Developing a Framework for Measuring Community Resilience: Summary of a Workshop

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Dominic A. Brose, Rapporteur; Committee on Measures of Community Resilience: From Lessons Learned to Lessons Applied; Policy and Global Affairs; National Research Council

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SUMMARY OF A WORKSHOP

Dominic A. Brose, *Rapporteur*

Committee on Measures of Community Resilience:
From Lessons Learned to Lessons Applied

Resilient America Roundtable

Policy and Global Affairs Division

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Preface and Acknowledgments

In 2012, the National Research Council convened a committee of experts to address the importance of resilience, discuss different challenges and approaches for building resilience, and outline steps for implementing resilience efforts in communities and within government. The committee's report *Disaster Resilience: A National Imperative* provided a central reference for the current state of the nation's resilience to disasters, and presents ways in which the nation can move forward on a path toward greater resilience.[1] The report, sponsored by eight federal agencies and a community resilience organization, was national in scope and extended to stakeholders beyond the Washington, D.C. governmental community to recognize that experiential information necessary to understand national resilience lies in communities across the United States. On September 5, 2014 the National Research Council convened a one-day workshop in Washington, D.C. that built upon the report's recommendation to develop a framework of resilience measures and indicators to support communities in increasing their resilience.

This report is a summary of the one-day workshop, which consisted of a keynote address and two panel sessions in the morning, and afternoon breakout sessions that began the discussion on how to develop a framework of resilience measures.

This workshop summary report has been prepared by the workshop rapporteur as a factual summary of what occurred at the workshop. The statements made are those of the rapporteur and do not necessarily represent positions of the workshop participants as a whole, the planning committee, or the National Research Council. This workshop summary is the result of the efforts and collaboration among several organizations and individuals. The workshop's success would not have been possible without the invaluable contributions by the many speakers, panelists, moderators, and other participants who donated their time and expertise to inform these discussions. We would like to say a special thanks to Susan Cutter, Gerald Galloway, Roy Wright, Thomas de Lannoy, Michael Szönyi, Chuck Wemple, Arrietta Chakos, Sandi Fowler, Clay Stamp, Miriam Chion, Laura Cabiness, John Carberry, Lori Peek, Bill Solecki, Eric Tate, and Julie Hassett for their insightful presentations and discussion. We wish to also extend a sincere thanks to each member of the planning committee for their contributions in scoping, developing, and carrying out this project, Susan Cutter, chair, Gerald Galloway, Bob Kolasky, Richard Reed, Linda Langston, and Jacqueline Snelling.

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise in accordance with procedures approved by the National Academies' Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for quality and objectivity. The review comments and draft manuscript remain confidential to protect the integrity of the process.

We wish to thank the following individuals for their review of this report: Erwann Michel-Kerjan, University of Pennsylvania; Chris Poland, Chris D Poland Consulting Engineer; Clay Stamp, Talbot County Government; Monica Schoch-Spana, University of Pittsburgh; and Gene Whitney, Independent Consultant.

[1]National Research Council (NRC). 2012. Disaster Resilience: A National Imperative. The National Academy Press, Washington, D.C.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the content of the report, nor did they see the final draft before its release. The review of this report was overseen by Mary Lou Zoback, Stanford University. Appointed by the National Academies, she was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the rapporteur and the institution.

The Resilient America Roundtable[2] will use the workshop ideas as it develops a framework of resilience measures/indicators. The framework can help communities better understand their progress towards building resilience. The participants' input and feedback from the plenary and the breakout sessions will be included in that framework and shared with the pilot communities and partner communities participating in the Resilient America program. Over the next two years, we will continue to receive additional input from our partners, through activities such as meetings, workshops, and webinars, and we will test the framework in our pilot communities. The overarching goal is to develop a framework that is applicable to many communities for measuring or tracking their efforts for building resilience.

Lauren Alexander Augustine, *Director*
Program on Risk, Resilience, and Extreme Events

[2]Further information on the Resilient America Roundtable can be found at: http://sites.nationalacademies.org/PGA/resilientamerica/. For more information on this workshop and to view the plenary discussions of the workshop, please visit: http://sites.nationalacademies.org/PGA/ResilientAmerica/PGA_152193.

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Introduction

The 2012 National Research Council report *Disaster Resilience: A National Imperative* highlighted the challenges of increasing national resilience in the United States. The report, sponsored by eight federal agencies and a community resilience organization, was national in scope and extended to stakeholders beyond the Washington, D.C. governmental community to recognize that experiential information necessary to understand national resilience lies in communities across the United States.[1] One finding issued by the committee was that "without numerical means of assessing resilience, it would be impossible to identify the priority needs for improvement, to monitor changes, to show that resilience had improved, or to compare the benefits of increasing resilience with the associated costs."

Although measuring resilience is a challenge, measures and indicators to evaluate progress, and the data necessary to establish those measures, are critical for helping communities to clarify and formalize what the concept of resilience means for them, and to support efforts to develop and prioritize resilience investments. In the NRC (2012) report, the committee reviewed the strengths and challenges of different frameworks for measuring resilience, and identified four critical dimensions of a consistent system of resilience indicators or measures:

1. Vulnerable Populations—factors that capture special needs of individuals and groups, related to components such as minority status, health issues, mobility, and socioeconomic status
2. Critical and Environmental Infrastructure—the ability of critical and environmental infrastructure to recover from events—components may include water and sewage, transportation, power, communications, and natural infrastructure
3. Social Factors—factors that enhance or limit a community's ability to recover, including components such as social capital, education, language, governance, financial structures, culture, and workforce
4. Built Infrastructure—the ability of built infrastructure to withstand impacts of disasters, including components such as hospitals, local government, emergency response facilities, schools, homes and businesses, bridges, and roads

The United States does not currently have a consistent basis for measuring resilience that includes all of these dimensions, making it difficult for communities to monitor improvements or changes in their resilience. One of the recommendations from the 2012 report stated that government entities at federal, state, and local levels, and professional organizations should partner to help develop a framework—the report suggested the word "scorecard"—for communities to adapt to their circumstances and begin to track their progress toward increasing resilience.

[1]Sponsors included the U.S. Army Corps of Engineers, U.S. Department of Agriculture Forest Service, U.S. Department of Energy, U.S. Department of Commerce National Oceanic and Atmospheric Administration, Department of Homeland Security and Federal Emergency Management Agency, Department of the Interior U.S. Geological Survey, National Aeronautics and Space Administration, and the Oak Ridge National Laboratory/Community and Regional Resilience Institute.

To build upon this recommendation and begin to help communities formulate such a framework, the Resilient America Roundtable of the National Academies convened the workshop *Measures of Community Resilience: From Lessons Learned to Lessons Applied* on September 5, 2014 in Washington, D.C. The mission of the Resilient America Roundtable is to convene experts from the academic, public, and private sectors to design or catalyze activities that build resilience to extreme events. The Roundtable provides a venue for current research, science, and evidence-based foundations to inform whole community strategies for building resilience. This workshop's overarching objective was to begin to develop a framework of measures and indicators that could support community efforts to increase their resilience. The framework will be further developed through feedback and testing in pilot and other partner communities that are working with the Resilient America Roundtable. The workshop was structured around three broad questions:

- What is the value of resilience?
- How do I know that my investments are going to increase my resilience?
- How can measures/indicators be scaled and adapted to different frames of reference (e.g., community to community; nongovernmental organizations (NGOs) to business; citizen to elected official)?

In addition to the planning committee, the workshop included representatives from the federal government, private sector and businesses, nongovernmental organizations, the academic community, and members of the Resilient America Roundtable. The workshop aimed to develop or frame measures and indicators, which could be applied across a range of communities, to support community efforts to place a meaningful value on resilience. Measuring real improvements is dependent, in part, on understanding baselines for various indicator categories; using measures can help communities see improvements in their resilience over time, better gauge and measure their investments, understand tradeoffs among community priorities, and assist decision makers in establishing incentives for increasing resilience (National Academy of Sciences, 2012).

Measuring Community Resilience: The Landscape of Resilience Indicators

Susan L. Cutter, Carolina Distinguished professor and director, Hazards and Vulnerability Research Institute, University of South Carolina and chair of the committee that wrote the NRC (2012) report started the workshop by describing the current landscape of resilience indicators and frameworks. Dr. Cutter stated that in addition to the efforts at the National Academies, resilience has recently gained a lot of attention, both nationally and internationally. Those working on resilience often struggle to define and measure it; however, the goal, Dr. Cutter stated, is to move from disaster risk reduction[2] to a more sustainable future and for many, resilience is the mechanism that will facilitate that movement.

Dr. Cutter noted that there are many different definitions of resilience; the 2012 committee defined resilience as the "ability to prepare and plan for, absorb, recover from or more successfully adapt to actual or potential adverse events" (National Academy of Sciences, 2012). The challenge is not in drafting the definition of resilience, but rather in operationalizing that definition. A resilient community is one in which people are able to adapt to changing conditions and assess if that adaptation is appropriate for the place (e.g., building on sand knowing it may be windblown or washed away with coastal flooding).

[2]The United Nations Office for Disaster Risk Reduction (UNISDR) defines disaster risk reduction as the concept and practice of reducing disaster risks through systematic efforts to analyze and reduce the causal factors of disasters. Reducing exposure to hazards, lessening vulnerability of people and property, wise management of land and the environment, and improving preparedness and early warning for adverse events are all examples of disaster risk reduction. Additional information can be found at: http://www.unisdr.org/who-we-are/what-is-drr.

In order to perform such an assessment, Dr. Cutter stated, communities need to be able to measure their resilience. Communities are often located in high hazard areas. For example the community of Seabright in New Jersey is located between the Atlantic Ocean and the Navesink River on a barrier island that is not much more than two houses wide; in 2012, the community was devastated by Hurricane Sandy. Dr. Cutter offered that Seabright is an example of a community that needs to measure its resilience in order to understand its capacity to respond to, recover from, and adapt to adverse events. Part of that adaptation may be to move away from the coast, an option that more coastal communities are starting to consider as they recognize the increased risk of adverse events occurring in proximity to the coastline.

A tool to measure resilience can help communities assess their priorities, goals, and needs, and also help establish baselines. Baselines are needed to better assess progress and to set goals in order to allocate resources. A mechanism is also needed to help understand investments made to improve resilience, added Dr. Cutter, especially since such investments can be of considerable size for many communities. Such a mechanism could also be used to evaluate different intervention options to improve and enhance resilience.

Dr. Cutter said that the 2012 *Disaster Resilience* report outlined 17 assessment tools and systems, and that in the two years since the report was released there has been an explosion in the number of additional resilience measuring tools developed by government agencies, academia, NGOs, communities, and the private sector. These tools vary in range and purpose—top-down to bottom-up, qualitative to quantitative, hazard specific to hazard-neutral, local to global, and pre- to post-event. Because there are so many assessment tools available, the challenge to communities is how to navigate the landscape and identify the right tool or combination of tools to meet their needs.

Dr. Cutter provided a table with a series of examples of tools grouped into those that are top-down and those that are bottom-up (Table 1-1 & 1-2). Top-down tools are developed by an organization external to a community using academic or institutional data with little community involvement. Developing bottom-up tools generally includes the coproduction of knowledge that occurs when the community is engaged in the process.

TABLE 1-1 Top Down Approaches & Indexes for building resilience. Prepared by NRC staff.

TOP DOWN:	Hyogo Framework for Action (HFA) - United Nations	DFID Interagency Group	San Francisco Planning and Urban Research Association (SPUR)	Baseline Resilience Indicator for Communities (BRIC)	ResilUS	PEOPLES Resilience Framework
Purpose	Prioritize risk reduction (RR) in communities	Shows what a disaster resilient community might look like	Measure ability to recover from earthquakes	Measure overall pre-existing community resilience	Recovery over time of critical services and community capital	Holistic framework for designing and measuring resilience
Target categories	Institutions and actions promoting risk reduction, preparedness, response	Governance, risk assessment; knowledge & education; risk management; disaster prepare and response	Buildings and infrastructure, services restoration	Infrastructure, ecosystems, institutions, economic, social, community capacity	Ability to perform; opportunity to perform of critical infrastructure	Population; environment; government services; physical infrastructure; lifestyle; economic; socio-cultural capital
Scale? Who measures? Hazards?	National	Local, national	Local, earthquakes	Local, national comparisons	Local, earthquake case study	Local, no case study
Quant or Qual?	Qualitative	Qualitative	Semi-quantitative	Quantitative	Quantitative	Quantitative, qualitative
Costs to measure	$$	$$	$$	$	$$	$$$
Info sources	Existing institutional reported info	Local, field work, interviews	Existing engineering info	Academic research and community info	Academic research	Academic research

TABLE 1-2 Bottom Up Approaches & Indexes for building resilience. Prepared by NRC staff.

