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Dynamic Risk Perception in Two Communities: Risk Events and Changes in Perceived Risk

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ABSTRACT *This paper examines the relationship between perceived risk and hazard events in two communities in terms of the perception and acceptability of risk. One community experienced an acute risk event comprised of a fire at a chemical plant that resulted in a large-scale evacuation (an acute hazard). The other community was involved in a seven-year controversy over the siting of a hazardous waste incinerator (a chronic risk). While the results are broadly consistent with a learning model of perceived risk, the support is more limited than envisioned; hence, the static forces of risk perception are stronger than anticipated.*

Introduction

This paper addresses the nature and extent to which perceived risk responds to risk events in two communities with distinct environmental hazard profiles. Odessa is a city of 89 000 people in West Texas, while La Porte is a city of 30 000 along the Houston Ship Channel. The economy of both cities, like that of the state, depends heavily on the petrochemical industry. On 20 August 1992, residents of Odessa experienced a fire, triggered by lightning, in the Champion Chemical Facility. The plume associated with this fire resulted in an evacuation that involved nearly a third of the community. This event is considered an acute hazard occurrence in that it began in the early-morning hours, people were subsequently evacuated and returned to the area before noon that same day. Residents of La Porte experienced a dramatically different risk event. People in La Porte have been involved in an ongoing controversy concerning a proposed hazardous waste incinerator since 1986. The principal concerns involved the location and effectiveness of the incineration process being proposed. Hence, the risk event in La Porte was principally chronic and ongoing. This paper examines the effect of these dramatically different risk events on the public's perception of risk. Specifically two fundamental research questions are addressed: (1) does the nature of the risk events produce different public responses? and (2) what is the character of the effects?

Lawless (1977) examined 45 case histories of technology leading to social shock. One of the most frequent mechanisms he found to be involved in regulating technology involved trigger events that tended to sensitize the media

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and the public to the potential for harm. Often these early warnings are missed in the sense that the use of the technology continues to grow after the initial concerns are raised. Lawless (1977, p. 490) found that over half of the technologies examined were employed "with less than adequate responsibility by its users". Most of these occurred after initial concerns were raised. In nearly two thirds of the cases, new research concerning the technology "played an important or central role in the discovery that a threat existed" (p. 491). What usually happened, according to Lawless (1977, p. 508), is that risk events often trigger initial public concern and media attention which seldom lead directly to threat reduction; but rather, "public concern very often led, after a time, to a hearing by a government agency...and sufficient publicity resulted from this platform of expression, that change was initiated".

People in distant locations are at least as concerned, sometimes more concerned, than people residing near hazardous facilities (Lindell & Earle, 1983; MacGregor *et al.*, 1994). In examining why people residing near nuclear power plants estimate risk at lower levels than people living further away, Rogers (1984) was unable to reject an economic dependence and experience hypothesis. The experience hypothesis posited that, in the period prior to the Three Mile Island accident, relatively low occurrences of risk events in the nuclear industry was interpreted in the context of daily activity as low risk. Meanwhile non-neighbours estimated risk at higher levels because the relatively few events associated with nuclear energy that they became aware of were negative. This paper examines the processes by which people learn about risk in the context of two distinct types of risk events: an existing acute risk; and a potential chronic risk. This paper examines the former in terms of risk estimates among people living near a potentially hazardous facility that recently experienced a risk event, while the latter examines a contentious siting process of a hazardous waste incinerator.

The predominant literature on risk perception examines risk from a static point of view. Certainly the experimental risk perception literature examines risk as if it were a snapshot at a particular time (Slovic *et al.*, 1986; Slovic, 1992; McDaniels *et al.*, 1995). The cultural literature focuses on the underlying values associated with risk perception and thereby considers risk perception from a relatively stable foundation (Douglas & Wildavsky, 1982). The social structural perspective on risk perception explicitly incorporates experience into the models that impact perceived and acceptable risk (Rogers, 1983), unfortunately most of the data used to test these models is cross-sectional. This is not to say that these literatures presume that risk perception remains constant, in fact the implicit assumption of risk communication, at least in the early days, was that risk perception could be changed (Covello & Allen, 1988; Fischhoff, 1995) if people were given additional information. Later on, the goal of risk communication focused more on the process of incorporating public interests in decisions involving risk (Krimsky & Plough, 1988). In each of these literatures there are discussions of increased or decreased risk perception, but the fundamental nature of the perspective is static. For example, Wildavsky (1988) argues that risk policy should rely more on trial and error, but does not address how people learn from the risk experience associated with trial and error. It is certainly reasonable to assume that people can and do learn about risk, otherwise survival of the species would be difficult. But yet there is little scientific research that addresses this process. In contrast, this paper focuses on the dynamics of risk

Table 1. Chronology of an acute hazard in Odessa, Texas, 20 August 1992

Time	Description
4.53 a.m.	Fire department receives call that lightning has struck storage tank at Champion Chemical
5.10 a.m.	Firefighters arrive on scene, not enough water to safely fight fire
5.30 a.m.	Holiday Inn Centre (3.9 km downwind) evacuated
6.10 a.m.	Emergency Operations Center (EOC) activated
6.20 a.m.	General evacuation began
6.30 a.m.	Evacuation zone expanded to University and areas south of 42nd St (6.6 km N) and east of Shepperd Pkwy (5.0 km W)
8.30 a.m.	Elementary School evacuated
9.25 a.m.	Another Elementary School evacuated
9.30 a.m.	Emergency workers report plume moving north of 42nd and west of Dawn Ave (11.0 km W); 116 residents of nursing home evacuated
9.50 a.m.	Evacuation zone expanded to Grandview Ave (8.9 km W); ~30% of geographic area where 27 000 of 89 000 people in Odessa reside; 54 people treated for watering eyes, burning skin and breathing difficulty
10.42 a.m.	Evacuation lifted
10.45 a.m.	Evacuation centres notify all clear
11.15 a.m.	EOC closes

perception in the light of the risk events occurring in two communities, where the salience of these risk events is greatest.

This study takes advantage of research conducted in the Spring of 1992 on perceived and acceptable risk in two Texas communities. These pre-event survey data are used in a panel design by re-interviewing respondents in Odessa and La Porte, Texas, in the Spring of 1993. This paper analyses the effect risk events have on perceived risk in terms of the perceived risk prior to and after the fire and subsequent plume in Odessa, and 1992 and 1993 in the on-going controversy in La Porte.

The Risk Events

Two risk events are examined herein. The chemical plant fire in Odessa, Texas, occurred, presenting an acute risk event, or hazard, to the community (summarized in Table 1). Unlike this risk event, where the facility existed and a hazard occurred, the siting controversy in La Porte, Texas (summarized in Table 2) represents a potential facility, where the risk cannot be materialized, because it does not exist. The hazardous waste incinerator controversy remains a risk event in that it sets the conditions under which future hazards can materialize. Moreover, the event directly addresses the nature of hazards and risks in the community. If the controversy only communicates with the public about risk, it would be considered a risk event. These two risk events are summarized below.

