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Translating the complexity of disaster resilience with local leaders

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Disaster resilience involves a complex web of processes, policies, regulatory requirements, and data that is difficult—if not impossible—to fully comprehend, even by seasoned experts. Yet resilience is not owned by "experts"—it is owned by local communities. Local leaders must be empowered to understand and trained to skillfully navigate complex systems to strengthen and continually build their resilience. Similarly, though billions of dollars in federal disaster recovery and mitigation funds are available to help local communities strengthen their resilience, additional work is needed to communicate, understand, assess, and address vulnerabilities at the local level, and particularly in small towns and in underserved communities, by harnessing local knowledge and data. In this article we present a framework developed to guide locally-owned resilience in Texas following Hurricane Harvey. The case study discusses methodologies to enhance the granularity of existing tools that assess resilience and social vulnerability by focusing on the local context for each, while building institutional to individual leadership needed to build disaster resilience over the longer-term. In particular, we discuss approaches being advanced by the Regional Resilience Partnership, which was formed to strengthen capacity for resilience in the 11 county Coastal Bend region, where Harvey first made landfall.

KEYWORDS

disaster resilience, local empowerment, capacity building, knowledge co-production, community resilience, small-town, rural, underserved communities

Introduction

Building community resilience to disasters—or the ability to prepare for anticipated hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions (National Institute of Standards and Technology, 2023)—is an enormous challenge. This is particularly so considering the complexity and potential interplay across key pillars of socio-ecological systems resilience (Walker et al., 2002), which we propose as socio-cultural, economic, infrastructure, environment, and governance. As well, understanding community resilience is an ongoing challenge because the application of resilience frameworks has largely outpaced theoretical development, and because of conceptual differences among researchers that regard resilience as a process (dynamic) or an outcome (static) lead to stark differences in the measurement of resilient properties. In most resilience assessments there also remains a technical disconnect between the structure, function, and processes of complex social-ecological systems and the systems' impacts on human wellbeing. This disconnect must be addressed through deepening resilience frameworks with local

experiences, including contextualized data, information and, importantly, capacity not only to participate in theory development, but in leading resilience assessment and implementing priority actions.

The capacity to identify and contextualize local resilience is often lacking in the very communities where vulnerabilities persist. This can lead to the problem of "parachute science," where external researchers collect and analyze data on a challenge in or adjacent to a local community, yet little to no benefit is received by the community from the work. This is a recognized problem in international research (Stefanoudis et al., 2021; Odeny and Bosurgi, 2022), but it should be acknowledged that this also occurs domestically in the U.S., particularly following disasters like Hurricane Harvey. The capacity challenge to engage in the research needed to build resilience pre- and post-event extends to small-town, rural, and underserved communities (SRUCs), home to dedicated and talented public officials who work tirelessly on behalf of their communities but who also may serve in their public role on a volunteer or part-time basis. Even in full-time salaried positions, they often wear multiple hats—County Judge (the Texas County Executive), Emergency Manager, Floodplain Administrator, Permitting Officer—while also being asked to do the difficult job of resilience building. These communities and regional leaders want to mitigate risk but need help understanding and navigating complex and changing federal and state recovery and mitigation rules while identifying, assessing, communicating and documenting the nuances of local resilience-building needs.