BOTTOM UP:	NOAA Coastal Resilience Index	Communities Advancing Resilience Toolkit (CART)	Toolkit for Health and Resilience in Vulnerable Environments (THRIVE)
Purpose	Help community predict if they will function well after disaster	Enhance community resilience through planning and action	Help communities bolster health outcomes
Target categories	Critical infrastructure and facilities; transportation, community plans; mitigation measures; business plans; social systems	Connection and caring, resources, transformative potential, disaster management	Communities of color to remedy health disparities
Scale? Who measures?	Local; bottom-up	Local; bottom up	Local; bottom-up and top-down
Hazard-specific?	Adaptable to community's hazards	All hazards	No
Quant or Qual?	Qualitative	Qualitative	Semi-quantitative
Costs to measure	$	$$	$
Info sources	Existing community info	Existing community info, surveys, key informant interviews	Academic research and community info

Top-down tools are often intended for use by an oversight body or require external expertise—a government office or an academic entity, for example—to help a community measure different aspects of their resilience to inform decision making. Dr. Cutter noted that the purpose, scale, and target of these top-down approaches vary, and outlined several examples. The Hyogo Framework for Action (HFA) from the United Nations is a qualitative model that prioritizes risk reduction activities across different nation states.[3] ResilUS quantitatively assesses the recovery of critical services within a community[4]. The San Francisco Planning and Urban Research Association (SPUR) model is semi-quantitative and infrastructure-focused, and assesses the ability of a community's infrastructure to recover from earthquakes.[5] The PEOPLES Resilience Framework is a quantitative and qualitative holistic framework for designing and measuring resilience at the local level,[6] which uses a GIS-based assessment that incorporates different elements of resilience into a single inventory. The Baseline Resilience Indicators for Communities (BRIC) is a quantitative measure of overall pre-existing community resilience at the county level designed to compare counties across the United States.[7] The BRIC index assesses the inherent characteristics of a community that contribute to resilience, such as social and economic capital, ecosystems, infrastructure, and institutional capacity. This information is developed into six indicators that can be used to compare communities across the United States. Dr. Cutter explained that deconstructing the BRIC index allows for the analysis of the driving components—social, economic, community, and institutional capacity—that vary geographically, just as resilience as a whole varies geographically.

[3]Available at: www.unisdr.org/we/coordinate/hfa
[4]Available at: https://huxley.wwu.edu/ri/resilus
[5]Available at: http://www.spur.org/
[6]Available at: http://peoplesresilience.org
[7]Cutter, Susan L.; Burton, Christopher G.; and Emrich, Christopher T. (2010) "Disaster Resilience Indicators for Benchmarking Baseline Conditions, Journal of Homeland Security and Emergency Management: Vol. 7: Iss. 1, Article 51.

Dr. Cutter also presented bottom-up tools, which are locally based and locally driven indexes and models. One example is the National Oceanic and Atmospheric Administration's (NOAA) Coastal Resilience Index,[8] designed to help communities predict how well they would function following a disaster. It consists of a scorecard completed by a community as a qualitative self-assessment that evaluates critical infrastructure and facilities, hazard mitigation measures, and the community's overall plan. The index is adaptable to the hazard context of that community; however, that community-specific element can make it a challenge to compare different communities. The Toolkit for Health and Resilience in Vulnerable Environments (THRIVE) was initially developed to help communities of color bolster their health outcomes and remedy health disparities.[9] This tool is a combination of a self-assessment and quantitative information, and is a bottom-up assessment coupled with a top-down assessment. The Communities Advancing Resilience Toolkit (CART), a product of the National Consortium for the Study of Terrorist and Response to Terrorism (START),[10] focuses on enhancing a community's resilience through planning and action, with an emphasis on building and sustaining connections within communities. This tool requires a lot of time and effort at the local level to implement, but applies to all hazards and includes elements of community information gathered from statistical analysis, surveys, and key informant interviews.

Dr. Cutter stated that in reviewing community tools, the 2012 committee developed overarching principles that every tool should contain, including:

- Openness and transparency
- Alignment with the community's goals and visions
- Measures that:
  - Are simple and well documented (evidence-based)
  - Can be replicated
  - Can address multiple hazards
  - Are representative of a community's geographical extent, physical characteristics, and diversity
  - Are adaptable and scalable to different community sizes, compositions, and changing circumstances.

Four overarching target categories for developing community-based resilience measures are identified in the 2012 *Disaster Resilience* report: critical infrastructure, social factors, buildings and structures, and vulnerable populations (Figure 1-1). Communities are a system of systems, Dr. Cutter offered. The components in those systems, however, are often assessed individually because it is easier to understand the measure of a single component than it is to measure and understand all the connectivity and interdependencies within the system as a whole. Communities need to understand and measure the entire system in order to fully implement resilience. Dr. Cutter described the process of developing a measuring tool as beginning with the identification of a target category, such as critical infrastructure, followed by identifying a list of several key components for that community in that target category. Objectives for those components must then be established before ultimately identifying measures for those objectives. For example, water and sewage, power systems, and environmental infrastructure are components of critical infrastructure (Figure 1-2). A clean water supply is an example of an objective for the water and sewage component.

Dr. Cutter reinforced the many reasons why communities need to increase resilience:

- Saves lives and money needed to respond to a disaster by taking action before an event occurs, and builds stronger, safer, and more secure communities
- Helps in understanding current levels of exposure and potential impacts from adverse events, thereby helping a community take responsibility for its own disaster risk

[8]Available at: http://masgc.org/coastal-storms-program/resilience-index
[9]Available at: http://thrive.preventioninstitute.org/thrive/index.php
[10]Available at: www.start.umd.edu/research-projects/community-assessment-resilience-tool-cart

- Allows for identification of the community's capacity to cope with adverse effects and where improvements are needed
- Fosters a culture of self-sufficiency, helping-behavior, and betterment
- Fosters cooperation among all members of the community

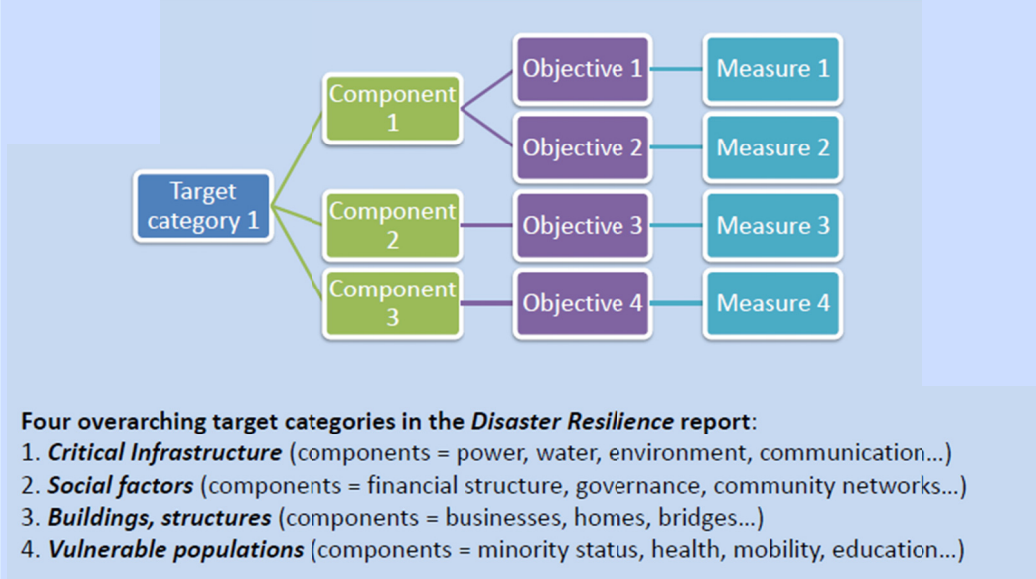

FIGURE 1-1 Four overarching target categories, components, objectives, and measures used in identifying elements for community resilience. SOURCE: Dr. Susan Cutter, presentation, September 5, 2014, Washington, D.C.

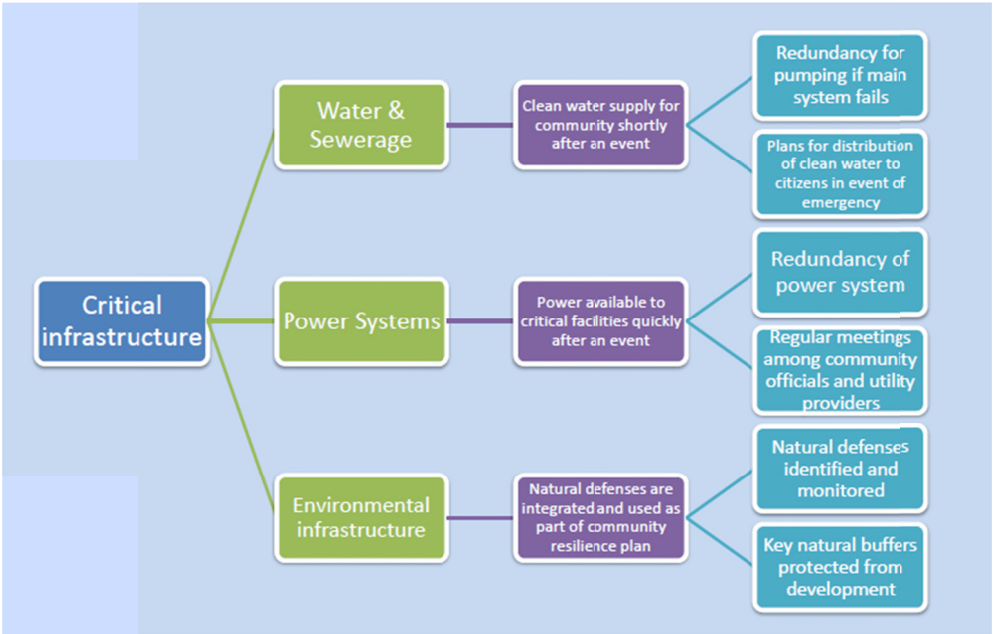

FIGURE 1-2 An example of components, objectives, and measures identified using the critical infrastructure target category. SOURCE: Dr. Susan Cutter, presentation, September 5, 2014, Washington D.C.

In addition, communities need a resilience measures tool that can:

- Assess and help prioritize needs and goals
- Establish baselines for monitoring progress and recognizing success
- Evaluate costs (investments) and benefits (results)
- Assess the effects of different policies and approaches

Dr. Cutter concluded by stating that a single, one-size measure for all facets of resilience is unlikely to work because the goals and aspirations, compositions, and threats and hazards of communities are different. Rather, a suite of tools with several indicators is needed. Many tools have been developed; however, few are actually used by communities because they are too complex, too computationally intensive, or too simple and do not provide the right information. These tools need to be adjusted and modified to fit communities' needs, as well as be promoted in a way that makes the business case for why resilience is important.

Question & Answers

A member of the audience asked about how hazard and disaster planning are different from identifying measures. Dr. Cutter clarified that planning includes measures and indicators, and involves assessing the physical infrastructure and land used for zoning, but does not necessarily take into account the adaptive capacity, the social networks, or the perceptions of the community with respect to risk. Planning is a tool that can be used to help achieve resilience, but resilience is a much broader framework. Similarly, mitigation is a tool that can be used to achieve resilience, but does not take into account different elements within a community that are important in achieving resilience. Leadership, for example, is an element not accounted for under planning or mitigation yet is an integral part of why some communities are more resilient than others.