Table 2. Chronology of a siting controversy in La Porte, Texas

Date	Description
1986	HCS files for hazardous waste incineration permit
1986	Non-binding referendum passes 3 to 1 against permit and the use of municipal tax dollars to oppose HCS facility
1986	Harris County joins opposition to permit
1989	Formal hearing process begins
1990 (9 Feb)	TWC evidentiary hearing closed with opposition focused on technical feasibility and locational proximity
1990 (13 July)	TWC hearing examiner recommends permit denial, cites problems with: (1) incinerator design; (2) siting; (3) waste analysis; (4) financial assurances; and (5) air emission uncertainties HCS complains that TACB engineer's testimony dismissed City of La Porte cites problems: (1) location; (2) no construction or operation plans; and (3) HCS's president signed and stamped engineering drawing without review (violating TWC rules)
1990 (13 Aug)	Chartered bus takes residents to TWC hearing in Austin; TWC postpones decision after five hours of testimony
1990 (11 Sept)	TWC votes 2 to 1 to grant provisional approval of permit. HCS announces it will continue to pursue damages against La Porte for trying to annex site (between $10–20 million); HCS estimates construction spring 1991, and operation one year later
1990 (Sept)	Opposition mounts: (1) La Porte ISD passes resolution opposing incinerator; (2) San Jancinto CC Board of Regents oppose incinerator; (3) Bay Shore National Bank gives $1000 to citizens groups opposing incinerator; and (4) US Rep. Mike Andrews writes EPA asking for review
1990 (26 Sept)	TWC postpones final approval 12 minutes into proceedings
1990 (16 Oct)	HCS promises consideration of alternative sites
1990 (17 Oct)	TWC votes 3 to 0 to approve final permit; TWC denies 4 motions for retrial
1990 (Oct)	Four parties allowed to file appeal with Travis County District Court, but four plaintiffs found ineligible. City and county file appeal based on defendant's attorney working for TWC at time of permit application. Travis County District Judge Williams rules against city and county, but criticizes TWC staff for not taking a stand on the issuance of the permit. TWC Staff come back one week later to strongly state opposition to permit and ask Williams to reverse the earlier TWC decision
1992 (7 July)	Judge Williams rules in favour of HCS's motion to strike TWC staff letter of opposition
1992	Four plaintiffs file in the Court of Appeals (case pending at time of survey)

A Chemical Plant Fire

At 4.53 a.m. on 20 August 1992 the Odessa Fire Department received its first report of lightning striking a fibreglass storage tank at the Champion Chemical facility in Odessa, Texas. At 5.10 a.m. firefighters arrived at the scene, but did not have enough water to maintain a safe fire fighting operation. By 5.30 a.m. the Holiday Inn Centre, approximately 3.9 km downwind (Figure 1), was evacuated as the thunder storm moved out of the area. At 6.10 a.m. the Emergency Operations Center was activated, and by 6.20 a.m. the evacuation began. By 6.30 a.m. the evacuation area was expanded to include the university and the residential areas south of 42nd Street (approximately 6.6 km north of the facility) and east of the John Ben Shepperd Parkway (approximately 5.0 km west). At

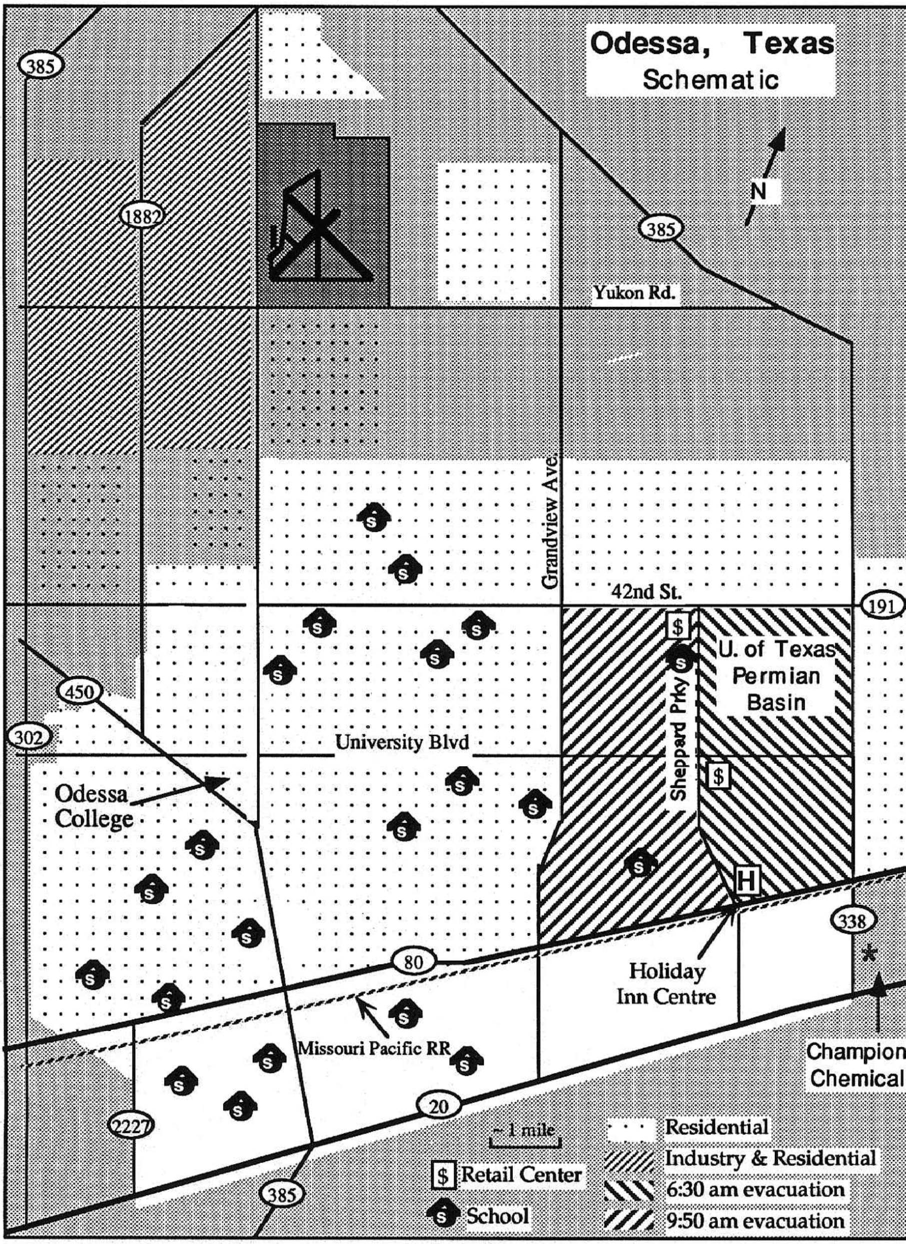

Figure 1. Schematic of Champion Chemical location and evacuation on 20 August 1992.

8.30 a.m. an elementary school was evacuated, and by 9.25 a.m. another elementary school was evacuated. At 9.30 a.m. emergency workers reported the plume was moving north of 42nd Street and east of Dawn Avenue (approximately 11.0 km downwind); 116 residents of a nursing home were evacuated. At 9.50 a.m. the evacuation area included all areas east of Grandview Avenue (approximately 8.9 km downwind).

