SCIENCE ADVISORY BOARD

Leadership in Coastal Resilience Report

A NOAA Science Advisory Board Report
Developed with support from the Climate Working Group and
Ecosystem Sciences and Management Working Group

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Summary of Recommendations

This report identified three areas where NOAA's leadership can foster demonstrable change in coastal resilience: Continued Discovery, Networks of Knowledge Delivery, and Making a Difference on the Ground. Nine recommendations were developed and are summarized here:

Recommendation 1, Nature-Based Approaches to Risk Reduction:

Conduct research in partnership with others to increase the understanding of tradeoffs between the performance of natural coastal habitats in mitigating current and future flood risk and the provision of other ecological functions.

Recommendation 2, Supporting Adaptation of Important Coastal Species:

Identify and address gaps in scientific understanding that limit the ability of NOAA and its partner agencies to anticipate and effectively respond through mitigation, adaptation, restoration, or other management measures to climatologically induced threats to important coastal fisheries and other marine species.

Recommendation 3, Socio-economic Inquiry:

Conduct and support social science research to increase the understanding of how people (individually and collectively) understand, react to, and are affected by changing coastal conditions (both chronic and acute) including consideration of interactions among economic consequences and social and cultural changes that the loss of (or restoration of) coastal resilience can affect or engender.

Recommendation 4, Enhance Observing Systems:

Further refine the development and deployment of land/water and space-based observing networks that are directly useful to local entities to track and forecast a variety of coastal ocean conditions over time.

Recommendation 5, Integrated Coastal Resilience Modeling:

Establish an Integrated Coastal Resilience Modeling framework that uses existing and enhanced observing systems to provide coastal decision makers with key insights into the cumulative effects of future physical, chemical, and ecological change at subseasonal, seasonal, and multidecadal time scales.

Recommendation 6, Predicting Human-Natural System Feedbacks:

Build on socio-economic research and modeling of biogeophysical change to develop tools that encompass feedbacks between human and natural systems to support exploration of future social, economic, and environmental conditions on saltwater and freshwater coasts at a variety of scales.

Recommendation 7, From Stakeholder Engagement to Co-production and Co-design:

Build new partnerships to engage in the co-production and co-design of knowledge and action to generate new knowledge, capacities, networks, and actions that are more inclusive, relevant, and impactful.

Recommendation 8, Facilitating Social Learning:

Develop, evaluate, and refine interactive approaches that enable a variety of coastal audiences to access and interpret outputs from the Integrated Coastal Resilience Modeling framework and human-natural systems modeling and understand the varied potential consequences of action/inaction on their interests, including timelines for change and adaptation and costs and benefits to people and businesses.

Recommendation 9, Support for Implementation:

Enhance and expand the network capacity and efficacy of NOAA and partner engagements at local and community scales to help communities and community decision makers identify and implement solutions that build coastal resilience.

Introduction

Extreme weather events and chronic system-scale changes, including storm intensity, sea level rise, harmful algal blooms, ocean acidification, lake and ocean warming, and hypoxia all threaten the natural environment, living marine resources and the built infrastructure along our coasts. Adverse impacts from these hazards are exacerbated or accelerated by climate change and are projected to continue to worsen in intensity, duration, and frequency over the coming decades. To thrive in this changing world, we need to understand the changes taking place and convey that understanding to federal, state, and local decision makers, businesses, service providers, and citizens along our saltwater and freshwater coasts.

This report focuses on how NOAA can work over the next decade across line offices and with other Federal agencies, local communities, and the private sector to ensure our nation's coasts and coastal infrastructures, and those who rely on them, are resilient to both acute and chronic threats.

The SAB uses the following definition of *coastal resilience* in this report:

"The ability to prepare for, absorb, recover from, and successfully adapt to change. Change can be at multiple timescales and change can be physical, biological, or ecological. This can be specific events (storms and hurricanes, pollutant spills, Harmful Algal Blooms) or ongoing change (ocean warming, shifting Great Lakes water levels, sea level rise)."