We present a framework that builds on theoretical underpinnings of resilience, defined above, and capacity building, defined as "the process of developing and strengthening the skills, instincts, abilities, processes and resources that organizations and communities need to survive, adapt, and thrive in a fast-changing world" [United Nations (n.d.)]. The framework focuses on empowering local institutions to navigate complex administrative systems while also working to identify, assess, communicate, and act on the hyper-local and oft longstanding challenges of communities termed underserved, socially vulnerable, disadvantaged, etc. This framework was used to implement the Regional Resilience Partnership (RRP), established following Hurricane Harvey by formal agreement between the Harte Research Institute for Gulf of Mexico Studies at Texas A&M University-Corpus Christi (HRI) and the Coastal Bend Council of Governments (CBCOG), a regional governmental organization covering 11 primarily small town and rural counties around the lower Texas coast (Figure 1). RRP was created specifically to strengthen resilience and mitigate disaster risk in the impacted region by *building local capacity for resilience*, which will take years, if not decades. Because the institutions are locally based, this partnership can continually translate the complexity of disaster resilience with local leaders, i.e., bridge the gap between SRUCs, external experts, and state and federal partners to iteratively assess risk; enhance communications and engagement to inform local leaders while building trust; and support knowledge co-production processes that harness local knowledge and data while building shared understanding, buy-in and ownership of potential solutions. RRP is working to empower locally-owned resilience.
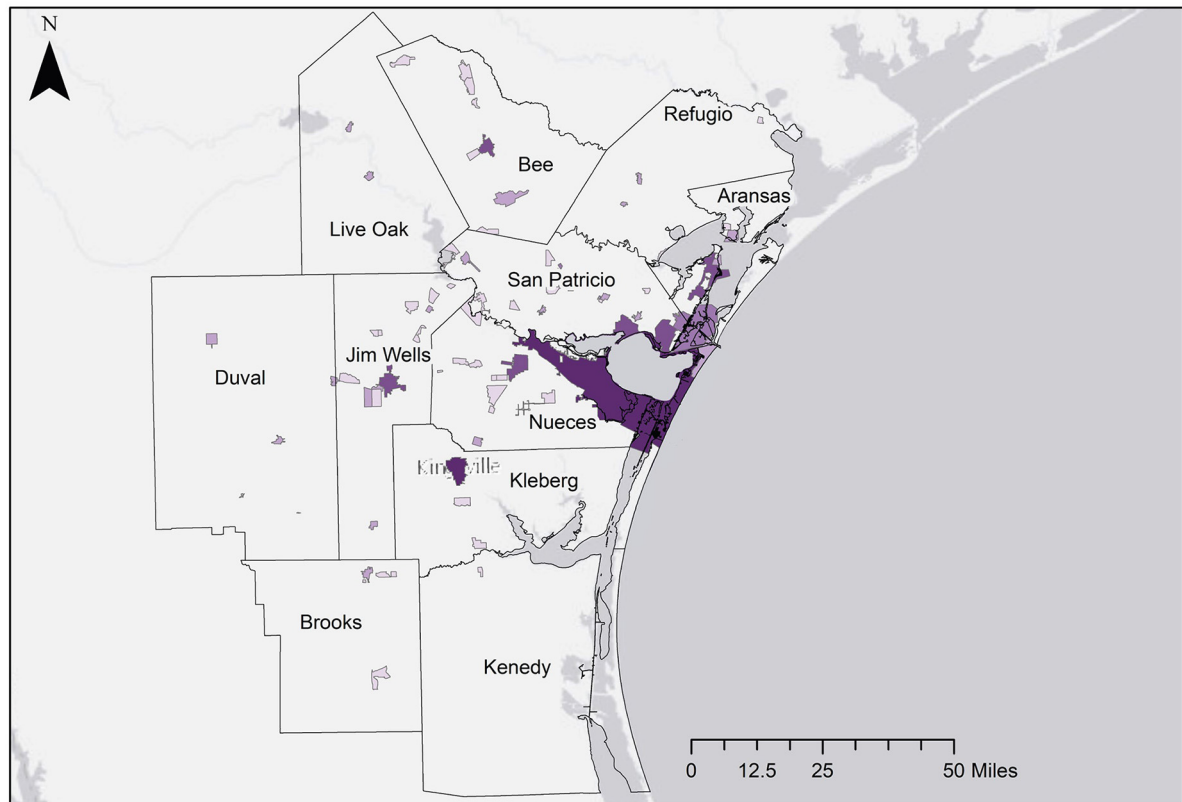
Context setting

Hurricane Harvey made initial landfall on August 25, 2017, in the small town of Rockport, Texas, the county seat of Aransas. The impacts of this Category 4 event were devastating. In Aransas County alone, with a total population at the time of just 25,350, Harvey caused about $812 million in damages for residents and an additional $134 million for businesses (Aransas County, 2018). The disaster wreaked havoc in the community and surrounding Coastal Bend region. For example, in response to the event, Aransas moved over 3.1 million cubic yards of debris, whereas the City of Houston moved about 1.7 million cubic yards (Aransas County, 2018).

