COMMUNITY PILOT PARTNERSHIP PROGRAM

2014 - 2018

ResilientAmerica Program

The National Academies of Sciences, Engineering, and Medicine

Contents

Background and Origin of Resilient America Program

ORIGIN OF THE ROUNDTABLE

In 2012, the National Academies of Sciences, Engineering, and Medicine's National Research Council (NRC) published the report, *Disaster Resilience: A National Imperative*,[1] which provided recommendations around critical issues of resilience and strategic steps the United States could take to build resilience to disasters. The report defines resilience as *"the ability to prepare and plan for, absorb, recover from, or more successfully adapt to actual or potential adverse events."* After the 2012 report was published, individuals from several federal agencies, academia, and the practitioner community approached the National Academies for help in implementing the report's recommendations (see Box 1). From these requests, the Resilient America Roundtable was founded.

> ***Resilience*** *is the ability to prepare and plan for, absorb, recover from, or more successfully adapt to actual or potential adverse events.*

The Resilient America Roundtable (Roundtable), a unit located in the Policy and Global Affairs Division's (PGA) Office of Special Projects, was created in 2014. The Roundtable provides a venue for current research, science, and evidence-based foundations to inform whole community strategies for building resilience. It focuses on implementing new approaches to build resilience to disasters and other disruptions; applying and testing tools for improved understanding of risk; and connecting and facilitating partnerships among scientists, data providers, practitioners, and decision makers. In its beginning years, its core activities revolved around focused engagement in four U.S. communities: Cedar Rapids, IA; Charleston, SC; Seattle (region), WA; and Tulsa, OK.

> ***The mission of the Resilient America Roundtable*** *is to convene experts from the academic, public, private, and nonprofit sectors to design, catalyze, or facilitate activities and provide decision makers the intellectual heft of Academy members and other volunteers to take actions that build resilience.*

The Roundtable is comprised of experts from the research community, government, private sector, foundations, and non-governmental organizations. Since its inception, the Roundtable has had 69 members with diverse expertise and experience in the physical sciences, engineering, social sciences, economics, community resilience, emergency management, local government, resilience measures, and urban planning. The makeup of the Roundtable evolves to reflect the program's dynamic activities.

In its first five years, the Roundtable drew much interest and undertook several lines of work. It was expanded from just a Roundtable to the Resilient America Program (Resilient America) to reflect its broad portfolio of work: a community pilot program, convening activities, consensus studies, community engagement efforts, and role-playing games. Resilient America has hosted workshops, conferences, and tabletop exercises nationally and internationally. It has completed three consensus studies: *Building and Measuring Community Resilience: Actions for Communities and the Gulf Research Program* (2019);[2]

[1] National Research Council. 2012. Disaster Resilience: A National Imperative. Washington, DC: The National Academies Press. https://doi.org/10.17226/13457.

[2] *Building and Measuring Community Resilience: Actions for Communities and the Gulf Research Program* is available at https://www.nap.edu/catalog/25383/building-and-measuring-community-resilience-actions-for-communities-and-the.

Framing the Challenge of Urban Flooding in the United States (2019);[3] and *Strengthening Post-Hurricane Supply Chain Resilience: Observations from Hurricanes Harvey, Irma, and Maria (2020).*[4] It partnered with the Koshland Science Museum (now LabX[5]) to develop the role-playing game, Extreme Event.[6] And its stories have been published by the World Economic Forum (2015) and *European Review* (2018). Since the close of its community pilot program in 2018, Resilient America continued its community engagement focus in the southeastern region of the United States and in southeast Texas to tackle issues around flood risk, preparedness, and mitigation.

The end of 2018 drew the inaugural five-year period of the Resilient America Program to a close. This report reviews what the program was able to undertake and accomplish during its first five years, takes stock of its successes and lessons for the program and the National Academies more broadly, and considers next steps for resilience work.

The Community Pilot Program

Partnering with Communities – Selection and Approach

During its first five years, the community pilot program formed the core activity of the Resilient America Program. The purpose of this program was to partner with four U.S. communities to implement four recommendations from the NRC 2012 report (see Box 1).

Box 1
Four Recommendations for Building Community Resilience

All communities are at-risk of impacts from disasters and other hazards, whether they are natural disasters (e.g., hurricanes, wildfires, or droughts) or human-made disasters (e.g., terrorist attacks, financial collapse, or social unrest). One way communities can reduce the impacts of disasters is to enhance their resilience (NRC 2012, p. 1). A resilient community is better able to prepare for, respond to, and recover from a disaster or other disruption.

The NRC 2012 report outlines four recommendations for building community resilience:

1. Communicating, understanding, and managing risk.
2. Building coalitions and partnerships across stakeholders in the public, private, nonprofit, and academic sectors.
3. Measuring resilience.
4. Sharing data and information about best practices, hazards, communication, and policies that build resilience.

These four recommendations provide the foundation for the work of the Resilient America Program and the community pilot program.

[3] *Framing the Challenge of Urban Flooding in the United States* is available at: https://www.nap.edu/catalog/25381/framing-the-challenge-of-urban-flooding-in-the-united-states.
[4] *Strengthening Post-Hurricane Supply Chain Resilience: Observations from Hurricanes Harvey, Irma, and Maria* is available at: https://www.nap.edu/catalog/25490/strengthening-post-hurricane-supply-chain-resilience-observations-from-hurricanes-harvey.
[5] More information about LabX is available at https://labx.org/.
[6] More information about the Extreme Event game is at https://labx.org/extreme-event/about-the-extreme-event-game/.

In September 2014, Charleston and Cedar Rapids/Linn County became the first two pilot communities. Seattle joined as the third pilot in early 2015 and subsequently grew to include jurisdictions across the Central Puget Sound Region (King, Kitsap, Pierce, and Snohomish). Tulsa became the fourth pilot community in 2016 (Figure 1).

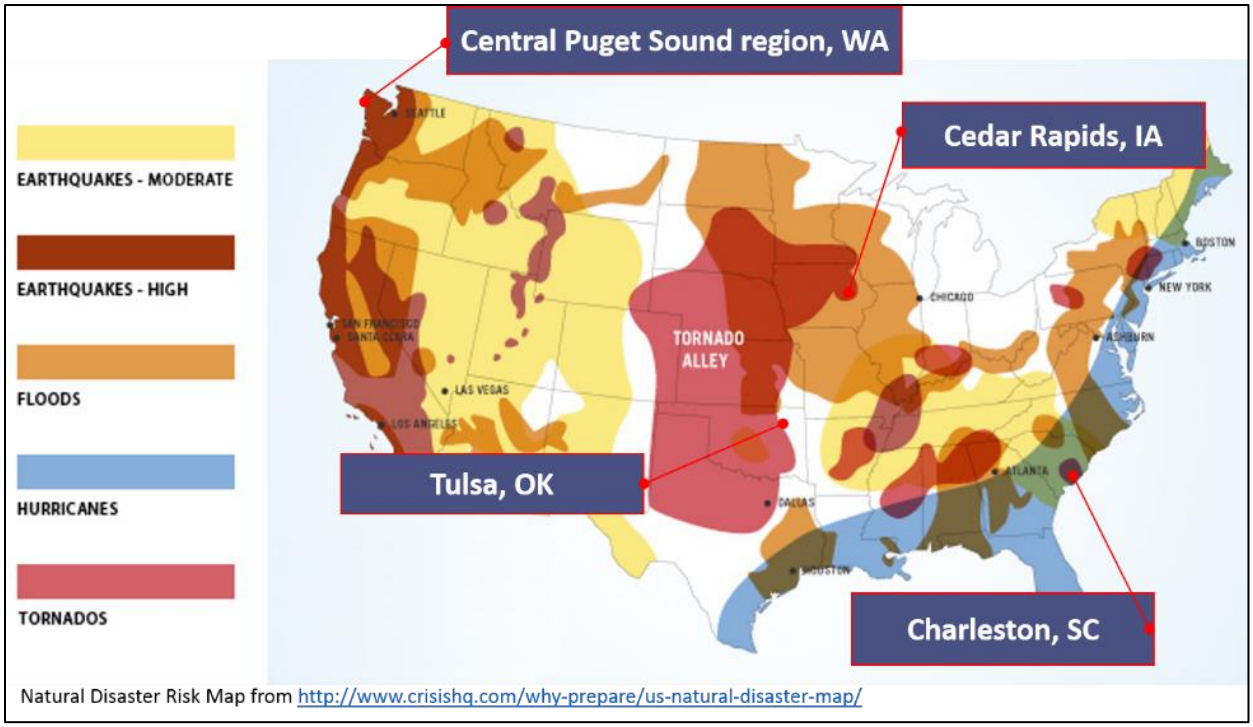

Figure 1. Resilient America pilot communities.

Building resilience requires engaged and proactive efforts at the local level. Resilient America Roundtable members and staff worked with each community to identify its key priorities; tie those priorities to risks that the community faces; and identify actions that the community could take to build resilience to those risks. The community pilot program entailed intense work at the community level, partnering with decision makers and other community stakeholders to identify resilience challenges, priorities, and potential actions they could take to build or enhance resilience in their communities. One of the Resilient America Program's most important roles was as "resilience matchmaker": it fostered connections among diverse community stakeholders, facilitated dialogue and learning, helped them identify which questions to ask, and provided access to experts and the technical expertise needed to answer those questions.

The Roundtable established criteria to guide the community partner selection process and nominated communities for the community pilot program based on these criteria. Communities were selected from different regions in the United States (e.g., west, east, south, and Midwest) and they had diverse hazard profiles and demographics. A key determinant was the level of enthusiasm of local decision makers and key stakeholders to partner with the National Academies and commit to their community's resilience efforts. Ultimately, the communities that were chosen reflected issues and characteristics common to a broader set of communities across the nation to enable Resilient America to connect its pilot communities with other communities that shared similar characteristics and experiences (e.g., Charleston shares similar hazard profiles and demographics with Biloxi, MS and Savannah, GA) as well as to enable the sharing of experiences and lessons learned with communities across the United States. These connections were a pathway to expand the program's reach.

Resilient America tailored its activities in each community to the community's risks, priorities, and needs. Flexibility was essential to the program's success to ensure program activities could be adapted to community priorities, as needed.

The community engagement process involved continuous outreach and relationship-building over the life of the community pilot program. In each community, a "ground team"—a core group of local stakeholders—was established that provided input and guidance, and whose members acted as liaisons to the broader community. These local resilience champions were leaders in developing and/or implementing resilience-building activities in the community. Resilient America identified, established, and cultivated these ground teams and ensured they included representation from the academic, private, public, and non-profit communities.

Roundtable members brought their expertise and knowledge to help design and facilitate activities, and they provided technical assistance to address specific resilience challenges. In addition, Resilient America leveraged the vast National Academies network to convene experts from the academic, public, and private sectors to participate in workshops, conferences, and other events; these activities were tailored to the specific needs of each community. The focus of Resilient America's work in each pilot community was as follows:

- Charleston, SC, and Cedar Rapids, IA, focused on building resilience to flooding, both chronic and acute, specifically through the use of flood resilience measures.
- In the Central Puget Sound, WA (King, Kitsap, Pierce, and Snohomish Counties), Resilient America partnered with the Puget Sound Regional Council (PSRC) to support the integration of climate resilience policy into the Regional Transportation Plan and the Vision 2050 plan and build relationships and facilitate opportunities to share information between local, county, state, and federal stakeholders.
- Tulsa, OK, focused on partnering with the Office of Finance in the Mayor's office to explore issues of economic resilience, specifically looking at the relationship between sales tax revenues and building resilience in the community.

Based on its extensive community engagement work, Resilient America ultimately developed a community engagement process that was applied and replicated (see Box 4).

COMMUNITY PARTNERS – WHO THEY WERE AND WHAT WE DID

Based on its selection criteria, the Roundtable chose four diverse communities (See Table 1.1) and engaged each community based on its needs and where it was in taking actions for resilience. This resulted in a different approach for each community, though the foundation of the work was firmly rooted in the four pillars from the NRC 2012 report.

