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A changing global threat environment, coupled with increasingly interdependent societies and aging infrastructures, is a dangerous combination that must be addressed by today's preparedness leaders.

October 2016

Examining Coastal Resiliency: How Policy, Education, Partnerships, and Data Can Help Change the Future

Erin Lavelle and John Betancourt

Foreword by Marko Bourne

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Partnerships, and Data
Can Help Change the Future**

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The Preparedness Leadership Council International

The Preparedness Leadership Council International (PLC), formerly the DomPrep40, is a thought leadership group comprising insider practitioners and opinion leaders who offer advice and recommendations on topics relevant to emergency planners, responders, receivers, local-state-federal authorities, nongovernmental organizations, and the private sector. Focusing primarily on prevention, protection, response, recovery, and mitigation, the PLC is tasked with developing quantifiable and quantitative feedback from surveys and roundtable discussions that is gathered from and shared with a broad multidiscipline, multijurisdictional audience of operational professionals and policy advisors. Information shared via the publications: DomesticPreparedness.com (online and mobile), *DP Weekly Brief* (email newsletter), and the *DomPrep Journal* (PDF download).

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DomPrep is an information service for the preparedness and resilience community. Created in 1998, offers content—provided by practitioners and subject matter experts—to tens of thousands of first responders, medical receivers, emergency planners, local-state-federal authorities, nongovernment organizations, and private-sector professionals.

Note: All comments provided in this report reflect the opinions of the individuals and do not necessarily represent the views of their agencies, departments, companies, or organizations. Quotes within the report without acknowledgment were made anonymously by respondents.

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ACKNOWLEDGMENTS

The Preparedness Leadership Council International (PLC) was created because “a changing global threat environment, coupled with increasingly interdependent societies and aging infrastructures, is a dangerous combination that must be addressed by today’s preparedness leaders.” Policy and operational leaders plan, train, and prepare for imminent threats. Because of limited resources, they triage and, therefore, postpone the issue of coastal resilience, even though it is an existential threat.

The PLC was privileged to host a roundtable discussion at The Down Town Association in New York City on 29 February 2016. My deepest appreciation goes to Marko Bourne, PLC Executive Committee member and principal with Booz Allen Hamilton (BAH), who moderated 25 subject matter experts at the roundtable. Thank you, Marko.

After compiling information from the discussion along with supporting input from over 250 DomPrep readers nationwide, John Betancourt and Erin Lavelle, also with Booz Allen Hamilton, did a masterful job of organizing all the content and creating this comprehensive report. Thank you to the underwriter of this report, Booz Allen Hamilton. Without its financial support, this report would not have been possible.

Finally, thank you to the DomPrep team, including Catherine Feinman and Carole Parker. A good job by all, indeed.

Martin D. Masiuk
Executive Director
Preparedness Leadership Council International

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FOREWORD

As each year passes, we struggle as a nation to understand the built environment and its relation to the ever-changing planet and its changes in climate. Some of these changes we affect and some we have little to no control over. As we wrestle with the challenges we have created through development in coastal regions, along riverine settings, in seismically active zones, in the wildland/urban interface, we place more and more citizens and their property in harm's way. Even more dramatically, we are seeing how poor planning and actions toward resiliency are actually threatening the economic viability of communities, regions, states, and the nation. It does not take a catastrophic event to provide lessons on the reality of this present situation.

What we do as a nation in the future means making very, very difficult choices we have not shown a willingness to make to date. Those choices include such important investments in improving infrastructure and maintaining it properly, investing in new codes, standards, and building practices, redefining what insurance is, who should be covered, and what the government's role should truly be. Unless we are willing to work together across jurisdictional lines, to build clear value propositions and enhance the returns on investment of resilience measures, we will continue to doom many communities and the nation to a never-ending cycle of damage, repair, heartbreak, and loss of life.

The Coastal Community Resilience Roundtable, hosted by the Preparedness Leadership Council International was part of an ongoing effort to actually discuss solutions, not just talk about the problem. The results are contained in this report. Our goal is to create a climate of action. Time and effort will be the judge of whether this roundtable has had an impact.

Marko Bourne
PLC Executive Committee

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EXECUTIVE SUMMARY

Recognizing the magnitude of the challenges facing coastal communities in developing resilience measures specifically related to the threat of sea-level rise, the Preparedness Leadership Council International hosted a roundtable discussion to prompt meaningful dialogue, share ideas, and foster relationships. The participants included approximately 30 representatives from state and local governments along with emergency management professionals and experts from academia in a half-day dialogue. The following keynote presentations provided a point of reference for facilitated discussions:

Keynote 1: *Improving Regional Partnerships for Planning and Response*–

Lisa Goddard, Director at International Research Institute for Climate & Society, The Earth Institute, Columbia University

- Interagency Coordination and Partnering
- Role of Private Sector
- Lack of Science Influence on Policy
- Recommended Actions

Keynote 2: *Improving Data Sharing and Analysis for Planning and Response*–

Adam Sobel, Department of Applied Physics and Applied Mathematics and Lamont-Doherty Earth Observatory, Columbia University

- Regional Data and Analysis Platforms
- Data Sets, Data Sharing, and Analytics

This report is informed by a targeted, nationwide survey to elicit diverse perspectives and expertise on selected discussion points. The goal of this report is to sufficiently illuminate opportunities to improve resilience planning, specifically through effective partnerships and data sharing, and to provide actionable next steps for the community at large to consider.

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RELEVANCE AND FIRST STEPS IN EDUCATION AND POLICY

History and Significance

As sea levels rise, leading to more frequent flooding, damage to wetlands, loss of wildlife, and destruction of infrastructure, coastal communities continue to struggle with the short-term and long-term economic, social, biological, and physical impacts. New Jersey, which was hit by Hurricane Sandy less than four years ago, has only recently reached its final recovery stages, and the Federal Emergency Management Agency (FEMA) funding for recovery in New Jersey has exceeded \$6.8 billion.¹ Scientists say that the New York/New Jersey coastline remains vulnerable to an even stronger storm surge with greater catastrophic consequences.² Other major coastal metropolitan areas in the United States are facing comparable threats, including San Francisco, Los Angeles, Boston, the Gulf Coast, Miami, Seattle, and the nation's capital. However, highly populated cities are not the only areas susceptible to sea-level rise. Of the 12,383 miles of U.S. coastline, small towns and suburban areas make up a large portion of the coast and are often in need of additional resources, support, and resilience capabilities in comparison to their urban counterparts along the coast. For instance, recovery occurred much faster in New Jersey after Sandy than in Mississippi after Katrina due to New Jersey's greater concentration of wealth and access to personal assets.³ Additionally, populations that are not on the coast experience both short-term and long-term indirect impacts of flooding of coastal communities and also often require supplementary, unanticipated resources.

Flooding due to storm surge is not the only threat the nation faces. Higher sea levels lead to greater and more powerful storm surges during hurricanes and pose a long-term threat that could submerge coastal cities, causing populations to move further inland. In the last century, sea levels have risen faster than any other time in history. Based on recent data published by Kopp et al. (2016), sea levels have risen five inches in the 20th century.⁴ Although it is difficult to predict exact amounts of sea-level rise in the coming years, a recent study stated that the nation can expect oceans to rise between 2.5 and 6.5 feet by 2100, which is enough to swamp many cities along the East Coast. There even exist more dismal estimates that push sea-level rise to amounts that could totally immerse London, England.⁵ A key challenge communities face in dealing with coastal resilience is understanding the effects of a gradual change versus the easy analysis of short-term events like hurricanes.

Although sea-level rise is an imminent threat, hurricanes pose a constant high-level threat to flooding of coastal areas. Coastal communities will become more resilient to sea-level rise and flooding from hurricanes through outreach and education, changes in policy, collaboration and partnerships, and data sharing.

