Common Sense - A critical review of

Calculating Risks: The Spatial and Political Dimensions of Hazardous Waste Policy

by James T. Hamilton and W.Kip Viscusi

Lisa Bithell Kirk
University of Idaho
Principles of Environmental Toxicology
December 2000

It ought to be a matter of plain old common sense, this business of discerning actual risk at a hazardous waste site from calculated risk. After all, as individuals we set priorities based on our available resources and understanding of risks every day. You would think that would help us to make good risk decisions as a society. However, public misperceptions of actual risk from hazardous waste and the resulting political climate have produced an extremely conservative and cumbersome bureaucratic approach to risk assessment under Superfund. Conservative guidelines intended to meet the Superfund mandate of protecting human health and the environment have produced a distorted process of establishing priorities for remedial action, with highly inefficient allocation of public funds for cleanup. The costs are not small, nor do the majority of expenditures lie in our past. In their discussion *The Toxic Liability Problem: Why Is it Too Large? (2000)*, Richard Stroup and Roger Meiners report that remedying identified hazards under current policy will cost a staggering one trillion dollars over the next 30 years to accomplish no reduction in human health risk.

The American public continues to struggle to fund increasingly stringent remediation of contaminated land and water, through a program that is clearly lacking in common sense. Along the way we have asked, “How serious is the risk, and to whom? How clean is clean enough? Do our existing programs manage our limited resources to optimize human and environmental health? Are there simpler, more sensible ways to wade through the morass of data and litigious public opinion that surround our national hazardous waste policy”? In the EPA-funded study that is presented in ***Calculating Risks: The Spatial and Political Dimensions of Hazardous Waste Policy***, we begin to get answers to these questions.

In ***Calculating Risk***, James Hamilton and Kip Viscusi present a refreshing series of insightful and rigorous re-evaluations of risk assessments that were originally calculated (based on conventional EPA risk assessment guidance) for some 150 Superfund sites in the early 1990's. This thorough and well referenced research shows that hazardous waste policy can be made more efficient and effective by improving the accuracy of risk calculations, considering the population risk in addition to individual risk, and incorporating cost effectiveness into risk management decisions.

Do not let the statistics stop you from enjoying the well organized, clearly written, and occasionally humorous discussion of the political and economic issues that result from existing risk assessment policy under Superfund. Beginning with an analysis of how risk is calculated for individuals under Superfund, the authors identify key elements of conservativism that are compounded in risk calculations. Two key factors are the use of the 95^{th} upper confidence limit on the mean concentration of each contaminant for model inputs and the assumption that future land use for waste sites will be residential. The assumption that future land use will be residential is unrealistic, a problem which has been recognized by EPA in recent years in its risk assessment guidance rules. By systematically calculating risk under scenarios that alter these assumptions, the authors illustrate the importance of these assumptions in inflating calculated risk relative to actual risk. Risks calculated with 95% confidence values rather than mean values produce estimates of risk ranging 17 to 27 times higher than values calculated using a measure of central tendency. Using a probabilistic (Monte Carlo) approach that accounts for true variability and uncertainty in the distribution of input values for contaminant concentrations, bodyweight, exposure duration, and ingestion rate, the

authors show that EPA's conventional Reasonable Maximum Exposure values produce calculated risk values in the 99th percentile of the probability distribution. In other words, there is only a 1% chance that the actual risk at the studied sites is as high as the risk calculated by EPA.

The authors note that the EPA approach, which is focused on individual lifetime risk of cancer and non-cancer affects, fails to consider the actual population associated with each site. The need to identify population risk was also raised by the Presidential/Congressional Commission on Risk Assessment and Risk Management (PCCRARM, 1997). By focusing remediation resources on individual risk, EPA is not efficiently focusing on reducing human health affects due to hazardous waste exposure, and has created a system that is easily manipulated politically and legally. By integrating population data using geographic information system methods, the authors demonstrate that this policy results in environmental inequities including higher levels of exposure for minority groups (in particular, at highly populated high risk sites) and lack of response to other, potentially more significant sites. Taking a final step, costs per case of cancer prevented are calculated as a measure of policy cost-benefit, which indicate that an astonishing 95% of Superfund expenditures are spent to eliminate only 0.5% of cancer risk.

