

The Reality of Perception: Demonstrable Effects of Perceived Risk in Goiania, Brazil

By John S. Petterson

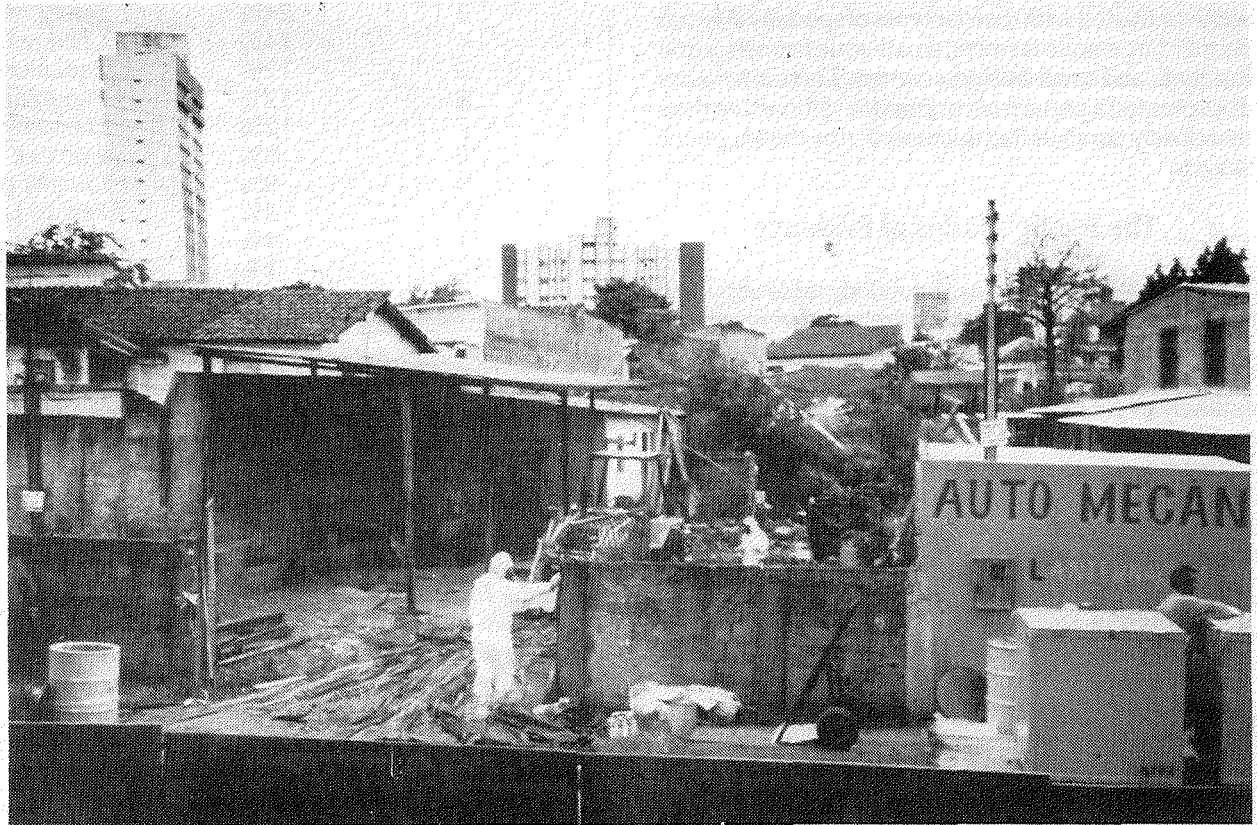
On September 13, 1987, two metal and paper scavengers of the city of Goiania (pop. 1,000,000), in the central Brazilian state of Goias (pop. 13,000,000) entered an abandoned clinic in search of scrap metal. They discovered a 400-kilogram machine that had been used to treat cancer patients with controlled doses of radiation. They dismantled the device and extracted a stainless steel cylinder; then they took the cylinder to a junkyard, broke it open with a sledge hammer, and removed a one-cubic-inch platinum capsule. Subsequently they sawed open the capsule, revealing approximately 100 grams of luminescent material, which was described by witnesses as "carnival glitter."

