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Applying a community resilience framework to examine household emergency planning and exposure-reducing behavior among residents of Louisiana's industrial corridor

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Abstract

Residents facing environmental hazards can take steps to reduce their exposure risks, and these actions may be considered adaptations that can enhance the overall resilience of communities. Applying concepts from social-ecological resilience theory, the authors examine emergency planning and exposure-reducing behaviors among residents of the upper Industrial Corridor of Louisiana, and explore the extent to which the behaviors are associated with key theoretical influences on community resilience: exposure, vulnerability, and the "adaptive capacity" of residents. The behaviors of interest are adoption of a household emergency plan in the case of acute exposure events (like chemical spills), and limiting outdoor activities in response to Air-Quality Index (AQI) reports, thus potentially reducing chronic exposure risks. Statistical analyses indicate that adaptive behaviors are associated both with greater exposure to hazards and confidence in one's knowledge and ability to reduce exposure risks. Thus, the study yields evidence that "adaptive capacity" is particularly relevant to understanding and encouraging household emergency planning. Residents who believe that they are well-informed about risk-reducing strategies, regardless of education or income, were found to be more likely to have adopted these measures. Evidence that knowledge and confidence levels are linked to adaptive behaviors is good news for those working in public education and outreach programs, as these are attitudes and skills that can be nurtured. While factors associated with exposure and vulnerability to hazards are difficult to change, knowledge of risk-reducing strategies and confidence in one's abilities to reduce exposure risks can be improved through well-designed public education efforts.

Keywords

emergency planning; exposure reduction; adaptive behavior; environmental hazards; community resilience; risk exposure; socioeconomics; vulnerability

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Introduction

The social-ecological resilience literature provides insight into sources of community resilience in the face of various environmental hazards and offers a useful framework for the examination of adaptive behaviors among residents. Researchers have identified as attributes of more resilient communities higher levels of scientific understanding of hazards, more opportunities for stakeholders to "self organize" and share information, and an ability to learn from past events and to take adaptive measures to reduce risks in the future (1,2,3). Adaptations may be made both collectively and individually by members of the community in order to limit or mitigate the impacts likely to result from future disturbances to the system. These disturbances may be either abrupt, suddenly occurring events like an industrial plant explosion or a hazardous materials spill, resulting in acute exposure risks, or more slow-moving disruptions like diminished air quality, leading to potentially chronic exposure risks.

Limiting environmental exposure risks is a relevant topic to residents and policy makers of Louisiana's upper Industrial Corridor, where the post-WWII years brought rapid growth in oil and gas extracting, refining and transporting, and in chemical manufacturing activities. Located along the Mississippi River, the Baton Rouge area is home to numerous petro-chemical manufacturing plants, two Superfund sites and multiple hazardous waste treatment, storage and disposal facilities (4), resulting in the potential for cumulative environmental exposure risks to residents. Encouraging behaviors to limit exposure to environmental hazards is an important public outreach goal since risks can be reduced through effective mitigation practices or they can be amplified by poor or non-existent efforts and practices (5).

The objectives of this study are to examine patterns of adoption of exposure-reducing strategies and behaviors among Baton Rouge residents. The behaviors of interest are adoption of a household emergency plan in the case of acute exposure events (like chemical spills), and limiting outdoor activities in response to Air-Quality Index (AQI) reports, thus potentially reducing chronic exposure risks. We apply concepts from the social-ecological resilience literature to identify and examine the potential influences of key contextual factors: indicators of exposure, vulnerability, and the ability of residents to adapt to hazardous conditions.

Thus, the theoretical framework to be applied considers resilience to be a function of these three influences:

Resilience = f(exposure, vulnerability, adaptive capacity)

Exposure refers to the types and intensities of hazards; *vulnerability* or sensitivity relates to aspects of the people, property and other assets in harms' way; and a*daptive capacity is* the ability of the community to adjust to changing threat levels of future disturbances, or to cope with the consequences of such events (6, 7, 8).

Information related to the nature of local environmental hazards is available to the public from a variety of sources including local news, state and federal government agencies, and non-governmental organizations. These include local air-quality forecasts concerning ozone and particulate matter, and public-service announcements encouraging residents to be prepared during and after environmentally hazardous events to reduce exposure risks (9, 10). However it is unclear the extent to which residents in industrialized areas such as Baton Rouge access this information, and then adopt strategies or change behaviors in order to reduce their exposure risks. A framework to better understand the conditions under which residents may be more likely to limit exposure risks would aid in the design of more effective emergency planning and environmental health outreach programs.

Related Research

An examination of recent related research from the community resilience literature and other studies concerning potential influences on individual or household-level adaptations to environmental exposure risks is informative.

