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PERCEIVED AND CALCULATED HEALTH RISKS:
DO THE IMPACTS DIFFER?

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PERCEIVED AND CALCULATED HEALTH RISKS: DO THE IMPACTS DIFFER?

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ABSTRACT

In many cases of radioactive and hazardous waste management, some members of the general public perceive that human health risks associated with the wastes are higher than the calculated risks. Calculated risks are projections that have been derived from models, and it is these risks that are usually used as the basis for waste management. However, for various reasons, the calculated risks are often considered by the public as too low or inappropriate. The reasons that calculated risks are not perceived as accurate and the factors that affect these perceptions are explored in this paper. Also discussed are the impacts related to the perceived and calculated health risks: what they are, and if and how they differ. The kinds of potential impacts examined are health effects, land value changes, and social, transportation, and economic effects. The paper concludes with a discussion of the implications of incorporating these different risk perspectives in decisions on waste management.

INTRODUCTION

A problem common to all managers of radioactive and hazardous wastes is dealing with public views that the health risks from the waste materials are potentially greater than the managers are taking into account, regardless of the measures used to reduce the risks. Publicity about waste management operations presents extreme views ranging from public claims of increased incidence of cancer to statements by waste managers that health risks are either at or below all appropriate regulations for the protection of the general public. Despite assurances from waste handlers, government regulators, and experts, doubt remains in the public mind regarding the reliability and validity of the health risk estimates and their applicability to all situations. Public doubt alone creates problems for waste managers simply because it makes communication difficult. Underlying premises of the waste managers and community members are different and must be reconciled or compromised in order for communication and planning to take place.

However, communication is not the only problem created by the discrepancy in views of health risks. The question pursued in this paper is whether other environmental impacts--e.g., on land values, health, and community planning--occur just because the public perceives the health risks to be greater than the waste managers' calculations may show, particularly if the calculated health risks are below regulatory standards or are considered to be negligible. Three major points are discussed:

- (1) When calculated health risks are low, perceived risks are of greater importance in determining the impacts.
- (2) There are special social effects of hazardous and radioactive waste management that may not occur in other situations (e.g., siting of a coal-fired power plant), and
- (3) The impacts occurring in situations of perceived health risk are as important as those in situations of calculated risks.

CALCULATED AND PERCEIVED HEALTH RISKS

Risk is actually a theoretical concept. It does not exist in concrete terms but is a concept used to

place a probability on the consequences of some hazard. In reference to radioactive or hazardous materials, actual risk is the real probability that the public would actually be harmed as a consequence of exposure. Neither the exposure nor its effects can be known or accurately measured, although scientific techniques are constantly being developed and advanced to improve the methods. For the purposes of this paper, calculated risks will be used as our estimates of the actual risks, with the understanding that they may or may not be accurate estimates.

Calculated risks are those that have been derived from models that simulate the ways the source pollutant travels through soil, air, and water to expose an estimated population. The exposure is then translated to a dose equivalent which is then translated to an estimate of risk. This risk estimate is usually used by decision-makers as the basis for choosing how to manage waste. Thus, inherent in calculated health risks are the levels of exposure legally set to protect public health and exposure to hazardous and radioactive materials. Because of the intrinsic relationship between regulatory standards and health risk estimates made in a waste management situation, doubt about the appropriateness of the standards implies doubt about the risk estimates in the specific situation.

The calculated risk is determined by the technical characteristics of the wastes, the environment in which the wastes are located, the proximity and size of the population, and the effectiveness of the control measures. However, measurements of these characteristics are always subject to some level of error because of the sampling techniques, instruments, and statistical analyses used to make the calculations.¹ These potential sources of error introduce uncertainty even in the best of situations.

Perceived health risks are those that the public believes exist or will likely exist--whether they be less than, equal to, or greater than calculated health risks. Public perception of potential health risks is different from public perception of calculated health risks and the regulations and standards on which they are based. Although the relationship between these represent a potentially fruitful area of research, only the former will be dealt with in detail in this paper. The perception of health risks is discussed under three topics: characteristics of the hazard and

its associated risks, credibility of sources of information about the risk and of the waste managers, and characteristics of the concerned public.

Extensive research on public perception of the relative risk of various hazards--e.g., being involved in an automobile accident or a tornado--has led to the identification of a number of factors that affect risk estimates. The public perceives higher risk if an event is believed to be "involuntary, catastrophic, not personally controllable, inequitable in the distribution of risks and benefits, unfamiliar, highly complex,"² having delayed and uncertain effects, resulting from an unnecessary technology, and/or resulting in potential fatalities.^{1,3} Perceived risk is not necessarily correlated with actual mortality rates associated with hazards.⁴ Hazardous and radioactive waste-handling situations could be characterized by most, if not all, of the factors listed above--e.g., involuntary, catastrophic, not personally controllable. Thus, the attributes attached to the hazard affect the level of perceived risk.