Children playing in the junkyard were attracted to this glowing "magical" material and began to play with it—spreading it on their hands and bodies. The children and the workers, in turn, took it home with them, showed their friends, and spread it on clothing, paper, walls, floors, and, in the case of a six-year-old child, even consumed some of the material that had spread from her hands to her food. In this last case, the child began to vomit after just ten minutes. Within a few days, many others fell ill. It was nearly two weeks, however, before their illnesses were diagnosed as radiation poisoning, and the source of the problem, cesium-137 exposure, was identified.

On October 22, 1987, 39 days after the cesium-137 material was released from the capsule, the six-year-old child died. Since then three other individuals have died and one man has had an arm amputated. Several others have been treated for external lesions, a few of which have been quite serious and have involved repeated attempts at tissue grafting. But perhaps most significant are the secondary consequences that have occurred as a result of the public's reactions following the initial accident—reactions resulting from the public's perception of their own risk of contamination.

The Goiania event provided a unique opportunity to examine: (1) how a relatively minor accident involving radioactive material could result in a chain of events affecting an entire state's economy, stigmatize an entire state's population, and disrupt social relations throughout a community and region; (2) the process by which the public perception of risks, not the actual event or risk itself, can result in a wide array of painful and costly responses; and (3) the consequences of perceived risk and stigma under actual conditions. Thus, in November 1987, I began to structure a study in which the central objective was to clarify the processes by which perceived risks and concerns are channelled into measurable socioeconomic impacts.

I obtained data during two field visits to Brazil: the first visit occurred during the height of the post-accident panic (in November, 1987) and lasted two weeks; the second occurred between April 6 and May 5, 1988, some seven months after the accident. Thus I was able to observe both the short- and medium-term socioeconomic effects of the accident. Formal and informal interviews were conducted with representatives of the various state and federal economic agencies and tourist offices, and with local residents and local, state, and national officials working in Goiania, and in Rio de Janeiro, where the most seriously contaminated victims were being treated and where the Comissão Nacional de Energia Nuclear (CNEN) (National Nuclear Energy Commission) is located.



Cleanup in the metal salvage yard where the radioactive capsule was broken open

Consequences of the Goiania Accident

The consequences of this event have been varied and far-reaching. Beyond the obvious physical consequences, the event also has had a significant impact on the economic stability and the social and political fabric of this Brazilian state. The full extent of these impacts will not be known for some time.

As of January 1988, 249 cases of contamination had been identified. Of these, 128 concerned clothing only and 121 involved traces in skin, of which 57 were decontaminated and sent home and 64 were hospitalized at least overnight. As mentioned earlier, there have been four fatalities and one amputation. The event has been characterized as one of the most serious nuclear-related accidents in history, second only to Chernobyl. When measured in terms of fatalities and injuries alone, however, the event itself would hardly seem to be of international significance, and no worse than many industrial accidents. Only when one considers the intensity and duration of the social and economic consequences does the severity of the incident become clear.

Economic Consequences

The economic impacts of the event have been significant. These impacts fall into two broad categories: material costs of dealing with the accident (i.e. treatment of victims and site cleanup costs); and socioeconomic costs resulting from perceptions of risk (including the collapse of agricultural and textile markets, property values, and the local tourist industry). The material cost of treating and maintaining victims, some for the rest of their lives, has been estimated at several million dollars. The costs of storing and transporting the nearly 40 tons of contaminated materials, of rebuilding all of the homes destroyed in the process of decontamination, and of paying and housing nearly 500 technical

workers and staff involved in the monitoring and cleanup operation have been significant and unavoidable.

