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MANAGING NUCLEAR WASTE: SOCIAL AND ECONOMIC IMPACTS

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ABSTRACT

Recent research has focused on perceptions of risk as a dominant source of economic impacts due to siting a high level radioactive waste facility. This article addresses the social and economic considerations involved with the issue of risk perception and other types of negative imagery. Emphasis is placed on ways of measuring the potential for economic effects resulting from perceptions prior to construction and operation of a HLW facility. We describe the problems in arriving at defensible estimates of economic impacts. Our review has found that although legal and regulatory bases may soon allow inclusion of these impacts in EIS and for compensation purposes, credible scientific methods do not currently exist for predicting the existence or magnitude of changes in economic decision-making. Policy-makers should recognize the potential for perception-based economic impacts in determining the location and means of managing radioactive waste; but, they also need be cognizant of the current limitations of quantitative estimates of impacts in this area.

INTRODUCTION

The problems associated with the management and storage of high-level radioactive waste (HLW) have recently gained national attention. A large (and growing) inventory of spent nuclear fuel now exists in the U.S; it is currently being stored in pools of water inside each of the power plants that produced it. It is uniformly recognized that ultimately the HLW must be stored in a facility that does not require daily monitoring. Congress, with passage of the Nuclear Waste Policy Act (and its amendments), designated Yucca Mountain, Nevada as the site for the "permanent" repository of this civilian HLW. However, scientific debates continue about the safety of this facility; legal challenges are being made to the actions of the federal government; and, political battles are being waged about the social equity of the overall storage program. As a result, the public opposition to the program to transport and store HLW at Yucca Mountain has severely slowed progress in the nuclear waste management program.

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Regardless of how soon we choose to "permanently" store HLW, or the means used to store and monitor the waste, the issues salient in the scientific, legal and political realms require resolution. These issues surrounding the management of HLW have implications beyond the current dilemma; those problems thwarting progress in storing civilian HLW can have policy ramifications for the management of any activity perceived to be hazardous by the general public. It should be noted that there is not one issue that can be singled out as playing a dominant role in the problems associated with radioactive waste management. Policy makers must treat the problem of public opposition as a tightly bundled combination of interrelated issues, each of which requires separate treatment. For example, issues that arise in the storage of HLW include the trust and confidence the public has in the institution vested with the responsibility to safely manage the hazardous waste. Certainly, this is going to be strongly correlated with the perceptions the public has regarding the riskiness of the activity and the potential for perception-based economic impacts.

This article addresses one issue that has created considerable concern with the current efforts to store HLW: the perception-based economic impacts incurred by the host region. This article addresses the social and economic considerations involved with the issue of risk perception and other types of negative imagery. Emphasis is placed on measuring the potential for economic effects resulting from perceptions prior to construction and operation of a HLW facility. The debate in Nevada has included a strong argument that public perceptions of the repository will result in severe economic effects on the region (see Slovic et. al., 1991).

We find that although legal and regulatory bases may soon allow inclusion of these impacts for compensation purposes. However we also find that credible scientific methods do not currently exist for predicting the existence or magnitude of economic impacts. Policy-makers need to recognize the potential for perception-based economic impacts in determining the location and means of managing radioactive waste; but, they also must be aware of the current limitations of quantitative estimates.

We consider the issues relating to the impacts and measurement of impacts due to perceived risk. The next section summarizes the technical consideration of perception-based

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economic impacts. Next, we consider the economic basis for including these impacts and point to problems in arriving at defensible estimates. Finally, we discuss the implications this issue has for policy makers. Our conclusion is that the courts are coming close to requiring an infeasible solution to the problem. They are moving to accept perception-based impacts and hence will require quantitative estimates of such impacts, despite the fact that there currently is no generally accepted method for obtaining and defending quantitative estimates.

PERCEPTION-BASED ECONOMIC IMPACTS

Perception-based impacts result when the public's view of a given activity has economic and social impacts. In using the word "perceptions" there is no presumption as to whether they are real or illusory. Perception-based impacts can exist above and beyond the direct (standard) socioeconomic impacts that typically are identified with siting and construction of hazardous facilities and included in environmental impact statements. The public's perceptions of hazardous facilities or activities will shape the manner in which they behave, which will be manifested through the market of goods and services, and this will ultimately result in quantifiable impacts on local economies.

