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A Summary of Climate Change Impacts and Preparedness Opportunities for the Coastal Communities in New Jersey

This report is one of a series of working briefs prepared by the New Jersey Climate Adaptation Alliance to provide background information on projected climate impacts for six major sectors in New Jersey, including agriculture, built infrastructure (utilities and transportation), coastal communities, natural resources, public health, and water resources. These working briefs present information to be used throughout the Alliance's deliberations to develop recommendations for state and local public policy that will enhance climate change preparedness and resilience in New Jersey. These briefs are living documents that are periodically updated. This document updates a prior version from January 2013. For more information about the Alliance and its activities, visit *http://njadapt.rutgers.edu*.

This analysis provides an overview of adaptation planning for climate change as specifically relates to coastal communities. The first section of this report outlines background information on coastal communities in New Jersey, including a description of how the coastline is currently regulated and managed. The next section deals with the broad potential impacts of climate change on coastal communities, followed by a discussion of these impacts specific to New Jersey. Any current New Jersey efforts as well as current and planned adaptation practices and strategies in other states along the Atlantic Coast are presented as the basis for a series of recommendations as a starting point for discussion and prioritization of comprehensive adaptation planning for New Jersey. Although the focus is on impacts to coastal communities, particular attention is given to initiatives and strategies that can be undertaken at the state level, which offers the greatest opportunity for a more coordinated effort to respond and adapt to climate change.

Coastal Communities in New Jersey

New Jersey's Department of Environmental Protection defines 'coastal' as any land adjacent to a tidally influenced waterway for purposes of the public trust doctrine.[1] In this scoping paper, coastal communities will be defined as any community adjacent to a tidally influenced waterway. New Jersey has three primary coastal regions: the Atlantic Coast, which includes communities along the Atlantic Ocean and communities that lie inland of the Atlantic coast barrier islands such as those along Barnegat Bay; the Delaware Bayshore; and the urban coast which includes communities such as Jersey City and Hoboken that lie along the tidal portion of the Hudson River.

New Jersey has 127 miles of Atlantic coastline and approximately 1,800 miles of tidal shoreline.[2] Twenty of New Jersey's 21 counties are defined as coastal counties by the National Oceanic and Atmospheric Administration (NOAA).[3] These counties contain nearly 8 million residents, and this population increases dramatically during the summer months due to an influx of tourists.[4] Coastal communities play a critical role in New Jersey's economy; in 2008 tourism generated $27.9 billion, or 5.8% of the state's economy; half of tourism expenditures occurred in just three coastal counties: Atlantic, Cape May, and Ocean.[5]

Regulation of land use and development in New Jersey is primarily left to individual municipalities. As a home rule state, local governments have the authority to enact their own zoning regulations and other applicable laws affecting coastal development. However, because of the importance of the coast to the state's economy and because of the concentration of population in coastal areas, the state has taken an active role in coastal management.

1 NJDEP (2005)
2 New Jersey Sea Grant Consortium (2010)
3 NOAA (2012b)
4 NJDEP (2011a)
5 NJDEP (2010)

The Coastal Area Facility Review Act of 1973 (CAFRA) gives the state authority to regulate and approve the location, design, and construction of major new development in a designated 1,376 square mile coastal zone. CAFRA regulates construction of infrastructure facilities (e.g. energy facilities, new roads, wastewater treatment systems), industrial facilities, residential projects of 25 units or more, and all development on or directly adjacent to beaches, dunes and tidal waters.[6] The Wetlands Act of 1970 prohibits development in tidal wetlands.[7] The Waterfront Development Law of 1914 regulates construction within and up to 500 feet upland of water bodies, including construction of docks, bridges, bulkheads, and the like.[8] Following severe flooding in 2004, laws regulating development in flood hazard areas were made more stringent in 2007; CAFRA and Waterfront Development permits included a new requirement that the "lowest finished floor of new buildings be at least one foot above base flood elevation."[9] NJDEP also oversees the coastal dredging and shore protection efforts such as beach replenishment and installation and maintenance of bulkheads, groins, and seawalls through its Engineering and Construction Program.[10]

New Jersey has an unusually strong Public Trust Doctrine regulating access to the coast. The public has a right not only to horizontal access along dry beach, but also the right of perpendicular access to get to the beach. This right was upheld by the State Supreme Court in the 1984 Matthews v Bay Head Improvement Association case,[11] but is continually challenged in the state court system.

