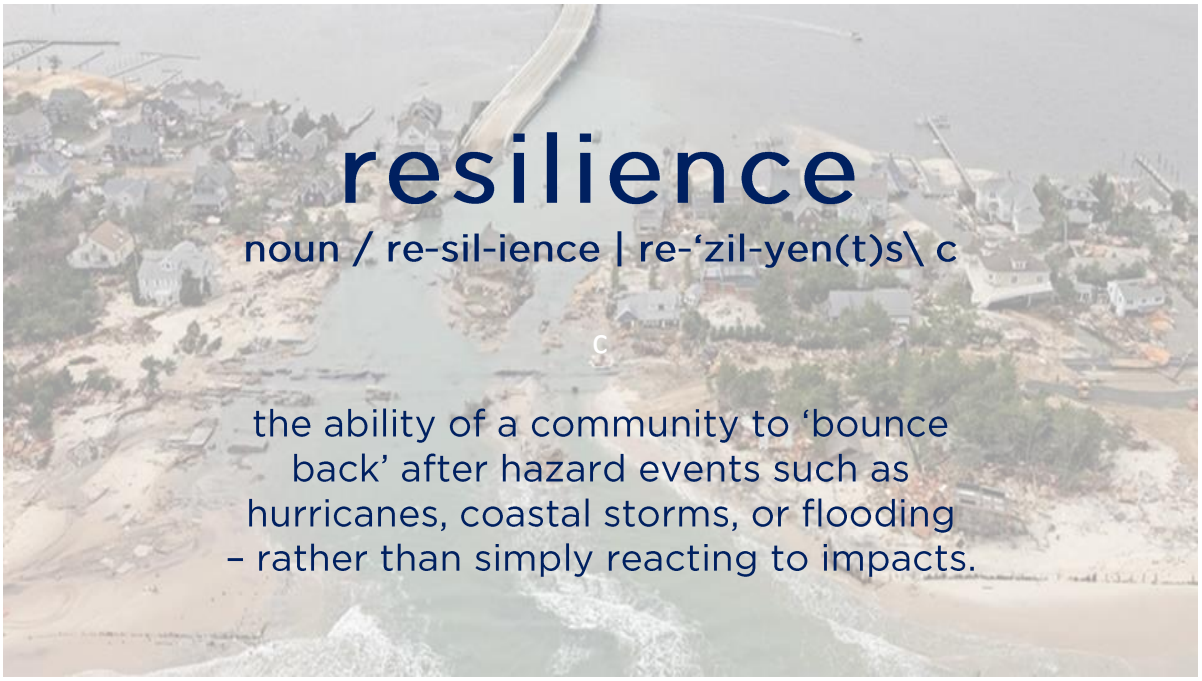
4/2019

Local Options/Local Actions

Resilience Strategies Case Studies

PREPARED FOR THE NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION



NEW JERSEY FUTURE

Contents

Appendices

A Note of Appreciation
Interviewees

Preparing case studies that comprise the main body of this report would not have been possible without the assistance of individuals who developed and administer the various policies, and programs on which the case studies are based. Below are the names and affiliations of the individuals who were interviewed and who kindly provided insights into their work.

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Part 1: Introduction

a. Context

New Jersey's coastal communities face risks from rising sea levels, erosion, and coastal storms that are likely to have profound impacts on land-use and development patterns. Scientific analysis reveals that flooding and storm damage will occur at an increasing pace into the foreseeable future.[1] These conditions have the potential to cause considerable property damage, loss of property value and declines in municipal tax revenues.

A number of factors make it clear why assessment of climate-change risks, and actions to address them, are urgently needed. Information from New Jersey's Department of Environmental Protection, Coastal Management Program, indicates that 239 of New Jersey's 565 municipalities are coastal communities. These towns encompass approximately 3,145 square miles, or more than one third of the area of the state. These communities are home to approximately 4,603,000 people, or more than 52 percent of the state's total population.[2] Research currently being conducted by Rutgers University indicates that there are 334,095 parcels of land in New Jersey located within FEMA's 1 percent and 0.2 percent Flood Hazard Areas. These parcels have a total value of $175.5 billion (land value plus improvement value).[3] Although the value of coast property continues to increase at the present time, a report released February 27, 2019, describing research being conducted by the First Street Foundation and Columbia University, indicated that those values would be considerably greater if the coast was not being threatened by shoreline erosion, regular flooding and sea-level rise. The report indicated that New Jersey experienced the second greatest loss in home values ($4.5 billion), among 17 states analyzed, due to these conditions. According to a 2017 study, New Jersey's shore-based tourism industry accounted for 328,560 New Jersey jobs and contributed $4.8 billion in state and local tax revenues. For these reasons, it is vitally important to the state that communities enact strategies that will minimize the extent of their exposure to coastal risk and increase resilience to flood events and sea-level rise.