Throughout the region recovery efforts were uneven, with some counties better positioned than others to incorporate resilience measures into long-term recovery. Despite the lingering challenges that would continue to stress local officials and residents, Aransas County received a grant from the Sid Richardson Foundation that enabled the establishment of a Long-Term Recovery Team. The Team brought much needed capacity to the area, particularly in navigating and translating the complexities of recovery planning into a strategic planning process that resulted in a Long-Term Recovery Plan, which serves as a model in our Coastal Bend region (Aransas County, 2018). In neighboring areas, however, resources were less available to organize resilient recovery. Characterized as a rural county comprised of small towns, San Patricio County (2018 population of 66,576) engaged local experts at HRI to help organize and facilitate a process leading to their long-term recovery plan (Lopez, 2019). In neighboring rural and hard-hit Refugio County (2018 population of 6,921), resources were not available, and the county did not have the capacity needed to build a long-term recovery plan. How these differences impact longer-term resilience remains to be assessed, but overall the lack of capacity—financial resources, data and technical expertise, and just plain people-power—is a significant challenge in building broader community resilience (National Academies of Sciences, 2018).

Even with an enhanced understanding of factors that affect resilience at the local scale, numerous unknowns in the coupled social-ecological system remain, which can lead to decision paralysis (Cairney, 2016). Furthermore, facilitating decision-making for resilience is complex, with interactions across living and non-living components—formal, natural, and humanistic—that are ever changing, and require iterative and continual assessment (Berkes and Folke, 1998). Though the need to consider sound science should be a pre-requisite for any decision-making process, capacity to do so is lacking, especially at the local level, and especially in SRUCs. Stakeholders, or, as we term them, Community Agents (in the case study, primarily local officials, residents, rights and title holders, community-based or non-governmental organizations, local academia, and workforce), often do not have time or resources to consistently engage in deeper collaboration and analysis with experts, resulting in scientific products that are not tailored to meet local needs, a lack of two-way communication and trust, and a host of additional barriers (National Academies of Sciences, 2018).

Building disaster resilience is overwhelming to communities of all types and sizes—for SRUCs that lack a deep labor pool and resources, resilience is a significantly larger challenge. SRUCs

FIGURE 1
Map of the Texas Coastal Bend and population (Del Angel et al., 2022).

are frequently operating with limited staff and the community leaders responsible for recovery efforts are themselves survivors. Federal and state recovery programs involve a complex web of

processes, policies, and regulatory requirements that are difficult to navigate. Further complicating matters, years between disasters can lead to the loss of organizational knowledge about local

recovery processes and history (Brady, 2018). As federal disasters are, by definition, large complex events that overwhelm local resources, the magnitude of recovery efforts tends to highlight disparities in existing systems, which can have the effect of eroding public trust in government (Wachinger et al., 2013), particularly when such disparities are not systematically identified, assessed, communicated and addressed.

Key elements: Framework for locally-owned community resilience

While across academia, government, non-governmental organizations and the private sector there are dozens of resilience assessment methodologies, tools and systems, these tend to focus on civic infrastructure, facilities, transportation, or health (National Research Council, 2012, 2015; Federal Emergency Management Agency, 2022). Though there are some assessments focusing on human well-being and socio-ecological factors (both static and dynamic) that in a pre- or post-disaster context communities can use to establish a framework to assess their resilience (Renschler, 2013; Winderl, 2014; Abt. Associates, 2015; Cutter, 2016), the degree of utility of these tools when applied at the local level varies greatly. This is true across both nomothetic (top-down) and idiographic (bottom-up) approaches, which as Pfefferbaum et al. (2015) explain have their strengths and weaknesses in ability to understand local contexts and enable comparison across units of analysis for, e.g., resource allocation. Notably, frameworks are emerging that specifically focus on strengthening equity in resilience-building, including through assessing and prioritizing local capabilities and priorities (Stringer et al., 2018; Know-Hayes et al., 2022). What they lack, however, is emphasis on also strengthening the local institutions that can continue to translate the complexity of disaster resilience, working with Community Agents over timescales needed to build equitable resilience.

