

Building community resilience through cross-sector partnerships and interdisciplinary research

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Abstract

Building community resilience has become a national imperative. Substantial uncertainties in dynamic environments of emergencies and crises require real-time information collection and dissemination based on big data analytics. These, in turn, require networked communities and cross-sector partnerships to build lasting resilience. This viewpoint article highlights an interdisciplinary approach to building community resilience through community-engaged research and partnerships. This perspective leverages existing community partnerships and network resources, undertakes an all-hazard and whole-community approach, and evaluates the use of state-of-the-art information communication technologies. In doing so, it reinforces the multifaceted intergovernmental and cross-sector networks through which resilience can be developed and sustained.

Evidence for practice

- Local communities can benefit from resources aggregated from different sectors and academia to enhance their capacity to plan, prepare for, and respond to emergencies.
- Interdisciplinary collaboration with community partners and stakeholders can help build community resilience in dealing with all hazards and public emergencies.
- Recent technological advancements can help improve real-time data collection and information sharing for networked and connected communities.

INTRODUCTION

As the scale and intensity of disasters continue to increase, building community resilience to all hazards has become a “national imperative” (NAS, 2012). This imperative highlights the need to build community capacity and coalitions, as well as to promote partnerships and networks across all levels of government, academia, and nonprofit and private sectors, to collectively respond to disasters and thus improve resilience (NRC, 2011). Community resilience is a shared responsibility among all sectors. It is critical for allowing a community to function during and after a crisis event, and it requires leveraging adaptive capacities built by partnerships and intra-community networks (Bloomfield, 2006). Technological advances in the big data era have enabled more effective preparedness for, and timely responses to, the

adverse impacts of natural and manmade disasters. However, decision and policy making for community resilience, as a complex socio-technical process, are often subject to short decision horizons within which collective and collaborative data collection, validation, and dissemination must take place. Modern technological capabilities coupled with an open governance partnership offers the potential for such decisions to be made more rationally (rather than intuitively) within the constraints of an emergency or a disaster.

For this viewpoint article, community resilience is considered as a function of a community’s adaptive governance, which helps develop community capacity through adaptive management, continuous learning, and coalition building (Comfort et al., 2010; Kapucu et al., 2013). In this era of reduced-boundary governance (Hall & Battaglio, 2018a), collaborative and adaptive forms of network governance, as a

method of collective decision-making, promote the capacity of organizations and community stakeholders to adjust and adapt their evolving relationships in a dynamic and uncertain environment of disasters and crises (Comfort et al., 2020; Kapucu, 2006). Because performance is a function of capacity (Hall, 2007, 2008), communities need to adapt to external environmental factors and utilize their internal technical capabilities and community capital. Increasingly, scholars are recognizing that outcomes of public policies are coproduced and taking their actions and decisions into account is necessary for our models to accurately and adequately understand the factors that influence resilience performance. In the uncertainties of impending disasters, communities must develop the necessary infrastructures and adaptive capacity to respond to and recover from emergencies (FEMA, 2011).

Substantial uncertainties in dynamic environments of emergencies and crises require access to information based on real-time big data analyses and coordinated data analytics through networked communities and cross-sector partnerships. In the meantime, resilience assessment (Rus et al., 2018) has not explicitly considered uncertainties incurred from coupled disasters, such as a hurricane coupled with a pandemic. Some effective protective actions in hurricane response tend to congregate people (e.g., sharing a community shelter) while working against the social distancing requirement for infectious disease control as a public health emergency response. In addition, equitable resilience is a difficult task to be incorporated into the resilience planning and policy making process that considers how social vulnerability leads to disproportionate suffering of disaster impacts by different subpopulations (Coleman et al., 2020). These practical challenges urge a data-driven approach to conducting interdisciplinary and community-engaged resilience research, with long-term goals and integrated research protocols addressing the complex issues of public emergencies (Ge et al., 2021).