Table 1. Characteristics* of Resilient America Roundtable Pilot Communities									
Community			Population	Race (%)				Median Household Income	Disaster Risks
				White	Black/ Afr-Am	Asian	Hispanic		
Cedar Rapids			133,174	84.7	7.1	3.4	3.7	$59,152	River flooding, flash floods, tornadoes, extreme heat, drought, winter storms
Charleston			136,208	73.8	22.4	1.9	3.0	$64,599	Flooding, storm surge, king tides, earthquakes, hurricanes, tornadoes
Tulsa			400,669	64.0	15.3	3.3	16.3	$46,113	Tornados, drought, earthquakes, extreme heat, flood, hail storms, wildfires
Central Puget Sound†	Seattle, WA (in King County)		744, 955	68.0	7.0	15.1	6.6	$85,562	Earthquakes, ice, snow, extreme cold, landslides, tsunamis, volcanic hazards, wildfires, excessive heat, floods, windstorms
	Kitsap County		269,805	82.6	3.1	5.5	8.0	$71,610	
	Pierce County		891,299	74.8	7.6	6.9	11.1	$67,868	
	Pierce County	Puyallup Indian Reservation§	46,605 (4,500 registered members)						
	Pierce County	University Place	33,740	69.2	6.8	10.8	7.0	$70,796	
	Snohomish County	Arlington	19,803	86.9	1.4	3.2	9.8	$76,097	
	Snohomish County	Everett	111,262	73.5	4.7	9.1	15.6	$57,205	
	Snohomish County	Tulalip Tribe Reservation¶	9,246 (22% are Native Americans)	72.1				$47,453	

* 2018 data obtained from Quickfacts, available at https://www.census.gov/quickfacts/fact/table/US/PST045218.

† These eight communities represent those that Resilient America directly engaged with in the Central Puget Sound.

§ Puyallup Tribe of Indians. 2017-2022. "Profile Section." *Puyallup Tribe All Hazard Mitigation Plan*, *2017-2022 Edition*, Section 2. Available at http://www.puyallup-tribe.com/publicsafety/hazard_mitigation_plan/2017PTI%20Profile%20Section.pdf.

¶ Tulalip Tribes. "Section II: Community Profile." *Hazard mitigation Plan 2010 Update.* Available at https://www.tulaliptribes-nsn.gov/Base/File/TTT-PDF-Section-2-Community-Profile.

Cedar Rapids/Linn County, IA

Linn County is located in central-eastern Iowa (see Figure 2). In 2018, the population of Linn County was estimated at 225,909 people (89,807 households 2014-2018). Cedar Rapids is the county's largest city, and has an estimated population of 133,174 people (54,431 households in 2014-2018). Linn County is made up of 88.4% White residents, 5.9% Black or African American residents, 2.6% Asian residents, and 3.4 % Hispanic residents; the median household income is $64,862.[7]

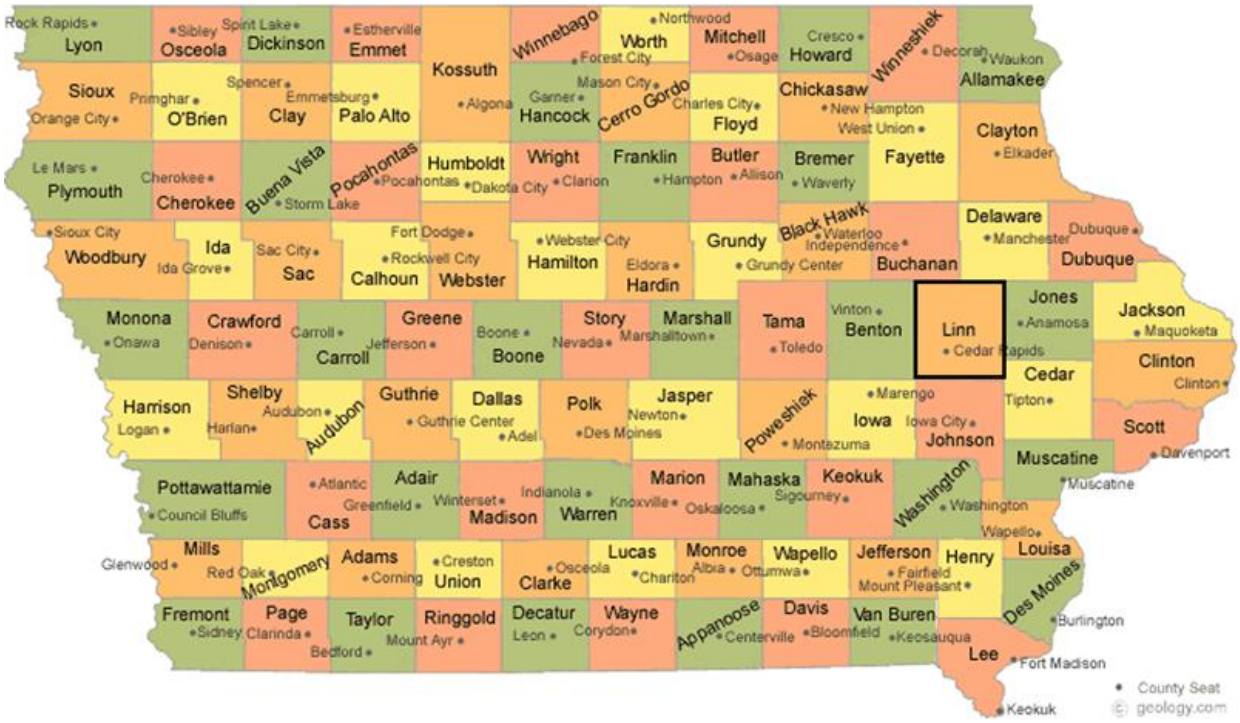

Figure 2. Map of State of Iowa showing Linn County (outlined in black) with location of Cedar Rapids (Source: http://ontheworldmap.com/usa/state/iowa/large-detailed-map-of-iowa-with-cities-and-towns.html).

Linn County faces a variety of natural and manmade hazards including riverine and flash flooding, tornadoes, drought, infrastructure failure, and hazardous material incidents. While all present unique challenges, flooding has been particularly devastating. In 2008, Cedar Rapids experienced the most destructive flood in its history. This flood, a Presidentially Declared Disaster, impacted 85 counties in Iowa. Over 12 inches of rain fell across portions of the Midwest June 1-15, 2008, exacerbating already saturated soil from a historically wet period in Iowa from January to June. The Cedar River, which runs directly through the center of Cedar Rapids, crested at almost 32 feet, resulting in overtopped levees and major damage to homes and businesses. Previously, the highest river crest had been at 19.66 feet. More than $5.4 billion in flood losses were reported, and infrastructure that was outside of the 500-year floodplain (e.g., Linn County Sheriff's Office and Mercy Medical Center) experienced damage.[8]

[7] Statistics about each of the four pilot communities obtained from *QuickFacts* available at https://www.census.gov/quickfacts/fact/table/US/PST045218.

[8] FEMA. October 2009. *Midwest Floods of 2008 in Iowa and Wisconsin: Building Performance Observations, Recommendations, and Technical Guidance*. Retrieved from http://www.fema.gov/media-library-data/20130726-1722-25045-0903/fema_p_765.pdf.

Since 2008, Cedar Rapids made significant progress toward recovery and focused much of its efforts on preparedness and resilience to future flood events and other hazards. The city is developing a flood protection system, participates in a watershed management program, developed green spaces through acquisitions of damaged properties, and improved stormwater management systems. In late September 2016, Cedar Rapids experienced another flood event when the Cedar River crested at the second highest level (about 22 feet) in its history. Because of the numerous flood mitigation efforts the city had implemented since 2008, the community's response to the 2016 flood was positive and it weathered the 2016 flood mostly unscathed. Despite the success of the city's preparedness and mitigation efforts, the 2016 flood resulted in $25.7 million in losses due to multiple factors including loss of business revenues (downtown Cedar Rapids, where many businesses are located, was evacuated for about one week), rental of flood protection equipment (e.g., HESCO barriers), lost inventory and production, and lost wages (in addition to businesses being closed, the public school system and childcare facilities were shut down for one week).[9]

The 2008 flood necessitated a huge response and coordinated effort between the city and county. During the response and recovery efforts, stakeholders in the city and across the county established strong relationships. These relationships continue today and provided the foundation for the partnership between Resilient America and the community. Resilient America established a local ground team which was composed of about 30 key stakeholders from multiple community sectors in Cedar Rapids and Linn County, including local government, first responders, non-profit communities, and the private sector; these stakeholders included the City of Cedar Rapids (e.g., city manager's office, planning department, building services, fire department, police department, community development), Linn County (e.g., board of supervisors, emergency management, public health), Cedar Rapids School District, United Way, Iowa Legal Aid, LAP-AID, Greater Cedar Rapids Foundation, Cedar Rapids Metro Economic Alliance, and the East Central Iowa Council of Governments. The community is working on building resilience to all hazards and disruptions, with a particular focus on its riverine flood risk. The priorities identified for the Cedar Rapids/Linn County partnership included:

- Improving risk communication and community engagement of all members of the community.
- Better understanding of the community's resilience baseline and progress for building resilience using measures.
- Increasing the preparedness and resilience of vulnerable populations, and the capacity of local community organizations to provide services to these vulnerable communities.
- Building the disaster preparedness capacity of small businesses.

Resilient America conducted meetings and activities in Cedar Rapids and Linn County to enhance the resilience of the community, identify and prioritize resilience needs, and support preparedness efforts. A major thrust of the work focused on building resilience to floods through the implementation of the Zurich Flood Resilience Measurement Framework[10] (see "Measuring Flood Resilience in Cedar Rapids and Charleston" below).

[9] *The Gazette*. February 17, 2017. "Report: Cedar Rapids businesses took $25 million hit during 2016 flood." Available at https://www.thegazette.com/subject/news/business/report-cedar-rapids-businesses-took-25-million-hit-during-2016-flood-20170217.

[10] More information about the Zurich Flood Resilience Measurement Framework is available at https://www.zurich.com/en/sustainability/our-role-in-society/flood-resilience/measuring-flood-resilience.

Charleston, SC

Charleston County is located along the central Atlantic coast of South Carolina (see Figure 3). In 2018, the county had an estimated population of 405,905 (156,482 households in 2014-2018). The City of Charleston, the county's largest city, had an estimated population of 136,208 people (55,013 households). The county is comprised of 69.2% White residents, 26.8% Black or African American residents, 1.8% Asian residents, and 5.1% Hispanic or Latino residents; the median household income is $61,028.[11]

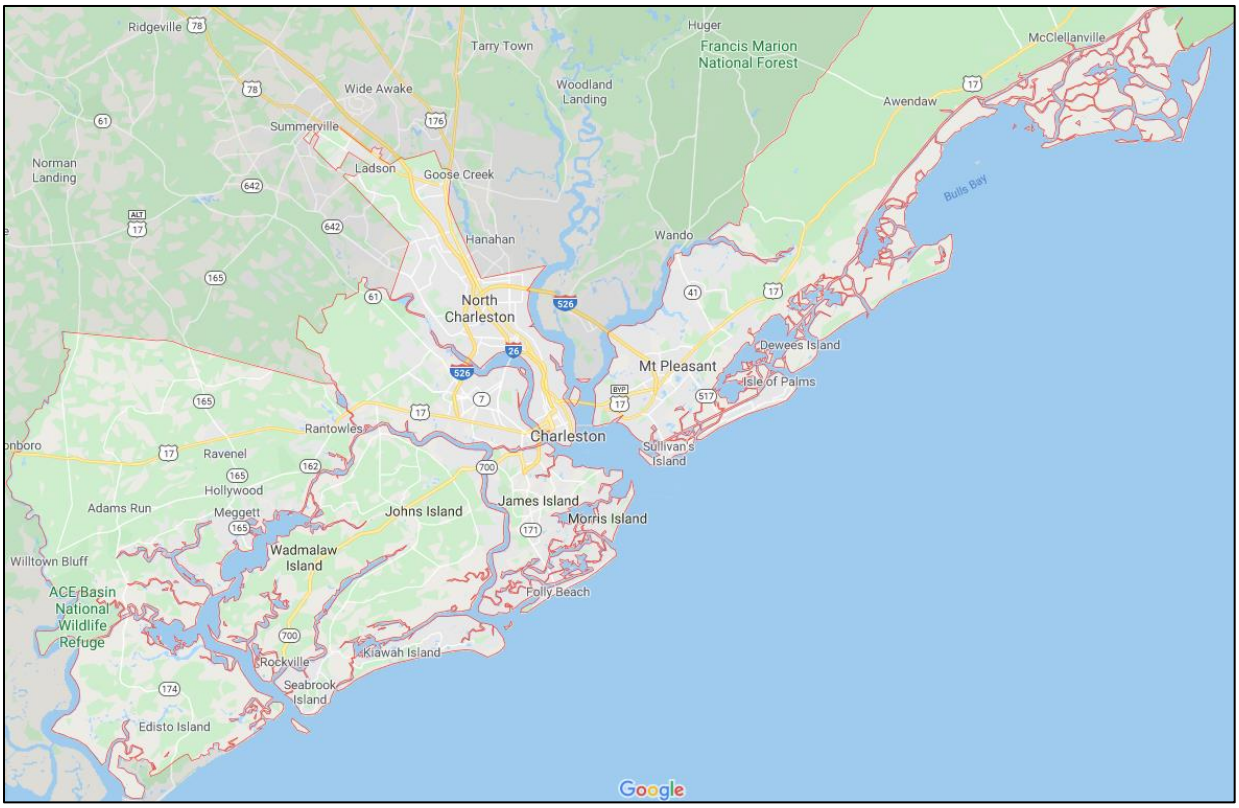

Figure 3. Map of Charleston County, SC. (Source: Google maps.)