Another member of the audience asked about the incorporation of temporal scales into the use of measures or indicators. Dr. Cutter responded that the interval between the use of measures is how the temporal scale is generally addressed. The BRIC index, for example, was measured in 2000 and again in 2005, which allowed for the progression over time to show changes in the inherent resilience (inherent characteristics of a community that contribute to resilience include social and economic capital, ecosystems, infrastructure, and institutional capacity) of the regions assessed. Once there is a consistent measure, Dr. Cutter stated, it can be implemented in a timeframe that allows for the evaluation of changes over time—either short- or long-term; the drivers causing those changes can then be identified by the community. Often the occurrence of a large event, such as a hurricane, provides an explanation for the changes that have occurred; incorporating the temporal scale is important in order to understand that timeframe clearly.

Dr. Cutter was asked about including risk as part of measures and indicators as opposed to just resilience—a relative versus absolute measure of resilience. She explained that the BRIC index, for example, describes the inherent resilience in a community irrespective of the risk. Risk would need to be overlain by a resilience layer in order to assess the intersection of risk with resilience. Some locations may have elements that result in them having high resilience, but may also have high risk for a natural disaster, such as being in proximity to a coastline. This highlights the ongoing challenge of choosing measures and indicators, because the BRIC index, for example, was not designed to assess risk. It was designed to evaluate those characteristics in communities that can help them move towards resilience irrespective of risk.

A final question was asked about future steps that could help to clarify the landscape of the different tools and measures available to communities. Dr. Cutter responded that one of the objectives of the Resilient America Roundtable is to partner with pilot communities to begin the process of identifying critical elements of different tools and make those tools more accessible, to help communities prioritize resources and better reach their resilience goals.

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2

Developing Resilience Indicators and Measures

Dr. Gerald Galloway, research professor at the University of Maryland and member of the Resilient America Roundtable, moderated the panel *Developing Resilience Indicators and Measures.* The panel provided a global perspective on the role of national and international (European Union [E.U.]) governments in ensuring resilience. The panelists also discussed lessons learned from their experience with development, application, and/or analysis of systems of resilience measures and indicators. The panelists included Roy Wright, Thomas de Lannoy, Michael Szönyi, and Chuck Wemple:

- **Roy Wright**, deputy associate administrator for mitigation at the U.S. Department of Homeland Security Federal Emergency Management Agency (FEMA), is responsible for FEMA's risk analysis and risk reduction programs. These include FEMA's Stafford Act authorities for mitigation, the National Earthquake Hazards Reduction Program, the National Dam Safety Program, and the National Flood Insurance Program. Mr. Wright is also responsible for FEMA Disaster Reservists within the Mitigation Cadre as well as the delivery of environmental and historic preservation technical assistance and compliance across all FEMA programs.
- **Thomas de Lannoy**, policy officer in the Directorate General for Humanitarian Aid and Civil Protection, European Commission, is responsible for the development and implementation of an E.U. framework for disaster prevention that encompasses risk assessment and management, data comparability and research, international relations (in particular the preparation of the E.U. position on the post-2015 Hyogo Framework for Action), and integration of disaster prevention into E.U. policy and financial instruments.
- **Michael Szönyi**, senior risk engineer with the Zurich Insurance Company, is currently working as a flood resilience specialist, assessing flood hazards and flood risks and advising the company and the alliance partners on risk insights and risk mitigation strategies as part of Zurich's flood resilience program. Besides advising the community projects of the flood resilience program on technical flood aspects and supporting the alliance partners on flood resilience assessment and measurement, he is also leading the post-event review function and analyzing large flood events around the world.
- **Chuck Wemple**, chief operating officer for the Houston-Galveston Area Council, oversees all programs and services including transportation planning, community and environmental planning, public safety, and workforce development for that large metropolitan region. He has extensive experience in addressing infrastructure, housing, and economic recovery needs following Hurricanes Rita and Ike.

Mr. Wright began the panel discussion by stating that a compelling case for resilience ultimately needs to be made for every community, and that all elements of resilience need to be considered including economic, health and social services, infrastructure, ecosystems, and civil society. Actions can be taken to address multiple elements of resilience, but the elements addressed need to be important to and valued by the community. A key lesson learned while working with local elected leaders, Mr. Wright offered, is the importance of communicating these elements to community leaders in a way that reflects what is important to their community.

Mr. Wright proposed that having a measure or indicator that provides a single number for how resilient a community is may not be possible, or necessary. He gave the analogy of a parent researching test scores for schools across a state, but who chooses whether to relocate based not solely on the test score number but also on housing prices, length of commute, and other community factors. A measure of resilience, similarly, would need to take into account many factors across a community. From the federal government perspective, a lot of data are available at the national level that can be brought to support a community's resilience assessment.

To take a long-term view, key indicators are required and better understanding of risk should be a priority. Mr. Wright cautioned that although no one opposes resilience, there could be negative reactions from a community regarding the term "high risk" however, exposure has to be understood in order to take appropriate action. For example, a lot of money is distributed from the Disaster Relief Fund, most of which is for public infrastructure, yet there is no list or clear understanding for what is covered under this program. It is not until after a disaster that people find out if they are eligible when requesting funds. This raises an important factor, the need for transparency in all these processes, and doing so in a way that provides consistent decisions yet enough flexibility to adjust to changing circumstances.

Mr. Wright concluded that it is necessary to advance the value of incorporating resilience measures and indicators into communities while also making them replicable, analyzable, scalable, and most important, usable. The most complicated or sophisticated tools and indicators are not going to be helpful if state legislators, county commissioners, or mayors are not able to understand and use them to make decisions about where to allocate resources.

Mr. de Lannoy stated that disaster prevention and resilience are now on equal footing with disaster preparedness and response across the E.U. New civil protection legislation exists to cover preparedness, response, and prevention. Part of this legislation obligates all 28-member nations of the E.U. to develop their own risk assessments, which can be based on qualitative and quantitative indicators. In order to receive E.U. funding to finance disaster response and disaster preparedness or prevention measures, a nation needs to show that their disaster plans are part of their national risk assessment. Currently, 17 member nations have developed national risk assessments; however, different methodologies are used resulting in data compatibility issues.

One tool Mr. de Lannoy highlighted was InfoRm—the Index for Disaster Risk Management. InfoRM is a risk-analysis tool designed to support decisions about crisis prevention, preparedness, and response.[1] Although not predictive, InfoRm provides a systematic way to account for complex risk information in a decision-making process. The tool assesses vulnerability and is based on a partnership between the Inter-Agency Standing Committee (IASC) and the European Commission. Mr. de Lannoy highlighted five key principles that InfoRm adheres to:

- Global—uses datasets with global coverage
- Open—is open source and based on evidence collectively gathered and owned by public, agencies, governments, NGOs, and academia
- Continuous—includes five years of historical data to allow for immediate trends analysis
- Transparent—the methodology and data sources are published and available for review via a website that allows users to download underlying data
- Flexible—is designed to operate as a standalone model to establish a common, basic understanding of risk

Mr. de Lannoy explained that the tool is a composite index that combines the assessment of results, vulnerability, and coping capacity into one index. They key idea is to incorporate a range of indicators into a very simplified tool to assess risk.

[1]Available at: http://inform.jrc.ec.europa.eu/

Zurich Insurance Company recently launched the Global Flood Resilience Program, a part of its corporate responsibility strategy, began Mr. Szönyi, and partnered with the Wharton School of Economics at the University of Pennsylvania as part of a flood alliance in an effort to produce better analytics information necessary to develop a resilience tool. Part of the overall effort focuses on community programs, additional partnerships include the International Federation of Red Cross—Red Crescent Societies and the non-government organization Practical Action, which works to improve community flood resilience in various countries around the world. The program is currently active in Nepal, Indonesia, Mexico, and Peru.

It is really important, emphasized Mr. Szönyi, to be able to demonstrate impact. The Zurich Insurance Company has a 5-year Corporate Responsibility Program investing resources in the Global Flood Resilience Program and they need to show the program has improved the lives of people in communities at risk of flooding. Mr. Szönyi agreed that there is no one-size-fits-all solution, and added that the tool needs to be specific to the peril. The program is developing a measures tool with similar components used to assess earthquakes, wildfires, or other risks, but the data used will be very specific for assessing flood resilience.

Although flood resilience is assessed at the community level, defining a "community" can often be unclear. Mr. Szönyi explained that a community participating in the program is defined by identifying an area or entity where there is interaction and social cohesion, rather than by political or administrative boundaries alone. For example, they work with a community in Nepal that is separated by a river; although politically it is the same community, there is no exchange or cohesion across the river. Therefore the community has to be approached as two distinct communities.

To make the most impact, the tool that the Global Flood Resilience Program will develop is a decision and prioritization tool. The term "index" is not necessarily the right descriptor, Mr. Szönyi explained, because the aim is not to compare one community against another in a ranking system, but instead to use indicators to highlight a community's strengths in flood resilience. Indicators with weaker scores would help prioritize solutions to improving resilience. The process also incorporates community decision makers and leaders in order to find a solution that would have real impact in their community.

Mr. Szönyi stated that the framework being developed is based on the sustainable livelihoods approach (SLA), a formal approach from the International Fund for Agricultural Development (IFAD) for improving the understanding of the livelihoods of poor people.[2] This approach is used in planning new development and in assessing the contribution that existing development has made to the sustainability of the community. There are two key components of the SLA: a framework that helps in understanding the complexities of poverty and a set of principles to guide action to address and overcome poverty. Mr. Szönyi said that there are five categories of capital following the SLA's guiding principles that are used in assessing community resilience: natural, physical, financial, human, and social.

It is challenging to find meaningful indicators within each of those five categories that can be measured. The ultimate tool will be semi-quantitative using data, facts, and figures, but will also need a level of judgment in assessing a community. Mr. Szönyi noted that one of the key elements that Zurich teams bring is the expertise to help make those judgment-based decisions. To establish a resilience baseline, they are working with pilot communities over the next 5 years, which will help to prioritize the strengths and weaknesses of the program, and lead to actionable solutions. Progress will be measured in these communities over time to evaluate improvement towards being more resilient to floods. In an effort to capture the full breadth of the resilience spectrum, the program will test these same indicators in communities that are already reasonably resilient in order to ensure that the scoring is adequate. Mr. Szönyi concluded that these are iterative processes that require adjustments and continual improvement as more information is incorporated into the framework.

Mr. Wemple described a council of governments as a voluntary association of local governments established by state legislation. The Houston-Galveston Area Council (H-GAC) covers 13 counties, 20 cities, and is centered on Harris County and the City of Houston. The region is highly industrialized with petrochemical facilities and a major medical center. There are also suburban communities, rural areas, and coastline that make up the region, which are all located on the upper Texas coast and vulnerable to

[2]Available at: www.ifad.org/sla/

hurricanes. The region is flat, and receives upwards of 50 inches of rain annually, which frequently results in flooding. The past year, however, has resulted in extreme drought conditions and wildfires, illustrating the range of risks from natural disasters to the region.

The governing board for H-GAC comprises local elected officials and is voluntary. The H-GAC cannot regulate, pass ordinances, or levy taxes; therefore, all initiatives are done through collaboration and persuasion. In 2009, Hurricane Ike made landfall in the region resulting in $7 billion in damages, with much of that damage in coastal communities. Increased natural disasters in the region led the state to designate H-GAC to review funding priorities from the U.S. Department of Housing and Urban Development's Community Development Block Grant Program to help move towards a regional approach to resiliency.

The H-GAC came to recognize the importance of resilience from the long recovery time and high cost of not being resilient to natural disasters. Because their initiatives are voluntary, they work closely with local officials and their designees, and operate by relying on best practices and promoting flexibility and local control whenever possible in order to gain consensus. The H-GAC is assessing elements in the regional communities that they could monitor and measure to better evaluate progress towards resilience, such as physical vulnerability, participation in hazard mitigation action plans, evacuation plans, engagement in the community rating system, participation in programs like the National Fire Protection Association's Firewise, and the use of natural buffers and green infrastructure to help mitigate damage from flooding and storm surges.