Using best practices in theory building from case studies (Eisenhardt, 1989; Eisenhardt and Graebner, 2007) and the foundations provided in resilience frameworks for social-ecological systems, including through enhanced governance (Walker et al., 2002; Garmestani and Benson, 2013), we present an analytical framework that is being applied in South Texas to strengthen resilience through capacity building of local institutions, which then engage and empower Community Agents. The approach is modeled after Regional Climate Collaboratives working in many regions of the U.S. to convene local governments and stakeholders to mitigate and adapt to climate change. Importantly, such associations leverage existing capacity to administer programs over time (Bennett and Grannis, 2017).

The framework is structured to:

1. *Empower Local Capacity*: Enhancing capacity to address complex problems at the local level is key, yet it is impossible to deploy national assets to each community and deliver the science-informed but tailored approaches needed. Boundary organizations build the necessary relationships between local decision-makers and scientists (Garmestani and Benson, 2013; Durham et al., 2014). Empowering local institutions to assist in building capacity for resilience is critical, particularly when viewing resilience building as an ongoing process rather than an outcome (Norris et al., 2008). The process takes time—years if not decades—and must iteratively assess new information or changing risk profiles. Local institutions can continue to beat the drum of resilience building through time, even when leaders and decision-makers change. Local institutions are community members with vested interests—not parachuting scientists.

2. *Iteratively Assess Risk*: Viewing resilience as a process highlights key actions such as reducing resource inequities, engaging local people in mitigation, creating organizational linkages, protecting social supports, and "planning for not having a plan," which requires community members to both understand their risks, have trusted sources of information (and communication channels), and to have flexibility in their decision-making skills (Norris et al., 2008). However, while risk modeling and tools offer much in terms of understanding variables and processes that represent a state of risk (e.g., Medina-Cetina and Nadim, 2008), they must be complemented with local knowledge and context. For example, when using the Federal Emergency Management Agency's (FEMA) Resilience Analysis and Planning tool for the Coastal Bend, the local hospital Care Regional Medical Center in Aransas Pass still appears as a data point (Federal Emergency Management Agency, 2023). While the tool notes the hospital is closed, local knowledge is needed to understand that the hospital is not just closed—it was destroyed in Hurricane Harvey and as of the time of this writing there are no plans to bring it back. This paints a starkly different risk profile picture, with lack of access to care over many years for the surrounding SRUC. We must invest in local institutions that specialize in or can meaningfully connect with experts in the science, data, information and regulatory requirements of risk assessment. Such institutions can iteratively integrate local knowledge and context into structured assessments, bridging the gap between SRUCs, external experts and state and federal partners.

3. *Strengthen Communication and Engagement*: Because decision-support processes also are often accompanied by a high degree of skepticism in trusting information and/or unwillingness and/or inability to act (Funtowiczi and Ravetz, 2003; Cairney, 2016; Amel et al., 2017; Wowk et al., 2017), trust in data, methodologies and resulting tools must be fostered through years of communication, engagement, and dialogue. This is critical to enhancing transparency in decision-making, as resilience - building can come with difficult trade-offs—real and perceived—where there are necessarily winners and losers (Zobel, 2011; Adapting to Rising Tides Program, 2015; Chelleri et al., 2015; Sampson et al., 2019). Using consistent and trusted communications is key to enhancing understanding of and buy-in to emerging data, assessments and tools, which can then facilitate the application of science (Pielke et al., 2010; Villiers and Molinari, 2022; Hubbart, 2023). As well, information overload can lead to decision paralysis (Bawden and Robinson, 2020; Misra et al., 2020), while important federal and state rules and regulations with respect to resilience building can change, sometimes in obscure ways. Local institutions can assist by building trust with consistent and confident

communications, engaging communities to understand their specific information needs, and helping to provide culled, tailored and timely information specific to local resilience building needs.

