" and "after" both in terms of the event itself and in terms of social and economic life. In contrast, chronic technological disasters can be largely or totally integrated into the fabric of a community such that they become a part of the context of community life. Sixth, although it may take a very long time to "recover" from acute disasters, there often are visible signs of recovery such as re-built structures or floodwaters receding to normal levels. Signs of recovery from chronic technological disasters may be much less visible.

The complex interweaving of social, economic, environmental, and health factors in chronic technological disasters also raises the issue of what constitutes a disaster. This topic can be examined by focusing on the cultural construction of disaster in the context of decision making about the remediation (cleanup) of two sites contaminated by activities occurring on the U.S. Department of Energy's (DOE's) Oak Ridge Reservation in Tennessee. These cases illustrate how (1) decision-making efforts fit within the varied and evolving social, political, regulatory, economic, and technological contexts in which they occur; (2) key constituency groups' perspectives on definitions and attributes of "successful" environmental decision making vary; and (3) anthropological approaches contribute to improvements in environmental decision making.

The work reported here is part of a series of projects undertaken by the National Center for Environmental Decision-making Research[1] (NCEDR), a research institute that aims to understand and help improve environmental decision making. Case studies of environmental decision making are a key component of NCEDR's activities. The two case studies presented in this chapter are still under way. Like other NCEDR activities, the case studies are interdisciplinary, collaborative efforts. Our methods are typical of work conducted in a non-academic setting, consisting of document reviews, semi-structured interviews with key informants, information elicitation in group settings such as workshops and small "advisory" group sessions. Our approach is based on grounded theory,[2] in which empirical observations and analyses are used to refine the theoretical approach during the course of study. These refinements, in turn, are used to hone the field observations and analyses. Moreover, the anthropological traditions of holistic inquiry, and of social structural, institutional, and cultural analyses are integral to our efforts.

The Setting

The two cases described in this chapter involve decisions made in the recent past about cleaning up contaminated sites on and near the Oak Ridge Reservation, in Tennessee. These cases concern two of many contamination problems on and near the Reservation. Although the sites are similar in many regards, they involve different contaminants, different environmental settings, different kinds of debates about the potential threats posed to human life and the environment, and

[1] The National Center for Environmental Decision-making Research (NCEDR) is funded by the National Science Foundation, with additional support provided by its three parent institutions, Oak Ridge National Laboratory, Tennessee Valley Authority, and University of Tennessee. NCEDR focuses on the suite of issues, approaches, tools, and processes that constitute environmental decision making.

[2] Barney Glaser and Anselm Strauss, 1967. *The Discovery of Grounded Theory.* Chicago: Aldine.

different environmental decision-making processes. Together, they constitute an interesting view on the cultural construction of chronic technological disasters.

Background

DOE's Oak Ridge Reservation is located within the city limits of Oak Ridge, a community of approximately 28,000 residents. The city is located in the ridge and valley physiographic province about 25 miles northwest of the larger urban center of Knoxville, Tennessee. Oak Ridge was created by the federal government in the early 1940s as part of the Manhattan Project. Uranium-235 produced in Oak Ridge was used in the "Little Boy" bomb dropped on Hiroshima on August 5, 1945. Three research and production facilities were built, each one located in a different valley for safety reasons—to isolate it from the other facilities and from the community's residential areas. The three facilities were designated K-25 (later called the Oak Ridge Gaseous Diffusion Plant), X-10 (now known as the Oak Ridge National Laboratory), and Y-12 (not known by other names). K-25 was built to produce enriched uranium. Because the method of producing enriched uranium at K-25 was a highly experimental process in the 1940s, the Y-12 Plant was built to produce enriched uranium through a different process. After the war, K-25 continued as a uranium enrichment production facility. Y-12 shifted to a diverse set of activities that include producing nuclear weapons components, providing support for weapons design, specialized nuclear material processing, and stable isotope production. From its inception, X-10 primarily has been a research facility rather than a production facility. During the war, a major activity was to build a pilot plant for plutonium production, to serve as a model for plutonium facilities to be built in Hanford, Washington. After the war, activities at X-10 focused on a wide range of matters associated with nuclear energy; activities became even more diverse in the 1970s and 1980s to encompass a wide range of non-nuclear energy and environmental research.

The variety of research and industrial activities conducted at the three facilities was responsible for the production of a long list of wastes, including radioactive wastes, hazardous wastes, mixed wastes (hazardous and radioactive), and conventional waste. There is contamination of the air, water, and soil, potentially affecting plant, animal, and human life. The Oak Ridge Reservation is one of several DOE reservations in which there is a mosaic of different kinds of pollution (some DOE sites have much more constrained sets of pollutants or smaller geographic areas of concern than is the case in Oak Ridge).