Define the Critical Terms

The first step in achieving resilience and adapting to sea-level rise is to work toward a mutual interpretation of terms in order to promote a shared understanding among stakeholders. It is critical to understand terms before using them in action-oriented discussion. People are limited in acting effectively if those involved have a different interpretation of the key words. Different definitions could lead to mixed or false expectations and responses to a situation. In 2006, the Organisation for Economic Co-operation and Development (OECD) published a paper that presents the varying definitions of numerous adaptation terms in order to highlight the need for a common understanding and the financial implications that arise when stakeholders are not of the same mindset. Figure 1 shows the survey question, “Which of the following definitions do you associate most with the word resilience?” as well as the responses.

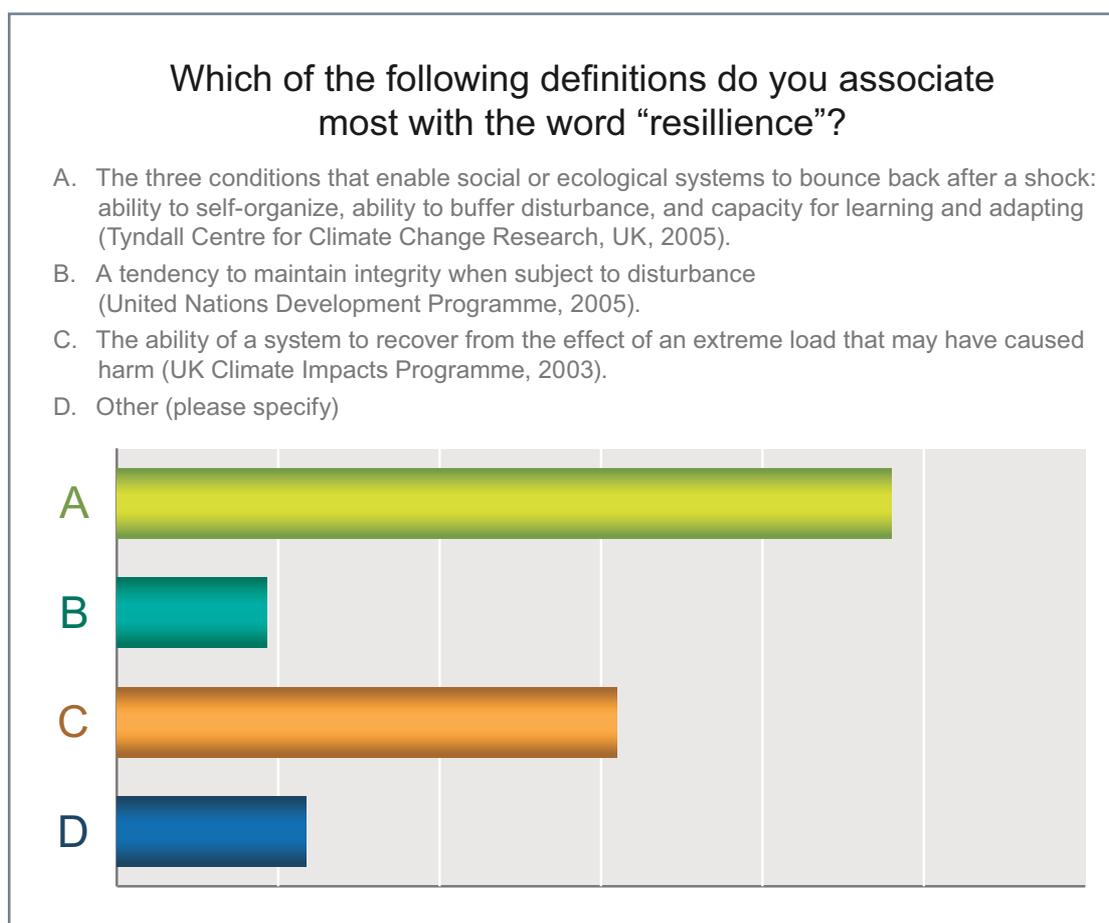


Figure 1

The survey demonstrates that people are unable to agree on a standard definition of a key term. Nearly half of the respondents associated resilience to Tompkins et al.'s (2005) definition that resilience, “refers to three conditions that enable social or ecological systems to bounce back after a shock. The conditions are: ability to self-organize, ability to buffer disturbance and capacity for learning and adapting.”⁶ Twelve percent of respondents drafted their own definition, finding that none of the three popularized characterizations appropriately fit. Comparable results were found when asking to identify a definition for adaptation as shown in Figure 2.

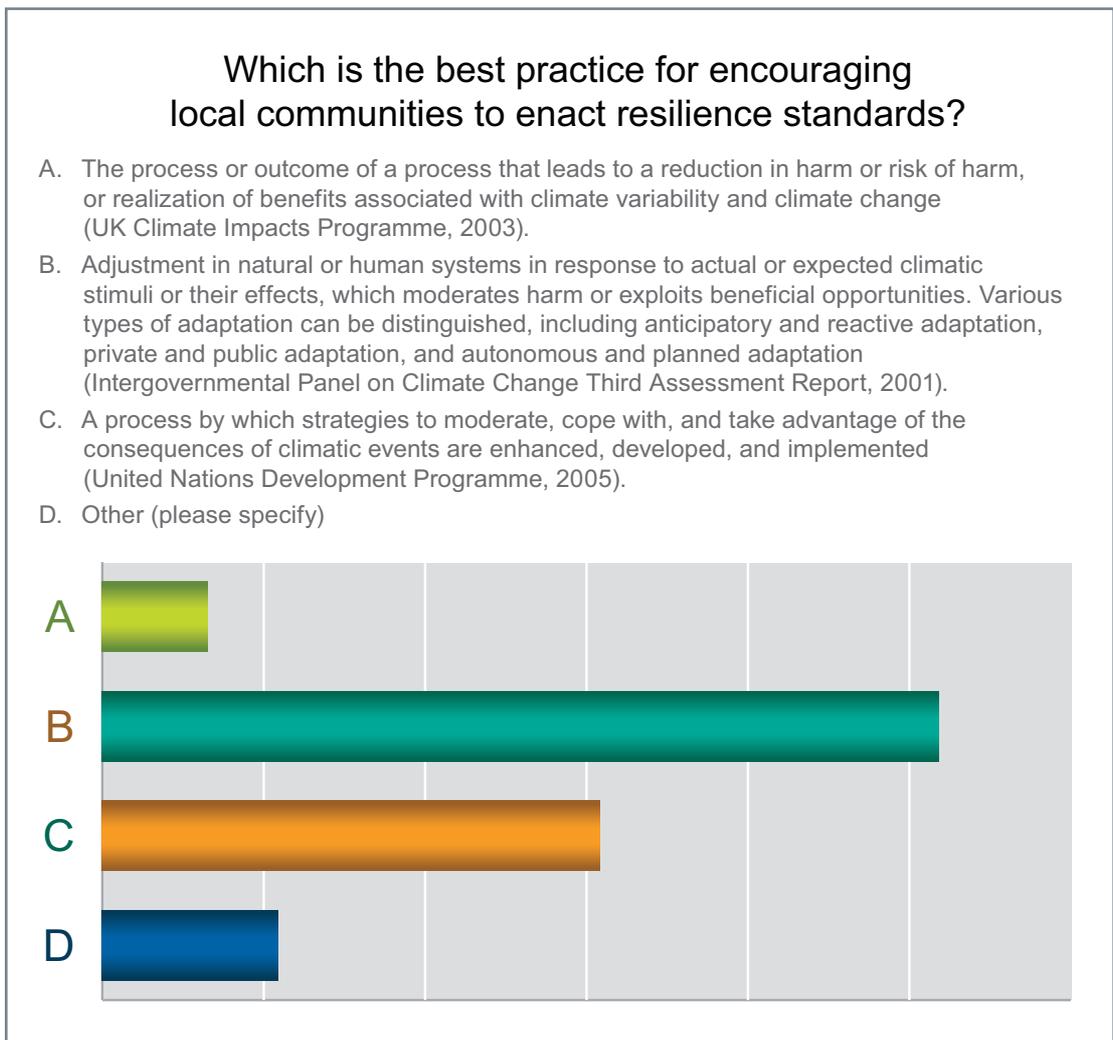


Figure 2

Although there was not complete agreement in the definition of adaptation, 52% of respondents associated Intergovernmental Panel on Climate Change's (IPCC) definition with their understanding of the term (Figure 2). This is likely because IPCC's definition is quite broad and all encompassing, it calls out various types of adaptation (e.g., anticipatory, reactive, public, planned adaptation), and it includes adaptation of natural systems not just human.

