JOURNAL OF APPLIED COMMUNICATION RESEARCH
2020, VOL. 48, NO. 1, 91–113
https://doi.org/10.1080/00909882.2019.1704828

Risk communication infrastructure and community resilience: does involvement in planning build cross-sector planning and response networks?

Joshua B. Barbour [a], David H. Bierling[b,c], Paul A. Sommer[d] and Bradley A. Trefz[b]

[a]The University of Texas at Austin, Austin, TX, USA; [b]Texas A&M Transportation Institute, College Station, TX, USA; [c]Hazard Reduction & Recovery Center, Texas A&M University, College Station, TX, USA; [d]Kent State University at Stark, North Canton, OH, USA

ABSTRACT

The community resilience needed for effective disaster response and recovery depends in part on robust cross-sector, interorganizational networks, but differences among networked stakeholders can make building community resilience difficult. Local emergency planning committees (LEPCs) may help by acting as risk communication infrastructure. LEPCs help conduct emergency chemical hazards planning and support the public's right-to-know about those hazards. Focusing on an LEPC situated in a major U.S. petrochemical corridor, this study surveyed LEPC stakeholders (N = 171) to investigate their perceptions of a hypothetical hazardous materials (HazMat) incident and their planning and response networks, comparing differences among agency and non-agency stakeholders. Respondents reported being part of robust planning and response networks, indicative of capacity for community resilience. Stakeholders' involvement in planning efforts was associated with their perceptions of the HazMat incident and their networks. This study provides evidence for the efficacy and limits of the LEPC as risk communication infrastructure.

ARTICLE HISTORY
Received 14 February 2019
Accepted 8 November 2019

KEYWORDS
Local Emergency Planning Committees (LEPCs); Hazardous Materials (HazMat); resilience; community; networks

Communication can build community resilience and improve disaster preparedness in part by forming and sustaining networks of engaged community members (Doerfel, 2016; Houston, 2018). In the context of the manufacture, use, storage, and transportation of hazardous materials (HazMat), U.S. law and policy mandate specific risk communication efforts (Amendola & De Marchi, 1996; Barbour & James, 2015; Heath, Bradshaw, & Lee, 2002). The Emergency Planning and Community Right-to-Know Act (EPCRA, U. S. Environmental Protection Agency [EPA], 2018) was enacted in 1986 in response to the 1984 Union Carbide chemical disaster in Bhopal, India, and a near-miss incident the following year at Union Carbide's Institute, West Virginia facility (Willey, Crowl, & Lepkowski, 2005). EPCRA included requirements for emergency planning for local communities, state and tribal government, and the petrochemical industry; set reporting standards for HazMat facilities; and mandated the formation of local

CONTACT Joshua B. Barbour barbourjosh@utexas.edu
This article has been republished with minor changes. These changes do not impact the academic content of the article.

emergency planning committees (LEPCs). Today, among their many functions, LEPCs help plan for HazMat-related emergencies and serve as forums for stakeholders in communities near high-risk, HazMat facilities or transportation routes (Heath, Lee, Palenchar, & Lemon, 2018; Palenchar, Heath, & Orberton, 2005). In principle, LEPCs bring together key stakeholders such as elected leaders, government agency personnel (e.g. emergency managers, law enforcement, firefighting, health organizations), media organizations, community groups, citizens, and EPCRA-covered facilities and transportation companies, to help communities prepare for HazMat incidents (see Figure 1).

In practice, communities have not always been successful at forming and maintaining LEPCs with the requisite membership from stakeholder groups, preparing and maintaining emergency response plans, or disclosing the presence of HazMat (EPA, 2008; Lindell & Perry, 2001). Including all implicated stakeholders directly in LEPCs would be difficult because of the numbers involved, but the logic of LEPCs is that those stakeholders who participate directly and are relatively more engaged in planning than the general public will build networks and share information useful in HazMat incidents. Nonetheless, LEPCs have been criticized for failures to adequately reach stakeholders who are not involved in day-to-day preparation or response to HazMat incidents, but who are nonetheless important for HazMat planning, such as the organizations that manufacture, use, store, and transport HazMat. The goal of this study was to investigate (a) LEPC

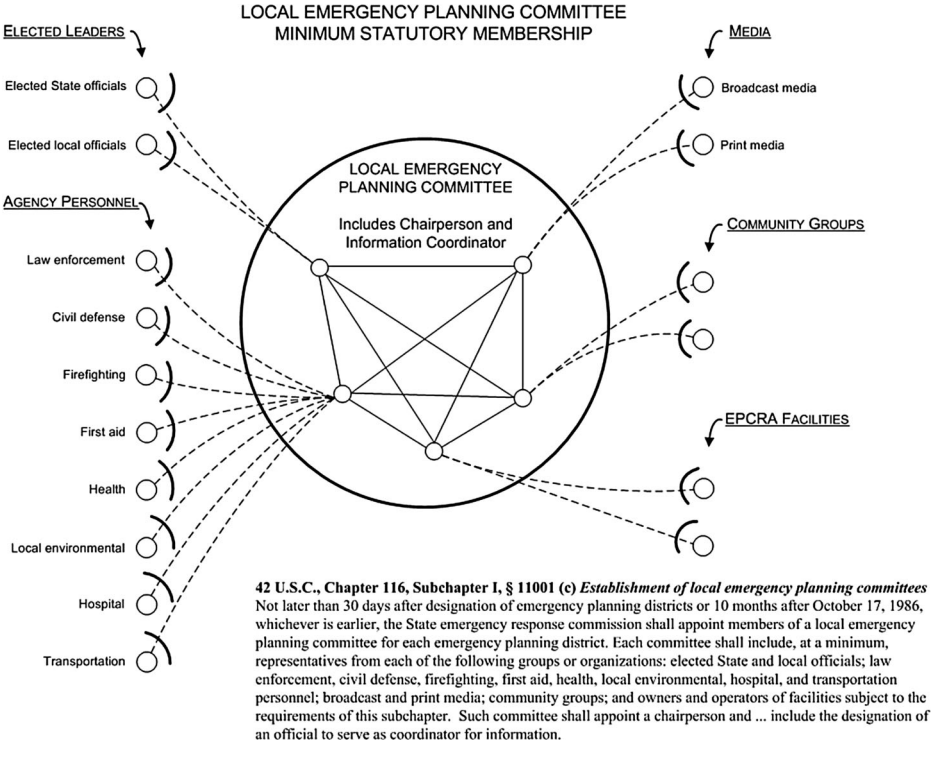


Figure 1. Local emergency planning committee minimum statutory members. From *Participants and information outcomes in planning organizations* by D. H. Bierling, 2012. Copyright 2012 by David H. Bierling. Reprinted with permission.

stakeholders' responses to a hypothetical HazMat incident, (b) their planning and response networks, and (c) the efficacy of LEPCs for building community resilience among those stakeholders. In doing so, this research informs understandings of communication and resilience by illuminating the mechanisms that constitute resilient communities.

Communication efforts for safeguarding and managing HazMat such as those coordinated through LEPCs are important. Chemical industries are targets for terrorist attacks (Palenchar et al., 2005), and they are increasingly vulnerable to aging infrastructure and ineffective governmental oversight (Laboureur et al., 2016). At the same time, security concerns mean that information about HazMat present in communities cannot be as widely as publicized or as easily obtained as in the past (Youngblood, 2012). HazMat can also exacerbate natural disaster impacts. These issues are of particular importance in petrochemical corridors where LEPCs need to be especially active, such as the Gulf Coast region of Texas and Louisiana, home to the majority of the United States petrochemical industry, where flood risks are increasing (Heath et al., 2018; Palenchar et al., 2005). For example, the *Houston Chronicle* published a series of articles entitled, 'Silent Spills,' on the unfolding environmental disaster in the wake of Hurricane Harvey, where, in addition to toxic chemicals released into flood waters, extensive damage to facilities and additional releases occurred (e.g. Bajak & Olsen, 2018). LEPCs may help build community resilience for incidents that include or are exacerbated by HazMat by making connections among implicated stakeholders who otherwise might not communicate with each other. The EPA (2008) argued that 'Because of their broad-based membership, LEPCs are able to foster a valuable dialogue within the community to prevent and prepare for accidental (and terrorist-related) releases of hazardous chemicals' (p. 3).