COMMUNITY RESILIENCE

Community resilience is a multifaceted and complicated concept. The complex challenge of supporting community disaster resilience reflects a series of overlapping and interconnected subsets of problems, cross-cutting multiple policy domains and engagement of different levels of government and community stakeholders. Stakeholders attempting to grapple with the complexities of resilience must contend with a range of perspectives, worldviews, political agendas, educational and professional backgrounds, programmatic responsibilities, and cultural traditions. To overcome these challenges, a comprehensive interdisciplinary approach to resilience is required—one that will leverage existing community partnerships, networks, and resources, adopt an all-hazards perspective, and embrace state-of-the-art information and communication technologies (ICTs). This viewpoint article introduces such an approach by investigating such

partnerships among public, private, and nonprofit sector organizations, including academic institutions and community resilience functionalities, in the east central Florida (ECF) region (including 8 counties and 78 member towns/cities as shown in Figure 1). The discussion highlights ongoing regional interdisciplinary collaborative research in terms of its methodologies, data analytics, and resilience policy and planning implications as an exemplary case for both scholars and practitioners.

The selection of ECF as a testbed was inspired by the well-established community connectedness of this region through local and regional initiatives (e.g., the *Regional Resiliency Action Plan* by the East Central Florida Regional Planning Council (ECFRPC), the Future-Ready City Initiatives by the City of Orlando, and the Local Emergency Planning Committee (LEPC)) pertinent to emergency preparedness, response, and recovery. This effort emphasizes multi-scale (regional and local) ICT applications with a focus on cross-sector partnerships for community disaster resilience. Multiple stakeholder groups are engaged, including government officials, business operators, and nonprofit representatives in ECF, with respect to how they collaboratively communicate and coordinate their efforts as a team to make timely and effective decisions to strengthen community resilience to disasters including public health emergencies. With all-hazard and whole-community approaches (see Figure 1), the natural hazards of hurricane, tornado, wildfire, and flood and manmade hazards of active assailant and hazardous materials spill are taken into consideration in the collaborative research initiative. Please note these identified hazards are not all-inclusive of all hazards identified as threats to Florida and ECF, specifically.

The National Research Council defines resilience to be “the continued ability of a person, group, or system to function during and after any sort of stress” (NRC, 2011, p. 3). They further note that building and maintaining a resilient community requires not only monitoring change but also adapting behaviors in such a way as to accommodate any changes that occur (NRC, 2011). This aligns very well with the perspective of Norris et al. (2008) who suggest not only that resilience is the process behind those adaptive behaviors, but also that the amount of resilience a community exhibits is directly related to the speed at which it returns to its pre-event level of functioning or better. In turn, this implies a need to measure not only the “pre-event functioning” but also the level of functioning during and after the event, to assess when the community has returned to its initial state or an even better position. It is important also to recognize that resisting the initial impacts of a disruptive event can contribute significantly to the community’s ability to recover quickly, and thus to its resilience. Because community functioning is inherently multi-dimensional, any such measurement requires a multi-dimensional representation of resilience, including the social, technological, and cyber dimensions of community engagement (see Figure 2).