Vision for the Future

The SAB envisions NOAA as a central driving force for understanding, integrating and progressing engagement on global, national, and regionally specific information on the underlying basis of coastal resilience. In this regard, we see coastal resilience as a deeply informed integration of the biogeophysical and socio-economic processes.

Coastal resilience is about the ability of shorelines to withstand increasingly destructive and energetic disruptions, and the socio-economic systems that enable people to interpret, adapt, move, alter, or otherwise respond to such changes. NOAA has within its broad mandate the latitude and intellectual capacity to continue to integrate research, insight, and monitoring systems with people and place. A key component of this is advancing NOAA's predictive capabilities through advanced modeling using enhanced observations of natural and social system dynamics. The SAB has already made recommendations to NOAA on how to enhance the quality and value of NOAA's Earth system prediction[1]. This report focuses on integrative prediction of ecological, economic and societal response to both global and local changes that challenge coastal resilience.

[1] https://sab.noaa.gov/wp-content/uploads/2021/08/SAB_Report_Advancing-ESP_02April2021_Final.pdf

NOAA can build off its currently widespread and deep nature as a trusted source of scientifically informed insights and can adeptly serve to coalesce any number of other federal and private research into this domain. NOAA's leadership extends from local and state levels (e.g., Sea Grant extension, CZMA) to regional (e.g., fishery management councils, marine protected areas) to global levels (e.g., Intergovernmental Oceanographic Commission, World Maritime Organization, Global Earth Observations System, Sustained Arctic Observing Network, Seabed 2030, other UN Decade of Ocean Sciences activities). NOAA's leadership role must be leveraged to ensure natural and social science advances make a difference on the ground in ensuring coastal resilience.

One aspect of NOAA that we seek to emphasize and reinforce is NOAA's ability to convene diverse audiences and to learn from those audiences what they may most need for forthcoming decisions. This answer is often couched in terms of the need for money to carry out the plans that a community envisions, but the ability to convene individuals and groups can help them see and learn to gather the courage to act within the authorities and capacities inherent within their own communities. As a preponderance of shoreline is in private hands, local planning for coastal resilience is a complex societal undertaking that NOAA is positioned to engage on. Success here allows all units of government to be informed with appropriate insights and armed with tools to tackle coastal resilience within current and future governance frameworks.

The recommendations provided here provide a foundation for future coastal systems where:

- Management expects and anticipates change, builds on the natural resilience of coastal ecosystems, and can adapt to the unexpected.
- Plans and actions are based on integrated understanding of interactions between the natural environment, society, and economy.
- Society as a whole is engaged in decision making with full awareness of the consequences of action and inaction.

This can only be achieved with concerted and collaborative research and development. The SAB urges NOAA to work with its partners and embark on an ambitious agenda of discovery science, knowledge delivery, and ground level engagement to deliver this future.

Leadership in Coastal Resilience

Coastal resilience at NOAA is not any one program, but reflects a purposeful application of a wide range of expert resources, programs, and partnerships, including both providing to and receiving support from other federal agencies. NOAA's mission is to produce science and ensure the successful translation, delivery, and operational use of that science for emergency response, conservation, preparedness planning, and adaptation at the coast. This mission was founded in 1807 when President Thomas Jefferson established the U.S. Coast and Geodetic Survey to provide nautical charts that enabled safe passage into American ports and along our young nation's coastline. Enabling science-informed decision-making on the coast is the longest standing facet of NOAA's service to the nation. NOAA's coastal resilience mandates include:

- National Weather Service Organic Act (1890) "*the collection and transmission of marine intelligence for the benefit of commerce and navigation... tropical cyclone surveillance… protect the citizens of the coastal areas of the United States...*"
- Coast & Geodetic Survey Act (1947) "*conduct tide and current observations and investigations and research in geophysical sciences…*"
- National Sea Grant College Program Act (1966) "*understanding, assessment, development, management, utilization, and conservation of ocean, coastal, and Great Lakes resources…*"
- Coastal Zone Management Act (1972) "*preserve, protect, develop, and where possible, to restore or enhance the resources of the nation's coastal zone...*"
- Magnuson-Stevens Fishery Conservation & Management Act (1976) "*take into account the importance of fishery resources to fishing communities by utilizing economic and social data...*"
- Harmful Algal Bloom and Hypoxia Research & Control Act (1998) "*local and regional scientific assessments of hypoxia and harmful algal blooms...*"
- Hydrographic Services Improvement Act (2008) "*acquire hydrographic data and provide hydrographic services to support the conservation and management of coastal and ocean resources…*"
- Coordinated Ocean Observations and Research Act (2020) "*monitor and model changes in the oceans and Great Lakes, including with respect to chemistry, harmful algal blooms, hypoxia, water levels, and other phenomena…*"

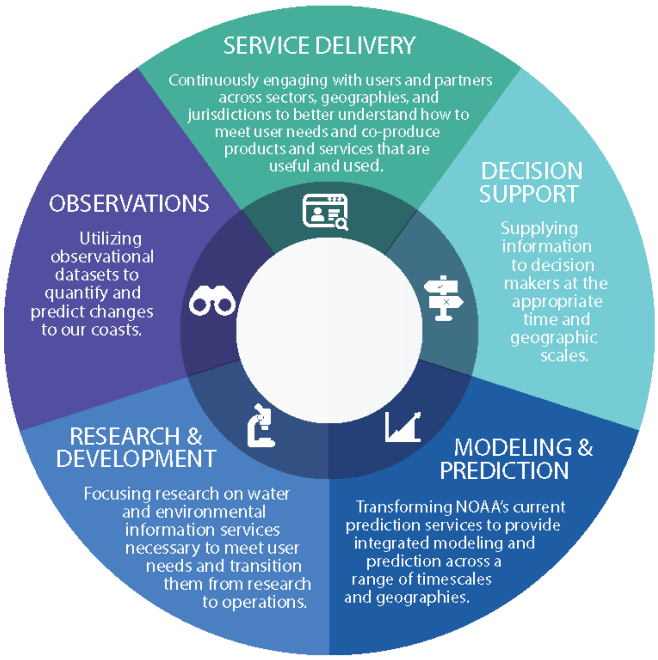
Partnerships are a cornerstone of NOAA's work to enable coastal resilience, reflecting the understanding that no single program or agency is able to independently produce the required science or to meet the array of needs from stakeholders. In practice, NOAA's commitment to partnerships involves supporting, convening, and leading collaborations with all levels of government, academia, non-profits, tribal entities, and the private sector on the production of science, the translation of science, and the delivery of services. Given this complexity and

NOAA saves lives, protects property, and supports science-based decision making in the face of climate change and extreme events along the coasts through a combination of science, service, and stewardship.

emerging coastal resilience challenges, continued effort to further these partnerships will be an important element in the overall success of coastal resilience initiatives.

NOAA with its established partners has the leadership mandates and the capability to fulfill a national vision for coastal resilience based on:

- Responsiveness to emerging problems through original research to understand the behavior of the atmosphere, oceans, coasts, and ice and their interactions with the ecosystem.
- Ongoing, consistent, and reliable delivery of essential information that is locally relevant and comprehensive.
- Trusted partnerships that make a difference on the ground by providing education, training, outreach, and extension services to communities.



Fulfilling this vision requires integration across research and development, observations, modeling, and prediction to provide decision support and service delivery.

