Motivating Local Climate Adaptation and Strengthening Resilience: Making Local Data Trusted, Useful, and Used (2021)

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MOTIVATING LOCAL CLIMATE ADAPTATION AND STRENGTHENING RESILIENCE

Making Local Data Trusted, Useful, and Used

Committee on Applied Research Topics for Hazard Mitigation and Resilience

Policy and Global Affairs

A Consensus Study Report of

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ACKNOWLEDGMENT OF REVIEWERS

This Consensus Study Report was reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise. The purpose of this independent review is to provide candid and critical comments that will assist the National Academies of Sciences, Engineering, and Medicine in making each published report as sound as possible and to ensure that it meets the institutional standards for quality, objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

We thank the following individuals for their review of this report: Divya Chandrasekhar, University of Utah; Nikki Cooley, Northern Arizona University; Beth Gibbons, American Society of Adaptation Professionals; Rashid Hassan, University of Pretoria; Ali Mosleh, University of California, Los Angeles; Sanjay Seth, City of Boston; and William Wallace, Rensselaer Polytechnic Institute.

Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations of this report nor did they see the final draft before its release. The review of this report was overseen by Gerald Galloway, University of Maryland, College Park. He was responsible for making certain that an independent examination of this report was carried out in accordance with the standards of the National Academies and that all review comments were carefully considered. Responsibility for the final content rests entirely with the authoring committee and the National Academies.

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Executive Summary

To help reduce the immense human and financial toll of disasters caused by natural hazards and other large-scale emergencies, the Committee on Applied Research Topics for Hazard Mitigation and Resilience has been charged with identifying applied research topics, information, and expertise that can inform action and identify collaborative priorities to advance natural hazard mitigation and resilience. The committee, which was formed at the request of the Federal Emergency Management Agency (FEMA) by the Resilient America Program of the National Academies of Sciences, Engineering, and Medicine, selected two large-scale themes within which to identify applied research topics. An initial report examined the theme of *Social Capital and Social Connectedness for Resilience*.[1] A second report, detailed here, considers the theme of *Motivating Local Climate Adaptation and Strengthening Resilience*.

To meet this charge, the committee organized a public, 1 day-long virtual workshop to survey existing knowledge and practice, featuring a diversity of voices and expertise on this topic. Based on information from this workshop and committee members' backgrounds and experience with hazard mitigation and resilience, three topics were identified as being particularly important for motivating local climate adaptation and strengthening resilience: (1) co-production of stakeholder-friendly data and useful information with local communities, (2) development of integrated local approaches to strengthening climate adaptation and resilience, and (3) building trust in data, processes, and partners to motivate local climate action.

On the first topic, co-production of stakeholder-friendly data and useful information with local communities, data need to be converted into useful, valid information for communities to make decisions and investments that ensure the safety and resilience of their residents, economy, and environment. Information that communities receive needs to reflect the challenges and opportunities of those communities so that it will not just be useful, but also used.

Collaborative relationships between all stakeholders who transfer data, information, knowledge, and insight into on-the-ground needs, opportunities, and constraints for community action can enable broader agreement for critical, life-saving decisions and actions. Co-development and co-production of data and information provide useful approaches to collaborative work between stakeholders.

Translating data into information can imply a one-way process, but a better concept may be a crosswalk in which data providers and users in the community examine available data to determine their applicability relative to the community's needs. Collaborative relationships between all stakeholders can enable shared understanding of issues and broader agreement and buy-in to decisions and actions.

A clearinghouse of climate data and analysis tools that are vetted for quality and applicability by hazard, location, and audience could be useful for many communities.

[1] National Academies of Sciences, Engineering, and Medicine. 2021. *Enhancing Community Resilience through Social Capital and Connectedness: Stronger Together!* Washington, DC: The National Academies Press.

Communities may also need ways of feeding data back to state or federal organizations to improve hazard assessments.

On the second topic, development of integrated local approaches to strengthening climate adaptation and resilience, integrating data and information into community decision-making requires a framework that will lead to tangible, appropriate results. An integrated systems approach to translate information into action can help ensure holistic decisions.

Connecting information with opportunities for action requires understanding different hazard and vulnerabilities, risk perceptions and values, historical inequities and their impacts, and available community capabilities and assets. Extensive community involvement expands the information and experience base for deliberations, builds understanding and buy-in for decisions, and strengthens networks for implementing climate actions.

Extending benefit-cost analyses (BCAs) to factors beyond money is a valuable topic for applied research because current tools have many limitations that may lead to disproportionate distribution of costs and benefits across the community when used for determining resource allocations for climate actions. Individuals and communities also often have difficulties with considering and prioritizing long-term challenges. Communities may need technical expertise to make decisions in integrated ways and achieve full participation of community groups in the process.

On the third topic, building trust in data, processes, and partners to motivate local climate action, local community members often have a more direct and tangible connection to current local risks and recent disasters than do state and federal officials. Unless they trust the authority and credibility of the information being provided to them by the state and federal governments, they are unlikely to take action based on that information. The characteristics of this trust and of the processes that build and strengthen it are valuable objectives of future applied research.

Trust is also needed between different levels of government. For many communities, developing a system to allow local communities to provide vetted data (both scientifically and traditionally generated) to a regional or national product could build the trust needed on both sides for data to be useful and used.

Researchers can play a role in building trust in communities, in part by learning to include key local players in the conversation. Trust develops when the entire community is engaged honestly and fully.

In addition to these three applied research topics, the committee identified three principles that cut across all three topics: (1) equity and inclusion, (2) community co-development and ownership, and (3) community-level feasibility.

Opportunities for understanding and addressing existing inequities and disparate impacts from climate change are available when compiling and analyzing climate data, setting community priorities, and making decisions and investments to adapt to climate change. Equity is an inherently transdisciplinary issue that encompasses many different indicators of health and well-being and many different population groups, including under-served, under-resourced, and historically or systemically marginalized communities. Research on inequity covers not just the origins of disadvantage but also the conditions that make possible positive health- and life-affirming programs and practices.

Addressing and adapting to climate change may require significant changes in a community's development patterns, infrastructure, and investments. Participation and co-development of alternatives and solutions by community members can help build critical ownership in the resulting decisions and actions. In particular, peer-level and peer-to-peer engagement can help build community ownership as community members engage with each other to join climate-related discussions and decisions.

The feasibility of motivating local action to address climate impacts and build resilience depends on several factors, including applicability, affordability, practicality, portability, scalability, and justifiability. Perhaps most importantly, communities need resources to move forward on climate action, whether in the form of data, dollars, knowledge, or understanding.

Many communities are already experiencing impacts and challenges related to climate change and many more are taking seriously the impacts they recognize are coming. However, the range of pressing challenges that demand attention at the local level often limits the attention paid to future threats. The hazard mitigation community, which has long faced similar challenges when advancing pre-disaster investment and action, can provide insight and experience to inform climate adaptation action.

Motivating Local Climate Adaptation and Strengthening Resilience: Making Local Data Trusted, Useful, and Used

BACKGROUND

Local communities are already experiencing dire effects caused by climate change that are expected to increase in frequency, intensity, duration, and type.[2] Rising temperatures and changing rainfall patterns are causing droughts, floods, and declines in air and water quality. Heat waves and droughts are worsening human health, increasing the risks of wildfires, and damaging ecosystems, including the parks, playfields, and natural areas within and close to communities. Warming water, sea-level rise, high-tide flooding, coastal erosion, and higher storm surges are creating severe hazards for communities and infrastructure along and near coastlines. Changes in climate are disrupting agriculture and fisheries, threatening livelihoods, and posing the risk of food price instability.

Towns and cities, states, and the nation are already experiencing increased impacts from this changing risk landscape.[3] The majority of Americans say that climate change is affecting their local communities,[4] and the impacts on communities will continue to grow. Simultaneously, public concern about climate-related challenges is increasing, available information and resources on climate risks are expanding, and cities across the country and the globe are developing approaches to and experience with measures for mitigating climate impacts. Building and sustaining local capacities for climate resilience requires both resilient physical and social infrastructure systems and inclusive, resilient communities.

GOALS OF THE COMMITTEE

In 2020, as part of its efforts to reduce the immense human and financial toll of natural hazards and other large-scale emergencies, FEMA asked the Resilient America Program of the National Academies of Sciences, Engineering, and Medicine to convene the Committee on Applied Research Topics for Hazard Mitigation and Resilience. (See Box 1 for further information on the Resilient America Program). Biographical sketches of the committee members appear in Appendix A of this report.

The Statement of Task from FEMA to the committee is as follows:

A committee of the National Academies of Sciences, Engineering, and Medicine will identify applied research topics, information, and expertise that can inform action and collaborative opportunities within the natural hazard mitigation and resilience fields. The

[2] U.S. Global Change Research Program. 2019. *Impacts, risks, and adaptation in the United States: Fourth National Climate Assessment, Volume II*. Washington, DC: U.S. Government Publishing Office.
[3] National Academies of Sciences, Engineering, and Medicine. 2016. *Attribution of extreme weather events in the context of climate change.* Washington, DC: The National Academies Press.
[4] Hefferon, M. 2019. *Most Americans say climate change impacts their community, but effects vary by region*. Pew Research Center. https://www.pewresearch.org/fact-tank/2019/12/02/most-americans-say-climate-change-impacts-their-community-but-effects-vary-by-region.

committee will convene two public workshops as the primary source of information for its work, supplemented by background materials collected for the workshops and discussions at public sessions of the Resilient America Roundtable.

Each workshop will focus on distinct hazard mitigation and resilience issues and research questions, such as compound and cascading hazard incidents; risk communication and decision-making in a changing risk landscape; nature-based solutions, buyouts, and managed retreat options for coastal risks; and equity and social vulnerability considerations in risk and decision metrics. Following each workshop, the committee will prepare a brief consensus study report that identifies and summarizes key research topics for the applied research community in the specific areas discussed at the workshop. Each report will contain findings but no recommendations and will be limited to the topics covered at that workshop.

The committee's initial meeting examined a list of possible themes for the workshops generated by the Resilient America Program, its staff, and members of the committee. These themes included *Buyouts, Managed Retreat, and Relocation*; *Incorporating Future Climate Conditions into Local Actions*; *Nature-Based Infrastructure*; *Compounding and Cascading Events*; *Social Capital and Social Connectedness for Resilience*; *Making the Business Case for Resilience Investment*; and *Effective Risk Communications*. The committee evaluated these potential themes based on their importance to advancing hazard mitigation and resilience, the state of current science and practice available for applied research on each theme, and the potential for new insights and approaches. Based on these criteria, the committee selected *Social Capital and Social Connectedness for Resilience* as the theme of the first workshop and the subject of an earlier report.[5] A second workshop and this report examine the theme of *Motivating Local Climate Adaptation and Strengthening Resilience* (originally titled Incorporating Future Climate Conditions into Local Action).

As with the first report, a public workshop organized and delivered by the committee served as the primary input for the committee's deliberations and the conclusions in this report. Rather than a proceedings or summary of the information-gathering workshop, this report represents the committee's distillation of what was heard at the workshop and what was have judged to be the most important applied research topics to motivate local action to address climate impacts and build resilience.

This report contains the committee's findings and conclusions, but no recommendations, and is limited to the topics covered at the public information gathering events. This activity was designed to provide guidance for active and ongoing efforts to move science and data into action and to focus the attention and efforts of the applied research community. FEMA asked the committee to prepare the two reports on an accelerated timescale, with the aim of informing and energizing current applied research and yielding "compound interest" on such investments and initiatives. To provide this rapid guidance, the committee conducted this study using a consensus approach that centered information gathering around a public, 1 day-long virtual workshop. The workshop surveyed existing knowledge and practice, featuring a diversity of voices and expertise on this topic in place of in-depth literature reviews. Committee members then combined the information presented at each workshop with their own knowledge and experience to arrive at a list of priority applied research topics. They recognize that significant and growing bodies of

[5] National Academies of Sciences, Engineering, and Medicine. 2021. *Enhancing community resilience through social capital and social connectedness: Stronger together!* Washington, DC: The National Academies Press.

literature and experience exist for each of the chosen applied research topics and recognize the need for a comprehensive inventory of information and expertise related to these topics. An initial list of references on motivating local climate adaptation and strengthening resilience is provided at the end of the report.

Box 1
The Program on Risk, Resilience, and Extreme Events

Since its creation following the release of the 2012 report *Disaster Resilience: A National Imperative*,[a] the Program on Risk, Resilience, and Extreme Events at the National Academies of Sciences, Engineering, and Medicine, known more generally as Resilient America, has sought to harness the power of science, information, and community experience and knowledge to create a more adaptive and resilient nation.[b] To achieve this aim, Resilient America engages with the academic, public, and private sectors at the national and local levels to:

- Increase understanding of complex risks and extreme events in a changing environment, and the exposure of communities, infrastructure, and natural systems to these threats.
- Investigate and strengthen attributes of equitable, resilient systems and communities, including their interconnections and interdependencies.
- Test, communicate, and strengthen implementation of equitable strategies for adapting to changing risks and robust recovery from disruptions.
- Share accessible science and data for strengthening resilience and adaptive action, including policies, tools, best practices, and metrics.
- Connect and facilitate partnerships among scientists, data providers, practitioners, and decision-makers.