The combination of a subsiding coastline, increasing rate of sea-level rise, and accelerating frequency and severity of storms points to a growing threat to the viability of every New Jersey community that borders a tidally-influenced waterway. However, discussing climate-related risks, let alone the actions that may be necessary to address them, is extremely difficult for local officials in shore communities that have a well-established cultural as well as financial connection to their patterns of development. Without support and guidance, municipal officials are often ill-equipped to address the risk to their communities of climate change, or to discuss these risks with their constituents. These discussions can be particularly difficult when they involve the potential for altering long-standing patterns of land use and development.

However, if these issues remain unaddressed, municipal officials are likely to perpetuate the flood-rebuild-flood pattern of storm-damage response to which communities along New Jersey's coastline have adhered for decades. The common practice following a storm event is to rebuild in place as quickly as possible, putting people and property back in harm's way, rather than consider likely future risks and chart a course for resilient coastal development.

[1] Assessing New Jersey's Exposure to Sea-Level Rise and Coastal Storms: Report of the New Jersey Climate Adaptation Alliance Science and Technical Advisory Panel, NJ Climate Adaptation Alliance, October 2016

[2] 2010 census data

[3] Lucas Marxen. 2018. Applications of MOD IV Tax Record Database to Coastal Flood Exposure Hazards

In the interest of remedying this practice, this report presents detailed descriptions of initiatives local officials can consider adopting in order to respond to growing risks associated with sea-level rise and climate change. Each of the strategies described in the case studies presented in **Section 2** of this report are either planned or are currently applied practice in municipalities throughout the country. The objective of the case studies is to recount experiences and provide real-world examples of policies and programs that New Jersey municipal officials can readily apply to their resilience planning.

b. Importance/challenge of local-level strategies

In the long-term, addressing sea-level rise associated with climate change is, at its core, rooted in land use. This is because current science-based sea-level rise projections indicate that achieving resilience in the face of a changing climate, will eventually require considerable changes in development patterns – how we build, where we build and what we build. The challenge New Jersey faces is that, as a home-rule state, control of land-use, zoning and development regulation rest entirely in the hands of local decision makers who often perceive that the risk they must confront is the possible threat to their tax base. Of course, New Jersey is not alone in grappling with this dilemma. All but two U.S. states have enacted either home rule or Dillon's rule - and most have conferred land-use planning and regulatory power to municipal jurisdiction.

If planning to address climate change-risks could begin with a clean slate, it's unlikely that it would start by creating 565 independent municipal entities that control the fundamental elements that can dictate resilience. But these are the circumstances with which New Jersey must contend. As a result, learning how to help local officials take actions they may be reluctant to consider is absolutely essential if there is any likelihood of confronting climate-change in a meaningful way.

In New Jersey, as with other home rule states, local governments are on the front line of risk response as it relates to land-use and development impacts. Local elected officials, planning boards, and boards of adjustment are the primary arbiters of the location, form, and intensity of municipal development. These local bodies exercise considerable influence over a community's development pattern and, through the planning and development approval process, hold substantial sway over the extent to which a municipality is prepared to respond to risks of future climate-change hazards. New Jersey's land-use laws delegate discretion (although not explicitly – see **An important first step – revise the MLUL**, below) to municipal officials whether to consider sea-level rise projections in order to enact adaptation and mitigation strategies. Through local plans, land-use and development decisions, and capital investments in local services and infrastructure, municipalities can minimize considerably their exposure to storms and the expense of recovery and adaptation. In fact, since Hurricane Sandy several New Jersey communities have taken initial steps to identify, quantify, and mitigate coastal risks.