As part of the research on impacts associated with the Yucca Mountain repository, Kasperson et. al. (1988), Slovic(1987a., 1987b., 1991) and Kunreuther (1988, 1990) develop a framework for determining the process of risk perception leading to socioeconomic impacts. Kasperson et al. (1988) termed this process the social amplification of risk where the socioeconomic impacts resulting from the amplification of risk are expressed as a function of major sources of amplification: social stations of amplification, group/individual responses, and ripple (multiplier) effects. A risk event in the model causes a flow of information through sources, channels, social stations, individual stations, and group or individual responses. Personal experience and indirect communication feed into direct communication. The channels of amplification are individual senses, informal social networks and professional information brokers. The social stations of amplification include the leaders of the community, cultural and social groups, governmental agencies, and all forms of information media. The individual stations of amplification decode the information provided from the social stations to bring about a response. The responses include attitude changes, social action and behavior responses. The potential social and economic impacts identified include:

- loss of business activity
- financial losses
- regulatory constraints
- organizational changes
- litigation
- increase (or decrease) in physical risk
- sabotage or terrorism
- loss of confidence in the institutions.

Besides perceived risk, there are other types of perceptions that researchers have identified as having the capability to result in behavior changes and ultimately impacts.

The State of Nevada study concentrates much of its effort on imagery and stigma. This is where the public associates a geographic area with something positive or negative. In the case of unattractive industries or government-sponsored projects the public may view the whole geographic region as having the characteristics of the entity in question. Stroup and Leal (1989) confirm that the most widely held concern in the "Not In My Backyard" (NIMBY) syndrome is the potential for loss in property values and general aesthetic values.

The research conducted on behalf of the State of Nevada divides the socioeconomic impacts into two categories; (1) standard effects and (2) special effects. The standard socioeconomic impacts are based on an expectation that the DOE will spend \$8.1 billion (1987-1988 dollars) over the 70 year period of site characterization, construction, operations and decommissioning at the Yucca Mountain Site. The peak construction period will result in primary and secondary employment of approximately 15,000 jobs and a population increase of 24,000. The average annual impacts over the life of the project are estimated at 3,000-4,000 jobs with a corresponding population increase of 6,000-7,000 people. The net negative impact to the State of Nevada General Fund due to this population increase is estimated at \$22 million during site characterization; \$27 million during construction; and \$22 million during emplacement. The county and municipal government impacts are estimated to be over \$500 million during the 70 year life of the project. Additional costs of \$85 to \$156 million are mentioned to cover the "extraordinary demands for oversight, public safety, and new facilities."

Special effects includes those that are due to changes in perceived riskness of the area and stigmatization of Nevada as a nuclear and dangerous place. The impetus for concentrating on these impacts is that hazardous features of the repository may affect Nevada because (1) it will diminish the quality of life for the Nevada residents, and (2) it has the potential to negatively impact the economic base of the state.

The impacts have been estimated using survey methods. First, a general risk perception survey was conducted using national and Nevada samples to assess the risks people associate with nuclear energy and its consequent wastes. Next a national survey was conducted to determine the relative attractiveness of Las Vegas for residential and business location and the sensitivity of such opinions to the introduction of nuclear wastes. Third telephone surveys were conducted to determine the images associated with Nevada and Las Vegas and to assess the implications of such imagery for economic behavior. Finally, special surveys were conducted to assess the impacts of the repository on convention planning, tourism, business location decisions and economic development potential.

Based on the surveys it has been concluded by the Nevada research that there is the potential for substantial impacts for the major sectors of the Nevada economy due to the images the public will have regarding the site area and the perceptions of risk associated with the radioactive wastes; see (MWR, 1989). A rough estimate of the magnitude of the potential impacts is inferred from noting that

"...each one-percent decline for Clark County in spending by visitors, retired people, and investors relative to the baseline levels assumed to occur in some future year (e.g. 2010) could produce an annual loss of 7,000 jobs and \$200 million in income."

This is viewed to be a significant impact on the economy that has led some of the researchers to reach the following conclusion regarding the future of the radioactive waste management program.

"Analysis of these perceptions shows them to be deeply rooted in images of fear and dread that have been present since the discovery of radioactivity. The development and use of nuclear weapons linked these images to reality and the mishandling of radioactive wastes from the nations military weapons facilities has contributed toward creating a profound state of distrust that cannot be erased quickly or easily. Postponing the permanent repository and employing dry-cask storage of wastes on site would provide the time necessary for difficult social and political issues to be resolved."

The issue of perception-based impacts has fostered arguments on both legal and technical grounds. On the legal front, there are many that believe that the issue of perceptions does not qualify as a "real" impact and therefore does not warrant treatment in the EIS framework. This argument is evaluated below.

PRACTICAL PROBLEMS OF ESTIMATING PERCEPTION-BASED ECONOMIC IMPACTS

Surveys have been used extensively to identify public attitudes of potential future events. Economic agents are surveyed to derive forecasts of how they would behave when confronted with a hypothesized situation.