Communication theory and research on community resilience frames and guides this investigation. It builds in particular on Houston and colleagues' communicative model of community resilience (e.g. Houston, 2018; Houston, Spialek, Cox, Greenwood, & First, 2015) and Doerfel and colleagues' research on networked forms of organizing in disaster preparation, response, and recovery (e.g. Doerfel, 2016; Doerfel, Chewning, & Lai, 2013). In the following sections, we explicate the theoretical framework for the study. First, we define community resilience and its communicative mechanisms emphasizing the importance of the formation and sustenance of community relationships. We then review the research that makes clear the difficulties inherent to building those relationships. Second, we describe the distinctive context of HazMat preparedness and LEPCs, making the case that they exemplify the communicative and organizational difficulties important in community resilience. Integrating communication theory and research on community resilience and the practical exigencies of LEPCs, we explicate the research questions that guided this investigation. The analysis focuses on the planning and response networks of LEPC stakeholders, demonstrating that involvement in planning may contribute to community resilience by ameliorating stakeholder differences and fostering connections among LEPC stakeholders.

Community resilience and HazMat incidents

Cross-sector, interorganizational networks are essential infrastructures for community resilience. The Houston et al. (2015) communicative model of community resilience

emphasizes the importance of communication in and through community relationships. They build on the work of Norris, Stevens, Pfefferbaum, Wyche, and Pfefferbaum (2008) who defined community resilience as 'a process linking a set of adaptive capacities to a positive trajectory of functioning and adaptation after a disturbance' (p. 130). Resilient communities are more likely to be able to 'bounce forward' and to anticipate and plan for incidents, and communication processes are essential to resilience for individuals and organizations (Buzzanell, 2010; Houston, 2018). Communities need to develop individual, organizational, and interorganizational communication infrastructures that allow them to coordinate and provide information and support during crises (Seeger, 2006; Ulmer, 2012). The Norris et al. model identified four overlapping and interdependent, or 'networked,' adaptive capabilities including economic development, social capital, information and communication, and community competence. In this model and in the Houston et al. development of it, the network linkages are key to community resilience, because such networks support information sharing and meaning making. Information, Norris et al. argued, is 'the primary resource in technical and organizational systems that enables adaptive performance' (p. 140).

Houston et al. (2015) built on the Norris et al. (2008) model to emphasize the importance of communication including strategic communication processes such as disaster and risk information dissemination and use, education, discussion, preparedness and planning; community resilience awareness; and community planning, critical reflection, problem solving, and empowerment. Their model highlighted the recursive relationships between these strategic communication efforts and the formation and sustenance of community relationships. Community relationships included social support, social capital, citizen engagement, sense of community, attachment to place, organizational linkages, public–private partnerships, political partnerships, and media relations. Doerfel (2016) argued that community resilience 'involves organizations communicating through networks to gain and share information and resources' (p. 367). Taken together, this theorizing indicates that communication processes are key for developing community relationships, formal and informal communication networks among stakeholders, which are essential to community resilience.

HazMat as a challenging context for building community resilience

The safe transport, storage, and use of HazMat are especially important contexts for the study of community resilience. HazMat presents risks to environmental and human health. Investigations of community resilience have tended to focus on natural hazards and disasters, not technological ones; although, as the events of Hurricane Harvey showed, natural hazards can cause or exacerbate technological incidents (e.g. Bajak & Olsen, 2018).

HazMat incidents also present difficulties for preparedness. HazMat planning involves cross-sector work among private and public organizations that use and transport HazMat and the entities that regulate their use (EPA, 2008), and industrial corridors cross-jurisdictional boundaries necessitating intergovernmental collaboration (e.g. Palenchar et al., 2005). At the same time, the varied organizations that make, use, or transport HazMat tend to be distributed throughout communities, and the presence of HazMat is largely unknown to community members (EPA, 2008; Heath et al., 2002; Heath et al., 2018). Organizing

across sectors means that LEPCs work with stakeholders that have highly variable disaster planning, preparation, and response processes and procedures (Doerfel, 2016), different levels of readiness (Kirschenbaum & Rapaport, 2018; Ulmer, 2012), and differing priorities for preparedness (Barbour & Manly, 2016; McConnell & Drennan, 2006).

Previous research has criticized disaster planning and response efforts for deferring too much to established role definitions and formal disaster response models as proxies for actual relationships and shared understanding of who knows what (Barbour & Manly, 2016; Curnin, Owen, Paton, Trist, & Parsons, 2015; Doerfel, 2016). The organizing needed for day-to-day preparedness and oversight requires different structures and processes than the organizing required during response and recovery (Chen, Sharman, Rao, & Upadhyaya, 2008; Curnin et al., 2015). The specialization and division of labor used in organization's day-to-day operations can be problematic during crisis (Chen et al., 2008; Majchrzak, Jarvenpaa, & Hollingshead, 2007; McConnell & Drennan, 2006), and networks characterized by linkages that cut across domains can help navigate novel and uncertain problems (Kirschenbaum & Rapaport, 2018; Krackhardt & Stern, 1988). Emergency management and first responder organizations tend to be hierarchical and need to establish command and control structures during incidents (Donahue, 2004). The 'shared ownership of problems and their solutions, decentralized decision making, and cross-functional teams' needed for community resilience mean that the interorganizational networks characteristic of community resilience tends to be more organic, flexible, and informal (Doerfel, 2016, p. 367; Doerfel et al., 2013).

The mix of network and bureaucratic logics for organizing that can make disaster planning, response, and recovery more difficult in general (Doerfel, 2016) may be particularly problematic in HazMat. Appropriate HazMat responses requires advanced technical expertise and specialized training, which are not often part of basic responder training. Ad hoc responses to chemical spills, fires, and other incidents by the uninformed are dangerous, because of the need to manage chemicals in particular ways to avoid exacerbating them. Outside of formal HazMat response teams, figuring out who has and who needs that expertise prior to incidents is challenging.

Community resilience literature suggests these challenges can be addressed in part by building networks among those who have, and who may need, that expertise ahead of time (Doerfel et al., 2013). In theory, these networks can effectively coordinate expertise to respond to complex, emergent events if the needed expertise is present (Weick & Sutcliffe, 2015). To the extent that planners build these networks prior to incidents, they can support communication while increasing the diversity of knowledge and actions available (Kirschenbaum & Rapaport, 2018). Doerfel et al. (2013) found that structural inertia was a key mechanism in recovery wherein recovering organizations depended on networks made pre-disaster. To build such networks, 'crisis planners and communicators should … *develop relationships with stakeholders at all levels* [emphasis added]' (Seeger, 2006, p. 240). These cross-sector networks may facilitate more effective responses and more effective preparation.

LEPCs as risk communication infrastructure

LEPCs exist in part to ameliorate the difficulties associated with HazMat preparation. Heath et al. (2002) described LEPCs as a kind of risk communication infrastructure.

LEPCs may encourage the formation of linkages across a community and thereby build community resilience. LEPCs, led by a committee chair and an information coordinator, include representatives from local government, response agencies, media organizations, community groups, and facilities that use, store, and/or transport HazMat regulated by EPCRA (see Figure 1). LEPCs make information about local HazMat available to diverse stakeholders and provide opportunities for them to meet to discuss emergency planning. Organizations that participate in LEPCs may possess higher levels of preparedness than is typical (Ulmer, 2012), because of governmental mandates specific to HazMat and the value of preparedness for reducing operating risks.

At the same time, LEPCs exemplify the complexities and difficulties of the cross-sector, expertise-intensive preparedness needed for HazMat described above (Trefz, Bierling, & Williams, 2019). The overlapping requirements of EPCRA and other relevant federal and state laws like the Clean Air Act, Occupational Health and Safety Act, and various oil spill regulations have created multiple, complex, and interwoven systems of HazMat regulation and planning requirements for communities. Private entities with planning requirements should coordinate their plans with communities via LEPCs, but many do not. Per EPCRA, LEPCs and local fire departments receive Safety Data Sheets and HazMat inventories called Tier II reports, filed by organizations that possess certain hazardous chemicals in quantities above specified thresholds, but the information in those Tier II reports is not always readily available during incidents and facilities may not provide information in a format responders can use. LEPCs have no response duties per se, but most LEPCs assume an advisory role, reviewing and providing input for emergency plans, or a coordinating role, such as aligning planning and messaging across organizations or hosting multi-organizational trainings and exercises. As such, LEPCs are separate from established emergency management and planning systems though those relationships are starting to change.