Some of the more potent economic impacts, however, have come not as a result of the physical consequences but as a result of the social perception of risks. For example, the impact of such perceptions on agriculture was dramatic. Within two weeks of the announcement of the contamination, the wholesale value of the entire state's agricultural production fell by 50 percent. It is perhaps important to note that all of the major agricultural products of the region and state are produced outside of the community of Goiania and none has been shown to be contaminated in any way. Manufacturing, including textiles, clothing, and other finished products, also was affected. The sale prices for such items produced in and around Goiania (and to some extent throughout the state of Goias) dropped by approximately 40 percent immediately following the announcement. None of these items was ever shown to have been contaminated. In fact, as far as I was able to determine, there was never even a published suggestion that they could have been contaminated. The average loss of 30 percent of official sales (i.e., sales on which taxes are paid) for October and November will amount to perhaps 1 billion cruzados (\$20 million). The impact on sub-rosa sales which pass through the economy without official taxes—the vast majority of goods—would be several times greater. The closer one gets to the contaminated areas, the greater the impact on the number of home sales, home sale prices, rental prices, and land prices. In the vicinity of the accident itself real estate values plummeted.

The impact of the accident on tourism was also profound. The leading tourist attraction in the vicinity of Goiania is the small community of Caldas Novas, which owes its existence to what is perhaps the largest collection of hot springs in the world. Numerous hotels have been constructed to take

advantage of these natural springs. There are gigantic swimming pools, water falls, and streams throughout the area. Even though reservations and advanced payments normally are required, the occupancy rate dropped approximately 35 percent immediately following the announcement. Hotel occupancy in Goiania itself, normally near capacity at that time of the year, showed vacancy levels around 40 percent for the six weeks following the announcement of the accident. One of the larger hotels in Goiania alone lost an estimated 1,000 reservations for a drop of nearly 60 percent. At least four major conventions scheduled to be held in Goiania were canceled in response to the perceived risk and stigma that became associated with the communities and populations surrounding the site of the accident.

Social Consequences

The impacts of perceived risks and stigma were almost immediately apparent. Once the source of the problem had been identified in the media, a virtual panic ensued. Concern very quickly reached the point where the CNEN had to establish monitoring stations to check people for contamination. It is important to recognize that the entire "monitoring" effort (i.e., being checked from head to foot for contamination) was a response to perceived risk. The state and federal governments did nothing to encourage people to come in for monitoring. They worked hard, in fact, to calm fears and to discourage people from coming in to be monitored. The fact that 125,000 people were personally afraid that they might inadvertently have been contaminated is a significant statistic. Approximately one of every ten residents of a city of over 1,000,000 felt sufficiently at risk to take time off work or use weekend hours to travel across town and wait in line to have someone scan his or her body with a Geiger counter for potential contamination. This is a significant behavioral response to a perceived risk!

Perhaps the most important finding of my examination of the Goiania event, however, was the fact that of the first 60,000 individuals to be monitored, approximately 5,000 individuals (8.3 percent) presented acute stress or allergic symptoms (i.e., rash around neck and upper body, vomiting, diarrhea, etc.). Curiously, the majority of these individuals

claimed that these symptoms had begun after the capsule was broken but before the announcement in the news media. Not a single one of these individuals was contaminated! This has profound implications for the study of perceived risk in general and of "special" nuclear-related impacts in particular.

In addition, more than 8,000 residents requested and received official certification that they were not contaminated. These certificates were requested as an effort to counter the stigma attached to the area—stigma as evidenced by: (1) hotels in other parts of the country refusing to allow Goiania residents to register (e.g., in São Paulo, Cuiyaban, Manaus); (2) airline pilots refusing to fly with Goiania residents aboard; (3) bus drivers refusing to allow Goiania residents on their buses; (4) stoning of automobiles with Goiania license plates in São Paulo; and (5) virtually all conventions originally scheduled for hotels in Goiania during this period being canceled or rescheduled for other communities.

