Why Environmental Policy Needs a Cognitive Dimension

Adopting Adapting
Managing Superfund and Global Warming

Timber Investing
Future of America’s Private Forests

Calculated Risk
Benefits of Avoiding Climate Change
A New Dynamic

Facing uncertainty, variability, and long time spans, Superfund has nonetheless been characterized by an inflexible approach to hazardous waste cleanup. Adaptive management can provide the reform the program needs to emphasize reuse and a respect for community values as it addresses the large, ecologically complex sites still remaining on the nation’s cleanup list.

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The world of environmental cleanup has changed dramatically since activist Lois Gibbs took EPA staff hostage at Love Canal to draw public attention to the plight of her community. The outrage over the chemicals buried in a residential neighborhood led to passage of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 — the Superfund law. In the nearly three decades since, the Environmental Protection Agency has cleaned up roughly 900 sites and returned 170 in 40 states to productive use.

During that time, the agency has produced a number of effective tools in the battle to clean up pollution — the National Priorities List of polluted sites, the National Contingency Plan for responding to oil spills and hazardous releases, the Hazard Ranking System to prioritize cleanup efforts, and the CERCLIS information database, to name just a few. But these and related regulations, strategies, and guidance formed in the era of bell-bottom pants still guide the remediation of contaminated properties. Meanwhile, our understanding of Superfund’s mission has matured.

Environmental priorities have changed, and so has the nature of contaminated sites. Today, the smaller, more confined cleanups are mostly completed as are larger sites with obvious reuse potential. Sites still in the pipeline are much tougher. They involve entire watersheds or other challenging environmental and health concerns that require considerable time and resource commitments. The Superfund program unfortunately has rigid procedures that treat sites as if they are isolated from human activities and other environmental programs. It has little room for cooperation and creative problem-solving, typecasting the polluter and the regulator as adversaries while ignoring community needs and input. One area in particular that needs modernization is Superfund’s approach to liability; voluntary agreements, consent orders, collaborative cleanups, and other approaches that bring all parties to the table early on should be the rule rather than the exception in hazardous waste remediation.

Because remediated sites can provide alternative locations to development in pristine green spaces and benefit neighborhoods via economic development, promoting reuse needs to be a priority for Superfund. EPA’s primary responsibility, however, is to protect human health and the environment. To simultaneously promote reuse alongside its traditional goals, Superfund needs to broaden its strategy, seeking input from surrounding communities,

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not just agency officials and responsible parties.

Adaptive management, the practice whereby institutions evaluate their progress and adjust accordingly on an ongoing basis, provides the tools to address these challenges. Put simply, it means plan, act, monitor, and modify. In other settings, adaptive management has proven to be an effective tool that allows bureaucracies and other stakeholders to learn and act accordingly. In the context of Superfund, it is an approach that would take into account site variability, environmental mutability, and the uncertainty of environmental and social conditions. It would better inform the remediation process and improve its results by enhancing EPA’s ability to learn about, assess, and accommodate to site-specific circumstances. It would provide for more active stakeholder representation, broadening the knowledge base. Adaptive management can give Superfund an opportunity to simultaneously leverage its role and enhance its legacy.

Reforms Recognize the Statute’s Potential, Show the Need for More

The need for adaptation has been highlighted by reforms in the way Superfund operates and the scope of the sites it addresses. During the 1990s, EPA began several rounds of reforms to improve all stages of the Superfund program to make it “faster, fairer, and more efficient.” The agency hoped to make systematic changes to the way Superfund operates. It sought to reduce transaction costs and create a more transparent and inclusive process. EPA also took into account previously neglected considerations such as environmental justice and redevelopment possibilities. And it reformed remedy selection by addressing end use in a process previously conducted in a vacuum. These measures, some still in the testing stage, indicate that EPA continues to recognize Superfund’s potential to achieve better re-
results. Adaptive management can provide the means to realize that goal.

For its part, Congress has acted to broaden participation, widen the scope, and inject flexibility while addressing problems that the 1980 statute does not. The 1986 Superfund Amendments and Reauthorization Act created a template for community input through its famed right-to-know provision. The 2002 Small Business Liability Relief and Brownfields Revitalization Act speaks to sites outside the reach of the National Priorities List, providing funds for site assessments and cleanups. It codifies policies that EPA has developed to assist states, localities, and other stakeholders to put brownfields back into productive use.

The birth of the brownfields program opened new windows of perception to the ways that contaminated properties, whether lightly or heavily impaired, are cleaned up. For one thing, the growth of state voluntary programs and a variety of alternate approaches has blurred the traditional bright lines between Superfund, the Resource Conservation and Recovery Act, and petroleum-contaminated sites outside the purview of CERCLA. The enormous gap between the often stove-piped water and waste programs is already being bridged through integrated cleanups and green infrastructure approaches like the Mid-Atlantic Green Highways Program.