Charleston faces a variety of natural and manmade hazards including floods, king tides, hurricanes, tornados, earthquakes, wildfires, terrorism, and hazardous material incidents. Over the past several years, it has experienced notable flood events including an historic rainfall in October 2015, Hurricane Matthew in 2016, Hurricane Irma in 2017, and Hurricane Florence in 2018. The last significant event prior to these was Hurricane Hugo in 1989. The city experiences "nuisance flooding" on a regular basis, and this type of flooding is increasing each year. The region as a whole is experiencing impacts from climate change; for example, many areas are facing increased risks due to sea level rise.

[11] Statistics about each of the four pilot communities obtained from *QuickFacts* available at https://www.census.gov/quickfacts/fact/table/US/PST045218.

The City of Charleston has undertaken research and resilience-related work for many years. For example, the city was a FEMA Project Impact[12] community and a Community and Regional Resilience Institute[13] (CARRI) partner community. However, with the increased hurricane and flood events of the past several years, the City of Charleston has demonstrated a recommitment to flood resilience. When Resilient America began its partnership with Charleston, the region was in the early stages of self-organizing to address its flood hazard in recognition that it was not prepared to deal with another Hurricane Hugo. Local stakeholders formed the Charleston Resilience Network (CRN),[14] a group of stakeholders composed of city, county, state, federal, and private sector representatives that was interested in enhancing the resilience of their community. The CRN works to build resilience in the community by sharing information, connecting partners, and creating a unified strategy. The CRN became the Resilient America's primary partner for its work in Charleston.

Regarding resilience-related work in Charleston, in December 2015, the City of Charleston identified sea level rise as a top priority and developed its first *Sea Level Rise Strategy*[15] (the city recently published the second edition of this strategy, *Flooding and Sea Level Rise Strategy*[16]). Of the 76 items recommended in the sea level rise strategy, 60 have been completed or are being implemented.[17] The strategy is focused on three types of actions: reinvest, respond, and ready. For example, the city is collaborating with the CRN; the CRN won grants to better understand the ability of the region's infrastructure to handle nuisance and severe flooding and to develop "multi-hazard indices and tools for Coastal Resilient Infrastructure Assessment and Adaptation for small businesses, municipalities, and individuals in the Charleston, SC region."[18] The city is in the process of studying the zoning code to identify ways to promote development that minimizes risk to sea level rise, incentivize low impact development, and encourage retrofits of existing structures. The city is also installing flood gauge devices in areas that experience repetitive flooding and developing a city flood parking plan to help prevent vehicle loss. Finally, the city hired a chief resilience officer in early 2017.

Resilient America established multi-stakeholder relationships (e.g., NOAA, SC Sea Grant Consortium, SC Department of Health and Environmental Control, City of Charleston, College of Charleston, American Red Cross, South Carolina Aquarium) within the community to address the community's resilience goals and priorities. In addition to the CRN, Resilient America engaged other stakeholders in the region to understand resilience priorities and challenges across multiple sectors. Flooding, both chronic and catastrophic, was the primary risk identified across multiple stakeholders and became the focus of the Resilient America's work in the community. The priorities identified for the Charleston partnership included:

- Building and facilitating regional, multi-stakeholder partnerships.

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[12] More information about FEMA's Project Impact program is available at https://training.fema.gov/hiedu/docs/hazriskmanage/hazards%20risk%20mgmt%20-%20session%204%20-%20project%20impact%20guidebook.pdf.

[13] More information about CARRI is available at https://merid.org/case-study/community-and-regional-resilience-institute/.

[14] Charleston Resilience Network website: http://www.charlestonresilience.net/.

[15] City of Charleston. December 2015. *Sea Level Rise Strategy: Charleston, South Carolina*. Available online http://www.charleston-sc.gov/DocumentCenter/View/10089.

[16] City of Charleston. February 2019. *Flooding and Sea Level rise Strategy*. Available at https://www.charleston-sc.gov/1981/Flooding-Sea-Level-Rise-Strategy).

[17] See online tracking of projects at https://docs.google.com/spreadsheets/d/e/2PACX-1vQzHAUlbeRUHu6gWbJlJyQzTxQW_lB9t5IW3RICSGrDwIKCSSOB0pqM4n1UMC7525_uaGBYXFV9I_pW/pubhtml?gid=1635394151&single=true.

[18] See "Development of Multi-hazard Coastal Resiliency Assessment and Adaptation Indices and Tools for the Charleston, SC Region," available at http://www.charlestonresilience.net/projects/nipp-security-and-resilience-challenge/.

- Understanding the community's flood resilience baseline and identifying ways to enhance flood resilience.
- Improving risk communication and community engagement to promote better preparedness for flood events.
- Understanding the impacts of development and tourism on the community's economic resilience.

Resilient America conducted meetings and activities in Charleston that focused on prioritizing the community's resilience goals and providing opportunities for relationship-building among diverse stakeholders across community sectors. As in Linn County, a major aspect of the work focused on building resilience to floods through the implementation of the Zurich Flood Resilience Measurement Framework.

Measuring Flood Resilience in Cedar Rapids and Charleston

One of Resilient America's key activities in both Charleston and Cedar Rapids/Linn County was a data collection effort using a flood resilience measurement framework to understand the communities' baseline flood resilience. Through a partnership with the Zurich Alliance, a private-public-academic group, Resilient America implemented and beta-tested the Z Zurich Foundation's flood resilience measurement framework (see Appendix A for a description of the Zurich framework). This project consisted of identifying community goals and priorities, collecting data to measure the community's baseline flood resilience, working with community members to assess the data, and identifying actions the community could take to address resilience challenges. This project was conducted in two phases over two years and included a baseline and endline flood resilience assessment.

For the baseline and endline assessments, data were collected through stakeholder group discussions, community meetings, key informant interviews, household surveys, and third party sources. The Zurich framework organizes data sources across the five community capitals: human, social, natural, physical and financial (see Box 2). These five capitals represent a community's assets (i.e., attributes, resources, and capabilities). Assets that can contribute to a community's resilience to flood represent the sources (i.e., indicators) of flood resilience. Resilient America collected data from and about both communities for each resilience source in order to assess each community's level of resilience for that source. While this activity was specifically focused on flooding, the data collected were also useful in understanding the communities' resilience more broadly to hazards and disruptions.

Box 2
Flood Resilience Measurement Project: Data Collection Efforts

Resilient America's flood resilience measurement project in Cedar Rapids/Linn County and Charleston focused on collecting and analyzing a variety of data associated with five community capitals to capture information about each community's understanding of its risks, flood-related challenges, and current efforts to prepare for and mitigate those risks. Resilient America worked with each community to use this data to identify its flood-related challenges and potential actions the community could take to enhance its flood resilience. Examples of the types of data collected from community stakeholders included:

- Natural capital: sustainable use of natural resources, conservation management plan, basin health.
- Human capital: flood protective behavior and knowledge, flood water control knowledge, flood exposure perception, understanding of future flood risk.

- Social capital: mutual assistance systems and safety nets; culture for information sharing; strategy to maintain or quickly resume services in healthcare, transportation, water, power, food, education, etc. that were interrupted by flooding; watershed management.
- Physical capital: early warning systems, flood control, water supply, food security, sanitation facilities, waste collection, power sources, communication infrastructure.
- Financial capital: continuity of business, income and affordability, household financial savings to protect assets, flood insurance, household income continuity strategies, mitigation financing.

The goals for this flood resilience measurement project were to help the Cedar Rapids/Linn County and Charleston communities:

- Identify their flood resilience strengths, challenges, and priorities.
- Identify actions or interventions they could take to build or enhance resilience to floods.
- Implement actions to increase flood resilience in the community.
- Measure their progress towards becoming more flood resilient.

After the data were collected, Resilient America facilitated the data assessment process with a local team of community stakeholders. To ensure an accurate interpretation of the data, it was essential that local experts with deep knowledge of the community participated in the data assessment process. The interpretation of the data and the potential actions to address identified challenges were based on local expert knowledge and understanding of the culture and needs of the community. The results of the data analysis were shared more broadly with other members of the ground teams and their networks for additional feedback.

Community resilience building is an incremental process that can take years, and time is needed between the implementation of resilience-building actions and the measurement of the success of those actions. Because of Zurich's framework development timeline, there was only one year between the baseline and endline assessments in Cedar Rapids/Linn County and Charleston. This was not enough time to measure meaningful change in flood resilience in either community. Between the baseline and endline assessments, a major flood event occurred in each community (September 2016 flood in Cedar Rapids and Hurricane Matthew in 2016 in Charleston).

The most important outcomes of the baseline and endline assessments were the lessons learned by the communities, the discussions among stakeholders present during the assessments, and the subsequent discussions about and development of potential actions to address flood resilience challenges identified from the data.

As a result of these flood resilience measurement efforts, the communities identified the following lessons as important to the resilience of their communities:

- Cedar Rapids/Linn County:
    - **Relationships and partnerships**: Cultivating relationships and building partnerships ahead of a disaster is critical for successful response and recovery. Pre-existing plans, pre-event cross-sector training (e.g., nuclear plant drills, emergency management exercises), and strong personal relationships (e.g., between city government and NGOs, city and county governments, emergency management and NGOs) allow operations to run more smoothly during a disaster.
    - **Risk communication:** Communicating with the public in advance of and following a disaster is critical.
    - **Individual preparedness**: Individuals need to assume responsibility for their risk and enhance their own resilience by building their capacity to prepare and recover.

- **Regional collaboration**: For flood resilience, it is important to manage floodplains and collaborate at a broader watershed level rather than at the level of a city, county, or individual jurisdiction.

- Charleston:
  - **Responsible growth**: When managing flood events (e.g., nuisance flooding, storm surge, heavy rain events), a critical balance is needed between fostering a thriving economy (through growth, development, and tourism) and conserving and preserving the environment and cultural heritage.
  - **Risk communication**: Through community engagement, local government can raise awareness among residents about how to prepare for flood risks, what is needed for mitigation, and how development impacts the environment. This includes increasing local residents' awareness of their vulnerability to and need for action to address sea level rise.
  - **Community buy-in**: The City of Charleston is making strides towards building resilience to their growing flood risk. Broader community buy-in is needed in order to move the community toward greater resilience. In addition to the numerous flood resilience-building events and initiatives that have occurred over the past several years, the city adopted its first sea level rise strategy in 2016 and hired its first chief resilience officer in 2017. Since its formation in 2015, the CRN has since grown into a multi-stakeholder group of volunteers committed to increasing resilience to natural disasters and other coastal hazards.

Central Puget Sound (King, Kitsap, Pierce, and Snohomish Counties), WA

Resilient America worked across four counties that make up the Central Puget Sound Region, which has a population of 4.2 million.[19] According to 2018 population estimates, King County has a population of 2,233,163 and is comprised of 66.9% White residents, 6.9% Black or African American residents, 19.2% Asian residents, and 9.8% Hispanic or Latino residents; the median household income is $89,418. Seattle, located in King County and the largest city in the Puget Sound Region, has a population of 744,955 (323,446 households in 2014-2018); the median household income is $85,526.

Snohomish County has an estimated population of 814,901 and is comprised of 77.6% White residents, 3.7% Black or African American residents, 11.6% Asian residents, and 10.4% Hispanic or Latino residents; the median household income is $82,751. Pierce County has an estimated population of 891,299 and is comprised of 74.8% White residents, 7.6% Black or African American residents, 6.9% Asian residents, and 11.1% Hispanic or Latino residents; the median household income is $67,868. Kitsap County has an estimated population of 269,805 and is comprised of 82.6% White residents, 3.1% Black or African American residents, 5.5% Asian residents, and 8.0% Hispanic or Latino residents; the median household income is $71,610.[20]

The Central Puget Sound Region is located along the northwest coast of Washington State (Figure 4). The Puget Sound Region faces a variety of natural and manmade hazards including earthquakes, snow, ice, extreme cold, landslides, transportation incidents, infrastructure failures, tsunamis, volcanic hazards, fires, excessive heat, floods, and windstorms. The most recent notable events in the region

[19] Puget Sound Regional Council. 2019. *Puget Sound Trends.* Available at https://www.psrc.org/sites/default/files/trend-population-201908.pdf.
[20] Statistics about each of the four pilot communities obtained from *QuickFacts* available at https://www.census.gov/quickfacts/fact/table/US/PST045218.

include the Oso landslide in March 2014, the Pacific Northwest heat wave in July 2009, and the Hanukkah Eve windstorm of 2006.