Historical waste disposal practices on the Reservation were inappropriate by today's standards; at least three factors may have contributed to this situation. First, plant managers did not always place high priority on safe disposal practices.[3] Second, the best available technologies in the past may not meet today's standards. Third, a lack of knowledge contributed to decisions that, despite good intentions, created environmental problems; at that time, little was known about the behavior and effects of some contaminants, the hydrogeology of the area, and the likely behavior of contaminants in the local environment.

The legacy of contamination of the Oak Ridge Reservation, and other DOE reservations like Hanford and Los Alamos, has a major influence on DOE headquarters and other federal agencies, the DOE laboratories, businesses, and surrounding communities. Huge amounts of money and other resources are spent studying, planning, and sometimes engaging in environmental remediation efforts. The suite of contamination problems at DOE sites is so vast and so costly to remedy (it may not always be technically possible to clean sites to pristine levels) that there is an increasing and explicit discussion within federal and state agencies of how to set priorities for clean-up activities, the level to which sites ought to be cleaned up, and how to clean them up in a cost-effective manner. In some ways, and to some parties, the prospect of economic disaster seems to loom larger than environmental disaster.

It is in this context that decision making about the Lower East Fork Poplar Creek and Waste Area Grouping 6 were made. Our investigations look retrospectively at key decision points, to focus our examination of the participants in the decision-making process, the issues of primary concern to them, and the larger set of environmental decision-making issues the cases raise.

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[3] Although it often is assumed that the urgency of the war years may have superseded an emphasis on safe disposal practices, Stow 1996 counters this idea. He points out that it was after the war that some of the poor (in retrospect) waste disposal decisions were made. [NOTE: check reference to be sure this summary is accurate.]

Lower East Fork Poplar Creek

Lower East Fork Poplar Creek is located inside the Oak Ridge City limits, in close proximity to both commercial and residential areas. In the early 1980s, the U.S. Department of Energy (DOE) acknowledged that the creek itself and the soils of the surrounding floodplain were contaminated due to past releases of mercury from a nearby federal weapons facility. Over the next 10 years, the problem was studied and discussed by government officials at all levels as well as by neighboring property owners and the general public. Major actions during that time included forming an interagency group with members from key federal, state, and local government agencies to evaluate and report on the mercury contamination, collecting and testing samples from land along the creek, and holding multiple workshops for neighboring property owners.

In May 1992, toward the end of a public meeting to discuss possible clean-up activities, DOE asked for volunteers to form a Citizens Working Group to provide feedback on possible alternatives for cleaning up the floodplain soils. While this group was to be informal, with no official decision-making power, it still generated substantial interest and more than 30 people volunteered—and were accepted—for membership. Members included nearby property owners, retired scientists from the three DOE facilities in Oak Ridge, an Oak Ridge City Council member, a member of the city's Environmental Quality Advisory Board, and people affiliated with the League of Women Voters, a local environmental and health interest group known as the Oak Ridge Health Liaison, and several other local organizations.

Many government agencies and their contractors, while not official members of the working group, were very interested in the Citizens Working Group's activities and interacted with it. These organizations included: DOE, the agency responsible for the clean-up effort; Martin Marietta Energy Systems Inc., the primary contractor responsible for managing DOE's Oak Ridge facilities at that time; the Tennessee Department of Environment and Conservation, the state agency with regulatory authority over DOE's remediation activities; the U.S. Environmental Protection Agency (EPA), the major *federal* regulator in this case; the Agency for Toxic Substances and Disease Registry (ATSDR); the U.S. Fish and Wildlife Service; and the U.S. Corps of Engineers.

The Citizens Working Group met approximately once a month, responding to the clean-up alternatives that DOE proposed and also providing its own ideas and suggestions. This group functioned from June 1992 until the end of 1994 and played a key role in determining the Remedial Goal Objective that ultimately was set for the floodplain soils surrounding Lower East Fork Poplar Creek. Initially, the state of Tennessee considered a Remedial Goal Objective of 10 parts per million (ppm), meaning that all soils with a mercury content of more than 10 ppm would have to be removed from the floodplain. Later, the state suggested that the floodplain soils be cleaned up to a level of 50 ppm, an action that would have cost approximately $163 million.

The Citizens Working Group became very interested in the issue of the chemical speciation (i.e., the specific form) of the mercury that was present in the floodplain soils. Further investigation, prompted by Citizens Working Group concerns, showed that the dominant form of mercury in the floodplain soils was mercuric sulfide, which is much less soluble in water and less biologically available through human and animal digestion than the mercuric chloride on which the suggested Remedial Goal Objective of 50 ppm was based. Based on this speciation information, DOE proposed a clean-up standard of 180 ppm at a January 1995 public meeting that was attended by more than 200 people.