Mr. Wemple added that there is an unknown economic vulnerability that plays an important role in resilience. For example, many local governments in the region are heavily dependent upon sales tax revenue, and when a community is hit by a disaster, businesses are damaged and local sales decline. When 80 percent of a community's operating revenue is based on sales tax, this becomes a major barrier to recovery. The H-GAC works with communities to help them develop a checklist and analytical processes to evaluate and better understand their level of economic vulnerability; for example, it is critical to help communities establish lines of credit prior to a disaster in order to keep them operational during recovery. Another key element to economic resilience is evaluating how dependent or over-reliant a community or region is on a large, single employer or sector of industry.

Mr. Wemple stated that the sooner employees are back to work and residents are back in their homes, the faster that community will recover and the stronger that recovery will be. There is, however, a chicken and egg conundrum with the recovery process. People will not move back home until schools and businesses are open, but businesses will not open again until people return to their homes. Opportunities exist to fix these barriers by having contracts in place to receive housing recovery funds quickly, and developing ordinances to permit temporary housing on a resident's home site instead of on the edge of town or a different part of the region. A business network is also needed to keep businesses informed about when residents are back and workers are available to keep the local economy moving.

Mr. Wemple discussed surge protection as a key component of improving resilience in the region. Hurricane Ike was only a category 2 hurricane, but the storm surge was closer to a category 4 or 5 storm. Some communities had 18 feet of storm surge flooding that resulted in tremendous property damage and loss. One strategy H-GAC is employing is to bring two local universities together to discuss solutions and areas of commonality that can provide space for cooperation. Part of this planning involves taking a long-range view of resilience and incorporating that view into a regional hazard mitigation plan. That view is also part of the regional transportation planning efforts and regional economic development strategy.

An ongoing challenge to implementing these plans on a regional scale is complacency, cautioned Mr. Wemple. In the years since Hurricane Ike made landfall, most people in the region have recovered and moved on, and the growth of about 1 million new people to the region has resulted in a large portion of new residents not fully understanding the risk of natural disasters; a majority of the new population have never experienced a major flooding event. Mr. Wemple concluded by stating that important actions in overcoming the barriers to incorporating resilience in the Houston-Galveston Area's communities include: increasing resources for resilience, finding flexibility by exploring many options, and helping keep decisions and actions at the local level.

Question & Answers

Dr. Galloway asked the panelists how they would identify and advise local leaders on the issue of organizational resilience. Mr. Wright stated that communities are composed of people that make up organizational resilience. It is the social fabric that allows for the whole community to recover from a disaster. Having this level of resilience, however, takes experience. There are community dynamics and organizational demands that change with time, and the community needs a holistic view of recovery and a willingness to make changes. Mr. Wemple stated that he views community organization as key to resilience. From H-GAC's perspective, when the first round of federal disaster relief funding arrived for Hurricane Ike, it was quickly allocated with input from local governments. For the second round of funding, H-GAC convened a committee of local officials that has remained in place beyond Hurricane Ike to identify which communities need to add capacity to their local governments. Mr. Szönyi noted that the communities they engage are some of the poorest areas in the countries they work in, and so physical resilience plays less of a role than social structures, and that resilience needs that holistic view. For example, whether or not a school is physically resistant to floods is not as important as having a school that exists both as an idea and as an organization within the community. That allows for the idea of maintaining a school and education to persist.

Another participant asked the panelists to describe an example of how a local or regional decision maker has used the indicators or measures discussed, or how they could use them. Mr. Wright stated that the National Flood Insurance Program has 22,000 participating communities. When a community is willing to take affirmative steps to address structural elements, then those efforts can be quantified and will result in discounts in the premiums for that community. These discounts can range from 5 to 45 percent. This has provided incentive for communities to better assess their risk and ability to sustain themselves in the recovery from disasters.

Mr. Wright used Tampa, Florida as an example of a community that has taken a holistic approach to assessing their risk by incorporating eight different dimensions into their community plans. Tampa has laid out very specific actions to do post-disaster, but also started implementing actions pre-disaster. They identified hubs to attract more businesses and focused on improving infrastructure, and local decision makers took information about risk and priorities for the community and quantified those data to produce discounts for its citizens. Mr. Wemple stated that H-GAC worked with a number of local governments to use indices to prioritize disaster recovery funds and initiate large buyout programs for heavily hit regions. One challenge that resulted from Hurricane Ike was in identifying a metric that addressed indigent health care. The University of Texas Medical Center, which handles 80 percent of the indigent health care within the region, was closed following Hurricane Ike; this posed a challenge in providing care for vulnerable populations.

Mr. de Lannoy indicated that a key challenge is to develop a global index that can also be used by communities at a local level. Such a tool requires high resolution to be useful for prioritizing local planning and investment decisions. Mr. Szönyi followed with three points. First, an index needs to be an integrated tool that addresses the whole resilience process and is inherently participatory to working with communities, such as the Vulnerability and Capacity Assessment. Secondly, being more problem-oriented than solution-oriented is a useful approach. It is important as a development agency to not come in with a standard menu of solutions, but rather to work with communities to identify problems and then develop solutions. Lastly, pre-disaster loss prevention is very important—it is necessary to convince communities to take action prior to a disaster.

An audience member asked how building codes play a role in community resilience; building codes are implemented locally but often result from input at national or regional levels. Mr. Wright answered that building codes are possibly the single greatest mitigation tool that can be implemented at the community level. In the United States, there is the International Code Council that sets many of the building codes, but there are state-adopted codes as well. These codes have made real impacts.

A final question from the audience was about the challenge of thinking long-term, given that people think more about short-term returns. Mr. Szönyi replied that persistence is a key element of trying to push leaders to think in longer timeframes. This requires small steps that build momentum rather than finding the perfect, large-scale solution immediately. Another key element, Mr. Szönyi said, is that it is necessary to be able to assess how the resilience framework for a community is functioning in the absence of an event, which will help people to recognize resilience outside of the context of recovery. Mr. de Lannoy raised the issue of convincing policymakers to make necessary investments in the short term, using a cost-benefit analysis that takes a long-term view.

Mr. Wemple agreed about the importance of convincing residents and community members to think in the long-term, and then encouraging those community members, in turn, to convince local elected officials to take action. Elected officials are stewards of community assets and resources, and should be responsive to the community members who elected them to office. Mr. Wright pointed to the need to consider economic drivers in the community as part of long-term thinking, such as the role of insurance and private sector investments. Managing community infrastructure and economic capital requires measures and indicators that support evaluation of investments with a long-term perspective.

3

Implementing Resilience Indicators and Measures at the Community Level

Arietta Chakos of Urban Resilience Strategies and a member of the Resilient America Roundtable opened the panel by stating that in the days preceding this workshop, there were discussions with community leaders from Charleston, South Carolina and Cedar Rapids/Linn County, Iowa, the first two communities that will work with the Resilient America Roundtable in a new pilot project. The Roundtable is working with decision makers and diverse stakeholders in communities to build their resilience and identify community priorities, risks that face that community, and ultimately design a community resilience strategy that the community would own. The pilot projects are based on four pillars of the 2012 *Disaster Resilience* report:

- understanding and communicating risk;
- identifying measures or metrics of resilience in terms of baseline conditions, milestones, or un/acceptable consequences of the identified risk/s;
- building or strengthening coalitions or partnerships in building community resilience; and
- sharing information or data related to better decision making for building resilient communities.

Criteria for consideration of working with a community included attributes such as community size, critical infrastructure, important economic supply chain nodes, demographic and economic diversity, and types of natural hazard risks the community faces. In addition to representatives from the two pilot community partners, Cedar Rapids/Linn County, Iowa, and the region of Charleston, South Carolina, representatives from Talbot County, Maryland and San Francisco, California participated on the panel.

The panelists included Sandi Fowler, Laura Cabiness, Clay Stamp, and Miriam Chion:

- **Sandi Fowler**, assistant city manager for the City of Cedar Rapids, Iowa has held positions in city government for nearly 25 years, working with neighborhood groups, citizen services, internal operations, and facility rebuilding from the 2008 flood. She now leads the departments of Public Works, Community Development, and Building Services, as well as economic development and development plan review for the city.
- **Laura S. Cabiness**, public service director for the City of Charleston, South Carolina, began her career working for the Department of Defense at Southern Division Naval Facilities Engineering Command. She subsequently worked for Keck and Wood, Inc., in Atlanta, Georgia and Florida Land Design, Inc., in Tampa, Florida prior to returning to Southern Division Naval Facilities Engineering Command in 1989. In 1990 she began her career with the city of Charleston, first as the city engineer and currently as the director of the Department of Public Service.
- **Clay Stamp**, county manager for Talbot County, Maryland, a rural county on Maryland's Eastern Shore, oversees all affairs of county government on behalf of the Talbot County Council, the elected officials who serve as the governing body of Talbot County. Mr. Stamp began his professional career working for the Town of Ocean City, Maryland, eventually retiring as their emergency services director.

- **Miriam Chion**, director of planning and research at the Association of Bay Area Governments, is responsible for the development of regional strategies addressing social equity, economic vitality, and environmental challenges. Between 2004 and 2009, she was faculty at the Department of International Development, Community, and Environment, at Clark University, Massachusetts.

Ms. Fowler opened the panel by describing Cedar Rapids, which lies at the heart of Linn County in northeastern Iowa, as a primarily service-oriented economy with some manufacturing. Agriculture and agricultural-based products including cereals, corn, soybeans and oat processing are all predominant in the region. Cedar Rapids, named an All American City in 2014, recovered from massive flooding in 2008, which provided many lessons about resilience for the county and its decision makers, but also generated many questions. One goal of Cedar Rapids and the Linn County community is to build the language and professional understanding of resiliency within the community and to learn how to turn that understanding into a long-term vision that supersedes fiscal budget and election cycles. Cedar Rapids faces many hazards, including flooding, drought, tornados, high winds, and winter storm and ice damage.

In 2008, the major flooding event resulted in Cedar Rapids implementing a buyout program to acquire and demolish 1,400 structures out of 40,000 homes. This was a flood protection effort that spanned 10 miles along the Cedar River and cost approximately $570 million. Despite historic flooding and recent flash flooding in the region, there is a challenge to instill personal responsibility in the community, especially with regard to purchasing household flood insurance. Ms. Fowler stated that they are now preparing for the future rather than gauging efforts based on what happened in 2008. Cedar Rapids, she stressed, needs to plan for what they have not yet experienced. Although a key element of planning is collaboration within city government, increased sharing of resources and risk planning are also needed. The city government, Ms. Fowler noted, is a cohesive group and it is not a challenge to bring different departments and organizations together; however, it is necessary to keep that cohesiveness every day so that they are prepared when there is an adverse event.

Tourism is a key industry for Charleston, South Carolina, began Ms. Cabiness, and the city was recently named as the 59th best place for business and careers in the United States. Like many coastal cities, Charleston has a flat topography. Downtown Charleston is an eight-square mile peninsula, but the city has grown to a total of 110 square miles. The population has also grown in pace with the expansion of city limits, and there are many new people in the region who have not experienced Charleston's hazards: hurricanes, floods, earthquakes, and ice storms.

Ms. Cabiness described her experience during Hurricane Hugo, a devastating event that hit Charleston 25 years ago. Her family stayed in their home, listening to the storm and trees falling nearby. The radio broadcast described the storm surge, and warned residents to move to the second floor because of flooding. Ms. Cabiness recalled that when the winds calmed down during the eye of the storm she thought they would not make it through, adding that those who stayed for Hurricane Hugo would likely never stay for another one.

When Ms. Cabiness started working for the city shortly after Hurricane Hugo, Charleston had recently completed a master drainage plan. The city received a $2.9 million mitigation grant, which allowed them to begin a structural improvement project to build a new drainage system. The drainage project began in the peninsula section of the city, which was a densely developed area where many of the streets had multiple utilities running underneath and much of the subsurface material was contaminated. Charleston opted over the next 10 years to install a deep tunnel drainage system, a 10-foot diameter tunnel buried 140 feet below the surface that captured storm water runoff during heavy rain events.