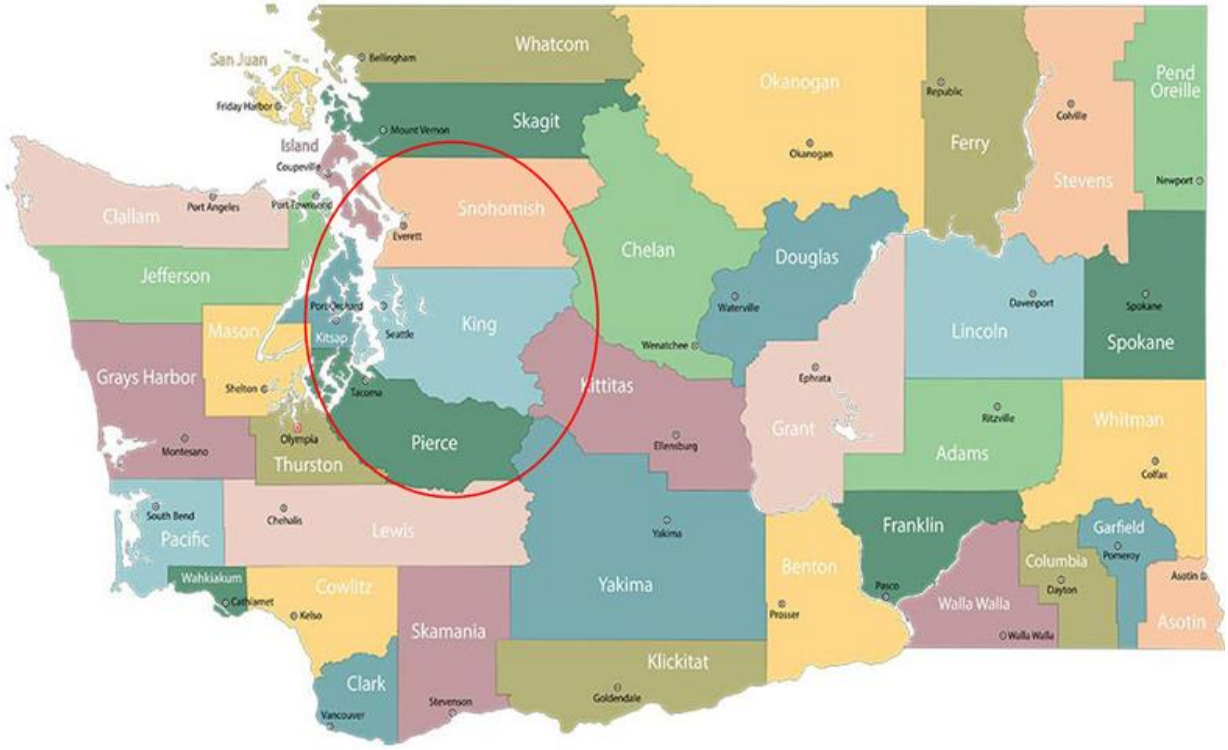

Figure 4. Map of Washington State with Snohomish, King, Pierce, and Kitsap Counties circled in red (Source: http://choosewashingtonstate.com/why-washington/our-region/).

Resilient America's key partner in the region was the Puget Sound Regional Council (PSRC) whose membership includes representatives from 88 jurisdictions in King, Snohomish, Pierce, and Kitsap counties. The partnership between Resilient America and the PSRC focused on climate change impacts in communities. The priorities identified for this partnership included:

- Integrating resilience into regional transportation planning and vision planning for the region.
- Understanding how communities were assessing and addressing their climate risks.
- Helping multiple jurisdictions across the four counties better understand their climate risks and ways to adapt to and mitigate these risks.

Local jurisdictions in the Central Puget Sound Region have varying degrees of understanding, planning, and activities addressing their climate risks. As a starting point, the PSRC needed to better understand the extent to which local jurisdictions in the four counties were addressing their climate risks and building resilience to those risks, and what the PSRC could do to help local decision makers identify and integrate actions to build climate resilience into their future plans and efforts. Resilient America leveraged its relationship with the PSRC in its community engagement activities in the region to gather information about how local jurisdictions were addressing future climate impacts and climate resiliency and what challenges they faced in their climate resilience-building efforts.

Central Puget Sound Baseline

Resilient America and the PSRC worked together on a regional approach to better understand how climate was impacting communities and how communities were planning for and addressing those

impacts. As a first step, a survey was sent to the 88 local jurisdictions across Central Puget Sound Region; the response rate was 32%.

The purpose of the survey was to better understand:

- Climate risks and impacts that local decision makers face;
- Types of climate resilience or adaptation policies that were included in local planning processes and documents;
- Challenges decision makers face incorporating climate resilience into their planning;
- What PSRC could do to help local decision makers address their climate risks; and
- Actions that could be taken at the regional level to mitigate climate impacts.

In summary, the baseline survey found that flooding, sea level rise, landslides, storms, and increasing temperatures are the top five climate impact concerns across jurisdictions in the Central Puget Sound Region. Climate resiliency or adaptation policies were incorporated into planning documents or efforts in over 50% of the jurisdictions in King, Kitsap, and Snohomish Counties who responded to the survey; less than 20% of jurisdictions in Pierce County were addressing climate resiliency.

According to survey responses, the four main challenges communities have incorporating climate resiliency into their planning or implementation efforts are a lack of resources, need for education or expertise, lack of incentives, or lack of political will. The top three ways the PSRC could help local jurisdictions address their climate risks would be to set regional policies, provide technical assistance, or provide jurisdictions with the best available science; PSRC could also provide funding and expertise as well as opportunities for peer-to-peer learning and training. At the regional level, jurisdictions suggested that the two main methods for mitigating climate impacts are through regional coordination efforts and the development of regional standards and goals.

After the survey, Roundtable staff and members facilitated meetings with seven local jurisdictions for more in-depth discussions about their specific risks, needs, and priorities, and ways that the PSRC could support their efforts. A common theme across the jurisdictions was the importance of economic resilience and concern about how disaster impacts will affect it. Investment in communities post-disaster can impact a community's ability to recover and rebuild, but it is often difficult for smaller communities to get attention from investors. Another common theme was risk communication, and most jurisdictions struggle with effectively communicating to the public about climate resiliency. A third common theme was that jurisdictions value peer-to-peer learning opportunities; learning how other communities are approaching or implementing climate resiliency planning and activities helps communities build relationships with each other and learn about different ways they could address similar challenges. As was identified in the initial survey of PSRC jurisdictions, finding the resources (staff time, funding) to implement climate resiliency planning and efforts continues to be a challenge for all communities. Several communities expressed a desire for and help with collaboration with other communities and local tribes to share funding and leverage resources. Often, funding opportunities create competition between communities that can deter collaboration.

Some communities are working with federal agencies (e.g., U. S. Army Corps of Engineers) to implement projects, but would like better alignment and flexibility between federal project funding requirements and community needs. For example, a federal agency may require funds to be used to build a flood wall but the community would rather develop river setbacks, slow down sediment build up, and open up levees to create side channel habitats for young fish. Many jurisdictions identified a need for data that was understandable, relevant, and accessible to help them understand their future climate risks. Jurisdictions also need support and information on how to incentivize residents, farmers, and businesses to participate in climate resilience adaptation and mitigation. Finally, jurisdictions are worried about the

impacts of population growth in the region and how it will affect transportation, air quality, and development.

Through the survey and community discussions, common themes emerged about the needs and challenges jurisdictions face in addressing their climate risks and impacts (see Box 3).

Box 3
Common Challenges Jurisdictions in the Central Puget Sound Region Face in Addressing Climate Risks and Impacts

- Economic resilience is key. It is difficult to address uncertain or future risks if the community is not economically thriving.
- Communities lack funding and resources to implement activities that promote resilience and address climate impacts.
- Communities need to better understand and have access to creative and sustainable financing solutions for implementing climate adaptation and resiliency.
- The terminology "climate change" is still not accepted by many citizens and decision makers in some jurisdictions of the Central Puget Sound Region. For these jurisdictions, communicating the importance of resilience and/or climate change is challenging, not only with the public but also with leadership.
- Data are often lacking or inaccessible for decision making at local levels.
- Communities need support to develop the partnerships and collaboration opportunities needed to:
    - leverage expertise and resources.
    - advance mutual disaster resilience-related work.

The jurisdictions identified ways that the PSRC could help advance these issues including training, technical assistance, convening activities to build a climate community, integration of climate into current policies, and leadership in the community. The PSRC used this information to inform their planning documents, support their efforts to build a climate community, and identify activities (e.g., training on specific topics or networking opportunities) that the PSCR could implement to support climate efforts.

Tulsa, OK

Tulsa County (see Figure 5) is the most densely populated county in Oklahoma with a 2018 estimated population of 648,360 (251,176 households in 2014-2018); the county's population is 72.6% White residents, 10.8% Black or African American residents, 3.4% Asian residents, and 13.0% Hispanic or Latino residents; the median household income is $53,901. The entire Tulsa Metropolitan Area comprises seven counties: Creek, Okmulgee, Osage, Pawnee, Rogers, Tulsa and Wagoner, whose aggregate population is estimated to be 981,005 or 25.1% of the population of the state of Oklahoma. The gross product or value of all goods and services produced in the seven-county Metropolitan Area is estimated to be $58.7 billion (2009 dollars), or 33.4% of the Oklahoma economy.[21] The City of Tulsa is the second-largest city in the state of Oklahoma and serves as the county seat of Tulsa County; it has a population of 400,669 (164,224 households in 2014-2018).

[21] "2018 Economic Summary with Forecasts for 2019-2023." Retrieved January 21, 2019, from Tulsa Regional Chamber: http://www.growmetrotulsa.com/business-attraction/relocation-data/economic-profile.

Figure 5. Map of Tulsa County (outlined in red). (Source: Google maps.)

Tulsa County faces a variety of natural and man-made hazards including floods, tornadoes, high winds, lightning, hailstorms, severe winter storms, extreme heat, drought, expansive soils, wildfires, earthquakes, and dam and levee failures. The City of Tulsa also faces a unique economic challenge. In Oklahoma, city budgets are largely based on yearly sales tax revenues, which can fluctuate and add a dimension of uncertainty in the city's ability to provide critical services.

The City of Tulsa is one of the Rockefeller Foundation's original 100 Resilient Cities. Initially, Resilient America partnered with the chief resilience officer and city officials to identify priorities for the partnership. In 2016, a new mayor was elected which resulted in a change in the core ground team and a different set of priorities. Mayor G. T. Bynum's team identified economic resilience as its key priority, with a particular need to better understand the relationship between sales tax revenue and resilience. In Oklahoma, cities rely on sales tax revenue for a large part of their annual budget.[22] Tax revenue can fluctuate from year to year, which presents uncertainty regarding resources available for many of the

[22] City of Tulsa. "City Budget." Available at https://www.cityoftulsa.org/government/departments/finance/financial-reports/city-budget/.

city's services. When basic community resilience needs such as health, public safety, transportation, and employment face budgetary uncertainties, disaster preparedness is not a high priority.

A Different Approach in Tulsa

To address Tulsa's economic resilience priority, Resilient America undertook an analysis of the potential relationship between sales tax generation and community resilience. Tulsa is especially concerned about how potential preconditions, hidden dependencies, and interdependencies may influence sales tax revenue (STR) generation. In the last decade, Tulsa's STR growth has generally stagnated or declined. This occurred even as the population and the city's median household income increased slightly.

To accomplish this work, Resilient America partnered with the City of Tulsa's Department of Finance and the City Auditor's Office; without their support Resilient America would not have been able to access the relevant sales tax data. STR data were obtained across 28 zip codes in Tulsa over the period of 1998-2016. Using network analysis, two main questions were investigated:

- Is there geographic concentration in Tulsa's sales tax revenues? If so, how significant is it and is it increasing, decreasing, or remaining stable?
- Is there a statistical relationship between the levels of geographic or categorical concentration and the decline in Tulsa's sales tax revenues?

To begin to answer these questions, STR data were organized to reflect the zip codes where commercial transactions took place. For the preliminary analysis, STR data were statistically assessed for a set of five factors for each zip code (population, median household income, commercial establishments, payroll, and employees) as reported by the U.S. Census Bureau in the American Community Survey and the Economic Census. Data from the Tulsa County Department of Health were also utilized. Preliminary analysis of the data found a statistically significant correlation between 1) geographic densification of economic activity, 2) reduced sales tax revenues, and 3) poor population health outcomes.