However, New Jersey has been developing densely and extensively along its 1,800 miles of tidal coastline and fragile barrier islands for more than three centuries. Over several generations, living and recreating at the shore has become deeply rooted in the social and cultural psyche of New Jersey residents. Unfortunately, it is becoming apparent that these patterns of development have left many people and structures dangerously vulnerable to climate-change impacts. Scientific analysis reveals that flooding and storm damage will occur at an increasing

pace into the foreseeable future.[4] As noted above, these conditions have the potential to threaten community viability considerably. There is also growing recognition and concern that in some places along the coast, rising sea levels will result in increasingly intense flooding on a recurring basis. Local officials who represent New Jersey communities need to re-imagine coastal development patterns and institute pre-emptive, effective adaptation and mitigation strategies ***before*** nuisance flooding becomes a far more regular threat, tolerance to accommodate inundation is exhausted, and communities are no longer socially or economically sustainable.

c. Project Objective

New Jersey has long been a national leader in effective planning, land-use, and resource protection. Local and regional initiatives, such as the Pinelands' Transfer of Development Rights program and the revenue-sharing program developed in the Meadowlands, served as groundbreaking models of innovative and effective strategies to protect vulnerable resources that are critical to the economic, social, and environmental character of the state. A similar, forward-thinking approach is needed to respond to the climate-change risks New Jersey faces, particularly as storm events and sea-level rise regularly threaten our coastal and riverine communities.

Fortunately, coastal states, regions, and local entities throughout the country have initiated climate risk-response programs, and enacted policies and regulations that can serve as models and help to guide New Jersey municipalities' efforts to promote resilience. The objective of this research project is to present case studies of innovative and effective management practices, policies and programs that that are being applied by local and regional governments throughout the country that can provide insights into resilience strategies New Jersey's local decision-makers can employ, how the strategies can be enacted, and what those strategies can accomplish.

Many coastal states in the United States, with populations that are as vulnerable to the impacts of sea-level rise as residents of New Jersey, are implementing strategies intended to reshape existing development patterns, preserve economic vitality, protect natural and historic resources and community culture, redirect infrastructure investments, shift development in flood-prone areas, and communicate climate-change risks effectively – particularly in socially vulnerable communities. Adopting or building on the experiences, policies, programs, and strategies employed elsewhere can equip New Jersey to respond more effectively to, and mitigate or avoid potentially devastating impacts from, rising sea levels and a changing climate.

[4] Assessing New Jersey's Exposure to Sea-Level Rise and Coastal Storms: Report of the New Jersey Climate Adaptation Alliance Science and Technical Advisory Panel, NJ Climate Adaptation Alliance, October 2016

Part 2: CASE STUDIES

In order to develop this report, New Jersey Future conducted a nationwide exploration (although we immigrated [sic] to Mexico in one case) to identify, research, and describe strategies planned or being implemented by municipalities and regions throughout the country that are intended to respond to sea-level rise. A total of 350 strategies were identified that are being applied in 76 cities or regional areas. It is important to note that this research is intended to be illustrative; because the field of resilience continues to evolve rapidly and new strategies are being developed continuously, it is not practical or possible for this effort to be exhaustive.

a. Strategies Typology

To organize this research effort, New Jersey Future applied a strategies typology, developed in consultation with NJDEP OCLUP staff, that included the following six categories:

1. Planning
2. Regulatory
3. Ecological
4. Economic
5. Social
6. Communications/Outreach/Education

Detailed case studies have been assembled for 15 strategies, each of which fell into one of the above categories, was deemed to be particularly innovative, would serve as a model for resilience initiatives, and could be adapted and adopted readily for application by New Jersey municipalities.

It is important to emphasize that no single strategy will yield resilience. Effective local-level response to climate change impacts will need to encompass a combination of plans, policies and implementation actions based on each individual community's vulnerability, development patterns, financial resources, risk tolerance, preparedness, and public support for action. Also, to add a little complexity to this mix, all of these variables exist in a constant state of flux since climate risks will increase over time, and the public's understanding of the implication of those risks will, we hope, grow. Consequently, the list of response strategies a municipality elects to enact is likely to expand as its tolerance for risk diminishes and/or the need for more ambitious strategies is warranted. For these reasons, communities must have access to a menu of options, processes for their enactment, descriptions of possible pitfalls, estimates of implementation costs and benefits, and an assessment of the useful life of any particular strategy. The options menu should also be updated regularly to stay current with the growing number and variety of new strategies that are being introduced throughout the country.

