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The social psychological impacts of a technological accident: Collective stress and perceived health risks

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Abstract

Technological accidents pose a threat to community structure and the social psychological well-being of community residents. This research provides an evaluation of the impact of a major train derailment and toxic spill in Livingston, Louisiana, a rural community in the United States. The nature, direction and magnitude of this impact are assessed through data collected under a court-order and introduced as evidence in class-action litigation. A disaster impact assessment design was developed and data were collected 20 months after the accident. Findings for the residents of Livingston reveal that victims closer to the impact site, members of families who are evacuated for longer time periods and members of families who were separated at the time of the accident experienced the most collective stress and manifested strongest concerns about risks to their health. Many of the community residents wanted to move because they were upset with the source of the accident and they perceived that they had "increased risks of getting cancer" and feared that their "drinking water was contaminated". The social-psychological impact of this technological accident varied in terms of disaster demographics, providing one basis for mitigation and the allocation of compensation through a court settlement.

Introduction

Technological disasters, like other man-made and natural disasters are associated with collective stress [1,2]. Collective stress has several attributes which have been identified in the literature (e.g., community stress, family/small group stress, and social psychological stress). Changes in community attitudes, values, and perceptions are indicative of social psychological stress [3–8]. This research attempts to conceptualize, measure and empirically evaluate long-term (20 months following the accident) social psychological stress

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among residents of a small rural community in the United States who were victims of a train derailment and toxic spill.

Social psychological stress

Social psychological stress can be viewed as a collective adaptation of a community resulting in behavioral, attitudinal and perceptual changes and adjustments. Attitudes and perceptions are indicators of the "quality of life" within a community. Social psychological stress can also be conceptualized as the discrepancy between the "perceived quality of life" and "expected quality of life". Inconsistent evaluations at this level of analysis may be attributable to disaster impacts and probably vary by characteristics of the disaster and the social system of the impacted community.

The measure of social psychological stress considered in this research reflects: (1) disruption perceptions; (2) risk perceptions; and (3) community satisfaction perceptions. The focus of this research is on a train derailment and toxic spill, therefore, research findings from other technological disasters in the U.S. are reported to provide a basis for conceptualizing these measures of social psychological stress. Specifically, research on the following events will be reviewed: (1) Three Mile Island (TMI), a nuclear reactor accident; (2) Love Canal, a toxic waste disposal site; and (3) Buffalo Creek, the site of a dam collapse and flood [7–11].

Disruption perception

One form of social psychological stress evident in disasters is the social perception of "disruption" experienced by community members. The initial responses to the disorder created by such an event include feelings of apprehension towards the imminent danger and threat, i.e., feelings of disturbance resulting from evacuation activities and the uncertainty in trying to resolve the problems associated with the disaster event [6,7]. These perceptions can be viewed as psychological reactions, initial definitions of the event and the mental health of the victims. Furthermore, these perceptions may persist long after the event has occurred [8,10].

The intensity of disruption is manifested in the fear and uncertainty that characterize disaster victims during and immediately after the accident. This involves the disruption of normal social routines and patterns of interaction which result from evacuations and/or the awareness that something is wrong. The findings by Goldhaber et al., for Three Mile Island (TMI) regarding the psychological and emotional disaster situation experienced by the nearby residents are indicative of perceptions of disruption [9]. Feelings of being numbed, afraid and vulnerable experienced by Buffalo Creek victims provide another example [10,12]. When there is no sudden impact, as in the case of toxic waste disposal sites, disruption may be more subtle and ambiguous. Disruption in

this case may reflect beliefs and perceptions which lead individuals to define the situation as a disaster. The "publicity" of such an event may also disrupt the lives of those residents who do not define their situation as hazardous [7,8].

Perceptions of risk

A second type of social psychological stress is reflected by an increased awareness of potential future risks. Disasters reveal a precarious relationship between the environment and existing social order. In the aftermath of a disaster, community members may develop an increased awareness of vulnerability to natural and technological hazards in their ecosystem. Future risks reflect perceptions of the likelihood that a hazard event will occur. For example, Erikson found that Buffalo Creek residents have a sense of awareness of potential risk from flooding which is heightened during severe thunderstorms [10]. Such intrusive stress patterns may have long-term consequences.