The U.S. Federal Emergency Management Agency (FEMA) and emergency management practitioners nationwide increasingly use a whole-community approach. This whole-community, all-hazards approach views emergency response as beginning with the individual citizen or facility worker and proceeding all the way to the leadership of the FEMA, the U.S. Department of Homeland Security, and the President of the United States. It is a resilience-based model that includes actions that occur outside of government control within communities and encourages planning and education efforts that account for such actions. In many respects, it represents a return to the more collaborative vision of emergency management planning envisioned in EPCRA and reflected in theories of community resilience (Doerfel, 2016; Houston et al., 2015).

In sum, the logic underlying LEPCs is that bringing stakeholders together may (a) facilitate information sharing about the presence and risks of HazMat, (b) develop shared perceptions of HazMat incidents, (c) engage implicated publics by building connections that cut across stakeholder groups, and thereby (d) cultivate interorganizational networks that may be needed in a HazMat incident (EPA, 2008). LEPCs should theoretically make communities more resilient to disaster generally by, for example, producing social capital, engaging citizens, adding or enhancing community relationships, and developing community competence (Doerfel, 2016; Houston et al., 2015; Norris et al., 2008).

A key LEPC function is building cross-sector connections despite the difficulties involved. For the purposes of this study, we simplified the mix of organizations involved

in HazMat. We operationalized LEPC stakeholder differences by comparing (a) agency stakeholders—those specifically involved in the broader planning, preparation, or response to chemical hazard emergencies and disasters—and (b) non-agency stakeholders—those implicated in, but not typically focused on, chemical hazard planning, preparation, or response (see Figure 1). This bifurcation is overly simple, but it captures a key cross-sector contrast and is analytically useful. The following research questions structured the data collection and analysis. These questions were guided by community resilience theorizing and the logic of how LEPCs should work. Namely, we compared differences in stakeholders' perceptions of HazMat incidents, their involvement in planning efforts and information seeking related to HazMat incidents, and their planning and response networks. We then considered the degree to which involvement in planning moderated the differences among stakeholders.

We first asked, how do agency and non-agency LEPC stakeholders differ in terms of their perceptions of a hypothetical HazMat incident (RQ1)? Making clear the risks, likelihood, believability, and relevance of incidents is a key aim for risk communicators (Heath et al., 2002; Heath et al., 2018; Seeger, 2006). Inconsistent ideas about risks can make policymaking and preparedness efforts more difficult (Kinsella, Kelly, & Kittle Autry, 2013). Shared understandings reflected in 'communal narratives' and overlapping frames are essential for community resilience (Norris et al., 2008, p. 141), because 'a resilient community is not simply a grouping of resilient individuals or organizations, but is a collection of people and groups who are able to interact successfully to facilitate adaption of the whole' (Houston, 2018, p. 19). For example, Mumford and Gray (2009) found that being able to voice safety risks collectively allowed differing stakeholders to develop shared conceptualizations. Forums like LEPC meetings should provide opportunities to replace stereotypical notions of stakeholders' positions and to develop shared understandings of HazMat incidents.

We also asked, how do agency and non-agency LEPC stakeholders differ in terms of their involvement in planning and their hazards-related information seeking (RQ2)? As argued above, offering information and supporting HazMat emergency planning are key functions of LEPCs. Community resilience theorizing identifies them as key strategic communication efforts that can build community resilience (Doerfel, 2016; Houston, 2018; Norris et al., 2008).

LEPCs also create opportunities for the formation of interorganizational network linkages or community relationships that build community resilience (Doerfel, 2016). We therefore asked, how do agency and non-agency LEPC stakeholders differ in terms of the size, heterogeneity, communication with, and perceptions of the expertise in their (a) response and (b) planning networks (RQ3)? As argued above, building networks prior to incidents can enhance response by supporting coordination and establishing the credibility of information sources. The rationale for these specific variables is that the size of their planning and response networks, the frequency of their communication with those in the networks, and their evaluations of the expertise of those in their networks provide indicators of relational resources available to them and, thereby, their capacity for community resilience (Doerfel et al., 2013; Houston et al., 2015). The literature highlighting the differences in organizing in- and outside of crisis guided our study of both planning and response networks (Barbour & Manly, 2016; Doerfel, 2016; McConnell & Drennan, 2006). Focusing on planning and response also helped encompass the different roles

played by LEPC stakeholders. Expertise is in particular key given the focus on HazMat, which requires technically complex response strategies. Heterogeneity provides an indicator of the degree to which their networks include a mix of stakeholders across sectors.

We examined stakeholders' personal or ego networks as indicative of the community resilience social capital available to them and the mix of their connections to different LEPC disciplines. Generally, 'ego networks,' 'personal networks,' or 'personal communities,' provide social support, help people manage crises, deal with change, and procure resources and information (Chua, Madej, & Wellman, 2011). Personal networks consist of the persons under study (egos), the individuals with whom they have connections (alters), and the ties among them.

To reiterate, LEPCs should build capacity for community resilience across sectors. Doerfel (2016) contended that interorganizational relationships can create a 'social infrastructure' important for 'community resilience as a buffer to anticipated and unanticipated problems' (p. 368). She further argued that because of the different requirements, forms, and effects of planning and response organizing, the differences in perceptions of communication, community, and disaster problems complicate the formation and robustness of those relationships. Examining their networks provides evidence about the formation of connections across the stakeholder groups, and engagement in planning efforts should help mitigate differences among stakeholders. Thus we asked, does involvement in planning moderate the differences among LEPC stakeholders (RQ4)?

Methods

In consultation with an LEPC (hereafter LEPC-A) in the Texas-Louisiana Gulf Coast area, we conducted an online (Qualtrics) survey of LEPC-A stakeholders. The questionnaire asked participants to identify the type of organization they represented and then to read and reflect on a hypothetical HazMat incident. It asked participants to list the individuals and organizations they would contact in responding to and preparing for such an incident. Participants answered questions about the hypothetical incident, their networks, their experience in planning for HazMat incidents, the sources from which they sought information about HazMat incidents, and their professional backgrounds.

Sample and participants

We constructed a sample of LEPC-A's stakeholders using multiple data sources available in summer 2013. The sample frame included the rosters from three recent after-action reviews of events and exercises organized by the local OEM in 2012 and involving the LEPC, the 2013 database of Tier II filers, 2011 accident data compiled from the U.S. DOT Pipeline and Hazardous Material Administration's Hazardous Materials Incident Reports database, the local OEM's electronic mailing list, and recommendations from key informants interviewed as part of the larger project. After pooling these sources and removing duplicates, the initial sample consisted of 916 individuals who we contacted by email in multiple waves. We received 242 responses (response rate = 26.4%), a rate consistent with surveys of this sort (Heath et al., 2018; Lindell & Perry, 2001). Of these responses, 171 contained sufficient data for analysis (completion rate = 70.6%).

Procedure

The questionnaire landing page described the study and provided information about participation. Recruitment was designed to allow participants to consult information online and ask questions to complete informed consent before proceeding. After agreeing, participants identified their organizational type and then read a scenario tailored to them that described a hypothetical HazMat incident involving an accident between a tanker truck and an enclosed box tractor-trailer (provided in full in the appendix). The median time spent on the scenario page was approximately 2 minutes (*median* = 109.86 s, *LQ* = 73.52, *UQ* = 179.32). After reading the scenario, participants completed the remainder of the 40-item questionnaire.

Measures

Stakeholder type

Before providing the incident description, we asked participants to categorize themselves as well as provide the name of their organization and their title. They could self-identify as 'a hazardous materials transportation carrier,' 'a facility that stores, uses, or produces hazardous materials,' 'an agency involved in planning for and responding to hazardous materials incidents,' 'a media organization,' 'a community group/organization,' or 'other.' We integrated this information and their contact information to identify participants as agency or non-agency stakeholders.