Over 100 comments were made at the January 1995 public meeting, the large majority of them characterizing the proposed Remedial Goal Objective as too restrictive and calling for a less stringent clean-up standard that would engender less ecological disruption in the vicinity of Lower East Fork Poplar Creek. Several vocal Citizens Working Group members were among those stating that the proposed clean-up goal of 180 ppm was too conservative for the purpose of protecting human health. Subsequently, DOE proposed a Remedial Goal Objective of 400 ppm—which reflected a lower bioavailability of mercury than had been assumed in setting the earlier clean-up goal of 180 ppm—and this standard was judged acceptable by EPA, state regulators, and the ATSDR. As with the earlier proposals, this new clean-up level would allow unrestricted land use in the vicinity of Lower East Fork Poplar Creek.

The new standard, proposed at a June 1995 public meeting in Oak Ridge, did not generate a significant amount of expressed opposition, either during or after the meeting. Two months later, a Remedial Goal Objective of 400 ppm was formalized in the official Record of Decision issued under the Comprehensive Environmental Response and Liability Act (CERCLA, often referred to as "Superfund").

The issuance of the CERCLA Record of Decision cleared the way for the clean-up effort to begin. Some preliminary actions—most notably clearing trees and building access roads—were taken in the Summer of 1996, with the bulk of the clean-up activities scheduled to commence in mid-1997. The remediation process involves removing all floodplain soil that is contaminated with mercury above the 400 ppm level and taking it to a nearby landfill. It is estimated that approximately 28,000 cubic yards of soil will have to be removed, at a cost of $8 to 9 million.

Waste Area Grouping 6

WAG 6 is a 68-acre Oak Ridge Reservation facility for disposal of "mixed" wastes, which are a combination of radioactive and hazardous wastes. WAG 6 contains low-level radioactive wastes, solids, sludges, asbestos, and biological and associated laboratory wastes at the Oak Ridge National Laboratory (ORNL). Contaminated sites located within WAG 6 are: (1) Solid Waste Storage Area 6, (2) the Explosives Detonation Trench, and (3) the Emergency Waste Basin. Of these sites, Solid Waste Storage Area 6 is the largest (19 acres) and the principal source of environmental contamination at WAG 6.

When WAG 6 opened in 1969, it was the only available disposal facility at ORNL for solid low-level radioactive waste. It operated as a repository for mixed and hazardous wastes until 1986. In that year, DOE acknowledged that Resource Conservation and Recovery Act (RCRA)-regulated hazardous and mixed wastes inadvertently were being disposed of in Solid Waste Storage Area 6 trenches and pits. RCRA required closure of those areas that had received hazardous wastes after 1980. It also established certain deadlines and carried with it the threat of shutting down all of ORNL waste disposal activities if required actions were not taken. RCRA, therefore, became the driver for WAG 6 management activities.

Achieving compliance with RCRA was not a simple matter; WAG 6 presented a complicated situation with regard to the wastes it contains, the location of those wastes, and the applicability of RCRA to those wastes. The primary contaminant in WAG 6 is radioactive waste, which is not covered by RCRA. Radioactive waste disposal areas are interspersed with RCRA-regulated disposal areas and with disposal areas that, because they received hazardous wastes before 1980, are not regulated by that Act. The mixture of RCRA and non-RCRA areas within WAG 6 made it difficult to close only the RCRA areas. Adding to these difficulties are the site's complex hydrogeology, its large size, and lack of proven technologies for use in this kind of situation.

Nevertheless, a RCRA closure plan requiring an October 1993 completion date for final closure was approved by the Tennessee Department of Environment and Conservation in September 1988. In accordance with this plan, an interim closure of those portions of WAG 6 containing RCRA-regulated waste was initiated in 1988. This interim closure plan would be followed until DOE could develop a comprehensive closure and remediation plan for all of WAG 6. Those interim measures—six high-density polyethylene caps over eight acres of RCRA-regulated disposal areas—still are in place.

However, in December 1989 the Oak Ridge Reservation was put on the U.S. Environmental Protection Agency (EPA) National Priorities List of Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, better known as "Superfund") sites. In August 1991, DOE asked the Tennessee Department of Environment and Conservation to extend the WAG 6 closure deadline until 1997. The Tennessee Department of Environment and Conservation deferred its decision until the Feasibility Study and Proposed Plan, being developed in compliance with CERCLA, was completed. On the first day of 1992, a CERCLA-required Federal Facilities Agreement among the EPA, DOE, and the State of Tennessee (via its Department of Environment and Conservation) became effective for Oak Ridge Reservation cleanup.

A February 9, 1993 public meeting was held in Oak Ridge, in accordance with CERCLA public participation requirements. The goal of this meeting was to present the Proposed Plan for interim remedial action at WAG 6. The Proposed Plan included the use of plastic caps and water diversion devices to halt or substantially reduce contaminant migration to surface and groundwater.