The OECD notes that the differences in defining adaptation likely stem from the varying definitions of climate change provided by the United Nations Framework Convention on Climate Change (UNFCCC) and the IPCC.⁶ They found that definitions vary because the discussion on adaptation is still fairly new and developing:

“The analysis... demonstrates that definitions vary across institutions and different groups of stakeholders. The lack of precision is a reflection of a highly dynamic discussion of the adaptation issue where the lexicon is still evolving and the relatively young age of these discussions. Once adaptation enters wider circles of policy makers and analytical community it may need to be handled with more care and accuracy.” (May 2006)

As time goes on, policy makers, scientists, and the public will need to determine a universal definition.

Education and Policy

Before educating the public and the state/local governments on resilience and adaptation measures, they must first acknowledge that sea-level rise is a national threat. A popular misconception about sea-level rise is that it is occurring at a slow pace. In reality, researchers have proven that sea-level rise is actually occurring at the rapid rate of 0.14 inches per year, since 1990 alone.⁵

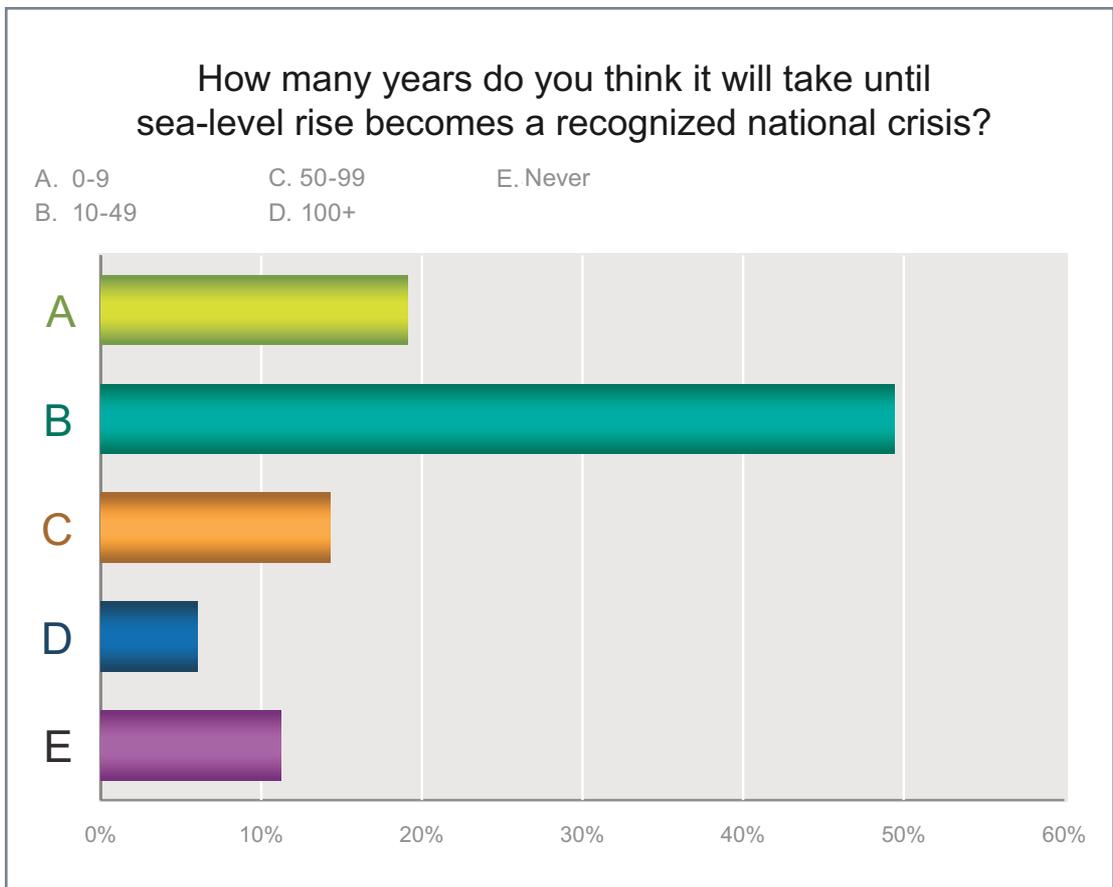


Figure 3

Despite the evidence of sea-level rise and the media coverage of coastal flooding over the last 20 years, 50% of respondents believe that it will take another 10-49 years for the nation to recognize sea-level rise as a national threat (Figure 3). Nearly one-fifth of respondents think it will take over 100 years or will never become a top priority among Americans. Once the general public and decision-makers have bought into the impending threat and agree on a common understanding of relevant terms like resilience, adaptation, and mitigation, the real outreach and action can begin.

When disaster strikes, people await the aid of the government. In the same way that families are not properly prepared and rely on their municipality to provide funding and resources to assist them, the state government is awaiting federal aid and resources. The federal government is consenting to state and local dependency on them due to their lack of encouragement of preventative actions and shortage of incentives for enacting policies with resilience measures. Flood management is often done at the local level. However, getting the locals to enact resilience standards is a challenge.

Which is the best practice for encouraging local communities to enact resilience standards?

- A. Changes to grant funding requirements for infrastructure
- B. New funding for resilience planning in coastal areas
- C. Outreach and education initiatives
- D. Other (please specify)

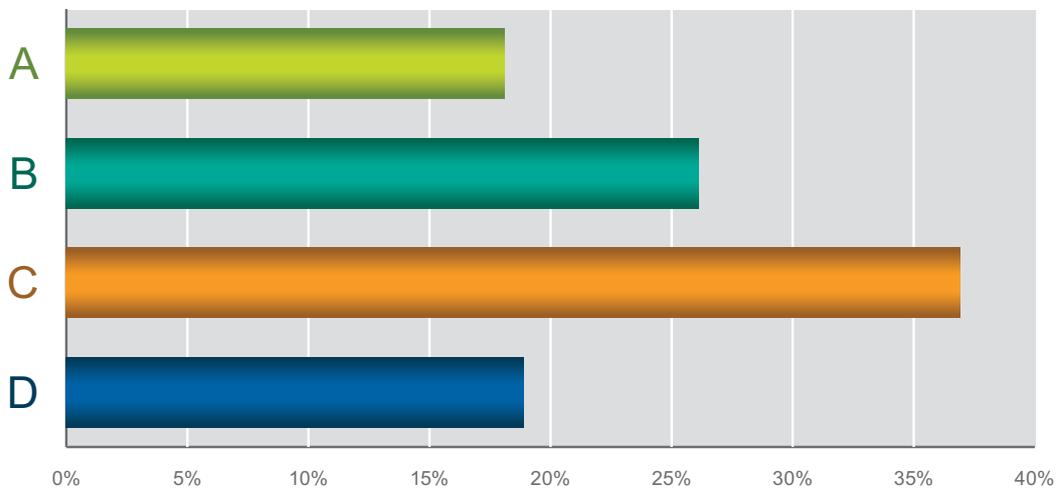


Figure 4

Respondents were nearly split on the best practice for encouraging local communities to enact resilience standards, as shown in Figure 4. Thirty-seven percent felt that outreach and education initiatives are the best approach. Of those who provided their own answers, many felt a combination of all of the practices should be used, others felt incentivizing communities is the proper approach, and sustained (not just new) funding for coastal resilience projects and restoration efforts were also called out as potential best practices. Protection of historic properties can also be a driver for developing resilient solutions in local communities since these buildings have regional significance to the residents.