Environmental conditions within communities provide an important context to residents' actions to reduce their exposure risks. Nelson, Adger, and Brown (11) propose that exposure to prior environmental emergencies and disasters may encourage adaptations among residents facing risks of similar events in the future. After experiencing such occurrences, residents may be more likely to remember the past emergencies and consequences, and therefore tend to perceive possible future events in less abstract terms. Other researchers point to a similar adaptive capacity among residents facing more chronic exposure risks, such as those associated with poor air quality. For example Wakefield and her associates determined that residents of communities with lower air quality will tend to modify their behavior in numerous ways including avoiding outdoor activities to reduce chronic exposure risks linked to air pollution (12).

Socioeconomic attributes of residents and communities also are relevant considerations. Several studies have yielded evidence of an inverse relationship between the socioeconomic vulnerability of residents and their ability to adapt to better withstand environmental threats. Socioeconomic vulnerability may be thought to include two elements: the degree to which a population is sensitive to damages associated with hazards and the ability of the community to respond to and bounce back or recover from the effects of the disturbance (8). Social vulnerability may result from many conditions, including lack of economic resources, limited access to political power and representation, the absence of social networks and connections, and the presence of frail and physically limited individuals (2, 13, 14, 15).

Overall community resilience is thought to be enhanced through stronger social networks, greater economic resources, and the capacity to identify and adopt effective strategies to mitigate risks (16, 17, 18, 19, 20). Access to technical information concerning exposure risks and steps that can be taken to reduce those risks may be particularly useful to lower socioeconomic residents. These residents may be at greater exposure risks from a variety of sources of hazardous wastes and other toxins within their neighborhoods (21). Additional research suggests that socioeconomic conditions may affect the confidence with which lower-income individuals judge the likely effectiveness of risk-reducing strategies in the work place (22). Further, researchers examining residents of the Mississippi Delta region found that less-educated individuals were less likely to be familiar with the government agencies and public policies designed to protect human health and environmental quality (23). As a result, they were less likely to be aware of or know how to access the information disseminated to the public by these state and federal government agencies.

Several recent studies have found that access to information concerning hazard levels and higher levels of awareness of environmental risks tend to encourage adoption of risk-reducing behaviors (24, 25, 26). For example, when attempting to encourage exposure-reducing behaviors among farm workers who use pesticides, Flocks and her colleagues found that higher knowledge levels and access to technical information were important factors in effective risk-reduction interventions (27). Similarly, researchers examining adaptive behavior to reduce risks associated with climate change, including implementing a household emergency plan and maintaining a first-aid kit, found that residents who reported having the necessary information concerning the risk and adaptive strategies to deal with potential heat waves and severe weather events were much more likely to have adopted the measures (28). Also, researchers examining public response to media alerts concerning air quality across six U.S. states found that over 30% of residents with asthma and 16% of those without asthma reported having changed outdoor behavior in response to increased information about local air conditions (29). Other researchers have found that when residents know more about the risks associated with air pollution and hazardous waste, and are more active in their communities, they tend to be less fatalistic about exposure risks (30).

In addition to knowledge and awareness of environmental hazards, perceived control over exposure risks appears to influence adoption of risk-reducing behaviors (31, 32). Individuals who perceive that they have more control over exposure risks have been found to worry less about the risk and express more confidence about living with the hazard (33).

Related research also includes several models or explanations of individual behaviors intended to protect or conserve natural resources or otherwise address specific environmental problems. Although we consider household emergency planning and exposure-reducing behaviors as somewhat distinct from environmental behaviors whose primary objective is environmental protection or natural resource conservation, some relevant insights are applicable from this research. Specifically, the extent to which individuals believe their actions can be effective in improving an environmental problem has been shown to be related to their actions (34, 35, 36, 37), and these attitudes are relevant to the “adaptive capacity” of residents to reduce environmental exposure risks. For example, Ajzen’s theory of planned behavior (TPB) considers individual actions to be influenced by the expected likely consequences of the action, the social value placed on these consequences, and the perceived ability to carry out the behavior (35).

Other theories of environmental behavior are summarized by Patchen (34) and include the value-belief-norm (VBN) model, introduced by Stern (36). This model assumes that individuals will implement pro-environmental practices if the action is consistent with his or her personal values, he or she believes inaction would lead to harm, and the potential action would be helpful or effective in avoiding that harm. Also, the “structural model” explanation of environmental behavior proposes that perceived control of the outcomes associated with

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the potential action is one determinant of the behavior, in addition to personal values, emotions and level of awareness of the issue or problem (38).

Additional insights concerning the adaptive capacity of residents are drawn from Heifetz and colleagues research into the nature of adaptive challenges facing organizations and communities (39). They distinguish “technical challenges”, wherein solutions based on current knowledge can be implemented by authorities, from “adaptive challenges”, which require new ways of looking at problems, with the community residents in this case being asked to take action to make themselves safer. The exposure-reducing challenges facing residents in Louisiana may be considered “adaptive” in nature because the locus of the work to be done and the responsibility to reduce exposure risks is at the stakeholder level – with some leadership and information provided by local government authorities. As Heifetz and colleagues point out, adaptive challenges often prompt resistance because the associated behavior changes require reconsiderations of established habits, cultural norms and values, and, also in this case, assumptions about safety and environmental quality in one’s community. Moreover, as residents consider assuming more responsibility for reducing environmental exposure risks, many may question whether they have the necessary technical knowledge and skills required to implement risk-mitigation measures.