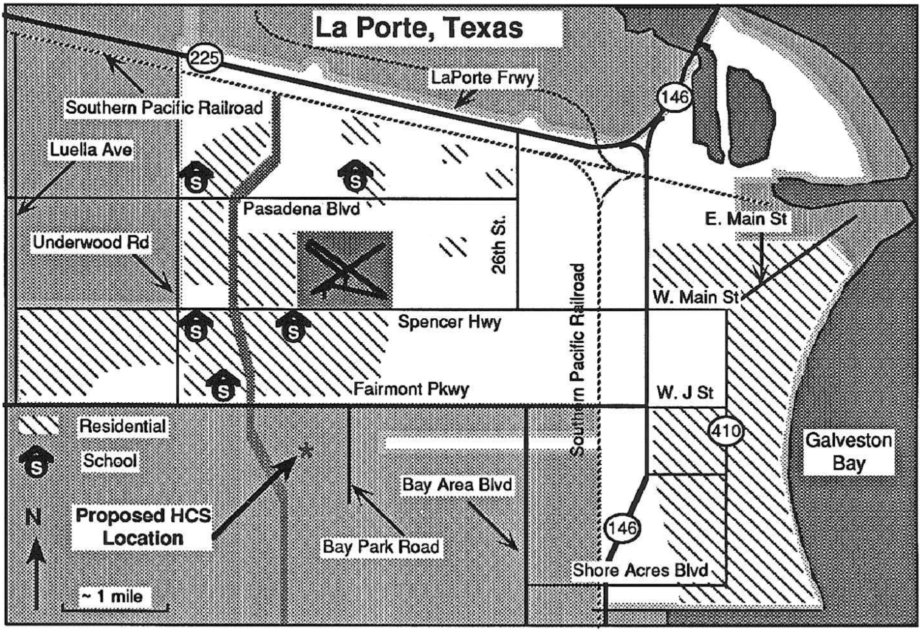

Figure 2. Schematic of proposed HCS incinerator location.

The evacuation area, like most of Odessa, is predominantly residential with strip shopping districts along major streets. The resulting fire and explosions forced the evacuation of around 30% of the geographic area of the city, where an estimated 27 000 of the 89 000 people in Odessa live. In addition, an estimated 550 businesses as well as one university, two elementary schools, one nursing home, two motels[1] and two shopping centres were evacuated; 54 people were treated for watering and burning eyes, itching skin and breathing difficulty at the local hospital.

A Siting Controversy

In 1975 Quaker Oats built a facility which produced alcohol from rice hulls at 12901 Bay Park Road, just off the Fairmont Parkway, between Bay Park Road and Big Island Slough in La Porte, Texas (Figure 2). By the end of 1978 the facility was in operation, but the subject of more or less continuous public concern with noxious emissions and odour. The production process left residue that essentially destroyed the equipment itself, and as a consequence the facility closed for economic reasons in 1983. In the spring of 1984 Quaker Oats sold its chemical division, and the site remained unoccupied for a time.

The facility on Bay Park Road was eventually sold to Houston Chemical Services (HCS) who filed for a permit to build and operate a hazardous waste incinerator at the site in 1986. On 1 June 1986, the City of La Porte entered into an agreement with Southern Ionics Inc. and HCS that precluded it from regulating the business on the property, and hence from trying to control the proposed incinerator at the site. Apparently both parties to the agreement thought the site was part of the Bayport Industrial District; however, the boundary of that district is some 400 feet away. Hence, the proposed facility would be in the City of La Porte's extra-territorial jurisdiction, and subject to its rules of operation. By 1990 the City of La Porte was attempting to annex this area in an attempt to control the site's use.

On 13 July 1990 the Texas Water Commission (TWC) examiner Bill Zukauckas issued a 300-page report on the permit. The report recommended that the permit be denied, because of problems with incineration design, siting, waste analysis, operating financial assurance uncertainties and uncertainties about air emissions. On Tuesday 11 September 1990 in Austin, Texas, the TWC questioned the staff of the Texas Air Control Board regarding the design of the incinerator and the test burns to establish the incinerator's ability to operate within existing emissions standards. The testimony indicated that the proposed incinerator could operate within the parameters of the permit. Citing the state's need for more incinerators and the Texas Air Quality Control Board's very strong position that air emission standards can be met, the TWC voted two to one in favour of the permit. The TWC asked that the final permit be prepared by the TWC's staff for formal approval on 26 September 1990, which was delayed until 3 October and later postponed until 10 October 1990. The permit was issued for a 10-year period beginning 10 December 1990 and expiring at midnight 10 December 2000.

Reaction to the vote was immediate and strong. Representatives of Harris County, the City of La Porte and citizens were critical of the permitting process, the reliance on full-scale trial burns to establish emissions compliance, and the rejection of the recommendation of the Commission's own examiner. On 28 September 1990 Bayshore National Bank presented the Citizens for Quality Environment with a check for $1000 to cover expenses related to their continued opposition of the HCS incinerator. Later that evening, the La Porte Independent School District met in special session and voted unanimously to strongly oppose the issuance of a permit to HCS. On 1 October 1990 the San Jacinto College Board of Regents unanimously passed a resolution opposing the permit application. On 10 October 1990 a chartered bus full of La Porte residents in opposition to the HCS incinerator crowded the meeting room in Austin, Texas, more than 150 miles away, only to have the TWC reach a decision just 12 minutes into the meeting to delay the final decision on the HCS permit. On 17 October 1990 the TWC voted unanimously to approve the permit. When the district attorney for Harris County was not allowed to address the commission, the hearing room erupted in protests, prompting the chair to clear the room with Capitol security officials. Within 24-hours, people opposed to the incinerator announced a rally to be held on 1 November 1990. On 4 November 1990, the *Bayshore Sun*[2] reported that 1500 people attended the community based rally that featured 25 elected officials and their representatives opposing the HCS plan to build and operate a hazardous waste incinerator at the former Quaker Oats site.

Motions for re-hearing were filed within a month, by the city and county, a state representative and a resident of a nearby residential area. These motions raised 427 different points in which they contend that the TWC made errors in the conduct of the hearing. More than 250 of these claim that various parts of the permit's approval were not supported by substantial evidence presented in the hearing process. However, the TWC let the motions be "overruled by operation of law" without a public deliberation and decision on the motions. Meanwhile, local officials were attempting to enlist the assistance of the US Environmental Protection Agency (EPA), with meetings in mid-November with regional officials, and written documentation of concerns in early December. In early January 1991 the regional administrator of the EPA wrote that the TWC's regulations were at least equivalent to the EPA's standards, and that the EPA has delegated permitting authority to the TWC with just a few exceptions related to the Hazardous and Solid Waste Amendments of 1984.

By January of 1991, the City of La Porte and Harris County had filed suit in Travis County District Court in opposition to the TWC permit for the HCS incinerator. That opposition was based partly on the participation of the former executive director of the TWC when HCS applied for the permit, his continuation in that post for more than a year while it was under consideration, and his subsequent resignation and employment as an HCS attorney. On 16 April 1991, the State Senator from the area filed a Bill in the State Legislature directly aimed at stopping the HCS incinerator. By mid-March 1991, the City of La Porte had authorized the expenditure of nearly a million dollars in their opposition to the incinerator. By June of 1991, the entire composition of the TWC had changed; the two Commissioners that initially voted in favour of the permit had resigned; the Chair of the TWC at the time of the vote resigned to assume a position with the US EPA; and in the Fall of 1991 the third Commissioner died.