Recommendations

The SAB has identified three general areas of interest where focused attention and research and development by NOAA can result in advances that address ongoing and emerging issues related to coastal resilience. These elements of inquiry, research, and insight into the foundations of healthy coastal systems and climate mediated threats to such healthy systems embrace fundamental needs for discovery in science, cutting-edge technologies, and an expanded responsiveness to needs at the local and subregional levels on the ground and in communities.

The SAB acknowledges that NOAA's leadership role involves not only making strides within the agency but also working as a convener, facilitator and integrator, a hub for knowledge and tools, and, at times, as an active supporter of other agencies.

Many of these recommendations call for NOAA to work in partnership with others. These partnerships may be formal or informal - there will be no 'one size fits all' approach. The SAB recognizes that part of NOAA's leadership role in coastal resilience is recognizing where and how to marshal expertise, resources, and skills from an array of entities to achieve its goals.

Continued Discovery

Many of the problems facing coastal communities, residents, and the infrastructure and jobs they rely on require additional fundamental mechanistic understanding of biogeophysical dynamics of our nearshore and estuarine waters, and both sheltered and exposed shorelines. Changes in storm intensity, interactions with watershed discharges, and ongoing vertical land motion present challenges in predicting future coastal inundation. Yet these dynamics are only a few of the factors influencing the resilience of coastal communities and livelihoods, and those other influences (and feedbacks as people and ecosystems respond to change) are in most cases even less well understood.

NOAA is already at the forefront of some of these issues, thus these recommendations focus on providing leadership to advance and extend the work of NOAA and its partners. NOAA must continue its work to address key gaps of fundamental understanding in a number of critical domains related to coastal processes and coastal resilience. In addition, extensive investments in understanding the processes and feedbacks underlying coastal resilience are being made by several agencies but many are investigator driven and often deliver important but fragmented insights. ***NOAA's leadership is needed to guide research across agency, academic, and private sectors toward a comprehensive understanding of system change.***

Nature-Based Approaches to Risk Reduction

Finding:

NOAA is a strong advocate of the use of natural and nature-based features to mitigate coastal flooding and prevent shoreline erosion, while providing an array of additional habitat benefits. However, applying such solutions and realizing their benefits requires a detailed understanding of their performance (e.g., under differing hazards, varying ecological conditions, such as seasonality of vegetation vigor) and their susceptibility to stress by hydrological disruption and changing climate, such as disease, to allow their realistic incorporation into detailed coastal resilience plans for coastal communities. Broad generalizations about applicability of natural and nature-based solutions must be replaced with information on thresholds for application and probabilities of performance.

Recommendation 1:

Conduct research in partnership with others, including the use of field surveys, controlled experiments, numerical modeling, and pilot projects, to increase the understanding of tradeoffs between the performance of natural coastal habitats in mitigating current and future flood risk and the provision of other ecological functions.

Expected Outcomes:

Nature-based flood risk reduction features are effectively integrated into coastal resilience plans and actions based on quantitative predictions of their performance over an array of expected future conditions. Adaptive management plans are in place to provide for adjustments in approach that support coastal resilience, as changing conditions alter the character and distribution of natural habitats.

Supporting Adaptation of Important Coastal Species

Finding:

Coastal systems are the foundation of many important commercial and recreational fisheries, provide subsistence to vulnerable residents, and afford habitat to both common and rare or endangered marine species. Climate change and the human-induced modifications of watersheds and coasts threaten the sustainability and suitability of these resources. While some human-mediated coastal changes are inevitable, targeted mitigation or restoration measures may be possible to alleviate event-based threats such as marine heat waves, harmful algal blooms (HABs), or ocean acidification; provide refuge for species during stressful conditions; and support or facilitate gradual transitions rather than catastrophic, acute, or otherwise abrupt disruptive declines.

If individual restoration or mitigation measures are to bring about a meaningful positive change, they must be planned and executed based on a systems level understanding of their effectiveness. This approach is being used by NOAA in the new Climate Fisheries Initiative, but will require tailoring to support coastal resilience needs due to the complexities of watershed-coast-ocean/lake interactions, both direct and indirect

influence of coastal development, and the array of coastal habitat characteristics that are essential to support coastal species.