This brief review of selected related research supports the inclusion and examination in this study of key contextual factors from the community resilience and adaptation theoretical framework. Specifically, exposure to environmental hazards, socioeconomic vulnerability of residents, and factors related to the “adaptive capacity” of residents - including access to information and personal attitudes - are important influences on the choices and behaviors of residents as they face environmental exposure risks in their communities.

Examining Household Exposure-Reducing Behaviors

The exposure-reducing actions considered in this analysis are use of and response to the daily Air Quality Index (AQI) and the adoption of a household emergency response plan.

Baton Rouge’s Air Quality Index (AQI)—Of the six EPA air quality standards - carbon monoxide, lead, nitrogen dioxide, ozone, particle pollution and sulfur dioxide - the most persistent challenge in Baton Rouge has been meeting federal ozone-attainment standards. Through combined efforts of residents and businesses in Baton Rouge, the city has been able to improve air quality over time. For example, in 2011 the area met for the first time the 1997 8-hour standard, as well as the 1-hour standard for ozone. Elevated levels of ground-level ozone present health hazards to residents; inhalation can cause inflammation of airways, coughing, throat irritation, shortness of breath, and decrease in lung function (40). . These risks are more pronounced in individuals with underlying respiratory problems.

The Air Quality Index (AQI) is disseminated by the Louisiana Department of Environmental Quality (LDEQ) and informs the public about the various health risks associated with prolonged exposure to air contaminants at various threat levels. The AQI reports provides daily forecasts concerning changing local conditions. The AQI is divided into six categories which correspond to specific levels of health concerns. The EPA has assigned a specific color to each AQI category to make it easier for people to understand quickly whether air pollution is expected to reach unhealthy levels in their communities. The AQI categories are shown in Table 1.

The Louisiana Department of Environmental Quality (LDEQ) provides daily AQI ratings and forecasts, accessible by internet or telephone. In Baton Rouge, local television and some radio news programs also announce the AQI forecast for the next day as a regular segment of weather reports. The LDEQ recommends that residents limit outdoor activity on lower air quality days and for people with respiratory problems to avoid going outdoors altogether. Reduced AQI reports and forecasts are not unusual occurrences in Baton Rouge. For example, the EPA reports that average AQI ratings during the month of May from 2006–2008 indicated that over one half of the days were classified as less than “good” (41).

Household Emergency Plans—The East Baton Rouge Mayor’s Office of Homeland Security and Emergency Preparedness provides information advising residents about appropriate actions to take before, during and after a public emergency event. During emergency events, residents may be ordered to evacuate the area or to remain in their houses or work places and “shelter in place”. The Office also provides guidelines and encourages residents to implement a family or household emergency plan in the case of a hazardous event. The suggested elements of such a household emergency plan are listed in Table 2. Environmental emergencies are not uncommon in the Baton Rouge area; for example the US Department of Transportation lists over 2400 incidents involving hazardous-material spills from transportation accidents and pipeline breaks in the state between 2003 and 2012 (42).

Methods

To gain insight into the factors that may influence adoption of exposure-reducing behaviors among residents of Baton Rouge, we applied concepts from the social-ecological resilience theoretical framework discussed above and compiled indicators of environmental exposure risks, socioeconomic vulnerability, and ability or capacity for reducing exposure risks.

Sixty-four attendees of three East Baton Rouge Parish Metropolitan Council meetings[1] participated in structured interviews. All elements of the study, including interview questions, securing of informed consent, and protection of data, were approved by the Institutional Review Board (IRB) of Louisiana State University. Respondents were selected solely on their willingness to participate and different public meetings in 2011 were chosen to ensure the inclusion of individuals from different communities within the parish (county). The interviewees were drawn from ten different zip codes within the East Baton Rouge Parish (county), however, because of the variation in the number of attendees at the district meetings, the interviewees were not equally distributed throughout the zip codes. Four researchers interviewed meeting attendees and each interview lasted approximately 30 minutes, although several interviewees did not provide responses to all of the questions. In

[1]According to their website “The Metropolitan Council acts as the governing authority for the City and Parish of East Baton Rouge. Its authority is exercised over the City and Parish general funds, all districts created by the Council, the Greater Baton Rouge Airport District, the Public Transportation Commission, the East Baton Rogue Parish Sewage Control Commission, and the Greater Baton Rouge Parking Authority. The Council acts as the official policy-making board for all of the above.” For additional information see: http://brgov.com/dept/council/

general, the interviewees were older, better educated, and more affluent than the average residents of the East Baton Rouge Parish. This is not surprising since the attendees of the monthly Metro Council meetings are by definition more involved in their communities; these are individuals with the time and resources to attend meetings and participate in civic affairs. Eighty percent were age 50 and older and close to 76% reported having at least an associate college degree, and 34% reported an annual household income of more than $66,000. Also, women made up 54% of the group and over 80% indicated that they had no children in the household.