The federal government passed the Coastal Zone Management Act in 1972, which is a voluntary federal-state partnership designed to encourage states to develop coastal management plans. New Jersey participates in this NOAA-administered program and developed a federally approved coastal management program in 1978; the area covered by this program encompasses "all important coastal resources including transitional and intertidal areas, salt marshes, beaches, coastal waters and adjacent shorelands where activities have the potential to impact coastal waters."[12] The state's coastal jurisdiction extends three miles past the shore; beyond three miles is subject to federal jurisdiction.

FEMA's National Flood Insurance Program (NFIP) is another federal initiative that has a major influence on how coastal communities are designed and managed. All of the coastal communities in New Jersey participate in the NFIP; in order to be eligible for federal flood insurance, buildings must be designed to NFIP standards. Sixty-two New Jersey municipalities (11% of municipalities in the state) participate in the Community Rating System, in which communities whose regulations are more stringent than NFIP standards get discounted flood insurance. The majority of the participating communities are along the coast.[13] Additionally, most counties in NJ have produced all-hazard mitigation plans which, once approved by FEMA, qualify these counties for FEMA grant funding for mitigation planning.[14] Current FEMA mapping uses historical floodplain data, which does not account for future sea level rise. NJDEP uses FEMA elevations as the baseline for determining design standards.

As a matter of state policy, New Jersey pursues a strategy of shoreline protection. Living shoreline strategies such as beach replenishment and dune protection are preferred over hard armoring strategies such as construction of seawalls, groins, and bulkheads, which have been shown to have adverse impacts such as increased erosion. Nearly 50 million cubic yards of sand were pumped or dredged onto New Jersey beaches in the period from 1998-2007. In 2009, following a decline of federal funding for beach nourishment, NJDEP spent $19 million in state money and $6 million in municipal money for shoreline replenishment projects.[15] NJDEP

6 NJDEP (2002)
7 N.J.S.A. 13:9A-1
8 NJDEP (2002)
9 Mid-Atlantic Regional Council on the Ocean (2010)
10 NJDEP (2010)
11 CCSP (2009)
12 NJDEP (2002)
13 FEMA (2012)
14 Mid-Atlantic Regional Council on the Ocean (2010)
15 NJDEP (2010)

and ACOE continue to fund beach replenishment and shoreline protection projects in New Jersey.[16]

Sector Risks and Impacts

The impact of climate change on coastal communities has been heavily studied. Though there is always a need for better data and improved predictive modeling capacity, use of LiDAR technologies in mapping shorelines has enhanced the data available publicly and provided greater abilities to model and predict the effects of climate change on coastal areas.

The impacts of climate change on coastal communities will primarily result from two climate challenges:

1. Sea Level Rise
2. Extreme Storm Events

Sea Level Rise

Sea level has been gradually rising throughout the last half century, and the rate of sea level rise is predicted to accelerate as a result of climate change. The two primary ways in which sea level rise impacts coastal areas are by inundation and erosion. Inundation, in which land is directly submerged by rising sea levels, has the greatest impact on low-lying areas, with the extent of inundation determined by how rapidly the land slopes upwards. Sea level rise will also accelerate rates of coastal erosion, with the greatest impact on sandy shore environments. Removal of protective dunes, beaches, and wetlands as a result of erosion will lead to further land loss. Sea level rise may also cause the inland migration or drowning of wetlands and barrier islands.[17]

Development on coastal flood plains is especially vulnerable as a result of rising sea level. Some areas will be permanently inundated while others will experience more frequent flooding, both from normal tidal events and from storm surge, which will operate from an elevated base as a result of sea level rise. This will substantially impact the population and property in coastal communities. Coastal communities are at increased risk of flood-related damage to homes, businesses, and infrastructure, with major consequences for tourism, property values, and public health.

Extreme Storm Events

An increase in sea level implies that storm surges will operate from an elevated base, so severe coastal flooding will be more frequent in the future.[18] Coastal communities will therefore face an increased risk of damage from storm surges associated with extreme storm events such as hurricanes, tropical storms, and nor'easters. Storm surge occurs because water is pushed towards the shore by powerful winds inside cyclonic storms such as hurricanes; the winds cause water to pile up at the front of the storm system. Storm surges can be intensely powerful; the movement of the water itself, typically moving at 10-15 miles an hour, is highly destructive, and this damage is compounded by debris that gets carried along with the water, such as cars, boats, and trees, which can act as battering rams. In addition, there is damage caused by flooding and saturation, for example the shorting of electrical systems. Coastal communities must also deal with the aftermath of storm surges. Sediments, debris, and standing water get left behind; surge water is often contaminated with various biological and chemical pollutants which can create a host of environmental and public health challenges if not quickly and properly addressed.[19]