Recommendation 2:
Identify and address gaps in scientific understanding that limit the ability of NOAA and its partner agencies to anticipate and effectively respond through mitigation, adaptation, restoration, or other management measures to climatologically induced threats to important coastal fisheries and other marine species including invasive species, life cycle disruption, thermocline and ice cover changes, and HABs.

Expected Outcomes:
Coastal fisheries and other living marine resource management practices proactively integrate expected transitions and changes in coastal environments including temperature, acidification, and habitat shifts. Incorporate proven approaches to mitigate risk from multiple chronic and acute stressors, e.g., HABs, disease, etc.

Socio-economic Inquiry

Finding:
Human activities, investments, and histories are concentrated along the coasts making it critical to understand how the processes and consequences of material changes to our coastal systems affect people and places. Will these changes affect some groups or people more than others? What are the consequences of periodic but large-scale disruptions to local and regional economies under individual or multiple coastal stresses? What adaptation options are feasible, effective, and desirable for communities over time and what information is needed to make those decisions? Do people stay in the face of increased storm impacts and rising waters? When and how might some decide to move and how will this affect those who have no choice but to stay? These are all critical elements of coastal resiliency that impact NOAA's ability to carry out its mission. Changing biogeophysical dynamics impact the resilience of people and of place, communities, identities, rootedness, social cohesion, and affinity. These interactions need to be more deeply understood for adaptation and mitigation measures to be successful. Research conducted and supported by other federal agencies, such as the National Science Foundation's Coastlines and People program, provide complementary research capacity.

Recommendation 3:
Conduct and support social science research to increase the understanding of how people (individually and collectively) understand, react to, and are affected by changing coastal conditions (both chronic and acute). These studies should consider interactions among economic consequences and social and cultural changes that the loss of (or restoration of) coastal resilience can affect or engender. Given the complexity of local responses, an array of methods should be supported including survey techniques, econometric and behavioral economic

analysis, and qualitative and participatory engagements, including comparative approaches among cases.

Expected Outcomes:
Coastal resilience plans and management actions are based on understanding the interactions of biogeophysical dynamics and the socio-economic system, and enable coastal adaptation that provides for ecosystem health, supports the coastal economy and coast-dependent commerce, and delivers sustenance and livelihoods for coastal residents.

Networks of Knowledge Delivery

Given the development of further understanding of biogeophysical and socio-economic consequences of both coastal change and restoration actions described above, new and more effective mechanisms for delivering that knowledge are needed. Networks of knowledge delivery are needed to increase our ability to detect change over a variety of timescales and aggregate and "package" findings and insights in ways useful to a variety of stakeholders. These recommendations call upon NOAA to develop a new integrated capability for monitoring and predictive modeling to support future coastal resilience.

Enhance Observing Systems

Finding:
Local governments, tribes, non-profits, and other entities are clamoring for more localized nowcasts and forecasts of coastal change in order to aid local adaptation mitigation and response strategies. To be responsive to needs identified at the local level, a variety of enhanced observing systems are needed that make use of platforms and sensors that are robust, cost-effective, and easily deployable across a wide range of environments and user groups. In particular, enhanced observing systems are needed to collect data for water levels, nearshore bathymetry and shoreline change, harmful algal blooms, ocean acidification, and hypoxia. Many of these systems already exist but require additional R&D to further their development and usage, including use in community-based science. In addition, satellite observations of the nearshore environment are still rudimentary or lacking and not of the necessary resolution for use in local forecasts. Improvements will require enhanced collaborations between NOAA and the many federal agencies and academic institutions researching in this arena.