Future risk also includes perceptions of latent health effects. Community concern for latent health effects is particularly apparent when toxic chemical or radiation exposure is involved. The presence of these substances heightens uncertainty regarding the long-term consequences of exposure. This consensus of uncertainty can be heightened by a lack on knowledge by the public and is further exacerbated when scientific experts display a lack of agreement and precise understanding [13]. In addition, the content of mass media coverage may instill a greater sense of uncertainty regarding the effects of exposure to hazardous substances. The community may reflect this uncertainty by increased fear and awareness of long-term negative health effects.

Research findings from TMI and Love Canal reflect community concern for health risks from exposure to hazardous substances. Houts and co-workers found a high rate of health care utilization among persons who were upset during the TMI crisis [14]. In addition, some local TMI residents exhibited heightened levels of anxiety and emotional distress with regard to the health effects of low-level radiation exposure [15,16]. In their analysis of Love Canal homeowners, Fowlkes and Miller found that families with dependent children were characterized by beliefs of widespread contamination and fear of health risks associated with exposure to hazardous substances [7].

Community satisfaction perception

Community satisfaction refers to those attitudes and perceptions regarding the quality of social life in the community. It is based upon a subjective evaluation of the community as a desirable place to live. Campbell notes that quality of life is more than material well-being; it includes subjective feelings of psychological well-being [17]. Tolman's concept of "psychological man" reflects this subjective element of well-being by focusing on non-material values such as social prestige, sense of achievement, social relations, and self-esteem [18]. Maslow characterizes these non-material aspects as "higher needs", not-

ing that people are motivated by the need for social support, belongingness, love, self-esteem, the respect of others and self-fulfillment [11].

These "higher needs" are embodied in community relationships. Community, as Deseran notes, "... can be viewed as an arena in which policy issues, major life events, and general environmental factors become linked to individual perceptions" [19]. Everyday life in the community consists of beliefs, values, expectations, social loyalties, interaction, etc. which provide the context in which the psychological well-being is actualized. The community also reflects stability and order in which individual perceptions regarding the social and physical environment are formed. Erikson describes this stability as being experienced "... as a part of the natural order of things" [10].

This selected review of technological disasters suggests that this "natural order" can be substantially altered as a consequence of the events. Objectively, this may be viewed as a loss of community relationships through death or migration. Subjectively, this may be viewed as changes in satisfaction with the community as a desirable place in which to live [6].

In terms of this conceptual orientation, the experience of a technological disaster, like that of natural disasters, has a potential negative impact on any community or organizational network within a community. Technological disasters impact at three critical points: (1) perceptions of disruption; (2) perceptions of perceived risks, and; (3) perceptions of community satisfaction [8].

Methodology

In the fall of 1982, at 5:12 a.m., a train derailed in Livingston, Louisiana, a small rural town in the Southern region of the United States. Over forty tank cars derailed. Approximately one-half of these tank cars contained hazardous chemicals. Most of these tank cars subsequently leaked, burned and/or exploded. Fires broke out at the derailment site shortly after the accident and continued to burn for 13 days. The town was evacuated immediately after the derailment with a major portion of the population officially evacuated from their homes for 14 to 17 days. Derailed tank cars contaminated a ten acre (4 ha) site with a variety of hazardous substances (e.g., methyl chloride, sodium, tetraethyl lead, toluene diisocyanate, perchloroethylene, styrene). Over 96,000 cubic yards (70,000 m^3) of contaminated soil were moved to a toxic waste site. The excavation and restoration, complete with recovery wells, took 20 months to complete [20].

Despite the magnitude of the accident, there were no deaths or serious injuries and the amount of physical destruction to private property was relatively minimal. However, the community of Livingston perceived the situation as disaster-like and responded accordingly. In the aftermath of the disaster, a class action lawsuit was filed by the community against the railroad. The district court ordered an assessment of the physical, ecological, economic, psy-

chological and sociological impacts of the derailment. The latter three assessments were not initiated until 20 months after the derailment [20]. The results of all assessments were used in a unique out-of-court settlement which utilized panel discussions and cross-examinations of expert witnesses under oath [21].