Vulnerable Groups

Given the potential effects of climate change on coastal communities, certain groups are particularly vulnerable:

- Residents and property owners in low-lying areas
- Elderly and disabled persons that are vulnerable to flood hazards due to limited mobility
- Low-income, minority, and immigrant communities with limited economic resources
- Individuals with mental illness

[16] NJDEP (2012b)
[17] CCSP (2009). See New Jersey Climate Adaptation Alliance Natural Resources Scoping Paper for a further discussion of the impacts of climate change on wetland resources.
[18] Broccoli et al. (2013)
[19] Botts et al. (2012)

Table 1: New Jersey Impacts and Risk for coastal communities as a result of climate change

Climate Impacts	New Jersey Risks
Sea Level Rise	• Loss of land due to inundation and erosion • Damage to public and private property as a result of inundation • Greater vulnerability to flooding due to higher storm surge from higher sea level base levels • Diminished tourism and tax revenues due to beach erosion
Extreme Storm Events	• Damage to public and private property from flooding, intense precipitation events, or storm surge • Risk to human life and public health from extreme storm events as well as subsequent water contamination

New Jersey Specific Impacts

The aforementioned risks to coastal communities are of particular concern to many areas in New Jersey. Specific impacts on New Jersey are discussed below.

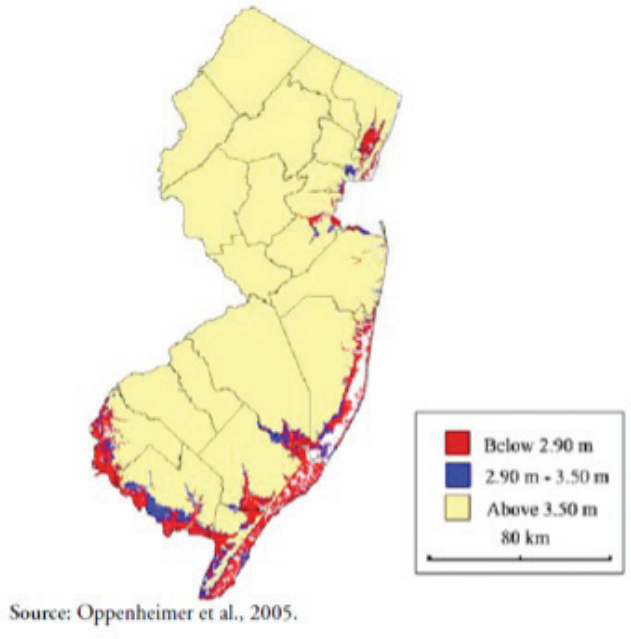
Sea Level Rise

The New Jersey coast is particularly susceptible to inundation for a number of reasons, including the presence of sandy beaches, low-lying barrier islands, and a flat coastal plain with a gradually sloping shoreline.[20] Much of the Jersey shoreline is gradually subsiding, compounding the effects of sea level rise.[21] New Jersey has already experienced relative sea level rise of 1.5 inches per decade at Atlantic City (15 inches total), where records have been kept since 1912. It is predicted that relative sea level in New Jersey will rise 13 to 28 inches by 2050, with a best estimate of 18 inches, and 30 to 71 inches by 2100, with a best estimate of 42 inches or 3.5 feet, taking into account both sea level rise and land subsidence.[22] Currently, approximately 353,353 acres along the New Jersey coast are exposed to extreme levels of flooding, meaning they are currently exposed to relatively frequent storms or chronic flooding.[23]

Much of New Jersey's development is concentrated along coastal areas. The Rutgers University Center for Remote Sensing and Spatial Analysis (CRSSA) identified that 48% of beach and dune systems along the Jersey Coast have development within 100m.[24] Because of this intensity of coastal development, a great deal of low-lying infrastructure such as roads, rails, bridges, parks, sewer systems, water treatment plants, and power plants are at risk in the event of sea level rise, as are the many private homes and businesses located near the coast. $80.8 million worth of residential land, $12.1 million of commercial land, and $2.4 million worth of industrial land in New Jersey are in coastal areas exposed to moderate, high, or extreme levels of flooding.[25] The cost of protecting existing development will be heavy; a 2000 estimate projected that the beach nourishment program alone would cost New Jersey $5 billion over the next half century; this does not include costs for other initiatives such as raising buildings and streets to account for sea level rise.[26]