By the end of September 1991, the District Court had set a date of 14 October to begin the hearing process; subsequently this hearing was postponed until 25 November and then cancelled and rescheduled for 13 January 1992. But once again the hearing was rescheduled to 23 January and later cancelled. On 21 February 1992, the judge heard motions from both sides. On 24 February the judge ruled that the City of La Porte could no longer participate in the opposition to the HCS incinerator, because of their previous agreement with the company. Meanwhile, on 16 March 1992 residents of a nearby residential area presented HCS with a petition calling for the revocation of the hazardous waste permit on the grounds of failure to comply with the terms of the permit; that petition was filed with the TWC on 1 April 1992. On 15 June 1992, in nearly 9 hours of testimony, the judge was highly critical of the Attorney General's Office for their declared active neutrality in the case in spite of the fact that the TWC was named as a defendant in the case. On 24 June the Attorney General's Office presented the judge with a letter admitting 70 allegations contained in the appeal, and asked the judge to reverse the original order granting the permit, and render a decision denying the original HCS application altogether. In a letter dated 7 July 1992, the judge ignored the request to reverse and render, and pointed to substantial evidence in the record to support the TWC's decision to grant the permit, and thereby upheld the permit. When the appeal was filed with the Texas Court of Appeals the TWC joined the litigants against the HCS permit. While the courts ruled in favour of HCS, the delays associated with litigation may require HCS to request a renewal of the permit prior to beginning operations at the facility. Moreover, the composition of the TWC has completely changed and current members have voiced concerns with HCS's current permit. Hence, while the company won the permitting battle, they may choose not to operate the incinerator, in part because of the delays and the initial 10-year operation window.

Data and Methods

Sampling

A survey was conducted between 23 February and 7 April 1992. This survey addressed the public perception of the risks associated with two types of technological facilities: hazardous waste and energy production.[3] Seven independent samples represent households in the United States, the State of Texas and five communities therein; each sample was a random-digit-dialled sample of working residential blocks in the telephone exchanges associated with the municipalities where a specific facility (i.e. hazardous waste storage, incinerator, transport depot, or a nuclear- or coal-fired electrical generation facility) was located. The survey was conducted using a computer-aided telephone-interviewing system and interviews lasted an average of 28 minutes. Each survey addressed the respondent's assessment of the likelihood of accidents and favourability associated with various conditions of operation for the three types of hazardous waste facilities (i.e. storage, incineration and transportation) and three types of electrical generation facilities (i.e. coal-fired and nuclear-powered steam generation, and a hypothetical wind-farm). In addition, respondents where asked about the facility in the community that presented the greatest risk to the public. This question became the foundation for the comparison of risk attitudes associated with a specific facility prior to the events described above.

The 1992 surveys in Odessa and La Porte form the initial base of data reported herein. In the Spring of 1992 surveys, 70.3% ($n = 244$) and 63.7% ($n = 239$) of the respondents completed the items regarding the likelihood of risk in Odessa and La Porte, respectively. These respondents were re-interviewed between 18 April and 18 May 1993, and new respondents were added to replace those lost by attrition. In Odessa, a 62.6% response rate overall[4] resulted in a sample of 283 respondents in Odessa with a sample precision, e (i.e. where $e = 1/\sqrt{n}$), of $\pm$5.9%. In La Porte, a 69.6% response rate overall[5] resulted in a sample of 287 interviews with a sample precision, e, of $\pm$5.9%. The interviews took an average of 23 and 24 minutes to complete in Odessa and La Porte, respectively.

Measurement

The likelihood of risk is examined in the Spring of 1992 and a year later in 1993. In Odessa, this is before and after the events of 20 August 1992. In La Porte, this is two consecutive years near the end of a long contentious public permitting process. In Odessa, there was no way of knowing which facility would have the fire and resulting emergency when the Spring of 1992 survey was conducted. While in La Porte it was theoretically knowable, the HCS controversy was not included in the 1992 survey. Some respondents (19 in Odessa and 60 in La Porte) told us in 1993 that they had the specific reference facility (i.e. Champion or HCS) in mind in 1992 as the riskiest facility in the community. Even though all respondents rated the likelihood of the risk (of exposure) associated with the riskiest facility, only those referring to the reference facility could be considered specifically related to the risk events. Hence, in Odessa, four-fifths of the responses (98) were retrospective, while in La Porte only a fifth (17) of the responses were retrospective.

Perception of risk is assessed in terms of three items assessing the perceived likelihood of risk, and eight items addressing various conditions of acceptability.

First, people were asked to rate "the chance that the Champion Chemical Facility [in Odessa, or "if an incinerator operated by HCS in La Porte was built"] would have a significant release of potentially toxic materials" on a five-point scale from very unlikely to very likely, with a 50–50 chance mid-point. In addition, respondent's were allowed to respond spontaneously that the event had already occurred or "could not happen" or "never will occur". The categories were arbitrarily assigned equidistant values between zero and one (i.e. 0.17 is very unlikely, 0.33 is unlikely, 0.50 is a 50–50 chance, 0.67 is likely, 0.83 is very likely and 1.0 is already occurred). This Likert scale treats likelihood as a seven-point approximation of the probability of occurrence with spontaneous end-points, which, because it has many interval characteristics, can be analysed as if it is interval. Unfortunately, this scale is somewhat insensitive to subtle changes in perceived risk, because changes have to be interpreted in terms of the underlying scale to be meaningful. Changes in underlying category result when the likelihood scale changes more than half the distance between arbitrary points on the likelihood scale (i.e. increases or decreases of approximately 0.08 points). A binary representation is used so that significant changes in the proportion of respondents estimating risk as greater than a 50–50 chance can be observed and reported. This binary measure also allows the examination of potential biases introduced by the fact that the arbitrary coding of a Likert type ordinal scale technically remains ordinal. Since there is a direct correspondence between a 50–50 chance and a likelihood of 0.5, codes greater than 0.5 may be considered likely (1) while all other responses may be considered not likely (0).

Second, respondents were asked to identify the riskiest facility in the respective community. In 1993, respondents who mentioned the reference facility were coded one, all others were coded zero. Because the reference facilities were unknown in 1992, respondents who spontaneously mentioned the reference facility as the most risky in 1993 were asked if this was "the same facility you had in mind when we talked last spring?" Operationally, the number of people spontaneously selecting the reference facility as the riskiest in 1992, is smaller than the number of respondents making that selection in 1993. Hence, the operational definition only allows risk to increase, which means no directional test is appropriate. People who responded positively were coded 1, while all other responses were coded 0. Third, respondents were read a randomized list of three facilities and asked to identify the riskiest and the least risky facility among those listed. The most risky response reflects the designation of the facility as the most risky relative to the others listed. A complete ranking of the three facilities listed was achieved by assigning the rank of the reference facility: 1 if selected as the most risky facility, 3 if selected as the least risky, or 2 if not selected as either most or least risky.[6] The perceived likelihood and the riskiest facility operationalization of perceived risk tap the catastrophic potential of hazardous events. Gregory & Mendelsohn (1993, p. 263) found that catastrophic potential, along with three other factors "strongly influence the ratings of dread and perceived risk associated with technologies, products and activities".

Perceived risk in the community was more generally assessed in terms of potential risks associated with power plants and hazardous waste facilities located in the community. Specifically, people were asked to rate the risks associated with a nuclear, a conventional and a wind-farm power generation facility, and a hazardous waste storage, incinerator or transport facility in the community. Each was assessed in terms of chronic-ongoing risks associated with routine operations, and the acute-catastrophic risks associated with accidents. The items used to assess the generalized risk in the community were randomly presented.[7] In addition, respondents were asked to assess eight conditions of acceptability. These randomly presented items were rated in terms of favourability.[8] Because the 1992 survey did not address chemical plants these questions were addressed only in the 1993 survey. However, the hazardous waste incinerator questions were asked in the 1992 and 1993 surveys in both communities.