Charleston is installing another drainage system using an initial $10 million from the U.S. Department of Transportation's Transportation Investment Generating Economic Recovery (TIGER) Discretionary Grant program. This initial funding allowed the city to install surface drainage improvements, which helped them to receive another $88 million from the South Carolina Transportation Infrastructure Bank and a 50/50 match grant from the Federal Highway Administration. Charleston is anticipating to have spent nearly $230 million by 2020. It is important with all these improvements, Ms. Cabiness said,

to ensure constituents in rural regions benefit from these investments, and that efforts are not only focused on downtown.

Another critical activity is improving community planning, which includes discussions with business and community partners to move resilience forward. The city port and medical centers, for example, are key partners in the discussion and are helping to make plans that contribute to the overall resilience of the region. Ms. Cabiness concluded that short-term response, such as first responders; medium-term efforts, such as building codes and land development plans; and long-term regional planning are all key elements of the resilience planning effort.

Mr. Stamp outlined opportunities he sees as part of a movement to address resilience in a more comprehensive way. Talbot County, Maryland is a rural county with about 40,000 people, 5 municipalities, 12 villages, and nearly 650 miles of shoreline along the Chesapeake Bay. Moving from the emergency manager to the county manager, Mr. Stamp noted, shifted his perspective from emergency management to a broader local government-oriented view that required engaging with villages, organizations, mayors, and the public in a different way. It provided the opportunity to bring the communities together to identify elements that should be the foundation of resilience in the region.

Mr. Stamp described the elements—the pillars—that a community needs to be healthy, including public safety, health and welfare, economic stability, and education; identifying these pillars allows the community to better target their investments. One area for investment in Talbot County is along the shoreline; environmental and shoreline protection are pillars of the community foundation. Currently, there are six ongoing shoreline protection projects. There are additional opportunities to invest in new construction to boost resilience; for example, the replacement of a roof on a school is also an investment in education. When going into a new budget cycle, the risk for each of these pillars can be assessed in order to prioritize future investments. Mr. Stamp described a principle that he always followed as a disaster manager: in order to be successful in responding to a disaster, systems, projects, and programs need to be created that work every day so that they are in place and functional. Mr. Stamp finished by stating that a comprehensive plan, which includes a hazard mitigation plan, is a powerful tool to have at the local level.

Ms. Chion described examples of successes and challenges faced by the Association of Bay Area Governments (ABAG) in building resilience. ABAG has been compiling data on and developing indicators for natural hazards and associated risks for nearly 30 years. It is a regional agency covering 9 counties, 101 cities, and 7 million people. Much of the data collected thus far are on economic indicators at the regional level, but they are now beginning to engage at the neighborhood level by designating priority development areas. One challenge to development will be that nearly 60 percent of the growth in the region is concentrated in only 5 percent of the region's total area.

Through the Regional Prosperity Consortium, ABAG works with community representatives from across the region to address equity and implementation of resilience strategies; part of this work aims to integrate resilience to natural disasters into a number of other economic and social initiatives in order to address housing vulnerability. The focus, Ms. Chion said, is on protection from flooding and earthquakes, but also on a housing crisis; increasingly people are spending up to 70 percent of their income on housing and are being displaced as the average housing price in San Francisco has reached $1 million. It is necessary to integrate these social and economic considerations into regional planning.

In 2013, ABAG approved their first regional plan connecting transportation to housing and land use; similar plans, stemming from a 2008 state requirement, are being prepared by the major councils of government across the State of California. This comprehensive regional plan serves as a platform to work with local jurisdictions on how to incorporate these different elements of resilience into local plans. Ms. Chion stated that the association is compiling, in a systematic way, a housing vulnerability index to help support better dialogue with communities. The index is based on community profiles that allow for regional and local specificity for assessing housing costs and vulnerable populations. This index will also allow for estimates of how much affordable housing will be retained following a major disaster. Retaining functionality in terms of local business and services is a key component of these plans. Linking these resilience elements to long-term chronic problems, such as affordable housing, is one of the ongoing challenges with the Regional Prosperity Consortium, but overall has helped to have a more substantial dia-

logue among the residential, environmental, and business stakeholders. This dialogue is important for building trust, and has helped to engage and coordinate the administrators and supervisors between the city and county.

Question & Answers

Ms. Chakos highlighted a theme brought up by several of the panelists that local leaders need to adapt to changing political situations and be responsive to communities. Local leaders need to know how to use persuasion and influence in informative ways in order to reach communities and guide them in making good decisions. A member of the audience asked about what training the panelists take advantage of to train the next generation of leaders who will be working on resilience issues. The audience member also noted that working with colleges and universities to create emergency management-related courses and degree programs are necessary to ensure that the next generation is able to understand the complexity of the challenges that communities face. Ms. Fowler responded that they had a team of FEMA Corps members in their community last summer helping to finish recovery work.[1] Next generation workforce development in the Cedar Rapids area is an economic priority, and although it is a challenge for the city to attract younger employees in general, the younger planners and engineers bring a new mindset and perspective.

Another member of the audience asked about the mutual benefit to building resilience that can be derived by partnering with local businesses. Mr. Stamp responded that partnering with the business community is an untapped resource. The challenge to these partnerships is the limitation imposed by government rules and regulations. It requires creativity and innovative thinking to establish partnerships with private industry, universities, and even other government agencies, but these partnerships provide a great opportunity to leverage grant money to accomplish goals that might otherwise be unreachable.

Another question focused on identifying gaps and information at the local level that would help to incorporate ecosystems as part of building resilience. Ms. Fowler pointed to the demolition project along the Cedar River, which created the opportunity to develop a 110-acre greenway. This greenway allows for natural flood protection, and has led to the identification of other natural areas that will be similarly maintained. Ms. Cabiness described a Greenbelt Program where a half-cent sales tax was enacted in which the funds were dedicated to purchasing green space around Charleston to aid in mitigating storm water. One of the challenges to these programs is that often development is already built up along high flood-prone areas, Fowler indicated. In some areas, if dikes were removed, natural wetlands would be restored, creating a more natural buffer to hurricanes and storms. However, homes are often built in areas that rely on dikes for flood protection. Finding areas that are not overdeveloped is a key factor in restoring these natural ecosystems to protect against flooding.

Another participant asked the panelists to provide two or three indicators that they feel would be most useful to their decision-making. Ms. Chion replied that there are two pieces of information that would help at the regional and local levels. The first is a better understanding of measures related to whom within the community has appropriate housing and who will have it after a major disaster. The second piece is related to infrastructure and interconnectedness. Because much of the infrastructure is privately held, there is a challenge in collecting data on the vulnerabilities. For example, being able to have better information on gas pipe infrastructure would help to predict future leaks or knowing about how water is supplied around a region would help to identify potential safe drinking water reservoirs following a major disaster. Ms. Fowler described vulnerability as a way for communities to use measures and indicators. It is necessary to evaluate building codes and public services to identify risks and assess if standards are appropriate enough to meet those risks.

[1]FEMA Corps members serve for a 10-month term plus an optional second year. The program aims to prepare thousands of young people for careers in emergency management and related fields by providing significant training and experience in disaster services and recovery.

Following on a similar theme, Ms. Cabiness stated that more information is needed on structural vulnerabilities; for example, one key metric they do not have is a count of how many structures are below base flood elevation. There are many structures that predate a 1974 flood insurance program that are likely below flood elevation and are vulnerable. This is also true for earthquakes in the Charleston region; there is currently no measure for how many structures are vulnerable to moderate or severe earthquakes. Another useful metric, Ms. Cabiness added, would be a measure of the economic impact of nuisance flooding. There is a dollar value associated with businesses closing or people staying home from work due to floods, and it would be helpful to have cost/benefit ratios developed to help prioritize projects.

4

Developing a Decision-Making Framework

Following the panel discussions, participants were divided into breakout groups. The groups corresponded to four overarching categories that the 2012 *Disaster Resilience* report recommended any index of resilience measures or indicators should include:

- Vulnerable Populations
- Critical and Environmental Infrastructure
- Social Factors
- Built Infrastructure

Each breakout group was tasked with identifying up to five key components within their category and providing objectives and goals for each component that could then be used to discuss specific resilience measures (See Box 4-1 for detailed instructions). Breakout groups were made up of participants at the workshop from diverse backgrounds, including academics and researchers, local decision makers and practitioners, and representatives from federal agencies, NGO's, and the private sector. Effort was made to put together balanced groups that included experts in fields and disciplines directly related to the particular categories, as well as participants who work in other areas related to resilience that could provide alternate perspectives to the discussion. Using this workflow, each group was asked to develop a simple, hazard-neutral framework that could serve as a starting point for any community to begin to develop its own resilience measures. Tables with key points from each group's discussion can be found in Appendix A.

Group One: Vulnerable Communities

The Vulnerable Communities breakout group began with the approach of trying to identify components as specific socially vulnerable groups, such as seniors, children, racial and ethnic minorities, low-income populations, non-English speakers, the homeless, the medically dependent, mobility impaired, persons in nursing homes, and persons with drug addictions. From the initial discussion, Group One discovered that this list of community groups did not provide the necessary overarching characteristics that would lead them to articulation of useful objectives. To address this issue, Group One identified characteristics that rendered certain population groups vulnerable through components that are based on the functional needs of an individual. For example, a person with special medical needs could be considered part of a vulnerable population if that individual had special communication needs, lacked independence, or required medical supervision. Other examples could include populations with transportation dependency, or that lack social and economic resources.

After identifying a series of components (see Appendix A), the group used the example of communication needs to begin to identify objectives for that component. Three objectives that were articulated included a) measuring the number of people in a community with special communication needs, b) identifying mechanisms to address communication needs with those who have a limited ability to receive or understand information, and c) identifying resources to assist these community members. Some of the representative communities that could be considered vulnerable due to communication needs included those who are non-English speaking, deaf/hearing-impaired, vision-impaired, illiterate, undocumented or documented immigrants, tourists, and/or students.

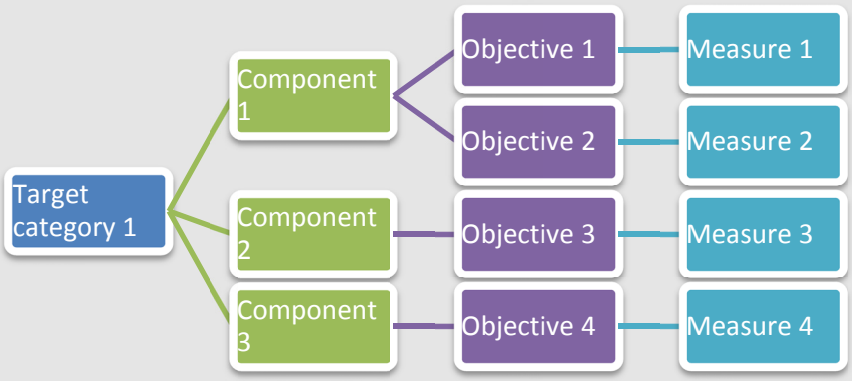
BOX 4-1 Breakout Group Instructions

The goal for each of the breakout group was to develop a simple, hazard-neutral framework to serve as a starting point for communities to begin to develop their own resilience measures. Workshop participants were divided into four pre-assigned groups, with 15 participants in each group. The breakout topics, based on the NRC report, *Disaster Resilience: A National Imperative*, represent four overarching **categories** fundamental to developing resilience indicators and measures (2012).

- Vulnerable Populations—factors that capture special needs of individuals and groups, related to components such as minority status, health issues, mobility, and socioeconomic status
- Critical and Environmental Infrastructure—the ability of critical and environmental infrastructure to recover from events, components may include water and sewage, transportation, power, communications, and natural infrastructure
- Social Factors—factors that enhance or limit a community's ability to recover, including components such as social capital, education, language, governance, financial structures, culture, and workforce
- Built Infrastructure—the ability of built infrastructure to withstand impacts of disasters—including components such as hospitals, local government, emergency response facilities, schools, homes and businesses, bridges, and roads

A moderator and rapporteur facilitated and recorded the discussions. Each group was provided a workflow schematic (based on Dr. Susan Cutter's presentation) with additional guidance to help frame the discussions. The workflow for each breakout group entailed identifying key **components** within that category and **objectives/goals** for each component that can then be used to discuss specific resilience **measures**.