Resilient America's Approach for Working with Communities: The Community Engagement Process

Over the course of the pilot community work, the Resilient America developed and refined a community engagement process (see Box 4). This process supported communities in identifying resilience needs and prioritizing those needs, and helped build a custom set of activities to address the communities' resilience goals. In the process, Resilient America built trust in the scientific community, identified ways to help decision makers access and utilize data, and facilitated public engagement on public safety, disaster preparedness, and issues that impact quality of life. Each community was a unique exercise in resilience building. Yet, common to all of the communities was convening activities, data collection and analysis, and community engagement to identify local challenges and design approaches to meet local resilience goals or priorities.

Box 4
Resilient America Community Engagement Process

1. **Establish a ground team**: By establishing a team of stakeholders that represented a variety of community sectors (e.g., local and county government, academia, nonprofits, the private sector), Resilient America had a core group of people it met with regularly who could act as liaisons and points of contact to the larger community.

2. **Foster and build relationships, partnerships, and networks**: Building and nurturing relationships was an ongoing process throughout the community pilot partnership and it was key to effectively working in a community. *This step is important for building relationships and networks within a community (aligns with Recommendation 4, Box 1).*
3. **Identify community resilience challenges, needs, and goals**: Holding meetings and workshops that included a variety of community stakeholders ensured all voices were heard and a variety of perspectives taken into consideration. *This step is an important part of communicating, understanding, and managing risk among community members and stakeholders (aligns with Recommendation 1, Box 1).*
4. **Establish resilience baselines, identify key issues, and prioritize resilience-building actions**: Communities are interested in data that will better help them to target their resilience-building efforts. *This step is an important aspect of measuring resilience (aligns with Recommendation 3, Box 1).*
5. **Implement resilience actions**: In each community, Resilient America kick-started the process of implementing actions by facilitating a set of resilience building activities. However, it is up to the community to continue its resilience building efforts. *Through the development of resilience solutions, community stakeholders can share data and information about best practices, hazards, communication, and policies that would help them implement effective actions for building resilience (aligns with Recommendation 2, Box 1).*
6. **Provide opportunities for peer-to-peer learning opportunities and knowledge exchange among communities and with other engaged stakeholders:** This includes nonprofits, the private sector, and state and federal agencies that are working to increase the nation's resilience. *(This aligns with Recommendation 2, Box 1.)*

In all four communities, Resilient America implemented the community engagement process to meet the specific goals of each community. In some of the communities, including Cedar Rapids/Linn County and Charleston, all six steps were fully implemented. In the Central Puget Sound Region and Tulsa, which had shorter timelines and projects with a narrower scope, the process was modified. For example, in Tulsa, Resilient America focused on a specific project—the relationship between sales tax revenue and community resilience—as that was a particular priority of local government. In the Central Puget Sound, the Resilient America's primary partner was most interested in advancing climate resiliency in a region where many jurisdictions had not yet begun planning for future climate risks. In both of these instances, the Resilient America predominantly worked with a single local organization as its "ground team." Resilient America's community engagement process is a flexible framework that provided a foundation to begin resilience discussions, better understand where a community was and where it wanted to go, and implement resilience actions. Each step in the process was tailored to the community.

1. Establish a Ground Team

The NRC 2012 report stressed the importance of the "development of broad-based community coalitions" noting that, "Rather than just an instrument to secure a community's concrete commitment to disaster resilience, the development of a broad-based community coalition is itself a resilience-generating mechanism in that it links people together to solve problems and builds trust" (p. 118). Because resilience building requires the participation of all sectors in a community, at the outset of each pilot community partnership Resilient America spent several months meeting with a variety of stakeholders, recognizing the need for a core group of committed partners from different sectors to provide sustained input and guidance throughout the partnership and feedback on the scope, priorities, and participants for various activities. Ultimately, this resulted in the establishment of a "ground team" composed of key community stakeholders that became Resilient America's primary point of contact and its liaison to the broader community (see Box 5). In Cedar Rapids, Resilient America partnered with an

already established informal network of community stakeholders that developed around the response to and recovery from the 2008 flood. In Charleston, Resilient America partnered with a newly formed formal volunteer network, the Charleston Resilience Network, that had a specific mission and pursued projects that supported that mission. In the Central Puget Sound Region and Tulsa, the partnerships were with a specific organization (the Puget Sound Regional Council and the local Tulsa government). In all cases, the work would not have been possible without these partners.

Box 5
Pilot Community Ground Teams

In June 2014, the Department of Homeland Security's National Protection and Programs Directorate sponsored a workshop in Charleston to better understand local climate preparedness, adaptation, and resilience efforts.[23] The Charleston Resilience Network (CRN) formed out of this workshop, in early 2015. When Resilient America began working with the CRN, it was composed of about ten members, almost all of whom were government representatives (local, state, and federal). Since then, the CRN has grown to include stakeholders across three counties, all levels of government, academia, the private sector, nonprofits, public health, and faith-based organizations. Resilient America supported the CRN throughout its partnership by hosting convening activities, partnering on a post-event symposium, and bringing together diverse stakeholders from the region to facilitate relationship building between the CRN and other community stakeholders. Additionally, Resilient America provided opportunities for members of the CRN to participate in various knowledge exchange activities and share lessons learned with other communities across the country (e.g., at Resilient America's State of Resilience Leadership Forum and Community Workshop in Washington, DC and at the Measures of Community Resilience workshop in Cedar Rapids).

Before Resilient America began its work in Cedar Rapids, the National Academies' Committee on Increasing National Resilience to Hazards and Disasters had visited the community as it was working on the NRC 2012 report (Cedar Rapids was highlighted in the 2012 report). Resilient America leveraged the relationships that formed out of the committee's interactions with Cedar Rapids to build a local ground team. Whereas the CRN was created as a formal group of partners, the Linn County ground team was an informal network of local stakeholders. Many relationships were established in the wake of the 2008 flood in Cedar Rapids, and over time these relationships were cultivated and strengthened. For the most part, Cedar Rapids/Linn County is a close-knit community where local stakeholders have established informal relationships with each other. Because of this, the ground team was informal, composed of a group of people from multiple sectors (local and county government, private sector, nonprofit sector, academia) who were already connected.

2. Build and Foster Relationships

To build resilience, it is essential that community stakeholders develop and cultivate strong relationships and collaborations with other community stakeholders across diverse community sectors and across communities. In its pilot community work, Resilient America supported each community's efforts to build and enhance relationships through three mechanisms. First, it provided opportunities for networking and relationship building across the four pilot communities by hosting events that brought representatives from the communities together. Second, it provided opportunities for community stakeholders to connect with Roundtable members and other experts across the country. And third, it facilitated multi-stakeholder discussions with local community organizations, residents, stakeholder

[23] Barr, L. and S. Nider. 2015. *Critical Infrastructure & Climate Adaptation*. Available online at: https://cip.gmu.edu/2015/08/20/critical-infrastructure-climate-adaptation/.

groups, and other experts to better understand the issues, context, challenges, and priorities for building resilience. Not only did this inform the pilot community work but it also provided a forum for dialogue and relationship building among diverse community stakeholders who often work in silos, but who share common interests and objectives for building resilience.

3. Identify Resilience Challenges, Needs, and Goals

Communities face multiple challenges and needs that often compete for funding and resources. Many of these challenges and needs relate to chronic stressors in the community that take precedence over preparing for a disaster that may not occur until well into the future. Therefore, establishing and prioritizing clear goals is key.

Both Cedar Rapids/Linn County and Charleston prioritized flood risks as the focus of their partnership with Resilient America. In both communities, Resilient America employed a framework that guided its stakeholder discussions along five community dimensions or capitals: physical, natural, human, social, and economic (see Appendix A for a description of the five capitals). This five capitals framework provided a foundation for several stakeholder discussions and helped to identify:

- Resilience challenges, needs, and priorities,
- Ways that communities were addressing their challenges,
- Actions the community could implement to build resilience,
- Additional stakeholders who should be part of the discussions,
- Where opportunities existed to form new partnerships to leverage resources and expertise.

4. Establish Resilience Baselines and Prioritize Resilience-building Actions

Understanding a community's resilience baseline— "where are we now?"—is key to making progress towards resilience goals. In each community, Resilient America collected data to provide a foundation for measuring progress towards meeting community goals. While each community took a different approach, data collection included some combination of surveys, community meetings, stakeholder meetings, expert interviews, the collection of quantitative data, and data analysis. Local stakeholders used results from these baseline assessments to inform their local planning efforts, identify potential resilience projects, and/or to support applications for funding. For example, the PSRC incorporated the results of the climate resiliency survey into its Regional Transportation Plan.[24] The process of bringing together different groups, residents, and experts had the added benefit of catalyzing new collaboration and partnerships. It also provided an opportunity to communicate with local groups about their risks and the importance of preparing for those risks.

5. Implement Resilience Actions

Action is the key to advancing resilience in a community. As one Roundtable member often said, "We need to stop admiring the problem and move into the solution." Once the community established its resilience priorities and identified potential resilience-building actions, Resilient America supported and facilitated the implementation of a resilience-building action within the community (see Box 6). The community is ultimately responsible for implementing resilience-building actions. Actions could address short- or long-term needs and could require relatively low amounts of resources, such as a targeted communication campaign to help a specific group better understand its risk or ways to increase

[24] Puget Sound Regional Council. 2018. "Appendix O: Resilience," from *The Regional Transportation Plan -2018*, pp. 17-32. Available at https://www.psrc.org/sites/default/files/rtp-appendixo-resilience.pdf.

preparedness. Actions could also be larger in scope, such as the implementation of a large infrastructure project that requires a large amount of funds and time.

Box 6
Resilience Building in Cedar Rapids

One of the main resilience challenges in Cedar Rapids identified through the flood resilience baseline project was the lack of business continuity planning in the private and nonprofit sectors. To begin addressing this challenge, Resilient America hosted the NGO Disaster Preparedness Training workshop.* Representatives from 20 local nonprofit organizations participated in the training.

State Senator Rob Hogg (standing on the right) provided remarks at the NGO disaster preparedness training workshop. Brian Whitlow (standing on left) from SF Card provided the training.

Workshop attendees learned about disaster preparedness and received examples of and templates for disaster mission statements, personal family planning, skills assessment, guidance for meeting client needs, on-site supplies cache, emergency messaging, evacuation drill procedures, communication guidance, how to identify volunteer positions, Memorandums of Understanding, continuity of service, financial resources, and the incident command system.

After participating in this training, United Way promoted business continuity planning among the LAP-AID membership and implemented new disaster preparedness classes for members. For example, the Iowa Flood Center gave a presentation to LAP-AID members on how to use flood inundation maps.

*"*The Gazette.* July 12, 2017. "Eastern Iowa area nonprofits, experienced in disasters, examine emergency plans." Available online at: https://www.thegazette.com/subject/news/government/eastern-iowa-area-nonprofits-experienced-in-disasters-examine-emergency-plans-20170712.

6. Provide opportunities for knowledge exchange among communities and with other stakeholders.

Communities across the nation are implementing a variety of efforts to build resilience, and organizations at all levels (e.g., NGOs, the private sector, and state and federal agencies) are taking actions to address risks and increase the nation's resilience. Resilient America found that communities benefited from sharing their experiences through peer-to-peer learning (see Box 7). Resilient America also found that communities are often not aware of resources available to them for resilience building or how to access those resources. One of Resilient America's most important roles was as "resilience matchmaker," providing the catalyst for its community partners to start their resilience building efforts by connecting diverse community stakeholders with each other, facilitating dialogue and learning,

helping communities identify what questions to ask, and providing access to experts and technical expertise to answer those questions.

Box 7
Knowledge Exchange: Resources for Building Resilience in the Puget Sound Region, WA*

In January 2018, Resilient America and the Puget Sound Regional Council hosted a knowledge exchange between community stakeholders in the Central Puget Sound Region and representatives from federal and state agencies. Resilient America organized this event after learning from multiple stakeholders that communities did not know what resources were available to them from federal and state agencies to help them address their climate risks or how to access these resources. Representatives from the U.S. Geological Survey, U.S. Army Corps of Engineers, Environmental Protection Agency, Federal Emergency Management Agency, National Oceanic and Atmospheric Administration, Washington State Department of Health, Washington Department of Commerce, and Puget Sound Partnerships discussed resources, tools, and funding opportunities available to local communities for resilience building.

In addition, a panel of community representatives talked about their resilience building efforts: an earthquake early warning system, climate resilience plan, floodplain management project, and creation of a climate change citizen advisory committee. One outcome of this event was that communities were able to establish relationships with federal and state agency representatives who work in the region.

It is essential that the lessons learned, data collected and analyzed, and resilience actions implemented align with a community's culture, goals, and priorities. Ultimately, the community is responsible for moving this work forward when the community pilot partnership ended. Over the course of the partnership, Resilient America sought to support the communities in establishing or continuing their own mechanisms to address their challenges and implement actions to build resilience in line with their systems and institutions, and their short-, medium-, and long-term priorities. Each community will ultimately take its own approach in institutionalizing and creating long-lasting, productive partnerships to advance their resilience efforts.