Methods

When any variable is monitored over time, the amount of change in that variable may be characterized as:

$$y_1 = a + b_1 x_0 + e \tag{1}$$

where y_1 is the current value of the variable, a is the intercept, x_0 is the value of the variable being monitored at the previous time and e is a random error term. Hence x and y are the same variable at two times, $t = 0$ and $t = 1$. The slope b_1 of equation (1) is interpreted as the change in the variable associated with time. If the slope b_1 is not significantly different from 0, then y_1 is approximately equal to the intercept a and both are approximately equal to x_0. That is, there is no change in the underlying variable. To examine the amount of change in the risk estimates between the 1992 and 1993 surveys, let y equal the 1993 risk estimate, and x be the 1992 estimate. The following simple regression equation results:

$$y_{93} = a + b x_{92} + e \tag{2}$$

To examine the difference in the amount of change associated with some situational attribute Z, equation (2) becomes:

$$y_{93} = a + b_1 x_{92} + b_2 Z + b_3 Z x_{92} + e \tag{3}$$

where b_2 modifies the intercept for having the attribute, and b_3 modifies the slope of the equation for those cases with attribute Z. For example, if Z is residing in the impact zone, this tests for a difference in the change associated with living in the impact zone.

To test the impact of the two situations described above in terms of residing in Odessa or La Porte and residing in the impact zone on the adjustment process, the risk estimates are estimated in terms of:

$$\begin{aligned} y_{93} = {} & a + b_1 x_{92} + b_2 Z + b_3 Z x_{92} + b_4 O \\ & + b_5 O x_{92} + b_6 Z O + b_7 Z O x_{92} + e \end{aligned} \tag{4}$$

where y_{93}, a, x_{92} and e are defined as in equation (2) and Z is 1, if the respondent lives in the impact zone, or else Z equals 0, and O is 1 if the respondent lives in Odessa, and 0 if the respondent resides in La Porte. The intercept a is modified by b_2, b_4, and b_6 for residing in the impact zone, Odessa, and both the impact zone and Odessa, respectively. The amount of change b_1 is modified by b_3, b_5 and b_7 associated with these three situational attributes, respectively.

These terms may be thought of as modifications to the adjustment process. People living in the impact zone in Odessa, would be expected to have different estimates of the likelihood of risk. Increased estimates would most likely be associated with the occurrence of the fire, and subsequent emergency, and its direct salience for people in the zone. Similarly, a feeling of enhanced security may be associated with observing the emergency system swing into action on 20 August 1992, which would in turn reduce risk estimates. Alternatively, those people residing outside the zone of impact may experience an enhanced feeling of invulnerability, precisely because it did not impact their area. In La Porte the change may be associated with the risk communicated during the controversy.

Findings

More than two out of three respondents (66.7%) in Odessa, and seven out of 10 respondents (70.3%) in La Porte, indicated that their estimates of the likelihood of risk had changed during the study period. But this also means that one-third of the people in Odessa (33.3%) and three in 10 in La Porte (29.7%) said they had not changed their perception of the risks associated with the reference facility.

Change in risk perception before and after risk events is examined in terms of the specific facility, other potential facilities in the community and the conditions of acceptability for potentially risky facilities. Table 3 presents the specific *t*-tests concerning the reference facility in each community (i.e. Champion Chemical in Odessa and HCS in La Porte). The likelihood that Champion Chemical would release significant toxic materials was seen to be only 0.002 higher in 1993 than it was in the spring of 1992. Moreover, the proportion of respondents estimating the likelihood as above a 50–50 chance increased only 0.011. Neither the estimated likelihood or the proportion estimating the risk as being greater than a 50–50 chance had significantly changed between the 1992 and 1993 surveys. This is contrasted with the situation in La Porte, where both the likelihood estimate and the proportion estimating the likelihood as greater than a 50–50 chance of an HCS incinerator exposing residents had significantly increased. The average likelihood had increased by 0.054 points to 0.617, which is less than a category of measurement (i.e. the two nearest categories used for measuring likelihood were 0.05 = 50–50 chance, and 0.667 = likely). However, the proportion estimating the likelihood above a 50–50 chance increased almost a quarter from nearly 6 out of 10 respondents to more than 3 out of 4 respondents.

Meanwhile, among those respondents that selected the reference facility in both surveys, only La Porte showed significantly different risk estimates. Because of the limited number of respondents in this category in Odessa this non-significant finding is not surprising. In La Porte, the likelihood estimate increased by 0.09, reaching nearly a three-fourths chance of occurrence. The proportion of respondents in La Porte that placed the likelihood above a 50–50 chance increased 0.30 to approximately nine out of ten respondents.

The proportion spontaneously selecting the reference facility as the most risky facility in the community (compared with all facilities in the community) was significantly higher in both communities in 1993. In Odessa, 2.9% of the respondents selected Champion Chemical in 1992, but 13.6% selected it in 1993. This amounts to a 10.7 percentage point increase, but only 15 additional people that selected the Champion Chemical facility in 1993. In La Porte, 11.8% of the respondents said HCS was the most risky in 1992, but in 1993 nearly 3 out of 10 (29.6%) selected HCS as the most risky facility in the community. This amounts to a 17.7 percentage point increase, or 36 respondents that selected the HCS facility in 1993 that did not select it in 1992. Meanwhile, the proportion of

Table 3. Difference of means *t*-tests on specific facility

		Spring 1992	Spring 1993	Mean difference
Odessa				
Specific risk[a]	*N*	116	95	91
Likelihood estimate	Mean	0.524	0.540	0.002
	Std dev (α)	0.290	0.300	ns
Proportion > 50–50	Mean	0.371	0.411	0.011
	Std dev (α)	0.485	0.495	ns
Most risky: absolute	*N*	140	140	140
	Mean	0.029	0.136	0.107
	Std dev (α)	0.167	0.344	(0.000)
Most risky: relative	*N*	209	203	199
	Mean	0.134	0.167	0.030
	Std dev (α)	0.341	0.374	ns
Rank[b]	*N*	210	203	200
	Mean	2.14	2.06	− 0.080
	Std dev (α)	0.625	0.627	(0.049)
Odessa				
Specific risk[a]	*N*	18	10	10
Likelihood estimate	Mean	0.556	0.617	0.017
	Std dev (α)	0.243	0.273	ns
Proportion > 50–50	Mean	0.389	0.500	0.316
	Std dev (α)	0.502	0.527	ns
La Porte				
Specific risk[a]	*N*	128	132	105
Likelihood estimate	Mean	0.635	0.678	0.054
	Std dev (α)	0.207	0.180	(0.016)
Proportion > 50–50	Mean	0.586	0.773	0.238
	Std dev (α)	0.494	0.421	(0.000)
Most risky-absolute	*N*	203	203	203
	Mean	0.118	0.296	0.177
	Std dev (α)	0.324	0.457	(0.000)
Most risky: relative	*N*	201	205	181
	Mean	0.542	0.556	0.006
	Std dev (α)	0.499	0.498	ns
Rank[b]	*N*	201	205	181
	Mean	1.59	1.55	− 0.039
	Std dev (α)	0.716	0.674	ns
La Porte (before–after only)				
Specific risk[a]	*N*	50	38	33
Likelihood estimate	Mean	0.677	0.741	0.091
	Std dev (α)	0.200	0.114	(0.002)
Proportion > 50–50	Mean	0.660	0.895	0.303
	Std dev (α)	0.479	0.311	(0.001)

[a]Specific risk at Champion Chemical in Odessa and HCS in La Porte, where 0.17 is very unlikely, 0.33 is unlikely, 0.50 is a 50–50 chance, 0.67 is likely, 0.83 is very likely and 1.0 is already occurred (spontaneous).