Key elements of weakness in the existing system of setting priorities for the Superfund program that are identified by Hamilton and Viscusi include:

- Calculation of Individual lifetime risk, with no consideration of population exposure
- Use of the 95% value for input parameters, not a measure central tendency such as the mean or median. Replacement of the 95 percentile with mean values

would significantly improve the ability of policy to prevent the largest number of cancer cases within any given budget for remedial action.

- Assumption of future residential land use in areas that are not currently inhabited, and which clearly will not be desirable for future development. Nearly 72% of all risk pathways pertain to future land use in the cases studied. Of these pathways, groundwater is the source associated with highest risk, which paradoxically could easily be mitigated through institutional control of future use (i.e. use of a public water supply rather than local groundwater wells).
- Lack of consideration of cost-benefit factors for remediation decisions.

The identified inefficiencies leave risk assessment and remediation decisions vulnerable to irrational political decisions driven by perceptions of risk, with higher spending and more stringent remedial actions taken where the public is more likely to engage in collective action. Unfortunately, this is not news. EPA and other investigators have recognized such vagaries since 1987 (PCCRARM, 1997). As a result of these inefficiencies, the cost per cancer case avoided was more than $100 million, at most of the Superfund sites examined in the Hamilton and Viscusi study. Median cost per cancer case avoided was a staggering $388 million. These costs are well above the value-of-life estimates of $4 to $7 million that are typical in market studies, indicating that consumers are willing to spend considerably higher amounts of someone else's money to avoid human health risk than they would spend of their own money. **Calculating Risks** shows that well informed consumers who are allowed to make economic decisions in the marketplace about risk from hazardous waste, respond financially at levels of spending that are much more proportionate to risk. More importantly, the current level of spending per cancer case avoided is well above any cost-benefit threshold for other federal risk management programs, suggesting that

money might be better spent to reduce human health risk through other programs, such as improving transportation safety or providing health insurance.

Despite the controversial nature of cost-benefit analysis in regulatory decision making, in that not all aspects of health and the environment can be quantified financially, and the use of cost-benefit approaches would weigh only those factors that could be quantified, the Presidential commission did recommend its use as a tool in support of other decision making tools (PCCRARM, 1997). The National Academy of Public Administration (NAPA) report to Congress on EPA resource allocation (1995) also supported the use of cost-benefit analysis, but noted the significant challenges inherent in reducing tangible and intangible benefits to dollar values in accurate cost benefit analysis. Expansion of the ***Calculating Risks*** cost-benefit analysis approach to include reduction in non-cancer human health and ecological risks would need to address these concerns.

The strength of ***Calculating Risks*** lies in its presentation of scenarios under alternative, risk assessment criteria using actual site data, thus allowing the reader to quantitatively evaluate the costs and benefits of the risk assessment program currently used in Superfund. Due to the early 1990's timing of the original risk evaluation for the 150 sites included in this study, there is less emphasis on non-cancer health effects and ecological risk than is incorporated in more recent risk assessments. The focus on cancer risk facilitates the quantitative comparison, which is one of ***Calculating Risks*** greatest strengths, but is also its most significant weakness. It would be very interesting to see a similar effort that incorporates more information on non-cancer health effects and ecological risk, when more quantitative measures of these affects become

available. The need to incorporate ecological and non-cancer health risks into hazardous waste management decisions has been clearly defined as a goal by many stakeholders, as identified in the NAPA report to Congress (1995), the Presidential/Congressional Commission report on risk assessment (PCCRARM, 1997), and in recent modifications to the Superfund risk analysis program (USEPA, 1999). Review of abstracts presented at the most recent annual meeting of the Society for Risk Analysis by Bettinger and Sugatt (2000), and Ells (2000), indicate that progress is being made in developing quantitative approaches to ecological risk assessment. Recently published work by Hope (2000) indicates that concerns similar to those identified for human health by Hamilton and Viscusi (2000) regarding the validity of exposure estimates (95% vs. mean, etc.) for individuals and populations are being addressed in development of ecological risk assessment models. Wilson et al. identified similar progress for non-cancer risk assessment (2000).