Successes, Challenges, and What We Learned

What It Means to Be a Resilient Community

The NRC 2012 report, which outlined a vision for what is needed to become a resilient nation, was the foundation for the Resilient America community pilot program. The 2012 report called for a paradigm shift and a new national culture of disaster resilience. It identified specific components to achieve this vision from the federal to the individual level. In addition, the report pointed to communities as the key to building resilience in the nation and identified four key recommendations for building resilience in communities. These four recommendations provided the foundation for Resilient America's pilot community work. Implementing these recommendations and working collaboratively with the pilot communities required new approaches and innovative thinking. Resilient America drew upon traditional National Academies convening activities coupled with a novel approach for stakeholder engagement, and tested and applied different approaches for working with communities. In addition, Resilient America facilitated opportunities for broader interaction and learning across communities.

Community stakeholders often commented on the value of Resilient America's convening activities for bringing together community stakeholders who never or rarely worked together, connecting them

A Vision for a Resilient Nation*

1. *"Taking responsibility for disaster risk;*
2. *Addressing the challenges of establishing the core values of resilience in communities, including the use of disaster loss data to foster long-term commitments to enhancing resilience;*
3. *Developing and deploying tools or metrics for monitoring progress towards resilience;*
4. *Building local, community capacity because decisions and the ultimate resilience of a community are driven from the bottom up;*
5. *Understanding the landscape of government policies and practices to help communities increase resilience; and*
6. *Identifying and communicating the roles and responsibilities of communities and all levels of government in building resilience."*

**From the NRC 2012 report, p. 2.*

through a shared understanding of the importance of resilience to the community, helping build new relationships across community sectors, and expanding a community's network by linking it with other communities.

Many of the elements identified in the NRC 2012 report for building a culture of disaster resilience resonated with what Resilient America heard from communities. Community stakeholders identified the need for individual responsibility for risk, better and more accessible data, measuring progress, and capacity building. However, Resilient America also found that community decision makers and stakeholders lack the time and resources to devote to resilience building and lack opportunities to learn from their peers, both within their community and across communities. Many of the communities that participated in Resilient America activities (e.g., meetings, workshops, conferences) do not understand how to work effectively with federal or state agencies to access resources or support their mitigation and preparedness efforts. While communities agreed on the importance and need for building resilience, they also need support, incentives, and opportunities to advance their efforts.

Though some lessons learned were place-specific, Resilient America found that communities share common challenges and needs in understanding, addressing, and reducing risk and building resilience. They also benefit from being able to exchange information and learn from one another's experiences with taking on these challenges. Although the lessons learned about becoming a resilient community apply to the unique circumstances of the Resilient America's pilot communities, they provide valuable insight for other communities around the nation and internationally.

WHAT COMMUNITIES TOLD US THEY LEARNED

Some of the lessons the communities learned through their participation in the Resilient America community pilot program include:

Becoming resilient requires a culture change. In order for resilience to stick, change has to come from within the community, from both its leaders—especially within local government—and the general population. For that to happen, people need to understand what they have to do to become resilient and how their actions impact resilience.

Relationships are key. Building resilience requires relationships, both formal and informal, among key stakeholders of the community. This enables the identification of key priorities, common goals, and who is responsible for implementing the various resilience efforts. It also ensures that a diverse range of stakeholders and groups across the community can be reached through community engagement efforts. People tend to work in their own silos but it is important to connect across community sectors to identify common goals and opportunities for leveraging resources. Relationships depend on trust, both of which can take a long time to develop.

Building resilience requires engaging stakeholders across diverse community sectors. Diverse voices are needed as part of the resilience discussions, and building resilience requires buy-in from everyone in the community. One way to gain community buy-in is through community engagement. For example, diverse stakeholders can be engaged to align interests, identify common ground, connect with related work in the community, and leverage resources. Resilient America was able to provide opportunities for diverse stakeholders who had never connected before to participate together in a variety of resilience-related activities and discussions.

Building resilience requires building trust. Community support for resilience-building activities requires the trust of community members—in its leadership and decision makers, in its institutions and organizations, and in each other. Trust is founded on strong relationships. Resilient America itself had to build trust with local decision makers and stakeholders in order to work effectively at the community level. Through multiple visits, meetings, and activities over many months, and in some cases years, Resilient America was able to form strong relationships and build trust with a core group of key stakeholders in each community that enabled Resilient America to overcome challenges, leverage opportunities for consistent interaction, and effectively tailor projects according to community needs. Building relationships and trust is not easy, and it takes years to do, especially for individuals and organizations that come from outside the community.

What Communities Learned about Resilience

- Becoming resilient requires a culture change.
- Relationships are key.
- Building resilience requires engaging stakeholders across diverse community sectors.
- Building resilience requires building trust.
- Communities struggle with how to effectively communicate risk.
- Addressing social equity and the needs of vulnerable populations are critical for building resilience.

Communities struggle with how to effectively communicate risk. Understanding risk is consistently identified as one of the top needs and priorities at the community level: what the risks are, who is at risk, what is at risk, how to communicate those risks, and how to mitigate those risks. How to effectively communicate risks proved to be difficult for most communities.

Addressing social equity and the needs of vulnerable populations are critical for building resilience. All communities recognized the disparity between the resilience levels of those with economic means or political power and those without. All of the pilot communities recognized that the resilience of a community could be understood and viewed through the lens of the resilience and well-being of its most vulnerable residents. Building community resilience can be very difficult for people whose primary focus is dealing with day-to-day stresses and challenges.

WHAT RESILIENT AMERICA LEARNED THROUGH ITS WORK IN COMMUNITIES

Resilient America learned several lessons through the diverse activities it participated in and hosted. Roundtable members and staff worked directly with the four pilot communities in the partnership program, continuously engaged with a network of other communities and diverse experts and practitioners that participated in Resilient America convening activities, and facilitated knowledge exchanges and peer-to-peer learning opportunities. Some of the most important lessons included:

The concept of resilience strongly resonates with communities. Over the last decade, resilience has gained significant traction across the nation and it continues to be incorporated into programs at the federal, state, and local levels; at nonprofit organizations; and in the private sector. The momentum of implementation and action being undertaken in communities should continue to be fostered and expanded. Fundamentally, community resilience is about finding ways to maintain and elevate the quality and protection of life of community residents, and the implementation of resilience on the ground is a mix of addressing the episodic disasters and disturbances and the everyday challenges that local decision makers face. Due to the changing social and political conditions in the United States, supporting local action is essential.

Being resilient means something different in each community. Communities approach resilience based on their own values, goals, priorities, and challenges. Communities want to be resilient and many communities share common challenges. But what resilience means within the context of a specific community and how it implements resilience actions differs across communities.

Local commitment and support is one of the most important criteria for building resilience. This commitment can be seen via key decision makers' and stakeholders' willingness to work together to build resilience over time. Becoming resilient requires a culture shift and that shift starts at the local level. One lesson was that sometimes even the most committed communities need a catalyst to get the resilience ball rolling. For many communities, such as Cedar Rapids, the experience of a disaster itself acts as a catalyst for instituting change and building resilience to future disasters. In others, such as Charleston, a small group of local stakeholders come together in a common understanding of the importance of community resilience and may need an individual or entity (such as Resilient America) to help catalyze the community's focus on resilience. Ultimately, a community needs to continue working together and committing resources to resilience efforts after the catalysis ends.

Communities have a difficult time figuring out how to start the resilience building process. It is really hard for communities to understand how to take action for resilience. Resilient America developed an approach for working with communities that provided a flexible framework for guiding communities in their resilience-building efforts. This approach can be tailored for use by any community.

When it comes to resilience, the process of building resilience may be more important than the specific outcomes. The process of building resilience—for example, through cultivating relationships, identifying challenges and priorities, and engaging the entire community in discussions—is an important act of strengthening resilience. Resilient America received much positive feedback from community stakeholders about how its convening activities to build resilience have created awareness about the importance of resilience and what the community is doing to address it, built new relationships among local stakeholders, and brought new partners into the process.

Communities need to know their starting point in order to know whether or not they are making progress toward their goals. If communities want to measure progress towards meeting resilience goals, they need to understand what their starting point (i.e., baseline) is and what their desired end point is. That said, many communities either do not or feel they do not have the resources or capacity to measure resilience.

Resilience needs to be mainstreamed into existing budgets, plans, and operations. People are time- and resource-constrained, so it is important to work within the capacity of a community's resources and time and build resilience into existing efforts.

There is no resilience without economic resilience. A common theme heard in communities was the importance of economic resilience as much as or more so than disaster resilience. Economic aspects of resilience included discussions around development, tourism, the workforce, insurance, mitigation, investments, local budgets, and supply chains. Fragility in any of these areas puts a community at risk to experience a loss of livelihood, tax base, or income which could trigger a cascade of other risks and problems that could reverberate into the most fundamental functions of government or society. These economic dimensions of resilience play into various national interests (e.g., National Flood Insurance Program, mitigation, and logistics) and local interests (e.g., the tax base, outside investment, local development). On the other hand, even absent strong economic conditions, communities rebuild through sweat equity projects and by leveraging partnerships and resources among nonprofits, including faith-based groups, to recover and revive after disasters.

What Resilient America Learned Through its Work in Communities

- The concept of resilience strongly resonates with communities.
- Being resilient means something different in each community.
- Local commitment and support is one of the most important criteria for building resilience.
- Communities have a difficult time figuring out how to start building resilience.
- When it comes to resilience, the process of building resilience may be more important than the specific outcomes.
- Communities need to know their starting point in order to know whether or not they are making progress toward their goals.
- Resilience needs to be mainstreamed into existing budgets, plans, and operations.
- There is no resilience without economic resilience.
- Risk and resilience issues cross political and geographical boundaries.
- Climate change and other trends are poised to concentrate risk in communities.
- The involvement of Resilient America Roundtable members from the federal government, who sponsored this work, was uniquely important.

Risk and resilience issues cross political and geographical boundaries. While the community pilot program focused initially on four separate communities in the United States, Resilient America was able to interact with many more communities through the National Academies Policy and Global Affairs Division's Office of Special Project's (OSP) broader work. OSP conducted activities in more than a dozen communities that included major metropolitan areas like New York City, Houston, Chicago, New Orleans

and Phoenix, as well as smaller towns and rural communities including Waveland, MS; Pine Ridge Reservation, SD; Arlington, WA; and Walker, IA. Outside of the United States, OSP had partnerships with other organizations and experts in Japan, Argentina, Germany, Belgium, and Switzerland, and multi-lateral organizations like the World Economic Forum, NATO, and the United Nations. The universality of resilience messages underscores that the Resilient America Program has applications and utility in domestic, regional, and international arenas.

Climate change and other trends are poised to concentrate risk in communities. Climate change, sea level rise, heat waves, wildfires, more frequent and costly disaster events, greater social inequity, urbanization, and population movement to coastal and other high-hazard areas are trends that impact communities and the nation. These trends portend a concentration, not a diffusion, of risk despite increasingly sophisticated tools and understanding of what and who are at risk. There is a gap between what is known about risks and what actions decision makers should take to address those risks. For some communities, there is a sense of urgency to address the impacts of these trends; for others, the impacts are too gradual for its community members to take action even though they may recognize them. In either case, decision makers want the best science and data to help them better prepare and plan for these current and future hazards. There is a need to address topics that can highlight short-term and long-term options for decision makers to help them manage and mitigate the risks for today and in the future.

The involvement of Roundtable members from the federal government, who sponsored this work, was uniquely important. Their participation in various activities enabled a two-way interaction between the federal sponsors and community stakeholders, with federal participants gaining firsthand knowledge about the needs and challenges faced by communities and how they are (or are not) addressing their risks. Conversely, local decision makers and stakeholders had direct access to representatives from federal agencies (e.g., DHS, FEMA, NOAA, USGS) who could provide information on available resources, established approaches for resilience building activities, and clarity on relevant policies (e.g., NFIP, National Mitigation Framework).

CHALLENGES IMPLEMENTING THE FOUR RECOMMENDATIONS FOR BUILDING RESILIENT COMMUNITIES

When the community pilot program began, building resilience to disasters was still emerging as an actionable concept for communities and very few communities had engaged in a deliberative process. Around the same time Resilient America began its community pilot program, several national organizations began working with communities to build resilience, including The Nature Conservancy, RAND Corp., and the Rockefeller Foundation's 100 Resilient Cities program. While, in many ways, these programs had complimentary goals, these initiatives took very different resilience-building approaches.