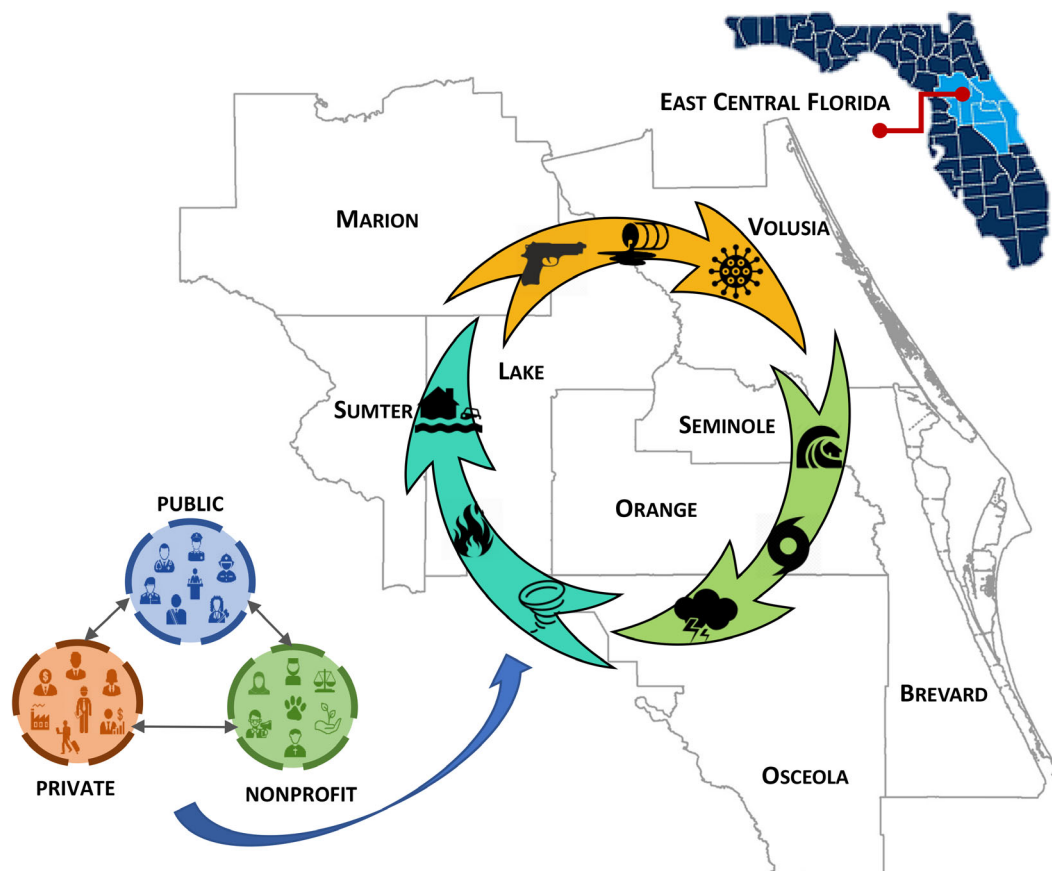


FIGURE 1 The East Central Florida (ECF) region with multi-hazards and multi-stakeholders.

Emergency communication and community resilience planning in response to the COVID-19 pandemic is even more of a challenge when coupled with the impacts of hurricanes and other natural or manmade disasters (Hasan et al., 2020; Sapat et al., 2023). The complexity that results from the cascading effects of multiple emergencies makes it necessary to (1) introduce an integrative paradigm of interdisciplinary community resilience research (NASEM, 2005; NRC, 2006); (2) advocate a community-engaged research orientation for community resilience planning and policy making (Kapucu et al., 2021) (Murray-Tuite et al., 2021); and 3) address the importance of understanding multi-modal and multi-typed data when considering time, space, and effective decision-making agents for a coordinated response.

AN INTERDISCIPLINARY RESEARCH APPROACH TO COMMUNITY RESILIENCE

Community resilience is a process that connects networks of adaptive capacities to actions that may be taken in response to a disruptive event (Aldrich & Meyer, 2015; Norris et al., 2008). It is an interdisciplinary concept that bridges social science, engineering, science, and more

recently, data science. It is imperative that interdisciplinary and convergent research efforts (NASEM, 2005; NRC, 2006; Peek et al., 2020) be sought to study resilient communities (NAS, 2012) that have the capacity to anticipate risks, collect information, and then manage those risks, including climate-related hazards, geological hazards, public health crises, civil unrest, technological incidents, and other human-made and natural hazards. Recent events have witnessed the disruptive power of cascading crises such as the COVID-19 pandemic, the California wildfires, and major hurricanes along the Gulf Coast and Atlantic Coast. Communities increasingly need to demonstrate that they can provide a healthy, safe, secure, and equitable environment that is resilient to external shocks and stresses.