The sociological assessment consisted of 233 personal interviews with the head and spouse (if applicable) of 133 households. The households were randomly selected within each mile radius of the derailment site (up to seven miles). A control community was selected to provide a community based standard of comparison. The control community was selected using ACORN, a rigorous statistical procedure which matched demographic and community variables to find the most similar communities located by a railroad. A random sample of 166 residents in the control community was interviewed by telephone. A comparison of demographic characteristics of both communities revealed no differences prior to the disastrous derailment in Livingston [20].

The interview format included questions which served as indicators of social psychological stress. Respondents were asked a series of Likert-type questions regarding their community, perceptions of future risks and migration desires. A comparison of community responses to these questions provide a basis for examining disruption perception, risk perception and community satisfaction.

Data analysis

The data analysis consists of three parts. First, a Livingston-control community comparative analysis will be presented. Next, a series of regression models will be presented. These models will be calculated for indicators of *collective stress* and *perceived health risks* within the Livingston community.

Comparative analysis

The comparative analysis of Livingston and the control community is based on an examination of indicators of disruption perception, community satisfaction and risk perception. Statistically significant differences between Livingston and the control community are based on the chi-square and Cramer's V tests. Overall this comparison revealed a large number of statistically significant differences between the two communities after the accident. The observed variations between the two communities reveal that the Livingston respondents manifested: (a) outmigration desires and plans: (b) perceptions of danger and increased chances of never knowing the full extent of the pollution caused by the derailment; (c) less community satisfaction; and (d) perceptions of increased risks of future technological accidents. Detailed empirical results can be summarized as follows [20]:

(1) A larger proportion of Livingston community respondents manifested desires and plans to leave their community than did respondents from the control community.

(2) A larger proportion of Livingston community respondents felt it was dangerous to live near railroad tracks than did respondents from the control group.

(3) More Livingston community respondents than control community respondents felt that the extent of the pollution caused by the train derailment would never be known.

(4) Livingston community respondents were less optimistic than control community respondents concerning full compensation from the railroad for the derailment. However, more Livingston respondents than control community respondents indicated that they believed court judgments regarding the derailment would be fair.

(5) Livingston and control community respondents were found to have relatively similar perceptions of the chances of a variety of natural disasters affecting their families during the next year.

(6) Proportionately more Livingston respondents than control community respondents perceived greater chances of a variety of technological accidents affecting their families over the next year. Specifically, pollution from hazardous waste sites, contaminated drinking water, and air pollution were all viewed as high risks by the Livingston respondents.

(7) No significant differences between the two communities were observed for community friendship values.

(8) Proportionately more Livingston respondents than control community respondents indicated less satisfaction with their community as a good place to live, raise children, and have a happy life.

(9) Livingston community respondents and the control community respondents held similar positive views toward community growth.

(10) Respondents from Livingston and the control community agreed that personal safety was not a major problem. In fact, Livingston community members expressed less fear for personal safety at night.

In general, the magnitude and consistency of observed differences found throughout the comparative analysis strongly suggest impacts from the technological accident existed 20 months after the derailment. The substantive nature of this long-term impact is negative in that respondents in the Livingston sample indicated a variety of attitudes and perceptions that can be interpreted as threatening the future well-being of the community. For example, in contrast to the control community respondents, Livingston area respondents indicated that their community (i.e., the evacuated area) was a less desirable place to live, raise children and have a happy life. The less desirable nature of the Livingston area was further reinforced by their increased desires and plans to move out of the community.

Furthermore, additional evidence of a continuing impact can be inferred from the analytical findings that Livingston area respondents were not optimistic about the future (based on their perceptions of the danger of living near

railroad tracks and never knowing the full extent of pollution caused by the accident). This continuing expression of concern and fear of potential unknown environmental dangers could result in a continued perception of the area as an undesirable place to live.

It should be noted that the derailment, as would be expected, had little apparent effect on community values characteristically associated with people (i.e., community friendship and community safety). In addition, Livingston respondents, like respondents in the control community, were found to favor growth. The strongest difference that emerged between community values was that respondents from Livingston perceived their community as an undesirable place to raise children and to have a happy life.

The impact of the Livingston derailment was found to have consequences similar to those documented for other technological accidents (most notably the 1979 Mississauga, Canada, train derailment), in that increased awareness within the Livingston area suggests that a collective concern regarding potential technological dangers permeates perceptions of the desirability of residing in this community [22].