The use of probabilistic (stochastic, or Monte Carlo, methods) is an excellent means of evaluating the uncertainty and identifying inefficiency in current risk assessment programs. Probabilistic risk assessment methods facilitate understanding the variability in exposure and calculated risk, as well developing an understanding of uncertainty in input parameters used for risk calculation. By calculating risk across the complete range of possible values using a random method of calculation, the probable distribution of risk can be illustrated. (USEPA, 1998). As Burmaster and Von Stackelberg have shown (1991), probabilistic methods can resolve the major limitations of conservative point estimates of risk by allowing the degree of conservativism to be calculated, along with a variety of scenarios for comparison across the range of

probable occurrence. This allows the risk manager to evaluate the factors influencing the risk assessment results.

Hamilton and Viscusi recommend several policy changes designed to improve the efficiency of the resource allocation system, including use of probabilistic methods with central tendency estimates to calculate risk and individual risk thresholds, and the application of risk thresholds of 1:10,000 (instead of 1:1,000,000) or higher. Such changes in criteria would reduce the extreme conservativism in risk calculations and enable risk managers to consider a broader range of actions at sites, including strategies that are less focused on permanent reduction of volume, toxicity, and mobility (as dicated under current policy) and more focused on reducing population exposures in cost effective ways. Recommendations focused on improving the accuracy of risk assessment could be integrated with iterative approaches to risk assessment (as recommended in the NAPA report to Congress), which provide a more conservative level of screening analysis followed by more comprehensive and realistic assessment for sites that pass the screening level analysis.

Reforms of risk assessment and risk management recommended by Hamilton and Viscusi would involve determining population risk (in addition to individual risk), as well as focusing remediation on sites where people currently reside. They also recommend that cost-benefit analyses (such as cost-per-cancer-case-prevented) be incorporated into risk management decisions for sites exceeding $5 million in remediation costs. This would focus the additional cost-benefit study on the most expensive sites. Implementation of these reforms, according to ***Calculating Risks***, would reduce the number of remediated sites by 40% and costs by almost 30%, while

reducing the number of cancer cases averted by only 3%. Such policy reform makes good sense, as long as non-cancer effects and ecological risk can be addressed. Further, as sites that pass a cost-benefit test have a higher mean minority percentage for the sites studied in **Calculating Risks**, the proposed reforms will foster environmental equity. This type of calculation, as provided by Viscusi and Hamilton, clearly responds to the Presidential commission request for economic analyses that identify impacts on environmental equity issues.

Policy changes are needed to limit the influence of risk perception bias on environmental management decisions. This need has been addressed by other investigators, including the Presidential/Congressional Commission on Risk Assessment and Risk Management (1997) and the National Academy of Public Administration (1995). The Presidential/Congressional commission recommends enhanced communication between stakeholders to improve understanding about risks, explain decisions about resource allocation, and distinguish between contaminant emissions and exposures associated with negligible risk levels and those associated with unacceptable risk levels. The use of probabilistic models to put risk thresholds into context, as done by Hamilton and Viscusi in **Calculating Risks**, were recommended by the commission. Further, they recommend a non-regulatory approach to "increase efficiency and effectiveness", such as development of more flexible alternatives for site management to reduce the cost of excessive remedial action and regulation, a conclusion which supports the recommendations of Hamilton and Vicscusi. Farber et al., (2000) of the US EPA, reported at the Society for Risk Analysis meeting that EPA

has begun to “explore and test the extent to which more flexible and cost-effective regulatory strategies can be developed”.

An important consideration identified by the Presidential/Congressional commission is the need for a common metric to compare cancer and non-cancer affects. Such a metric would permit expansion of the approach taken by Hamilton and Viscusi, and thereby extend our understanding of current policy performance. Rather than emphasizing a market efficiency based approach like the cost-benefit analysis, the Presidential commission and NAPA report to Congress recommended comparative risk assessment as a basis for improving efficiency. This approach has received much criticism however, and, like risk assessment and cost benefit analysis, requires comprehensive and accurate data to be meaningful.