The specific organizations named included facilities ($n = 56$), HazMat carriers ($n = 6$), civil defense and emergency management organizations ($n = 20$), HazMat response-specific organizations ($n = 2$), law enforcement ($n = 4$), fire departments ($n = 18$), weather organizations ($n = 1$), citizens at large who had volunteered or been involved in one of these organizations in the past ($n = 7$), contractors ($n = 6$), county government ($n = 10$), city government ($n = 6$), utilities and public works ($n = 10$), public transportation organizations ($n = 3$), hospitals and clinics ($n = 15$), social services ($n = 14$), public health organizations ($n = 3$), environmental regulatory organizations ($n = 3$), schools and school district organizations ($n = 16$), emergency medical organizations ($n = 5$), and volunteer and non-governmental organizations ($n = 7$). We received only one response from a media organization, and it was not complete enough to be included in this analysis.

Agency stakeholders ($n = 62$) included those specifically involved in the broader planning, preparation, or response to disasters and emergencies (e.g. law enforcement, fire, specific HazMat organizations; emergency management officers and government staff; and first aid, environmental, transportation, and environmental agencies; see Figure 1). Non-agency stakeholders ($n = 109$) included those who were not typically involved in chemical hazard planning, preparation, or response in their day-to-day work but who may be called upon to act during HazMat incidents. The primary missions of their organizations were not planning, preparation, or response (e.g. HazMat carriers and facilities; government staff not involved in emergency management, planning, or response; religious community organizations; school and school district organizations; local businesses; and citizens at large).

Perceptions of the incident

Participants rated the believability, relevance, and likelihood of the incident as well as the risks to human health and the environment. Single item measures were used to assess

perceptions of likelihood ('How likely is it that an incident like this could actually happen in [LEPC-A] County?'), relevance ('How relevant would your organization/community role be in a scenario like this if it actually happened?'), and believability ('How believable is the scenario?') on scales that ranged from 1 (*very unlikely, completely unbelievable, or very irrelevant*) to 6 (*very likely, very relevant, or completely believable*). Single item measures were also used to assess perceptions of risk ('How risky is the scenario to human health and safety?' and 'How risky is the scenario to the environment?') on a scale from 1 (*not at all risky*) to 5 (*extremely risky*).

Involvement in emergency planning

Participants rated their involvement in emergency planning activities by responding to four items, which were combined into a single measure ($\alpha = 0.87$). Two items asked, 'How much have you personally been involved with 'all-hazards' emergency planning … ' on a scale from 1 (*minimally involved*) to 5 (*extensively involved*) for 'your organization/constituency' and for '[LEPC-A] County.' A second pair asked, 'How much have you personally been involved with chemical hazards emergency planning … ' for 'your organization/constituency' and for '[LEPC-A] County.'

HazMat-related information seeking

Participants indicated the degree to which they sought information from 18 types of information sources (Bierling, 2012). Categories of sources included previous emergency planning studies, technical data provided by various entities, general information from the internet, media reports, and interviews with various LEPC stakeholders. Participants could select all that applied.

Planning and response ego networks

Participants provided information regarding their networks using established procedures (Burt, 1984). Participants completed a name generator and name interpreters for response networks followed by a parallel set of questions for planning networks. First, the questionnaire prompted participants to list up to 10 persons/organizations by responding to the question, 'If you/your organization were involved in an incident like this, who (what organizations/people) would you reach out to?' Then, using measures from previous research (Huang, Barbour, Su, & Contractor, 2013; Yuan, Fulk, Monge, & Contractor, 2010), participants were asked to indicate how often they communicated with the individuals/organizations listed (*never, less than once per month, once per month, 2–3 times per month, once a week, 2–3 times per week, or daily*). Responses were rescaled for analysis to times per year. Participants also rated the expertise of each individual as 'Expert—one of the most knowledgeable people/organizations on the topic,' 'Intermediate—has a clear understanding of the topic,' 'Beginner—a basic understanding of the topic,' or 'None—not familiar with this topic.' These responses were scaled from 3 (*expert*) to 0 (*none*).

The questionnaire then repeated this process, but the name generator focused on the question, 'If you were *planning* for an incident like this, from which people/organizations would you seek advice?' The items regarding communication and expertise were then repeated with this list. Using the information provided, network size was calculated by summing the number of individuals/organizations listed in each participants' network.

Measures of participants' communication with their networks and expertise evaluations were calculated by averaging participants' ratings of those in their planning and response networks respectively.

Network homophily/heterogeneity

The research team also categorized each individual/organization listed as representing either an agency or non-agency stakeholder. We calculated a measure of the mix of the organizational memberships composing participants' planning and response networks, the E–I index (Everett & Borgatti, 2012; Krackhardt & Stern, 1988). The measure is a ratio of connections to organizations within and outside each participant's own stakeholder group:

$$\text{E-I Index} = \frac{\text{EL-IL}}{\text{EL} + \text{IL}},$$

where

EL = the number of connections to organizations outside the participant's area and

IL = the number of connections to organizations inside the participant's area.

The scores for this measure range from +1.00, wherein all participants' connections are to those outside of their area (heterophily), and −1.00, wherein all participants connections are to those inside of their area (homophily) (Table 1).

Data analysis

To address RQs 1–3, we tested separate multilevel models contrasting agency and non-agency LEPC stakeholders. The multilevel models nested participants within their responding organizations ($J = 122$) to address problems of statistical independence (Raudenbush & Bryk, 2002). Most statistical tests assume that observations are independent, but non-independence is an inherent part of the orthodox analysis of network data (Wasserman & Faust, 1994). The structural effects of individuals' relationships with others in the network are the object of interest. Nesting participants in their organizations help address problems with the lack of independence among observations by modeling the variation as comprised of differences among individuals and among their organizations (Raudenbush & Bryk, 2002). Doing so limited the overweighting of individuals from the same organization. This approach, versus aggregating the data to the organizational level, preserves the variability in the individual responses. We report Cohen's *d* as an indicator of the magnitude of differences. For RQ4, each of the models developed for RQs 1–3 was modified by adding an interaction term. We compared (a) models with the stakeholder type and involvement variables for each outcome measure with (b) models that added an interaction term between planning involvement and stakeholder type. Models were constructed using maximum likelihood (ML) estimation, and we compared the deviance scores for the models (i.e. the likelihood ratio test) where lower deviance values indicate better model fit (Hox, 2010). We report the individual-level variance changes as indicators of the explanatory power of the interaction. Tables 2 and 3 report the mean comparisons and statistical tests for RQs 1–3, and, for readability, only effect sizes indicative of the differences between agency and non-agency stakeholders that are statistically significant are reported in text.

Table 1. Descriptive statistics.

	Mean	*SD*	*ICC*	*N*	02	03	04	05	06	07	08	09	10	11	12	13	14	15
01 Health risk perceptions	4.89	0.37	0.03	159	.52	*.01*	*−.10*	*.02*	*.10*	.16	*.01*	*.04*	*.14*	*.08*	*−.01*	.21	*.05*	*.08*
02 Environmental risk perceptions	4.65	0.64	0.05	158		*.10*	*.08*	*.04*	*−.06*	*.12*	*.00*	*−.16*	*.05*	*−.03*	*.12*	.21	*.10*	*.11*
03 Scenario likelihood	5.20	1.31	0.07	115			.54	.28	*.10*	*.10*	*.07*	*.08*	*.14*	*.10*	*−.09*	*.06*	−.29	−.25
04 Scenario believability	5.05	0.95	0.07	119				.22	.09	*.11*	*.16*	*.11*	*.09*	*.10*	*−.08*	*.04*	*−.15*	*−.10*
05 Scenario relevance	4.76	1.43	0.65	117					.37	.37	.32	.20	.32	.27	*.01*	*.06*	−.27	−.22
06 Planning involvement	2.79	1.32	0.34	116						.43	.27	*.18*	.29	.22	*.01*	*.14*	*−.15*	*−.12*
07 Information sources	4.13	4.64	0.03	171							.37	.36	.33	.35	*−.15*	*.00*	−.19	−.22
08 Response network size	5.41	2.73	0.14	136								.64	*.11*	.20	*−.17*	*−.05*	*−.15*	*−.14*
09 Planning network size	4.87	2.67	0.28	111									*.02*	.20	*−.02*	*−.16*	−.21	−.24
10 Response network comm.	60.37	69.94	0.01	132										.64	−.18	*−.03*	−.27	−.28
11 Planning network comm.	46.67	54.79	0.01	108											*.01*	*−.14*	−.27	−.32
12 Response network expertise	2.27	0.52	0.27	125												.43	*.09*	*.07*
13 Planning network expertise	2.52	0.49	0.16	106													*.11*	.21
14 Response network EI index	−0.10	0.84	0.83	136														.94
15 Planning network EI index	−0.11	0.85	0.82	111														

Note. The table contains measure means, standard deviations, the intraclass coefficients for the nesting of individual participants within their primary organizational affiliations, the number of participants, and zero-order correlations. All correlations are significant ($p < 0.05$) except for those in italics.