For Resilient America, the four recommendations from the NRC 2012 report provided the framework for engaging with communities to build resilience and a roadmap for the critical components a community would need to increase its resilience. Resilient America's resilience-building activities centered around convening activities, facilitating relationships among local stakeholders, connecting local stakeholders with experts, providing communities with opportunities to share information and learn from others, providing access to technical expertise, and supporting local resilience-building efforts. A critical lesson from the pilot community work is that the resilience-building process is ongoing and iterative—there is no one "aha moment" when a community knows it has become resilient.

What is clear is that many communities need a catalyst and support to get started in building resilience. Resilience is not only a new and evolving concept for many communities, but also often an unfunded

mandate or aspiration without clear direction or guidelines on how to integrate it into current plans and efforts. Communities struggle to find an entry point, and they need a framework to shift their thinking and identify ways to go from resilience as a concept to actions specific for their needs (see Box 8). In the pilot communities, resilience was initiated with local decision makers who were often already overloaded and resource constrained in their work. While everyone generally agreed on the core principles of building relationships—learning from their colleagues and other stakeholders, communicating with diverse groups and individuals in their community, and using measures—all of them expressed a scarcity of time, funds, and resources. Resilient America directly stepped in to provide support, often acting as an extra set of "staff" to help with organizing convening activities, identifying diverse stakeholders to the table for important discussions, providing foundational materials, and providing access to the technical expertise of the Roundtable members and other experts.

Box 8
Feedback Received from Local Stakeholders about the Complexity of Building Community Resilience

- "Interrelationships are important. We tend to work in our silos but need to see better how they interrelate."
- "We need to be sure people understand what they need to do to be resilient."
- "We need to educate the people about what resilience is and what the impacts of hazards are."
- "We need to keep reminding ourselves that we need diverse voices at the table."
- "Thinking about resilience holistically requires thinking about the various components of a community."
- "When we first started the infrastructure discussion, it was from the point of response priorities. But when we started looking at it in terms of resilience, the conversation shifted and people became the priority."
- When it comes to the natural environment, "we were seeing the connections with the other environments; we can't be a resilient community without integrating many community components."
- Regarding social disparities in communities: "We shouldn't just come up with broad generalizations; we need to take these disparities into account and be sensitive to complexities and nuances."

Feedback from local stakeholders about Resilient America activities often highlighted the value of bringing people together that they had never before had an opportunity to engage with, including those from within their own communities (see Box 9). This led to opportunities to build relationships, share lessons learned, and talk about challenges. Resilient America's pilot communities especially noted the value of interacting with and learning from other communities across the country, and found it heartening that other communities also struggle with building and measuring resilience. It was helpful for them to hear how other communities were approaching resilience, overcoming obstacles, identifying solutions.

Box 9
Participant Feedback about Roundtable Events

- "Lots of key people were in the room together for the first time!"
- "Good mix of people and perspectives."
- "Lots of interesting discussions and ideas came out of the [breakout discussions]."
- "The workshop put the concept and importance of community resilience into context."

- "People were really jazzed after the panel [session] because [it provided] tangible examples of what communities are doing" to build resilience.
- The workshop "helped set the stage to start thinking about what's next."
- The Extreme Event game "was very engaging and realistic; it was hard making decisions on which resources to keep, as happens in real life."

Resilient America's activities often catalyzed new thinking and raised awareness about issues that were previously not on most community stakeholders' radar. For example, communities engaged in positive resilience actions that they had not previously undertaken (e.g., integrating resilience into city and regional planning, breaking siloes to create new coalitions and relationships). Communities also began to explore the hard questions that needed to be addressed for building resilience, although often the specific mechanisms to address them remain a work in progress (see Box 10).

Box 10
Questions Communities Grapple with as They Embark on Resilience-building Efforts

- How do we build relationship capacity pre-disaster and maintain it post-disaster?
- How do we develop trust? Who are the leaders that people trust? How do you measure public trust and confidence in leadership?
- How do we engage the younger generations?
- How can we engage the private sector and motivate them to become a partner in community resilience building?
- How well do people understand their risk to hazards? How well do people understand what to do during a disaster? Within diverse communities, what are peoples' perceptions of risk to different hazards and what would they do about them?
- How well do the local government and the broader community understand their climate risk; how well are we integrating this understanding into government programs?
- How willing are community members to become proactive in preparedness? What skills do community members possess that could be leveraged?
- How could the government measure and identify its capacity to empower the community to be more resilient?
- How do we best address the special needs of vulnerable populations?
- What are the cascading effects of different system breakdowns?

It can take years before a community's resilience-building efforts have been fully implemented, and even longer to achieve a culture change toward a more resilient mindset. Resilient America spent its first one to two years in its pilot communities establishing relationships and building awareness about and socializing the concept of community resilience. After four years working in and with communities, Resilient America's efforts to implement the four resilience-building recommendations (i.e., communicating risk, measuring resilience, building partnerships, and sharing data and information) in each pilot community are continuing through local efforts as Resilient America moved on to new resilience projects.

Challenges implementing resilience-building efforts in communities

In working with the pilot communities, Resilient America encountered challenges in building resilience, both expected and unexpected. However, through these challenges, it gained valuable insights for working with and in communities. Resilient America also learned critical lessons of how communities are overcoming resilience-building barriers and obstacles.

What the Roundtable perceived as a community's priority risk did not always align with what the community perceived as its priority risk. Prior to beginning its work in each pilot community, Resilient America identified the primary hazards/risks around which to focus its resilience-building efforts in the community. However, Resilient America had to accommodate each community's understanding and prioritization of its own risks and resilience. For example, though the Central Puget Sound Region and Charleston have significant earthquakes risks, both communities prioritized different hazards, tackling climate change and flooding, respectively.

Building relationships with community stakeholders takes a lot of time. It can take many months and years to build relationships in a community before the "real work" can begin and even longer to determine whether Resilient America's resilience-building efforts (and the four recommendations from the NRC 2012 report) actually helped communities become more resilient. The community pilot program started in early 2014 and was envisioned as a three-year program; the program ran for four years. Resilient America held its kickoff meetings in both Cedar Rapids/Linn County and Charleston in the fall of 2014. After many meetings and other activities, the community pilot partnership honed in on the Zurich flood resilience measurement project in late 2016. When it comes to building resilience in communities, funders underestimate the amount of time and resources it takes to produce measureable results and often do not understand that it takes the first few years just to build the relationships and trust needed to implement the work. One way Resilient America was able to lessen the impact of this challenge was to bring individuals onto the Roundtable who had relevant expertise and were local to the pilot communities.

Leadership changes can result in resilience work being put on hold or necessitate a change in the direction of the work. Both Charleston and Tulsa experienced leadership changes during Resilient America's community pilot partnership. Incoming leadership often shifts its priorities from the previous administration. In early 2016, the City of Charleston swore in a new mayor who replaced a mayor who had held the office for 40 years. Though the direction of Resilient America's work in Charleston did not change, Resilient America lost several key partners from local government who left to take other jobs. Several months into its work in Tulsa, a new mayor was elected; as a result, Resilient America had to shift its focus to align with that of the new Tulsa leadership whose key priority was addressing economic resilience.

Communicating risk was a difficult challenge to address. One common challenge across communities was the difficulty in effectively communicating risk to their community members. Helping communities address this challenge was also difficult. There are many variables to consider in risk communication efforts such as the message to convey, method to use to communicate the risk, audience receiving the message, and development of messages that are culturally sensitive.

Measuring the impact of Resilient America's resilience-building actions is challenging. Because of the qualitative nature of Resilient America's resilience-building approaches in the pilot communities (e.g., convening activities, relationship building and cultivation, data and information sharing, peer-to-peer learning), it has been difficult to measure the impact the four resilience-building actions have had on a community's resilience. To address challenges that communities may have in measuring resilience, the Office of Special Projects conducted a consensus study which produced a report *Building and Measuring Community Resilience: Actions for Communities and the Gulf Research Program* (2019) (https://www.nationalacademies.org/our-work/measuring-community-resilience) that provides a framework communities can use to help them build and measure their resilience.

Engaging the private sector was challenging. Another common challenge across communities was that they had a hard time engaging the private sector in resilience building. Resilient America also had a

difficult time engaging the private sector, though it had some successes in Cedar Rapids and Charleston in securing representation from the private sector on the ground teams and getting private sector representatives to attend some of its events and participate in focus groups in the communities. However, private sector representatives can be reluctant to participate in activities or planning that do not align with their priorities and pace of doing business. Additionally many companies cite proprietary issues for sharing data or information. While most private sector representatives expressed a desire to help their community, a compelling business case must be made that aligns with their goals.

Resilient America was able to solicit feedback from the private sector about the challenges the private sector perceives in engaging with the broader community about resilience building including:

- The public and private sectors do not speak the same "language."
- There's a lack of trust, which goes both ways.
- There are privacy and/or security issues when it comes to data sharing.
- Many in the private sector lack experience with disasters or have not been significantly impacted by disasters so there is a lack of urgency to prepare or think about building resilience to disasters.
- Public sector resilience-building projects move too slowly.
- There is a lack of market incentives to invest in resilience-building efforts.
- Reestablishment of their supply lines after a catastrophe is the private sector's major concern.

During meetings, private sector stakeholders provided Resilient America with a few ideas for how local government and other organizations could more effectively engage with them.

- Local government should actively cultivate relationships with private sector stakeholders.
- Communication is key. Local government should develop a resilience business case that will motivate private sector buy-in.
- Local government should highlight stories of successful public-private partnerships.
- It is essential to engage the private sector in emergency preparedness and response; examples include creating a centralized business emergency operations center and providing assistance to small businesses in developing continuity plans.
- Local government should provide the private sector with clear objectives and standards of what the community needs and work with the private sector to identify a common problem both can tackle together (e.g., supply chains, economic growth, resilient infrastructure).

Identified Research Gaps and Community Needs

Over the past five years, several key needs and gaps stand out. Some of these could be addressed in the form of a consensus study while others would benefit from direct community engagement, or both. Some fall within the National Academies' core work, while others may be better addressed by the broader community, including federal and local governments, nonprofits, and the private sector.

Funders do not provide enough resources to enable researchers to successfully implement community resilience projects—from building relationships and trust with local stakeholders to producing measurable results—a process that can take multiple years. When it comes to building resilience in communities, funders rarely provide enough resources to cover the amount of time it takes to produce measureable results and often do not understand that it could take months to years to build the relationships and trust needed to implement the work.

Communities tend to focus on short-term disaster events that are annual to decadal rather than long-term approaches to building disaster resilience. None of the communities Resilient America interacted with were preparing for long-term disasters such century or millennial events (e.g., the eruption of

Mount St. Helens). One exception was Cedar Rapids. The community is near a nuclear power plant and holds exercises four times a year. Doing this has increased their preparedness and ability to respond to and recover from other types of hazards and disruptions.

Climate change and other trends are poised to concentrate risk in communities. Climate change, sea level rise, heat waves, wildfires, more frequent and costly disaster events, greater social inequity, urbanization, and population movement to coastal and other high-hazard areas are trends that are impacting or will impact communities and the nation. These trends portend a concentration, not a diffusion, of risk despite increasingly sophisticated tools and understanding of what and who are at stake.

For many communities experiencing climate change, the impacts are too gradual to motivate them to take action. Some communities are already experiencing the impacts of climate change (e.g., sea level rise, heat waves, drought, increased wildfires) and feel a sense of urgency to address these impacts. For many other communities, these impacts are too gradual to become a motivating force for action. The gap between recognizing that disasters are becoming more frequent and/or destructive and the actions that communities should take to tackle them is one that needs to be addressed. In particular, the events of 2017, 2018, and 2019 (e.g., hurricanes, wildfires) highlight the need to continue addressing how communities are experiencing increased risk from the impacts of climate change in the short- and long-terms.

Wildfires are gaining increased attention as they become more frequent, deadly, and destructive. During the course of this study, wildfires have become a prominent hazard, and the likelihood that they will remain so is high because of the large stockpile of unhealthy trees and tinder accumulated over nearly a century of fire suppression. Much of what Resilient America has learned from and discussed with communities about floods can be of relevance to communities that are trying to build resilience to wildfires.

The need to address the displacement of populations living along the coast around the world is becoming more urgent with a warming climate and sea level rise. In the United States, counties located along the coast have some of the nation's largest concentrations of population and economic activity, making up about 29% (about 94 million people) of the total U.S. population. The population of counties along the Atlantic and Gulf Coast regions have grown every year (except 2005 and 2006) from 51.9 million people in 2000 to almost 60 million people in 2016.[25] In the next several decades, entire communities may be forced to move if governments are not able to mitigate the impacts of sea level rise and other hazards such as hurricanes and flooding.

There is a need for a full-cost accounting of disasters in the United States. There is no comprehensive data source that provides information about the impact of disasters, both federally declared disasters and low attention disasters that are more common in communities across the country. Data needed include costs from both direct (e.g., infrastructure damage, business losses, etc.) and indirect impacts (e.g., long-term effects from loss of employment, business closures, residents moving out of the community, etc.).