Approximately 175–250 people attended the meeting; written comments also were received by DOE. Participants at the meeting generally conveyed the belief that the Proposed Plan was seriously flawed for three interrelated reasons. First, the amount of risk reduction to human health was insignificant, particularly when likely exposures rather than possible exposures were considered. Because WAG 6 is located within the boundaries of the Oak Ridge Reservation, it is relatively inaccessible to the general public. Meeting participants thought that the scenario on which human risk assessments was based—which involved a homesteading family, living on the site for about 30 years, drinking well water—was unrealistic. Further, participants pressed to learn estimated off-site human health risks; these risks were minimal. Second, the Plan proposed very costly (approximately $140 million[4]) interim—but not final—measures. Third, in the context of contamination within the entirety of the Oak Ridge Reservation, WAG 6 represented a trivial contribution, and therefore should be accorded much lower priority than remediation of other sites.

In addition, participants in the public meeting questioned the proposed technology. They wanted to know how the proposed preferred alternative was going to be implemented and whether there was a guarantee that the plastic caps would do what was expected.

After this single public meeting, DOE appointed an Action Resolution Committee to study and respond to public comments on proposed WAG 6 remedial actions. The end result was a non-binding Record of Agreement among DOE, the Tennessee Department of Environment and Conservation, and EPA rather than a legally binding Record of Decision. This Agreement, signed in June 1994, delayed action on WAG 6 remedial action until such time as higher risk releases are addressed. The signatories agreed that WAG 6 final closure under RCRA and CERCLA remedial action completion would be made to coincide, and that CERCLA final action would meet RCRA requirements. A second agreement was to establish an Environmental Restoration Technology Program to demonstrate innovative technologies for all aspects of remedial action at WAG 6. These technologies presumably would be applicable to other Oak Ridge Reservation sites. Third, the Record of Agreement stated that environmental monitoring would be undertaken and the results reported on a regular basis.

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[4] The cost figures included in the written plan were on the order of $12–$14 million [check figure]. But, during the public meeting, it became clear that those projected costs were for the increment of work over and above the infrastructure development and other work necessary for *any* substantial remediation effort, and that the total costs for interim

The Contextual Definition Of Disaster

The two Oak Ridge Reservation cases raise questions about what constitutes a disaster, what kind of disaster a situation may be, how different parties perceive disaster, and how the context and the cultural construction of chronic technological disasters change over time. They also illustrate the multiple dimensions of chronic technological disasters, and how these dimensions interact to influence perceptions of—and responses to—disaster.

What constitutes a chronic technological disaster? Does contamination, alone, make a situation a disaster? In the cases of Lower East Fork Poplar Creek and WAG 6, neither the types of contaminants nor the contaminant load has changed appreciably in the last decade. The nature of the impacts to physiological human health and the ecosystem have not changed over that same period of time, except for the cumulative effects of the contaminants. Initially, these chemical, physiological, and ecological dimensions of the cases essentially were disasters waiting to be recognized.

Public recognition of Lower East Fork Poplar Creek and WAG 6 contamination problems occurred in different ways. DOE's acknowledgment of mercury contamination along Lower East Fork Poplar Creek in the 1980s came in the midst of considerable local and national news media attention. That attention was fairly dramatic; it included whistleblowing, DOE untrustworthiness, additional stigma for the community, a posted creek, the inadvertent dispersion of mercury-contaminated soils in the city (through the use of dredged floodplain soils for fill dirt around a local junior high school and elsewhere), and congressional hearings. Lower East Fork Poplar Creek contamination constituted highly visible evidence of off-site contamination, that is, contamination flowing beyond the borders of an Oak Ridge Reservation facility into the community that housed it. Disaster in this context of "recognition" involved uncertainties about the chemical, physiological, and ecological dimensions of the problem. Subsequent actions included identifying the nature and extent of the contamination and its associated human health and ecosystem impacts. During this recognition phase, the Lower East Fork Poplar Creek case encompassed other dimensions of chronic technological disaster. Conflict emerged at several levels. Within the community, there were different views on the seriousness of the problem and on the degree to which DOE should be trusted, as

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remediation approached $140 million.

examples. The glare of outsiders' critical views of the community and its environmental problems may have exacerbated a we–they (within community–outside community) tension that existed since Manhattan Project days. Further, there were economic dimensions of the Lower East Fork Poplar Creek disaster during the recognition phase. Individuals' property values (and ability to develop large parcels) as well as the community's economic development potential were at stake.

Public recognition of WAG 6 contamination problems occurred quite differently from Lower East Fork Poplar Creek. Although the February 1993 public meeting was advertised, WAG 6 probably received more local media attention in the aftermath of that meeting. Post-meeting coverage discussed citizens' negative responses to the proposed clean-up plan, focusing on outrage over the huge cost of an interim clean-up measure that would hardly reduce human risk levels. Thus, one economic dimension of disaster in this case had more to do with the cost of cleanup—particularly for one contaminated site among many on the Reservation—than with the economic development concerns evident at Lower East Fork Poplar Creek..