A problem in measuring the correct level of compensation is that it is difficult to assess the possible risks of a hazardous facility and express these risks in monetary terms. As discussed earlier, the risk posed by a hazardous facility can be characterized as a highly uncertain situation with the probability of an accident unknown. People may devote substantial or little resources in adapting to a risk that is highly uncertain. If people exhibit risk-averse behavior, they may pay a high price to reduce their exposure to a highly uncertain and potentially high-cost situation; on the other hand, people may be willing to pay a low price, if they believe that they would be spending money on avoiding an overstated risk. Psychological studies indicate that people commonly overestimate the risk of low probability-high impact events -- the type of risk posed by a hazardous facility (Smith and Desvousges, 1987).

Many of the studies measuring individuals' willingness to pay or willingness to accept a noxious facility apply a hypothetical situation (see Freeman, 1979; and Smith and Desvousges, 1986). A large discrepancy may exist between how a person responds to the questions of a survey and how they

would respond in a real situation. Different reasons may account for the discrepancy: they include strategic behavior, lack of incentive to think hard about the question, and changing information over time (see Edwards and Anderson, 1987; Freeman, 1979; and Schulze et al., 1981). As an example, a respondent may convey a high perceived risk for a proposed noxious facility if he believes his answers will influence the amount of compensation for siting the facility in his area or the decision of where to site the facility.

A person may face changed information between the time he responds to questions about a hypothetical situation and when the actual situation may occur. For example, a person may perceive a high risk associated with a proposed nuclear waste repository at the time of a contingent valuation study. As the person gathers more information about the repository, and as he observes its construction and operation, the person may respond to his "updated" perceived risk of the repository differently from his expectation at the time of the survey. Uncertain behavior is especially acute when a respondent to a survey is unfamiliar with the likelihood of a bad event or with its impact, or when the risk change has not been previously experienced.

There are also questions about incentives for respondents to faithfully reveal their actual intentions, especially when the respondent infers that the answers will be the basis of future compensation. For example, asking respondents to put a value on a given state or to avoid a particular action could result in biased results if the questionnaire is not carefully designed and conducted. Also, estimates based on contingent valuation studies have the problems of the respondents being unfamiliar with the scenarios posed. This problem will continue to be true so long as the impact study attempts to analyze an event in the future. Such studies, for example, to estimate the damages of deteriorated air and water quality and the higher wages required to attract people into risky occupations (see Bartik, 1988; Brookshire et al., 1982; Freeman, 1979; and Viscusi and Magat, 1987).

Because of the problems associated with ex ante estimation, an ex post measurement of welfare losses may be preferable to one that acquires data at a time when a person's risk perception of a noxious facility does not account for any personal experiences with a noxious facility. Determining compensation on the basis of an ex ante survey, may distort the amount of payment commensurate with the real third-party costs of a noxious facility. However, the dilemma facing policy-makers is the successful siting of a hazardous facility. In order to use the existing methods of ex post measurement, the responsible agency must convince the affected population that they will be fully compensated once the impacts are identified and measured.

POLICY IMPLICATIONS

Perception-based impacts play an important role in the problems associated with managing high-level radioactive waste. Further, the issue of perceptions will play an important role in the management and storage of any activity perceived to be hazardous by the general public. Perceived risk will

dominate the discussion of potential socioeconomic effects resulting from any type of hazardous activity. This has strong implications for the management of hazardous substances all over the country. It is becoming accepted that perception-based impacts can exist above and beyond the direct regional economic impacts that typically are identified with siting and construction of hazardous facilities and included in environmental impact statements. The siting of a waste facility near a residential area is likely to trigger responses by local residents. In addition, future migration to the area can be affected by the existence of the waste facility. Even if the wastes could be disposed of in a manner that ensured that no losses would be caused by the facility, it is possible that there will be impacts of some sort. In sum, there is little disagreement on *whether* perceptions should be incorporated into socioeconomic impact assessments. The issues that begs treatment lie in *how* perceptions should be incorporated into socioeconomic impact assessments.

The legal requirements of the NWPA and NEPA to analyze and quantify socioeconomic impacts will require the development of methodologies acceptable to the Courts. Historically the courts have permitted expert testimony if such testimony was consistent with generally accepted scientific principles (i.e., methods considered valid among other scientists in the same field). However, as discussed by Huber (1991), the courts are moving towards the acceptance of a wider scope of expert testimony and evidence. Policy makers need to be aware that the legal system is moving towards consideration of perception-based economic impacts before questions regarding their measurement have been resolved. The legal system will not hesitate to rule on the continuance of a major program or the compensation of affected parties based on doubts of scientific rigor.