The ECF study offers an example of a convergent research effort that focuses on the use of smart technologies to strengthen the set of adaptive capacities associated with organizational and community-level information and communication. Specifically, it addresses the issues of incomplete and ineffective information sharing related to risks and vulnerabilities during a disaster situation, and the effects that lack of information has on decision making and cross-sector partnerships for building more resilient communities. The study benefits from interdisciplinary perspectives (Ge et al., 2021) with synergistic contributions from emergency

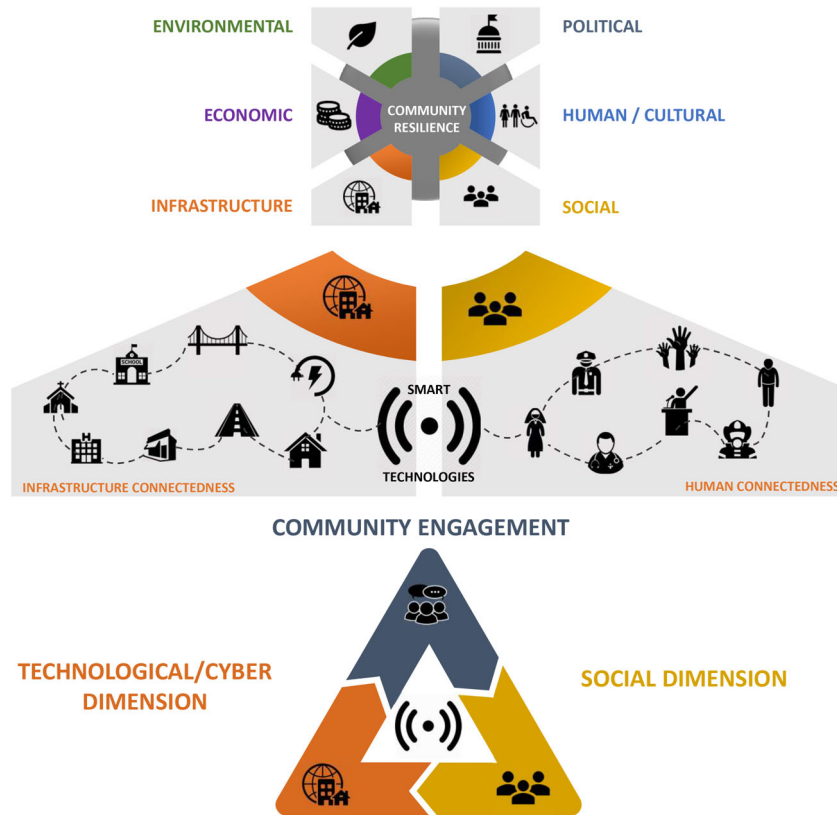


FIGURE 2 An interdisciplinary conceptual community-engaged framework.

management, public policy and governance, urban and regional planning, geographic information systems (GIS), computer science, information technology, and civil engineering. Several interrelated and complementary team-based subprojects leverage cross-disciplinary collaboration to address the complex, dynamic, and multifaceted nature of this regional study (Hall et al., 2018). The interdisciplinary approach helps to transcend the traditional “silos of knowledge” to explore the networks embedded within interdependent systems addressing community resilience challenges.

COMMUNITY-ENGAGED RESILIENCE RESEARCH

Building community resilience goes beyond simply acknowledging its multidimensionality and bringing together an interdisciplinary team of experts. Building resilient communities is a shared responsibility involving the recognition of different types of knowledge beyond formal academic scholarship and requiring the integration of both “bottom-up” approaches and “top-down” strategies. The involvement of a diverse group of stakeholders and community partners builds trust within the community and distributes the responsibility across the different groups in building resilience. Cross-sector partnerships, in particular, are a fundamental aspect of

the resilience process as they are thought to promote trust and to improve the efficiency and effectiveness of the applied strategies. The United Nations has emphasized the importance of these partnerships by dedicating as one of 17 sustainable development goals (SDGs) *encouraging multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology, and financial resources* (United Nations, 2015).