Resilient America pursues these objectives through two main activities. The first is the Resilient America Program, which seeks to implement recommendations from the 2012 report to strengthen community resilience and adaptation. The second is the Resilient America Roundtable, which convenes experts to discuss and catalyze activities that build resilience to extreme events at the community, regional, national, and international levels. Together, these activities seek to promote innovative research to inform strategies for resilience and adaptation; incubate ideas and projects; and conduct education, outreach, and community exchange that advance resilient systems and adaptive capacities.

[a] National Research Council. 2012. *Disaster resilience: A national imperative*. Washington, DC: The National Academies Press.

[b] See more about the Resilient America Program at https://www.nationalacademies.org/resilient-america/about.

In the committee's initial meeting, committee members identified several requirements for applied research that have relevance to both subsequent reports. First, the committee considers equity to be the top priority to ensure that all communities, and all groups within communities, are included in and benefit from applied research and enhanced resilience. Second, the committee emphasizes the importance of incorporating multi-directional knowledge transfer to support community dissemination and implementation. Third, to facilitate the adoption and application of research results, the committee focuses on practical, achievable, affordable,

sustainable, and scalable solutions. These three principles are discussed in detail later in this report.

The conception of community and community groups has also been an important consideration in the committee's thinking. The term "community" is used in an expansive sense as reflecting the full range of groups comprising a community, each of which has individual and shared interests, concerns, and resources. (See Box 2 for definitions used in this report). Throughout this report, the committee identifies important prerequisites and considerations for engaging and learning from all parts of the community to build trust and support for community decisions and actions. Climate change impacts will differ by community, potentially affecting access and use of some locations, the economy, or traditional ways of living in the community, each of which may challenge how a community defines and understands itself. Based on its location, history, residents, and economy, every community is unique in its climate-related challenges and opportunities for addressing and adapting to them.

The primary audience for this report includes researchers in the fields of hazard and disaster risk reduction, resilience, and related fields that contribute to these disciplines. This includes researchers in hazard-specific or general hazard and resilience research centers and cooperative institutions engaged with states and local communities on hazard-related challenges. Broader audiences include public, private, nongovernmental, philanthropic, and academic organizations at the local, regional, state, federal, and international levels seeking to reduce the impacts, losses, and suffering across the United States from disasters due to natural or technological hazards, public health emergencies, and other significant threats to communities and the nation. The ultimate aim of the committee's activities is to enable and empower applied research that will strengthen capacities for hazard mitigation and resilience in communities, across the nation, and around the world. A wide range of groups are involved in and lead this applied research, from academic research programs to local communities and community groups. In recent years, significant applied research and action on climate adaptation have been happening at the local level across the United States. The committee seeks to learn from those experiences and improve the nature and applicability of basic and applied hazards research for strengthened community resilience to threats and disruptions from hazards, including those affected by climate change.

PUBLIC WORKSHOP

On May 25, 2021, the committee held a 1 day-long virtual webinar on the theme of *Motivating Local Climate Adaptation and Strengthening Resilience*. The agenda for the workshop appears in Appendix B, and biographical sketches for presenters are in Appendix C. Workshop panelists included individuals from the public and private sectors, organizations involved in various resilience activities across the United States, and the research, communications, practitioner, community engagement, and policy communities, including state and local officials. Virtual participants attending the workshop represented similar communities. The committee asked workshop panelists to consider and address the questions listed in Appendix D to help determine unmet applied research needs within the workshop theme.

Workshop presentations and discussions provided rich information, offered varied perspectives, and identified significant research opportunities for the theme of *Motivating Local Climate Adaptation and Strengthening Resilience.* In this report, the committee considered and

integrated information from these presentations to identify and select the applied research topics discussed in this report. Full videos of the individual panelists' contributions are available on the webpage for the event.[6]

In addition to the workshop, the committee joined an open session of the Resilient America Roundtable on May 28, 2021, to discuss this theme with roundtable members.

APPLIED RESEARCH PRIORITIES

Based on input from the workshop and committee members' knowledge and experiences with natural hazard mitigation and resilience, the committee chose three applied research topics as priorities in motivating local action to address climate impacts and build resilience:

1. Co-production of stakeholder-friendly data and useful information with local communities
2. Development of integrated local approaches to strengthening climate adaptation and resilience
3. Building trust in data, processes, and partners to motivate local climate action

Each of these applied research priorities is discussed in detail in the following sections. At the end of each section, the committee includes specific applied research topics and research questions that were considered important for advancing these priorities (see Figure 1).

FIGURE 1 Applied research topics for making local data trusted, useful, and used to support local action to address climate impacts and build resilience.

Available, applicable, and accessible data and information are essential for informed hazard mitigation and climate adaptation actions. The applied research topics identified in this report are focused on the production and compilation of community and climate data appropriate for use at the local level within integrated approaches to climate adaptation. Whether scientifically generated or gathered from local knowledge (e.g., oral histories or everyday

[6] See https://www.nationalacademies.org/event/05-25-2021/applied-research-topics-for-hazard-mitigation-and-resilience-incorporating-future-climate-conditions-into-local-actions-data-gathering-workshop-2.

experiences), it is crucial that such data is co-produced and vetted. Only then will there be trust and mutual respect in the integration and use of such data and information in local systems and climate adaptation work.

This applied research aims to enable communities to reduce vulnerabilities to climate impacts. The committee recognizes that other important gaps and barriers remain to convert local climate knowledge into sustained and equitable climate adaptation actions. These include governance, communication, funding, community decision-making, and coordination with neighbors and other levels of government. To address these additional challenges, applied research for climate adaptation would benefit from inclusion of experts in fields such as public administration, political science, political economy, and decision sciences.

Box 2
Definitions of Terms Used in This Report

HAZARD: An agent that can cause harm or damage to humans, property, or the environment.

ENVIRONMENTAL HAZARD: A substance, state, or event that has the potential to threaten the surrounding natural environment or adversely affect people's health, well-being, or property. This includes pollution, pathogens, and the effects of natural hazards such as flooding and waves during storms and ground shaking during earthquakes.

RISK: The probability that exposure to a hazard will lead to a negative consequence. More explicitly, risk is defined as the likelihood or probability of a given hazard of a given level causing a particular level of loss or damage. The elements of risk are populations, communities, the built environment, the natural environment, human health, and economic activities and services.

HAZARD MITIGATION: Steps taken to reduce the exposure of people and property to environmental hazards and to reduce the negative impacts of those hazards.

COMMUNITY: The members of a collectivity who share a common territorial area as their base of operation for daily activities. Also, a social group whose members are bound together by the sense of belonging created out of everyday contacts covering the entire range of human activities.

SOURCES: Adapted by committee from various sources. Definition of community based on Parsons, T. 1969. Citizenship and modern society. In *Politics and social structure*. New York: Free Press. Pp. 327-329; Parsons, T. 1989. *A tentative outline of American values. Theory, Culture & Society* 6(4):577-612.

CO-PRODUCTION OF STAKEHOLDER-FRIENDLY DATA AND USEFUL INFORMATION FOR LOCAL COMMUNITIES

Data and information are essential for understanding and addressing climate-driven hazards and their impacts. In this report, the term "data" is used generally to refer to raw numbers, observations, or recorded phenomena that have not yet been organized to help inform decisions or actions systematically. "Information" generally refers to data that have been systematically organized, analyzed, or interpreted and may have been derived through reviews of findings on quality, applicability, and appropriate decisions for a specific locale or region. Translation of data into information is an action to be considered at each stage of information

dissemination and use, as the specific form and content of that information may vary by user and application. Accuracy, reproducibility, accessibility, transparency, and usability are important factors for data and information to inform community deliberations, priorities, and decisions.

Collaborative relationships between all stakeholders who transfer data, information, knowledge, and insight into on-the-ground needs, opportunities, and constraints for community action can enable a shared understanding of issues and broader agreement for critical, life-saving decisions and actions. This document uses the terms "co-development" and "co-production" to refer to multi-stakeholder, mutually developed collaborative work.[7] "Co-development" refers to stakeholders bilaterally agreeing on data, information, goals, and agendas. "Co-production" refers to stakeholders bilaterally agreeing on actions to implement collaborative work to achieve the goals. Reciprocity and transparency among participants are key to successful collaborations and mutual co-development. Participants will need to agree upon processes for goal setting and decision-making, depending on the type and importance of issues.

Co-production respectfully engages the ultimate users of data, information, and solutions in their collection, development, and long-term refinement. Co-development processes provide ongoing opportunities to incorporate and address local questions and concerns, strengthen existing knowledge and understanding, and focus attention on facilitation in addition to community-relevant delivery.[8] Stakeholder groups engaged in co-production for climate resilience solutions bring different perspectives and will likely have different levels of experience with each topic under investigation. Co-production requires the mutual engagement of all affected stakeholders at the earliest possible moment. Special attention must be given to identifying and respectfully including local groups who have been historically marginalized, such as Native peoples who may have critical, Indigenous knowledge of resource management and natural environments.

Communities need information that they can effectively use in making decisions and investments that reduce the vulnerability and strengthen the resilience of their residents, economy, and environment. Assembling and using that information requires three things. First, data, while often abundantly available to communities, can be challenging for local communities and users to navigate, access, understand, and evaluate relative to local needs and questions. Second, climate data need to be vetted and translated into information that is useful at a local level. Finally, information that communities receive from other sources needs to reflect the challenges and opportunities of those communities to not just be useful, but also used. Each of these processes can be the target of applied research.

Data must be meaningful for communities. Translation of data into information can imply a one-way process. However, a better concept might be a crosswalk in which data providers and users in the community examine available data to determine its applicability (e.g., type, scale, detail of data) relative to the community's needs. For data developed externally to the community, a crosswalk may be conducted with the assistance of a climate data "translator." Such a translator should have knowledge of available data, the data's applications and limits, and the community's needs and wants, which may vary across community groups. The public

[7] Woodall, L. C., S. Talma, O. Steeds, P. Stefanoudis, M-M. Jeremie-Muzungaile, and A. de Comarmond. 2021. Co-development, coproduction and co-dissemination of scientific research: a case study to demonstrate mutual benefits. *Biology Letters* 17(4):20200699.

[8] Boyle, D., J. Slay, and L. Stephens. 2010. *Public services inside out: Putting co-production into practice.* New Economics Foundation. https://neweconomics.org/2010/04/public-services-inside.

workshop included multiple examples of National Oceanic and Atmospheric Administration (NOAA) programs that partner with communities to navigate and translate climate data for local use, including Mark Shafer's (University of Oklahoma) discussion of the NOAA/RISA [Regional Integrated Sciences and Assessments] program and his work in the southeast United States (see Box 3) and the work of the Northeast Regional Climate Center, presented by Arthur DeGaetano (Cornell University).

Consistent with a commitment to co-development, translation work aims to facilitate community engagement and decision-making. In co-development, climate translators contribute as authentic and integrated participants, which requires transparency and trust, particularly if they are not native to that community. For communities with sufficient resources, appropriately selected "impact analysts" who translate data into information on tangible effects in the community could play an important role (e.g., through modeling and analysis tools not otherwise available within the community). For other communities, approaches need to be identified in which information can flow both ways between data providers and community recipients of data and information. Community stakeholders give essential context and meaning to data and information through shared purpose and values, history, and lived experience. In addition to ensuring that data and information fit local conditions and needs, collaborative engagement between data providers and local users builds mutual knowledge and understanding of the data and local conditions and experiences. Boxes 3 and 4 provide examples of translating local and climate data into actionable information for adaptation planning.

Box 3
Planning for and Managing Societal Response to Extreme Events and Climate Change

The Southern Climate Impacts Planning Program (SCIPP), part of the National Oceanic and Atmospheric Administration's Regional Integrated Sciences and Assessments, works with communities to create regional hazard mitigation plans that help them build resilience to weather- and climate-related events. SCIPP specifically aims to strengthen the linkage between climate sciences and resilience by collaboratively producing research, tools, and knowledge focused on coastal impacts, climate adaptation, drought, and the use of seasonal to sub-seasonal predictions across the south–central United States. SCIPP works with communities in Arkansas, Louisiana, coastal Mississippi, Oklahoma, and Texas—all of which are states that experience a multitude of hazard types, including severe storms, hurricanes, floods, droughts, winter storms, sea-level rise, and wildfires. SCIPP primarily partners with small- to medium-sized communities in these states to help them develop better plans to prepare for and respond to extreme events and climate change.

In most of these communities, access to climate change data is not the issue. Instead, communities face such an overwhelming volume of data that they struggle to identify critical, relevant, and easy-to-use sources. SCIPP helps communities develop frameworks and tools that enable them to find the information they need for local hazard planning and other emergency response preparations.

Many of these small- to medium-sized communities also do not have the expertise to analyze climate data, which hinders the use of the data. SCIPP therefore facilitates interactions that allow community members to develop analysis capabilities. In this way, SCIPP elevates a community's ability to anticipate, face, and recover from the adverse effects of extreme weather events and climate change.