Political and Legal Consequences

Also of interest was an assessment of the longer-term ramifications of the Goiania accident on political processes and relations between the city of Goiania and other cities, between Goiania and the state of Goias, between Goias and other states, between Goias and the federal government, and between other states and the federal government. The event did not occur in a vacuum; rather, its context was an active and complex domestic political environment. This radiological materials accident also generated international political consequences. Therefore, what on the surface might appear to be a localized event has had far-reaching consequences on each of several political levels, including organizational and programmatic effects on institutions, consequences for political relations, and also certain legal consequences.

The incident also has had a profound effect on Brazil's institutional organizations dealing with nuclear matters and has had some serious effects on the public's attitude toward the Brazilian nuclear program. Flaws in the CNEN's regulatory policy and the regulatory implementation process became obvious in the aftermath of the accident. Also, a number of other fundamental questions remain. Who is responsible for reimbursement, mitigation,

and compensation, and who is to be held accountable? Agencies generally failed to assume responsibility themselves, claiming instead that other agencies had been responsible. Four political issues emerged which were examined in some detail. These included: (1) the levels of jurisdictional conflict; (2) the fact that the accident served as a catalyst which fomented domestic political opposition; (3) the involvement of international political interests in the incident; and (4) the roles of politics and crisis resolution during the decontamination process.

Jurisdictional conflicts occurred on several levels, involving points of friction, contention, or dispute over administrative, legal, or financial responsibility. Conflicts evolved between Goiania and neighboring communities and regions centering on issues of travel and economic relations. Conflicts also arose between Goiania and the state of Goias and between Goias and the federal government concerning who was to assume the administrative, legal, and financial responsibilities for the accident, and who was to be responsible for the waste disposal problem. Interstate conflicts were among the most serious. States in economic competition with Goias successfully magnified the impacts of the accident to manipulate the price of virtually every product produced in Goias.

These concerted actions by other states to take advantage of Goias' predicament have exacerbated existing rifts between Goias and neighboring states, and they have tended overall to significantly weaken Goias' relative political and economic position. The incident also initiated a rash of political actions by other states to prevent nuclear waste from being buried within their borders—creating a major problem for the national government's efforts to locate and construct a high-level nuclear waste repository for anticipated commercial and military wastes. The State of Rio de Janeiro, for example, quickly passed a law prohibiting burial of nuclear waste within its boundaries, even though it is among the largest users of nuclear materials. Other states have begun similar movements and tribal groups in areas slated for future national burial sites have held protest marches in the national capital.

The accident also has aroused political dissent, in effect providing a public forum for more or less distantly related opponents. A member of a minority party, for example, attempted to gain political leverage for his own efforts at election by bringing in an "outside expert" to contradict the official version of the event. In this case, a member of the Brazilian "Green" party arranged to have a nuclear physicist from the German Green Party come to Goiania to investigate the incident, with the idea of providing an independent perspective. This caused untold damage when the so-called "scientific" findings of this "expert" (which included grossly exaggerated radiation readings) were reported in the press.

Implications

First, it is dangerous to assume that these impacts are somehow "culture-specific" phenomena, or that analysis of case studies occurring in other cultural contexts has no bearing on socioeconomic and sociocultural impact analysis for domestic projects. Cultural differences aside, this incident took place in a milieu not unlike many in the United States in several respects, as the incident started and flourished in a well-educated, sophisticated suburban population of a cosmopolitan city of one million residents. Obviously, there are some factors that promoted the spread of the problem which are more common in Brazil than in the United States, such as sensationalism and unchecked manipulation by the media and the use made of "outside experts." In some other ways, however, perceived risks may be heightened in the United States—information travels faster, has an immediate impact on a larger number of people, and can affect national commodity markets literally in a matter of minutes. On the



Petterson and local residents watch CNEN workers at a paper recycling yard in Goiania

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The tribes have been concerned about the repository's development potentially disturbing important cultural resources and religious freedoms, both of which are afforded legal protections. Tribal sovereignty and the tribal right to self-government are also protected by law, as is the tribes' right to manage natural resources within their jurisdictions. Changes in economic activity and an influx of repository workers from outside the region have also been of some concern to the tribes.