Table 2. Summary of mean difference comparisons.

Comparisons between agency and non-agency LEPC stakeholders	Agency stakeholders	Non-agency stakeholders	Effect size	Involvement in planning moderation
RQ1. Perceptions of a hypothetical HazMat incident				
• Risk to human health	4.85 (0.40)	4.91 (0.36)	0.14 *ns*	None
• Risk to the environment	4.52 (0.70)	4.72 (0.60)	0.31 *ns*	None
• Believability	5.11 (0.74)	4.99 (1.05)	−0.13 *ns*	None
• Relevance to their org.	5.32 (0.94)	4.40 (1.57)	−0.59*	Yes–Figure 2
• Likelihood	5.45 (0.85)	5.01 (1.52)	−0.38 *ns*	None
RQ2. Involvement in planning	3.09 (1.30)	2.57 (1.30)	−0.41*	Not applicable
RQ2. Hazards-related information seeking	5.56 (5.21)	3.28 (4.11)	−0.61*	None
RQ3a. Response networks				
• Size	6.27 (2.79)	4.81 (2.53)	−0.54*	Yes–Figure 2
• Heterogeneity	−0.84 (0.22)	0.35 (0.76)	1.81*	None
• Communication frequency	78.05 (72.13)	50.21 (67.11)	−0.40*	None
• Perceptions of expertise	2.21 (0.49)	2.30 (0.55)	0.14 *ns*	None
RQ3b. Planning networks				
• Size	5.95 (2.65)	4.25 (2.49)	−0.63*	None
• Heterogeneity	−0.84 (0.27)	0.32 (0.79)	1.71*	None
• Communication frequency	64.68 (58.51)	36.05 (49.93)	−0.45*	None
• Perceptions of expertise	2.38 (0.40)	2.59 (0.52)	0.47*	Yes–Figure 2

Note. The table reports means, standard deviations in parenthesis, and effect sizes (Cohen's *d*). Significant differences are highlighted with an asterisk ($\alpha = 0.05$), and '*ns*' indicates the difference was not significant. See Table 3 for tests of the comparisons.

Results

Differences in perceptions of a hypothetical HazMat incident (RQ1)

For the most part, LEPC stakeholders reported similar perceptions of the hypothetical HazMat incident. Agency and non-agency stakeholders had similar perceptions of the risk of the incident to human health and the environment, which they saw as substantial. They also had similar perceptions of the believability of the incident, which they found believable. Agency stakeholders were more likely to see the incident as relevant to their organizations' missions ($d = -0.59$). Both reported that it was likely that an incident similar to the one described could actually occur, and agency LEPC stakeholders just slightly more so ($d = -0.38$). For perceptions of the relevance of the scenario, involvement in planning interacted with stakeholder type, which we discuss below.

Differences in involvement in planning and hazards-related information seeking (RQ2)

Agency LEPC stakeholders reported more involvement in planning ($d = -0.41$). Agency stakeholders reported seeking information from more sources than non-agency LEPC stakeholders ($d = -0.61$). The relative popularity of specific sources of information was similar, but a greater proportion of agency stakeholders reported accessing them. The most popular sources were data provided by (a) local agencies, (b) state agencies, and (c) federal agencies; previous emergency planning studies conducted by (d) LEPC-A's County and (e) by other jurisdictions; and (f) general information from the Internet (with 74.41–51.12% of agency stakeholders and 59.68–43.55% of non-agency stakeholders reporting accessing these sources).

Table 3. Tests of mean differences.

Comparisons between agency and non-agency LEPC stakeholders	Effect size	*b*	*SE*	*t*	*p*
RQ1. Perceptions of a hypothetical HazMat incident					
• Risk to human health	0.14 *ns*	0.06	0.06	0.87	0.38
• Risk to the environment	0.31 *ns*	0.21	0.11	1.91	0.06
• Believability	−0.13 *ns*	−0.14	0.20	−0.69	0.49
• Relevance to their org.	−0.59*	−0.95	0.31	−3.07	<0.01
• Likelihood	−0.38 *ns*	−0.54	0.28	−1.98	0.05
RQ2. Involvement in planning	−0.41*	−0.56	0.27	−2.05	0.04
RQ2. Hazards-related information seeking	−0.61*	−2.34	0.75	−3.14	<0.01
RQ3a. Response networks					
• Size	−0.54*	−1.46	0.48	−3.07	<0.01
• Heterogeneity	1.81*	1.25	0.12	10.27	<0.01
• Communication frequency	−0.40*	−27.96	12.68	−2.21	0.03
• Perceptions of expertise	0.14 *ns*	0.08	0.10	0.76	0.45
RQ3b. Planning networks					
• Size	−0.63*	−1.71	0.53	−3.22	<0.01
• Heterogeneity	1.71*	1.23	0.14	8.77	<0.01
• Communication frequency	−0.45*	−29.37	12.93	−2.27	0.02
• Perceptions of expertise	0.47*	0.23	0.10	2.33	0.02

Note. The table reports effect sizes (Cohen's *d*) and the unstandardized coefficients (*b*), standard errors (*SE*), *t*-values (*t*), and *p*-values (*p*) of the multilevel models contrasting agency and non-agency LEPC stakeholders. Significant differences are highlighted with an asterisk (α = 0.05), and '*ns*' indicates the difference was not significant. See Table 2 for means and standard deviations.

Differences in planning and response networks (RQ3)

Agency LEPC stakeholders reported larger response networks ($d = -0.54$) and planning networks ($d = -0.63$). Agency stakeholders also reported much more homophilous response networks ($d = 1.81$) and planning networks ($d = 1.71$) than non-agency LEPC stakeholders. Agency stakeholders reported communicating more frequently with their response networks in the course of their day-to-day work ($d = -0.40$), and this held true for their planning networks as well ($d = -0.45$).

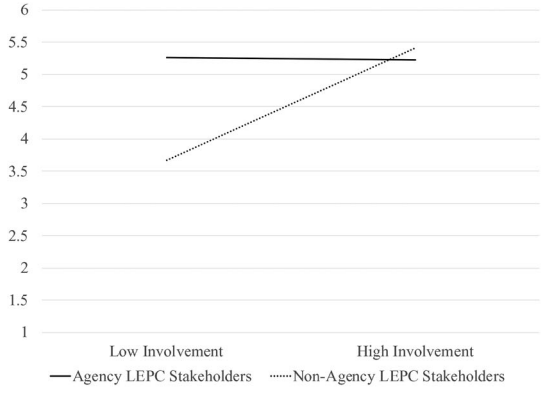
Agency stakeholders reported communicating with their response and planning networks one or two times a week, which was slightly, but not significantly, more than non-agency stakeholders who reported communicating with their response networks about once per week and their planning networks about three times per month. Agency and non-agency stakeholders also rated the expertise of their response networks similarly, indicating that they believed those in their response networks had a clear to expert understanding of hazardous material incident response. Non-agency LEPC stakeholders rated the expertise of their planning networks slightly higher than agency stakeholders ($d = 0.47$); however, involvement in planning interacted with stakeholder type for perceptions of planning network expertise and response network size, the focus of RQ4.