[b]Rank is the respondent's rating of Champion Chemical in Odessa and Houston Chemical Services in La Porte as most or least risky of three specific facilities (i.e. most risky = 1; least risky = 3; or else rank = 2).

respondents selecting the reference facility from a short list of three specific facilities as the most risky failed to increase significantly in either community.

Finally, the rank of the reference facility relative to the three listed facilities increased significantly in Odessa, but failed to change significantly in La Porte. In Odessa, the average ranking decreased from 2.14 in 1992 to 2.06 in 1993 (i.e. 1 is the most risky and 3 is the least risky). This 0.08 change is significant at the 0.049 level. Hence, Champion Chemical was viewed as more risky relative to the listed facilities in 1993 compared to 1992, while HCS was not ranked as significantly more risky in the 1993 than in the 1992 survey.

In all, seven tests were conducted involving the risk associated with the reference facility in 1992 and 1993. In Odessa, only two of these tests indicated significantly different risk perception among our respondents. Granted, two of these non-significant difference findings most assuredly stem from small sample size; ignoring these still leaves only two of five tests indicating significant change between the two surveys. In La Porte, five of the seven *t*-tests indicated significant change in the period.

Table 4 summarizes the results of the *t*-tests regarding the extent to which generalized risk was impacted by risk events in Odessa and La Porte. These tests attempt to understand the extent to which risk events associated with a specific risk, impact perceptions of other risks present (and not present) in the community. In Odessa, only three of 12 indicators of generalized risk were found to be significantly different ($\alpha < 0.05$) in the 1993 survey from the risks estimated in the 1992 survey. The risks associated with nuclear power plants, both chronic and acute, declined by just over five percentage points, while the acute risk associated with wind-generation decreased almost five percentage points. An additional two items are marginally significant ($\alpha < 0.1$) including the chronic risks associated with coal-fired electrical generation and waste transport. In La Porte, only one risk was found to be significantly different ($\alpha < 0.05$); the acute risks associated with waste incinerators in general increased nearly seven percentage points. Three additional items were marginally significant ($\alpha < 0.1$), including both the acute risks associated with coal-fired and wind-farm electrical generation, and hazardous waste storage.

Table 5 presents the conditions of risk acceptability associated with facilities like the reference facilities. The amount of change in sentiments concerning hazardous waste incinerators is tested in La Porte, which reflects a specific test of the reference facility. But because of the nature of the 1992 data in Odessa, the changes in the conditions of acceptability associated with chemical plants were not available in Odessa. Instead the conditions of acceptability associated with hazardous waste incinerators are examined. Interestingly, only continuous monitoring, requiring emergency plans and community advisory boards are favoured on average in either community. In Odessa, the acceptability of reducing income taxes for nearby residents is marginally ($\alpha < 0.1$) more favourable in 1993 than in 1992. Meanwhile in La Porte, the acceptability of asking for scholarships shifted significantly ($\alpha < 0.05$) from favouring asking for scholarships toward neutrality. In addition, requiring continuous monitoring shifted marginally ($\alpha < 0.1$), while staying near favouring it leaned toward strongly favouring.

Table 6 presents the simplified general linear models for each risk estimate. Most importantly, three terms in equation (4) are found to have no significant impact on the current estimates of risk, given the prior estimates: (1) saliency in terms of living in the impact 'zone', (2) residing in 'Odessa' and being exposed

Table 4. Difference of means *t*-tests on generalized risk

	Spring 1992			Spring 1993			Difference		
	N	Mean	SD	*N*	Mean	SD	*N*	Mean	(α)
Odessa									
a. Chronic coal fired	219	0.552	0.223	180	0.469	0.215	96	−0.049	0.074
b. Acute coal fired	214	0.452	0.225	179	0.403	0.210	91	ns	
c. Chronic incinerator	212	0.546	0.209	187	0.511	0.226	103	ns	
d. Acute incinerator	221	0.538	0.209	192	0.526	0.237	108	ns	
e. Acute nuclear plant	223	0.519	0.230	187	0.453	0.244	110	−0.056	0.050
f. Chronic nuclear plant	223	0.519	0.225	187	0.459	0.218	104	−0.067	0.014
g. Acute waste storage	219	0.543	0.218	188	0.533	0.221	106	ns	
h. Chronic waste storage	221	0.577	0.211	189	0.553	0.227	107	ns	
i. Chronic waste transport	219	0.544	0.204	187	0.518	0.214	103	0.049	0.085
j. Acute waste transport	220	0.577	0.207	198	0.544	0.207	111	ns	
k. Acute wind farm	208	0.438	0.219	176	0.389	0.207	92	0.049	0.044
l. Chronic wind farm	200	0.390	0.193	179	0.399	0.202	92	ns	
La Porte									
a. Chronic coal fired	218	0.595	0.204	190	0.596	0.210	123	ns	
b. Acute coal fired	209	0.502	0.211	180	0.494	0.218	111	0.044	0.067
c. Chronic incinerator	220	0.636	0.197	206	0.647	0.177	137	ns	
d. Acute incinerator	223	0.610	0.219	207	0.692	0.174	135	0.067	0.001
e. Acute nuclear plant	207	0.544	0.225	198	0.596	0.234	122	ns	
f. Chronic nuclear plant	216	0.544	0.226	195	0.567	0.226	123	ns	
g. Acute waste storage	221	0.630	0.193	205	0.676	0.164	134	0.035	0.082
h. Chronic waste storage	224	0.641	0.201	205	0.680	0.166	131	ns	
i. Chronic waste transport	220	0.606	0.195	209	0.640	0.184	137	ns	
j. Acute waste transport	225	0.644	0.207	214	0.659	0.178	139	ns	
k. Acute wind farm	198	0.410	0.201	177	0.389	0.199	104	−0.042	0.096
l. Chronic wind farm	183	0.388	0.196	167	0.422	0.204	96	ns	

to the actual events of 20 August 1992; and (3) living in the 'impact zone in Odessa'. Hence the expectation that people in Odessa would learn or adjust their risk estimates to account for the information associated with the emergency were not supported. Moreover, those people residing in the zone, in either city, would be expected to adjust their risk estimates most, but this too is not supported by this test. Finally, people residing in the evacuation zone in Odessa failed to learn or adjust their estimates of risk in many significantly different ways from those people outside the evacuation zone.

Discussion

While the acute risk events in Odessa would certainly be considered candidate trigger events *à la* Lawless (1977), with definite potential for change in the political or regulatory framework, this can only happen if public concern is altered. Because the support for fundamental change in perceived risk associated with the acute events of 20 August 1992 is rather limited, risk events such as these may not be triggers for regulatory change. Conversely, the incinerator controversy in La Porte not only created greater change in public concern but also led to a resolution in the courts. The findings herein are consistent with