4. *Co-Produce Equitable Pathways*: Local institutions serve as boundary organizations that can support proven methods of engagement, such as early and transparent consulting, inclusiveness, responsiveness and knowledge co-production (Megdal et al., 2017). In particular, knowledge co-production processes strengthen the transfer, use and utility of research by using proven methods to engage transdisciplinary teams, identify priorities, co-develop questions, build trust, and ensure iterative feedback (Meadow et al., 2015; Beier et al., 2017; Wall et al., 2017; Bamzai-Dodson et al., 2021). Such frameworks are needed to contextualize risk and resilience assessments with the concerns, constraints, and policy preferences perceived by key end-users, and to enhance the application of results in alleviating environmental and societal stressors. Used in tandem with the above interrelated techniques, co-production processes support two-way interaction and consensus building to empower not only local institutions but also local leaders as coequal team members, while also engaging broader community members to participate in specific project components. Such approaches are necessary to build capacity for resilience in SRUCs.

Building locally-owned, community resilience: The Regional Resilience Partnership

Engaging with community leaders following Hurricane Harvey, it became clear to researchers at HRI that, in the primarily small-town and rural area of the Texas Coastal Bend (Figure 1), a lack of capacity was perhaps the biggest challenge. There was a lack of capacity to assess local priority risks and to understand the complexity of myriad federal and state programs available to support recovery and resilience building. Importantly, there was also a significant lack of people-power needed to engage in the many meetings, workshops and teams spun up to strengthen resilient recovery. As then Judge of Refugio County Honorable Robert Blaschke emphasized time and time again, "We don't need more plans. We need capacity. We need trained people to improve and implement the plans we already have."

Empower local capacity

Recognizing the need for capacity building, HRI partnered with CBCOG, an association of cities and counties in the eleven-county region with legal responsibility for multi-jurisdictional planning, to help build capacity at the regional level for locally tailored and science-driven solutions. As its first priority action, the institutions worked with the FEMA Philanthropic Advisor for Hurricane Harvey to connect with existing disaster recovery networks, including federal and state agencies offering grant dollars through recovery and resilience programs. Local officials repeatedly noted a lack of understanding of the various programs; thus a regional meeting was convened in 2018 on "Coastal Bend Recovery and Mitigation: Grants Training Workshop," which featured nine federal and state programs to explain their grant programs in their own words and provide advice on how to build successful applications to the over 50 local officials in attendance. Recognizing the momentum built through one regional meeting, HRI, CBCOG and the FEMA Advisor (now with the Texas General Land Office)—co-authors on this paper—conducted information interviews with organizations outside the Coastal Bend working to build resilience and capacity in their local communities. A key partner in this process was the Alamo Area Council of Government, which has had significant success providing grants writing, administration and procurement support to its SRUCs. With renewed emphasis on providing administrative support and the model of the Regional Climate Collaboratives (Bennett and Grannis, 2017), which offer various structures for administrative or fiscal hosts of such associations, it became clear that a beacon of capacity in our region is Texas A&M University-Corpus Christi—and that the Harte Research Institute at TAMUCC could lead the way. HRI and CBCOG worked to formalize their partnership by MOU in December of 2019, when the Regional Resilience Partnership was officially launched (Regional Resilience Partnership, 2022). RRP continues to focus on building local to regional capacity to mitigate disaster risk with significant success itself—outside of the ~$3M in grants received directly by RRP, the partnership has secured over $5M in direct grants to Coastal Bend communities, some of which RRP is helping to administer (Regional Resilience Partnership, 2022). These dollars not only support infrastructure and the advancement of science but, critically, increase the people-power of our region. RRP itself has grown from a team of two to eight in just three short years.

Iteratively assess risk

A priority of RRP is to harness and analyze local, state, and federal data to iteratively build assessments that identify and translate risk into digestible, specific and actionable information. As an example, RRP organized a meeting for local officials to discuss a coordinated response to a 2019 survey released by the Texas General Land Office (GLO), which is the state agency responsible for allocating Department of Housing and Urban Development (HUD) Community Development Block Grant funds for Disaster Recovery and Mitigation (CDBG-DR, CDBG-MIT). The survey focused on gathering local input for a state Mitigation Action Plan, which outlines eligible activities and recipients of $4.297 billion in federal CDBG-MIT funds (Texas General Land Office, 2021). RRP worked with over thirty Coastal Bend local officials to identify specific activities that should be included in the state plan, and helped draft a coordinated response for local officials to use in responding to the GLO survey (Table 1). This input continues to guide regional planning efforts, as subsequent analyses determined the priority issue areas identified not only align to examples of eligible activities included in the GLO survey, but also address key concerns from Coastal Bend County hazard mitigation plans, especially with respect to: (1) Public awareness and education;