> SCIPP has discovered that the primary levers for reducing vulnerability to climate change exist in the social aspects within communities, such as understanding neighborhood variability and addressing underlying regional weaknesses. While climate data can inform the actions needed to develop resilience, social awareness, perception, and buy-in are crucial for executing these actions.

A common message heard during the workshop is that local officials are inundated with data but lack usable information. One problem is that local officials often do not have the background information, training, resources, or time they need to use and analyze the available data. Small- and medium-sized communities typically lack access to the technical expertise needed to interpret and apply such data. Larger communities are more likely to have expertise on staff but may be required to address complex dependencies and overlapping issues related to higher densities and urban infrastructure systems. Available data may not apply to the problems that community members face. They may use metrics that do not translate to local applications, or they may be too broad or narrowly focused to be usable. For example, rainfall data can be especially challenging to interpret locally or for short time intervals. National or regional datasets, such as flood maps or modelling-based information, may contain gaps or out-of-date information, in which case local groups may have more current and accurate information based on recent experience. Applied research can provide important guidance on adjusting solutions for local situations and constraints to produce promising climate adaptation actions and investments.

Data may lack recognition of the indirect and intangible factors that make a substantial difference in the lives of community members. Less obvious or intangible factors of climate change threats may include impacts on social identity (e.g., collective activism such as the ongoing youth climate strikes) or loss of community cohesiveness (e.g., from climate migration, disruptions to the built environment, or intergroup tensions because of ideological conflicts). Short- and long-term indirect costs from hazard and climate impacts can include economic effects on businesses and tourism, disruption of transportation and supplies, and stressed community social fabric and quality of life. The COVID-19 pandemic, for example, revealed many social impacts (e.g., isolation, mistrust in public officials, and remote working and schooling) and health impacts (e.g., the cost of suffering from disease or mental health conditions) that are largely distinct from specific costs that are primarily calculated in BCAs. (Benefit-benefit analyses are discussed further in the next section of this report.)

The usefulness and availability of data vary by time, place, and hazard across the country. Communities operate differently, face different threats, and have different vulnerabilities. Individual communities may want different kinds of data depending on their own needs and preferences. Communities may also have evolving data needs, especially given climate-related hazards that are changing over time. One such example from the workshop concerning data usefulness is Victoria Keener's (East-West Center) presentation of the East-West Center's work across Hawaii and the U.S.-affiliated Pacific islands. Their region covers more than 300,000 square miles of land and millions of square miles of ocean, including key strategic sites for the U.S. military. Local communities often request climate data about rainfall from the East-West Center; however, there is only one remaining stream gauge in the region. With varying microclimates, contentious historical contexts, and vast data uncertainties, the East-West Center

has found that predictions and models are most valuable when co-developed with as many stakeholders as possible.

Understanding expected climate impacts on a community and designing adaptation responses requires access and use of various data on physical assets, natural hazards, and demographic and social characteristics, all of which may differ on data scale, definitions, currency, and collection methods. In combining data, a challenge at all levels of government is how to select and integrate data while retaining validity. FEMA's National Risk Index (NRI)[9] combines historical data on detailed hazard information for 18 natural hazards with economic impact and vulnerability measures. The NRI provides a methodology for calculating risk, economic loss, social vulnerability, and resilience based on these inputs and nationwide results from these calculations for planning and comparison purposes at the national level. The NRI primer[10] and technical documentation[11] provide important sources and background information on the data and methodologies applied in constructing the NRI. The "assumptions and limitations" listed in the NRI Primer recognize that locally available data will often be more accurate than the data used in the national index and recommend that communities use this local data to recalculate impact indices for local applications.

Data derived from experiences with past hazards likely provides an incomplete picture of the future, although great strides can be made with thoughtful and adaptive forecasts and models. As the climate and land development continually change, what was previously the 100-year flood could be today's 10-year flood. Communities are also changing, and vulnerability, as depicted in population data, may be known only up to the last data gathering interval, such as a decennial census. How data are received and documented over time evolves, and data always contain uncertainties and biases. All of these factors can affect the process of converting data into useful, valid information for community use.

One possible approach to these issues could be developing a clearinghouse of climate data and analysis tools that are vetted for quality and applicability by hazard, location, and audience (e.g., riverine flooding in the Southeast). Though such a clearinghouse would undoubtedly have omissions, it could be helpful for many communities by providing an easily accessible guide to available information and a clear starting point for communities beginning this work, and expanding resources used by communities that are further advanced in this work.

In some cases, local officials have access to better data and information than state or federal hazard managers do. For example, a local community may pay for light detection and ranging data defining land elevation with better than 1 foot of elevation accuracy. Local communities also have the lived experience of how hazards manifest at their level. However, state and federal officials may not have systematic ways of knowing about and accessing these data, as communities typically do not have ways of feeding data back to state or federal organizations to improve their hazard assessments. Sometimes communities may resist having hazards identified accurately because of the costs that could be involved. Such costs could be monetary or inequitable impacts on community groups. For instance, communities with significant flood risks may be concerned that updated assessments may result in higher insurance

[9] See https://www.fema.gov/flood-maps/products-tools/national-risk-index/overview.
[10] See https://www.fema.gov/sites/default/files/documents/fema_national-risk-index_primer.pdf.
[11] See https://www.fema.gov/sites/default/files/documents/fema_national-risk-index_technical-documentation.pdf.

rates, while community groups who have experienced displacement in the past may have concerns for community integrity or cultural heritage.

Box 4
Climate Capacity-Building Through Public–Private Partnerships

FernLeaf Interactive, a public–private partnership that delivers resilience decision support solutions, has worked across the Carolinas and Florida, specifically with municipal, county, and regional government entities, to empower communities to make the right investments for effective resilience and adaptation. Using a data-driven approach, FernLeaf has helped these communities develop adaptation planning projects, often within a formal hazard mitigation planning process.

FernLeaf tends to be hired by small- to medium-sized communities that, often through state programs, acquire the funding necessary to initiate the process of resilience planning. When FernLeaf starts to work with a community, it conducts a vulnerability assessment at the local level, integrating multiple datasets and geographic information system work. Importantly, FernLeaf asks the community to gather multiple representatives to participate in the analysis and offer their unique perspectives.

During early discussions with these communities, FernLeaf uses tools like Climate Explorer and Headwaters Economics' Neighborhoods at Risk tool to uncover the primary vulnerabilities specific to each region's unique geography and climate. The maps in the National Oceanic and Atmospheric Administration's (NOAA's) Sea Level Rise Viewer dataset are employed to identify flooding extents for different sea-level rise scenarios and current high-tide flooding projections. Similarly, NOAA's national storm surge maps are analyzed to consider worst-case consequences from extreme hurricane events, and the Federal Emergency Management Agency's floodplain maps feature strongly in FernLeaf's community analyses. In the Southeast, FernLeaf also uses the Southern Group of State Foresters' maps to identify wildfire risks.

These analyses typically do not reveal new threats. Communities generally understand where flooding and heat hazards exist within their built environments. However, the resulting quantitative information is often valuable in making the case to the city government to prioritize resilience in its investments and activities.

Even with all of the data that FernLeaf provides, communities need to know how to use the data to drive change. To motivate action, FernLeaf works with communities to combine a range of climate datasets, spatially explicit datasets, parcel-based property information, social vulnerability metrics, and economic datasets. Analyzing such a wide range of sources allows for a deeper understanding of community-wide and neighborhood-specific vulnerabilities, revealing the largest gaps in hazard preparedness and informing actions that improve resilience.

More research on frontline communities would enhance this work, and disaggregated metrics would enable identification of intersectional social vulnerabilities. In addition, well-being metrics could quantify the social and cultural impacts of climate change and resilience planning. Research on how extreme weather events affect frontline communities can provide critical insights into where to direct funds and resources.

Once a community has assembled the available data and information, it will need to vet, integrate, analyze, and interpret that information and analysis to inform priorities, policies, and actions for climate adaptation. Guidance for climate adaptation planning is available from many sources, including federal agencies,[12] cities, and regions across the United States that have implemented climate adaptation plans. Box 5 discusses two guides that make technical information and processes accessible and useful to specific user groups—elected officials and citizens. Engaging with jurisdictions that have implemented adaptation plans, particularly ones with similar local characteristics or hazard profiles, provides opportunities for peer-to-peer learning between communities.

Box 5
Translating Data and Information for Stakeholders and Decision-Makers

Local jurisdictions often face a wide range of challenges and decisions, including maintaining physical and social infrastructure, funding schools and parks, advancing the economy, and protecting their communities against threats (from natural hazards to cyber attacks). Local elected officials are expected to make informed decisions on these consequential community matters, which may be well outside their areas of knowledge and expertise. To do this, local decision-makers need to understand the problem or opportunity for their community and its impacts, not only for their constituencies but also for the community at large. Additionally, decisions will require them to identify and evaluate policies, investments, and actions and make decisions in the context of other priorities and constraints.

The Association of State Floodplain Managers, Inc. (ASFPM) has recently released an updated digital version of its resource *Understanding and Managing Flood Risk: A Guide for Elected Officials*. ASFPM wrote the guide recognizing that elected officials are not flood experts. The guide is structured to address elected officials' particular needs for accessible information on flood hazards, hazard mitigation measures, and resources by answering specific questions that communities often have. Case studies provide elected officials with examples of challenges and successful programs implemented by peers in other jurisdictions. [https://www.floodsciencecenter.org/products/elected-officials-flood-risk-guide]

The National Association of Counties has developed the *Local Government Guide to Coastal Resilience*, which provides local governments with accessible information on coastal hazards and a clear process for assessing vulnerability, building resilience strategies, and implementing those strategies for coastal resilience. The guide provides local governments with comprehensive information and links for funding sources and resources from other organizations. It also includes case studies that demonstrate how other jurisdictions have approached and addressed these challenges. [https://www.naco.org/resources/local-government-guide-coastal-resilience]

Citizens face challenges similar to elected officials in gathering the information and resources that they need to fully engage in local discussions about climate actions. The Louisiana Environmental Action Network has developed a *Citizen's Guide* to facilitate citizen engagement with environmental issues and concerns. The *Citizen's Guide* provides a roadmap to regulations and government agencies, focusing on air and water quality, health and safety, and emergency preparedness. [https://leanweb.org/citizens-guide]

[12] See resource list at the end of this report.

Federal, state, and local governments have different and complementary roles and responsibilities for climate adaptation and other actions, often with different dividing lines between those roles in different locations. Municipalities may have greater latitude for action in "home rule" states than those in states with limited authority. In the workshop, for example, Ann Phillips (State of Virginia) cited Virginia's "Dillon's Rule," under which the Virginia localities' ability to enact local laws is generally restricted except where authorized by the state's General Assembly. By law, FEMA interfaces with state governments and consequently only works indirectly with local governments in its programs. However, hazard mitigation typically happens at the local level, even if the state or federal government provides resources for that mitigation. Applied research could benefit processes that allow local community data to be fed into state and federal systems and on how such feedback affects the information available to and decisions made by localities. However, for agencies and organizations compiling integrated datasets at the regional or national levels, checking locally supplied data for accuracy and consistency can be challenging.

Ultimately, the ability of local stakeholders and decision-makers to take appropriate action is the best measure of success for co-production of climate hazard and impact data. True co-production efforts strengthen this ability by building knowledge and understanding in both data producers and local partners. The same efforts simultaneously enhance the data and information produced and the transparency of and trust in the process and information.

Applied research topics on co-production of stakeholder-friendly data and useful information for local communities include

- *Develop data baselines that are both useful and used by local communities to evaluate climate-related threats*. What data, information, and resources are communities currently using (if any), how frequently are they using them, and why are they using them (e.g., do they trust the source or is it easily accessible)? How effective are communities at finding appropriate tools? What are key gaps in available data and why do they exist? In what ways do questions and information needs differ by community size and setting?
- *Compile roadmaps and scenarios for local communities to identify, access, and evaluate appropriate data for understanding and addressing climate threats.* What do stakeholders need to know to select and apply appropriate tools to get the best information to address their own needs and questions? How do communities and stakeholders navigate and evaluate (considering their location, audience, and usability) available and appropriate climate data sources and tools? What examples are available from other communities?
- *Develop guidance for evaluating climate data and information and improving accessibility and usability of climate data tools*. Who needs to be involved in the development of these resources beyond the data developers? Where are opportunities to reduce friction (time-consuming or inconvenient processes) in accessing actionable climate data? What are key changes that data and tool developers can make to accommodate and support varying levels of local community capacities in accessing and analyzing actionable information? What resources can communities engage to assess the reliability of available information?
- *Mutually engage local stakeholders in producing, analyzing, and communicating information on climate-related hazards and impacts*. What is required to strengthen

the capacity of community groups for full participation in these tasks? Why have other citizen science initiatives been successful (or unsuccessful) in their climate adaptation efforts? What are the opportunities and challenges for locally developed data to inform and be included in regional and national datasets? How can data repositories and users assess the reliability of locally developed data?

- *Co-identify information needs and methods for assessing actual and expected climate impacts on people, communities, economies, and natural systems.* What information is needed to understand and promote practitioner action on direct, indirect, and intangible impacts across communities (social, economic, environmental) and for vulnerable groups (e.g., under-resourced groups living in higher risk areas)? Has co-development of analyses that integrate climate science and data with community knowledge of vulnerabilities and impacts been successful, and if so, why?

