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A Call for a National Community Resilience Extension Partnership to Bridge Resilience Research to Communities

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Resilience planning and action is limited to communities with significant technical and administrative capabilities. Engaging communities to co-produce research enables a more equitable distribution of needed tools. A national Community Resilience Extension Partnership linking scientists with place-based planners and emergency managers provides the research-to-practice infrastructure for equitable development of community resilience science and technology.

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LIMITATIONS IN COMMUNITY RESILIENCE TECHNICAL SUPPORT

Under current U.S. disaster preparedness and planning doctrine, state, local, and tribal governments bear primary responsibility for anticipating and mitigating risks posed by natural hazards, including those exacerbated by climate change, and planning for and managing recovery^{1,2}. These risks are unequally distributed across and within communities. At a conceptual level, community resilience relates to the capacity for a community to address anticipated hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions³. This includes addressing underlying physical and social factors that affect community capacity to address hazard risk⁴.

This framing of resilience encompasses prior interpretations found in agricultural, biological, and environmental sciences and engineering⁵, whereby resilience is associated with a system trait (e.g., redundancy, buffering capacity, and adaptive capacity) or an outcome (e.g., reliability and robustness)⁶. However, increasingly the concept of resilience is used to describe processes (e.g., accountability to marginalized groups, adaptive governance, integration of local knowledge, and social learning)⁷, normative concepts (e.g., how things ought to be)⁸, or as a boundary object or bridging concept that facilitates interdisciplinary discourse^{9,10}. Further, the role of Indigenous and traditional knowledge is increasingly recognized for informing policy decisions related to climate change and resilience¹¹.

Communities increasingly aspire to address resilience objectives (e.g., hazard risk reduction, climate change mitigation and adaptation, and sustainability) through coordinated planning and implementation activities. However, in practice, achieving these objectives requires technical capabilities to identify and implement solutions that address long-term vulnerabilities in the built, natural, and socioeconomic systems. Depending on a community's priorities and needs, these resilience and sustainability-related objectives may complement or conflict with their social and economic goals (e.g., improving welfare and enhanced economic development).

Technical and administrative support for community resilience planning and action is often provided by private sector or research organizations on a short-term or ad hoc basis, which is a result of contemporary funding structures¹². Additionally, there is a long history of community response and reliance upon technocratic institutions for the maintenance and operation of their built

environment and supporting infrastructure systems^{13–17}. This framing of capacity support for designing and implementing resilient solutions at a community scale affects who is empowered to make decisions about community-scale resilience and ultimately who is burdened with becoming more resilient or coping with consequences when physical and social systems fail¹⁸.

As a result, resilience planning, to date, is often limited to communities that can navigate a fragmented funding landscape and possess the capacity to undertake technically and administratively complex studies. This is particularly problematic as changing climate and environmental conditions require communities to provide sustained leadership and action, a call being heeded primarily by leading urban centers nationally and around the globe^{19–21}. While the benefits of these actions are substantial at local and national scales²², they may not be realized for years or decades, nor trickle down to the local scale. To build and sustain resilience in urban areas and regions across the U.S., a wider range of communities need access to increased levels of technical, administrative, and financial resources—and the capacity to apply them in context-specific, multidisciplinary, and participatory planning efforts^{23–26}.

Current approaches for disseminating community resilience science and technology innovations focus on facilitating general guidance methods and supporting place-based implementation and the integration of new technical capabilities (e.g., use of forward-looking projections or integrating new data sources, piloting social and physical modeling capabilities or decision support tools). These efforts are often unidirectional. Communities are the designated end-user but are rarely consulted during the development of methods or tools²⁷. On the other hand, community partnership-based approaches for developing and translating new technical information are often exploratory and typically confined to research^{28,29}, although there are examples of user- or stakeholder-driven reciprocal learning in specific domains such as natural resource management³⁰.

Top-down unidirectional approaches are insufficient to assist the broad range of U.S. communities. Prior assessments have described these gaps^{26,31,32} and some emerging state-level efforts have attempted to fill them³³. However, continuing to rely primarily on local governments to integrate new technical information and decision support tools belies an inherently inequitable assumption—that all communities have the capacity and resources for this

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endeavor. This gap in the development and delivery of new community resilience technical resources and scientific knowledge across sectors—including emergency management, urban and community planning, economic development planning, engineering, and environmental management—limits the support that can be provided to communities with varied technical and administrative capacities. Without a deliberately coordinated commitment to co-develop usable technical advances with community members, these inequities will persist, and lower-capacity communities will have fewer opportunities to benefit from new publicly supported community resilience information and tools.