The structured interviews included questions related to specific risk-reducing behaviors. Two dependent variables were derived from two of the questions in the interview: whether the respondent had adopted a household emergency plan and whether he or she had ever limited outdoor activities in response to Air Quality Index (AQI) forecasts. These two dependent variables were coded as either “0” or “1”, indicating a response of either “no” or “yes” to these questions.

Other variables derived from the interviews indicated potential exposure risks, socioeconomic vulnerability and capacity to avoid or reduce environmental exposure risks. The potential exposure risks were indicated by three variables; whether the interviewee had experienced an environmental emergency within his or her neighborhood within the past five years, the total TRI emissions, and the number of facilities permitted to use toxins within the interviewees’ zip codes. The TRI report and number of permitted facilities for the participants’ zip codes were obtained through the Environmental Protection Agency’s website (43). Vulnerability to environmental risks was indicated by education level and household income. Individual “adaptive capacity” was indicated by knowledge and confidence in one’s ability to reduce exposure risks, length of residency within the zip code (suggesting knowledge of local environmental hazards), and perceptions of local air quality. The variables included in the analysis are shown in Table 3.

We conducted a series of exploratory cross-tabulations using the Cramer’s V test statistic to identify associations between the dichotomous dependent variables indicating exposure-reducing behavior adoption, and the nominal and ordinal-level independent variables derived from the Likert-scale questions from the interviews. Also, we conducted Difference-of-Means t-tests to identify significant differences between groups in terms of the continuous variables, TRI emission totals, number of facilities permitted to handle toxins, and interviewees’ length of residence within their zip code.

Results

Although 55 of the 64 residents interviewed live in zip codes with facilities permitted to discharge toxins, only nine reside within a zip code that had at least one regulated facility with toxic discharges large enough to require annual reports of releases as part of the Toxic Release Inventory (TRI). The TRI program exempts from the annual reporting requirement those permitted facilities manufacturing or processing less than 25,000 pounds of TRI-listed chemicals, or otherwise using less than 10,000 pounds of these chemicals each year. Also a facility is exempted if the business employs less than ten full-time workers (43). Three interviewees declined to provide their zip code of residence.

Frequency of Adoption of Behaviors

Sixty-seven percent of the interviewees reported being aware of the daily Air-Quality Index (AQI) forecasts and 53.8% said that they check the forecasts at least “sometimes”. Thirty-six percent of the group reported having limited their outdoor activities on days with lower air-quality. Regarding adoption of a household emergency response plan, only 24% of the interviewees indicated that they have done so. Among the nine interviewees residing in zip codes with TRI-reporting facilities, 44.4% reported having a household emergency plan, whereas among those living in zip codes without TRI-reporting facilities, the adoption rate was only 20.8%. A cross-tabulation analysis indicates that the two exposure-reducing behaviors of interest - adoption of a household emergency plan and limiting outdoor activities in response to the AQI forecasts - are not significantly associated with each other among these residents.

Factors Associated with Limiting Outdoor Activities

The analyses yielded several statistically significant findings (Table 4). First, applying a Difference-of-Means t-test, we found significant differences between the two groups - those who had responded to AQI forecasts and those who had not - in terms of the total TRI emissions within their zip codes of residence ($t = -1.696$, $p < .10$, Table 5a) and the number of regulated facilities permitted to use toxins ($t = -1.988$, $p < .05$, Table 5b). Also, not surprisingly, those who reported more frequent checking of the AQI forecasts each week, were more likely to adjust their outdoor activities in response to the information (Cramer’s V = .521, $p < .025$, Table 5c) as well as those who perceive local air quality in general to be lower (Cramer’s V = .438, $p < .10$, Table 5d). Household income, age and gender were not found to be significantly associated with the reported responses to Air Quality Index forecasts.

Factors Associated with Adoption of Household Emergency Plans

The analyses yielded several associations between household emergency plan adoption and the independent variables (Table 4). First, the cross-tabs analysis detected a trend in the data (approaching statistical significance) suggesting that recent experience with an environmental emergency within one’s neighborhood may be associated with adopting a household emergency plan (Cramer’s V = .304, $p = .157$, Table 6a). Somewhat surprisingly one measure of vulnerability, educational attainment, was found to be negatively associated with household plan adoption (Cramer’s V = .415, $p < .05$, Table 6b). Regarding the potential influence of the “adaptive capacity” of residents, those who reported knowing whom to call to obtain instructions concerning an environmental emergency appear to be more likely to adopt a household plan (Cramer’s V = .387, $p < .025$, Table 6c). Similarly, those who believe themselves to be better informed in general concerning how to limit exposure risks during emergencies were found to be more likely to have adopted household emergency plans (Cramer’s V = .490, $p < .025$, Table 6d). Also, an association was found between more frequent checking of the AQI forecasts and planning for an environmental emergency (Cramer’s V = .514, $p < .025$, Table 6e). Finally, residents who have lived in their zip code longer are more likely to have adopted a household emergency plan (Cramer's V = −1.714, p<.10, Table 6f). As was the case with limiting outdoor activities on days with reduced air quality, income, age and gender were not found to be significantly associated with the adoption of the household emergency plan.