The strategies evaluated in the course of assembling this report can be implemented at the local level, for the most part. However, funding that would be necessary to implement some, most notably buyouts associated with relocation, will require considerable financial contribution from the state (other possible funding strategies are suggested in **Case Study 12**, below). For others – for example, transfer of development rights – a regional or state-wide area of implementation (to designate sending and viable receiving areas) will be necessary.

The local resilience case studies included in this report are listed below according to the strategies typology:

Planning

1. Promote high-density, compact, mixed-use development – Burlington, VT

Regulatory

2. Restrictive redevelopment standards – Durham, NH
3. Resilient quotient system – Norfolk, VA

Ecological

4. Shoreland protection overlay district – Durham, NH
5. Created shoreline protection – Palm Beach County, FL
6. Beach erosion control with natural biopolymers – Progreso, Mexico

Economic

7. Transfer of development rights – Norfolk, VA
8. Infrastructure concentration in most resilient areas – Norfolk, VA
9. Flood adaptation tax credit – Annapolis, MD
10. Special tax district – San Francisco, CA
11. Capitalize on economic opportunities of emerging resilience-based industries – Norfolk, VA

Social

12. Voluntary climate change relocation – Shishmaref, AK
13. Empower vulnerable communities – Southeast Florida Region

Communication/Outreach/Education

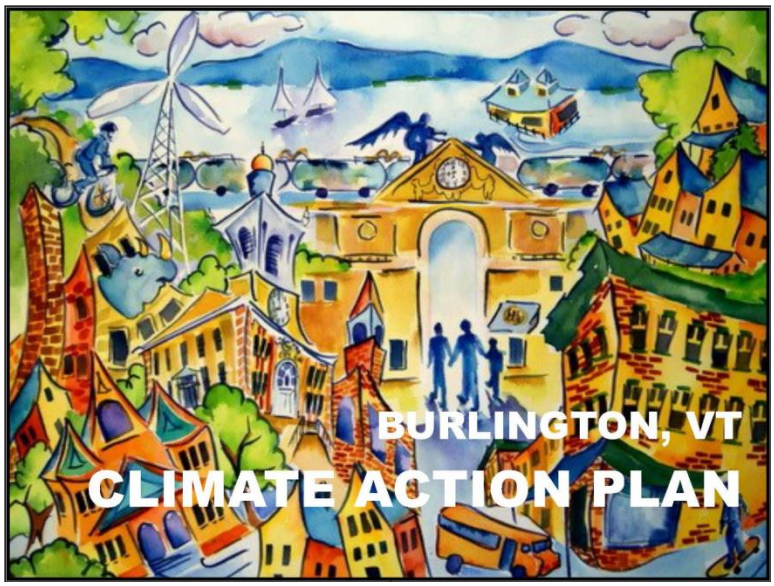
14. Unified sea-level projections – Southeast Florida Region
15. Flood risk disclosure – Durham, NH

b. Case Studies - Planning

1. High-density, compact, mixed-use development – Burlington, VT

ACTION

Promote compact, mixed-use, development and reduce auto dependency specifically to reduce a municipality's carbon footprint.



DESIRED OUTCOME

According to the City of Burlington's Climate Action Plan, studies of residential development have found that high-density development emits less than half as much greenhouse gas (GHG) per capita as low-density development. The plan points out that the National Academy of Sciences, in a recent study commissioned by Congress, found that compact mixed-use development is likely to reduce vehicle miles traveled (VMT) and could reduce energy use and greenhouse gas emissions both directly and indirectly.

Burlington's Climate Action Plan outlines specific actions the city intends to take to address climate change impacts and reduce greenhouse gas emissions and pollution, protect the environment, improve human health and economic vitality, and create a more livable community. The Climate Action Plan is an outgrowth of the city's comprehensive plan, planBTV, an updated draft of which was released in January 2019, and a companion document, planBTV - Downtown & Waterfront, which stresses the need to build more, and more affordable housing in Burlington's downtown. The city contends that additional housing density will enable more people to live closer to their workplace and services, thereby reducing auto dependency, resulting in lower energy costs and a smaller carbon footprint. The plan also proposes the placement of neighborhood activity centers throughout the city to provide opportunities for bringing housing, shopping, working, playing and transportation choices closer together and encourage pedestrian activity and bicycle use. The plan indicates that connecting these activity nodes with frequent and convenient transit will ultimately create a more efficient and inclusive transportation system.