In summary, the results of the Livingston-control community comparative analysis identified specific differences between these two communities. The observed differences support the assertion that the Livingston community was characterized by a long-term impact which was defined negatively by respondents. The specific nature of this negative impact appears to focus on a consistent definition of the Livingston area as an undesirable place to live. The indicators of such a definition range from "desires to move" to "increased perceptions of the risk of exposure to pollution" from hazardous waste sites and the "contamination of drinking water". These empirical results strongly suggest community consensus regarding continuing fears and concerns about family and personal safety.

Collective stress

The next stage of the analysis involves the development of a series of regression models used to identify characteristics within the Livingston community which predict various indicators of collective stress. Table 1 presents a regression model predicting respondents' desires to move out of the community. Distance from derailment and number of days evacuated provided the strongest direct predictors of desires to move away. The closer respondents were to the impact site and the longer the respondents were evacuated from their homes, the greater were their desires to leave the community. Married respondents and males also tended to have desires to move more so than their unmarried and female counterparts. The coefficients for these variables were not as strong as those observed for distance from derailment and number of days evacuated. The two family separation variables were found to have statistically insignificant effects.

TABLE 1

Standardized regression coefficients for out-migration desires of Livingston respondents ($N=225$)

Predictor variables	Standardized beta	Level of significance
Distance from derailment	0.168	0.025
Marital status	0.126	0.058
Sex	0.119	0.066
Number of days evacuated	0.146	0.050
Family separated at derailment	0.084	0.215
Family separated during evacuation	0.039	0.569
$R^2=0.112$		

TABLE 2

Standardized regression coefficients for "being upset" at the time of the accident: for Livingston respondents ($N=228$)

Predictor variables	Standardized beta	Level of significance
Distance from derailment	0.198	0.008
Sex	0.208	0.001
Number of days evacuated	0.090	0.214
$R^2=0.121$		

TABLE 3

Standardized regression coefficients for perception of "the railroad as a present threat" for Livingston respondents ($N=215$)

Predictor variable	Standardized beta	Level of significance
Distance from derailment	0.144	0.065
Number of days evacuated	0.082	0.294
$R^2=0.039$		

The next model was calculated for the item that measured the respondents' perceptions of being upset at the time of the accident (Table 2). Significant effects were observed for male respondents and for distance from derailment. Males and respondents residing closest to the derailment were most upset at the time of the accident.

Two variables were entered in the regression equation dealing with the indicator that the railroad was perceived as a present threat. The findings of

TABLE 4

Standardized regression coefficients for perception of the derailment as "a threat to family's safety" for Livingston respondents ($N=215$)

Predictor variable	Standardized beta	Level of significance
Distance from derailment	0.188	0.012
Number of days evacuated	0.214	0.004
$R^2=0.121$		

TABLE 5

Standardized regression coefficients for perception of "increased chance of getting cancer" for Livingston respondents ($N=157$)

Predictor variable	Standardized beta	Level of significance
Number of days evacuated	0.176	0.049
Distance from derailment	0.096	0.284
Family separated at derailment	0.052	0.505
$R^2=0.061$		

Table 3 reveal one significant effect; respondents living farthest from the derailment site perceived significantly less threat from the railroad.

Two predictor variables (distance from derailment and number of days evacuated) were entered into the regression equation with the dependent variable that asked respondents for their perception of the derailment as a threat to their families' safety. Both variables were statistically significant in predicting the perception of the accident as being a threat to family safety (Table 4).

Perceptions of health risk

The final stage of the analysis provides regression models which identify characteristics within Livingston that predict indicators of health risk perceptions. These indicators are perceptions of: (1) the increased chances of getting cancer; (2) the risk of air pollution exposure; and (3) the risk of exposure to drinking water contamination.

Table 5 examines Livingston respondents' perceptions of an increased chance of getting cancer. The number of days evacuated is the only independent variable to show a significant effect. Those respondents who were evacuated for longer periods of time showed a greater perception of increased cancer risk than those respondents who were evacuated for shorter periods.