Institutional Reluctance to Investigate Risk-Related Concerns

Radionuclides jeopardizing reserved treaty rights? Mine shaft construction as a threat to national identity? The two sides are using the same idiom—"risk"—to talk about remarkably different phenomena, and conflict has grown out of these confounded meanings. Resolving this conflict is not straightforward, however, for several reasons. First, the DOE is required to abide by statutory and regulatory codification of the public interest. If the Department is not specifically authorized to spend the taxpayers' money, it is at great pains to justify its activities. Even the Nuclear Waste Fund—the ratepayers' contribution to waste management solutions—is appropriated by Congress. The authority for spending these funds to investigate repository-related risk judgments is ambiguous, and subject to conflicting interpretations.

For example, a 1983 Supreme Court decision, *Metropolitan Edison v. People Against Nuclear Energy (PANE)* (460 U.S. 766, 75 L.Ed.2d 534, 1983) obscured the relevance of the National Environmental Policy Act as authorizing such investigations. The case dealt with the adequacy of an Environmental Impact Statement (EIS) that ignored the psychological effects of a potentially dangerous federal action. In *PANE*, the Court ruled that psychological stress induced by the possibility of an accident if the undamaged reactor at Three Mile Island were to be restarted is not closely enough related to some actual physical change in the environment to be included in the EIS. DOE attorneys have determined that the *PANE* decision applies to the repository site selection process, and that the social and psychological effects that result from anticipating an as yet unrealized risk need not be investigated for the impact assessment to be considered adequate.

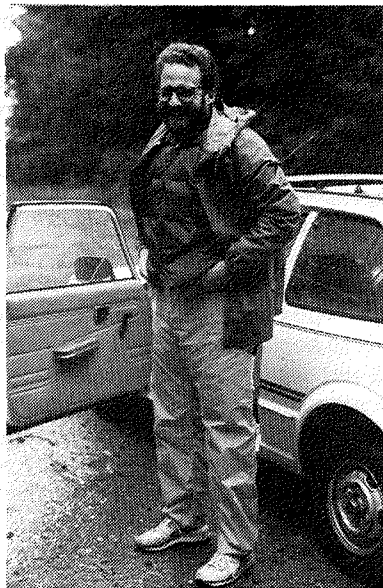
Protecting American Indian religious freedom, another salient risk-related concern of the affected tribes in the Northwest, is not altogether unconditional under the authority of the American Indian Religious Freedom Act (AIRFA). Case law suggests that there is no requirement under the AIRFA that considerations of native traditional religions must prevail to the exclusion of all else. That is, the AIRFA requires federal agencies to consider, but not necessarily to defer to, Indian religious values.

In addition to the ambiguous nature of federal authority for undertaking investigations concerning repository-related risk judgments, another difficulty is derived from the DOE's reaction to the opinionated tenor of expert advice. The use of what have been termed "opinionated experts," and the adversarial nature of the site selection proceedings has led DOE staffers to be skeptical of more carefully studying the consequences of risk judgments. Scientists (federal contractors, state and tribal government contractors, as well as the National Academy of Sciences) have asserted that more information needs to be obtained about attributes of the repository's development judged to be risky, and the extent to which risk judgments are influenced by perceptions of the agency's ability to manage the operation. The DOE has reacted, in general, by crying "Enough studies! We need to get on with the business of planning mitigation strategies." DOE representatives have expressed a lack of confidence in the objectivity with which investigators approach their research, pointing to conflicts within the community of experts over suitable analytical methods and supportable findings.

Finally, the prospects for investigations concerning risk have been regarded dimly by DOE Headquarters staff in Washington, DC (in contrast to the DOE project offices in Washington state, Nevada, and Texas), manifesting, in my view, a classic federal tension. This tension is created by the specific interests of each DOE project office, which must deal more directly with the tribal and state government representatives, and which is more likely to find valid their points of view. Risk-related issues were elevated to a position of paramount importance at Hanford by the State of Washington and affected Indian tribes, while in Nevada and Texas a number of other issues have been equally central to the conflict. Headquarters staff, from their vantage point, are faced with a comparison among all three sites. To preserve the comparability of data used to inform their site selection, headquarters staff members feel they must take great care to avoid favoring the particular circumstances of any one office.