Workflow Schematic



Basic Guidelines

Resilience measures should be:

- Open and transparent
- Replicable
- Well documented
- Simple enough to be used by a wide range of stakeholders

Approach to measuring resilience should:

- Address multiple hazards, and be adaptable to the specific communities and hazards they face
- Be place-based, rather than spatial and capable of dealing with a range of community sizes
- Be adaptable

Knowledge and Data questions to consider:

- What should be measured over what timeframe and geographic scale?
- Should resilience be assessed regularly or triggered by something?
- Should they be prescribed and uniform, or adapted for specific circumstances?
- Measured qualitatively or quantitatively?

(Continued)

BOX 4-1 Continued

Each group was provided a blank table (see below) in which to record the salient points of their discussion. The moderator and rapporteur were responsible for obtaining group input and recording it on two slides that were shared in the plenary session summary following the breakouts groups (Appendix A). Breakout group participants were specifically asked to:

1. Identify up to 5 key **components** within each primary category.
2. Identify up to 3 **objectives** (as statements or questions) for each of the components.
   - Identify 1-2 **measures** (qualitative or quantitative) that could be used to assess progress with each objective.
   - Discuss **data, costs, incentives, challenges** for objectives and/or measures
   - Discuss information/data required, how baselines can be developed, how often measures might be used, and who is responsible for measuring and follow up.
   - Discuss potential costs of implementing improvements and making use of measures (financial, time, personnel costs).
   - Discuss 1-2 key incentives to ensure progress with each objective/measure.
   - Discuss challenges, barriers (and/or successes).

Sample Table:

Components	Objectives	Measures/ Indicators	Data, Frequency, Responsibility	Costs	Incentives

Through the process of formulating the table, the group felt that an additional column was needed—resilience goals—to address the broader issues associated with reducing vulnerability and enhancing the capacity of the community. For communication needs, four goals were identified:

- Develop flexibility in the community's communication systems to deal with uncertain events
- Have alternative means of communication/redundancy in the community's systems to provide information to vulnerable populations in case main systems are inoperable
- Develop a network of translators who could reach out to people with special communication needs
- Implement training for organizations/community groups to address special communication needs

Overall, the group felt that the table was a useful mechanism to begin the process of developing an approach to identify vulnerable populations in a community, articulating the needs of those populations, and developing objectives for meeting those needs. Although time constraints did not allow participants to identify specific measures and indicators, the process was an entry point to moving towards that end goal. Group One participants also experienced several challenges in moving through this process. First, they had difficulty in defining what it means to be part of a vulnerable or at-risk group; different people had different definitions depending on their frame of reference. Participants also found that components could be too all encompassing, yet exclusive of particular individuals at the same time, and it could be difficult to account for individuals who move in and out of the defined categories due to changing life circumstances. Lastly, overlapping language between resilience and emergency management posed a potential barrier to a community's ability to move from a response-only approach to an adverse event toward one of building resilience for the community.

Finally, one of the results of this exercise was articulation of awareness that, because resilience issues are complex, trying to move a community too quickly into the details of identifying indicators and measures for specific components can rapidly become complicated and overwhelming. Group One struggled with finding a starting point and deciding whether to first address the components or measures; for communities, it was noted that the starting point could be an even more difficult conversation that might also be politically charged. Nevertheless, most of the group participants observed that measures were an important tool in supporting efforts to become more resilient.

Group Two: Critical and Environmental Infrastructure

The Critical and Environmental Infrastructure group took a different approach to the exercise. Group Two focused on identifying key components and developing objectives for each of those components. As with Group One, definitions posed a challenge, particularly with how to define environmental infrastructure. While most group members agreed on elements of the term critical infrastructure, the term "environmental" was much more broadly interpreted. The group gravitated towards interpreting it as ecosystem services and green infrastructure.

The group considered classical preparedness components, such as water, energy, communication, transportation, and public health/services; the fifth component was the environment. Components were considered in context of short-term and long-term needs, and objectives were developed based on the critical elements of each component that would need to be maintained for continuation of service.

For water, objectives included: a) quality for human consumption, and for commercial and sanitation; b) containment of water sewage and wastewater treatment, and to address disruptions of service and inventory; and c) inventory to ensure a sufficient supply of drinking water and distribution to the public. These objectives proved to be similar for other components. Energy, for example, also had the objective of reliability and accessibility, which again relates to inventory. Long-term concepts addressed in regards to energy related to alternative energy supplies and being less dependent on fossil fuels, and alternative energy sources or technologies as a mechanism to provide households or communities a level of independence.

Transportation had mobility, accessibility, evacuation preparedness, and reliability as objectives. For communication, Group Two focused on mass communication, which is the ability to send out warnings and alerts, person-to-person communication, emergency responders and 911 functionality, and ensuring commercial activities. The group had extensive discussion around the environment component, and many group members stated that protection of community assets, such as wetlands as a buffer against severe storms, was critical, as was consideration of the quality for human and ecosystem health, interdependence of regions, and overall quality of life for residents.

Group Two spent most of the breakout session trying to tease out the various objectives for the components. Definitional issues were an ongoing challenge for making progress in completing the table. Besides the term "environmental," other major points of discussion included what resilience means for communities and the role of jurisdictional domains in terms of who controls critical infrastructure. Infrastructure related to energy and communication is often held by private sector entities, which raised many questions about how to account and embed that infrastructure into the resilience process. Discussion also focused on the importance of bringing in and engaging the private sector in the resilience conversation. Part of that conversation includes issues around data, and identifying what data are relevant to assessing the resilience of a given region.

Group Three: Social Factors

The Social Factors group reframed the discussion of components by examining what social factors were critical to preserve and protect a community from a resilience perspective—in essence, the identity of the community. Group Three members identified leadership as an essential component, but did not attribute solely to government leadership. Most group participants agreed that leadership is found in many

sectors and can take on different forms depending on the organization or entity taking the leadership role; it is important that those leaders have awareness of risk factors and are able to connect with leaders in other networks.

Another critical component was social connectedness and cohesion, which includes attachment to place and social networks. There are formal and informal connections among businesses, government, and community organizations, group members observed, which are necessary in building social cohesion across a community. Resourcefulness was also a key component, particularly in reference to workforce in sectors such as healthcare, emergency services, and the private sector. The group broadened workforce to include the retired and unemployed since those groups can contribute skills to the community. Another objective of resourcefulness was to reduce vulnerabilities and minimize displacement, which requires an assessment of each group's composition, distribution, and economic robustness.

A third component was interdependencies, particularly in consideration of a network, or networks, rather than a linear set of connections. This includes networks that move from the individual to community to regional scales, and the infrastructure needed to support these networks. Group Three discussed cultural diversity, including preparedness, individual capacity, and self-reliance as important cultural elements, and understanding the social and economic diversity of communities. The final component was education and schools. Although related and inseparable concepts, many Group Three participants made a case for considering them as separate – schools as a physical location and education as the prerequisite for developing skills, understanding risk, and improving livelihoods in the community.

In implementation of measures to address these components, they said, the community would need to tap into people with prior disaster experience within the community and who have influence with decision makers. If a community experienced a recent event, it might be more open to taking steps to increase resilience. The group discussed measures or indicators as investments that yield both short-term and long-term benefits. Finally, Group Three explored economic incentives and using rating systems to help drive resilience actions and mobilize members of a community.

Group Four: The Built Environment

Group Four identified housing, businesses, community facilities (e.g., schools, public administration, prisons), and health care facilities as four critical components of the Built Environment. The group focused on four "Rs" as objectives for each component: robustness, resourcefulness, recovery, and redundancy. For housing, the group discussed the presence of building codes, the percentage of buildings that meet the codes, presence of processes to bring housing up to code, and baseline assessments of housing stock to assess quality. Another important metric would involve a community's ability to enforce the building codes. Members of the group from city management stated that codes are great tools, but can be challenging to enforce. Other important measures include how much of the housing stock participates in insurance and insurance-related programs, and available grants and permits as incentives for taxpayers.

Group Four discussed measures for businesses in terms of establishing baseline conditions and awareness. How aware is the business community of their risk to loss of property, or disruption of services and revenue? In assessing the current state of businesses, employee engagement is a critical factor, as is how much businesses provide for their employees, such as daycare services. From a broader perspective, factors to consider include determining the size of the businesses (e.g., nationally versus locally owned), foot-based traffic vs. mostly an online presence, percentage of the community's population employed, and continuity plans. Baseline conditions include the state of community facilities: are they up to code and usable as shelters? Finally, the group discussed healthcare and the concept of "health deserts": do all parts of a community have access to hospitals, urgent care clinics, general primary care, and other health facilities?

Most Group Four members agreed that baseline conditions represented a key overarching theme for all built structures, including an understanding of the level of community activity within those buildings, which helps to assess how participatory a community is in general. This participatory characteristic relates to how

cohesive a community will be and how much "buy-in" residents and businesses will have in taking steps to become more resilient. Participation and adoption of key initiatives are indicators of a community's movement towards resilience, but the community also needs to identify short- and long-term actions to ensure that they are making progress in building resilience.

Appendix A

Breakout Group Tables

TABLE A-1 Vulnerable Communities Breakout Table

Component	**Objectives**	**Measures/indicators**	**Resilience Goals**
Communication	Measure number of people in community with special communication needs Identify mechanisms to address communication needs with those who have limited ability to understand information Identify resources to help those in the community	Measure how many people in the community: Non-English Deaf/Hearing Impaired Vision Impaired Illiterate Limited English Proficiency Undocumented/Documented Immigrants Tourists University Students	Develop flexibility in communication systems to deal with uncertain events Have alternative means of communication/ redundancy in systems to provide vulnerable populations information in case main systems are down Develop a network of translators who can reach out to people with special communication needs Implement training for organizations/community groups to address special communication needs
Other Components: Medical Independence/Mobility Supervision/Self-determination Transportation Social Networks/Connections Resources/Empowered			

TABLE A-2 Critical and Environmental Infrastructure Breakout Table

Component	**Objectives**	**Measures/Indicators**	**Incentives**
Water	Availability Quality Containment Inventory		
Energy	Reliability Recovery Reduced Env. Impact Accessibility Independence		
Transportation	Mobility Accessibility Evacuation Reliability		
Communication	Mass communication Person to person Emergency/911 functions/responder Commercial activity		
Environment	Protection of community assets Quality for human health and ecosystem health Interdependence of regions Quality of life		

TABLE A-3 Social Factors Breakout Table

Component	Objectives	Measures/Indicators	Incentives
Leadership	Identify who is listened to and speaks for community; credibility; capacity of leaders to connect to other leaders and networks; capacity to raise risk awareness		
Social Connectedness/ Cohesiveness	Relationships between and among businesses/organizations; institutional arrangements - formal and informal; capacity and effectiveness of communication		
Resourcefulness	Characterize workforce composition and distribution; identify key resources: healthcare, emergency services, private sector, retired people, unemployed – what is their resilience and vulnerability; minimize displacement		
Interdependencies	Scales - individual vs. neighborhood vs. regional; rural or urban. Conceptualize as network with nodes and links. Treat as a marker of strength. Analyze likelihood of business interruption		
Cultural Diversity	Culture of preparedness/self-reliance; income diversity; affordability; occupational diversity		
Education and Schools	Investigate role of schools in community – short term rallying points; long-term reasons to stay/return, livelihood advancement, skills development, understanding risk. Schools and education are separate concepts and same concept		

TABLE A-4 Built Environment Breakout Table

Component	Objectives	Measures/Indicators	Incentives
Housing	Robustness, Resourcefulness, Recovery, and Redundancy	Presence of building codes for housing including rental properties; percentage building codes met; processes in place to bring housing up to code Overall housing stock: manufactured, rental, owner; ability to enforce building codes; how much of housing stock participates in insurance Baseline conditions for the housing stock; ratio of home renters to home owners; percentage of transient citizens	Grants and innovative taxpayer incentives for upgrades Innovative permitting
Business	Robustness, Resourcefulness, Recovery, and Redundancy	Awareness: how aware is the business community of risks it faces for loss of business, property damage and disruption of services/revenue Baseline conditions Employee engagement Number of local versus national or multinational businesses Percentage of population employed by businesses Percentage of businesses with continuity plan in place	Grants and innovative taxpayer incentives for upgrades Innovative permitting
Community Facilities (e.g., schools, public administration)	Robustness, Resourcefulness, Recovery, and Redundancy	Baseline conditions of facility stock, housing code compliance	Grants and innovative taxpayer incentives for upgrades Innovative permitting
Health Care Facilities	Robustness, Resourcefulness, Recovery, and Redundancy	Health deserts Baseline conditions: continuity of operations; contingency plans; capacity for sheltering in place and critical health services; percentage of community that is retired	

Appendix B

Workshop Agenda

Measures of Community Resilience: From Lessons Learned to Lessons Applied:
A National Academies Workshop

September 5, 2014
The National Academies of Sciences
2100 C Street NW, Washington, D.C.