Involvement in planning as a moderating factor (RQ4)

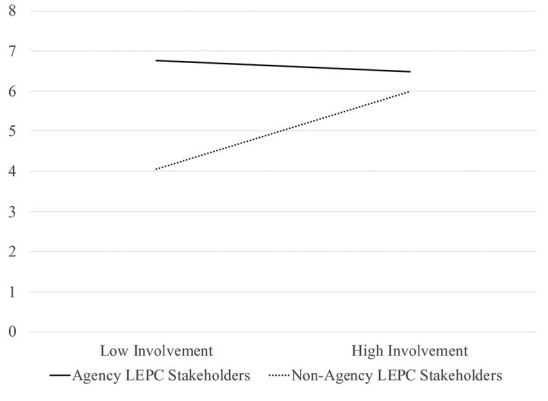
To summarize, agency and non-agency LEPC stakeholders had similar perceptions of the risks to human health and the environment in the scenario, the likelihood of the scenario, and similar perceptions of the expertise in their response and planning networks. Agency LEPC stakeholders reported a greater relevance of the scenario to their organization. They also reported greater involvement in planning and more information seeking related to emergency planning. The response and planning networks of agency informants tended

to be larger and more homophilous. Agency stakeholders also reported communicating with their response and planning networks more in their day-to-day work (see Tables 2 and 3).

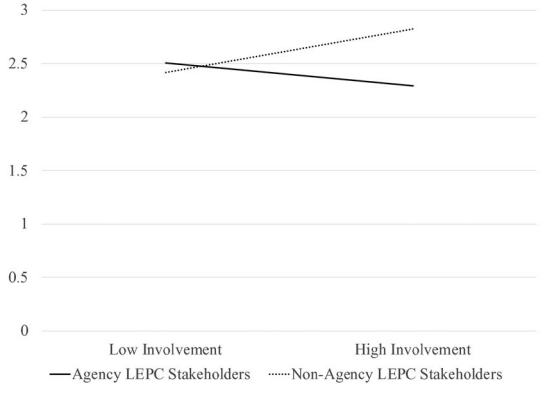
Involvement in emergency planning moderated differences in perceptions of the relevance of the hypothetical incident (Figure 2). The addition of the interaction term explained an additional 38.28% of the variability in relevance ($\chi^2[1] = 13.31$, $p < 0.01$, $V = 0.34$). The results indicate that, for this sample, involvement in planning may minimize the differences between the stakeholder groups' perceptions of the relevance of the



Interaction between Planning Involvement and Stakeholder Type on Perceptions of Scenario Relevance



Interaction between Planning Involvement and Stakeholder Type on Response Network Size



Interaction between Planning Involvement and Stakeholder Type on Perceptions of Planning Network Expertise

Figure 2. Interactions between planning involvement and stakeholder type on perceptions of organizational relevance, response network size, and planning network expertise.

scenario for their organizations by making the relevance clear to non-agency LEPC stakeholders.

Involvement in emergency planning moderated differences in their perceptions of the size of their response networks and expertise of their planning networks (Figure 2). The interaction explained an additional 3.35% of the variability in response network size ($\chi^2[1] = 5.78,\ p = 0.02,\ V = 0.23$). The results indicate that involvement in planning efforts minimized the differences in response network size between agency and non-agency LEPC stakeholders. Adding the interaction explained an additional 7.96% of the variance in perceptions of planning network expertise ($\chi^2[1] = 11.06,\ p < 0.01,\ V = 0.33$). Probing this interaction indicates that involvement had little effect for agency LEPC stakeholders, but was associated with heightened perceptions of expertise for non-agency LEPC stakeholders.

Discussion

Implications for practice and theory

The findings contribute to the study and practice of community resilience in the following ways: first, they demonstrate the efficacy of the LEPCs as risk communication infrastructure, and they point to the importance of perceptions of relevance in building community resilience. Second, the findings also provide evidence that involvement in planning may align how agency and non-agency stakeholders perceive HazMat incidents and grow their networks. The findings also suggest, however, that the effects of planning involvement may be limited, confirming the difficulty of building networks for community resilience. Third, the findings suggest that the organizational differences that make community resilience difficult may be visible in the make-up of LEPC stakeholders' planning and response networks. The sections that follow consider each contribution to practice and theory in turn followed by recommendations for directions.

LEPCs as risk communication infrastructure

First, and most importantly from a community resilience perspective, LEPC-A stakeholders reported seeking information about HazMat and having planning and response networks relevant to HazMat incidents. LEPCs exist in part to offer such information and to build such networks. That agency stakeholders reported seeking such information, having these networks, and communicating with them on a regular basis may not be surprising, but non-agency stakeholders did as well, identifying planning and response networks that moved beyond simply calling 9–1–1 in the event of a HazMat incident. For example, in our discussion with LEPC members during the conduct of this study, trucking companies reported that they coordinated responses with local fire departments, even though they would call 9–1–1 to send incidents 'up the line.' Such networks contribute to community resilience (Doerfel, 2016; Kirschenbaum & Rapaport, 2018).

The stakeholders also had similar perceptions of the risk of the exemplary incident, the likelihood that such an incident is possible, and the believability of the incident as described. LEPC-A stakeholders also reported seeking information about HazMat planning and response from similar types of sources with agency stakeholders reporting slightly more information seeking. Overlapping perceptions and information can make

planning for, responding to, and recovering from such incidents easier (Mumford & Gray, 2009) and may reflect a bridging of perspectives, which can be useful in building resilience (Doerfel, 2016; Houston et al., 2015).

Research on LEPCs as a part of HazMat risk communication previously focused on the usefulness of this communication for building community trust, encouraging perceptions of legitimacy for industry, and increasing citizen response efficacy (Heath et al., 2002; Heath et al., 2018). The findings in this study indicate the need to help stakeholders also understand why HazMat planning and preparation as well as incidents are relevant to them. Risk communication efforts should be aimed not only at understanding HazMat or safety but also at clarifying why particular stakeholder groups should care.

Involvement in planning makes a difference

Policymakers and leaders generally associate preparedness with the robustness of participation in preparedness and planning efforts (Hede, 2017; McConnell & Drennan, 2006), but gathering concrete evidence for the relationship between preparation and planning activities and preparedness is difficult (Barbour & Manly, 2016; Perry, 2004). In these data, involvement in planning was associated with (a) an increased sense of the relevance of HazMat incidents, (b) an increase in perceptions that planning networks included HazMat experts, and (c) larger response networks, for non-agency stakeholders. These findings are a promising sign for the usefulness of the sorts of efforts undertaken by LEPCs for growing community resilience by bolstering the community relationships needed to cope in crisis (Doerfel, 2016).

Differences and boundaries in organizing persist

The findings also contribute to the study of community resilience by providing evidence regarding differences in agency and non-agency member networks. That is, LEPC-A may have functioned as a setting for enhancing the interorganizational linkages suggested by theories of community resilience (Doerfel, 2016; Houston, 2018; Houston et al., 2015). For non-agency LEPC stakeholders, those networks were heterogenous—bridging across sectors as well as organizational boundaries. However, agency LEPC stakeholders' networks tended to be more homophilous. The findings indicate that the bureaucratic and network logics described by Doerfel (2016) may have operated per her theorizing, and, of particular interest here, that they did so differently in different stakeholder groups. Research and interventions aimed at community resilience building need to take those differences into account.

Although the findings point to the value of planning efforts for building community resilience capacity, the differences in the homophily of agency and non-agency stakeholders' networks persisted regardless of the degree of their involvement in planning. It may be that the effects of planning involvement on network homophily are small, and this study had insufficient power for finding them. However, for these data, agency stakeholders tended to have response and planning networks comprised of other agency stakeholders. In our informal conversations with LEPC-A members, agency stakeholders, most of whom were responders, talked about other responders, but rarely mentioned the expertise of the broader community of LEPC stakeholders. When asked about this, a member of the LEPC explained, 'I think it's a combination of people not coming to the meetings, and … the people that do come to the meetings are not sharing it with the people who are on

the streets.' Another active LEPC participant who was a member of a disaster-focused nonprofit organization explained, 'We do work with two different, I guess, type of people: the community and the first responders,' highlighting that they saw differences in the support needs and desires of these stakeholders.

Future directions

In sum, the findings indicate involvement in planning activities such as those supported by LEPCs may help align perceptions of HazMat incidents and build the community relationships needed for community resilience (Doerfel, 2016; Doerfel et al., 2013; Houston, 2018). The findings also suggest that relationships between planning and resilience are complicated in ways that deserve further attention. In this section, we highlight areas for future research and practical intervention including investigating the complexities involved in understanding the effects of planning and differences among LEPC stakeholders.