The second category of factors affecting the level of risk perceived by the public is a function of the credibility of the information sources and the waste managers. Hazardous and radioactive waste situations do not exist in a vacuum. They are handled in the context of private business organizations and government agencies in the setting of communities populated by concerned and unconcerned officials and citizens. Perceptions are affected by the experience and credentials of all persons involved. The trustworthiness of the waste managers will be based on their past reputation for accountability, financial stability, and experience in dealing with other communities.⁵ One of the major findings of a National Academy of Sciences panel was that general mistrust of government and perceived secrecy associated with radioactive waste decisions exacerbate public concern and negative public perception.⁶

Many discrepancies in information decrease the credibility of waste managers. Because the evidence and opinions of experts differ, those used by waste managers can often be refuted by apparently equally qualified experts. Studies performed on waste materials or management sites at different times may show different results, and calculated risks may change as more data are gathered. Regulations setting allowable exposure levels, and thus implying a certainty in "safe" levels, have changed as more investigations into effects have been made. Uncertainty often seems to be the dominant conclusion about the risks associated with a certain situation. To compound these discrepancies and uncertainties, research has shown that most people--including experts--are over-confident in their estimates of risk and are reluctant to change their beliefs even in the face of contradictory evidence.^{2,7} In light of all these elements, the credibility of waste managers is extremely hard to establish. Successful experience in dealing with the public in similar situations, openness to admitting uncertainties, and willingness to communicate with community members may be the best means to raise credibility, but the problem will never disappear. The more credible the waste managers are, the more likely public perceptions of risk will be near to the calculated risks.

Public perceptions of risk are also affected by characteristics of the public. These characteristics include age, sex, education, access to information, and experience with other waste management situations and with the institutions involved in the current

situation (e.g., a federal agency or large utility). Women and couples with young children or in child-bearing years are more concerned than men and younger or older couples about the health risks associated with radioactive and hazardous wastes.^{8,9} The public is not homogeneous in its perception of any issue, especially waste management. As with most issues, those members of the public with the strongest feelings on a given issue generally make their presence known. Perceptions of other members of the public may not be well represented, especially in the media. In addition, people who live in proximity to or work in some way with radioactive or hazardous materials or facilities may perceive lower risks to the general public than do other people but are more concerned about risks to workers.¹⁰ Thus, one might expect lower risk perceptions among nuclear engineers or people living near a waste disposal site. However, this is not always the case because greater familiarity with technologies and risk measurement techniques may make these people realize where uncertainties and difficulties lie.⁷

IMPACTS: TRADITIONAL AND SPECIAL

The impacts of managing a waste-handling situation--whether selecting a disposal site, processing the materials, cleaning an abandoned site, or disposing of the wastes--can be separated into two general types: traditional and special. Traditional impacts are those resulting from exposure to the waste, e.g., the presence of the waste or its by-products causes a direct impact in the form of cancer incidence or contamination of air and/or water. The particular impact depends on the characteristics of the waste, e.g., solubility, carcinogenic potential, chemical composition. Special impacts are those that result from actions taken or knowledge of the wastes, e.g., removal, burial, isolation. Special impacts include those on community satisfaction, perception of quality of life, institutions, economy, employment, land use and value, utilities, population distribution, housing, and transportation.

Examples of potential impacts are shown in Table I. The potential impacts are separated into short-term and long-term time frames. Some would occur only in the short term (e.g., during the planning and operational phase of a waste facility), whether from the action on the wastes or from exposure to the hazard; others would be long-lasting or appear only in the long term (e.g., after a waste facility has ceased operation)--e.g., increased incidence of cancer. There may be some differences across risk categories in duration of the impact as will be discussed below.

The most important comparisons to be made are between impacts from risk perceived at above standards and risk calculated at below standards. The greatest difficulties in communication between the public and waste managers, and the greatest potential discrepancy in risk perception by the two groups, exist in the comparison of these two cases.

The major health impact of perceived risk is most likely stress-related. If the public perceives a significant health effect in the absence of a calculated effect (assuming that the calculated effect approximates the actual effect fairly closely), it would expect higher incidences of diseases such as cancer, even though this will probably not occur. This increased concern about health effects--and other impacts--may result in stress-related health effects in the short term, such as insomnia or psychological and heart problems. Such health effects are what were