SUPPORT FOR COMMUNITY-DRIVEN RESILIENCE PLANNING AND ACTION

Federal and state governments, often working in partnership with professional organizations, serve an important role in establishing common planning processes and providing technical and financial support for community resilience planning. The implementation of community resilience planning for disaster recovery can be improved through boundary organizations that help address the inherent complexities of social and physical boundaries that define social-ecological systems³⁴. Boundary organizations, such as extension programs and services provided by the U.S. federal government, connect research and practice and tailor information and produce value-added products that are not possible through traditional information brokers²⁹. Drawing on the experience of existing boundary-spanning programs, this type of inclusive knowledge exchange can increase research efficiency and provide capacity for all parties to generate and integrate new data, methods, and perspectives³⁵. There is a need for this type of partnership across sectors to address shortcomings in current technical support for community resilience planning and action.

A successful partnership model for community resilience planning and action would link scientists, policymakers, and community members at a local scale with national-level support, via the common goal of addressing community-driven resilience objectives. This approach would leverage existing networks already working in communities, build on lessons from public-private sector boundary organizations, and provide a forum to scale up activities directly serving community end-users and decision makers. Ideally, its implementation would result in significant capacity support for communities, who are agents in their own risk-informed decision-making, and would increase access to resources to address the vulnerabilities communities themselves deem important. It would be informed by a core set of programs within the U.S. federal government and state governments that engage in user-oriented research on various aspects of resilience and provide associated extension services (e.g., USDA Cooperative Extension Service, USDA Natural Resources Conservation Service, USDA Climate Hubs, USGS Climate Adaptation Science Centers, US Fish and Wildlife Service Landscape Conservation Cooperatives, NOAA Climate Adaptation Partnerships-Regional Integrated Sciences and Assessments program, NOAA Sea Grant/National Sea Grant College Program).

At the state level, there are recent notable efforts by states, like the Colorado Resiliency Framework that has identified cross-sectoral linkages in its strategies for transportation infrastructure, food and agriculture as well as workforce initiatives³⁶. North Carolina's combined adaptation and hazard mitigation plan emphasizes nature-based solutions³⁷ and New Jersey passed legislation and has grants and technical assistance for stormwater management to advance local capacity for resilience planning³⁸. Non-governmental organizations and professional associations are also taking action to support state-level resilience action, recently forming a State Resilience Partnership^{39,40}. Research commissioned by the partnership revealed that most states lack a deliberate, forward-looking approach to address flood hazards as major state

flood planning efforts have historically occurred in response to disasters⁴¹. Bernstein and Rogin (2022) also find that state-level planning often relies on federal resources and support and are frequently responding directly to federal-level requirements.

These programs address scientific translation and technical assistance needs for a broad range of fields. However, this type of partnership program has not been systematically applied to community resilience disciplinary intersections, namely engineering, urban and community planning, emergency management, social and economic development, environmental science and management, and public policy. The creation of such a partnership program—a national Community Resilience Extension Partnership—would address the aforementioned gaps in community resilience technical assistance and sector collaboration, focus on addressing community-level capacity support through peer learning and knowledge sharing at the regional level⁴², build upon existing capacity for bridging the science-to-practice divide provided by the previously discussed boundary organizations, improve research quality through knowledge co-production, and address implementation inequities by providing a conduit between academic institutions, the private sector, governments, and community end-users.

A NATIONAL COMMUNITY RESILIENCE EXTENSION PARTNERSHIP

A national Community Resilience Extension Partnership can be modeled as a regionally networked boundary organization that provides capacity support to community officials through (1) a research-to-practice system of networked knowledge exchange that accelerates the sharing of advances between technical fields and community users, and informs the direction of research⁴³, (2) a forum for communities to ensure their resilience decision-making needs are addressed with their input and collaboration, and (3) support for equitable co-production and dissemination of technical developments with community stakeholders. Each regional partnership would provide the institutional infrastructure for community officials across a region to identify common physical and social challenges that span political boundaries (e.g., physical infrastructure and watershed management), provide a mechanism for peer learning, and when appropriate, advance coordinated decision-making and implementation across municipalities (e.g., land use and zoning and natural resource management). Further connecting these regional partnerships to a broader national organization would provide the opportunity to increase knowledge sharing across regions and a mechanism to progressively identify and respond to changing regional needs.

Each regional partnership would focus on its constituent communities' priorities, bringing together a cohort of public and private stakeholders representing place-based technical expertise, local knowledge brokers and decision makers, and coordinated technical support resources. Each partnership's priorities could emphasize common hazard risks and address known built environment vulnerabilities and their implications for engineering practices and/or common social and economic goals. Their proposed collective mission would be to (1) engage communities in the process of developing information and technical advances to address their short- and long-term resilience objectives; (2) recognize and facilitate the multidisciplinary and cross-sector implementation and sharing of best practices to advance community resilience; (3) build trust between communities, infrastructure owners and operators, professional and scientific organizations, and governments; (4) respect and integrate local and traditional knowledge; and (5) foster an environment where community resilience knowledge is equitably co-produced and accessible for communities of all resource levels and their scientific partners. Successful implementation of the regional partnerships would provide a mechanism for peer learning at local scales, a bi-directional channel for co-production of knowledge

between researchers and technical service providers, and the necessary capacity support to empower communities with technical and administrative resources to make risk-informed decisions that increase resilience. This approach encourages practical and locally appropriate decisions and actions to which individuals and collectives become deeply committed. People must be engaged and feel both responsibility and agency for co-created solutions that fit their context and culture.