(2) Infrastructure hardening; (3) Water drainage; (4) Repetitive loss structures; (5) Backup infrastructure; (6) Disaster resistant building codes; (7) Adopting "No Adverse Impact" policies; and (8) Wastewater system updates. These concerns, along with identifying match dollars for SRUCs, continue to be a priority for the Coastal Bend.

Because HUD requires CDBG-DR and CDBG-MIT funds primarily benefit low- and moderate-income (LMI) persons, a discussion across Community Agents was sparked on how we identify vulnerable populations in the region, where critical local contexts are not necessarily captured. For example, social vulnerability indices are often used to identify communities in priority need, and such indices also are used as scoring criteria in some funding competitions, including in the state Mitigation Action Plan (Texas General Land Office, 2021). These analyses, however, tend to rely heavily on data that are somewhat static and aggregate. In the U.S., social vulnerability analyses rely heavily on the U.S. Census Bureau's 5-year American Community Survey estimates and aggregate data at the county or census tract level, which can miss on-the-ground signals. While consideration should be given to poor and vulnerable populations, and broader vulnerability assessments are useful in providing a first ordering, such coarse estimates do not necessarily accurately reflect populations, e.g., along the coast where property values are high near the water, but where low-income neighborhoods are adjacently positioned. Many Coastal Bend towns rely on high-value properties that provide a foundational tax base for communities. However, these same properties distort vulnerability assessments and can mask communities and neighborhoods that should be prioritized for resilience building. As well, many Coastal Bend counties include colonias (unincorporated, low-income areas that often lack basic services), which are difficult to account for as they do not typically participate in census counts. RRP is continuing to work with Community Agents to better understand and assess local data that may be able to supplement social vulnerability assessments, such as urgent need mitigation, subsidized lunch, Supplemental Nutrition Assistance Program (SNAP) enrollment, and percent of homelessness populations. RRP is also working with local officials on a geospatial localized social vulnerability layer, planned to be released in Spring 2023 (Regional Resilience Partnership, 2022).

Strengthen communication and engagement

To address the immediate need to cull and summarize key information to Coastal Bend Community Agents, RRP created a listserv that serves two purposes: (1) making stakeholders aware of targeted resilience-building opportunities; and (2) sharing information on specific, identified needs. The RRP listserv has been released weekly since 2019 and currently has over 160 subscribers from the Coastal Bend, including in local government, economic development, community-based organizations and academia. The listserv culls together a diversity of information on available resilience related training opportunities—primarily online but also in-person and all free of cost—in which our local leaders can

engage to learn more about specific areas of need. The listserv also communicates available funding opportunities on resilience building from federal, state, private sector and philanthropic partners (Regional Resilience Partnership, 2022). In doing so, RRP has become a trusted source of information in the region.

RRP also supports local engagement processes with decision-support tools. RRP experts collaborated in developing a Method of Distribution (MOD) for the allocation of $179,547,000 in CDBG-MIT allocated to the region to develop strategic, high-impact activities to mitigate disaster risks and reduce future losses in areas impacted by recent disasters. The team used key data sets in creating a series of maps and releasing the product to Community Agents in advance of public meetings. Today, *Mapping Flood Hazards and Vulnerability in the Coastal Bend* is still being used to advance more meaningful discussions at the local level on mitigation priorities (Del Angel et al., 2022). To further build trust in decision-support processes, RRP iteratively engages Community Agents in local training on resilience as well as in meetings and workshops with broader state and federal partners on persistent and emerging issues that are important to our area. In response to a Fall 2023 meeting with the Department of Energy on carbon management, RRP is launching the *Coastal Bend Equity Dialogues*, which invites diverse Community Agent groups to co-develop what equity means in our region, e.g., how we define it, measure it, assess it, and identify the tradeoffs being made across various decision pathways in a region characterized by the industrialized Corpus Christi Bay, adjacent communities, and SRUCs that constitute the remainder of the region. The decisions that need to be made to attach value to those tradeoffs are inherently local. Local institutions like RRP are needed to ensure structured dialogue and processes advance to identify, capture and assess real and perceived tradeoffs, which then can be used as vetted inputs in national and state frameworks, tools and models.