Recommendation 4:
With agency and other partners, further refine the development and deployment of land/water and space-based observing networks (including but not limited to autonomous sensing systems) that are directly useful to local entities to track and forecast a variety of coastal ocean conditions over time. Nowcasts and forecasts using observations alone and those linked to coastal models can help augment and increase the utility and sensitivity of "networks of knowing" related to human dimensional and socio-economic factors.

Expected Outcomes:
Decision making at a variety of scales, but particularly at the local level, will be enhanced with more robust data and models.

Integrated Coastal Resilience Modeling

Finding:
Changing nearshore and oceanic/lake conditions will alter fisheries resources, aquaculture opportunities, tourism, other economies, and ways of life. Those planning for the future need to have ways of understanding how the combined effects of climate change will alter the shape of the shoreline, damage infrastructure, and produce significant disruptions to natural resources and human populations. This need can be met by development of a modeling framework, appropriately balancing the complexity of processes with the resolution of data and understanding that can be applied to explore the consequences of different actions across multiple scenarios. The development of the framework needs to be coordinated within NOAA and especially with other agencies. However, NOAA should be the 'keeper of the vision' and facilitate the integration of data and models across many disciplines, agencies, and perspectives, and develop a greater focus on multiple stressors and on spatial and temporal cumulative effects.

Recommendation 5:
Establish an Integrated Coastal Resilience Modeling framework that uses existing and enhanced observing systems to provide coastal decision makers with key insights into the cumulative effects of future physical, chemical, and ecological change at subseasonal, seasonal, and multidecadal time scales.

Expected Outcomes: Coastal practitioners from a wide array of fields, from fisheries managers to port authorities to local governments, can utilize a common modeling framework that appropriately balances the complexity of processes with the resolution of data and understanding, and can be readily user tailored to meet their needs to explore the consequences of different actions across multiple scenarios.

Predicting Human-Natural System Feedbacks

Finding:
Considering the future of coastal systems without explicit consideration of feedbacks between human and natural systems, at different scales, denies lessons from the past regarding the role of people in shaping coasts and the influence of coastal resource availability, from fisheries to viewsheds, on culture, society, and economy. The socio-economic inquiry (Recommendation 3) and Integrated Coastal Resilience Modeling (Recommendation 5) can be used by NOAA as a platform for the development of tools that enable predictions of how coastal adaptation and mitigation actions influence population migration, coast-dependent economic activity, and demand for community services. Such tools need to be scalable to allow community leaders and state officials to understand not only the consequences of coastal change for residents and

businesses, but also how potential actions could contribute to community resilience in the face of change. As future changes may be gradual or sudden, depending on the stressors and their interaction, it is important to allow officials to anticipate and plan for plausible changes, rather than react to events. This requires tools that enable exploration of possible future environmental, social, and economic pathways, and illustration of the costs, benefits, and tradeoffs, and their distribution across society associated with adaptation options and their timing.

Recommendation 6:
Build on socio-economic research (Recommendation 3) and improved models of biogeophysical change (Recommendation 5) to develop predictive tools that encompass feedbacks between human and natural systems to support exploration of how adaptation and mitigation actions alter future social, economic, and environmental conditions at a variety of scales.

Expected Outcomes:
Economic development, community infrastructure and investments, and ecosystem restoration can be planned and implemented in a coordinated way over decades to accommodate future climate change and support resilient communities, coast-dependent industries, and species.

Making a Difference on the Ground

In parallel with developing improved data sets and predictive capabilities, it is important to contemporaneously develop the necessary interfaces for users of the empirical insights, modeled outcomes, and predictions. This involves understanding the types of decision makers using such information, the information most useful to decision makers, managers, and residents, appropriate delivery mechanisms for that information (especially for dynamic processes, uncertain parameters, and multiple scenarios), sharing information in a way that supports adaptation to multiple simultaneous climate-related challenges, and the curation and dissemination of contextual information to support interpretation and action. It may also entail exploration of how coastal resilience is maintained (where it exists), how it is protected (what are the panoply of tools and techniques available and where may they have been deployed), and where can resilience be reestablished (and through what mechanisms). NOAA has extensive experience in this area and the SAB is calling for expanded, concerted, and collaborative effort in this area to support the long-term needs of coastal decision makers.