Discussion

Comparison of Adoption of Adaptive Behaviors

The analysis indicates that limiting outdoor activities in response to the chronic exposure hazards conveyed through the Air Quality Index (AQI) is a more common practice among these residents than creating a household emergency plan to deal with and limit acute exposure risks. This different rate of adoption may be related to the fact that the AQI forecasts carry information about potential exposures that affect residents throughout the Parish (county). This exposure hazard is chronic and more widespread across the entire Baton Rouge metropolitan area (as opposed to localized chemical spills, for example), and as such may attract the attention of a larger group of residents. Also, the decision simply to limit outdoor exposure for a few hours or to change plans is relatively simple and may not require the time, thought, or resources needed to develop a household emergency response plan, complete with emergency food and water and designation of a safe meeting place for family members.

Exposure to Environmental Hazards

The results of the analyses lend support to the resilience theoretical framework that considers exposure to hazards as an important component in understanding or anticipating the adaptations communities may make to become more resilient to future disturbances. A trend in the data suggests that interviewees who had experienced an environmental emergency within their neighborhoods, such as a chemical leak, plant explosion, or hazardous-materials spill, within the past five years may be more likely to have adopted a pre-emergency household response plan to help them cope more effectively with this type of acute environmental exposure event. This finding is consistent with those of Nelson, et al. (11) and Wakefield, et al (12) and suggests that the idea of a similar event happening again is not abstract or hypothetical to these residents. The emergency events may have what Slovic (44) referred to as a "signal value" for residents of the upper Industrial Corridor. These events may serve to raise awareness of other similar hazards within the community, and that awareness may encourage adoption of household emergency plans.

Also, although no significant association was found through the cross-tabs between total Toxic Release Inventory (TRI) emissions within the interviewees' zip codes and plan adoption, a trend in the data is apparent. About 44% of the individuals residing in zip codes with TRI facilities had adopted the plans, compared to roughly 21% of the interviewees from zip codes with no TRI-reporting facilities. Future examination based on a larger, random sample of residents living nearer the regulated facilities should help determine the relationship between proximity to the larger regulated manufacturing plants, waste disposal sites, and other noxious facilities and adoption of household emergency plans.

Regarding respondents' response to the AQI reports, the potential influence of local environmental conditions is clearer. Both of the TRI variables indicating potential environmental exposure conditions within the respondents' zip codes were found to be significantly associated with the choice to limit outdoor activities in response to the AQI forecasts. Residents of more industrialized communities as indicated by higher TRI releases and the presence of more regulated facilities that handle toxic materials, appear to be more likely to limit outdoor activities and even change plans based on AQI information.

Vulnerability to Hazard Exposure

The resilience framework considers the vulnerability of residents as a factor in understanding or predicting the overall resilience of communities to adapt to changing risks. The presence of more socioeconomically vulnerable elements is presumed to make it harder for communities to bounce back or cope with either slow-moving or fast-moving, abrupt disturbances. However, in this study, only one measure of socioeconomic vulnerability, lower level of educational attainment, was found to be associated with one of the adaptive behaviors, adoption of a household emergency plan. Somewhat surprisingly, among this group of interviewees, those with less education were more likely to have conducted proactive household-level planning for potential emergency events. This counter-intuitive finding may be related to the small sample size, the large number of well-educated interviewees in the study, and the possibility that less-educated interviewees may tend to reside in neighborhoods where environmental emergencies have occurred in recent years. Further analysis based on a larger number of survey respondents and inclusion of the number and location of recent emergency events, along with a multivariate statistical analysis should yield more insight into possible associations between education and adoption of risk-reducing behaviors.

Other indicators of social or economic vulnerability were not found to be associated with adoption of a household emergency plan or changing outdoor activities in response to the AQI reports. While some previous research suggests that demographic and socioeconomic attributes of residents may be related to awareness of environmental hazards and adoption of risk-reducing adaptations (23), this preliminary study found that factors such as age and income did not appear to be associated with risk-reducing behaviors among these interview participants. Instead, residents' proximity to TRI facilities, i.e., a location factor, may have played a more important role in influencing risk-reducing behaviors.