Chemical or risk-related dimensions of disaster for WAG 6 also were considerably different from the Lower East Fork Poplar Creek case. WAG 6 is a waste disposal burial ground—it was set aside to receive hazardous and radioactive wastes. The fact of contamination was not at issue even though, for historical reasons, the exact composition of the wastes buried at WAG 6 is not certain. Human health risk concerns were expressed in terms of on-site and off-site situations. On-site risk estimates were based on a homesteading scenario that people attending the public meeting found unrealistic. People attending the public meeting were more concerned about likely exposures at and beyond the borders of the Reservation. The human health dimensions of WAG 6 seem to point to a community-based definition of disaster that emphasizes "realistic" impacts to humans more than the presence of contaminants known to be harmful. Further, as was the case for Lower East Fork Poplar Creek, human health risk took precedence over ecological risk among the participants in the decision-making process.

The chemical dimensions of WAG 6 are intertwined with the regulatory dimensions of the case. In many regards, it was RCRA, CERCLA, and the inherent conflicts between the two that prompted public recognition of WAG 6. RCRA's influence had two major components. First, compliance with RCRA required the clean-up of RCRA-regulated wastes in WAG 6, no matter the financial costs or the risks to human health. Second, non-compliance with RCRA could impose a tremendous economic burden to a community like Oak Ridge if it resulted in the shut-down of all waste disposal activities (which generate a tremendous amount of business at the DOE facilities and among the numerous engineering and consulting firms located in and around Oak Ridge). CERCLA influenced the analyses that used homesteading scenarios for estimating risks to human health[5]. It also mandates public meetings like the one held in February 1993. But it was the simultaneous compliance with RCRA and CERCLA that proved disastrous for WAG 6. DOE, EPA, and the state tried to mesh RCRA and CERCLA activities in an effort to streamline the remediation process. However, at the public meeting DOE found it difficult to justify a RCRA-mandated remedy (though an interim one) with a CERCLA-style analysis.

After the WAG 6 recognition phase, which culminated in the February 1993 public meeting, it took over a year for the Action Resolution Committee to formalize a Record of Agreement. The Record of Agreement can be viewed as a reconciliation among the multiple dimensions of disaster made evident in the public meeting. Given that DOE, EPA, and the state decided to defer making a decision on clean-up, in part because of an explicit decision that there are other sites on the Reservation that should have higher priority in remediation, does WAG 6 now constitute a disaster?

Which dimensions of disaster should take precedence? There are no generic answers to this question. However, the two case studies provide evidence of which dimensions did take precedence at different points in time. In both cases, for example, human health risks implicitly or explicitly were deemed of greater importance than ecological risks. This point is particularly relevant for the Lower East Fork Poplar Creek. The now-established clean-up standard of 400 ppm is thought to be protective of human health; ecological risk analyses indicated that a 200 ppm level would provide greater certainty that the natural environment would be protected adequately. Interestingly, some respondents indicated that the deliberate narrowing of the bounds of the decision-making problem for Lower East Fork Poplar Creek (e.g., by focusing on human, rather than ecological, risk; by considering the floodplain and not the creek) enabled a remediation decision to be made.

[5] At the time that these analyses were being conducted, there was a greater emphasis on cleaning up to pristine, or "greenfield," conditions within regulatory agencies than generally is evident today. Now regulatory agencies are tending to be more willing to consider "appropriate" future land uses—which need not always require a return to pristine conditions. Of course, determining what "appropriate" future land uses are is not straight-forward, and involves multiple dimensions and perspectives such as those discussed in this chapter.

If one goes beyond the definition of disaster to the application of that definition in resulting environmental decision making, the multiple dimensions of disaster may become even more pronounced. WAG 6 is an example where the recognition of the chemical and risk dimensions of a problem was insufficient to warrant huge expenditures of money to remediate them, particularly for interim measures. The economic (financial) and technological (lack of proven technology) dimensions of this chronic technological disaster held sway. Lower East Fork Poplar Creek highlighted a different kind of conflict—between remedying an identified disaster and creating another kind of disaster by implementing the remedy. Specifically, the adverse ecological impacts of mercury contamination had to be considered in light of the habitat destruction attendant to the remedy of removing contaminated floodplain soil (and the vegetation growing in that soil). Which is worse, mercury contamination or soil removal?

Multiple Perspectives On Successful Environmental Decision Making

Anthropological case-study methods and theoretical approaches contribute to an understanding of (a) the varying contexts in which chronic technological disasters occur and are given social meaning and (b) the cultural dynamics associated with those disasters. But understanding, alone, will not assure the success of actions taken in response to these disasters; it is essential to know the desired end points of the decisions that generate those actions. Removing the chemical source of contamination may not always be the most locally desirable outcome. Both of the Oak Ridge Reservation cases demonstrate this point.