As noted previously, coastal areas are key to New Jersey's economy, generating 70% of the state's tourism dollars.[27] Beaches erode rapidly as sea level rises, resulting in possible loss of recreational resources and tourism income for the state. New Jersey's coastal counties also contribute to the state economy through shipping,

[20] Cooper, Beevers, and Oppenheimer (2005)
[21] Frumhoff et al. (2007)
[22] Broccoli et al. (2013)
[23] Lathrop, Bognar, and Buenaventura (2014)
[24] Lathrop (2007)
[25] Lathrop, Bognar, and Buenaventura (2014)
[26] Cooper, Beevers, and Oppenheimer (2005)
[27] National Conference of State Legislatures (2008)



Estimated coastal land area susceptible to episodic flooding applying current 100-year flood water level (2.90 m) and 0.61 m rise in sea level (3.50 m) in New Jersey.

commercial fishing, and aquaculture.[28]

Extreme Storm Events

Coastal communities in New Jersey have already experienced billions of dollars in damage as a result of hurricanes, tropical storms, and the associated storm surges. With more areas vulnerable to storm surge as a result of sea level rise, these costs are likely to increase. An assessment of the economic impact of Hurricane Sandy estimates that the storm cost New Jersey $11.7 billion in lost gross domestic product (GDP), including $950 million in losses for the state's tourism industry. The state government estimated the costs of repair and reconstruction at $29.4 billion.[29] The costs of rebuilding will place a heavy burden on taxpayers at every level of government. Private insurers such as Allstate and State Farm have already stopped writing coverage for homes along much of the Atlantic Coast, including New Jersey, and those insurers who are still willing to provide coverage charge high premiums and deductibles.[30] Government-subsidized insurance programs such as the National Flood Insurance Program (NFIP) increasingly bear the burden, but heavy losses following Hurricane Katrina in 2005 undermined the solvency of the program. As of July 2013, the NFIP was $24 billion in debt.[31] In 2012, the U.S. Congress passed the Biggert-Waters Flood Insurance Reform Act to improve the solvency of the NFIP. Provisions include raising flood insurance rates to more accurately reflect flood risk and phasing out subsidies for repetitive loss properties.[32] In March 2014, Biggert-Waters 2012 was modified by the Homeowners Flood Insurance Affordability Act (HFIAA), lengthening phase out of subsidies to full actuarial rates for some property types ; thus, it is not yet clear how NFIP solvency will fare.[33]

New Jersey's coastal communities are vulnerable to a host of public health impacts in the wake of extreme storm events, including direct morbidity and mortality and mental health disorders resulting from repetitive stressors.[34] The loss of valuable cultural and recreational resources, such as the Jersey Shore boardwalks and beaches, is difficult to quantify but has an undeniable social and cultural impact on the state.

New Jersey Efforts to Address Coastal Vulnerability

The New Jersey Coastal Management Office, Jacques Cousteau National Estuarine Research Research, Barnegat Bay Partnership and Rutgers Center for Remote Sensing and Spatial Analysis developed the Getting to Resilience community planning and evaluation tool and the NJ Floodmapper website to assist local professionals and residents in the identification of their community's vulnerability to coastal hazards and sea level rise and

[28] NJDEP (2011a)
[29] Mantell et al. (2013)
[30] Frumhoff et al. (2007)
[31] Kousky and Kunreuther (2013)
[32] Grannis (2012)
[33] ASFPM (2014)
[34] NJCAA (2014)

to assess how well towns have incorporated adaptation and mitigation efforts into planning and preparedness processes and documents.[35] There are also several funding initiatives underway resulting from post-Hurricane Sandy efforts to address coastal vulnerability. For example, the New Jersey legislature appropriated more than $100 million in additional funding to the Blue Acres and Green Acres programs to acquire vulnerable lands in coastal areas following Hurricane Sandy (S2246, S2247, S2248); these bills were signed into law on January 25, 2013. As mentioned above, NJDEP and ACOE continue with beach replenishment projects along the coast.