DEVELOPMENT OF INTEGRATED LOCAL APPROACHES TO STRENGTHENING CLIMATE ADAPTATION AND RESILIENCE

Once data and information are available in a community through the processes described above, they need to be integrated into community decision-making. This requires a framework to guide and inform decision-making that will lead to tangible, appropriate results. There are multiple dimensions to integrated approaches for climate adaptation and resilience. Co-production of data and information facilitate the integration of community needs and values into data collected and selected for use in the analysis. Integrating that information into the tools and systems used for community decision-making for climate challenges and ongoing operations leverages the data-gathering work to inform multiple decisions. Finally, climate impacts may affect many aspects of a community, such as infrastructure, housing, industry, and the economy. Consequently, climate adaptation planning and investment must be integrated broadly into local community planning and decision processes. Holistic approaches recognize and respond to inter-connections and dependencies across disciplines, as well as from the beginning to the end of local processes, iteratively connecting data and information on the drivers and impacts of community and climate challenges to the solutions that the community implements in response.

An integrated systems approach is a key way to translate information into action and ensure holistic decisions. Connecting information with opportunities for action requires understanding different hazards and vulnerabilities, risk perceptions and values, historical inequities and their impacts, and available community capabilities and assets. Extensive community involvement, with connections among institutions such as schools, businesses, and local governments, expands the information and experience base for deliberations, builds understanding and buy-in for decisions, and strengthens networks for implementing climate actions. Collection and development of data and the development of integrated approaches for assessing climate impact and determining action are not separate activities. An integrated framework for understanding and addressing a community's climate challenges can provide essential guidance for the types, scale, and detail of data needed to inform analysis and decision-making, which in turn can help focus co-development efforts.

A distributed but integrated decision-making approach can also help integrate climate resilience into the mainstream of community decision-making. Chaffee County, Colorado, for

instance, developed the shared vision, Envision Chaffee County,[13] through a broad-engagement process to identify goals and actions, including resilience efforts, such as a program to promote the development of defensible space to reduce wildfire risks to homes. Community members are engaged in collecting community data and monitoring progress on this vision.

The best decision-support mechanisms are frictionless (i.e., removal of unnecessary time-consuming or inconvenient processes). New technology can, when designed appropriately, enable access and analyses that are challenging or more expensive using manual methods. Mobile technologies, frictionless apps designed to seamlessly coordinate action, Cloud-based information support, and other innovations can facilitate productive data and information use. These kinds of technology-mediated, frictionless interactions provide access to data and tools in ways that motivate action. Poorly designed technological solutions or ones that use expensive technology or systems may impede climate action and erode trust for implementing future technologies. While ease of access and application of data and tools are important factors, getting to the right or best-fitting answers is the ultimate objective. Consequently, efforts to facilitate local access to data or enhance local use of analysis tools should focus on the datasets and tools most useful and applicable to appropriate local climate adaptation actions.

The costs and relative benefits of potential investment options are important considerations to help set local priorities. BCA tools have been developed to provide guidance for priority and investments. However, this approach has limitations. First, such analyses typically consider only financial factors. As a result, a BCA might lead a government to protect only the parts of a city that contain high-value properties while dismissing parts of a community where less advantaged people live. In this way, BCAs can perpetuate decades- and centuries-old social and economic disadvantages. Extending BCAs to factors beyond money, thus yielding a better cost-effectiveness approach, is a valuable topic for applied research.

BCA tools have been developed to quantify and compare risks and benefits for resource allocation decisions in terms of common units, usually dollars. Current BCA tools have many limitations that may lead to disproportionate distribution of costs and benefits across the community when these tools are used to determine resource allocation for climate actions. For example, the BCA results for flood protection in Cedar Rapids, Iowa, recommended only protecting the more "valuable" white-collar homes on the east side of the river. With no improvements for the west side, which mostly houses working-class residents, the project would have further reinforced a social divide that has existed for more than 150 years within the community. In her work with communities on climate change, Tonya Graham (City of Ashland, Oregon) highlighted during the workshop the need for revisiting BCAs after investments are complete to identify potential multiple, ongoing benefits that were overlooked in the initial analysis. Intangible community assets (e.g., community culture and history, social capital, and local connectedness) and climate threat impacts (e.g., life disruptions, mental health impacts) can be difficult to quantify adequately in a BCA, and many BCA inputs may incorporate and reinforce historical injustices. Similar to the Cedar Rapids example, racially motivated redlining practices throughout the country have negatively affected home values, primarily for people of color. Decisions based on analyses without considering these historical patterns can exacerbate existing disparities. For more information on redlining and its impact on climate injustices, as described in the workshop by Cate Mingoya (Groundworks USA), see Box 6.

[13] See https://envisionchaffeecounty.org.

Box 6
Redlining and the Climate Crisis

Redlining was the practice of the federal government and banks to draw red lines around neighborhoods that they deemed to be "high-risk" for home loans. This risk assessment was based chiefly on demographic information, explicitly denying mortgages for home buying to people of color, immigrants, and low-income residents. "Low-risk" neighborhoods were outlined in green on the same maps and generally consisted of white, high-income residents.

While the climate crisis is being felt differently from state to state and city to city, it is also dramatically different from neighborhood to neighborhood. The history of race-based housing segregation affects the modern-day built environment and how people are experiencing the climate crisis (see Figure 2). About 75 percent of formerly redlined neighborhoods are still low- to moderate-income communities today, and about two-thirds of them are majority-minority communities.

Groundwork USA is a network of 21 local organizations across the United States that are working to transform "the natural and built environment of low-resource communities" through equity initiatives and civic engagement. Their Climate Safe Neighborhoods program is a campaign and partnership to help residents understand the historical origins of why their communities suffer from worse air quality, asthma rates, heat, and flooding than surrounding areas. Today, historically redlined urban areas are on average about 4.5 degrees Fahrenheit hotter than their green counterparts, with some cities seeing discrepancies as high as 20 degrees.

"These neighborhoods don't look like this by accident, and they're not going to change by accident," said Cate Mingoya, Groundwork USA's Director of Capacity Building, at the May 25 workshop. She hopes to leverage the program to prioritize community-preferred mitigation measures, protect neighborhood financial stability and well-being, and build capacity for intervening in political systems to make those changes. The overall goal of Climate Safe Neighborhoods is to help repair the harm done by redlining and prevent future damage by putting residents into positions of leadership, where climate resilience decisions are often made.

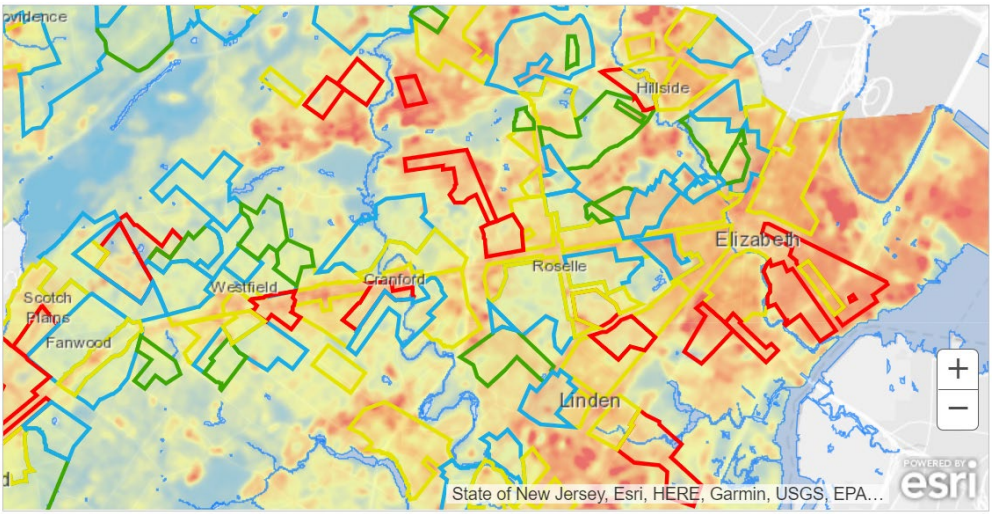

Figure 2 Land surface temperature map of Elizabeth, New Jersey, mapped with the 1939 "Redlined" Home Owners' Loan Corporation residential securities map.
SOURCE: Cate Mingoya, Groundwork USA.

Local climate adaptation actions should be designed to address current and future risks. Individuals and communities can often have difficulties with considering and prioritizing long-term challenges, even those with potentially significant impacts, in the face of current, pressing issues. In BCAs, the relative value of short- and long-term risk reduction investments may be embedded in parameters like discount rates, which limit intentional local discussion and decisions on these important tradeoffs. Similarly, the value of investments that grow over time, such as natural infrastructure, may be diminished in BCA when benefits are valued at the time of investment. An example of this is living shorelines (coastal edges made of natural materials), which, unlike concrete seawalls that begin deteriorating after installation, provide more wildlife habitat and community resilience as they grow over time. As communities consider tradeoffs and priorities between short- and long-term benefits and costs, the communications and decision sciences literature may provide useful guidance and insights.

BCA provides a measure for quantifying the returns on investment from a project, which can be attractive to lawmakers and program managers seeking to ensure that public money is well spent and advances program aims. Consequently, many programs that provide federal support for hazard mitigation and climate adaptation use BCA as a primary decision tool for evaluating funding proposals. The limitations of the BCA approach, including equity concerns, have prompted evaluations of BCA's role as a primary decision tool for federal and other funds.[14] There is a corresponding need for applied research into innovative approaches to evaluate the full, multi-dimensional costs and benefits of hazard mitigation and climate adaptation investments, both within BCA and as alternatives to it.

Communities may need technical expertise to make decisions in integrated ways and achieve full participation of community groups in the process. This often involves a feedback loop, in which a source of technical expertise is informed by the expertise that exists within a community. One possibility that deserves investigation is using a matching program in which a community is connected to a scientist, lawyer, urban planner, or other expert to assist with a specific problem. Another possible role is that of a "climate translator" who can assist communities and groups in accessing climate data and putting it to use. This can facilitate engagement by communities and groups who do not have expertise in climate impacts or applying climate data and information in adaptation discussions and deliberations over actions. The specifics of a place's history, geography, demographics, and economy distinguish communities from one another, and how they each approach current challenges. In the workshop, Scott Gabriel Knowles (Korea Advanced Institute of Science and Technology) illustrated these dynamics through the history of St. John the Baptist Parish, Louisiana, from the uprising of enslaved people in 1811 to environmental justice activism today. In the midst of these unique community stories and situations, many places share the same issues, even if they do not seem similar on the surface. A shared source of decisions, policies, and actions that other communities have taken for hazard risk reduction and climate adaptation, noting successes and challenges, could be an important resource for communities considering climate adaptation action. Applied

[14] See, for example, Junod, A., C. Martín, R. Marx, and A. Rogin. 2021. *Equitable investments in resilience: A review of benefit-cost analysis in federal flood mitigation infrastructure*. Urban Institute. https://www.urban.org/research/publication/equitable-investments-resilience.

research can play a critical role in identifying, testing, and documenting potentially promising experiences and actions.

Applied research topics on the development of integrated local approaches to strengthening climate adaptation and resilience include the following:

- *Identify components and participants for a holistic and integrated local approach to strengthening climate adaptation and resilience.* How do communities best consider and integrate social, economic, and environmental impacts from a changing climate into effective outcomes? How does a community identify, welcome, and most effectively include stakeholders in an equitable decision-making process? Why is it important to integrate local values and political and economic considerations into decision support processes and what are the most effective ways to do so? How do local communities identify and act on climate adaptation and resilience needs that require regional collaboration? What successful models exist that do this and why are they successful?
- *Institutionalize climate resilience considerations and actions in local community decision-making and investments.* Where do opportunities exist, and what is required to integrate climate resilience into existing local systems and plans, such as local hazard mitigation and land use plans? How can funders and regulators encourage and enable integrated local actions that address multiple benefits, promote collaboration between programs, and avoid siloed efforts?
- *Leverage and apply experiences from decision and communications sciences to motivate local climate adaptation decisions and actions*. Do factors such as understanding of threats, social norms, economic implications, and the ability to take effective action impact individual and local decisions and actions? What are effective methods for communities to consider and prioritize equitable actions that address (1) long- *and* short-term risks and benefits, and (2) multiple hazard threats and infrastructure interdependencies?
- *Co-address community inequities in all climate adaptation actions.* What insights exist from social vulnerability information and climate justice groups to inform equitable climate action? How and why should communities identify, through data and engagement, differential impacts from current and expected climate threats and potential responses?
- *Use transparent, inclusive local decision processes to evaluate alternatives, value, and impacts for locally relevant actions*. What are existing tools and methods for assessing (quantitatively or qualitatively) the impacts and benefits, such as avoided damages, long-term impacts of climate action, or the price of inaction? What are best practices to communicate relative costs, benefits, and associated uncertainty to support decision-making? How do communities enable individuals and groups to understand their climate impacts and weigh these factors in decisions? What are alternatives to or innovations in BCA that assess multi-dimensional costs and benefits to inform hazard mitigation and climate adaptation investments?