The common sense argument presented in ***Calculating Risks*** dictates that EPA should implement the policy changes identified by Hamilton and Viscusi immediately, although they will no doubt meet with significant political resistance. Perhaps Bruce Yandle (2000) said it best when he concluded, “Having learned more about risks and high-cost efforts to reduce them, we may be at a point where common sense will again prevail. However, before becoming too optimistic about the future prospects [for Congressional dismantling] of Superfund, we should remember that statutes that allow us to spend other peoples money always tend to be more attractive than rules which require us to bear the cost of our own behavior.”

References

Bettinger, N.A. and R. H. Sugatt, 2000. *Using Ecological Risk Assessment in Hazardous Waste Site Cleanup Decisions: A Massachusetts Perspective*. abstract in proceedings of 2000 Annual Meeting of the Society for Risk Analysis, http://www.riskworld.com/abstract/2000/SRAam00/ab0ac023.htm.

Burmaster, D.E. and K. Von Stackelberg, 1991. *Using Monte Carlo Simulations in Public Health Risk Assessments: Estimating and Presenting Full Distributions of Risk.* Journal of Exposure Analysis and Environmental Epidemiology*, Vol. 1, No 4, 1991, p. 491-512.*

Ells, S.J., 2000. *Using Ecological Risk Information to Drive Superfund Site Cleanups*, abstract in proceedings of 2000 Annual Meeting of the Society for Risk Analysis, http://www.riskworld.com/abstract/2000/SRAam00/ab0ac090.htm.

Farber, G, P. Borst, and L. Luben, 2000. Cost Effective Risk Management: Improving the Relationship between Risks and Regulatory Requirements. abstract in proceedings of 2000 Annual Meeting of the Society for Risk Analysis, http://www.riskworld.com/abstract/2000/SRAam00/ab0ac096.htm

Hamilton, J.T. and W. K. Viscusi, 1999. *Calculating Risks? The Spatial and Political Dimensions of Hazardous Waste Policy*. Cambridge MA: The MIT Press, 321 pp.

Hope, Bruce K. , 2000. *Generating Probabilistic Spatially-Explicit Individual and Population Exposure Estimates for Ecological Risk Assessments.* Journal of Risk Analysis, Vol. 20, issue 5, p. 573-590.

National Academy of Public Administration, 1995. *Setting Priorities, Getting Results: A New Direction for EPA*. A report to Congress on EPA resource Allocation.

Stroup, Richard L. and Roger E. Meiners, 2000. *The Toxic Liability Problem: Why is It Too Large?* in Stroup, R. and R. Meiners, ed. Cutting Green Tape: Toxic Pollutants, Environmental Regulation and the law, New Brunswick (USA): Transaction Publishers, p. 1-26..

The Presidential/Congressional Commission on Risk Assessment and Risk Management, 1997. *Risk Assessment and Risk Management in Regulatory Decision Making*, Final Report of the Commission to Congress, Vol. 2.

The Presidential/Congressional Commission on Risk Assessment and Risk Management, 1997. *Framework for Environmental Health Risk Management*, Final Report of the Commission to Congress, Vol. 1.

U.S. EPA, Office of Emergency and Remedial Response, 1999. *Risk Assessment in the Superfund Program*, http://www.epa.gov/superfund/programs/risk/rsk_sf1.htm.

U.S. E.P.A.,Office of Solid Waste and Emergency Response. Draft Supplemental Guidance to RAGS: The Use of Probabilistic Analysis in Risk Assessment. February 1998.

Wilson, A.M., P. Williams, S.J.S. Baird, L.R%. Rhomberg, and J.S. Evans, 2000. A sensitivity Analysis of Recently-Proposed Distributional and Data-Derived Approaches to Noncancer Risk Assessment, in abstract in proceedings of 2000 Annual Meeting of the Society for Risk Analysis, http://www.riskworld.com/abstract/2000/SRAam00/ab0ac391.htm.

Yandle, Bruce (2000). *Superfund and Risky Risk Reduction*, in Stroup, R. and R. Meiners, ed. Cutting Green Tape: Toxic Pollutants, Environmental Regulation and the law, New Brunswick (USA): Transaction Publishers, p. 27-57..