Benchmark Adaptation Practices

Several states along the Atlantic Coast have developed comprehensive climate change assessments, adaptation plans, and local assistance programs address the vulnerability of coastal communities. Maryland has made substantial efforts to analyze risks to the state from climate change and develop appropriate mitigation and adaptation strategies. In 2008, the Maryland Commission on Climate Change released Phase I of their Adaptation Strategy, the "Comprehensive Strategy to Reduce Maryland's Vulnerability to Climate Change". Phase II was released in 2011, and updated sea level rise projections were released in 2013. A critical focus of Maryland's plan is to incorporate sea level rise adaptation planning into local comprehensive plans, codes and ordinances as well state plans and regulatory programs. For example, Maryland recommends revising the state building code to require buildings to have two or more feet of freeboard (height above base flood elevation), requiring deep-pile foundations in areas vulnerable to erosion, and requiring builders to use flood-resistant materials. In 2008 Maryland passed the Living Shoreline Protection Act, which limits shoreline protection improvements to soft-armoring measures such as marsh creation, except where the property owner can demonstrate that living shoreline measures are not feasible. They also amended the Chesapeake and Coastal Bay Areas Critical Area Act; this act strengthened the previous regulations and now requires local governments to adopt comprehensive plans, zoning ordinances, and subdivision regulations that meet Critical Area Commission criteria. Recognizing the importance of supporting local governments' implementation of adaptation strategies, Maryland launched a CoastSmart Communities program which provides grants, technical assistance, and other resources to assist municipal and county governments. An important step Maryland has taken is in acknowledging that it is not feasible or environmentally beneficial to protect all vulnerable coastal infrastructure; their Comprehensive Strategy recommends that decisions on relocating or abandoning infrastructure be done in combination with other comprehensive planning and emergency management decision-making processes at both state and local levels.[36]

Delaware's Sea Level Rise Initiative, launched in 2009, also strives to institutionalize the consideration of sea level rise in all local and state decision making. The final report, containing fifty-five policy recommendations for adapting to sea level rise, was released in September 2013.[37] Many of the recommendations focus on improving coordination between different agencies and levels of government, providing consistent and accurate data, and including sea level rise projections in existing decision-making processes. The Delaware program's goals include providing technical support for decision-making, implementing on-the-ground projects with local stakeholders, conducting educational and outreach activities, and improving state and local management policies and practices. Delaware publishes compendiums of sea-level rise projects currently underway in order to increase communication between different agencies and levels of government and to publicize the data, tools, and methodologies available. One project undertaken as part of the Sea Level Rise Initiative was the development of statewide sea level rise inundation maps. Many projects focus on local capacity building; the state provides technical assistance and grant funding to help communities plan for future impacts of sea level rise. One such project was a study of marsh depletion and changes in sedimentation at Bombay Hook.[38]

[35] JCNERR and BBP (2013); CRSSA and JCNERR (2013)
[36] Maryland Commission on Climate Change (2008, 2011); Mid-Atlantic Regional Council on the Ocean (2010); Boesch et al. (2013)
[37] Delaware (2013)
[38] Delaware Coastal Programs (2011), Mid-Atlantic Regional Council on the Ocean (2010)

Virginia's 2008 Climate Change Action Plan recommends that local governments be required to revise zoning & permitting ordinances to consider climate change and recommends implementing a requirement that infrastructure projects must be designed to be resistant to climate change in order to be eligible for state funding. Virginia's plan suggested that "the Virginia Marine Resources Commission (VMRC) should adopt shoreline protection policies that emphasize the use of living shorelines and seek to avoid shoreline hardening (bulk heads, sea walls, rip rap) wherever feasible."[39] Virginia's Coastal Zone Management Program promotes Living Shoreline management techniques and works with local governments to implement these techniques.[40] Like Maryland and Delaware, Virginia has an initiative which provides funding to municipalities to launch local adaptation planning projects.[41]

South Carolina has an active Ocean & Coastal Resource Management Program and developed a management report for adapting to shoreline change which was released in 2010.[42] However, planning for sea level rise in South Carolina is not new; the South Carolina Beachfront Management Act established a policy of gradual retreat from the shoreline over a forty-year period back in 1988.[43] The Act focuses on restricting hard coastal armoring, minimizing erosion, and gradually relocating development away from the coast.

New York City's recently released report "A Stronger, More Resilient New York", written to address the need for additional coastal resiliency planning following Hurricane Sandy, includes localized climate change projections and a risk assessment of how these changes will impact the city's residents and infrastructure. The report describes a series of proposed initiatives to improve the quality of climate analysis and information, and outlines several strategies for coastal protection, including increasing the height of coastal edges using bulkheads, beaches, and other measures, installing floodwalls and levees at selected locations, and evaluating the use of green infrastructure as a coastal protection technique.[44]

Georgetown Climate Center has developed an 'Adaptation Tool Kit: Sea-Level Rise and Coastal Land Use: How Governments Can Use Land-Use Practices to Adapt to Sea-Level Rise', which describes a wide range of planning and regulatory practices that can be implemented on the local level. Strategies include acquisition of flood prone properties, rebuilding roads and infrastructure to higher levels during ordinary rebuilding, implementing rolling easements along the coast, imposing design requirements in 500 year floodplains, limiting rebuilding of flood-damaged structures, revising building codes to improve building resiliency, and allowing for transfer of development rights away from the coast.[45]

A number of themes and recommendations have emerged which are similar from state to state:

1. Revise state plans and policies to consider climate change. Require local governments to revise land use plans, zoning codes, hazard mitigation plans, and other local plans and policies to take sea level rise into account.