A regionally based boundary organization can take various forms, each of which would have different resource requirements. Given this, rather than prescribe a specific implementation approach, we outline several potential nested partnership model concepts. Each is intended to be flexible enough to meet regional needs and builds on the previous concept:

- (1) Providing institutional support for voluntary community resilience research and practice network through existing relationships: A series of regionally focused, voluntary organizations can be supported, based on existing partnerships that have research-to-practice networks in place⁴³. This approach would facilitate cross-organization collaboration by leveraging existing formal and informal community, research, and practitioner networks and foster peer-to-peer learning and collaboration. However, it would not intentionally create new organizations or networks and would rely on voluntary participation. It would assess where existing partnerships should be augmented to reflect regional priorities and connect with relevant scientific expertise and would seek the support of professional organizations to engage and provide services to communities. This voluntary network could be formed within existing institutions where community stakeholders, private-sector technical service providers, and researchers collaborate, such as through land grant universities or as a function of technical professional associations where extension capacity and a desire to engage and serve communities already exists. Furthermore, community-based meeting places, such as faith-based organizations and small businesses could be leveraged to reach those community members that may not otherwise be engaged.
- (2) Nationally supported Regional Community Resilience Hubs: Formalizing the voluntary research and practice network with national-level support would constitute a series of regional hubs with standard processes and resources. Regional hubs would retain autonomy and flexibility for articulating specific scientific and practical needs, and would connect resources for individual projects, such as scientific information and professional organizations. The hubs could provide a common location for community-driven problem identification, solution tailoring, and increasing awareness and dissemination of regionally tailored technical assistance resources from national granting programs advancing community resilience. These hubs could be located (physically or virtually) at major academic centers like land grant universities, within professional organizations, or as non-governmental organizations. This model builds on the regional presence, focus on developing sustained partnerships, and emphasis in information synthesis and tool development and implementation assistance in NOAA's Climate Adaptation Partnerships/Regional Integrated Sciences Assessments program, and the USDA Climate Hubs.
- (3) Leveraging a National Resilience Partnership "Corps" to support the implementation of the Regional Community Resilience Hubs: Building on the Regional Community Resilience Hubs model, which can be scaled up to provide direct support for technical and administrative resources and project implementation. Linking the Regional Community Resilience Hubs through national resources and personnel provides the mechanisms necessary to provide direct and

sustained capacity support to augment community resources and provide linkages to other regional innovations and national-level research organizations to support community-scale deployment. Resources could also be made available for national-level research and practice organizations to collaboratively address hub-identified community resilience needs. This model would support a corps of resilience professionals, backed by a national-level organization, to provide direct support to the Resilience Hubs and their stakeholder communities. This model is most similar in organizational structure, sustained regional presence, and capacity to provide direct technical assistance to what has been demonstrated in USDA's Cooperative Extension Service and the National Sea Grant College Program.

The proposed national Community Resilience Extension Partnership would build on the experience, lessons, and ongoing implementation of existing national boundary organizations³⁵, but would be a venture involving sectors and organizations not previously engaged in such a regionally networked partnership. Expected outcomes would include sustained capacity support for communities, increased opportunities for knowledge co-production and research between communities, researchers, and technical service providers; and the institutional infrastructure necessary to bridge the fields of emergency management, urban and community planning, economic development planning, engineering, and environmental management in service to community-driven resilience objectives. Regardless of the specific implementation model, regional-level leadership would be needed across local government, academic, and private-sector organizations representing (at minimum) urban planners, engineers, infrastructure owners and operators, and emergency managers. Future work for a national Community Resilience Extension Partnership includes feasibility studies that determine appropriate organizational and governance structures to match available resources and identify existing partnerships that can be augmented with additional resources. The presence of such a regionally networked organization would signal a deliberate shift and a recognition that community-oriented resilience research, practice, and implementation is an inherently participatory venture, requiring collaborative engagement and partnership from problem conception to technical assistance delivery. As future increases in natural hazard and climate risks manifest at local levels, this shift raises the likelihood of collective action across all communities in cooperation with their scientific and professional partners.

DATA AVAILABILITY

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C.C. and J.H. conceived and developed the idea for this article. C.C., J.H., and M.M. wrote the initial draft of the article, and C.C., J.H., M.M., and S.S. edited the manuscript and wrote the subsequent and final drafts. All authors provided final approval of the completed version.

COMPETING INTERESTS

The authors declare no competing interests.

ADDITIONAL INFORMATION

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