Actions taken at the local and state levels have a national impact. It is critical to act significantly enough at the local level rather than waiting on direction from the federal government. This requires a shift in the cultural behavior toward disasters.

There is a global pattern of human behavior during response and important actions after disasters. People are stuck in their homes without power for days during a blizzard. In the days during and immediately after the event, they purchase generators and snow

blowers. In the same manner, only after a beach home is flooded or destroyed due to a hurricane, do the owners rebuild their homes at an elevated height. Human behavior and thinking need to change so that people begin to act on long-term risks before disasters occur. The best way to begin turning impacts of short-term events into long-term solutions and changing the mindset of an entire nation is by reaching children.

Establishing educational outreach programs in communities where emergency managers can speak to kids about how their families can prepare for disasters is a beneficial approach to reaching both children as well as adults. Kids will go home to their parents and share what they learned in school, which will have an impact on their parents' actions. Awareness campaigns through television advertisements, billboards and signage, announcements at community meetings, and pamphlet distribution are costly yet efficient ways of educating people on their risks and how they can prepare. Community involvement via task forces and local leaders are crucial to raising awareness because they are grassroots efforts that enable people to prepare and educate themselves. In addition, during the recovery phase, people are in a rush to get back to normal, so they rebuild quickly instead of rebuilding correctly. Stricter building requirements post-disaster should be enforced to ensure the structure can withstand a similar or more powerful storm.

When educating the public, it is important to expand outreach beyond the coastal communities to inland populations as well. Populations not on the coast are the ones who feel the indirect impacts from coastal flooding and sea-level rise. For instance, as sea levels continue to rise and homeowners on the coast acknowledge the threat to their homes and businesses, they will seek relocation inland, thus causing a need for additional infrastructure such as housing, schools, and hospitals. Short-term impacts from coastal flooding can lead to fuel shortages, increased traffic, rise in crime, and housing needs further inland. Unless a city has experienced this ripple effect from coastal flooding, its residents are not likely realizing that coastal flooding and sea-level rise affects them too. The indirect impacts of climate change are not understood well by populations that do not live on the coast. They are not perceived as real in the minds of inland populations.

Many respondents highlighted that the proper approach to communicating indirect impacts of climate change depends on the demographics of the population as well as the message that is trying to be delivered. This is often an emotional topic or one filled with opinions as it relates to whether or not climate change exists. Many felt outreach, education, social networks, creative preparedness programs that grab viewers' attention, public service announcements (PSA), and trusted leaders are all outlets through which indirect impacts can be communicated. One respondent noted that using past examples would be a good way of showing people what could happen in the future. A handful of respondents felt that it is too difficult to convey and get people to change their minds or

they admitted to not knowing how to communicate this message. Ultimately, the majority of respondents felt some type of outreach via media outlets, the internet, or educational programs is the proper way to communicate the indirect cascading effects of climate change to populations that are not on the coast.

A potential action item is to develop a comprehensive outreach program, inclusive of both coastal and inland communities that educates people on their risks, mitigation and preparedness techniques, and resources for further learning. In addition, strong consideration should be made to change federal regulations that allow communities to build in floodplains. Collaboration and sharing of information are also key components of communicating direct and indirect impacts of climate change. It is critical to bring together people to share best practices and risk-oriented information, with a catastrophic focus, in order to make it relevant for people day-to-day.

The fundamentals of climate change are not integrated and mainstreamed into the disciplines that are essential for adapting to climate change such as infrastructure planning, civil engineering, etc. Increased emphasis on climate change during formal educational programs in college would encourage students to consider climate change in their future professional work.

After outreach and educational efforts, enacting policy changes that incorporate resilience measures is the next large step to resilience of coastal communities. When considering which types of policies should include these measures, one could argue any number of policies could incorporate some type of resilience measure. However, 81% of respondents said that construction (zoning, codes, and standards) policies are most in need of incorporating resilience measures in order to address sea-level rise (Figure 6).

Respondents were given the opportunity to check all options that apply. Based on the data, the majority of respondents checked all or nearly all of the policies that are in need of resilience measures. As previously stated, construction received the majority with 81% and infrastructure scored second highest at 74% (Figure 6). These two options are the ones that have to do with the physical structures in a community, as opposed to concepts, plans, or financial aspects. Respondents clearly see a need for policies that directly affect structures and the physical world.

Examples of policy change include promotion of beach and dune growth, upgrading zoning policies and building codes, adjusting mortgage rates or providing property tax incentives, or policies that might require that specific areas be addressed in response plans.

The short-term nature of most political, academic, and leadership appointments makes long-term planning and partnering for climate resilience challenging. There are instances, however, where short-term visceral impacts from natural disaster (e.g., Hazard Mitigation Grants to buyout homes in flood prone areas) can result in outcomes that are supportive of long-term solutions.