2. Reduce the impact to existing built environments by requiring that public and private structures be elevated and designed to reduce damage. Analyze existing building codes and determine where changes should be made to make buildings more resilient.

3. Avoid future impact by directing new growth and development away from vulnerable coastal areas. Avoid assumption of the financial risk of development and redevelopment in hazardous coastal areas.

4. Protect and restore natural shorelines, including tidal wetlands and marshes, vegetated buffers, dunes, and bay islands, which act as natural buffers against flooding.

[39] Virginia Governor's Commission on Climate Change (2008)
[40] Virginia Department of Environmental Quality (2012a)
[41] Virginia Department of Environmental Quality (2012b)
[42] South Carolina Department of Health and Environmental Control (2010)
[43] South Carolina Coastal Tidelands and Wetlands Act (1988)
[4] PlaNYC (2013)
[45] Grannis (2011)

5. Build capacity of local governments by providing funding and technical assistance.
6. Develop a framework for making protection, abandonment, and retreat/relocation decisions.

Discussion and Recommendations

Hurricane Sandy provides a unique opportunity for New Jersey to rebuild with adaptation strategies for coastal communities in mind. It is critical to focus not only on near-term recovery, but to undertake long-term planning efforts and make decisions that will enhance future resiliency. Given the risks to New Jersey's coastal communities as a result of sea level rise and extreme weather events, and an understanding of the measures nearby states have implemented, recommendations to consider include:

1. Improving coordination between different agencies and levels of government and facilitating multi-jurisdictional planning efforts.
2. Developing standard statewide projections for sea level rise and other climate change impacts, and requiring that these projections be incorporated into public decision-making processes.
3. Engaging and educating the public and government officials on climate change risks and adaptation strategies.
4. Evaluating the long-term cost effectiveness of different development scenarios, techniques, and options for coastal resiliency and engaging local communities to determine preferred future development patterns for coastal communities.
5. Reviewing statewide building codes, comprehensive plans, maps, etc. and recommending changes that would enhance climate resiliency and remove barriers to implementing adaptive actions.
6. Developing sustainable funding streams to build the capacity of local governments to implement climate adaptation strategies.

Table 2 : Specific areas for investigation based on leading practices and recommendations

New Jersey Adaptation Need	*Potential Initiatives for Investigation and Projects*
Cost Benefit Analysis of Coastal Management Measures	• Assess the cost of rebuilding homes, businesses, and infrastructure after flood and storm damage. Quantify potential future costs of repeated rebuilding in areas vulnerable to storm surge and sea level rise. • Evaluate the costs of existing shoreline replenishment and coastal armoring programs. • Assess the cost of expanding natural shorelines programs and land acquisition and conservation easement programs. • Assess the benefits of using natural infrastructure such as marshes and oyster reef breakwaters. • Analyze the insurability of coastal development • Evaluate the financial impacts on local tax and tourism revenue if a policy of retreat were to be adopted.
Integrate Climate Adaptation with Planning and Regulation Processes	• Account for climate change and adaptation planning as a required element of master plans, infrastructure planning, and emergency management. • Review current regulation with a focus on climate adaptation including: o Floodplain definitions and regulations o Permitting o Design and construction standards. For example, increase required freeboard. • Review zoning and land use in the context of climate adaptation, including consideration of coastal setbacks and buffer areas. • Review regulations for rebuilding structures destroyed by natural hazards; consider placing restrictions on rebuilding. • Regulate the construction of hard-engineered structures for flood and erosion control; facilitate permitting for soft coastal protection measures.
Engage Local Communities and the Public	• Work with communities to establish preferred development patterns that incorporate climate change considerations. • Provide technical assistance, research, and funding to local governments for implementation of climate adaptation strategies • Assist communities in implementing strategies that support desired land uses, including rolling conservation easements, tax incentives, and transfers of development rights. • Develop effective risk communication on cumulative impacts of climate change for local governments and the general public.

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