Cross-sector partnerships among community organizations and government agencies can improve the efficiency of the response and recovery phases of an emergency. In the context of technological advancements in the ways communities manage resilience operations, emergency planning and management through partnerships in emergency communication has become a key component. However, collaborative decision-making among public or private organizations has not been sufficiently addressed (Jabbour et al., 2019). Furthermore, decision making and its relation to planning and public policy has heretofore been approached merely from an analytical standpoint, rather than as a dynamic relationship where both are influenced by the other in an interactive fashion. This unidimensional perspective has driven a wedge between logistics decision making and alternative logistics actions in the field of emergency management (Campbell & Clarke, 2018). As such, it is imperative to comprehend how to address important aspects of emergency preparedness and response to arrive at a collaborative partnership among

the public, private, and nonprofit sectors. For example, there is a recognized need for governmental agencies to work with the community before the onset of a disaster, and it is suggested that such agencies should share adequate, real-time information both with the private sector and with the community members. The overarching goal of such information sharing is to facilitate and strengthen partnerships among public, private, and nonprofit entities that can increase resilience by identifying potential risks, sharing information, or projecting consequences and effectively addressing them (Levy & Prizzia, 2018).

Collaborative community-engaged resilience research expects that communities and partners are participating in a “living lab” of the emergency communication system “where technological, and social advances, and educational research are staged iteratively through pilot studies in communities” (NSF, 2022). In this paradigm, stakeholders are extensively engaged in informational meetings, surveys, social media, simulated emergency drills, and other data collection endeavors. This provides for the exchange of integrated and synthesized emergency information among all sectors in the community.

The ECF region, in particular, benefits from smart technologies being employed and evaluated in the context of community resilience capacity building, above and beyond this convergent and integrative study. These benefits include improving timely and effective risk communication in the multiethnic and fast-growing metropolitan region, strengthening long-term collaboration and partnerships among sectors and reducing social vulnerabilities to natural, manmade, and public health disasters. Three integrative goals can be achieved in the ECF region—(1) integrating smart technologies and community emergency communications applications; (2) integrating scientific research with community engagement; and (3) integrating community efforts from cross-sector organizations in a multiethnic region. Ultimately, sustained partnerships and collaborations in emergency communication and coordination for community resilience are anticipated in the long run among organizations, sectors, and jurisdictions in the ECF region. This can be replicated in other similar areas in the country.

MULTI-MODAL AND MULTI-TYPED DATA ANALYTICS

Collecting data for better emergency communication and coordination at multiple spatiotemporal resolutions is a challenging task. We applied a multi-modal and multi-typed data collection and analysis effort under an integrative data-driven approach. Such an approach can be used to measure the multi-dimensional resilience of smart and connected communities with respect to their adaptive capacities for information collection, analysis, and communication via cross-sector partnerships. Resilience capacities related to the information and communication dimensions are measured

via cross-sectional data gathered from the existing policies, plans, and frameworks in the ECF region. Every county in the region has an updated comprehensive emergency management plan developed based on the federal and state guidelines. ECFPRC engages in planning and preparedness activities quarterly. Behavioral survey data from community stakeholders and emergency managers indicated regular (annually or biannually) updates of their respective planning documents. These documents were also practiced with the emergency management stakeholders.

Social media data from emergency management organizations, 311 non-emergency municipal services request data, and regional- and local-level exercise and drill data can also be used as indicators of how different aspects of community functionality change over time, as well as of any potential gaps between the planned and implemented actions.¹ The approach introduced by Bruneau et al. (2003) and refined by Zobel (2011) can be used to capture a measure of actual or predicted resilience for each individual indicator by calculating the area under a time series curve of a given recovery process as a function of both loss and recovery time. Such a data-driven approach has strong potential to provide decision and policy makers with immediate and high-fidelity insights.