BUILDING TRUST IN DATA, PROCESSES, AND PARTNERS TO MOTIVATE LOCAL CLIMATE ACTION

An integrated system for converting data to information and then to action requires that the stakeholders trust the inputs to the system, the system itself, and each other. This trust's characteristics and the processes that build and strengthen it are valuable objectives of future applied research.

Local community members generally have a more direct and tangible connection to current local risks and recent disasters than state and federal officials. Unless they trust the authority and credibility of the information being provided to them by the state and federal governments, they are unlikely to act on that information. When encountering new maps showing local hazards or risks, residents often check the risk level for places that they know well, such as their homes, to make their own judgments about the accuracy and usefulness of a map. This approach, however, may undermine confidence in data that assess future threats, such as climate-related hazards, where future risks may differ considerably from past experience. Transparent communication becomes important in these interactions, such as the need to articulate the costs of inaction, avoided costs, limitations of any data sources, and the long-term implications of short-term actions. Data translation must communicate in the language of busy local decision-makers and community members who have many other competing interests and other differences such as in levels of understanding of science and effects from climate impacts and adaptation actions.

Research shows that trust in government at all levels has been falling, even at the local level.[15] This issue can be particularly salient among marginalized communities who may be more reluctant than other people to go to the city council to seek answers to problems. FEMA and other governmental organizations typically work through traditional structures in communities, but not all community members participate in those structures. Applied research could look at how to close such gaps to strengthen trust and connections between local groups and local institutions.

Trust is also needed between different levels of government. For many threats, local communities rely on national and state data to understand and assess their risks. However, local jurisdictions are likely the most current and comprehensive source for hazard and risk information for hazards with recent or recurrent impacts. Enabling a local community to provide vetted data to a regional or national product could be disruptive, but developing a system to do so can build the trust needed on both sides for data to be both useful and used.

Building successful and sustainable programs also requires trust by all participants in (1) the processes for translating information into understandable impacts and opportunities, and (2) how decisions are made to address identified challenges. Trust can be built both through honest engagement processes and by addressing key community needs. Co-production approaches promote inclusive engagement and enhance trust in both inputs and processes. Successful engagement is often iterative, involving refining and improving inputs with various audiences while considering and producing multiple solutions. Tangible action on communal priorities can enhance trust in future work. Box 7 describes a Virginia program that pairs experts

[15] Rainie, L., S. Keeter, and A. Perrin. 2019. *Trust and distrust in America.* Pew Research Center. https://www.pewresearch.org/politics/2019/07/22/trust-and-distrust-in-america.

in the state with local communities to identify and implement activities that strengthen local resilience to coastal flood hazards.

Transparency can be an element of trust, though the relationship between the two is complex. Transparency can be easier to measure than trust, which can make it more amenable to research. Clear documentation of data sources and analysis used in climate adaptation planning, in language accessible to all participants, can enhance comfort with and trust in the products and decisions that incorporate them. The research community has been undergoing a period of self-examination regarding transparency and reproducibility of research. This internal process has implications for future research and the relationships between researchers and other stakeholders in applying research results.

Box 7
Resilience Adaptation Feasibility Tool

The Resilience Adaptation Feasibility Tool (RAFT)[a] was designed to support communities in coastal Virginia in identifying and addressing community resilience challenges and opportunities for coastal flooding while strengthening communities' economic and social capacities. RAFT takes a broad view of resilience and engages a multi-disciplinary team of experts and stakeholders in the RAFT process. The first stage is creating a local scorecard, which rates community resilience to floods across five categories: Policy, Leadership, and Collaboration; Risk Assessment and Emergency Management; Infrastructure; Planning; and Community Engagement, Health, and Well-Being. Communities host local workshops where participants use the scorecard findings to identify available opportunities to strengthen local flood resilience and develop a 1-year Resilience Action Checklist. For example, in an August 2018 workshop, participants from the town of Chincoteague developed a Resilience Action Checklist for the town that focused on needed improvements to stormwater management, shoreline management, wastewater management, access to Chincoteague Island, comprehensive planning, and communication between the town, residents, and tourists.[b]

The RAFT core team, which includes experts at the University of Virginia, Old Dominion University, and the College of William & Mary, provides guidance and assistance to communities throughout the Resilience Action Checklist implementation. This integrated approach of expert insights and guidance with local deliberation and action has been well received by communities and planning commissions in coastal Virginia.

[a] See https://raft.ien.virginia.edu.

[b] See Chincoteague Resilience Action Checklist: Product of the Raft Resilience Action Workshop, August 2018 at https://raft.ien.virginia.edu/2018-2019-eastern-shore.

In some cases, building trust and partnerships to address one issue, such as climate threats, requires work on other concerns that may present a fundamental challenge to a community. Box 8 describes an example in the case of Navajo Nation.[16] As unique Sovereign Nations, tribal communities differ from non-tribal communities in the way that they govern

[16] The Navajo Nation is a large, federally recognized tribe, which means that it is treated as a sovereign nation under the U.S. Constitution. However, the federal government has certain obligations via legal trust with respect to the tribes that must be honored. It is often the tension between the two, along with historical complexities, that challenge effective policy. See Hershey, T. B. 2019. Collaborating with sovereign tribal nations to legally prepare for public health emergencies. *Journal of Law, Medicine and Ethics* 47(2_suppl):55-58.

themselves.[17] They are also complex in their relationships as sovereigns, with some being federally recognized and having a recognized position with regard to the federal government. Non-federally recognized tribes, which may have state recognition or exist as independent communities, have nuanced relationships and decision matrices at those levels.

Researchers can play a role in building trust in communities. Researchers who collect insights, experiences, and lessons from community members and groups should always share their research results with those who contributed to ensure trust and engagement in future research. Researchers should learn to include key local players in the conversation. Trust develops when the entire community is engaged honestly and fully.

Applied research topics on building trust in data, information, processes, and partners for climate action include the following:

- *Identify actions by public institutions (local to national level) that strengthen trust in policies and actions to address climate impacts.* Why is trust in the public institutions that program and fund collective climate actions declining? How can researchers and the private sector deliver more cooperative and effective climate adaptation outcomes that develop trusting relationships and identify trusted communicators?
- *Identify characteristics and actions that strengthen trust in data and tools for climate understanding and analysis*. Why do transparency of data sources and analysis methods, data limitations, and presentation formats affect trust in climate data and tools? How can local groups and governments build local capacity to access and evaluate actionable data and tools? Why are there trust, transparency, and equity concerns with widely used decision tools such as BCA? For community groups and stakeholders with limited bandwidth, what are some alternative means by which they can access expertise?
- *Identify characteristics and actions that strengthen trust in local decisions and action on climate adaptation*. What roles do co-development, co-production, access, and transparency play in trust among stakeholders and trust in local decisions and actions?
- *Build trust in local climate decisions by co-developing intentional, inclusive decision-making processes*. What are best practices for co-developing climate strategies with community members and leaders that have historically been under-served or marginalized? How and why does the history of a community or local groups contribute to existing and future vulnerability, trust, and participation in community processes?

[17] Further details are available through the "Climate assessment and adaptation: Tribal resources" listed under "Selected References" at the end of this report.

COMMON PRINCIPLES FOR APPLIED RESEARCH

While reaching consensus, the committee identified three common principles that extended across the three selected applied research topics: equity, community co-development and ownership, and community-level feasibility. These three were also common principles in the previous report on applied research to enhance community resilience through social capital and social connectedness. That report included a fourth common principle—trust—which has been elevated to an applied research topic in the context of strengthening climate resilience.

Box 8
Inequity by Design: 9-1-1 in Navajo Nation

In Navajo Nation, which is roughly the size of West Virginia, local emergency managers found that 9-1-1 calls were being routed to call centers hundreds of miles away (to cities like Albuquerque, New Mexico; Denver, Colorado; or Phoenix, Arizona). Their tests showed that a 9-1-1 call from Chinle, Arizona (the "geographical heart" of Navajo Nation), could be transferred through three or four cities before reaching someone who could directly address the emergency. This circuitous call routing impedes the "golden hour"—the 60 minutes after a traumatic injury in which a victim has the greatest chance at survival if given medical attention (see Figure 3). The tribe previously did not operate its emergency services due to a lack of federal support.

Federal agencies have long implemented tribal regulations, laws, policies, and processes that are often siloed within separate agencies (e.g., the Departments of the Interior, Housing and Urban Development, Health and Human Services, etc.). However, these agencies typically did not include tribes in their decision-making processes when creating these rules, which hampers accessibility to essential services for Indigenous peoples and further undermines trust from within this community. One example of the negative impacts on Indigenous lives occurred during the COVID-19 pandemic. Federal bureaucratic silos caused weeks-long delays in supplying dedicated funding for personal protective equipment to tribes in New Mexico, exacerbating an already dire health crisis.

Indigenous peoples are facing some of the harshest impacts from climate change because of their locations and marginalization. It has already been recognized that their links to the natural world and generational ecological and resource management knowledge are critical for local climate adaptation. Broken trust and structural racism continue to be major impediments in building coalitions for climate resilience with tribes. Executive Order 13175 ("Consultation and Coordination With Indian Tribal Governments," signed into law by President Clinton in November 2000) mandates that federal agencies work more closely and strengthen relationships with tribal communities. In the May 2021 workshop, Rose Whitehair, a disaster response and recovery expert of Diné Nation, urged participants to incorporate EO 13175 in decision-making processes and ask stakeholders, "Where are the tribes?"

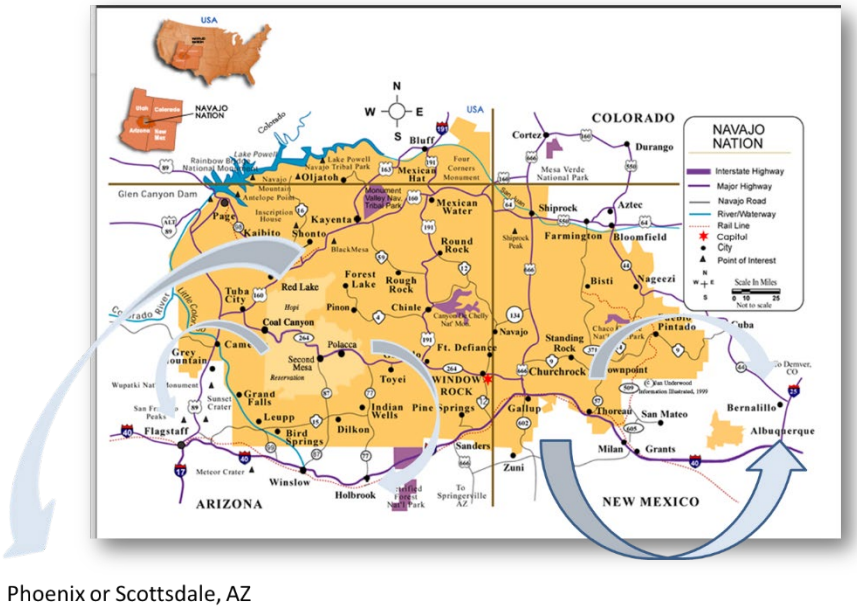

FIGURE 3 Map of 9-1-1 call routing.
SOURCE: Rose Whitehair, Diné Nation, Disaster Response & Recovery SME.

Equity and Inclusion

As with social capital and social connectedness, equity and inclusion are fundamental principles in considering local action to address climate impacts and strengthen resilience. As observed in the earlier report, equity is an inherently transdisciplinary issue that requires integrated research and engagement approaches. It encompasses many different indicators of health and well-being and many different population groups, including under-served, under-resourced, and historically or systemically marginalized communities. Research on inequity can include how damaging disparities arise and how they can be reduced. It covers not just the origins of disadvantage, but also the conditions that can promote positive health and life-affirming programs and practices. Opportunities for understanding and addressing existing inequities and disparate impacts from climate change are available when compiling and analyzing climate data, collectively setting community priorities, and making decisions and investments to adapt to climate change.

Community Co-Development and Ownership

In 2009, Elinor Ostrom received the Nobel Peace Prize for her research on shared natural resources in local communities. She demonstrated that such communities can develop approaches for managing and using common resources that are sustainable for the community and common resource management.[18] While contrary to commonly held assumptions, her work demonstrates the possibilities for sustainability of limited resources through shared

[18] Nobel Prize Outreach AB. n.d. *Elinor Ostrom—facts*. https://www.nobelprize.org/prizes/economic-sciences/2009/ostrom/facts.

responsibilities and actions. Climate change is expected to alter the context for many shared spaces and the resources that sustain them, making sustainable shared management and resource use simultaneously more difficult and more important.

Cities and towns were located and built in the places and shapes that they have in response to a myriad of constraints and opportunities. Location drivers often include geography, the economy, natural resources, demographics, trade, technology, and culture. People—residents, newcomers, developers, and politicians—make critical decisions throughout each phase of community growth and change. Under a changing climate, some of the same factors that defined earlier stages of development may be sources of future threats. Flooding from higher tides, storm surges, and riverine flooding may threaten development along coasts and rivers that originally provided critical transportation connections; changing precipitation and groundwater levels can challenge rural agricultural economies dependent on sufficient water for crops; and expanding wildfire zones and seasons endanger communities built within forested areas.