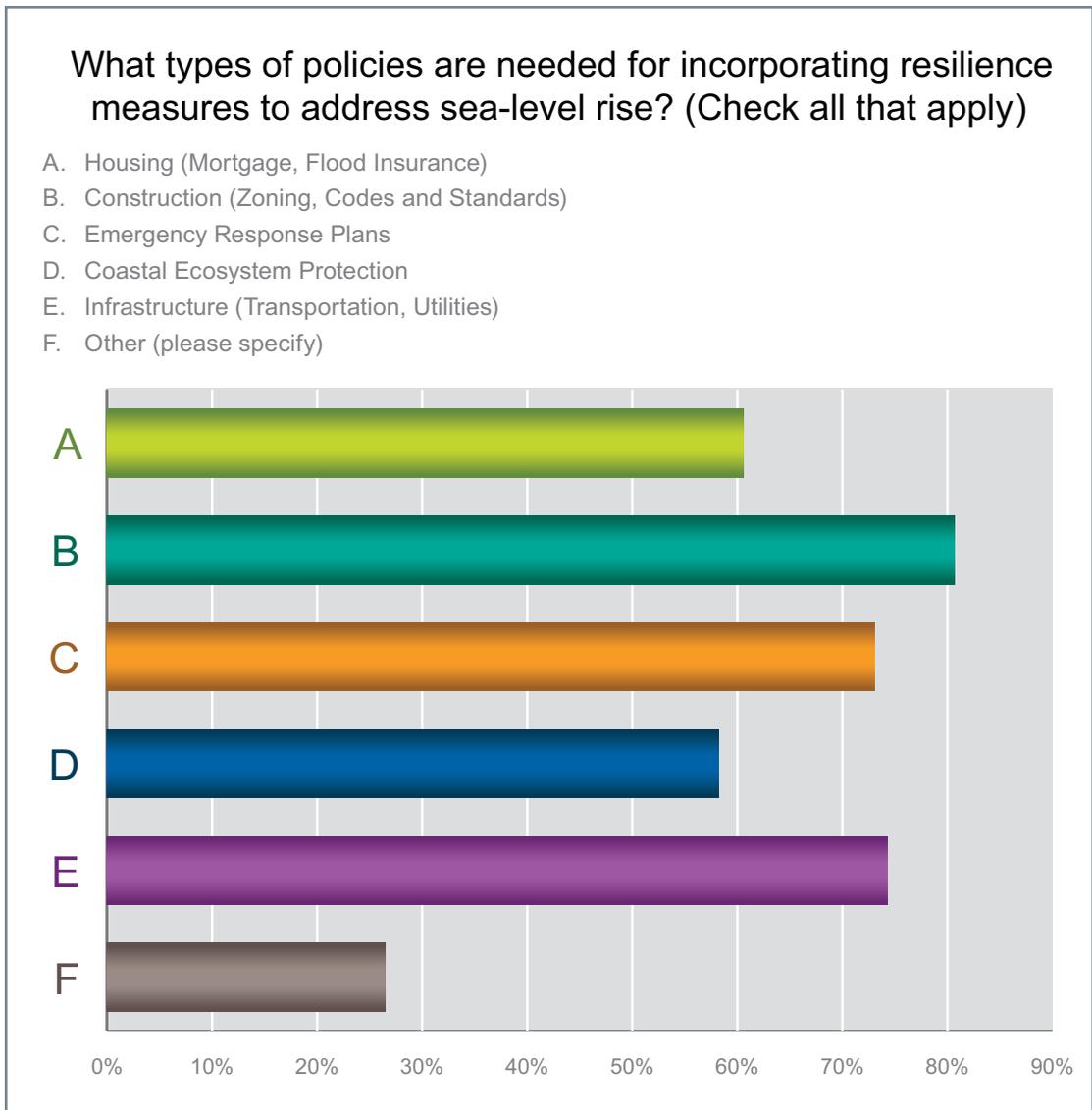


Figure 6

Survey participants were asked about what impact they think would create the earliest and most significant change in public policy and national behaviors toward sea-level rise. Figure 7 displays the results.

Survey respondents clearly identified economic and physical (property, infrastructure, and utilities) losses as the trigger for change in national behavior and thinking about sea-level rise (Figure 7). Infrastructure and utility losses are costly in terms of repair, replacement, or relocation, and as a disruption of services and way of life. The following two projects benefitted greatly from resilience measures:

- New Orleans Twin Span was raised from 8.5 to 30 feet above sea level. The storm surge from Hurricane Katrina that damaged the original Twin Span Bridge over Lake Pontchartrain prompted this resilience measure.
- New York City Subway system damage prevention systems includes “locking down” 540 vulnerable points for sea-water intrusion at six of the subway stations affected by Hurricane Sandy.

The responses to the survey verify that, without proactive measures, the drivers behind resilience projects would likely be catastrophic damages to key infrastructure and major economic losses.

There is a lack of scientific influence on policy. Policy makers need to recognize the importance of scientific findings that impact human life. For instance, vegetation is incredibly important in the protection of ecosystems and infrastructure. Wetlands act as a natural buffer to soak up water during storms that could flood a town. In addition, with the temperature rise, marine chemical pollution and thermal stress degrades ecosystems and affects biological organisms, which can result in increases in infectious disease. Scientific information on these linkages is not being used in developing policies. Loss of ecosystems and rising temperatures play a role in the spread of infectious disease. Resilience measures such as new construction, flood control measures, etc. must address ecology as a means to prevent infectious disease outbreaks and unnecessary flooding and economic losses.

One major challenge in all of this is translating policy into action. There is a lack of discussion on how research and findings are separate entities and often difficult to incorporate into community social systems. Policy makers and community leaders understand that they need to make their communities more resilient but do not understand how to do that. One helpful resource that teaches them how to do this is an online training for building resilient communities, which is “focused on addressing the tension between policy and implementation. *Building Community Resilience* distills the extensive body

of research on resilience-building into simple steps that communities and organizations can take to help strengthen themselves against all kinds of disasters” (Building Resilient Communities: An Online Training).⁷ Part of building community resilience requires improving coordination among partners and building new relationships.

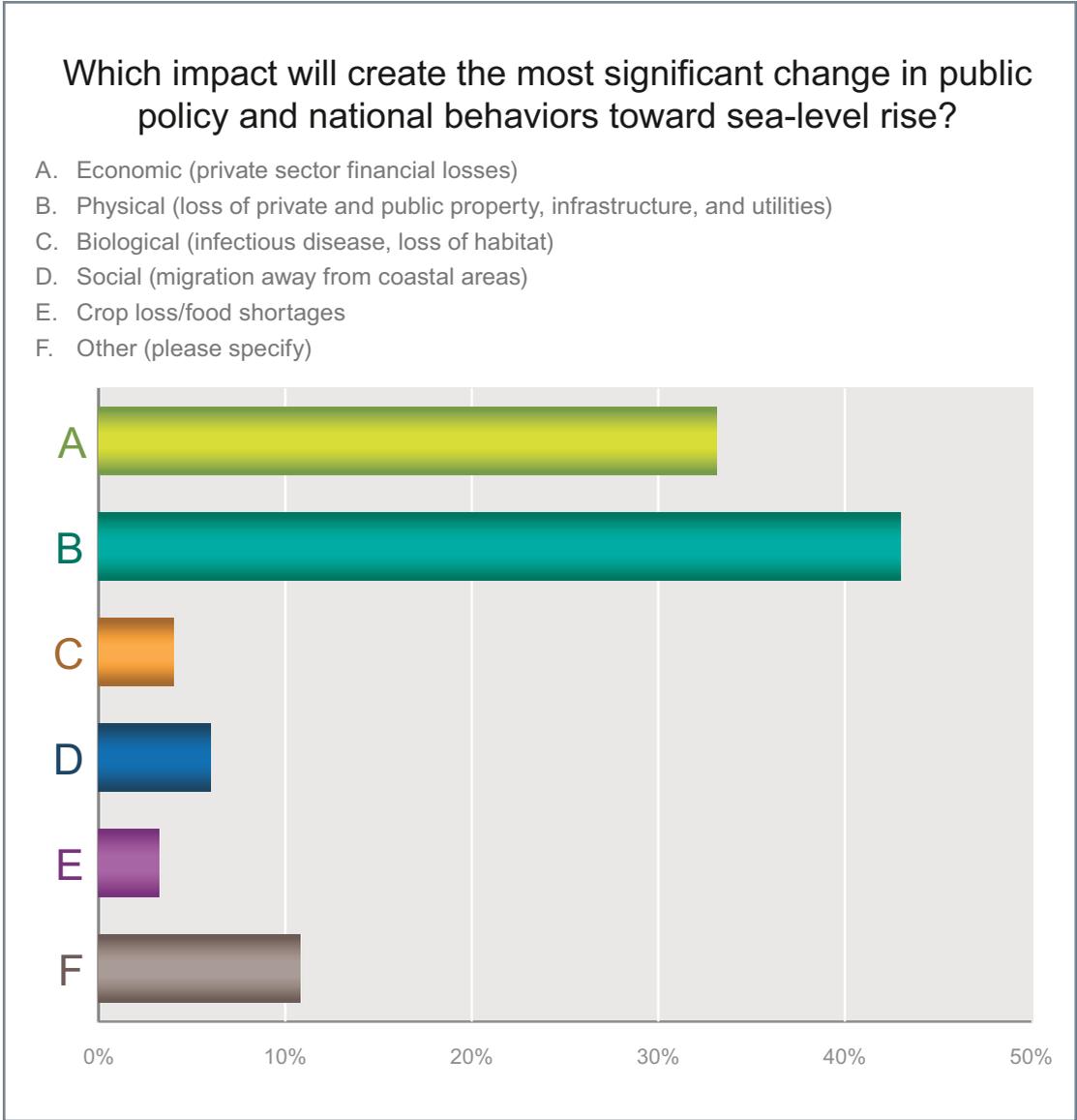


Figure 7

IMPROVING COORDINATION AND PARTNERSHIPS

Benefits of Partnerships

Building a resilience within the coastal communities against sea-level rise exceed the vision, motivation, and capacity of any single entity. An endeavor of historic proportion such as this will require large-scale cooperation of organizations and will be built upon networks of specialized partnerships.