Finally, the cross-sectional (e.g., behavioral survey responses, planning and policy documents) and dynamic data (e.g., social media posts in text and images, 311 non-emergency calls) can be uploaded and visualized in a GIS-supported web system. A master GIS database—LOTIS (Land Overlaid on Transportation Information System) has been developed by the ECFRPC, which compiles transportation and land use information for roadway segments and vacant parcels for the Orlando metropolitan area. The tool is delivered via a series of tailored applications that enhance the view of land use, transportation, emergency management, and other urban planning scenarios for community resilience. To extend LOTIS for large-scale distributed systems, a big-data real-time processing and collaborative decision support system—*Community Resilience Data Depot* (CoRD²)—is developed and optimized in the ECF region. The CoRD² is a regional data storage and retrieval platform for sharing and integrating resilience data among all sectors. It is supported by artificial intelligence (AI) techniques that enable large-scale data interpretation, categorization, and segmentation to improve resilience within and across communities. Emergency drills via a mobile app whose data will be loaded onto the CoRD² platform for rapid AI-aided real-time data analyses can also be considered for timely information collection, dissemination, and better stakeholder coordination for resilience.

A CHECKLIST FOR COORDINATED REGIONAL RESILIENCE

Our approach, outlined above, can be summarized by a number of steps. Keeping in mind that the following

checklist aggregates a great deal of nuance and detail, it provides a meaningful guidepost for action where state, regional, or local governments wish to advance their disaster preparedness and resilience efforts to next generation capabilities. Furthermore, the list demonstrates the value of each analytical component and perspective in the cumulative picture, by revealing the range of information and communication capabilities necessary to make such an approach effectual.

The steps we followed include:

1. Analyze the policy documents to identify partnerships.
2. Survey the partnership organizations to clarify the nature of the partnerships in practice, and especially the roles played in building and implementing resilience capacities.
3. Collect non-emergency service request data to characterize the normal operations of the community and its interaction with government organizations.
4. Extend service request data analysis to consider the changes that occur in these relationships in times of crisis.
5. Collect Twitter data to obtain the community perspective of what's happening in the crisis, and to capture the behavioral attributes of human response to crises.
6. Aggregate these data streams to accentuate the data-rich environment of CoRD² upon which the evacuation drills and information management can be built.

CONCLUSION

This viewpoint article has focused on identifying factors that contribute to community resilience, particularly the cross-sector partnerships and networks as “building blocks” of community capital and resilience capacity from an interdisciplinary and community-engaged perspective. It contributes to our understanding of the complex network governance and sociotechnical systems necessary to build and sustain community disaster resilience. First, the interdisciplinary approach to integrating multimodal and multi-typed resilience functionality data is instrumental to unveil the multifaceted inter-organizational relationships across public, private, and nonprofit sectors in local and regional scales. Second, the community engagement activities for interdisciplinary community engaged research highlight the interplay of advanced information technology and community capitals and stakeholders that can influence building community resilience capacities. As public policy outcomes are increasingly coproduced, it stands to reason that incorporating citizen actions and decisions will result in better understanding of the processes and patterns that influence the effectiveness of resilience efforts. Finally, research synergies across different disciplines and research input from various sectors in the ECF participating jurisdictions integrate the policy-driven core

functionalities of community resilience with evaluative indicators at the organization, community, network, and systems levels. Generating data associated with disaster preparedness and response in this context will yield evidence that will inform the next generation of resilience policies in keeping with the high standards of evidence-based policy and practice (Hall & Battaglio, 2018b; Hall & Jennings, 2008; Jennings & Hall, 2012). The approach presented here can be used in other communities addressing community and organizational resilience in metropolitan areas and/or an extended region based on a metropolitan area where internal organizational technical capabilities and community capitals can be leveraged.

ENDNOTE

¹ Not every community has a 311 system. And it is not a 24/7/365 resource for citizens but is only activated during certain emergency situations to help reduce call volumes to 911.

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