Inevitably the question is asked: How has all this turned out? Congress has chosen the Yucca Mountain, Nevada site as the one site for detailed studies, and now faces a different challenge. The comparison among sites is no longer relevant, but the social and economic consequences of risk judgments cannot simply be dismissed as fabrications in the minds of ill-informed obstructionists and their opinionated experts. In the past, agencies have attempted to educate the general public about the "real" risks associated with a large-scale development, and in the process reassure them that the technology is safe and the agency is trustworthy. This one-way disclosure of information has proven unsuccessful.

In applying lessons from any single case, we must not lose sight of the terrain in which the work has gained its purchase. Working with the sponsorship of an agency that resists setting precedents, the Hanford program's successes were bound to be small. We managed to institute discussions that led to a visit by several tribal members to a portion of the Hanford Reservation to which access had been restricted since the early days of the Manhattan Project. A testing facility built into the side of a prominent spiritual landmark is being removed, and the natural contours and vegetation are being reclaimed under tribal supervision. These modest successes direct our attention away from the begrudging disclosure of agency plans, and to the conflict-reducing promise of viewing risk communication as a two-way exchange of information about the nature and extent of risk-related concerns, what can be done to reduce the risks, and the advantages and limitations of such risk-reducing measures.



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matter of differences in "sophistication" between the populations of the two countries, as a population, we can hardly claim a much greater understanding of radioactive contamination. Finally, we must recognize that in the United States a "technical" risk assessment can be absolutely accurate and yet fail to anticipate, or protect against, the potentially devastating impacts of social interpretations of an accident event. Understanding the social channels, political institutions, and economic mechanisms through which socioeconomic impacts are distributed is of profound importance to the control and containment of potential nuclear-related socioeconomic impacts in the United States.

Any scenario that postulates the release of a relatively small amount of radiation to the environment will entail a wide array of consequences. In any such scenario, the radiation exposure itself will be an obvious problem both in terms of physical consequences and in terms of the socioeconomic impacts on the exposed persons and communities. As the Brazilian case illustrates, however, the aggregate impacts of the exposure itself will likely be minor when compared with the socioeconomic consequences of people's perceptions of the risks involved, and their reactions to those perceptions.

The lessons to be learned from the Goiania event apply to both low- and high-level radioactive waste siting decisions, to reactor siting decisions, to radioactive materials transport, to medical and technical uses of radioactive substances, and, in fact, to accidents involving any number of other materials which can injure or kill through what, to the public, are mysterious processes.

There are two principal benefits from the Goiania incident research. First, and most important, is the value of demonstrating linkages. Unlike recent work conducted in the United States focusing on the analysis of theoretical, logical, or more remotely possible real or perceived risk scenarios, the Goiania event provides a wide array of very serious and quantifiable social and economic impacts, many of which have yet to be considered in the literature. The Goiania event also demonstrates the actual linkages between the public perception of risk and socioeconomic impacts. These are precisely the elements that are most likely to convince somewhat skeptical individuals or organizations (e.g., Nuclear Regulatory Commission) that serious social and economic impacts are likely to be experienced in the event of a "minor" radiological accident.

A second potentially valuable aspect of the research concerns impact mitigation. Actions pertaining to issues such as compensation strategies, emergency response plans, and unanticipated social and economic impacts suggest important strategic responses. An understanding of the reasoning behind, and consequences of, mitigative actions taken by the State of Goias in response to the Goiania accident should prove of considerable future value. Finally, it should be noted that the Goiania incident continues to unfold. Additional research is needed to record longer-term effects of the incident to establish which effects persist, which do not, and the reasons behind these distinctions.

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