9:00 am	**Welcome and Introductions** *M. Granger Morgan, University and Lord Chair Professor of Engineering; Professor, Department of Engineering and Public Policy, Carnegie Mellon University* *Lauren Alexander Augustine, Director, Program on Risk, Resilience, and Extreme Events, The National Academies*
9:10 am	**Keynote: Measuring Community Resilience – the Landscape of Resilience Indicators** *Susan L. Cutter, Carolina Distinguished Professor and Director of the Hazards and Vulnerability Research Institute, Department of Geography, University of South Carolina*
9:45 am	**Panel 1: Developing Resilience Indicators and Measures: Lessons Learned** *Moderator: Gerald Galloway, Research Professor, Glenn L. Martin Institute Professor of Engineering, Department of Civil and Environmental Engineering, University of Maryland* *Roy Wright, Deputy Association Administrator for Mitigation, Federal Emergency Management Agency* *Thomas de Lannoy, European Commission, Civil Protection Unit* *Michael Szönyi, Zurich Insurance Group* *Chuck Wemple, Chief Operations Officer, Houston-Galveston Area Council*
10:45 am	Break
11:10 – 12:00 pm	**Panel 2: Developing and Implementing Resilience Indicators and Measures at the Community Level: Lessons Applied** *Moderator: Arrietta Chakos, Policy Advisor, Urban Resilience Strategies* *Sandi Fowler, Assistant City Manager – Development Services, City of Cedar Rapids* *Clay Stamp, County Manager, Talbot County (Maryland) Government* *Miriam Chion, Planning and Research Director, Association of Bay Area Governments* *Laura Cabiness, Director, Department of Public Service, City of Charleston, S.C.*
12:15 pm	Adjourn

Appendix C

Steering Committee, Speaker, and Moderator Biographies

SUSAN CUTTER (CHAIR) is a Carolina Distinguished Professor of Geography at the University of South Carolina where she directs the Hazards and Vulnerability Research Institute. Her primary research interests are in the area of disaster vulnerability/resilience science—what makes people and the places where they live vulnerable to extreme events and how vulnerability and resilience are measured, monitored, and assessed. She has authored or edited twelve books, more than 150 peer-reviewed articles and book chapters. Her most recent book, Hurricane Katrina and the Forgotten Coast of Mississippi was published by Cambridge University Press in 2014. She has led post event field teams in examining Three Mile Island (1979), Hurricane Floyd (1999), September 11th World Trade Center attack (2001), Graniteville, SC train derailment and chlorine spill (2005), Hurricane Katrina (2005), and Superstorm Sandy (2012). She has provided expert testimony to Congress on hazards and vulnerability and was a member of the US Army Corps of Engineers IPET team evaluating the social impacts of the New Orleans and Southeast Louisiana Hurricane Protection System in response to Hurricane Katrina. She is an elected as a Fellow of the American Association for the Advancement of Science (AAAS) (1999). She is also past President of the Association of American Geographers (2000) and past President of the Consortium of Social Science Associations (COSSA) (2008). In 2011 she received the Lifetime Achievement Award from the Association of American Geographers. Dr. Cutter held the MunichRe Foundation Chair (2009-2012) on Social Vulnerability through the United Nations University-Institute for Environment and Human Security, in Bonn, Germany. In 2013, she received the Southeastern Conference (SEC) Faculty Achievement award. She received her B.A. from California State University, East Bay and her M.A. and Ph.D. from the University of Chicago.

LAURA S. CABINESS is the Public Service Director for the City of Charleston, South Carolina. Ms. Cabiness began her career working for the Department of Defense at Southern Division Naval Facilities Engineering Command. She subsequently worked for Keck and Wood, Inc., in Atlanta, GA and Florida Land Design, Inc. in Tampa FL prior to returning to Southern Division Naval Facilities Engineering Command in 1989. In 1990 she began her career with the city of Charleston, first as the City Engineer and currently as the Director of the Department of Public Service. During her employment with the City of Charleston, Ms. Cabiness and her department have managed the design and construction of more than $88 million in storm water drainage and flood relief projects. Ms. Cabiness has been an active member of the American Public Works Association for 24 years, has been a member of the Advisory Council for the Civil Engineering Department at The Citadel for 12 years, and is also an active member of the Advisory Board for the Civil Engineering Department at Clemson University. She received a degree in Civil Engineering from Clemson University and is a registered professional engineer in South Carolina.

ARRIETTA CHAKOS is a consultant in urban resilience policy. Her specialties include disaster risk assessment, disaster loss estimates, public policy development, multi-party negotiations, and municipal government operations. She recently served as director of the Acting in Time Advance Disaster Recovery project at the Harvard Kennedy School, which was involved with disaster policy research and application.

A seismic safety advocate, she was assistant city manager in Berkeley, California until 2007 and managed the city's intergovernmental coordination and hazard mitigation initiatives. She directed California's first municipal hazard mitigation plan aimed at sustainable risk reduction. Berkeley's mitigation efforts are nationally recognized and use innovative tax incentives and locally funded programs to promote community resilience. Chakos worked with the Federal Emergency Management Agency (FEMA) for its report to the Congress on all hazards risk mitigation, and with the California Governor's Office of Emergency Services (CalEMA) on natural hazards projects and seismic safety legislation. She served as a technical advisor to the Organization for Economic Cooperation and Development (OECD) on its international seismic safety program for schools; the World Bank on disaster risk reduction and sustainable development in the metropolitan Istanbul region; and with the National Research Council's research on community disaster resilience. She has also advised on a recent Ford Foundation study on Stafford Act implementation in the Gulf Coast region; as well as with the Association of Bay Area Governments; the Earthquake Engineering Research Institute; GeoHazards International; the Center for Biosecurity; and the Natural Hazards Center on disaster policy issues. Publications include papers on disaster risk reduction for technical conferences; the American Society of Civil Engineers; Spectra, an engineering professional publication; the Natural Hazards' Observer; the United Nations journal, Regional Development, and as a contributor to Keeping Schools Safe in Earthquake Country (OECD, 2004) and Global Warming, Natural Hazards, and Emergency Management (2009). She received a B.A. from California State University, Humboldt and a M.P.A. from the Harvard Kennedy School.

MIRIAM CHION'S work has focused on urban and regional planning, land use policies, community resources and international development. In her current position as Director of Planning and Research at the Association of Bay Area Governments, she is responsible for the development of regional strategies addressing social equity, economic vitality and environmental challenges. Between 2004 and 2009, she was a faculty at the Department of International Development, Community, and Environment, at Clark University, Massachusetts. Prior to this position, she worked for the San Francisco Planning Department on community, housing and economic development. She completed her doctoral studies at the University of California, Berkeley and her architectural degree at Universidad Ricardo Palma in Lima, Peru.

SANDI FOWLER serves the City of Cedar Rapids as the Assistant City Manager. She has held several positions in her nearly 25 years in city government, working with neighborhood groups, citizen services, internal operations, and facility rebuilding from the 2008 flood. Ms. Fowler now leads the departments of Public Works, Community Development, Building Services, as well as economic development and development plan review. She holds a bachelor's degree in business administration and a master's degree in public administration.

GERALD E. GALLOWAY, Jr. (NAE) is a Glenn L. Martin Institute Professor of Engineering and an affiliate professor of Public Policy at the University of Maryland, College Park. His 38-year career in the military included positions such as commander of the Army Corps of Engineers District in Vicksburg, Mississippi, Member of the Mississippi River Commission, and professor and founding head of the Department of Geography and Environmental Engineering and dean of the Academic Board at the U.S. Military Academy. He retired from the Army in 1995 as a Brigadier General Dr. Galloway earned his M.S.E. at Princeton and his Ph.D. in geography (specializing in water resources) from the University of North Carolina at Chapel Hill. A civil engineer, public administrator, and geographer, Dr. Galloway's current research focuses on the development of U.S. national water policy and disaster resilience in general and national floodplain management policy in particular. Prior to joining Maryland, he was vice president, Geospatial Strategies, for the ES3 Sector of the Titan Corporation. He was a six-year member of the National Research Council's Water Science and Technology Board and has served as chair or member of 13 National Research Council Committees. He is a member of the National Academy of Engineering and the National Academy of Public Administration.

JULIE HASSETT is Managing Partner and co-founder of Hassett Willis and Company. Hassett has helped organizations navigate complex changes for more than two decades. Because change mastery is more than just planning, Hassett brings a wide array of tools ranging from strategy development and facilitation to conflict resolution and performance measurement. As a trusted advisor to executive leadership in both Fortune 500 companies and Homeland Security agencies, she has guided them through some of their most critical challenges. Hassett is especially adept at recognizing and re-engineering complicated patterns of organizational behavior that are the keys to enhancing performance. As a result, her clients often discover new ways to achieve their missions more efficiently and effectively. Hassett is a founding member of The Government Technical Services Coalition and a member of Women in Homeland Security. Hassett is a graduate of Guilford College with a major in psychology, she holds a Master's in Organizational Development and Behavior from The George Washington University in Washington, D.C

ROBERT KOLASKY currently serves as the Director of Strategy and Policy for the Department of Homeland Security (DHS) Office of Infrastructure Protection (IP), where he leads strategic initiatives on behalf of the Assistant Secretary to help IP achieve organizational priorities. These priorities include IP's activities to enhance its capabilities to integrate cyber and physical risk management efforts with critical infrastructure owners and operators, and approaches to improve infrastructure resilience in the face of terrorism, climate change and other risks. Previously, he served as Director of DHS' Integrated Task Force to implement Presidential Policy Directive 21 on Critical Infrastructure Security and Resilience, as well as Executive Order 13636 on Critical Infrastructure Cybersecurity. In this role, he was responsible for leading the delivery of the Department's requirements to the White House, including the update to the National Infrastructure Protection Plan and the growth of voluntary partnerships to support cyber security risk management and information sharing. Mr. Kolasky previously served as the Assistant Director for Risk Governance and Support in the Office of Risk Management Analysis at DHS where he was responsible for developing policies and processes to enable risk-informed strategic decisions by DHS. In addition, he led the conduct of the first ever Strategic National Risk Assessment, in partnership with FEMA, as part of the implementation of Presidential Policy Directive 8. Mr. Kolasky's career focus is on analyzing issues related to homeland security strategy, planning, and policy. He has supported program development for the DHS Secretary's Operational Integration Staff (I-STAFF), and the National Preparedness Task Force, and led strategic planning engagements for DHS components. In doing so, he has worked both as a government employee at DHS and the U.S. Government Accountability Office and as a management consultant at Booz Allen and Hamilton. Mr. Kolasky joined the Federal government following his graduation from the Harvard Kennedy School (HKS) in June of 2002. While at the Kennedy School, Mr. Kolasky concentrated on Business and Government Policy and Microeconomics. He also worked as a management consultant for several non-profit organizations. Prior to attending HKS, Mr. Kolasky was a journalist and an entrepreneur. He helped start two of the first public policy sites on the Internet and served as the Managing Editor for IntellectualCapital.com and the Director of Content for Policy.com. Mr. Kolasky graduated from Dartmouth College in 1994.