Adaptive Capacity of Residents

A third component of community resilience relates to the ability or capacity of residents to understand changing threat levels and respond in such a manner as to avoid or mitigate damages associated with future disturbances. The results of this study support the importance of this dimension of resilience. Three indicators of the capacity, or ability of residents to take steps to reduce exposure risks, were found to be associated with adoption of the household emergency plans and two were found to be linked to limiting outdoor exposure risks during days with lower air quality. First, interviewees who were familiar with the daily air quality forecasts and who reported checking the forecasts more frequently were more likely to have established a household emergency plan and, not surprisingly, also reported having limited outdoor activities in response to this information. This link suggests some possible crossover effect from one adaptive capacity-building activity to another. Second, longer length of residence within the same zip code was found to be associated with household emergency plan adoption. This finding is logical since those who have lived in the community longer may be better informed about overall environmental risk conditions in the area. They probably are more established in the community, have a better understanding of the local environmental history, and are more likely to anticipate future chemical spills or plant explosions. Also, longer-term residents may have derived some of the same benefits of group membership identified by Bonniface and Henley (37) through the increased social interactions and economic commitments that may be built over time.

Third, those who report being better informed about environmental hazards in their community, know whom to call in the case of an emergency, and are clear on what steps to take to reduce exposure risks were found to be more likely to have adopted a household emergency plan. This link is not surprising since keeping emergency phone numbers readily accessible is a suggested element of a household emergency response plan. (See table 2 for suggested plan elements.)

These findings are consistent with previous research suggesting that access to technical information concerning risks, along with confidence in one’s ability to affect environmental conditions, encourage adoption of a household emergency plan (28) and discourage a more fatalistic view of environmental problems (37). Also, the findings are consistent with elements of other models of environmental behavior, specifically concerning the importance of confidence in the likely effectiveness of one’s actions (35, 36, 37, 38). Confidence and more knowledge about risk-reducing strategies appear to help residents overcome the natural tendency to resist change when confronting this type of adaptive challenge as identified by Heitfetz and colleagues (39).

The results bode well for the potential positive effects of environmental health outreach programs, as information concerning threat levels and specific actions to reduce exposure risks can be communicated to residents. These communication methods are readily available and include websites, public-service announcements, and presentations to neighborhood associations and organizations. Also, “adaptive leadership” (39, 45) within public safety and environmental health outreach programs can help to reduce community resistance not only by disseminating specific strategies for risk reduction, but by involving stakeholders in assessing exposure risks, developing communication strategies, and even building coalitions among residents to enhance information sharing before, during, and after environmental-exposure events.

Summary and Conclusions

One central objective of the study was to demonstrate the utility of applying concepts from the social-ecological resilience theoretical framework to better understand the exposure-reducing behaviors of residents living with chronic and acute environmental exposure risks. The findings support the applicability of this framework, as key theoretical elements of more resilient communities were found to be associated with Baton Rouge residents’ adaptations to environmental hazards.

The study addressed two specific questions: To what extent are residents of Louisiana's Upper Industrial Corridor taking steps to reduce environmental exposure risks, and what factors may influence adoption of exposure-reducing behaviors? The "adaptive behaviors" considered were the adoption of a household emergency plan, more frequent checking of daily air-quality ratings, and limiting outdoor activities on lower air-quality days. Potential influences included indicators of the three elements of resilience: exposure to environmental hazards, vulnerability, and the capacity to adapt to environmental exposure risks.

The findings suggest that adoption of risk-reducing behaviors among these residents is far from universal, and therefore, opportunities exist for more vigorous public education and environmental health outreach efforts. The analysis found a greater adoption rate among interviewees of exposure-reducing actions in response to the chronic risk of reduced air quality, as communicated through the daily Air Quality Index (AQI). Also, the two adaptive behaviors - limiting outdoor activities in response to the AQI and adoption of a household emergency plan - were not found to be significantly associated with each other. In other words, there was variation among the interviewees regarding the adaptive measures, with some adopting one measure and not the other. This may suggest a difference in how residents view chronic, widespread environmental exposure problems such as air quality, versus more acute, localized events such as chemical spills and other environmental emergencies. Additional research based on a larger, randomly selected sample of residents would be useful to explore this question.

The study yielded evidence that "adaptive capacity" is particularly relevant to understanding and encouraging exposure-reducing behaviors. Residents who believe that they are well-informed about risk-reducing strategies, regardless of their own level of educational attainment, were found to be more likely to have adopted one or both of these measures. Evidence that knowledge and confidence levels among residents may be linked to adaptive behaviors is good news for those working in public education and community outreach programs, as these are attitudes and skills that can be nurtured and probably improved. While factors associated with "exposure" and "vulnerability" to hazards are difficult to change in communities like those of Louisiana's Industrial Corridor, knowledge of risk-reducing strategies and confidence in one's abilities to reduce exposure risks should be able to be improved through well-designed public education efforts. Applying the social ecological resilience conceptual framework, environmental health educational outreach programs that deliver information about sources of hazards within the community, including changing threat levels, and the specific strategies and mitigation tools for reducing risks should raise knowledge and confidence, and thus enhance the adaptive abilities of residents living with acute and chronic environmental exposure risks.