Table 5. Difference of means *t*-test on conditions[a] of acceptability

	Spring 1992			Spring 1993			Difference	
	N	Mean	SD	*N*	Mean	SD	*N*	Mean α
Odessa								
1. Developing/having	204	3.36	1.04	192	3.40	0.94	109	ns
2. Offering tax incentives	207	3.06	1.10	183	2.98	1.07	110	ns
3. Requiring continuous monitoring	210	1.95	0.57	200	1.99	0.53	115	ns
4. Requiring emergency plans	211	1.93	0.54	198	1.94	0.45	116	ns
5. Community advisory boards	212	2.08	0.66	201	2.02	0.60	115	ns
6. Ask for scholarships etc.	204	2.60	0.97	185	2.70	1.05	107	ns
7. Reduced taxes for residents	203	2.98	1.03	187	3.16	1.00	109	−0.12 0.051
8. Authority to residents	212	2.64	1.00	189	2.56	0.98	111	ns
La Porte								
1. Developing/having	208	3.91	0.832	202	3.91	0.82	128	ns
2. Offering tax incentives	205	3.42	1.07	185	3.60	0.90	115	ns
3. Requiring continuous monitoring	206	1.79	0.50	199	1.88	0.60	127	0.12 0.071
4. Requiring emergency plans	209	1.82	0.52	201	1.88	0.49	131	ns
5. Community advisory boards	209	1.87	0.54	200	1.90	0.50	129	ns
6. Ask for scholarships etc.	203	2.31	0.93	194	2.60	1.04	127	ns
7. Reduces taxes for residents	203	2.65	1.04	191	2.64	1.04	119	ns
8. Authority to residents	206	2.51	1.02	195	2.41	0.911	124	ns

[a]Conditions of acceptability of hazardous waste incinerator facilities in Odessa and La Porte were rated on a five point scale: (1) strongly favour; (2) favour; (3) neither favour or oppose; (4) oppose; and (5) strongly oppose. Unfortunately because chemical plants were not part of the 1992 study, the specific facility differences cannot be examined in Odessa. Conditions of acceptability associated with hazardous waste facilities for both communities are presented.

Lawless (1977) who found that, in the majority of the cases examined, trigger events such as accidents and early concerns alone are not sufficient impetus to change the regulatory environment. The early warnings that tend to stimulate public concerns to a level that leads to a public platform (e.g. public hearings, Congressional hearings and debates, media coverage) are more likely to lead to an ultimate resolution of the concerns. The findings are consistent with Lawless (1977) in that events that become part of an ongoing pattern are more likely to lead to enhanced public concern. So what leads some situations to public concern, controversy and resolution, while others characterized by risk events fail to trigger public concern in an appreciable manner?

In Odessa not only was there no pattern of accident or hazard for the 20 August 1992 fire to fit into, but the fire being ignited by lightning allowed the public to think of the event as an 'Act of God' rather than a technological failure where humans can act to prevent the occurrence. In addition, even though the fire in Odessa resulted in a large evacuation, there were no deaths and only

Table 6. Regression test of change in risk estimates from 1992 to 1993 survey

	Risk likelihood			Estimate > 50–50 chance		
	b	*β*	*t*	*b*	*β*	*t*
$Risk_{92}$ estimate	0.337	0.336	5.12	0.147	0.151	3.37
In Odessa	− 0.514	− 1.00	− 10.0	− 0.699	− 0.717	− 12.0
In Zone		ns			ns	
In Zone: $risk_{92}$		ns			ns	
Odessa: $risk_{92}$	0.751	0.994	9.59	0.872	0.694	9.23
In Zone: Odessa: $risk_{92}$		ns			ns	
$Risk_{92}$: retrospective[a]	− 0.108	− 0.140	− 3.15	− 0.162	− 0.160	
Constant	0.516	0.000	12.0	0.717	0.000	16.0
R^2		0.757			0.637	
Adj R^2		0.752			0.630	
Model probability		0.000			0.000	

[a]Those people reconstructing 1992 risk estimates retrospectively coded 1, people giving 1992 estimates for reference facility in spring 1992 survey coded 0.

limited injuries. This could well signal an adequate overall hazard management, in terms of emergency preparedness and response that is capable of protecting the public from such unfortunate events. Finally, the evacuation in Odessa can be interpreted as leaving the public in control; the people are able to make decisions (i.e. to evacuate or not) that bear directly on their own safety. In short they can do something to protect themselves. But in La Porte, people find themselves unable to constantly intervene in the generation of stack emissions. These occur on an ongoing basis, where they have little control, and their only recourse is to remove themselves permanently from the threatened area. Even if they are able to move, the overall value of the real estate declines due to market pressures created by an increased supply in that neighbourhood. Hence, proposed chronic hazards, such as incinerators, engender another motivation for increased public concern.

One compelling approach to regulating risk involves trial and error, rather than trial without error (Wildavsky, 1988). The trial and error approach searches for safety by allowing trials or experience to accumulate so that society can learn from the errors. This treats risk regulation much like a child learning not to touch a hot burner. The pain of the burn acts as a natural feedback system advising the child not to touch the burner in the future. Moreover, as long as the trial is not life-threatening, the child learns to avoid this risk in the future. In fact Wildavsky (1988, p. 26) argues that incremental errors "are welcomed so long as they are small and diverse" and not cumulative or catastrophic, because this is how people and societies learn about hazards. The trial and error strategy for risk management depends on learning; in fact, learning is the corner-stone of the trial and error strategy. But what happens to this strategy if people do not learn when hazards occur, as suggested by the events examined herein? It could be argued that exactly appropriate learning took place, inasmuch as there were no deaths and limited injuries associated with the fire of 20 August 1992. It could also be argued that one event does not form a pattern of either high risk or poor risk management. The natural research questions that cannot be addressed herein are how many events form a pattern that can lead to a regulatory transformation platform? How serious do they need to be to engender change in risk policy? Conversely, how effective can trial and error be as a risk management strategy, when as these findings suggest, public concerns are raised by controversies about potential risks of proposed facilities? This actually amounts to a kind of error without trial, rather than Wildavsky's nemesis, trial without error. That is, public concern is created by the mere proposal of a facility. On the surface this seems to be simply trial without error, but the results herein suggest that people are learning from these risk events, so the experience is accumulating without trial, but it is not an actuarial experience. Hence, the implications for this study, while preliminary, seem to run exactly counter to the effective use of a trial and error risk management strategy, particularly in cases where Wildavsky (1988) seems to be suggesting a larger role for trial and error: diverse, dispersed, moderate to low risk hazards.

Conclusions

The results are broadly consistent with a learning model; however, inasmuch as there was limited change observed in Odessa the support for learning is also limited. Only two of the five *t*-tests concerning the specific facility found significant differences in the level of concern after the fire and subsequent emergency on 20 August 1992. Meanwhile in La Porte, all but two of the specific facility tests found significant differences between the 1992 and 1993 surveys. These changes or adjustments were not widely generalized to other types of risks either currently present in the community or hypothetical risk posed for the community. Only three of 12 *t*-tests concerning generalized risk in Odessa showed significant differences, while only one of 12 *t*-tests showed significant differences in La Porte.

Because perceived risk was adjusted in La Porte during the period, but was not significantly altered in Odessa, the amount of change was significantly different in the two comparison communities. In fact the results indicate that for all potential values of risk (i.e. between 0 and 1), the best estimate in Odessa is essentially the 1992 risk estimate, but in La Porte the regression estimate is greater than the 1992 perceived risk, except for extremely large values (i.e. greater than 0.7 for risk estimates, or 0.85 for estimates above a 50–50 chance). Even though it can be argued that these results are consistent with a Bayesian learning model, there are no significant model adjustments associated with being in the zone of impact. This indicates that learning is selective, but that the selection criteria are not particularly related to salience.

These results suggest that even though they are consistent with a Bayesian learning model, there is a strong suggestion that learning does not occur in any predictable manner examined herein. These results also indicate that there is a strong component of inertia holding perceived risk at stable preconceived levels. Moreover, when changes in perceived risk do occur in Odessa, during the emergency, they quickly revert to previous levels. Yet in La Porte, the prospect of a proposed chronic hazard seems to form a platform for continued exposure to and accumulation of risk events that lead to increased concern. One clear message is that once a public platform for public participation is established, an active role in disseminating information concerning safety is required to balance the experience associated with negative publicity which is often the focus of media attention. Even though it is difficult to imagine a static risk perception, these results suggest that the static forces in risk perception observed in this research are stronger than anticipated.