TABLE I
Examples of Potential Impacts

Impacts	Potential Impacts	
	Short-Term	Long-Term
Human health	Stress-related health problems	Increased incidence of cancer
Biotic health	Acute ailments	Increased incidence of cancer
Water quality	Contamination of water supply via discharges	Leaching into groundwater of toxic materials
Air quality	Dispersion of contaminated materials via air transport during site action	Dispersion of contaminated materials via air transport due to erosion or intrusion
Community satisfaction	Dissatisfaction of residents with certain aspects of community as other factors (e.g., housing, land values, employment) are impacted	Feelings of cohesiveness among residents from handling adversity; continued dissatisfaction of residents in terms of employment, housing, economic development, etc., if population out-migration results from continued concern over pollution
Quality of life	Lowering of quality of life indicators related to health, environment, outdoor recreation, community satisfaction, etc.	Continued perception of lower quality of life
Institutions	Formation of new citizens' action groups; turnover in elected officials	Reorganization of local government; passage of laws to regulate waste management; potential loss of institutions if population disperses
Population distribution	Out-migration of couples with young children	Changes in zoning and planning for settlement patterns; out-migration of population from the area
Housing	Slowing or stopping of home building in area	Changes in planning and development patterns
Land use and value	Decrease in property values	Changes in planning and development patterns; continued low property values
Economy and employment	Refusal of employees to work near site; loss of clients to nearby businesses	Failure of nearby businesses
Community services	Loss of services to nearby schools	Changes in treatment of garbage and sewage for fear of creating another hazardous waste problem
Utilities	Loss of new water supply connections in area as development slows and fear of contamination grows	Development of new water supplies
Transportation	Disruption of traffic patterns	Changes in plans for new road systems to avoid waste site

called "psychological" impacts in the case of the accident at the Three Mile Island nuclear power plant. The results of the scant research on the existence of such effects are mixed. Studies of residents near Love Canal and a toxic waste site and of atomic veterans find evidence for stress-related health effects.¹¹ However, another study of residents of communities with nuclear power plants found no evidence of such effects above the normal rates.¹²

The special impacts potentially associated with perceived risk are a special subset of socioeconomic impacts. Waste managers and environmental impact assessors have stated often that these impacts can be troublesome not only because of the negative effects of their existence but also because of the difficulty in measuring them. The level of impacts and how to mitigate them are complicated by the lack of generally accepted measurement tools and of research to document the existence and persistence of the effects.

The existence of special impacts is likely when risks are perceived above standards. The perception of risk is part of what other authors have referred to as the "special" socioeconomic effects of waste management.¹³ These effects are likely to occur because of the perceptions and fears of health effects alone, independent of a finding of calculated health risks above standards. Citizens are less likely to buy homes in the area of the wastes or to remain living there with small children.¹⁴ If they try to sell their homes, they may find that the value of their property is lower than comparable properties in other areas.¹⁴ These effects, although difficult to measure except in retrospect, will likely occur because the fear of health effects exists, whether it is a fear based on calculated risk or not.

IMPLICATIONS

The primary implication of public perception of health risks for hazardous or radioactive waste managers is that many impacts may occur whether a health risk is calculated to be above regulatory standards (and, hence, unacceptable) or not. These impacts occur solely because the public perceives that health risks exist and that these perceived health risks are worthy of attention and perhaps remedial action or alternative management methods. Attempting to deny or refute these perceptions with data from site surveys and explanations of calculational methods will, at the least, bring up the question of credibility. As stated earlier, both experts and lay people are generally overconfident in their estimates and reluctant to change their strongly held views even in the face of contradictory evidence. These patterns must be taken seriously when discussions and planning with the local community take place, and they must not be dismissed as inappropriate. Compromise can take place despite differences in views on the health risks of the wastes.

Second, perception of risks can cause special socioeconomic impacts. These impacts should be anticipated and responded to realistically. For example, waste managers should be aware that properties near a waste site may decrease in value or local commercial operations may lose business as a result of publicity about the waste site and the perception of a health hazard. Ideally, evidence should be gathered to document such impacts. Mileti and Williams have proposed a comprehensive approach for inclusion of such variables in a model of community organization and change and have suggested that such a model be applied to waste management.¹⁵ In addition, these authors have suggested routinely

including social variables in risk assessment models.¹⁶ Such an approach would lead to a more realistic view of the situation for decision-makers. These special social effects are just as real in their consequences as if a calculated, above-standard health risk were found. Mitigation may be requested and appropriate. It should be considered as part of any investigation of a potentially hazardous waste site.

As part of any waste site investigation, data should be gathered on socioeconomic factors prior to and during the publicity period. Data on some variables will be obtainable through existing sources such as housing sales and prices, business volume, and demographics of the community. Data for such variables as community satisfaction and quality of life will have to be collected. If baseline data are unavailable, then monitoring data could be compared with similar control communities that are not experiencing such change. Certainly, if the claim is made that such effects are occurring, these data should be gathered to support or refute the claim--just as data on contamination are gathered to document potential impacts on human health and the environment. At a minimum, the claims should be taken as potentially realistic.

CONCLUSION

Perceived health risks of hazardous or radioactive wastes do not necessarily correspond to calculated risks, and the perceived health risks alone may cause impacts. However, the areas of impact differ for perceived and calculated risks. Second, these are special socioeconomic impacts related to waste management situations because the impacts are caused by the public perception of risks, which are independent of the calculated levels. Finally, the impacts caused by public perception of risk are real and the potential consequences are substantial. A need exists to ensure that the potential impacts related to perceived risks are recognized and are dealt with in the decision-making process.

The realization that perceived risk can have real consequences has serious implications for decision-makers. Efforts will have to be undertaken to include perception (as well as the variables that can be affected by perception) in waste-management decisions. This is the challenge for social impact assessors for the remainder of this century.

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