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Table 1

Air Quality Index (AQI) Values

Colors	Air Quality Index (AQI) Values	Levels of Health Concern	Meaning
…as Symbolized by this color;	*when the AQI is in this range:*	*…air quality conditions are:*	*the health implications are:*
Green	0 to 50	Good	Air quality is considered satisfactory, and air pollution poses little or no risk.
Yellow	51 to 100	Moderate	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Orange	101 to 150	Unhealthy for Sensitive Groups	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Red	151 to 200	Unhealthy	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Purple	201 to 300	Very Unhealthy	Health alert: everyone may experience more serious health effects.
Maroon	301 to 500	Hazardous	Health warnings of emergency conditions. The entire population is more likely to be affected.

Source: Reprinted from Understanding Air Quality Index by Louisiana Department of Environmental Quality. Available at: http://deq.state.la.us/portal/PROGRAMS/OzoneActionProgram/UnderstandingtheAirQualityIndex.aspx Accessed October 27, 2011.

Table 2

Elements of a Household Emergency Plan

1	Have a meeting with the members of your household to discuss the possible emergencies that exist and how to respond to each.
2	Identify the safe areas in your home for each type of emergency.
3	Explain what to do about power outages and personal injuries.
4	Draw a floor plan of your home and identify two escape routes from each room.
5	Show household members how to turn off the electricity, water, and gas at the main switches when necessary.
6	Identify emergency phone numbers and post near telephones.
7	Teach your children how and when to call 911.
8	Identify one out-of-state and one local contact (relative or friend) for family members to call if separated during an emergency.
9	Teach your children the phone numbers for your contacts.
10	Identify two emergency meeting places: near your home in case of a fire & outside your neighborhood in case you cannot return home after an emergency.
11	Take course for CPR and First Aid.
12	Family records should be kept in a water and fireproof container.
13	Instruct family members to monitor local radio and television stations for emergency information.

Source: East Baton Rouge Parish Mayor’s Office for Homeland Security and Emergency Preparedness website, http://www.brgov.com/dept/oep/. Accessed September 30, 2011.

Table 3

Variables Included in Analyses

Dependent Variables	**Indicator of**	**Measurement**	**Source**
HOUSEHOLD EMERGENCY PLAN ADOPTION	Adaptation	Nominal	Interview
AIR-QUALITY INDEX (AQI) RESPONSE	Adaptation	Nominal	Interview
Independent Variables			
Total TRI discharges within zip code (lbs.)	Exposure	Interval	EPA
Number facilities permitted to use toxins in zip code	Exposure	Interval	EPA
Experienced environmental emergency within 5 years	Exposure	Nominal	Interview
Educational attainment	Vulnerability	Ordinal	Interview
Household income	Vulnerability	Ordinal	Interview
Age	Vulnerability	Ordinal	Interview
Know which agencies to contact in emergency	Adaptive Capacity	Nominal	Interview
Feel informed to respond to emergency	Adaptive Capacity	Ordinal	Interview
Frequency of checking Air Quality Index (AIQ)	Adaptive Capacity	Ordinal	Interview
Perception of air quality	Adaptive Capacity	Ordinal	Interview
Length of residence within zip code	Adaptive Capacity	Interval	Interview

Table 4

Significant Associations between Exposure-Reducing Behaviors and Indicators of Exposure, Vulnerability and Adaptive Capacity

	Dependent Variables:	
Independent Variables:	**ADOPTION OF A HOUSEHOLD EMERGENCY PLAN**	**LIMIT OUTDOOR ACTIVITIES IN RESPONSE TO AQI FORECASTS**
EXPOSURE		
Total TRI discharges within zip code (lbs.)		Diff. of Means T test = −1.70 * (n=56)
Number facilities permitted to use toxins in zip code		Diff. of Means T test = −1.988 * (n=55)
Experienced environmental emergency within 5 years	Cramer's V=.223 , p=.157 (n=37)	
VULNERABILITY		
Educational attainment	Cramer's V = .410 ***(n=62)	
Household income		
Age		
ADAPTIVE CAPACITY		
Know which agencies to contact in emergency	Cramer's V = .387 *** (n=60)	
Feel informed to respond to emergency	Cramer's V = .490 *** (n=53)	
Frequency of checking Air Quality Index (AQI)	Cramer's V = .471 *** (n=54)	Cramer's V = .521**** (n=53)
Perception of local air quality		Cramer's V= .461* (n=48)
Length of residence within zip code	Diff. of Means T test = −1.714 * (n=53)	

* $p<.10$

** $p<.05$

*** $p<.025$

**** $p<.01$

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Table 5a

Difference of Means: Response to AQI Forecasts (AirPlan) and Total TRI Discharges within Zip Code