Just as there are multiple perspectives on what constitutes a disaster, there also are a number of different ways of defining "successful" environmental decision making. Different conceptualizations of success are common and reflect dissimilar constituent interests as well as the divergent topical, temporal, and geographic perspectives that are relevant to the various interested parties. Because success has many different, and potentially instructive, attributes, we believe that it makes sense to define successful decisions using a package of attributes that represent a broad range of legitimate perspectives and are applicable to many different kinds of environmental problems and sets of circumstances.

Factors Influencing How Different Parties See Success

The various constituent or stakeholder groups involved in environmental decision making often have disparate interests and divergent values, which cause them to define success in different ways. Owners of contaminated property, for instance, are likely to be highly motivated to achieve a thorough and timely clean-up, in order to remove the principal health risks and allow the full and unfettered use (including possible sale and development) of their land. Accordingly, the most salient attributes of success for this interest group might be the minimization of ecological and human health impacts; these interests are likely to be shared (though not necessarily for identical reasons) by environmental groups. For some parties, success would be predicated on thorough scientific understanding; this preference might lead to a decision to conduct studies rather than to initiate clean-up measures. State and federal environmental regulators and local government officials also are likely to be interested in reducing impacts to human health and the natural environment and, in addition, in ensuring that the decisions in question are politically durable and flexible enough to accommodate changing circumstances. Organizations whose primary concern is social justice, or individuals who are members of ethnic or socioeconomic groups that have absorbed disproportionate impacts in the past, are likely to define success in terms of how equitably any adverse impacts are distributed among all citizens. The agency responsible for performing the remediation is likely to temper its concern for environmental quality with a desire to spend funds as efficiently as possible. And, to expedite matters and avoid costly and time-consuming litigation, this party probably would also want any clean-up decisions to be widely accepted by the other interested parties. Clearly, these examples illustrate that constituent interests can affect preferred definitions of success profoundly.

Different topical perspectives also can lead to different views of successful decision making. One common topic of interest is the natural environment of the contaminated site and its surroundings. Parties motivated by a concern for these resources are likely to favor the use of attributes of success that focus on disruptions to nearby terrestrial and aquatic ecosystems. In contrast, an emphasis on human health effects could lead one to focus on a more limited set of resources. A much greater disparity in favored attributes would be likely for those parties whose primary focus is on the economic costs of remediation. Other topical perspectives also are possible, and each is likely to emphasize a different set of attributes of success.

The temporal and geographical perspectives of interested parties also can vary; these perspectives likewise can have implications for how successful decision making is defined. An emphasis on short-term effects is likely to lead one to favor different attributes of success than if the time frame of interest were mid-term, long-term, or inter-generational. Geographically, one could focus on impacts to the contaminated site itself, the area immediately surrounding it, the entire local community, downstream communities, a larger substate region, an entire state, a multi-state region, the whole nation, or the entire planet. Whatever one's time frame or geographic area of interest, attributes of success can be developed to capture that perspective, but different foci are likely to lead to different ways of conceptualizing and measuring success.

Individual Attributes of Success

Anthropological approaches enable researchers to discern the variety of perspectives on success surrounding a chronic technological disaster. Anthropology also can contribute to the formulation of measures of the success of environmental decision making from constituency-specific or, as we propose, cross-constituency perspectives. This approach, however, treats all attributes equally. We have not yet explored whether some attributes are essential to success or whether others may not be essential, but may enhance success. Anthropology, like virtually every other discipline, fails to offer much guidance in determining generically whether some attributes of success *should* have more weight than others during the course of environmental decision making and, if so, which attributes should have greater weight. Anthropological approaches can, however, be used to elicit and analyze the relative importance of these attributes (across a community and for different constituency groups) within a specific environmental decision-making setting.

With these caveats in mind, we present in Table 1 a list of 14 different attributes of successful environmental decision making suggested by our case studies. Each of these attributes describes a specific facet of success but none, by itself, provides a definitive picture of successful environmental decision making. Nor are the different attributes mutually exclusive. They can be grouped into the following four broad subject areas: (1) citizen participation and understanding; (2) technical attributes of decisions; (3) social and political attributes of decisions; and (4) effects of decisions on site conditions. This attributes list of is not exhaustive; nor are the four broad categories suggested here the only possible choices. Each of the attributes listed in Table 1 is explained briefly below.

Table 1. Attributes of Successful Decision Making

Citizen Participation and Understanding

- Decisions are based on input from all parties
- Decisions are understood by all parties

Technical Attributes of Decisions

- Decisions are scientifically and technically sound
- Decisions allow flexible response to changing circumstances
- Decisions are compatible with past and likely future decisions associated with the issue(s) in question

Social and Political Attributes of Decisions

- Decisions are widely accepted as legitimate
- Decisions comply with existing laws and regulations
- Decisions are politically durable
- Costs and benefits are balanced efficiently

Effects of Decisions on Site Conditions

- Adverse impacts to natural environment are minimized
- Adverse impacts to human health are minimized
- All adverse impacts are distributed equitably among the public
- Existing problems are solved rather than transferred to another time or location

Decisions are based on input from all parties. This attribute addresses how open the decision-making process is to inputs from a broad range of interested parties and how seriously the information and opinions provided by these participants are taken by those with ultimate decision-making authority.