There will likely be a day, not too far in the future, when cleanups are just cleanups. The era of uncertainty for PRPs — with multiple, often conflicting, approval processes from federal and state programs that are not speaking to one another — will be largely a thing of the past. Finality will be achieved in a speedier, less costly way, employing one-stop-shopping guidance, streamlined regulation, and more efficient protection of human health and the environment. This is already happening on a very small scale, among pockets of creative thinkers in both state and federal regulatory circles. What is missing is adaptive management to institutionalize collaboration, creative action, and learning from experience while accelerating the pace of cleanups.

At present, the National Priorities List contains 1,500 sites, with remediation for each site taking roughly 12 years to go from listing to cleanup. Many of the remaining cleanups involve sites connected to complex watersheds or poorly understood ecosystems. The risk of contamination thereby has the potential to affect a wider area and have environmental consequences outside a site’s perimeter. Experts have every reason to expect that as “simple” sites fall off the NPL, the average remediation time for the remaining ones will increase. Adaptive management is needed to manage intelligently amid this increasing complexity.

Setting the Stage for a New Approach

Because adaptive management confronts complexity and uncertainty inherent in an ecosystem and utilizes it to consider multiple options, the Superfund program is an ideal area to implement this management reform broadly. Factoring in variability and providing room to make continuous adjustments, it is preferable to the traditional top-down Superfund approach based upon federally driven cleanup objectives.

The complexity and the multitude of forces affecting an ecosystem only bolster the arguments for a tool that allows for learning, modification, and experimentation in order to achieve the best possible results. Adaptive management’s attractiveness does not come from an appeal to expertise but from the admission that people are often unaware of the factors and processes they need to understand to effectively manage ecosystems. It transforms the management process into an experiment to probe the response of ecosystems as human behavior changes.

Writing in the journal Conservation Ecology, Kai Lee, a prominent researcher of environmental applications for adaptive management, concludes that effective intervention occurs only when limits to learning are addressed in the design of managing institutions. He describes several institutional factors necessary to improve a project’s performance. They include:

- Agreement by stakeholders to act despite uncertainty;
- The ability to use models to predict ecosystem response;
- Resources to monitor and quantify ecosystem-wide reactions to experimentation;
- A culture that incorporates learning; and
- Patience to assess long-term results.

In the absence of these circumstances, uncertainty can frustrate and overwhelm environmental managers trying to achieve results based upon pre-
Adaptive management developed as an approach to the management of complex, largely natural ecosystems. Superfund, a program dealing with local site contamination in largely urban settings, was not an obvious candidate for this approach. But we are coming to understand Superfund sites as embedded in complex, interlinked human and natural systems. Adaptive management — a disciplined kind of learning by doing — is relevant to Superfund because we do not fully understand these systems nor the interactions that affect site outcomes. Properly applied, this approach can help manage uncertainties affecting site cleanup and reuse decisions; integrate decisionmaking among federal, state, and local officials; engage stakeholders in deliberations; and improve management of EPA’s entire portfolio of sites.

The Comprehensive Environmental Response, Compensation, and Liability Act was not written with adaptive management in mind, but there is room for this approach within the act’s framework. The statute and its implementing regulations define a number of decision points around which an adaptive approach to site management could be organized. These decision points are the familiar steps of the Superfund process: listing; remedy selection, implementation, and evaluation; possible remedy revision; deletion from the National Priorities List; and, for the roughly 60 percent of “construction complete” sites where some waste remains, a review that is repeated every five years until EPA determines (if ever) that contamination is below levels that allow for unrestricted use.

Adaptive management invites us to think of this process as a series of interventions over time, with the aim of ensuring that each intervention is based on the best current information, including information that has been systematically collected about what has occurred in response to previous interventions. On average, it takes more than 11 years for a site to move from proposed to completion of the remedy. At larger, more complicated sites, which are an increasing percentage of the portfolio, this process can take decades.

Without altering the existing structure, adaptive management could enhance decisionmaking over the life of EPA’s involvement at a site by improving monitoring and feedback mechanisms, not unnecessarily foreclosing options, and enabling adjustments to prior decisions, as warranted.

Adaptive management assumes that decisionmakers have latitude to respond to evolving information not only about natural systems but also about human preferences. Although the statute requires, as it should, that every Superfund remedy is protective of human health and the environment, EPA’s guidelines and historical practice permit discretion in selecting a remedy. The statute allows a range of considerations in addition to protectiveness, including state and community interests, bearing on cleanup and reuse. Increased use of sustained, collaborative stakeholder processes — a hallmark of adaptive management in other settings — would help ensure that these interests are brought fully into the decision process.

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With the understanding that remediation can span decades, the Superfund program should take advantage of the opportunity to experiment, adjust, and incorporate knowledge into an already lengthy process. With the overall goal of reuse in mind from the beginning and a strategy that avoids the pitfalls of predetermined outcomes, developers and officials will not commit to ultimate land uses that later prove unworkable.

There are nascent efforts toward an ecological approach to land use decisionmaking. We even see hints of an understanding that work on contaminated sites should not end with the removal of dangerous substances from water and soil, but with ongoing attention to habitat restoration, sustainable preservation of ecosystems, and of course, opportunities for economic revitalization where feasible. It is time for a more coherent, ecological approach to Superfund site stewardship based on community revitalization and reuse across the entire program.