LINDA LANGSTON was elected to the Linn County (Iowa) Board of Supervisors in the fall of 2002 and began her term of office in January 2003. She was re-elected in 2006, 2008, and again in November 2012. Ms. Langston is active in the National Association of Counties (NACo), currently serving as NACo's immediate past president; previously she was the first president of NACo. She is a member of NACo's Health Steering Committee, the Arts and Culture Commission, Women Officials of NACo, and the Healthy Counties Initiative. Ms. Langston was an inaugural participant in the County Leadership Institute presented by NACo and New York University in 2004. She also is active in the Iowa State Association of Counties. Locally, Ms. Langston chairs the East Central Iowa Council of Governments (ECICOG) and is past chair of the Workforce Development Board, along with serving on a variety of other boards and commissions in Linn County and Cedar Rapids. She also is an active member of Downtown Rotary. Supervisor Langston is widely recognized for her roles in the successful recovery from the devastating Iowa floods of 2008 and translating the lessons learned from that experience into countywide efforts to fortify

and make resilient those Iowa communities for future events. As president of the National Association of Counties (NACo), Supervisor Langston assisted the National Research Council to communicate key messages to the local and regional set of decision makers in the area of disaster resilience. That stakeholder group is critical to the successful efforts of reducing risk and building resilience to hazards and disasters. She was recently appointed to the National Advisory Council for FEMA. Ms. Langston received her B.A. from Knox College and she is a 2007 graduate of Harvard's Kennedy School of Government for State and Local Officials.

THOMAS DE LANNOY is a policy officer in the Directorate General for Humanitarian aid and civil protection, European Commission. His responsibilities include inter alia the development and implementation of an EU framework for disaster prevention that encompasses risk assessment and management, data comparability and research, international relations (in particular the preparation of EU position on the post 2015 Hyogo framework for action), and integration of disaster prevention into EU policy and financial instruments. He joined the European Commission in 2003 and worked for seven years in the Environment Directorate General (mainly on marine pollution and international relation issues). He is a French national and studied Business administration in France and in the United Kingdom, as well as European studies and public administration.

LORI PEEK is an associate professor in the Department of Sociology and co-director of the Center for Disaster and Risk Analysis (CDRA) at Colorado State University (CSU). She also is an adjunct research scientist at the National Center for Disaster Preparedness, the Earth Institute, Columbia University. Since 2006, she has served as associate chair of the Social Science Research Council Task Force on Hurricane Katrina and Rebuilding the Gulf Coast. Dr. Peek studies vulnerable populations in disaster, with a special emphasis on the experiences of low-income families, racial and ethnic minorities, women, and children. She is the author of *Behind the Backlash: Muslim Americans after 9/11* (Temple University Press, 2011), co-editor of *Displaced: Life in the Katrina Diaspora* (University of Texas Press, 2012), and co-author of *Children of Katrina* (University of Texas Press, 2015). *Behind the Backlash* received the Distinguished Book Award from the Midwest Sociological Society and the Best Book Award from the American Sociological Association Section on Altruism, Morality, and Social Solidarity. In 2009, the American Sociological Association Section on Children and Youth honored Dr. Peek with the Early Career Award for Outstanding Scholarship. She was named the 2010 Greek Life Professor of the Year and has received CSU's Alumni Association Best Teacher Award, College of Liberal Arts Excellence in Teaching Award, and the Waterpik Excellence in Education Award. In addition, the Institute on Teaching and Learning at CSU selected her as a 2011-2012 Teaching Fellow as part of a university-wide competition. Dr. Peek earned a B.A. in Sociology from Ottawa University in 1997, a M.Ed. in Education and Human Resource Studies from Colorado State University in 1999, and a Ph.D. in Sociology from the University of Colorado-Boulder in 2005.

RICHARD REED is Senior Vice President, Disaster Cycle Services at the American Red Cross. In this role, he leads the development and execution of programs that help Americans prevent, prepare for, and respond to disasters nationwide. He led a comprehensive organizational assessment of all American Red Cross preparedness, response, and recovery programs which resulted in revamped processes to improve service delivery in disasters small and large. Prior to taking the role at Red Cross, Mr. Reed was at the White House, serving as Deputy Assistant to the President for Homeland Security. He led the development of national policy related to resilience, transborder security, and community partnerships. With an experienced team of over 30 senior professionals, Mr. Reed covered a broad and deep homeland security portfolio that includes all-hazards preparedness, individual and community partnerships and resilience, critical infrastructure protection and resilience, domestic incident management, continuity of government, national exercises, transportation security (aviation, maritime, and ground), piracy, information sharing, border security, and immigration. Mr. Reed's prior White House tenure included service as Special Assistant to the President for Homeland Security and Director for Continuity (2006-2009) and Special Assis-

tant to the President and Senior Director for Resilience Policy (2009-12). His Federal service exceeds 20 years, with positions in the Department of Veterans Affairs, the Federal Emergency Management Agency, and the General Services Administration. Mr. Reed is known for his adept leadership of the U.S. Government interagency through disasters and emergencies of all types, including the 2009 H1N1 pandemic, Haiti earthquake (during which he was deployed), the BP Deepwater Horizon oil spill, the Fukushima earthquake, tsunami, and nuclear emergency, and countless domestic natural disasters, including hurricanes, tornados, and flooding. In addition, he has been instrumental in the development of national policy on a range of matters, including: Continuity of Government; National Preparedness; Critical Infrastructure Security and Resilience; National Security and Emergency Preparedness Communications; Medical Countermeasures Following a Biological Attack; Cyber Security; Border Security, and Immigration. Mr. Reed has Bachelor's degrees from Indiana University and Purdue University, and a Master's degree in social work from Indiana University.

JACQUELINE SNELLING serves as Senior Policy Advisor to the Director in the Department of Homeland Security Federal Emergency Management Agency (FEMA)'s Individual and Community Preparedness Division (ICPD) with responsibilities for national policy and guidance, research, and initiatives to support individual and community preparedness and resilience at all levels. As part of these duties, she is the Program Manager of a current project to update FEMA guidance to the public on 23 identified hazards. The project includes review and documentation of the research base for protective actions, recommendations for revisions to guidance for America's PrepareAthon and other public guidance materials, recommendations for research priorities to support guidance, and coordination with FEMA, other federal agencies, key organizations and the academic community for consistent research-based protective action messaging to the public. Since joining DHS in 2005, Ms. Snelling's work has included development of programs and partnerships for integrating government and nongovernment resources for preparedness, development of strategic metrics for reporting progress on preparedness, and research, analysis and reporting on the status of individual and community preparedness. Prior to joining the Department of Homeland Security (DHS), Ms. Snelling worked with local emergency management by establishing a community council representing all sectors to support public education and participation in preparedness planning, prevention, mitigation, response and recovery. In this capacity, she was selected to represent the community sector on the National Capital Region Council of Government's Homeland Security Strategic Planning group composed of regional leaders and sector representatives. Ms. Snelling's work for DHS/FEMA builds on a 30-year public service career of senior policy and management positions at all levels of government and extensive volunteer community service. Ms. Snelling has public management experience in diverse areas serving as Special Assistant to the U.S. Secretary of Education and as the Acting Director of the New York City Division of School Buildings. Ms. Snelling's community-based work has included a focus on analysis and metrics for community services to support community planning in areas including capital improvement planning, public health, public safety, school achievement, and services for children, youth and families. Ms. Snelling received her undergraduate and Master's degrees from Harvard University.

WILLIAM D. SOLECKI is professor and chair of the Department of Geography at Hunter College – CUNY and serves as the interim director of the CUNY Institute for Sustainable Cities, which seeks to create awareness and understanding of the connections between the everyday lives of urban citizens and their natural world, leading to the discovery and use of cities like New York as a learning laboratory to create a sustainable future for cities worldwide. He has served on several NRC committees including the Special Committee on Problems in the Environment (SCOPE). He currently is a member of the International Geographical Union (IGU) Megacity Study Group and the International Human Dimensions Programme (IHDP), Urbanization and Global Environmental Change Scientific Steering Committee. He currently serves as the co-leader of several climate impacts and land use studies in the New York metropolitan region, including the Metropolitan East Coast Assessment of Impacts of Potential Climate Variability and Change. He holds in degrees in Geography from Columbia University (B.A.) and Rutgers University (M.A., Ph.D.).

CLAY STAMP is the County Manager for Talbot County Maryland, a rural county of on Maryland's Eastern Shore, where he oversees all affairs of County government on behalf of the Talbot County Council, the elected officials who serve as the governing body of Talbot County. Mr. Stamp has a long history of serving in government and has been instrumental in many innovative planning and operational initiatives at the municipal, county, and State levels of Maryland government. Mr. Stamp began his professional career working for the Town of Ocean City, Maryland, eventually retiring as the Town's Emergency Services Director. During his tenure with Ocean City, he was instrumental in a number of creative projects, including the creation of the Town's comprehensive emergency management program, which assessed risk and planned for the mitigation, response and recovery of threats such as hurricanes and tropical storms, and participated in the successful implementation of the U.S. Army Corps of Engineers Hurricane Protection Project. Coming from an extensive emergency management background and subsequently migrating into a broader management role in local government, Mr. Stamp has now begun work to identify ways to improve community resiliency from a broader or more comprehensive approach than the traditional hazard mitigation planning perspective. He believes a unique opportunity exists to build and expand upon traditional planning efforts to identify key foundational pillars that support communities, which can subsequently shepherd a paradigm shift in how resiliency is viewed and embraced by community leaders.

MICHAEL SZÖNYI is a Senior Risk Engineer with Zurich Insurance Company, based in Switzerland, currently working in the role of Flood Resilience Specialist, assessing flood hazards and flood risks and advising the company and the alliance partners on risk insights and risk mitigation strategies as part of Zurich's flood resilience program. Specifically, besides advising the community projects of the flood resilience program on technical flood aspects and supporting the alliance partners on flood resilience assessment and measurement, he is leading the post-event review function, analyzing large flood events around the world. This function is based on on-site research during and after the flood events in-country as well as third party review. Mr. Szönyi has an Advanced Master's Degree in Natural Hazards Management from the Federal Institute of Technology Zurich, ETH, and is a natural scientist with an M.Sc. degree in Geophysics, also from ETH. In addition he holds a Teaching Degree in Geography. He is a Swiss Citizen and speaks German, English, French, Italian and Spanish. He recently spent a sabbatical volunteering for the United States National Park Service, working as a Park Ranger. He is also a keen photographer and author of a book series on geoscience travel.

CHUCK WEMPLE is the Chief Operating Officer for the Houston-Galveston Area Council where he oversees all programs and services including transportation planning, community and environmental planning, public safety, and workforce development. He has extensive experience in addressing infrastructure, housing and economic recovery needs following Hurricanes Rita and Ike—including the allocation and programming of over $2 billion in HUD recovery funds; implementing small business financing programs. Additionally, he has served on several State-level disaster-recovery policy committees designed to improve the speed and efficiency of disaster recovery. The Houston-Galveston area Council covers over 12,000 square miles along the upper Texas coast, and includes 13 counties and over 100 cities and towns, with 6.6 million people.

ROY E. WRIGHT serves as FEMA's Deputy Associate Administrator for Mitigation. He is responsible for FEMA's risk analysis and risk reduction programs. These include FEMA's Stafford Act authorities for mitigation, the National Earthquake Hazards Reduction Program, the National Dam Safety Program, and the National Flood Insurance Program. Mr. Wright is also responsible for FEMA Disaster Reservists within the Mitigation Cadre as well as the delivery of environmental and historic preservation technical assistance and compliance across all FEMA programs. Collectively, these programs promote a risk-conscious culture and address long-term vulnerabilities in communities across the Nation. Mr. Wright was appointed to the Federal Senior Executive Service in 2013. He holds a Master of Public Administration from The George Washington University and a Bachelor of Arts in Political Science from Azusa Pa-

cific University. His post-graduate studies include the Senior Executive Fellows program at Harvard University's Kennedy School of Government and the Executive Leaders Program at the Naval Postgraduate School's Center for Homeland Defense and Security.