[25] Cohen, D. T. August 6, 2018. "Coastline County Population Continues to Grow: 60 Million Live in the Path of Hurricanes." US Census Bureau. Available at https://www.census.gov/library/stories/2018/08/coastal-county-population-rises.html.

Appendix A. Zurich Flood Resilience Measurement Framework

Zurich Insurance Group (Zurich) launched a global flood resilience program in 2013 composed of five organizations that make up the Zurich Flood Resilience Alliance: Zurich, International Federation of Red Cross and Red Crescent Societies, International Institute of Applied Systems Analysis, Practical Action, and Wharton Risk Management and Decision Process Center. Because floods account for more losses than all other natural disasters combined, the mission of this alliance is to enhance communities' resilience to floods across the world.

The Alliance developed the Zurich Flood Resilience Measurement Framework and tested a beta version of the tool in nine countries: Afghanistan, Bangladesh, Haiti, Indonesia, Mexico, Nepal, Peru, Timor-Leste, and the United States. As of 2018, the framework has been implemented in over 100 communities.[26] The Alliance's ultimate goal is to develop a streamlined, empirically validated flood resilience measurement framework that could be used by communities around the world to measure their level of flood resilience. The beta test of the framework helped the Alliance answer four key questions:

- Does the framework help communities become more resilient to floods?
- Are the identified sources of resilience good indicators of resilience?
- What data collection methodologies work?
- How can the framework be improved?

The National Academies of Sciences, Engineering, and Medicine was part of Zurich's pilot program to beta test the framework in the United States. Specifically, the Office of Special Projects' Resilient America Roundtable implemented the framework in two of its pilot communities, Cedar Rapids/Linn County and Charleston.

The Zurich Flood Resilience Measurement Framework measures resilience in five community capitals: human, social, natural, physical and financial capitals. These five capitals represent a community's assets (i.e., attributes, resources, capabilities). The Zurich Alliance based the five capitals approach on the Department for International Development's Sustainable Livelihoods Framework,[27] which identifies these five capitals as representing a community's assets.

1. Human (education, knowledge, skills, health)
2. Social (social relationships and networks, bonds aiding cooperative action, links facilitating exchange of and access to ideas and resources)
3. Physical (things produced by economic activity from other capital, such as infrastructure, equipment, improvements in crops, livestock, etc.)
4. Natural (natural resource base, including land productivity and actions to sustain it, as well as water and other resources that underpin and sustain livelihoods)
5. Financial (savings of all kinds; level, variability, and diversity of income sources; access to other financial resources that contribute to wealth)

Some aspects of these community capitals can contribute to a community's resilience to flood; these represent the sources (i.e., indicators) of resilience. In the beta version of the tool, there are 88

[26] Zurich Insurance Group. 2018. *The Zurich flood resilience program – Phase 1 from 2013-2018: Stocktaking and impact evaluation report.* Available online at https://www.zurich.com/en/knowledge/articles/2018/07/flood-resilience-alliance-2.

[27] See Sustainable Livelihoods Guidance Sheets: https://www.ennonline.net/attachments/872/section2.pdf [Retrieved March 2, 2016].

indicators of resilience across the five community capitals. Different kinds of data are collected from and about the community for each source in order to assess the community's level of resilience for that source.

The framework is structured around three levels (See Figure 7):

1. The five capitals which characterize a community.
2. Sources of resilience (i.e., indicators) for each capital.
3. Data points for each source of resilience.

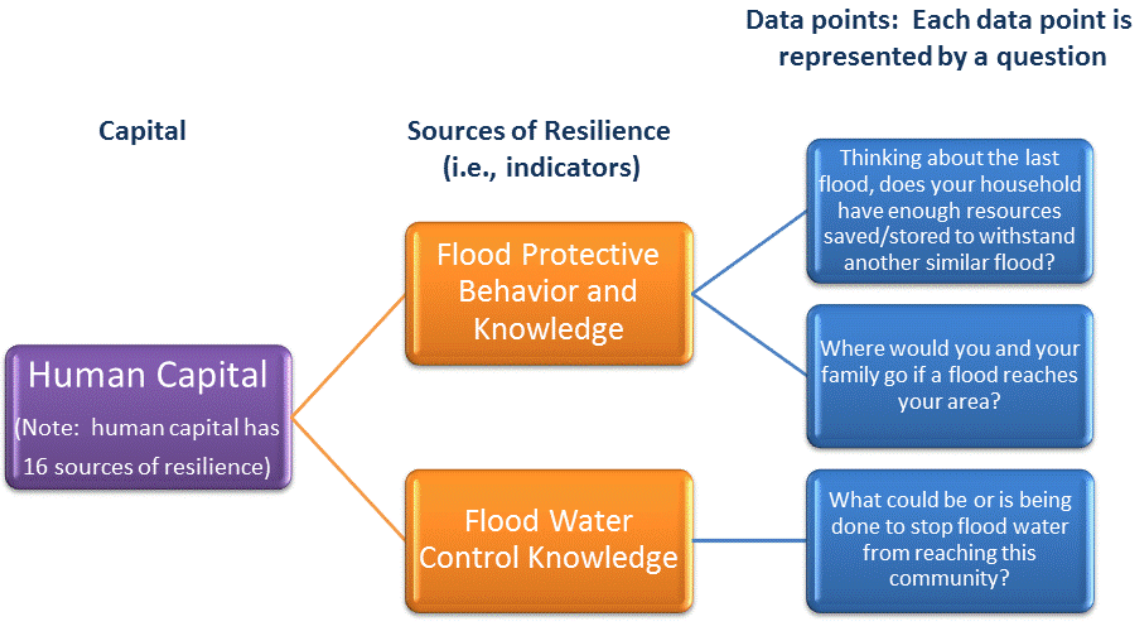

Figure 6. Zurich flood resilience measurement tool structure using Human Capital as an example.

Each capital is made up of various sources of resilience. Each source of resilience is represented by one or more data points. Each data point is represented by a question. Data for each question is collected using one or more of the following data collection methodologies:

1. Household surveys
2. Community/neighborhood discussion groups
3. Interest group discussions
4. Key informant interviews
5. Third party sources

Data is entered into a smartphone application and from there is uploaded to an online platform hosted by Zurich. This platform performs simple analyses on the data, the results of which can be downloaded into an Excel spreadsheet.

The sources of resilience are grouped into categories that cover one of the five capitals (a.k.a., the 5Cs) which provide resilience in a community:

- Human = 16 sources
- Social = 33 sources
- Physical = 16 sources
- Natural = 6 sources
- Financial = 7 sources

These sources are assessed on a four letter grade scale:

A = best practice for managing the risk
B = good industry standard, no immediate need for improvement
C = deficiencies, room for visible improvement
D = significantly below good standard, potential for imminent loss

The resilience assessment provides results at three levels:

1. Overall resilience: An overall result based on all the assessed sources following a numerical calculation. The overall result is expressed as a quantitative score between 0 and 100. The higher the score, the higher the flood resilience.
2. Category resilience: Quantitative results are provided per capital.
3. Individual resilience: Each source can be tracked by comparing grades (A, B, C, or D) between two assessments. This allows users to pinpoint key aspects that are impacting the overall resilience of a community and measure the direct impact of any actions taken as a result.

Each source of resilience is tied to a capital, a stage in the disaster risk management cycle, a theme, a resilient property, and to a sphere of influence (see below). Thus, the results can also be explored across each of these categories:

- Resilient properties (a.k.a., the 4Rs):
    - Robustness = ability to withstand a shock (e.g., housing and bridges built to withstand flood waters)
    - Redundancy = functional diversity (e.g., having many evacuation routes.)
    - Resourcefulness = ability to mobilize when threatened (e.g., a community group who can quickly turn a community center into a flood shelter)
    - Rapidity = ability to contain losses and recover in a timely manner (e.g., access to quick finance for recovery)
- Theme
    - Assets and livelihoods
    - Education
    - Energy
    - Food
    - Governance
    - Life and health
    - Natural environment
    - Transport and communications
    - Waste
    - Water
- Sphere of influence, which helps understand where resilience is strong/weak and the target audience of interventions
    - Internal (community level)
    - External
- Disaster risk management cycle
    - Crisis preparedness: action carried out before an event to build capacities needed to effectively manage the flood emergency situation and achieve orderly transitions from response to recovery and reconstruction.
    - Coping: the ability of a community to use available skills and resources to manage the adverse conditions brought on by the flood
    - Reconstruction: the restoration or improvement of facilities, livelihoods and living conditions in the community following damage from the flood and associated impacts

- Prospective risk reduction (planning for future risks): activities that address and seek to avoid the development of new or increased disaster risk
- Corrective risk reduction (addressing current risks, e.g., retrofitting houses for earthquakes): activities that address and seek to correct or reduce disaster risks which are already present

Appendix B. Resilient America's Resilience-Building Activities

Resilient America's specific activities to support resilience building efforts in the four pilot communities aligned with the four pillars of the community pilot program:

Communicating, understanding, and managing risk

- Community and stakeholder meetings: Resilient America facilitated meetings with community members and different stakeholder groups in Cedar Rapids/Linn County, Charleston, and Seattle to better understand their resilience challenges and priorities and what they are doing to become more resilient.

Sharing data and information about best practices, hazards, communication, and policies that build resilience. Roundtable activities included:

- February 2015: Resilient America partnered with the Charleston Resilience Network to host the symposium, "Understanding the October 2015 Charleston Floods"
- April 2015: Community Resilience workshops in Cedar Rapids/Linn County and Charleston
- July 2015: The Role of Disaster Insurance in Improving Resilience expert meeting brought together experts to discuss ways that insurance can be a powerful tool to enhance communities' resilience to floods and earthquakes. Representatives from all the pilot communities attended.
- June 2016: *State of Resilience Leadership Forum and Community Workshop* looked at the results of years of investment, experimentation, and research and considered what works, what doesn't, and what should happen next in the resilience arena. Representatives from all the pilot communities attended.
- August 2016: *Building Resilience in the Puget Sound Region Workshop* brought together diverse stakeholders from multiple jurisdictions in the Central Puget Sound Region and practitioners from other states to share lessons learned and explore solutions for building resilience that incorporated climate adaptation and equity into transportation/land use planning.
- January 2018: The *Puget Sound Knowledge Exchange: Resources for Building Resilience* event in Seattle brought together experts from the state and federal governments and local community representatives to share information about resilience-related initiatives and resources available to address climate risks and other hazards.
- June 2018: *Moving Forward: Pathways to Building Community Resilience symposium* in Cedar Rapids shared new learning and tools related to disaster preparedness and mitigation focused on at-risk populations, watersheds, and flood mapping/risk/insurance.
- September 2016-August 2018: Urban Flooding in the United States consensus study aimed to better understand the extent and causes of and potential solutions for chronic flooding events in major metropolitan areas.

Measuring resilience. Roundtable activities included:

- July 2015: "Developing Community Resilience Measures Workshop" (workshop report, *Measures of Community Resilience for Local Decision Makers).* Representatives from all the pilot communities attended.
- June 2016: State of Resilience Community Workshop panel discussion, Measuring Resilience, featured representatives from Minneapolis, MN and Longmont, CO who shared their journey in developing measures in their communities. Representatives from all the pilot communities attended.
- August 2016: Measuring Flood Resilience webinar provided an overview of the Zurich Flood Resilience Measurement Framework and Resilient America's experiences implementing the framework in Iowa and South Carolina.

- September 2017: Measuring Community Resilience webinar showcased two communities, Minneapolis and Spokane, that are using measures to track progress toward community goals.
- June 2016-January 2018: Implementation of the Zurich Flood Resilience Measurement Framework in Cedar Rapids, IA and Charleston, SC. to establish their baseline flood resilience.
- September 2016-August 2018: Measuring Community Resilience consensus study aims to better understand how measurement work is established or advancing in communities across the U.S., and to glean lessons from researchers, communities, and practitioners that can set forth promising ways to understand, communicate, or measure resilience in the future.

Building coalitions and partnerships across stakeholders in the public, private, NGO, and academic sectors

- Resilient America's workshops, symposia, conferences, and meetings brought together multiple community stakeholders, experts, and pilot community representatives to expand their networks and learn from and share with each other. A few examples of these events include the Developing Community Resilience Measures Workshop (July 2015), State of Resilience Leadership Forum and Community Workshop (June 2016), Building Resilience in the Puget Sound Region (August 2016), Puget Sound Knowledge Exchange: Resources for Building Resilience (January 2018), and Moving Forward: Pathways to Building Community Resilience symposium (June 2018).
- Extreme Events game: Resilient America hosted the Extreme Events games in Cedar Rapids/Linn County and Charleston.