The current paper is clearly important in that it reflects public risk estimates associated with concrete risk experience, and real life risk prospects in two communities. It is also significant in that it pursues a topic that has limited attention, namely dynamic risk perception. Even though this study is not limited to laboratory experiments with hypothetical risks and limited subjects, it must be considered exploratory. First, it can hardly be considered definitive in that it represents but two communities' experience with risk events. Second, while the samples involved are representative of the communities involved, the samples also present the most important limitation of this research. The sheer lack of cases forecloses the possibility of exploring potentially fruitful investigations into the nature of the process, the demographic profile of people selecting different learning paths and the social processes involved in the variations of adjustment to risk events. Put simply, larger samples would be extremely helpful. Third, these results can be criticized for being predominantly retrospective. This is a fundamental limitation of not controlling the risk events, but that is the nature of the phenomena under study. So, even if large empirical panels can be established for communities with potentially hazardous facilities, by not knowing which facility will have significant risk events in the future, the researcher is unable to establish effective before–after empirical data. Fourth, because this study chooses to represent actual risks in real communities, a 'broad-net' approach was used to increase the likelihood of forming a panel. That is, people were asked very limited information about many risks, rather than a lot about a few risks. While this is a reasonable approach in that it allows the exploration to take place, it also has its drawbacks. Perhaps the most important among these is the inability to fully represent perceived risk in a multidimensional way. In spite of these distinct limitations, this study represents the beginning of an important area of research that addresses changes in perceived risk associated with actual risk events in existing communities.

Four types of future research on the dynamic aspects of perceived risk are envisioned: (1) large-scale comparative retrospective surveys; (2) panel surveys in communities likely to experience risk; (3) experimental studies focused on change in perceived risk; and (4) focused panel studies in communities receiving specific risk information. Large-scale retrospective studies in communities where risk events have occurred allow the research to study a specific single risk in-depth, examine its dynamics via a tracing method, and compare the dynamics with communities without direct experience with the risk event. Panel studies in communities likely to experience risk events can achieve a comparative before–after research design for relative risks which are salient in the communities. Experimental studies can control the events surrounding risk events, but must simulate the risk events themselves. Panel surveys focused on communities receiving risk information allow the greatest amount of control in a field setting, but these studies need to focus both on the risk communication processes and the dynamics of perceived risk. For a field of study that is a quarter of a century old, risk analysts know remarkably little about how perceived risk changes in the face of risk events. This paper represents one of the first steps toward a better understanding of the processes by which people adjust their perceptions of risk. This important area of risk study requires much greater attention in the future.

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Notes

1. A small motel is located across the street from Champion Chemical.
2. The *Bayshore Sun* is the local bi-weekly newspaper in the city of La Porte. The author wishes to thank the Editor-Publisher John Black for his extensive co-operation in providing articles and information for this paper. This summary relies extensively on newspaper accounts of events attained primarily from articles originally published in the *Bayshore Sun*.
3. These data were collected under a grant from the Co-ordinating Board for Higher Education in Texas, Advanced Research Program (hazardous waste) under Grant No. 999903–225, and the Center for Energy and Mineral Resources, Texas A&M University, College Station Texas (energy resources).
4. Of the 244 initial respondents in Odessa, 127 completed the entire questionnaire in 1993, and 147 completed the risk items on the survey instrument, resulting in a 50.2% and 70.3% completion rate, respectively. To replace respondents lost to attrition, an additional 334 households were randomly selected. Of these 158 telephones were eliminated due to being disconnected, associated with a business or government, no answer on at least five separate occasions, a non-working telephone number or similar result; of the remaining 176 households, 136 respondents completed interviews in Odessa, yielding a 77.3% response rate among replacements. This results in a 62.6% response rate overall (i.e. completed interviews divided by the number of completed interviews plus refusals = (127 originals + 136 replacements)/(244 + 176)).
5. Of the 239 initial respondents in La Porte, 146 completed the entire questionnaire in 1993, and 168 completed the risk items on the survey instrument, resulting in a 61.1% and 70.3% completion rate, respectively. To replace those lost to attrition, an additional 262 households were randomly selected. Of these, 120 telephones were eliminated due to being disconnected, associated with a business or government, no answer on at least five separate occasions, a non-working telephone number or similar result; of the remaining 142 households, 119 respondents completed interviews in La Porte, yielding an 83.8% response rate among replacements. This results in a 69.6% response rate overall (i.e. completed interviews divided by the number of completed interviews plus refusals = (146 + 119)/(239 + 142)).
6. The ranking measure poses a theoretically superior method of assessing relative risks in a community. A complete ranking of all facilities in the community could be done. In the event that any facility on the list experienced an accident, the research could examine the subsequent change in ranking. However, this approach has serious methodological problems. It would be difficult for communities with large numbers of facilities because of the extreme demands placed on respondents (i.e. the more facilities to be ranked the greater the demand on respondents). While meaningful ranking might be achieved in personal (i.e. face-to-face) interviews, or perhaps in mail surveys, it would be nearly impossible to achieve a meaningful ranking in telephone interviews given large numbers of extant facilities. However, each of these communities have many facilities that would qualify by most criteria, and the surveys were conducted via telephone.
7. Respondents were asked: for each of the following situations please tell me whether you think it is very likely, likely, about a 50–50 chance, unlikely, or very unlikely that it will occur in your lifetime? How likely is it that:
   - air pollution from routine releases from a coal-fired power plant will cause respiratory diseases among people living nearby?;
   - an explosion at a coal-fired power plant will injure nearby residents?;
   - routine air-borne releases from a hazardous waste incinerator will cause life threatening lung diseases among nearby residents?;
   - an explosion at a hazardous waste incinerator exposes nearby residents to toxic materials?;
   - a major accident at a nuclear power plant releases significant radioactive fallout?;
   - routine releases from a nuclear facility will cause life threatening diseases among nearby residents

- a fire at a long term waste storage facility will release hazardous materials contaminating nearby communities?
- seepage from a long-term storage facility for hazardous waste will cause life threatening diseases among nearby residents?;
- an accident at facility processing hazardous waste for transportation (to an incinerator) exposes residents to toxic materials?;
- a truck transporting hazardous waste crashes exposing residents to toxic materials?;
- a fire starts at a wind farm (that produces electricity) resulting in nearby homes being destroyed?;
- electrical magnetic fields around wind-powered generators will cause potentially life threatening diseases among nearby residents?

8. Respondents were asked: do you strongly favour, favour, oppose, or strongly oppose:
   - (developing) *a hazardous waste incinerator* in your community?;
   - offering tax incentives to companies that operate *a hazardous waste incinerator*?;
   - requiring continuous monitoring of releases for air pollution from *a hazardous waste incinerator*?;
   - requiring emergency plans to deal with potential accidents at *a hazardous waste incinerator*?;
   - requiring community advisory boards to keep the public informed about developments at *a hazardous waste incinerator*?;
   - asking *a hazardous waste incinerator* to do things like provide college scholarships, recreational areas, or improved roads?;
   - giving people living near *a hazardous waste incinerator* reduced tax rates?;
   - giving people living near *a hazardous waste incinerator* authority to change the way the facility operates to improve safety?

These items were repeated by replacing a hazardous waste incinerator with a chemical plant in the 1993 survey.

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