From Stakeholder Engagement to Co-production and Co-design

Finding:
Stakeholder engagement is not a new concept and NOAA has many successful examples of incorporating it into agency decision making. However, given the rapid change coastal and marine ecosystems are experiencing, often due to a multitude of climate-related factors, NOAA in collaboration with other federal, state, and local partners needs to take a fresh look at understanding who the decision-makers are, what

groups are informing these unilateral or multilateral decision makers, and how best to engage with them throughout the entire life cycle of a program or project. For example, often decision-makers do not use data and information products and tools directly, but are informed by a cadre of others that support the decision-making process, including advisors, staff, advocates, and media among others. In addition, challenges for coastal resilience are increasingly complex and include new human dimension aspects and responses to multiple, simultaneous climate-related impacts. A new approach is to incorporate co-production of knowledge with decision-makers and especially with rights holders (such as tribes and others) throughout the entire process, not as one-time input into agency decision making. Co-production is understood as 'iterative and collaborative processes involving diverse types of expertise, knowledge, and actors to produce context-specific knowledge and pathways towards a sustainable future'.

Recommendation 7:
Build new partnerships to engage in the co-production and co-design of knowledge and action in order to generate new knowledge, capacities, networks, and actions that are more inclusive, relevant, and impactful. This is especially important for engaging with underserved and Indigenous communities.

Expected Outcomes: Actions taken by NOAA and its partners are those that are generated and implemented collectively.

Facilitating Social Learning

Finding:
Making a difference on the ground requires facilitating social learning rather than individual learning in group settings. Understanding social values and priorities, who participates, and how they are heard in coastal resilience conversations can enable the development of tools and products that resonate to inform and influence the community and other group decision-making processes. Already NOAA and its partners are making available and using approaches, such as 2D and 3D visualizations and virtual reality, animation, or video products, in many settings. The next generation of tools must facilitate engagement and dialog and enable the consequences of different actions to be accessible and understandable. It is especially important to convey the implications of factors that are uncertain or highly variable in nature to proposed adaptation decisions. Relevant factors include severity of storm impacts, the array of costs and benefits associated with different courses of action (and the distribution of those costs and benefits across society), and timelines for change, both with and without action being taken.

Recommendation 8:
Develop, evaluate, and refine interactive approaches that enable a variety of coastal audiences to access and interpret outputs from the Integrated Coastal Resilience Modeling framework and human-natural systems modeling (Recommendations 5 and 6 above) and understand the varied potential

consequences of action/inaction on their interests, including timelines for change and adaptation and costs and benefits to people and businesses.

Expected Outcomes:
Coastal resilience and adaptation is founded on broad societal appreciation of coastal change and an awareness of the multiple consequences of management and mitigation actions for this and future generations.

Support for Implementation

Finding:
While there is growing evidence of evaluating, assessing, and planning for coastal resilience to climate change (the what and how), actual implementation and service delivery is proceeding more slowly. Even as the federal government and others seek to provide funding, thereby reducing one key barrier to taking steps towards increased resilience, other political and socio-economic barriers remain. It is important to understand the processes influencing how and when communities of different sizes, compositions, and capacities are able to come to socially acceptable/tolerable implementation plans and how NOAA science and engagement can facilitate those processes and support enhanced service delivery and decision-making.

NOAA has considerable network capacity (e.g., Sea Grant, NERRs, Cooperative Institutes, Sanctuaries, IOOS Regional Associations, etc.) that allow NOAA and other entities to work at multiple geographic scales and especially with coastal communities.

Knowing there is a problem; knowing the range of solutions and costs is another, developing the confidence, trust, and courage to develop and champion such solutions is a third critical element.