Decisions are understood by all parties. The focus of this attribute is on the degree to which interested parties comprehend environmental decisions and the implications of those decisions. This kind of understanding can be promoted both through the decision-making process and by the efforts of the responsible agency to disseminate and explain decisions once they have been formulated.

Decisions are scientifically and technically sound. This attribute means that a proposed solution to an environmental problem has a valid scientific basis and brings credible scientific thinking and knowledge to the issue at hand. It is interesting to note that in the case of the Lower East Fork Poplar Creek, citizens prompted (and undertook) efforts to analyze mercury speciation with regard to human health risks. These analyses were deemed credible and technically sound by a variety of constituency groups, including state and federal regulatory agencies, DOE, and the Citizens' Working Group. The analyses resulted in a higher standard for the allowable levels of mercury in floodplain soils than originally proposed, even though the analyses concentrated on human health effects rather than on ecological impacts.

Decisions allow flexible response to changing circumstances. This attribute addresses how well the recommended course of action can be modified should it prove to be inadequate or if changes in external circumstances call for a different approach.

Decisions are politically durable. This attribute addresses the extent to which the decisions reached will remain viable over time and will not be overturned or made unworkable by political and social pressures. Flexible decisions (the preceding attribute) and politically durable decisions may appear to be conflicting attributes of successful environmental decision making. Some respondents, when questioned directly about this apparent contradiction, maintained that both are possible. In their views, since virtually no environmental decisions are final, there is the expectation that the underlying issues will be revisited as information and conditions change. Perhaps the "durability" they had in mind was for the near-term, such that decisions had sufficient scientific credibility, and were supported by sufficient social and political will to be implemented as planned.

Decisions are compatible with past and likely future decisions associated with the issue(s) in question. According to this attribute, successful decisions do not negatively affect the activities initiated through previous environmental decisions. Alternatively, successful decisions may build on past efforts, particularly if past decisions proved acceptable. At the same time, any interim decision should be compatible with what is likely to be the final decision and should not unduly limit future options.

Decisions are widely accepted as legitimate. This attribute describes the extent to which the various interested parties agree that the environmental decisions in question are fair and serve the broad public interest. It does not describe the extent to which these parties agree with the decision. Judgments about the legitimacy of environmental decisions may be based on judgments about the legitimacy or fairness of the process by which decisions were made.

Decisions comply with existing laws and regulations. The focus of this attribute is on how well the actions and initiatives developed by decision makers satisfy current legislative and regulatory mandates. Some respondents noted that legal and regulatory compliance was necessary, but not sufficient, to assure a good environmental decision. Further, as was the case with WAG 6, it may be difficult or impossible to comply with the variety of laws and regulations applicable to a particular site or situation.

Costs and benefits are balanced efficiently. This attribute refers to how well a decision balances the costs associated with a given decision against the benefits that are garnered. Typically, the focus is on economic costs versus environmental benefits, although environmental, social, and political costs as well as economic, social, and political benefits can arise from an environmental decision.

Adverse impacts to natural environment are minimized. This attribute focuses on how successful an environmental decision is in preventing or limiting damage to the affected ecosystems. Note that in both of the cases discussed in this chapter, particularly the Lower East Fork Poplar Creek case, that attention to adverse ecological impacts was minimal in comparison with human health impacts during the course of making decisions.

Adverse impacts to human health are minimized. This attribute is very similar to the previous one, except that the focus here is on how well adverse impacts to human health—as opposed to the natural environment—are minimized.

All adverse impacts are distributed equitably among the public. This attribute frames success in terms of how any negative effects arising from an environmental decision are spread throughout the impact region[6]. These distributional issues—which may arise when the parties or geographic areas that benefit from environmental decisions do not coincide with the parties or geographic areas adversely affected by those decisions—encompass "environmental justice" concerns, which center on disproportionately high and adverse impacts to minority and low-income communities.

Existing problems are solved rather than transferred to another time or location. This attribute, which dovetails with the previous attribute, addresses the extent to which a decision constitutes a complete and lasting solution to an environmental problem, as opposed to postponing difficult questions until a later date or shifting adverse effects to another geographic area or political jurisdiction.

Defining Success with Multiple Attributes

Clearly, there are many different perspectives on what constitutes a successful environmental decision. It is easy to imagine that different parties with disparate interests might favor different ways of defining and measuring success. Similarly, an attribute of success that would be entirely appropriate for describing how well an environmental decision addresses one type of environmental problem might not fit as well under a different set of circumstances. And, it is possible that a number of different attributes of success would be necessary to capture the full range of interests and concerns that are important to a single person or organization. For example, a government agency responsible for cleaning up toxic wastes might simultaneously value active public participation; the technical, social, and political attributes of decisions; and the effects of those decisions on key site conditions.