Burlington's climate action plan is intended to establish a detailed, strategic framework for measuring, and reducing greenhouse gas (GHG) emissions and related climatic impacts. The city uses the plan as a customized roadmap for making informed decisions and to plot how it intends to achieve the largest and most cost-effective emissions reductions that are in alignment with other municipal goals identified in a variety of elements of its comprehensive plan. The climate action plan includes an inventory of existing emissions, reduction goals or targets, and analyzed and prioritized reduction actions. It also includes a detailed implementation strategy that identifies required resources and funding mechanisms and designates the individual or city department that will have chief responsibility to lead each effort.

Burlington's climate action plan is intended to accomplish the following specific objectives (responsible departments for each are noted in parentheses):

1. **Promote an active and vibrant downtown and waterfront core**. planBTV-Downtown & Waterfront presents a good framework for the promotion of a vibrant downtown. (All departments)
2. **Offer urban infill development incentives in the city core and densest activity centers through zoning**. Continue to ensure that zoning regulations incentivize and allow for compact mixed-use development to occur in neighborhood activity centers. (Planning & Zoning)
3. **Expand housing choices and grow the downtown housing supply to create more live/work opportunities.** Remove existing regulatory barriers to the development of more housing downtown and provide additional incentives through regulations, programs, etc. (Planning & Zoning).
4. **Expand transportation choices and the Complete Streets system.** Implement the 2011 Transportation Plan to the greatest extent possible, ensuring that a Complete Street approach is taken for every reconstruction or redesign project. (Public Works)
5. **Encourage energy-efficient building siting, design and operation through zoning**. Develop a form-based code that will ensure efficient building design and siting and continue to require the use and implementation of the Energy Code. (Planning & Zoning)
6. **Expand the comprehensive stormwater management system to incentivize low-impact development technologies.** Develop and implement additional stormwater management policies for new development and find ways to incentivize their use. (Public Works)
7. **Create a more predictable development permitting process.** Develop a form-based code that improves the development review and permitting process, increasing its predictability for developers. (Planning & Zoning)

FACTORS TO CONSIDER

According to the city's sustainability officer, Burlington is fortunate to have a well-educated, environmentally aware population and government officials. The city's council *universally* adopted the Burlington Climate Action Plan. The various components of the strategy to promote compact, mixed-use development were not new, but came out of the city's municipal development plan, which focused on sustainable development. Because the city was well acquainted with these strategies it was not difficult to generate support from residents and elected officials. The municipal development plan evolved into planBTV, which was unanimously adopted in 2013 after a three-year vetting process. planBTV incorporates downtown Complete Streets design standards, a form-based code, a downtown parking management strategy, and concentrated downtown development. The city has been working to implement these concepts since at least 1996. The community has been reluctant to grow upward but is gradually coming to understand the need to allow greater height in the downtown. Mixed-use development has long been understood to be a fundamental downtown development principle. The city invests in, manages, and maintains CityPlace, a mixed-use downtown district.

APPLICATION IN NEW JERSEY

New Jersey is well acquainted with the principles of smart growth, and several long-standing initiatives have been implemented in the state to reduce sprawl and promote compact development. New Jersey Future, along with several other state-based organizations and institutions, has advocated actively for responsible development patterns; conservation and

preservation of environmental resources; compact, mixed-use, center-based growth; and transit-oriented development. However, to date, these initiatives have not been designed specifically to achieve resilience objectives. Given that municipalities throughout the state have been perusing these principles for many years, gaining acceptance to consider them as guidelines for resilience planning may not be a difficult to achieve in New Jersey, however, resistance to increased housing density in many suburban communities and relatively low gas taxes will continue to present barriers to their widespread application.