Addressing and adapting to such impacts may require significant changes in a community's development patterns, infrastructure, and investments. Participation and co-development of alternatives and solutions by community members can help build critical ownership in the resulting decisions and actions. The need and benefit of broad, mutual engagement and ownership are heightened as the magnitude of the challenge and impact of those actions grow, as is the case with climate impacts.

Community partnerships are also at the center of co-development and ownership of actions to improve climate resilience. When undertaking applied research that can motivate local action to address climate impacts and build resilience, researchers must work with communities and subgroups within communities to derive valid evidence and reasonable alternatives. Such collaborative efforts can produce co-benefits for both communities and scientific knowledge that can then be transported to other communities. Communities see what is possible, while researchers can access new information and ideas and apply their science for the common good. Inspiring individual-level and local peer-to-peer engagement can also strengthen community ownership. Communities may feel greater ownership and participate more in collaborative processes when community members engage each other to join climate-related discussions and decisions (as opposed to external partners or researchers instigating or leading such connections).

Community-Level Feasibility

As with strengthening and sustaining social capital and connectedness (the topic of the first report), the feasibility of motivating local action to address climate impacts and build resilience depends on several factors, including applicability, affordability, practicality, portability, scalability, and justifiability. But, perhaps most importantly, communities need resources to move forward on climate action, whether in the form of data, dollars, knowledge, or understanding.

Recognition of feasibility requirements and constraints informs the applied research topics identified in this report. Valid, accessible, and usable climate data and information are essential to making informed decisions and action on climate impacts. Data collection, analysis, and modeling efforts are often beyond the scope of local capabilities and budgets, requiring regional- or national-level platforms and programs. Such programs often do not include budgets or options for co-production of information with communities or incorporating local data into

broader datasets. Integrated approaches to understanding and addressing climate impacts depend on inclusive stakeholder engagement, which requires time and resources in design and implementation to facilitate understanding and participation by groups who bring different experiences and knowledge to the process.

While many communities are already experiencing climate change impacts and many more take seriously the coming impacts, pressing challenges that demand local attention often limit individual and communal attention to future threats. Communities responding to hazards and events with climate drivers, such as increased frequency of king-tide flooding or tropical cyclone activity, have immediate motivation and purpose for acting. In the workshop, Chad Berginnis (Association of State Floodplain Managers, Inc.) recognized the many challenges that compete for community resources, and that, outside of disaster situations, their attention and priorities are drawn to more immediate challenges. The hazard mitigation community, which has long faced similar challenges when advancing pre-disaster investment and action, can provide insight and experience to inform climate adaptation action.

CONCLUSION

Recognizing the challenge that impacts from a changing climate pose to communities across the country, now and in the future, the Committee on Applied Research Topics for Hazard Mitigation and Resilience focused on applied research needs and opportunities to better understand community-level needs in taking equitable action for climate adaptation. The committee sought to identify these applied research needs and opportunities in climate data, community decision-making, and existing local contexts to strengthen capacities for community climate resilience. To inform this work, the committee organized a 1-day workshop to gather information and applied research topic insights from researchers, with panels addressing the following topics:

- Climate and Data Science for Hazard Mitigation and Resilience at the Local Level
- Translating Data for Motivating Local Resilience Action
- Environmental Justice and Impacts of Historical Inequities: Lessons for Climate Adaptation and Resilience
- Reactive and Proactive Local Actions and Data Translation for Decision-Makers

Based on the presentations, examples, and research opportunities discussed in this workshop, the committee identified three applied research priorities with several underlying topics for *Motivating Local Action to Address Climate Impacts and Build Resilience*:

1. Co-production of stakeholder-friendly data and useful information for local communities:
    - *Develop data baselines that are both useful and used by local communities to evaluate climate-related threats.*
    - *Compile roadmaps and scenarios for local communities to identify, access, and evaluate appropriate data for understanding and addressing climate threats.*
    - *Develop guidance for evaluating climate data and information and improving accessibility and usability of climate data tools.*

- *Mutually engage local stakeholders in producing, analyzing, and communicating information on climate-related hazards and impacts.*
- *Co-identify information needs and methods for assessing actual and expected climate impacts on people, communities, economies, and natural systems*.

2. Development of integrated local approaches for strengthening climate adaptation and resilience:

   - *Identify components and participants for a holistic and integrated approach to strengthening local climate adaptation and resilience.*
   - *Institutionalize climate resilience considerations and actions in local community decision-making and investments.*
   - *Leverage and apply experiences from decision and communications sciences to motivate local climate adaptation decisions and action.*
   - *Co-address community inequities in all climate adaptation actions.*
   - *Use transparent, inclusive local decision-making processes to evaluate alternatives, benefits, and costs for locally relevant actions.*

3. Building trust in data, information, processes, and partners for climate action:

   - *Identify actions by public institutions (local to national level) that strengthen trust in policies and actions to address climate impacts.*
   - *Identify characteristics and actions that strengthen trust in data and tools for climate understanding and analysis.*
   - *Identify characteristics and actions that strengthen trust in local decisions and action on climate adaptation.*
   - *Build trust in local climate decisions by co-developing intentional, inclusive decision-making processes.*

This report provides examples of successful local efforts and challenges in illuminating these applied research topics and includes specific questions for consideration when undertaking this research. The committee's view of applied research and researchers is broad, from researchers in academia to small community groups exploring and testing approaches for addressing climate impacts. The three primary applied research topics that the committee identified frame three important components of sustainable local climate adaptation decision and action—data, integrated approaches, and the building of trust in information, collaborators, decision-makers, and actions. Each of these three is also tightly connected, as holistic approaches to analysis and action require valid, accessible data that are applicable and trusted at the local level. Equitable, inclusive, and trusted processes and leaders are essential for accepted and sustainable decisions, which are particularly important for challenges such as climate impacts that do not have short-term solutions.

The committee also identified a set of common principles for consideration and implementation of these applied research topics. These include a commitment to equity and inclusion in both participation and aims of any applied research and outcomes; the importance of co-development and ownership by communities; and attention to the feasibility of community-led implementation for the success of activities and interventions.

The workshop presentations and discussions drew from the academic literature, a growing repository of data and tools on climate and related impacts, and important lessons and

challenges from active work on hazard mitigation and climate adaptation at the local level across the United States. Applied research is needed to collect and expand this knowledge to better inform hazard mitigation and resilience and motivate further local action on climate resilience.

The committee hopes to inspire researchers and communities with this report. Research findings from these topics should bolster and extend attention and activities that strengthen capacities for community resilience through inclusive work at the local, regional, national, and global levels for robust and equitable action.

SELECTED REFERENCES

The following materials provide a further introduction to motivating local action to address climate impacts and build resilience, as well as for some of the programs and interventions referenced in this report.

The following materials provide examples of tools and programs for local action to address climate impacts and build resilience. This list was compiled primarily from presentations and discussions from the May 2021 workshop and the programs and interventions referenced in this report.

Climate assessment and adaptation: Resources and tools

- Environmental Protection Agency Climate Change Adaptation Resource Center: Planning for Climate Change Adaptation [https://www.epa.gov/arc-x/planning-climate-change-adaptation]
- NOAA [https://coast.noaa.gov/digitalcoast/training/climate-adaptation.html]

Climate assessment and adaptation: Examples and programs

- Pacific Islands Regional Climate Assessment: Local, impact-based climate assessments in the Pacific Islands [https://www.eastwestcenter.org/publications/browse-all-series/pacific-islands-regional-climate-assessment-pirca]
- City of Charleston, South Carolina: *All Hazards Vulnerability & Risk Assessment,* with end-to-end implementation guided by NOAA's Steps to Resilience framework for multi-hazard assessment [https://www.charleston-sc.gov/1975/All-Hazards-Vulnerability-Risk-Assessmen]

Climate assessment and adaptation: Sample tools

- Southern Climate Impacts Planning Program: Simple Planning Tool for Oklahoma Climate Hazards [http://www.southernclimate.org/documents/SPTOK.pdf] and other data tools [http://www.southernclimate.org/pages/data-tools]
- University of Washington Climate Impacts Group: Climate analysis tools for Seattle and the Pacific Northwest [https://cig.uw.edu/resources/analysis-tools]
- National Institute of Standards and Technology: Data collection instrument for assessing business disruption and recovery associated with extreme events [https://www.nist.gov/news-events/news/2020/11/data-collection-instruments-published-using-new-nist-data-collection]

Climate assessment and adaptation: Local adaptation programs and examples

- Groundwork USA: Climate Safe Neighborhoods [https://groundworkusa.org/focus-areas/climate-safe-neighborhoods]
- Cool Neighborhoods NYC: A Comprehensive Approach to Keep Communities Safe in Extreme Heat [https://www1.nyc.gov/assets/orr/pdf/Cool_Neighborhoods_NYC_Report.pdf]
- West Philadelphia Landscape Project [https://wplp.net]
- University of Maryland Stormwater Infrastructure Resilience and Justice Lab [https://arch.umd.edu/sirj]

Climate assessment and adaptation: Tribal resources

- Executive Order 13175: Consultation and Coordination with Indian Tribal Governments (November 9, 2000) [https://www.epa.gov/laws-regulations/summary-executive-order-13175-consultation-and-coordination-indian-tribal]
- National Congress of American Indians: Natural Resource Conservation Policy: Incorporating Tribal Perspectives [https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1045669.pdf]
- University of Washington Climate Impacts Group: Tribal Vulnerability Assessment Resources [https://cig.uw.edu/resources/tribal-vulnerability-assessment-resources/]

Climate assessment and adaptation: Community decision-making and trust

- van Valkengoed, A. M., and L. Steg. 2019. Meta-analyses of factors motivating climate change adaptation behaviour. *Nature Climate Change* 9:158-163.
- Fish & Wildlife Service National Conservation Training Center: Structured Decision Making [https://training.fws.gov/courses/programs/decision-analysis/structured-decision-making-overview.html]

A
Committee Member Biographical Sketches

Charles C. Branas (Chair)

Charles Branas is the Gelman Endowed Professor of Epidemiology and Chair of the Department of Epidemiology at the Columbia University Mailman School of Public Health. Dr. Branas has conducted research that extends from urban and rural areas in the United States to communities across the globe, incorporating place-based interventions and human geography. He has led win-win science that generates new knowledge while simultaneously creating positive, real-world changes and providing health-enhancing resources for local communities. His work on public safety, access to medical care, and disaster response has led to medical system changes, a series of national scientific replications in the United States and other countries, and citations in U.S. Supreme Court decisions and U.S. Congress. With community partners, Dr. Branas led the first city-wide randomized controlled trials of place-based solutions for improving health and safety. He has worked internationally on four continents and led multi-national efforts, producing extensive cohorts of scientists, national health metrics, and worldwide press coverage. Dr. Branas is a member of the National Academy of Medicine and the American Epidemiological Society.

Mark D. Abkowitz

Mark Abkowitz is a Professor of Civil and Environmental Engineering at Vanderbilt University. Dr. Abkowitz specializes in risk assessment; management and communication; community and infrastructure resilience; and transportation systems analysis. He has served as a researcher and consultant to a wide variety of businesses and government agencies, authored numerous publications, and appeared on national television and radio to discuss natural disasters. Dr. Abkowitz was appointed by President George W. Bush as a member of the Nuclear Waste Technical Review Board; is the recipient of the Charles H. Hochman Lifetime Achievement Award, conferred by the National Academies of Sciences, Engineering, and Medicine's Transportation Research Board; and has been inducted into the American Academy of Environmental Engineers & Scientists. He is also the author of *Operational Risk Management: A Case Study Approach to Effective Planning and Response*, published by John Wiley & Sons. Dr. Abkowitz currently serves as the Chair of the Transportation Research Board Standing Committee on Extreme Weather and Climate Change Adaptation.

Linda Langston

Linda Langston is the former Director of Strategic Relations for the National Association of Counties (NACo) in Washington, DC, and presently leads Langston Strategies Group, assists small- and mid-sized not-for-profit organizations with leadership, disaster planning, fundraising, and advocacy. Ms. Langston previously served as an elected official on the Linn County, Iowa, Board of Supervisors from 2003-2016. While an elected official, she also served as the Chair of the Corridor Metropolitan Planning Organization, Chair of the East Central Iowa Council of Governments, the state-wide Mental Health and Disability Services Commission, and Chair of

the Linn County Board of Health for several years. She also served as the President of the National Democratic County Officials (2008-2012).

Ms. Langston is a former president of NACo (2013-2014). Her presidential initiative was Resilient Counties, which focused on building communities' capacities to be ready, resilient, agile, and adaptive in the face of natural, man-made and economic disasters. Her home county was devastated by flooding in 2008.