Partnerships provide a forum for multiple parties to work toward a common goal. Depending on the purpose, members within partnerships will possess different underlying motivations and, therefore, varying levels of commitment. Understanding what each member brings to the partnership as well as what they seek to gain, the partnership can effectively channel its collective resources to accomplish well-defined tasks. The areas of focus that necessitate partnerships include but are not limited to:

- Research (data analysis, impact modeling, scientific)
- Planning (multijurisdictional, health and human services, housing)
- Outreach (coastal, interior)
- Governance (regional statutes, federal policy development)
- Physical projects (transportation, coastal and wetland protection/restoration)

Public-private partnerships supporting infrastructure projects such as toll roads provide a good example of this concept. The private entity seeks a long-term return on investment in exchange for providing a well-defined and much needed public service. The public entity mitigates its financial responsibility and gains private sector efficiency and best practices. In the context of coastal community infrastructure resilience, the capital funding costs required for upgrades and new construction will greatly exceed the capacity of local, state, and federal budgets.

If such a thing as a “solution” to sea-level rise exists, it will be brought about through the collective efforts of vast numbers of people, governments, and organizations functioning within the framework of partnerships. Efforts to build coastal community resilience in an era of the “whole community” emergency management require cooperation of multijurisdictional governments, private nonprofits, faith-based organizations, and the private sector to achieve the required vision, cohesive legislation, planning capacity, and project execution resources. A large number of specialty collaborations already exist today. The following list identifies a small sample:

- Global Network for Coastal Resilience
- Cooperative Conservation Blueprint for Florida (CCB)
- Sandy Regional Infrastructure Resilience Coordination Group (including FEMA and HUD)

- Metropolitan Resilience Network
- NYC Adaptation Task Force
- NY Climate Smart Program
- Columbia University and Red Cross Climate Partnership
- South Florida Regional Climate Compact
- Annapolis, Maryland, and Newport, Rhode Island

Acting independently of each other, these partnerships will accomplish small successes. However, the true power of these partnerships will only be actualized through a larger network of collaborative endeavors. The lessons learned and best practices developed in one particular situation takes on greater value when it is shared across the country or world. The ability to establish effective partnerships that share information and coordinate efforts across the global community stands out as the best hope for successfully adapting to the impacts of sea-level rise.

Private Sector Involvement

An important factor in understanding the proper use and limitations of a private sector partner’s contribution lies in its primary industry of expertise and operational time frame. Many business endeavors revolve around fixed cycles and have developed highly accurate processes for forecasting trends within a narrowly focused scope.

For example, standard insurance policies evaluate risk on a 10-year basis. Mortgages for housing purchases may span 30 years. Wall Street’s quarterly earning projections carry considerable importance in the valuation of publicly traded companies. In each of these examples, the private sector’s calculation of risk targets a specific amount of time. Understanding the time horizon most closely aligned with a private sector partner will better contextualize both its perspective and the strengths/weaknesses of its forecasts.

The full impacts of sea-level rise exceed the accuracy horizon of the private sector and, therefore, it is important to recognize the point at which accuracy begins to diminish. Within its particular realm of expertise, private sector partners often possess superior resources to public sector counterparts, such as highly specialized expertise, proprietary data and simulation techniques, and the ability to rapidly raise finances for specific ventures. Increasingly, climate data is becoming a commodity being bought and sold by large corporate interests and venture capital firms:

“IBM [October 2015] said that it had acquired most of The Weather Company (owned by NBC Universal, Bain Capital, and The Blackstone group) including Weather.com and Weather Underground news sites as well as its vast trove of weather data. The deal, reportedly worth over \$2 Billion dollars, does not include the company’s cable television outlet, The Weather Channel, which will continue to broadcast.”⁸

IMPROVING DATA SHARING AND ANALYSIS FOR PLANNING AND RESPONSE

Benefits of Sharing Data

Data sharing benefits the researcher/organization, data repositories, the scientific community, government, and the public. It encourages collaboration between scientists and both private and public entities, resulting in a more thorough database and more accurate information. Better data leads to more accurate forecasts/predictions, which leads to better decision-making. With all of the benefits of sharing data, there still exist many challenges and impediments to accessing and sharing it.

Data Challenges

Data often goes unshared due to lack of trusted relationships. There is a gap in the knowledge infrastructure between public knowledge and private production. Public models are often inaccurate or insufficient, thus leading to incorrect predictions or people struggling to make any future forecast at all. Private models are proprietary and confidential and companies either will not release them or those seeking the information are unaware that it is already available. There is also a challenge of modeling the future without historical precedence.

Meteorology science has its foundation in historical data and is, therefore, limited in its effectiveness to forecast the future where fundamental data will have changed. No records exist for expected sea-level rise, therefore, meteorological data and methods are limited. With all of these limitations, when it comes to sharing data regarding storms, flooding, and sea-level rise, respondents reported challenges with each aspect of data being surveyed, which indicates that the benefit of partnering is underutilized and/or inconsistently embraced (Figure 8). It should be noted that each answer in Figure 8 is based on a ranking of 1-7 (1 being an area that respondents struggle with the most). Therefore, an answer with a lower score signifies a greater challenge for the respondent. That being said, the response that had the lowest score (meaning it was the greatest challenge) was that there is a gap between the data that is available and what needs to be done to take action using the data. Over 40% of respondents rated this issue as either a 1 or a 2.

In today's information environment, it is understandable that the owners of data guard their valuable commodity. Whether the issue is one of trust or a business decision to retain data, partnerships would benefit from data-sharing agreements, allowing access to the appropriate parties while protecting the owner from loss or theft.

For publicly funded research, the National Science Foundation (NSF) serves as a leading example of addressing data sharing. Grant proposals to the NSF are only considered when they contain a data management plan defining methods for the dissemination of data collected.

What is the biggest issue you encounter with data, specifically data on storms, sea-level rise, and flooding?

(Rate the following in order of what you struggle with most [1] to least [7])

- A. Data is not shared due to lack of trusted relationships.
- B. There is a gap between the data that is available and what needs to be done to take action using the data.
- C. Communicating the data appropriately.
- D. Understanding the data.
- E. The data is inaccurate/not useful.
- F. The data is proprietary/confidential.
- G. It is a challenge to create models for the future without historical precedence.

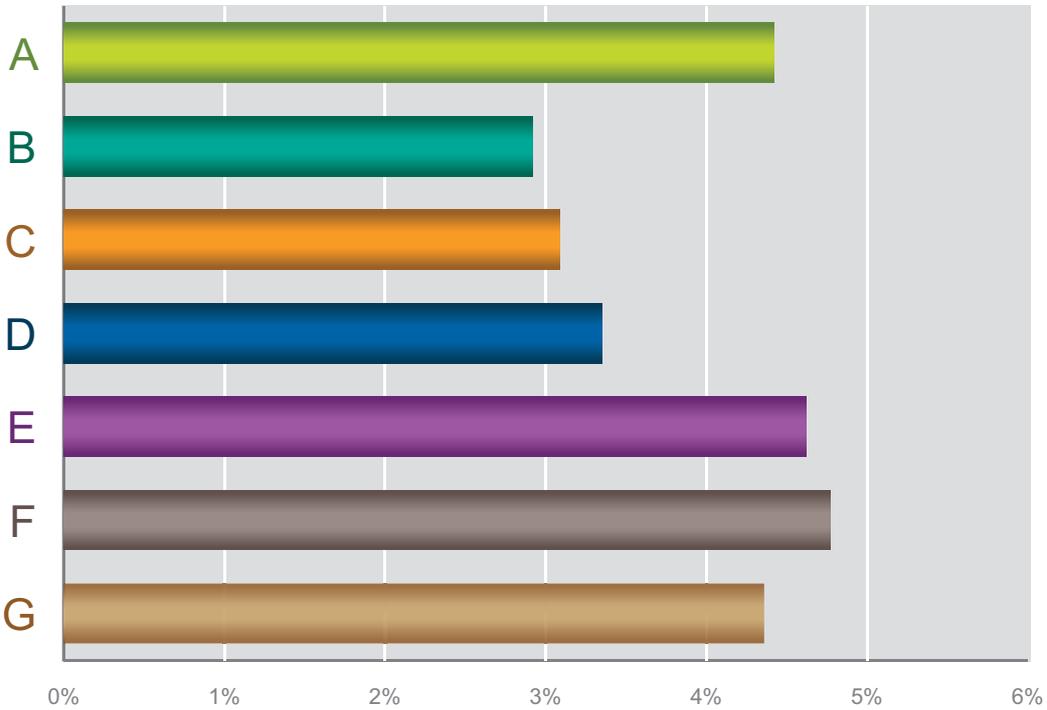


Figure 8

Still, the matter of privately collected data possessing significant market value remains a barrier to researchers. The risk of loss or theft often deter private institutions from sharing with public or nonprofit organizations where the returns are intangible. In these situations, strategies to collect, protect, and transfer ownership of new data to private institutions should be considered as a way to gain access and encourage future access to proprietary data.