Fortunately, it is possible to select a set of attributes that, among them, describe successful environmental decision making in a manner that is meaningful to a diverse set of interested parties

[6] These issues may be particularly pronounced, difficult to analyze, and to resolve when transportation impacts are at issue (as opposed to fixed-site impacts).

and for a broad range of problems and circumstances. Past research indicates that groups with widely divergent interests and who face many different types of environmental problems can reach a surprising degree of agreement on a core set of process- and outcome-oriented attributes to describe success (Carnes *et al.* 1996). This finding does not mean that *all* parties will be equally enthusiastic about all attributes. It does mean, however, that it is possible to devise a set of attributes that—taken as a whole—has significant meaning to, and is appropriate for, a broad array of interested parties under a wide variety of circumstances. The task of identifying these attributes requires careful attention to the interests of the various parties affected by environmental decisions, and the concluding section of this chapter offers some advice on how this can be accomplished.

The Role of Anthropology in Making Decisions about Chronic Technological Disasters

Throughout this chapter, we have focused on multiple perspectives for defining technological disasters, responding to such situations, and measuring the success of the responses. This awareness of different ways of viewing and addressing environmental problems can be thought of as an anthropological approach to disasters, because its foundation is a belief in—and respect for—the variety of human experience and the legitimate differences between various groups and cultures.

Value of the Multiple Perspectives Approach

The principal value of the multiple perspectives (or anthropological) approach is that it encourages environmental decision makers and all other interested parties to see technological disasters and appropriate responses to them through the eyes of the affected constituencies. By doing so, the principals involved with any given environmental problem or technological disaster will be able to discover and examine the extent to which different groups and individuals have different views on what constitutes a disaster, on how a particular situation should be addressed, and on how successful any given course of action is in addressing the problems at hand. The use of this approach also provides the opportunity to identify the topical, temporal, and geographic perspectives on environmental issues that lie behind these varying perceptions and reactions.

By understanding the disparate interests and perspectives of the various constituencies involved, those responsible for crafting and evaluating responses to environmental problems can attempt to directly tailor their programs and actions to the most important needs of the interested parties. Absent this anthropological perspective, environmental decision makers run the risk of defining problems and crafting solutions in ways that leave some individuals and groups dissatisfied and, as a result, resistant and antagonistic to the proposed course of action. In contrast, by acknowledging and addressing the needs and perspectives of all major constituents, the responsible parties enhance their chances of crafting stable and satisfactory solutions to the environmental problems at hand and of more fully protecting all potentially affected resources.

Using the Multiple Perspectives Approach

To ensure that all key interests and perspectives are represented when important issues are identified and defined, information concerning existing and potential environmental problems should be gathered through a variety of methods that elicit active public participation. Appropriate mechanisms include the use of focus groups, workshops, scoping meetings, face-to-face or telephone interviews, written surveys, newspaper searches, citizens' advisory boards, and task forces or working groups. All of these approaches might not be needed in any single instance, but the appropriateness and usefulness of each should be carefully considered before data collection is initiated. Further, it may be the case that some methods are more appropriate at different stages of the environmental decision-making process than others (insert English *et al.* ref.)

Once an environmental problem or disaster is defined in a manner that is meaningful and agreeable to all constituents, it is essential to involve all interested parties in crafting appropriate solutions. Many of the public participation mechanisms listed above for use in the problem definition stage would also be useful in uncovering the range of opinions concerning how best to address the problem(s) at hand. To take these inputs and fashion them into a set of activities that is acceptable to the different parties involved, direct negotiations among the principals can be helpful. The development of negotiated settlements is common in the environmental field. Negotiation often is employed where litigation is involved, but it can also be useful and productive as a substitute for litigation. The guiding principle here is that each interested party sacrifices certain things that are of marginal importance to them to achieve the objectives that they hold most dear and, in the process, a solution is reached that is attractive—though not necessarily perfect—for all involved.

After environmental decisions are made and the agreed-upon actions are taken, the multiple perspectives approach would suggest that all constituents be involved in evaluating the success of these efforts. Specifically, the various interested parties should be involved in selecting the set of attributes of success to use in the evaluation, and this set should be diverse enough to represent the principal interests and perspectives of the public at large. No single attribute is inclusive enough to adequately measure success. Similarly, evaluators should not weight or otherwise aggregate the individual attributes to come up with a single indicator of success, because this would risk losing the wealth of descriptive information that is provided when the attributes are examined one at a time.

Conclusion

A chronic technological disaster or other environmental problem should not be seen as only a set of adverse effects to the physical environment or a collection of impacts to human health or an economic burden on society. Rather, an environmental problem can be all these things and more, depending on the interests and perspectives of the individuals and organizations involved. By taking an anthropological approach to defining and addressing disasters, we can increase the likelihood that our chosen solutions will be meaningful to the diverse collection of constituencies that make up our society.