Ms. Langston is the former Chair of the Resilient America Roundtable for the National Academies of Sciences, Engineering, and Medicine and served for 6 years on the National Advisory Council for the Federal Emergency Management Agency. She is a frequent speaker on issues of resilience, disaster preparedness, and the perspective and engagement of elected officials. Ms. Langston graduated from Knox College in Galesburg, Illinois, with a degree in history. A 2007 graduate of Harvard's John F. Kennedy School of Government and the New York University County Leadership Institute (CLI) in 2004, she also spent 11 years in private practice as a psychotherapist.

Ann Lesperance

Ann Lesperance is the Director of the Northwest Regional Technology Center for Homeland Security's Environmental Science and Engineering Program at the Pacific Northwest National Laboratory, where she is developing regional programs to accelerate the demonstration and deployment of new homeland security technologies. Ms. Lesperance is also the Director of the College of Social Sciences and Humanities Programs at Northeastern University's Seattle campus, where she is building programs on security and resilience studies and urban informatics.

Ms. Lesperance works with state and local emergency responders and public safety officials to understand and help prioritize their operational needs and requirements. She brings to both roles a specialty in evaluating issues from a technical, public policy, and national security perspective. Her main area of interest is emergency management and technology development and deployment for innovative homeland security technologies. Her interest in the response enterprise spans domestic and international response to disasters of all types in light of today's and the future's disruptive technologies. In her nearly 30 years of service to the national security enterprise, Ms. Lesperance has collaborated with key regional partners in building productive partnerships to advance technology development and deployment for innovative homeland security, emergency preparedness, and environmental technologies. Ms. Lesperance is a recognized leader in response, recovery, and resiliency issues, having been selected to serve on a National Academy of Sciences steering committee exploring a "whole of government" approach to international chemical, biological, radiological, nuclear, and explosives events. Additionally, Ms. Lesperance has played key leadership roles in engaging the public and private sector energy and public safety sectors on issues related to cybersecurity and resiliency. She holds an M.S. in public health from the University of California, Los Angeles, School of Public Health and a B.A. in environmental science and Latin American studies from the University of Wisconsin.

Robin K. McGuire

Robin K. McGuire received his S.B. (1968) degree in civil engineering from the Massachusetts Institute of Technology (MIT), his M.S. (1969) degree in civil engineering (structural) from the University of California, Berkeley, and his Ph.D. (1974) degree in structural engineering from MIT. In 1984, he founded Risk Engineering, Inc., an international leader in the development of

extensively used software for probabilistic seismic hazard analysis and in consulting on hazard and reliability analyses related to natural forces (earthquake shaking, wind and wave loads, storm surge). Dr. McGuire served as the President of Risk Engineering, Inc., from its founding until it merged with Fugro William Lettis & Associates in 2008, where he was a Principal from 2008-2012. Since 2012, he has been a Senior Principal at Lettis Consultants International, Inc. Early in his career, he did engineering work as a Commissioned Corps officer of the U.S. Public Health Service, as a structural engineer with the U.S. Geological Survey, and as a registered engineer with several consulting engineering firms. Dr. McGuire is currently a Professional Engineer in Colorado.

Dr. McGuire has long been recognized as an international leader in the practice of seismic hazard evaluation and risk analysis. He is the author of the industry standard *Seismic Hazard and Risk Analysis*, an Earthquake Engineering Research Institute monograph published in 2004 that has been translated into the Persian language. He has been the technical director of major projects to estimate engineering design levels and damage to engineered facilities (including power plants, bridges, dams, and commercial structures) subjected to natural forces induced by earthquakes, hurricanes, and tornados. These projects have included applications in 35 foreign countries. He has also led projects to estimate combined losses to portfolios of properties, accounting for correlation of forces in space and for correlation of structural fragility among similarly designed or constructed facilities. He has authored or co-authored more than 100 technical papers and articles on these topics, many of which are in peer-reviewed journals, and several regulatory documents for the Nuclear Regulatory Commission. During his career, Dr. McGuire has served on committees of the National Research Council, including the Committee on Seismology and the Committee on Induced Seismicity Potential in Energy Technologies.

Monica Sanders

Monica Sanders is the Managing Director of the Georgetown Environmental Justice Program and holds a faculty appointment at the Georgetown University Law Center. She is also a Senior Fellow at the Tulane University Disaster Resilience Leadership Academy. Her experience as a practitioner includes serving as the Senior Legal Advisor for International Response and Programs at the American Red Cross, and as an attorney for the Small Business Administration during the Hurricane Maria and western wildfires responses. She was a Senior Committee Counsel for both the House of Representatives and Senate Committees on Homeland Security. In those roles, she focused on oversight of disaster response and recovery programs, cybersecurity, and critical infrastructure protection. Professor Sanders studied security and defense–civilian coordination in the European Union Visitors Program. She remains involved in crisis response operations as part of the Team Rubicon and UNDP rosters.

B
Agenda

Committee on Applied Research Topics for Hazard Mitigation and Resilience
Workshop 2: Motivating Local Action to Mitigate Climate Threats and Build Resilience
Tuesday, May 25, 2021

Objectives: Determine unmet applied research needs about motivating local action to promote hazard mitigation and resilience, including

- Practical, achievable, sustainable solutions that are transferrable and scalable
- An emphasis on community-engaged research
- Considering the framing assumptions of equity, applicability and affordability at a local level, economic feasibility and justifiability, and support of resilience education and knowledge transfer

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11:00AM-11:10AM **Welcome**
Charles Branas, Chair, Department of Epidemiology, Columbia University

11:10AM-12:15PM **Panel 1: Climate and Data Science for Hazard Mitigation and Resilience at the Local Level**
Speaker 1: **Victoria Keener**, Ph.D., Senior Research Fellow, East-West Center
Speaker 2: **Mark Shafer**, Ph.D., Associate Professor, University of Oklahoma Department of Geography and Environmental Sustainability, and Director of the Southern Climate Impacts Planning Program
Speaker 3: **Aashka Patel**, Resilience Specialist, FernLeaf Interactive
Speaker 4: **Arthur DeGaetano**, Ph.D., Professor, Cornell University Department of Earth and Atmospheric Sciences, and Director of the NOAA Northeast Regional Climate Center.
Moderator: **Mark Abkowitz**, Professor, Department of Civil and Environmental Engineering, Vanderbilt University

12:30PM-1:30PM **Panel 2: Translating Data for Motivating Local Resilience Action**
Speaker 1: **Abigail Sullivan**, Ph.D., Assistant Professor, Department of Earth & Environment, Boston University
Speaker 2: **Jennifer Helgeson**, Ph.D., Research Economist, National Institute of Standards and Technology
Speaker 3: **Amy Snover**, Ph.D., Director, Climate Impacts Group, University of Washington

Speaker 4: **Tancred Miller**, Policy & Planning Section Chief, North Carolina Division of Coastal Management
Speaker 5: **T.J. McDonald**, Technology Coordinator, City of Seattle Emergency Management
Moderator: **Ann Lesperance**, Director, Northwest Regional Technology Center for Homeland Security, Pacific Northwest National Laboratory; Director, College of Social Sciences and Humanities Programs, Northeastern University–Seattle

1:45PM-2:45PM **Panel 3: Environmental Justice and Impacts of Historical Inequities: Lessons for Climate Adaptation and Resilience**
Speaker 1: **Cate Mingoya**, Director of Capacity Building, Groundwork USA
Speaker 2: **David B. Abraham**, Ph.D., Faculty member, Natural Sciences, Rice University; Principal Investigator, Houston Sustainability Indicators Project
Speaker 3: **Rose Whitehair**, Diné Nation, Disaster Response & Recovery
Speaker 4: **Scott Gabriel Knowles**, Ph.D., Professor, Graduate School of Science and Technology Policy, Korea Advanced Institute of Science and Technology
Moderator: **Monica Sanders**, Associate Professor, University of Delaware; Adjunct, School of Continuing Studies, and Adjunct Professor, Law Center, Georgetown University

3:00PM-4:00PM **Panel 4: Reactive and Proactive Local Actions and Data Translation for Decision-Makers**
Speaker 1: **Tonya Graham**, City Councilor, City of Ashland, Oregon
Speaker 2: **Ann Phillips**, Special Assistant to the Governor of Virginia for Coastal Adaptation and Protection
Speaker 3: **Chad Berginnis**, Executive Director, Association of State Floodplain Managers, Inc.
Speaker 4: **Harriet Festing**, Executive Director, Anthropocene Alliance
Moderators: **Linda Langston**, President, Langston Strategies Group, and **Robin McGuire**, Senior Principal, Lettis Consultants International, Inc.

4:00PM-4:15PM **Recap and Closing**
Charles Branas, Chair, Department of Epidemiology, Columbia University

C
Panelist Biographical Sketches

Panel 1: Climate and Data Science for Hazard Mitigation and Resilience at the Local Level

Art DeGaetano is a Professor in the Department of Earth and Atmospheric Sciences at Cornell University. He is also the Director of the NOAA Northeast Regional Climate Center. Art has been a Principal Investigator on *The Integrated Assessment for Effective Climate Change Adaptation Strategies in New York State*, an author of the *Climate Ready Boston* report, and a contributor to the 2018 *Fourth National Climate Assessment*. Dr. DeGaetano's recent research focusses on past and future changes in rainfall extremes in the Northeast.

Dr. DeGaetano serves as a Climate Editor for the *Bulletin of the American Meteorological Society*. He received a Ph.D. focusing on climatology and horticulture from Rutgers, The State University of New Jersey, in 1989.

Victoria Keener is a Senior Research Fellow at the East-West Center, the Lead Principal Investigator of the National Oceanic and Atmospheric Administration's Pacific Regional Integrated Sciences and Assessments (NOAA/RISA) program, and is the Lead Author of the Hawaii and Pacific Islands chapter of the *Fourth National Climate Assessment*. Dr. Keener also serves as the Chair of the City and County of Honolulu Climate Change Commission, which provides science-based recommendations to the Mayor and City Council. She earned a Ph.D. in agricultural and biological engineering from the University of Florida, specializing in hydro-climatological research. Dr. Keener leads an interdisciplinary research team of social and physical scientists that aims to reduce the Pacific Islands' vulnerability to climate change by translating research into actionable knowledge and working with a variety of stakeholders at the local, state, and regional levels. Projects include producing downscaled climate and hydrological projections to estimate future water availability; assessing stakeholders' decision support needs and their capacity to use seasonal forecasts; impacts of climate and health on migration; and ecosystem service valuation and modeling.

Aashka Patel is a Resilience Specialist at FernLeaf Interactive. Combining her background in applied climate science, decision support, and environment resource management, Ms. Patel works closely with municipal and regional governments and private-sector partners to deliver actionable climate vulnerability assessments to inform adaptation and resilience planning. She facilitates workshops to identify, prioritize, and operationalize resilience and adaptation strategies. Ms. Patel also leads FernLeaf's efforts to embed social equity as a cornerstone of all resilience and adaptation work. Her past work as a researcher for Carolinas Integrated Sciences and Assessments revolved around tailoring climate projections and assessments for water resources and environmental decision-making. She received a master's in earth and environmental resource management from the University of South Carolina in 2011.

Mark Shafer is an Associate Professor at The University of Oklahoma's Department of Geography and Environmental Sustainability and is Director of the Southern Climate Impacts Planning Program, a NOAA/RISA Team for the South Central United States. His research

interests focus on natural hazards, particularly on communication between the scientific community and policymakers in planning for and managing societal response to extreme events and climate change. He received a Ph.D. in political science and an M.S. in meteorology from The University of Oklahoma and a B.S. in atmospheric sciences from the University of Illinois at Urbana-Champaign.

Panel 2: Translating Data for Motivating Local Resilience Action

Jennifer Helgeson is a Research Economist and the Associate Program Manager for the Community Resilience Program at the National Institute of Standards and Technology (NIST). Her research interests are focused around survey assessments and economic analyses that consider behavioral aspects and approaches to dealing with environmental issues. Dr. Helgeson's research revolves around resilience to hazards (shocks and stressors) in the built environment, with consideration for cost-effectiveness of community-scale mitigation and adaptation efforts.

At present, Dr. Helgeson is a member of the NIST National Construction Safety Team Technical Investigation of Hurricane Maria and its impacts on Puerto Rico. As part of her business resilience research, Dr. Helgeson leads a primary data collection effort in partnership with NOAA. This study focuses on decision-making processes for small- and medium-sized businesses in response to complex event impacts from natural hazards and COVID-19 impacts.

T.J. McDonald is the Technology Coordinator for City of Seattle Emergency Management, and has worked in emergency management since 1995. He is responsible for the Seattle Hazard Identification and Vulnerability Analysis (SHIVA) and most of the technology used in the Seattle Emergency Operations Center. In his role overseeing the SHIVA, Mr. McDonald interacts with numerous stakeholders in the scientific, business, nonprofit, and government communities to understand the consequences of natural and human-caused hazards on the Seattle community. He enjoys synthesizing large amounts of technical and historic information into concise analyses for decision-makers and the public.

Mr. McDonald got his start in emergency management as a Peace Corps volunteer in the State of Chuuk, Federated States of Micronesia, during 1990's Typhoon Owen and the recovery that followed. In 2005, he deployed to Louisiana to assist the State of Louisiana in its recovery from Hurricane Katrina. He has been a part of every major emergency response in Seattle since 1995. Mr. McDonald has a background in urban planning and has a master of city and regional planning degree from Cornell University.