Discussion

Is RRP co-producing equitable pathways?

Hyper-local co-production methodologies foster local capacity, communication and engagement while building on and leveraging partnerships, data and assessments at state and federal levels. They also incorporate local leadership, knowledge and data that can redefine the standards of advancing resilience to better resonate at the local level. Such methodologies must be led by targeted research questions that lay the groundwork for future integrative research to address fundamental science—as well as technological dimensions of resilience for a local transition to empowered communities, such as: what mechanisms and processes are needed for SRUCs to employ, coupled with people-power from citizens and local academia, in obtaining baseline data needed to assess and advance resilience; and how can new partnerships enhance capacity to use local to national data, historical trajectories, existing models, and local knowledge in driving positive action toward resilience-building?

RRP is empowering local capacity in the Coastal Bend and is strengthening trust through consistent and credible communications and engagement. However, the extent to which

TABLE 1 Coastal Bend priority mitigation actions—2019 GLO mitigation action plan survey.

Coastal Bend issue area	GLO mitigation examples from survey	Specific need (S = study; A = action)
Public awareness and education (e.g., insurance, family planning)	• Hazard safety education programs • Promoting homeowner flood insurance • Improve community awareness of hazard risk • Disaster warning system	**A:** Public awareness campaign to include an early warning alert system **A:** Create tailored risk communications plan to develop and deliver the right message, speak to local community interests, explain risks, offer options for reducing risk, work with a trusted source and the public, test messages and products, and use multiple ways to communicate
Infrastructure	• Develop or refine evacuation plan • Fortify critical facilities • Maintenance of vulnerable utilities • Replace inadequate or vulnerable bridges and causeways • Construct community hazard shelter	**A:** Advance Property Protection Policies to establish best practices in policies to reduce vulnerabilities to county owned properties **S:** Develop damage assessment best practices that could lead to Asset Management System based policies **S:** Investigate impacts of dam failure on the county population for Lake Corpus Christi and Choke Canyon Reservoir (i.e., Dam Breach Study)
Flooding (including rural/septic; drainage assessment and mapping; hydrological studies)	• Enhance the function of natural flood-mitigation • Flood-proofing and/or retrofits • Levees, flood walls, or related infrastructure • Local channel conveyance improvements • Regional or local retention basins • Roadway bridges, culverts, and other forms of stormwater conveyance • Local drainage improvements	**A:** Shoreline Erosion Plan to guide future development **S:** Drainage master study that combines surge and precipitation driven flood to assess the unique flat environment on the coast, including updated topo/bathy/land cover information for planning use **S:** Erosion Control Study using a mix of green and gray infrastructure **S:** Digital Elevation Map for the Coastal Bend Region-Zoning and emergency plans are guided by models but models are only as good as their inputs **S:** Coastal hazards analysis and mapping **S:** Comprehensive study of flood risk and flood reduction alternatives, with the assistance of the USACE, to implement feasible alternatives for flood reduction, including surface and subsurface conveyance pump systems
Regional to local planning: buyout, acquisition, reconstruction in high risk areas, enforcement, innovative funding	• Development restrictions in flood zones, capital planning for mitigation • Prevent development with buyouts/acquisitions • New culverts, storm-proofing windows, elevating buildings, etc. • Revising building codes • Reconstruction of noncompliant structures • Updating ordinances	**A:** Update subdivision and zoning ordinances, including a unified development code for the region **A:** Review and update zoning regulations to reduce population density in areas vulnerable to hazards, including open space regulations **S:** Conduct feasibility study of buying out and managing repetitive loss structures **S:** Geohazards Maps for Resilient Development to identify especially vulnerable assets in redevelopment. Supplement analytical work with GIS analysis of geohazards
Affordable housing	None provided in survey	**A:** Address the affordability gap through solutions to increase land supply, increase efficiency of housing construction, improve operation and management, and arrange financial support for resilient low-income housing **S:** Conduct risk analysis of low-income housing property development in the Coastal Bend
Regional mitigation and disaster recovery planning, including implementation (including capacity, i.e., labor and expertise)	• Implement or enhance communication infrastructure, such as radio and cell towers or tree maintenance where power and phone lines exist	**A:** Form a Regional Resilience Collaborative, to become self-sustaining, which can supplement much needed capacity in the Coastal Bend to build resilience by providing experts for strategic resilience assessment locally and across counties, funding strategies, grants applications and administration, GIS, and training for local officials **A:** Draft and implement a Recovery and Mitigation Roadmap to integrate hazards mitigation plans and resilience indices into redevelopment at the local and county scale **S:** Risk identification, analysis and prioritization (unbiased)
Economy diversification (tourism, manufacturing)	None provided in survey	**A:** Coordinate educational and training activities on business and community resilience **S:** Identify infrastructure needs and solutions to support economic recovery/growth **S:** Build Resilience Index to assess socioeconomic wellbeing and key natural resource assets, particularly in relation to supporting ecotourism growth in the Coastal Bend

