

Enhanced Life-Cycle Assessment (ELCA): Analysis to Guide Environmental Technology Implementation

Problem and Research Objectives:

The proposed research will develop an Enhanced Life-Cycle Assessment (ELCA) framework for the assessment of environmental technologies which will be demonstrated by assessing the life-cycle costs and benefits, risks, and stakeholder acceptability of using treatment wetlands for cleanup and restoration at the Tar Creek Superfund site.

Our overall objective is to develop a systematic process for environmental technology assessment that accounts explicitly for the interdependence among changes in releases of pollutants, human health risks, and economic impacts throughout the technology life cycle, and that is guided by stakeholder concerns and preferences regarding environmental management and pollution control. **Specific goals of the proposed research** include: i) development of methods of assessing stakeholder concerns and preferences suitable for guiding policy-relevant analyses; ii) to integrate risk assessment and benefit-cost analysis methods with life-cycle assessment techniques; iii) to demonstrate the ELCA framework by producing policy-relevant data regarding the costs, benefits, risks, and stakeholder acceptability of using treatment wetlands at the Tar Creek Superfund site; and iv) to identify priority information needs of the decision-making process to help guide future scientific research.

Methodology

The process of making environmental decisions involving health, societal, and economic issues is most commonly supported by three types of analysis: benefit-cost analysis (BCA), life-cycle assessment (LCA), and human health risk assessment. This project is advancing these analytic methods by integrating them into a coherent ELCA framework. The ELCA framework is both an integrated set of analysis tools that support the policymaking process as well as a procedure that involves stakeholders in defining the analysis process and therefore involves them in a critical part of policymaking. Involving stakeholders in the analysis process is important because stakeholders will not support a policy decision that they do not feel is fully legitimate.

The ELCA framework is being used to assess the technical effectiveness of the enhanced wetland technology in reducing human health risk through an integrated LCA and risk assessment process. The risk assessment process is guided by input from stakeholders gathered through survey and interviews. Benefit-Cost Analysis (BCA) is being used to assess the net benefit of the proposed use of treatment wetlands at the Tar Creek site. Incorporating BCA within the ELCA framework assures that the market and non-market site characteristics that are evaluated and included in the analysis are those that are important to the stakeholders and not simply those that an analyst thinks should be important. The BCA is also guided by the results of stakeholder interviews, Q sorts, and surveys. Stakeholder acceptability is being assessed from interviews with stakeholders residing or working near the proposed project site. Statements from these interviews are being Q sorted by stakeholders in a subsequent interview, and these Q sorts are being factor analyzed to reveal general perspectives on the technologies and to determine

whether a conflict exists among these perspectives. Finally, the information regarding stakeholder concerns and preferences regarding the proposed remediation technology being developed from narrative analysis of the open-ended interview transcripts, Q methodology, and preference ranking are being used to develop a survey instrument. Survey responses are being analyzed using descriptive statistics and regression to determine stakeholders' concerns and judgments of the acceptability of the proposed remediation technology as well as their willingness to tradeoff benefits and costs to implement the technology. The information regarding stakeholder preferences and concerns is being fed back to guide and inform the three assessment processes (LCA, BCA and risk assessment).

Principal Findings and Significance

Of the three assessment exercises in this project (social impact assessment; economic impact assessment; environmental risk assessment), the social impact assessment effort needed to be completed first, since it is used to help frame the conduct of the other components. This assessment was conducted by interviewing selected stakeholders who are nearby residents, regulatory officials having responsibility for site remediation, experts who have or are conducting studies of the site, and representatives of various interest groups who perceive that they have a stake in site remediation. The social impact assessment was conducted via two rounds of face-to-face stakeholder interviews conducted in the Picher-Cardin-North Miami area surrounding the Tar Creek site.

During the second interview, stakeholders were asked to perform a Q sorting exercise. Each subject was asked to review and sort statements about Tar Creek concerns (sort #1) and remediation preferences (sort #2) by reading representative statements taken from the first round of interviews and then placing them on a Q sort formboard. Interpretation of the factors derived from the Q sorts provide insight into stakeholders' perspectives on their concerns and preferences, which are in-turn being used to both frame subsequent economic and risk assessments and in characterizing the nature of the conflict that exists among perspectives. Knowledge of these perspectives will also be valuable to policymakers as they deliberate about the future of the Tar Creek site.

Based on the results of the Q-sorts we concluded that the conflict at Tar Creek was contingent and that it is possible to conceive of a policy solution to the Tar Creek Superfund controversy that is super-optimal, that is, can satisfy all parties in dispute. In this case, we can conceive of a resolution to the conflict by creatively addressing the fundamental concerns manifest in the four orthogonal perspectives, which, by definition, are not in veridical conflict. In other words, what any one party wants is not really opposed by any other party – despite the rhetoric and reporting that has occurred over the last 20 years.

Based on review of the four identified perspectives regarding remediation preferences, we are able to make recommendations that may help reduce conflict. We recommend that the USEPA seek to improve the legitimacy of remediation decision-making by involving all stakeholders in helping to frame the analyses that should be conducted and in participating in deliberations about the remedies that should be implemented. Easily

accessible information repositories should be located in the community, frequent meetings should be held to discuss proposals, and stakeholders' concerns and values should be incorporated into decision-making. A protocol for recursively integrating policy analysis with policy integration has been proposed by Stern and Fineberg (1996). This protocol suggests that deliberants should not only participate in making decisions but also in framing analyses that are designed to inform their deliberations.

The controversy over the remediation of the Tar Creek Superfund site has continued unabated for two decades with no end in sight. Distrust is growing, stakeholders are frustrated and angry, and hope is fading that any resolution that is satisfactory to residents will be found. We entered this investigation with profound respect for the difficulties that residents are facing and wondered whether we could discover possible solutions that could gain stakeholder support when so many others have failed. We conducted the Q methodological investigation with cautious hope and were pleased that we did not find bipolar factors – suggesting that the Tar Creek controversy represents a contingent conflict amenable to a super-optimum solution. We have suggested changed circumstances, particularly with respect to decision-making processes and remediation priorities, that we believe will find little opposition in the affected communities. Though the costs of implementing these measures are not trivial, they will likely pale in the face of the \$50 million that has been spent so far in remediating residential yards and diverting recharge into the Boone Formation that has proven ineffective at addressing stakeholder concerns and controversial.

We have only now completed the Q analysis of stakeholder perspectives on remediation preferences in this case and thus have not yet had an opportunity to determine just how well these recommendations will be received by those holding the four perspectives. We will be contacting the participants again in the coming months. We remain optimistic.

The results of social impact assessment have been used to frame the economic and technological effectiveness assessments that are now underway.

Reference:

Stern, Paul C., and Harvey V. Fineberg, eds. 1996. *Understanding Risk: Informing Decisions in a Democratic Society*. Committee on Risk Characterization, Commission on Behavioral and Social Sciences and Education, National Research Council. Washington, DC: National Academy Press.