The dilemma for policy makers continues to be how to evaluate perception-based impacts. In order for perceptions to become part of socioeconomic impact assessments, there must be first, sufficient regulatory bases for including these effects in the analysis as well as methods of assessment that are widely accepted in the scientific community. As we have seen, one can easily envision a scenario under which the existing laws and regulations are interpreted to require inclusion of perception issues. Note, however, that even if the regulatory avenues are open for acceptance of perception-based impact measures, there are not currently sufficient methods for arriving at credible estimates of economic effects.

All socioeconomic impact studies that incorporate perceptions ex ante rely on survey data. Therefore the predicted economic consequences should come under the same scrutiny as the surveys themselves. The difficulty in predicting behavior ex ante lies in the difficulty of demonstrating a significant link between public perceptions as indicated by survey responses, changes in behavior, and economic decision making. The many studies of perceptions that claim to provide predictions of economic impacts have not presented any evidence to demonstrate this linkage. And, unless the existing studies are challenged, there seems to be little promise that future studies will provide the evidence necessary to demonstrate the relationship between survey results and economic impacts.

Policy makers are faced with the dilemma of how to treat the issue of perception-based impacts. If it is ignored, or not dealt with squarely, no alternative course of action will succeed in defusing the problem of public opposition to hazardous waste storage. In the case of the program for managing HLW, changing the course of action from a single repository to multiple sites or on-site storage is not going to help resolve the issue of economic impacts if there is no commonly agreeable method of assessing the effects of negative perceptions. It will be the role of the policy maker to sift through the rhetoric to determine a course of action that will pay proper attention to the perception issues.

REFERENCES

- Brookshire, D.M., M. Thayer, W. Schulze, and R. d'Arge, 1982. *Valuing Public Goods: A Comparison of Survey and Hedonic Approaches*. American Economic Review, 72, No. 1, pp. 165-177 (March).
- Edwards, Steven F. and Glen D. Anderson, 1987. *Overlooked Biases in Contingent Valuation Surveys: Some Considerations*. Land Economics 63, No. 2, pp. 168-178 (May).
- Freeman, A. Myrick III, 1979. *The Benefits of Environmental Improvement: Theory and Practice*. Baltimore: Johns Hopkins University Press for Resources for the Future.
- Kasperson, Roger E., et. al., 1988. "The Social Amplification of Risk: A Conceptual Framework," Risk Analysis, Vol. 8, No. 2.
- Kasperson, Roger E., Gerald Berk, David Pijawka, Alan B. Sharaf, and James Wood, 1980. "Public Opposition to Nuclear Energy: Retrospect and Prospect," Science, Technology and Human Values, Vol. 5, No. 31.
- Kunreuther, Howard, et. al., 1990. "Public Attitudes Toward Siting a High-Level Nuclear Waste Repository in Nevada," Risk Analysis, Vol. 10, No. 4 (December).
- Kunreuther, Howard, William Desvousges, and Paul Slovic, 1988. *Public Perceptions of Risk from the Proposed Nuclear Waste Repository*. Environment 30, No. 8, pp. 17-33 (October 1988).
- Mountain West Research (MWR), 1989. *State of Nevada Interim Report on Socioeconomic Impacts*, Nevada Nuclear Waste Project Office, Las Vegas Nevada, June.
- Schulze, William D. Ralph C. d'Arge, and David S. Brookshire, 1981. "Valuing Environmental Commodities: Some Recent Experiments," Land Economics, Vol. 57, No. 1.
- Slovic, Paul, et al., 1991. "Perceived Risk, Stigma, and Potential Economic Impacts of a High-Level Nuclear Waste Repository in Nevada," Risk Analysis, Vol. 11, No. 4.
- Slovic, Paul, 1987a. "Perceptions of Risk", Science, Vol. 236, pp. 280-285 (April).

Slovic, Paul, 1987b. *Forecasting the Adverse Economic Effects of a Nuclear Waste Repository*. Waste Management '87: Proceedings of the Symposium on Waste Management at Tucson, Arizona. Tucson, AZ: University of Arizona Press.

Smith, V. Kerry and William H. Desvousges, 1986. Asymmetries in the Valuation of Risk and the Siting of Hazardous Waste Disposal Facilities. American Economic Review, Papers and Proceedings 76, No. 2, pp. 291-294 (May).

Smith, V. Kerry and William H. Desvousges, 1987. *An Empirical Analysis of the Economic Value of Risk Changes*. Journal of Political Economy 95, No. 1, pp. 89-113 (February).

Stroup, Richard L. and Donald R. Leal, 1989. "Dealing With the NIMBY Syndrome," Political Economy Research Center, Working Paper 89-8.

Viscusi, W. Kip and Wesley A. Magat with Joel Huber et al., 1987. *Consumer and Worker Responses to Hazard Information*, Cambridge, MA: Harvard University Press.