Tancred Miller is the Policy & Planning Section Chief for the North Carolina (NC) Division of Coastal Management and leads the division's work on building local government capacity for climate hazard resilience. In 2020, he led a team that created the NC Resilient Coastal Communities Program, which provides funds to local governments for resilience planning and implementation. He manages the land use planning program, which provides direction and support to local governments, as well as grant funding for beach and waterfront access. He also manages the division's rule and policy development functions, bringing scientists and stakeholders together with the NC Coastal Resources Commission to continuously improve regulations for coastal development. He sits on Governor Cooper's Climate Change Interagency Council, which was created to fulfill the Governor's Executive Order 80 directives. He holds a bachelor's degree in business administration from Morehouse College in Atlanta, and a masters in coastal environmental management from Duke University.

Amy Snover is the Director of the University of Washington (UW) Climate Impacts Group, the University Director of the Northwest Climate Adaptation Science Center, and Affiliate Associate Professor in the UW School of Marine and Environmental Affairs. She leads the Climate Impacts Group's efforts to provide the fundamental scientific understanding, data, tools, and technical support necessary for managing the climate risks facing the people, communities, and ecosystems of the Pacific Northwest. She works with a broad range of decision-makers to develop science-based climate risk management strategies, identify research priorities, and build climate resilience. Dr. Snover was recognized as a White House Champion of Change for Climate Education and Literacy in 2015, and served as a co-convening lead author for the *Third National Climate Assessment* and the lead author of the groundbreaking 2007 guidebook, *Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments*. Dr. Snover has a B.A. in chemistry, magna cum laude, from Carleton College and a Ph.D. in analytical/environmental chemistry from UW.

Abigail Sullivan is an Assistant Professor with Boston University's Department of Earth & Environment. She is an environmental social scientist, and her research focuses on unpacking the dynamics of institutions and collective action in aquatic and terrestrial social–ecological systems. By analyzing factors that influence collective action in communities facing environmental change, she provides insights into how people can optimally design institutions for adaptation to environmental change. She has explored a variety of human–environment issues, including the complexities of emerging issues in community forestry in Nepal, climate change adaptation in the Colorado River Basin, and aquatic invasive species in midwestern U.S. lakes. She received her Ph.D. in environmental social science from Arizona State University in 2016, an M.S. in ecology and environmental science from The University of Maine, and a B.S. in environmental science from Unity College.

Panel 3: Environmental Justice and Impacts of Historical Inequities: Lessons for Climate Adaptation and Resilience

David B. Abraham is a Faculty member in Natural Sciences, Rice University. Dr. Abraham specializes in sustainable development and the development of performance indicators for urban development. He is a certified and skilled research specialist with experience in community development, master planning, transportation planning, and sustainability planning. As the Principal Investigator for the Houston Sustainability Indicators (HSI) project, he developed a procedure and methodology for a robust program to monitor sustainable development in the Houston, Texas, area. His team developed a web-based management tool, the Houston Sustainability Indicators Quality of Life Atlas, capable of monitoring key urban performance indicators for Houston, and analyzing trends and correlations between indicators. This tool is capable of supporting the development of short term and long-range policy implications. The HSI database serves as a resource for various local government departments, elected officials, and local neighborhood organizations for urban sustainability projects.

Following a model of integrative science for building a comprehensive indicators dataset, the HSI database brought together a robust collection of different datasets, including raster data from the National Land Cover Database developed by the U.S. Geological Survey; greenhouse gas emissions inventory from the Vulcan Project based at Arizona State University; continuous cover of National Ambient Air Quality Standards from the Environmental Protection Agency; business agglomeration analysis and monitoring growth in primary businesses from InfoUSA; local and

state administrative data on voting performance, waste management, parks development, and capital improvement projects; and decennial census and American Community Survey socio-economic data is also included.

Dr. Abraham has presented findings from the HSI project throughout the United States and internationally in Barbados, Brazil, Canada, Ireland, and Portugal. Under Dr. Abraham's guidance, the research provides hands-on learning opportunities for students in various academic units at Rice University, including the Department of Statistics, the Professional Science Master's Program, the Health Sciences Program, the Master of Global Affairs Program, and the Jones Graduate School of Business.

Scott Gabriel Knowles is a Professor in the Graduate School of Science and Technology Policy at the Korea Advanced Institute of Science and Technology. He is a historian of disasters worldwide. He focuses on the historical processes that make disasters possible, and the application of history to reduce future disasters. Since March 2020, Professor Knowles has hosted #COVIDCalls, live podcast discussions of the COVID-19 pandemic, every weekday.

Professor Knowles is the author or editor of six books, including *The Disaster Experts: Mastering Risk in Modern America* (University of Pennsylvania Press, 2011), and most recently, *Legacies of Fukushima: 3.11 in Context* (co-edited with Kyle Cleveland and Ryuma Shineha, University of Pennsylvania Press, 2021)

His work on the history of risk and disaster has appeared in *Daedalus*, *The Anthropocene Review*, *Natural Hazards Observer*, *The New York Times*, *The Washington Post*, *Huffington Post*, and other venues.

Cate Mingoya serves as Groundwork USA's Director of Capacity Building. Originally from Queens, New York, Ms. Mingoya earned her B.A. in biology from Reed College in Portland, Oregon, and returned east to teach middle school science at traditional public and charter schools in the Bronx and in Brownsville, Brooklyn. She went on to earn a master of city planning degree from the Massachusetts Institute of Technology and has served as the Director of Policy and Program Development for the Commonwealth of Massachusetts's Division of Public Housing and Rental Assistance. In her current role, Ms. Mingoya provides equitable development technical assistance for those looking to transform brownfields into community assets. She also leads Groundwork USA's Climate Safe Neighborhoods partnership, a five-city partnership, to reduce heat and flooding related risks in neighborhoods with histories of institutional, race-based housing discrimination.

Rose Whitehair has more than 16 years of experience managing large-scale incidents including wildfires, hazardous chemical response, droughts, floods, and the current COVID-19 pandemic response. Her experience includes managing and closing out multi-million-dollar federal projects. She has been assisting clients with deciphering Federal Emergency Management Agency, CAA, ARP, and the Treasury Department's Office of Inspector General.

Most recently, Ms. Whitehair served as the State Coordinator Officer/Recovery Unit Manager and Emergency Operations Center (EOC) Director for the New Mexico Department of Homeland Security and Emergency Management (NM DHSEM), where she assisted with activating and operating the State of New Mexico's EOC and established protocols for all emergency support functions. She has assisted with providing testimony to the U.S. Congress

and created correspondence to the White House for disaster requests and declarations including the recent COVID-19 pandemic.

Additionally, as the former Director of the Navajo Department of Emergency Management, Ms. Whitehair brings invaluable experience with tribal-state-federal coordination. The Navajo became the first tribe in Arizona, and only the second in the nation, to get aid directly from the federal government via a Stafford Act declaration. She was inducted as one of the first Native Americans into the International Women in Homeland Security and Emergency Management Hall of Fame. She served as Tribal Advisor to the National Domestic Preparedness Consortium and volunteers with Team Rubicon.

Her maternal clan is To'ahedliini' (Water Flows Together), which traces back 16 generations to Window Rock, Navajo Nation.

Panel 4: Reactive and Proactive Local Actions and Data Translation for Decision-Makers

Chad Berginnis joined the staff of the Association of State Floodplain Managers, Inc. (ASFPM) in 2011. Since 1993, his work has focused on floodplain management, hazard mitigation, and land use planning at the state, local, and private-sector levels. As a state official, Mr. Berginnis worked in the Ohio Floodplain Management Program and was Ohio's State Hazard Mitigation Officer. As a local official, he administered planning, economic development, and floodplain management programs in Perry County, Ohio. In the private sector, he was the national Practice Leader in Hazard Mitigation for Michael Baker Jr., Inc. Mr. Berginnis has served in an ASFPM volunteer leadership capacity for more than a decade as Insurance Committee Chair, Mitigation Policy Committe Coordinator, Vice Chair, and Chair. He has a bachelor of science in natural resources from The Ohio State University.

Harriet Festing is the Co-Founder and Executive Director of Anthropocene Alliance (Aa), a Florida-based nonprofit. Aa is the nation's largest coalition of frontline communities fighting for climate and environmental justice. Ms. Festing's background includes milking cows in rural Dorset, establishing the first network of farmer's markets in England, and place-making advocacy in New York. From 2004-2010, she worked for the UK government on climate change and sustainable development. Immediately prior to founding Aa, Ms. Festing undertook groundbreaking research and advocacy on urban flooding. When Ms. Festing is not working with climate disaster survivors, she is tending to a large, demonstration garden comprised of more than 100 species of Florida-native plants.

Tonya Graham is the Executive Director of the GEOS Institute and the Director of its ClimateWise Initiative. She has taken a lead role in developing the concept of Whole Community Resilience, which takes a holistic approach to addressing climate change impacts and develops solutions that are both ecologically sound and socially equitable. She and her ClimateWise team help community leaders understand likely future conditions, determine vulnerabilities, and develop strategies to address them that care for both people and nature.

In 2019, she and her ClimateWise team launched Climate Ready Communities, an "assisted do-it-yourself" climate resilience planning program that provides affordable assistance to small, mid-sized, and/or under-resourced communities nation-wide. She is a co-author of *Climate Ready Communities: A Practical Guide to Building Climate Resilience*, a free, step-by-step planning guide that serves as the foundation for the Climate Ready Communities program.

She serves as a City Councilor in her hometown of Ashland, Oregon, and as a Council Liaison to the City's Wildfire Safety Commission, Climate Policy Commission, Conservation and Climate Outreach Commission, and Rogue Valley Transportation District. Through her work with the City of Ashland, she has presented on local climate action at the League of Oregon Cities' annual member conference. Tonya holds a B.S. in biophysical environmental studies from Northland College and a M.A. in community development from Goddard College.

Ann C. Phillips is the Special Assistant to the Governor for Coastal Adaptation and Protection for the State of Virginia. Prior to joining the administration, she worked to address sea level rise and climate impact on national security at the regional, national and international level, and chaired the Infrastructure Working Group for the Old Dominion University-convened Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Pilot Project.

Preceding her work on climate impact and sea level rise, Ms. Phillips served nearly 31 years on active duty. She had the honor to commission and command the USS MUSTIN (DDG-89) and to command Destroyer Squadron 28. Her final Flag command was as Commander, Expeditionary Strike Group TWO, including all of the Amphibious Expeditionary Forces on the East Coast of the United States.

Ms. Phillips earned a master of business administration from the College of William and Mary Raymond A. Mason School of Business in 2016. She is a graduate of The University of North Carolina at Chapel Hill. In addition, she is a certified Chesapeake Bay Landscape Professional, Level 2.

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Discussion Questions for Panelists

Guidance to Panel 1: Climate and Data Science for Hazard Mitigation and Resilience at the Local Level

- What climate data are available now (or will be shortly) that can be used to make decisions at the local level? What do local communities need to know to access and apply this information?
- How do the available data differ (detail, availability, uncertainty) across a range of climate-driven hazards (e.g., sea-level rise, tropical storms, precipitation, flooding, drought, wildfire)?
- What are the limits of downscaling and assessing data for local impacts? Where do things "start to break?"
- How can we best integrate climate and community data to understand impacts, especially in frontline communities?

Guidance to Panel 2: Translating Data for Motivating Local Resilience Action

- How do people digest climate-type information (short term versus long term, uncertainty, perception)?
- How do people and communities think about the future and future values based on conceptions of risk?
- How do beliefs and group affiliations (e.g., politics) affect interpretation and action on climate information?
- What are some useful frames for decision-makers to understand how the public perceives risk of climate threats, and for risk communications to effectively convey related challenges and opportunities?

Guidance to Panel 3: Environmental Justice and Impacts of Historical Inequities: Lessons for Climate Adaptation and Resilience

- How do discriminatory practices, such as redlining, inform current patterns of vulnerability across local geography and groups?
- What are available lessons from environmental and climate justice movements to inform climate adaptation that is just and equitable?
- How do climate science, research, and advocacy best interrelate?
- What lessons do the social and health disparities across affected groups have for environmental and climate justice?
- How can the economic/socio-economic impacts (e.g., housing) of historical disparities inform adaptation strategies, such as physical remediation and restoration, with respect to environmental hazards and the concept of financial reparations (broadly and specifically to environmental justice)?

Guidance to Panel 4: Reactive and Proactive Local Actions and Data Translation for Decision-Makers

- How can communities best balance short versus long term tradeoffs in decisions and investments and engage their communities in this work?
- How do groups and communities work together to make decisions for the climate challenges ahead? What partnerships and resources are available or needed (locally and beyond) to foster good decisions?
- How do communities put a value on the economic, social, and environmental costs and benefits (triple bottom line) of actions that address climate threats, and how do they use this to inform local decision-making?
- How do we invite more people to the table to inspire resilience action and involve more parts of the community (private sector, not-for-profit, government)? Within your own communities, why are people inspired to act and how do we leverage this action more successfully?
- What are we missing and/or what else do we need to know to assist local communities in this work?