Effects of involvement in planning

Future research should disentangle the effects of immediate and more distant network connections for community resilience. For example, it may be that non-agency stakeholders increase the expertise available to them in their networks by virtue of their involvement in planning, but stakeholders generally may grow the expertise in their response as well as planning networks through indirect connections. In talking to LEPC members to conduct the study, HazMat transporters mentioned safety professionals who worked in their facilities whom they expected would contact the local fire departments and HazMat teams as needed.

It should also be noted that the causality among involvement in planning and these indicators of community resilience may be the reverse of what we theorized. It may be that participants who saw the relevance of the scenario, or have larger response networks, or more robust evaluations of the expertise of their planning networks, have characteristics that make them more likely to seek out planning experiences in the first place. The lack of any moderating effect on planning network size suggests that planning networks may form as a precursor to increasing the size of the response networks. Post hoc, we examined the overlaps in individuals' planning and response networks using a QAP correlation (quadratic assignment procedure), and found a strong association ($r = 0.57$, $p < 0.01$), which is consistent with but not sufficient to establish that more robust planning networks lead to more robust response networks. This research suggests that future scholarship should investigate and practical interventions should be mindful of how the formation of planning networks affects response networks over time.

It may also be that the causality is recursive: a non-agency LEPC stakeholder who participates in planning may grow their network and then seek out more opportunities to participate, which further increases the size and perceived expertise of their networks. Alternatively, agency LEPC stakeholders who participate in planning may grow their planning network and as a result get assigned more duties to participate as part of their work. One LEPC member with whom we talked with, an amateur radio operator, reported getting involved because of his experience during hurricanes, and then, eventually, getting more involved in planning, including through LEPCs, once he participated in

training exercises. The point is that, for him, getting ready was a community effort involving overlapping, interlinked network memberships: He described working with his old boss at a large oil company who is in his radio network and with whom he trains. Our research suggests that LEPCs should encourage planning participation as part of multiple reinforcing pathways to community resilience.

Stakeholder differences

For this analysis, the simple categorization of stakeholders had value but also masks a more complex reality. LEPCs and other emergency planning exercises exist in part to blur the boundaries among stakeholders. Individuals who are involved in LEPCs and other community emergency and disaster planning and response roles do so in multiple and different capacities for multiple and different organizations. The subset of individuals who described themselves as belonging to disaster-focused nonprofit organizations like a Citizen Emergency Response Team or the Red Cross were treated as non-agency stakeholders, but this categorization makes clear the fuzziness of the distinction (see also Barbour & Manly, 2016). These disaster-focused nonprofit organization participants tended to have more heterogeneous networks ($M_{\text{RNEI}} = 0.83$, $M_{\text{PNEI}} = 0.87$) and larger than average sized networks ($M_{\text{RNSize}} = 5.50$, $M_{\text{PNSize}} = 6.00$).

We addressed this complexity imperfectly by asking participants to identify the primary capacity in which they were responding to the questionnaire. We also asked them to identify any and all previous experience working in domains relevant to the investigation (e.g. firefighting, law enforcement, government, military, emergency medical services, hospitals, HazMat facilities and carriers, emergency planning). 'No previous experience' in these domains was the most common response overall ($n = 65$), but for those who had experience, most identified only one ($n = 43$) or two ($n = 21$) domains ($M = 1.55$, $SD = 1.76$). The seven informants who indicated they represented volunteer and non-governmental organizations reported experience in more domains on the whole ($M = 2.71$, $SD = 2.81$), but it varied greatly.

The complexity of participation in LEPCs and emergency planning notwithstanding, the overarching practical question regarding the right sort of connectedness needed among LEPC stakeholders remains. A key dimension of the logic of LEPCs and community reliance is bridging sectors. Nonetheless, it is also *functional* for different stakeholders to play different roles and therefore to organize differently. During response, a core–periphery network structure with response and planning agencies at the center may be appropriate (Chen et al., 2008; Moynihan, 2008), but the persistence of that difference in their *planning* networks may be problematic for community resilience. Furthermore, overall, participants' perceptions of the expertise in planning networks were positively correlated with the heterogeneity of those networks ($r = 0.21$, $p < 0.05$), but the interaction between involvement in planning efforts and stakeholder types suggests that this may hold for non-agency stakeholders more than agency stakeholders.

Future research should consider differences in how stakeholders evaluate the utility of preparedness efforts and the value of working across sectors. In practice, it may help to involve responders in planning outside of their formal agency roles to encourage a whole-community view. These findings contribute to the study of community resilience by indicating that sector differences reflected in the make-up of stakeholders' networks can make it more difficult to bridge sectors.

Conclusion

LEPCs can serve as important risk communication infrastructure. Their efforts can reach community members and improve response efficacy (Heath et al., 2018), and this study demonstrates they can also bring together diverse organizations and build community resilience. This study advances communication theory of community resilience by indicating that differing logics of organizing not only influence planning and response networks in action, but that they do so differently for different stakeholder groups. LEPCs may contribute to community resilience by bridging perceptual and communication gaps among cross-sector stakeholders, and the effects may be stronger for those who do not work in disaster preparation, response, and recovery every day. Community resilience building efforts need to account for those differences.

Disclosure statement

The authors report they have no conflict of interest.

Funding

This material is based upon work supported by the U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, administered by the Texas Division of Emergency Management.

ORCID

Joshua B. Barbour http://orcid.org/0000-0001-8384-7175

References

Amendola, A., & De Marchi, B. (1996). Communication in chemical emergencies. *Journal of Contingencies and Crisis Management*, *4*, 45–50. doi:10.1111/j.1468-5973.1996.tb00075.x

Bajak, F., & Olsen, L. (2018). Silent spills, part 1: In Houston and beyond, Harvey's spills leave a toxic legacy. *Houston Chronicle*. Retrieved from https://www.houstonchronicle.com/news/houston-texas/houston/article/In-Houston-and-beyond-Harvey-s-spills-leave-a-12771237.php

Barbour, J. B., & James, E. P. (2015). Collaboration for compliance: Identity tensions in the interorganizational regulation of a toxic waste facility. *Journal of Applied Communication Research*, *43*, 363–384. doi:10.1080/00909882.2015.1083601

Barbour, J. B., & Manly, J. N. (2016). Redefining disaster preparedness: Institutional contradictions and praxis in volunteer responder organizing. *Management Communication Quarterly*, *30*, 333–361. doi:10.1177/0893318916629101

Bierling, D. H. (2012). *Participants and information outcomes in planning organizations* (Doctoral dissertation). Available from ProQuest Dissertations & Theses Global. (Order No. 3532110).

Burt, R. S. (1984). Network items and the general social survey. *Social Networks*, *6*, 293–339. doi:10.1016/0378-8733(84)90007-8

Buzzanell, P. M. (2010). Resilience: Talking, resisting, and imagining new normalcies into being. *Journal of Communication*, *60*, 1–14. doi:10.1111/j.1460-2466.2010.01469.x

Chen, R., Sharman, R., Rao, H. R., & Upadhyaya, S. J. (2008). Coordination in emergency response management: Developing a framework to analyze coordination patterns occurring in the emergency response life cycle. *Communications of the ACM*, *51*, 66–73.

Chua, V., Madej, J., & Wellman, B. (2011). Personal communities: The world according to me. In J. Scott, & P. J. Carrington (Eds.), *The SAGE handbook of social network analysis* (pp. 101–115). Thousand Oaks, CA: Sage.

Curnin, S., Owen, C., Paton, D., Trist, C., & Parsons, D. (2015). Role clarity, swift trust and multi-agency coordination. *Journal of Contingencies and Crisis Management*, *23*, 29–35. doi:10.1111/1468-5973.12072

Doerfel, M. L. (2016). Networked forms of organizing, disaster-related disruptions, and public health. In T. Harrison, & E. Williams (Eds.), *Organizations, communication, and health* (pp. 365–383). New York, NY: Routledge.

Doerfel, M. L., Chewning, L. V., & Lai, C.-H. (2013). The evolution of networks and the resilience of interorganizational relationships after disaster. *Communication Monographs*, *80*, 533–559. doi:10.1080/03637751.2013.828157

Donahue, A. K. (2004). Managerial perceptions and the production of fire protection. *Administration & Society*, *35*, 717–746. doi:10.1177/0095399703256777

Everett, M. G., & Borgatti, S. P. (2012). Categorical attribute based centrality: E–I and G–F centrality. *Social Networks*, *34*, 562–569. doi:10.1016/j.socnet.2012.06.002

Heath, R. L., Bradshaw, J., & Lee, J. (2002). Community relationship building: Local leadership in the risk communication infrastructure. *Journal of Public Relations Research*, *14*, 317–353.