RRP is advancing locally-owned resilience remains to be seen. Some of this is a product of our major funders and the research questions in which they are primarily interested. The U.S. Economic Development Administration is our biggest supporter, and thus many of our grant funded projects focus on building economic resilience. However, even across issue-based projects, it is possible to conduct structured assessment of the assets SRUCs need and have to build resilience. We also hope future work can focus on more foundational research questions, such as those outlined above.

RRP also is advancing knowledge co-production in each of its projects. Again, though, the degree to which the partnership is co-producing equitable pathways is unclear at this time. As detailed in the RRP Strategic Plan (Regional Resilience Partnership, 2022), we are in the process of structuring an evaluation framework to complement our Framework for Locally-Owned Community Resilience, which will build toward the six RRP Strategic Goals (Regional Resilience Partnership, 2022):

- Goal 1: Establish consistent, two-way communication with communities.
- Goal 2: Understand and define resilience at the local level with local data.
- Goal 3: Conduct a needs assessment in each Coastal Bend County.
- Goal 4: Create, implement and/or inform data-driven strategies for equitable resilience.
- Goal 5: Build local capacity to strengthen resilience and mitigate risk.
- Goal 6: Build RRP capacity for long-term partnerships with local communities.

Thoughtful design in continuing research and evaluation will need to address the challenges of using the RRP case study to advance equitable resilience and to strengthen the analytical framework here presented for the purposes of theory building, e.g., in relying on not only quantitative but also contextualized qualitative data to understand resilience (Eisenhardt, 1989; Eisenhardt and Graebner, 2007).

Because of the relative strengths of standardized frameworks as well as nuanced local information and knowledge, the best fitting methodology is an amalgamation of approaches, relying both on national and state frameworks that offer quantifiable, comparable measures, supplemented by quantitative and qualitative data at the local level that may be variable (in terms of consistency of data collected) but offer insight into social dynamics and refined interactions that influence resilience. However, challenges to engage at the local level such as a lack of funding, expertise, data and, as noted, people-power are a persistent issue, including in smaller and rural communities but also in underserved urban areas. These challenges, both real and perceived, show that disaster resilience-building can be overwhelming to communities. Nevertheless, with partnership

from local institutions that can serve as boundary organizations—including local academic institutions—communities can gain the capacity needed to advance science, data and information in assessing and tailoring resilience strategies while harnessing local knowledge. Ultimately, while disaster resilience requires state, federal, private sector and philanthropic partners, more than that it requires relationship building through trust and understanding, and the empowerment of local people and local data. The only way to advance that—and to shift mindsets toward a new way of being—is through effective and iterative engagement and communication. Resilience is locally-owned. We must co-produce solutions with—not for—local leaders.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

KW led manuscript drafting and text on co-production. MA contributed GLO survey information and text on SRUCs. EM contributed input from local leaders. All authors co-founded RRP and contributed to characterizing its formation in the text.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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