Another major data issue facing researchers lies in the understanding and accuracy of the information received. Although these issues are listed separately in the survey,

they often intermingle to create significant problems for researchers. In complicated data structures, a particular field may have multiple interpretations depending on context. To the owner of the data who understands this nuance, the data and results are highly reliable and accurate. When shared, recipients lacking the understanding of these nuances may produce inaccurate results and disregard the entire data set. Proper communication of the meaning and use of data improves the understanding and resulting accuracy of shared data.

Existing Systems/Sources

There is a strong record of shared data for weather. Unofficial climate data (particularly historical weather, long-term averages, and daily temperatures) is easily accessible online to the public. Certified weather data is also nearly as accessible and is available through the National Climatic Data Center in Asheville, North Carolina, and can be ordered online or over the phone. Some examples of helpful data sharing include seasonal weather forecasts, training, flood-control plans, and forecast-based financing. There are many existing data sources and analysis tools used by various parties today, including:

- NOAA's Climate Resilience Tool Kit
<https://toolkit.climate.gov/>
- NOAA's Digital Coast
<https://coast.noaa.gov/digitalcoast/>
- NOAA's High Impact Weather Prediction Project
<http://hiwpp.noaa.gov/>
- The Nature Conservancy (TNC) Coastal Resilience Approach and Tools
<http://coastalresilience.org/mapping-tool-apps/>
- NOAA's Regional Integrated Science and Assessments (RISA)
<http://cpo.noaa.gov/ClimatePrograms/ClimateandSocietalInteractions/RISAProgram.aspx>
- Argonne National Lab Regional Resilience Assessment Program
- NOAA's Resilient Lands and Water Initiative
- Global Forecast System
<https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/global-forecast-system-gfs>
- NOAA's Coastal and Marine Spatial Planning
<http://www.cmsp.noaa.gov/>
- IBM's Information Technology Disaster Resource Center

- NOAA’s Sea Level Rise and Coastal Flooding Impacts Viewer
<https://coast.noaa.gov/slr/>
- White House Climate Data Initiative
- Circle of Blue Qlik Business Intelligence and Analytics System

NOAA’s Sea Level Rise and Coastal Flooding Impacts Viewer provides coastal managers and scientists with a look at sea-level rise and coastal flooding impacts. It uses nationally reliable data sets and analyses so that users can explore visualizations of sea-level rise. Both the information and the maps on the viewer can be used at varying scales in order to measure trends and prioritize actions for alternate potential scenarios.

The Virginia Coastal Adaptation Data Portal is currently under development as a result of a collaboration by William & Mary Law School and William & Mary’s Virginia Institute of Marine Science (VIMS) and a grant from the blue moon fund. The portal will provide key information, data, analyses, and tools to support local, regional, and state efforts to adapt to sea-level rise. It will be used for risk assessment and adaptation planning. Since Hampton Roads has the highest rate of sea-level rise on the East Coast, the area is at a greater risk of frequent flooding.

Accessing the Systems

While much of the historic data is widely considered to be available, new research methods are expanding the pool of knowledge for fact-based analysis. For example, the results of a 2011 study of North Carolina salt-marsh sedimentary sequences provided the foundation for a 2016 study on the acceleration of sea-level rise. This process of new data discovered through research and subsequent analysis provides an increasingly reliable historical precedent from which realistic comparisons can be made.

“By extending their findings to future scenarios, the scientists showed that the amount of land that could be inundated in the coming years will depend heavily on whether humanity succeeds in slashing pollution from fuel burning, deforestation and farming. The Paris Agreement negotiated in December aims to do just that, with nations agreeing to take voluntary steps to reduce the amount of pollution they release after 2020. It could take decades, though, before that untested approach is revealed to have been a success, a failure, or something in between.”⁴

Additionally, new open-source weather monitoring protocols allow increased data sharing through cloud-based services. The Open Weather Map collects data from Moderate Resolution Imaging Spectroradiometer (MODIS), Landsat 7 and 8, and a network of on-the-ground sensors that cover more than 40,000 weather stations. What once was a challenge of not having enough data or accurate information has been replaced by an over-

whelming volume of ever-increasing and more precise data. Today, the critical resource is the ability to process and apply the vast amount of readily available information to local needs. Successful planning requires the blended expertise of climate science, statistical methods, and big data handling.

Large institutions are able to bring together the data, tools, and expertise required to address their challenges. However, the innumerable coastal communities with sparse resources will experience the first wave of impacts that truly need these assets. The common disclaimer for investment vehicles states, “Past performance is not an indicator of future results.” Despite the enhancements to the body of historical data, NOAA’s official predictions for sea-level rise span a range from 8 inches to 6.6 feet by 2100 (Figure 9).

A gap exists between the data, tools, and understanding available to stakeholders and what they need to make informed, justifiable actions. Future discussions, focus groups, and roundtables need to develop long-term, inclusive plans with measurable actions and definable goals to address this critical need. The participants in the roundtable discussion with supporting comments from survey respondents frequently cited a need for including scientific, data-driven facts into public policy planning and outreach.