AirPlan		N	Mean TRI	Std. Deviation TRI	T-test value	Approx. p value
Total TRI	0 (no)	35	84,308	279,367	−1.70	.096
	1 (yes)	21	714,423	2,181,700		

Table 5b

Difference of Means: Response to AQI Forecasts (AirPlan) and Number of Facilities Permitted to Use Toxins

AirPlan		N	Mean Number Facilities	Std. Deviation Number Facilities	T-test value	Approx. p value
Facilities	0 (no)	34	2.26	1.26	−1.988	.052
	1 (yes)	21	3.43	3.02		

Note: T-test indicates statistically significant differences between the total TRI discharges (although with very large standard deviations) and the number of facilities permitted to discharge toxins within the zip code for those interviewees who have limited outdoor activities in response to AQI forecasts. On average interviewees who have used the AQI information and adjusted their activities live in zip codes with more pounds of TRI discharges and more facilities permitted to use toxins.

Table 5c

Response to AQI Forecasts (AirPlan) and Frequency of Checking AQI Forecasts (CheckAir)

Count		**AirPlan * CheckAir Crosstabulation**					
		CheckAir					
		1	**2**	**3**	**4**	**5**	**Total**
AirPlan	0	13	6	9	1	2	31
	1	3	2	5	8	3	21
Total		16	8	14	9	5	52

Cramer's V = .512, p<.01

Note: "CheckAir" was measured on a scale from 1 ("never") to 5 ("always")

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Table 5d

Response to AQI Forecasts (AirPlan) and Perception of Local Air Quality (Air)

Count		**AirPlan * Air Crosstabulation**					
		Air					
		1	**2**	**3**	**4**	**5**	**Total**
AirPlan	0	3	3	13	7	4	30
	1	1	4	1	5	7	18
Total		4	7	14	12	11	48

Cramer's V = .461, $p<.05$

Note: "Perception of Air Quality" was measured on a scale of 1 ("excellent") to 5 ("very poor"); 7 interviewees answered "not sure".

Table 6a

Household Plan Adoption (Plan) and Environmental Emergency within One's Neighborhood within the past Five Years (FiveYears)

Plan * FiveYears Crosstabulation

Count

		Five Years 0	Five Years 1	Total
Plan	0	22	4	26
	1	7	4	11
Total		29	8	37

Cramer's V = .233, (p value approaching significance at .157)

Note: "FiveYears" Question Coded as 0= "no", 1="yes", Twenty interviewees were "not sure" whether there had been an environmental emergency within their neighborhood within the past five years.

Table 6b

Household Plan Adoption (Plan) and Education Level (Ed)

Count		Plan * Ed Crosstabulation				
		Ed				
		1	2	3	4	Total
Plan	0	0	7	18	21	46
	1	2	4	7	2	15
Total		2	11	25	23	61

Cramer’s v= .410; p<.025

Note: “Ed” was measured as: 1= Some high school, 2= GED/HS diploma, 3= college/associate degree, 4=some graduate study or degree

Table 6c

Household Plan Adoption (Plan) and Knowledge of which Agency to Contact in case of an Environmental Emergency (Contact)

Crosstab				
Count				
		Contact		
		0	**1**	**Total**
Plan	0	36	10	46
	1	5	9	14
Total		41	19	60

Cramer’s V = .387, $p<.025$

Note: For each variable, 0=“No”, 1=“Yes”

Table 6d

Household Plan Adoption (Plan) and Feel Informed to Respond to Emergency (Informed)

Count		Crosstab					
		Informed					
		1	2	3	4	5	Total
Plan	0	18	11	8	2	2	41
	1	1	2	5	4	0	12
Total		19	13	13	6	2	53

Cramer's V = .490; p<.025

Note: "Informed" was measured on a scale from 1 ("not at all informed") to 5 ("fully informed")

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Table 6e

Household Plan Adoption (Plan) and Frequency Checking Air Quality Index Forecasts (CheckAir)

Count		Plan * CheckAir Crosstabulation					
		CheckAir					
		1	**2**	**3**	**4**	**5**	**Total**
Plan	0	16	7	10	5	2	40
	1	0	1	5	4	3	13
Total		16	8	15	9	5	53

Cramer's V = .471, $p<.025$

Note: "CheckAir" was measured on a scale from 1 ("never") to 5 ("always")

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Table 6f

Difference of Means: Household Plan Adoption (Plan) and Years of Residence within Zip Code (YRS at Zip)

Plan		N	Mean Years	Std. Deviation Years	T-test value	Approx. p value
YRS at Zip	0 (no)	39	23.95	21.63	−1.714	.099
	1 (yes)	14	34.57	19.22		

Note: T-test indicates statistically significant difference in length of residence within zip code among those interviewees with and without a household emergency response plan. Interviewees with a household plan on average have lived in the same zip code for more years than those interviewees without a household plan.