Heath, R. L., Lee, J., Palenchar, M. J., & Lemon, L. L. (2018). Risk communication emergency response preparedness: Contextual assessment of the protective action decision model. *Risk Analysis*, *38*, 333–344. doi:10.1111/risa.12845

Hede, S. (2017). Perceptions of crisis preparedness and motivation: A study among municipal leaders. *Safety Science*, *95*, 83–91. doi:10.1016/j.ssci.2017.02.010

Houston, J. B. (2018). Community resilience and communication: Dynamic interconnections between and among individuals, families, and organizations. *Journal of Applied Communication Research*, *46*, 19–22. doi:10.1080/00909882.2018.1426704

Houston, J. B., Spialek, M. L., Cox, J., Greenwood, M. M., & First, J. (2015). The centrality of communication and media in fostering community resilience: A framework for assessment and intervention. *American Behavioral Scientist*, *59*, 270–283. doi:10.1177/0002764214548563

Hox, J. (2010). *Multilevel analysis: Techniques and applications* (2nd ed.). New York: Routledge.

Huang, M., Barbour, J. B., Su, C., & Contractor, N. (2013). Why do group members provide information to digital knowledge repositories? A multilevel application of transactive memory theory. *The Journal of the American Society for Information Science*, *64*, 540–557. doi:10.1002/asi.22805

Kinsella, W. J., Kelly, A. R., & Kittle Autry, M. (2013). Risk, regulation, and rhetorical boundaries: Claims and challenges surrounding a purported nuclear renaissance. *Communication Monographs*, *80*, 278–301. doi:10.1080/03637751.2013.788253

Kirschenbaum, A., & Rapaport, C. (2018). Informal social networks as generic contingency plans. *Journal of Contingencies and Crisis Management*. Advanced online publication, 1–8. doi:10.1111/1468-5973.12222

Krackhardt, D., & Stern, R. N. (1988). Informal networks and organizational crises: An experimental simulation. *Social Psychology Quarterly*, *51*, 123–140.

Laboureur, D. M., Han, Z., Harding, B. Z., Pineda, A., Pittman, W. C., Rosas, C., … Mannan, M. S. (2016). Case study and lessons learned from the ammonium nitrate explosion at the West Fertilizer facility. *Journal of Hazardous Materials*, *308*, 164–172. doi:10.1016/j.jhazmat.2016.01.039

Lindell, M. K., & Perry, R. W. (2001). Community innovation in hazardous materials management: Progress in implementing SARA Title III in the United States. *Journal of Hazardous Materials*, *88*, 169–194. doi:10.1016/S0304-3894(01)00266-7

Majchrzak, A., Jarvenpaa, S. L., & Hollingshead, A. B. (2007). Coordinating expertise among emergent groups responding to disasters. *Organization Science*, *18*, 147–161.

McConnell, A., & Drennan, L. (2006). Mission impossible? Planning and preparing for crisis. *Journal of Contingencies and Crisis Management*, *14*, 59–70. doi:10.1111/j.1468-5973.2006.00482.x

Moynihan, D. P. (2008). Combining structural forms in the search for policy tools: Incident command systems in U.S. Crisis management. *Governance*, *21*, 205–229. doi:10.1111/j.1468-0491.2008.00395.x

Mumford, J., & Gray, D. (2009). Reconciling conflicting interpretations of risk: A case study about the siting of a hazardous plant. *Journal of Communication Management*, *13*, 233–249. doi:10.1108/13632540910976680

Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008). Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American Journal of Community Psychology*, *41*, 127–150. doi:10.1007/s10464-007-9156-6

Palenchar, M., Heath, R., & Orberton, E. (2005). Terrorism and industrial chemical production: A new era of risk communication. *Communication Research Reports*, *22*, 59–67. doi:10.1080/08824090052000343525

Perry, R. W. (2004). Disaster exercise outcomes for professional emergency personnel and citizen volunteers. *Journal of Contingencies and Crisis Management*, *12*, 64–75. doi:10.1111/j.0966-0879.2004.00436.x

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (2nd ed.). Thousand Oaks, CA: Sage.

Seeger, M. W. (2006). Best practices in crisis communication: An expert panel process. *Journal of Applied Communication Research*, *34*, 232–244. doi:10.1080/00909880600769944

Trefz, B. A., Bierling, D. H., & Williams, F. A. (2019). *Local emergency planning committee guide: Revitalizing and improving Texas LEPCs for local preparedness*. Retrieved from Texas Division of Emergency Management: https://www.preparingtexas.org

Ulmer, R. R. (2012). Increasing the impact of thought leadership in crisis communication. *Management Communication Quarterly*, *26*, 523–542. doi:10.1177/0893318912461907

U. S. Environmental Protection Agency (EPA). (2008). *2008 nationwide survey of local emergency planning committees (LEPCs)*. Washington, DC: Office of Emergency Management (OEM).

U. S. Environmental Protection Agency (EPA). (2018). What is EPCRA? Retrieved from https://www.epa.gov/epcra/what-epcra

Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications*. New York: Cambridge University Press.

Weick, K. E., & Sutcliffe, K. M. (2015). *Managing the unexpected: Sustained performance in a complex world* (3rd ed.). Hoboken, NJ: John Wiley & Sons, Inc.

Willey, R. J., Crowl, D. A., & Lepkowski, W. (2005). The Bhopal tragedy: Its influence on process and community safety as practiced in the United States. *Journal of Loss Prevention in the Process Industries*, *18*, 365–374. doi:10.1016/j.jlp.2005.06.019

Youngblood, S. A. (2012). Balancing the rhetorical tension between right to know and security in risk communication. *Journal of Business and Technical Communication*, *26*, 35–64. doi:10.1177/1050651911421123

Yuan, Y. C., Fulk, J., Monge, P. R., & Contractor, N. (2010). Expertise directory development, shared task interdependence, and strength of communication network ties as multilevel predictors of expertise exchange in transactive memory work groups. *Communication Research*, *37*, 20–47. doi:10.1177/0093650209351469

Appendix

The hypothetical HazMat incident description began with a sentence tailored to responding stakeholders. For hazardous material transportation carriers, it began, 'A vehicle owned by your company is involved in the following accident;' for facilities that store, use, or produce HazMat it began, 'A vehicle that is handling your organization's hazardous materials is involved in the following accident;' for agencies involved in planning for and responding to HazMat incidents it began, 'You are involved in responding to the following accident;' for media organizations it began, 'You are reporting on the following accident;' and for community groups and other organizations, it began, 'The following accident occurs in your community.' The remainder read, 'During the morning commute, an accident occurred involving a tanker truck and an enclosed box tractor-trailer. The trucks collided at an intersection. The collision crushed the passenger side of the tanker truck cab and knocked the tanker onto its driver side. The tanker truck has red hazardous materials placards with '1993' written on them. The box trailer has hazardous materials placards for 'Poison', 'Corrosive,' and 'Flammable' materials. The cab of the box tractor-trailer is on fire and the driver may be injured. Liquid is dripping from the back of the box tractor-trailer and is pooling on and along the roadway. Fire from the cab of the box tractor-trailer has spread into dry grass along the side of the roadway opposite the tanker truck. The tanker truck is not on fire. Liquid is escaping from a small gash toward the rear of the tanker and running into a ditch. The tank truck driver is injured but conscious. He can be heard shouting that he is trapped in his cab. The accident occurred in front of a gas station. A residential area and a school are beyond the gas station, downwind from the accident. The residential area and school are on the other side of an open field approximately 200 yards away. School is in session. There is a light breeze and the weather conditions are clear with a temperature of 76 degrees Fahrenheit. Traffic has stopped on the road. There are tractor-trailers, automobiles, and other vehicles stopped on the roadways. Drivers are attempting to drive away from the accident, but trucks are trapped by other vehicles and limited turning space, and are unable to turn around. Some drivers have left their vehicles and are approaching the accident site on foot.'