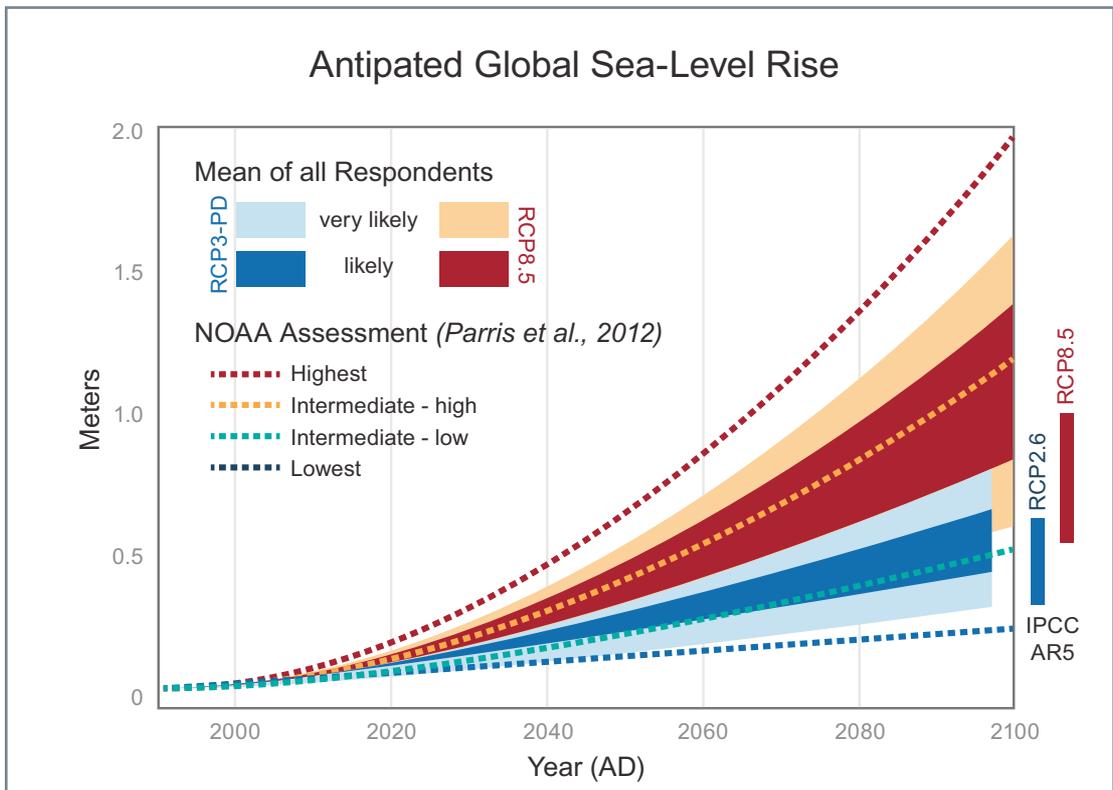


Figure 9

Much like New York City’s Office of Emergency Management building a repository of data to guide future analysis, a nationwide system for resilience data would create a framework for inventorying raw data sets (both public and private), analytic tools and methods, as well as best practices in model and simulation development, testing, and refinement. Key elements for future exploration of this topic include: the partnerships required to make this the de facto system; the governance of this system; and the guarantee of its future efficacy.

National System for Resilience Data

A critical resource for expediting Sea Level Rise and Coastal Community Resiliency studies will be a central knowledge repository for facilitating data exchange and transformation as well as analytical approaches and supporting tools. A national system for resilience data housing an inventory of existing data sets whether they are public or private, various types of analyses and predictive forecasting tools, and a unified methodology for standardizing data will give researchers a common, open-source platform to launch their research, share ideas, and build a knowledge center for future efforts.

KEY FINDINGS

History and Significance

- In the last century, sea levels have risen faster than any other time in history.
- Higher sea levels lead to greater and more powerful storm surges during hurricanes.
- Populations that are not on the coast experience both short-term and long-term indirect impacts of flooding of coastal communities.

Definitions of Critical Terms

- People are unable to agree on a standard definition of “resilience” and “adaptation.”
- Different understandings of terminology could lead to mixed or false expectations and responses to a situation.
- Policy makers, scientists, and the public need to determine a universal definition before tackling sea-level rise.

Education and Policy

- Sea-level rise is occurring at the rapid rate of 0.14 inches per year, since 1990 alone.
- Half (50%) of survey respondents believe it will take 10-49 years for the nation to recognize sea-level rise as a national crisis.
- The federal government is consenting to state and local dependency on them due to their lack of encouragement of preventative actions and shortage of incentives for enacting policies with resilience measures.
- Persuading locals to enact resilience standards is a challenge.
- Outreach and education is the best approach for encouraging local communities to enact resilience standards.
- Developing a comprehensive outreach program, inclusive of both coastal and inland communities will educate people on their risk, mitigation, and preparedness techniques, and provide resources for further learning.
- Increased emphasis on climate change during formal educational programs in college will encourage students to consider climate change in their future professional work.
- Most (81%) of respondents said that construction (zoning, codes, and standards) policies are most in need of incorporating resilience measures in order to address sea-level rise.

Private Sector Involvement

- Private sector can bring valuable resources to partnerships, such as:
 - Funding;
 - Proprietary data and/or modeling techniques; and
 - Expertise (research, policy, and professional services).
- Understanding the inherent timeframe within which a private sector partner operates properly contextualizes their views and expertise.
- Aligning the motivations and goals of private sector partners with the overall mission for a collaborative endeavor will produce a more effective partnership.
- While large amounts of data are freely available, the private sector is investing heavily in climate data.

Movement From Policy to Actionable Steps for Communities to Become Resilient

- Outreach and education initiatives need to be defined, funded, executed, and evaluated.
- Regional planning efforts should collaborate toward developing a comprehensive approach for all communities.

Benefits of Sharing Data

- Data sharing encourages collaboration between scientists and both private and public entities, resulting in a more thorough database and more accurate information.

Data Challenges

- Respondents struggle with all types of issues surrounding data sharing:
 - Less data sharing due to lack of trusted relationships;
 - A gap between the data that is available and what needs to be done to take action using the data;
 - Communicating the data appropriately;
 - Understanding the data;
 - Inaccurate/not useful data;
 - Proprietary/confidential data; and
 - Challenges to create models for the future without historical precedence.

Existing Systems/Sources

- Currently, there is a strong record of shared data for weather.
- Current existing systems include:
 - NOAA’s Sea Level Rise and Coastal Flooding Impacts Viewer; and
 - Virginia Coastal Adaptation Data Portal.

National System for Resilience Data

- This framework should provide:
 - A gateway to raw data sets that are available (public, private);
 - An inventory of the types of analyses and predictive forecasts available; and
 - Methods and approaches for sharing resulting information with public and private entities.
- Additional resources should include sample scenarios and models/simulation tools.

ACTION PLAN

Recommendations for Action

1. Clearly define terms such as recovery, resilience, and adaptation so that all parties understand their usage. Perhaps the development of a strategic communications package could fulfill this need.
2. Incorporate ecosystem service values into economic cost analyses.
3. Use current knowledge about climate science, ecosystem behavior, and the impact of ecosystem behaviors on infrastructure in the coastal environment to move forward.
4. Frame and conceptualize the problem of climate change in order to create needed partnerships.
5. Communicate the indirect impacts of climate change to populations that do not live on the coast.
6. Integrate and mainstream climate fundamentals into the disciplines that are essential for adapting to climate change, such as infrastructure planning, civil engineering, etc.
7. Inventory and collect information on existing partnerships and organize information on each. This includes information on what makes them work and steps in their creation. In addition, the PLC needs to develop a maturity model for regional partnerships looking at factors like rationale to engage, clear mission, clear governance, effective communication, element of metrics, and delivery of value.
8. Develop a data analysis and use framework that everyone can reference. This framework should provide: an inventory of raw data sets that are available (public, private); an inventory of the types of analyses and predictive forecasts available; description of the scenarios to consider and model; and methods and approaches for sharing resulting information with public and private entities.
9. Take the impact of a short-term event and turn it into a long-term solution.
10. Use scientific information – such as linkages between temperature rise, marine chemical pollution, and thermal stress that degrade ecosystems, impact biological organisms, and result in increases in infectious disease – needs to be used in developing policies.
11. Recognize the importance of vegetation to protect ecosystems.

ENDNOTES

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APPENDIX A

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APPENDIX D

Demographics of Survey Participants

Sector of Employment		
Sector	Number of Responses	Percentage of Responses
Fire Service	17	7.05%
Law Enforcement	7	2.90%
EMS	7	2.90%
Emergency Management	42	17.43%
Public Health	25	10.37%
Hospital (including VA)	18	7.47%
Federal Government	18	7.47%
Military	6	2.49%
State/Local Government	24	9.96%
Elected Office/Legislative Body	1	0.41%
Non-Government Organizations	6	2.49%
Privately Owned Company	11	4.56%
Publicly Traded Company	10	4.15%
Self-Employed	16	6.64%
Academic Institution	17	7.05%
Student	3	1.24%
Other	13	5.42%

Type of Position Held		
Answer Choices	Number of Responses	Percentage of Responses
Upper Management	76	30.16%
Middle Management	54	21.43%
Operations	32	12.70%
Technical	25	9.92%
Training	19	7.54%
Administration	12	4.76%
Appointed	5	1.98%
Other	29	11.51%

“A recent study, commissioned by the Risky Business Project, an initiative led by Henry Paulson, Michael Bloomberg and the hedge-fund billionaire and philanthropist Tom Steyer, concluded that as much as a half-trillion dollars’ worth of coastal property in the United States could be under water by the end of the century.”

– Jon Gertner
New York Times,
6 July 2016

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