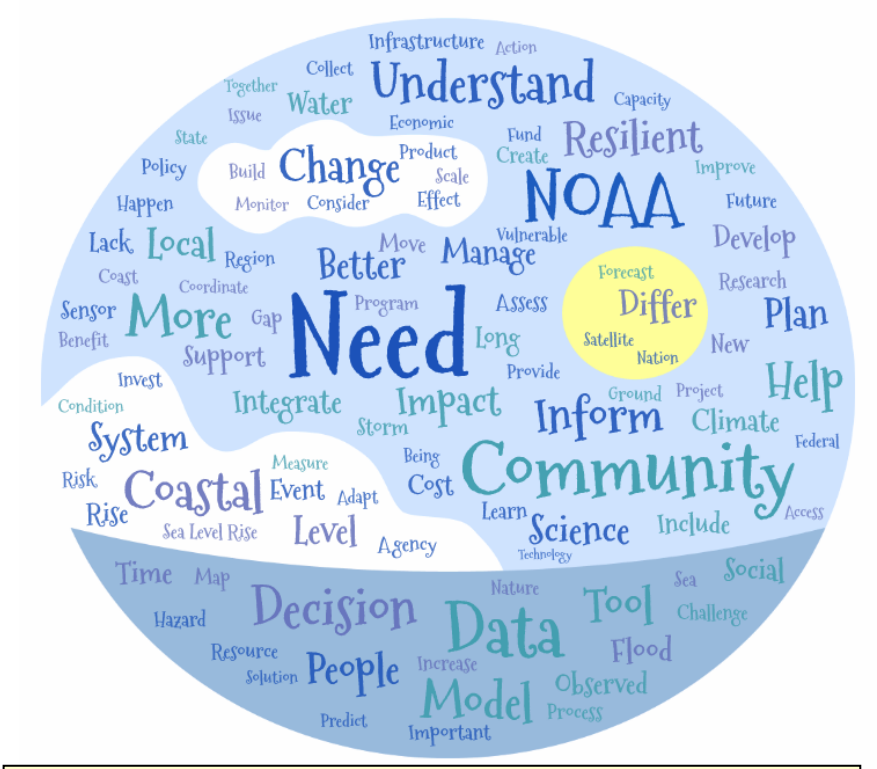
Recommendation 9:
Enhance and expand the network capacity and efficacy of NOAA and partner engagements at local and community scales (e.g., by evaluating program outcomes within and across programs, training, and development of peer leadership networks) to help communities and community decision makers identify and implement solutions that build coastal resilience.

Expected Outcome:
An increasing number of coastal communities can effectively and adroitly navigate complex decisions related to coastal resilience, more readily coalesce around solutions to major challenges, and become resources for other communities with similar needs.

Acknowledgements

This report was developed by ad hoc SAB workgroup including members of the SAB, the ESMWG and the CWG, with experience from New England, the Great Lakes, the South Atlantic, the Gulf of Mexico, and Alaska. The workgroup consulted with NOAA, including Mark Osler, Senior Advisor for Coastal Inundation and Resilience, and key staff from NOS, NMFS, NESDIS, OAR, and NWS. Discussions with broadly solicited stakeholder focus groups and more targeted meetings with NOAA partners were also conducted. Targeted meetings were held with the Integrated Ocean Observing System (IOOS) Advisory Committee, IOOS Association, Hydrographic Services Review Panel (HSRP) FAC, Sea Grant Association, and Digital Coastal Partnership. These discussions were designed to help inform the workgroup about the issues NOAA stakeholders and partners would like to see NOAA address to better support Coastal Resilience in the future. This included approximately 100 participants in all.

The workgroup used the discussions with NOAA, external partners, and the focus groups as a foundation for its deliberations and reflected on members' experience and knowledge of coastal resilience issues to develop the recommendations presented in this report.



Word cloud generated from the focus group discussion notes