According to Lee, the adaptive approach is useful precisely because the face of conservation is changing. Conservation must be “bioregional in scope and collaborative in governance” to achieve ambitious, positive goals, he writes. Lee has identified two phenomena that demonstrate the need for a change of conservation strategies and a reexamination of the underlying goals of a successful remediation. First, “highly valued ecological processes and species can only be preserved in large ecosystems.” Second, many biodiverse ecosystems are and will continue to be subject to human intrusion. Superfund’s evolution should take into account these factors in order to reconcile conservation and sustainable development.

A Troublesome Site, a Test Case for Adaptive Management

The example of the Coeur d’Alene River Basin, a site that has proven troublesome for EPA, demonstrates increasing recognition by technical experts that the agency should consider adaptive management for sites on the National Priorities List.

EPA listed the Coeur d’Alene River Basin in northern Idaho in 1983. The site formerly housed some of the nation’s most productive silver and lead mines. Consequently, roughly 62 million tons of hazardous substances produced from multiple mining sources has contaminated the area. The site includes portions of the Coeur d’Alene riverbed, its floodplain, and surrounding wetlands. Due to the contamination’s extent and the diversity of terrain and environments involved, the cleanup is a highly complex process which presents a myriad of unique considerations requiring extensive study.

For these reasons, stakeholders recognized early on that the cleanup will take several decades to complete. Many experts question whether a solution could ever completely contain or eliminate all contamination. Additionally, because the Coeur d’Alene basin is a dynamic landscape, natural processes are continually reacting to and complicating the site’s contamination, often unpredictably. Complex sites like Coeur d’Alene resist the typical rigid Superfund approach that assumes that EPA can determine with certainty how remediation should proceed and what results to expect.

In 2003, after 20 frustrating years on the NPL, Congress asked EPA to commission an independent evaluation of the Coeur d’Alene cleanup process. The National Research Council conducted this evaluation and issued a report with recommendations and considerations for future efforts to restore the site. After assessing the circumstances and figuring in the need for EPA to adjust if new complications arise or understanding increases, the NRC’s chief recommendation was an extensive adaptive management approach.

The NRC recommendation is based on its knowledge that this method provides the best way of dealing with uncertainty in order to effect successful remediation. Additionally, the NRC recognizes that management of this complex site requires the stakeholder buy-in that adaptive management provides in promoting lasting solutions. The NRC hopes that if an adaptive scheme at Coeur d’Alene produces a Superfund success story, EPA might turn to it for similarly complicated sites.

There are signs that the agency is beginning to embrace adaptive management as a method to improve Superfund. Its principles are already being applied at some sites. In addition to the General Electric example there is the cleanup of the Lower Fox River in Wisconsin, specifically, the Little Lake Butte des Morts area. Changing conditions on the ground made it clear to all parties that the 2002 plan for dredging would be far more expensive and much less effective than originally anticipated. Working together, EPA and the Wisconsin
Complexity and Uncertainty

Addressing contaminated sediments is one of the largest challenges facing the Superfund Program. The Environmental Protection Agency’s 2004 “Report on the Incidence of Sediment Contamination in Surface Waters of the United States” noted that 2,800 waterbodies had fish advisories, representing 33 percent of the nation’s lake acreage, 15 percent of the river miles, and 100 percent of the Great Lakes.

Not surprisingly, the Superfund program is actively addressing over 150 sediment sites, and 65 of these are large enough that they are being tracked at the national level. The complexity and uncertainty inherent in every aspect of addressing the legacy of contaminated sediments, from site evaluation to remedy implementation, poses a major challenge.

Adaptive management, whether officially identified as such or not, is playing an increasing role in achieving more realistic and efficient approaches for addressing larger sediment sites though its ability to accommodate complexity and uncertainty. In fact, the National Research Council’s 2007 Report “Sediment Dredging at Superfund Megasites” “recommends that adaptive-management approaches should be implemented [at sediment megasites] in the selection and implementation of remedies where there is a high degree of uncertainty about the effectiveness of the remedial action.”

Adaptive management is becoming more accepted at complex contaminated sediment sites because the significant uncertainty regarding the potential effectiveness of dredging, as concluded by the NRC report, necessitates the ability to be flexible as the actual remedy’s effectiveness unfolds. The more complex the site, the greater the uncertainty and the greater the cost consequences of proceeding down the wrong path. To address this concern, well-designed pilot studies are being used at complex sites, such as the Fox River and the Grasse River.

The concept of adaptive management has its own complexities and competing interests, however. For example, trade-offs and tensions arise when building flexibility into the remedy selection document, such that the remedial process can become an open-ended and potentially dangerous slippery slope with unbounded costs. On the other hand, if too detailed a framework for addressing uncertainty is developed, the benefit of the adaptive aspect of decisionmaking can be lost. Concerns regarding both approaches have been raised by the EPA and responsible parties.

Overall, applying the concept of adaptive management at complex sediment sites provides a promising approach for informed and flexible decisionmaking that should optimize our ability to effectively address these sites. In light of the Superfund program’s focus on contaminated sediments at the present time, it is a safe bet that the concept will be truly tested and developed in the coming years.

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