Tables 6 and 7 provide the results of the multiple regression analysis for the perceived risks of exposure to two types of technological hazards. The first risk

TABLE 6

Standardized regression coefficients for perceptions of "risk of air pollution" for Livingston respondents ($N=201$)

Predictor variable	Standardized beta	Level of significance
Distance from derailment	0.198	0.015
Family separated at evacuation	0.139	0.048
Number of days evacuated	0.030	0.720
Sex	0.063	0.361
$R^2=0.067$		

TABLE 7

Standardized regression coefficients for perceptions of "risk of drinking water contamination" for Livingston respondents ($N=203$)

Predictor variable	Standardized beta	Level of significance
Distance from derailment	0.232	0.002
Number of days evacuated	0.172	0.023
Family separated during evacuation	0.145	0.028
$R^2=0.152$		

item was concerned with perceptions of the likelihood of being exposed to air pollution within one year from the date of the interview (Table 6). The results indicate that distance from derailment and family separated during the evacuation had a significant influence on Livingston residents' perceptions of air pollution risk. Respondents living closer to the derailment site and those whose family was separated during the evacuation perceived a greater risk from air pollution than respondents who were farther from the site and had their family intact during the evacuation.

For the perceived risk of exposure to drinking water contamination, all three predictor variables were found to be significant (Table 7). The strongest direct effect was observed for distance from derailment, followed by number of days evacuated and by family separation during the evacuation. Respondents who were closest to the derailment site, evacuated for the longest time periods, and who were separated from family members during the evacuation perceived the greatest risks for experiencing contamination of their drinking water.

Summary and discussion

The results of the multiple regression analysis clearly suggest that household location (relative to the derailment site) was the most important character-

istic for predicting the intensity of the derailment impact. Distance from the derailment was found to have the most consistent and the strongest effects across the dependent variables that were analyzed. Respondents from households closest to the derailment site were more likely to: (1) desire movement out of the Livingston community; (2) be among the most upset at the time of the accident; (3) perceive the railroad line as being a present threat; (4) perceive the derailment as a threat to their families' safety; (5) be the most pessimistic about being fully compensated by the railroad for their losses; (6) perceive the community as not being a good place to raise children; and (7) have the perceptions of greatest risk exposure to air pollution, drinking water contamination, and pollution from hazardous waste sites. Within the evacuation area, it is clear that the greatest negative impact was experienced by people residing closest to the site of the accident.

The demographic characteristic that appears to be the second most important for predicting intensity of disaster impact is the number of days evacuated. Respondents who were evacuated for the longest time periods were found to: (1) desire movement out of the community; (2) perceive the derailment as a threat to their families' safety; (3) perceive an increased chance of getting cancer as a result of the accident; and (4) perceive an increased chance of having their drinking water contaminated within the next year. Thus, negative effects of the derailment were also heightened for those people evacuated for the longest periods of time.

The third most important demographic characteristic for increasing the negative impact of the derailment was the separation of family members during the evacuation period. Respondents who had experienced separation from family members during this time period were found to: (1) have the strongest perceptions that the Livingston community was not a good place to raise children; (2) have the greatest fear of exposure to drinking water contamination within the next year. It should also be noted that respondents who were separated from family members at the time the evacuation orders were received also perceived increased risks of exposure to air pollution within the next year. These findings suggest that the separation of family members at the time evacuation orders were received and throughout the evacuation period also influenced the negative impact of the derailment.

The three characteristics that were most important for determining the relative negative consequences of the derailment (distance from derailment, number of days evacuated, and family separation during evacuation) reflect the location and nature of the technological accident itself. Demographic characteristics of the Livingston evacuation area appear to have been of less consequence for increasing or decreasing the negative impacts of the accident. However, some general observations can be made. First, males and married respondents indicated that they desired to move more than did females or respondents who were not married. Second, females, more than males, reported

that they were more upset at the time of the accident. Third, more educated respondents were more pessimistic than were less-educated respondents about ever knowing the full extent of pollution and about receiving full compensation for losses. These patterns were the only relevant effects found for the demographic characteristics of the community itself. This analysis strongly suggests that the negative effects of the derailment emerged primarily from situation [21] and personal factors related to the time and location of the accident.

This research documents that technological accidents have identifiable long-term negative social psychological impacts on communities. Such impacts are often overlooked by "stakeholders" who are active participants in litigation activities. In particular, class-action litigation which is uniquely associated with technological accidents [23]. The focus of many of these litigation proceedings involves assessing economic impacts. Such economic assessments usually require straight forward and visible indicators of economic liability. Given our results (and the utilization of these and similar results in mitigating a court settlement between the Livingston community and the railroad carrier), it appears that the so-called "intangible effects of technological disasters", i.e., sociological and psychological impacts, can be measured, evaluated and translated into meaningful forms of compensation to appropriate community members [21].

In summary, our results signal an important need for the utilization of applied social science methodologies by the legal system to mitigate both short-term and long-term negative impacts of technological accidents for victims residing in affected communities. Such impacts are real and should be assessed on a case by case basis.

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References

1 R.R. Dynes, Organized behavior in disaster, D.C.: Heath and Company, Lexington, MA, 1970.

2 E.L. Quarantelli and R.R. Dynes, Editors' introduction, American Behavioral Scientist, 13(3) (1970) 326–330.

3 F.L. Ahearn, Man-made and natural disasters: A comparison of psychological impacts, Paper presented at the American Public Health Association, Los Angeles, CA, 1981.
4 A. Baum, R. Fleming and J.E. Singer, Stress at Three Mile Island: Applying psychological impact analysis, In: L. Bickman (Ed.), Applied Science Psychology Annual, 3, Beverly Hills, CA, 1982, pp. 217–248.
5 D.A. Gill, A disaster impact assessment model: An empirical study of a technological disaster, (dissertation) Department of Sociology, Texas A&M University, College Station, TX, 1986.
6 A. Baum, R. Fleming and J.E. Singer, Coping with vitimization by technological disaster, J. Social Issues, 39(2) (1983) 117–138.
7 M.R. Fowlkes and P.Y. Miller, Love canal: The social construction of disaster, federal emergency management agency, Washington, DC, 1982.
8 D.A. Gill and J.S. Picou, Toxic waste disposal sites as technological disasters, In: D. Peck (Ed.), Psychosocial Effects of Hazardous Toxic Waste Disposal on Communities, Charles C. Thomas, Springfield, IL, 1989.
9 M.K. Goldhaber, P.S. Houts and R. DiSabella, Moving after the crisis: A prospective study of Three Mile Island area population mobility, Environ. Behav., 15(1) (1983) 93–120.
10 K. Erikson, Everything in its path: Destruction of community in the Buffalo Creek Flood, Simon and Schuster, New York, NY, 1976.
11 A. Maslow, Motivation and Personality, Harper, New York, NY, 1954.
12 L. Rangell, Discussion of the Buffalo Creek disaster: The course of psychic trauma, Am. J. Psychiatry 133(3) (1976) 313–316.
13 A. Levine, Psychological impact of toxic chemical waste dumps, Environ. Health Perspectives, 48 (1983) 15–17.
14 P.S. Houts, T.W. Hu, R.A. Henderson, P.D. Cleary and G.K. Tokahuta, Utilization of medical care following the Three Mile Island crisis, Am. J. Public Health, 74(2) (1984) 140–142.
15 G.K. Tokuhata, Three Mile Island health effects research program, Proceedings of the Pennsylvania Academy of Science, 54 (1980) 19–21.
16 C.B. Flynn, Reactions of local residents to the accident at Three Mile Island, In: D.L. Sills, C.P. Wolf and V.B. Shelanski (Eds.), Accident at Three Mile Island: The Human Dimension, Westview Press, Boulder, CO, 1982.
17 A. Campbell, The sense of well-being in America: Recent patterns and trends, McGraw-Hill, New York, NY, 1981.
18 E.C. Tolman, Psychological man, J. Social Psychol., 13 (1941) 205–218.
19 F.A. Deseran, Community satisfaction as definition of the situation: Some conceptual issues, Rural Sociol., 43(2) (1978) 235–249.
20 J.S. Picou, Ecological, physical, economic, sociological and psychological assessment of the Illinois Central Gulf train derailment, Vol. 5: Sociological Assessment, Gulf South Research Institute, Baton Rouge, LA, 1984.
21 D. Rosebrook and J.S. Picou, A review of litigation activities associated with a technological accident: A summary of court-ordered research findings, Paper presented at the annual meetings of the Southern Sociological Society, Atlanta, GA, April, 1991.
22 Institute of Environmental Studies, The Mississauga evacuation, final report, University of Toronto, Toronto, Ont., 1981.
23 P. Shrivastava, Bhopal: An anatomy of a crisis, Harper and Row, Cambridge, MA, 1987.