CO-BENEFITS

- Enhanced municipal economic vitality and social interaction
- Enhanced housing affordability and choice
- More efficient use of natural and built resources, and lower energy costs
- Expanded focus on pedestrian accessibility and bicycle use while reducing auto dependency

MEASURES OF EFFECTIVENESS

Burlington retains and has posted detailed records of the city's greenhouse gas emissions trends, in three-year intervals, since 2007. Data are provided for electricity emissions, natural gas emissions, transportation emissions, and solid waste emissions. Tracking these data over time should enable the city to monitor whether implementation of the development principles outlined in planBTV and its Climate Action Plan help reduce emissions levels. However, development changes are slow to register, and the city will have to monitor several additional cycles before the data yield meaningful trend information.

FUNDING SOURCES

In New Jersey, this strategy would ordinarily be incorporated into the municipal master planning process. Vermont's Municipal and Regional Planning and Development Act (V.S.A. Title 24, Chapter 117) requires municipalities to update their comprehensive plans every five to eight years, Burlington typically does so on a five-year cycle. In comparison, New Jersey's MLUL requires that municipal master plans be updated at 10-year intervals. Regardless of what interval various state enabling legislation specifies, re-examination of a municipal master plan is the ideal opportunity to incorporate an assessment of climate change risks, and strategies to promote resilience, into a municipality's long-range plans, regulatory requirements, and capital investment strategies.

Municipalities typically pay the costs of preparing a master plan reexamination or a comprehensive plan update. However, in FY 2000, New Jersey instituted the Smart Growth Planning Grant Program, which provided financial and technical assistance to counties and municipalities to prepare or update master plans, among other planning efforts. Unfortunately, this program was discontinued in FY 2008. These grants had been an important funding source that encouraged sound municipal planning. Given the growing climate change risks that municipalities throughout the state are facing and in light of the urgency for sound and effective resilience planning, this program should be reinstated.

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Vermont Planning Manual, retrieved December 2018 at: https://accd.vermont.gov/sites/accdnew/files/documents/CD/CPR/DHCD-Planning-Manual-Module1.pdf

c. Case Studies - Regulatory

2. Restrictive Redevelopment Standards – Durham, NH

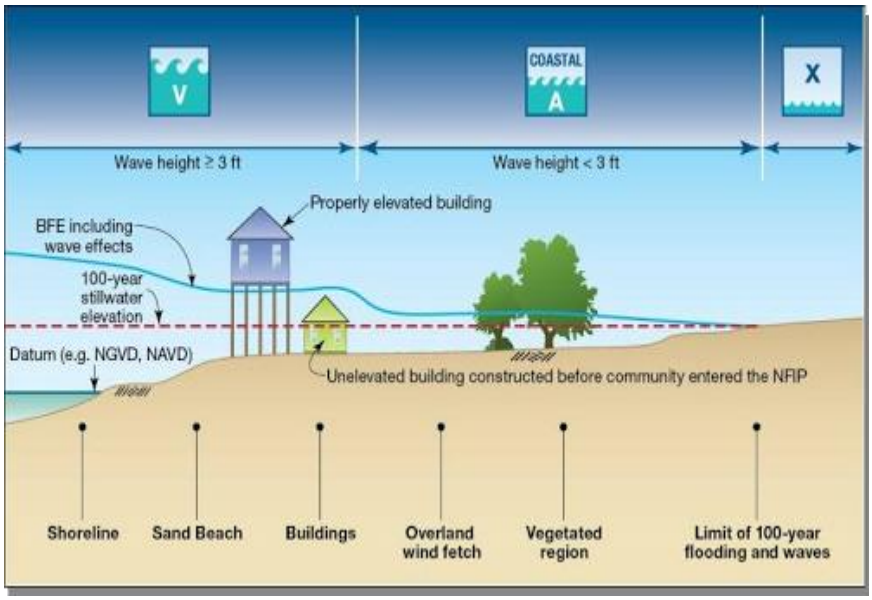
ACTION

Regulate shoreline development in potential sea-level rise hazard areas using zoning, subdivision and site plan regulations, and/or special overlay districts that specify conditions for use and development.

DESIRED OUTCOME

Prohibit redevelopment in areas that have been damaged repeatedly and severely by storms and/or chronic flooding.

Pursuant to the MLUL, New Jersey municipalities have the authority to regulate land use through formulation of a comprehensive master plan that guides physical development, and by enacting zoning laws consistent with the master plan (Harrison and John-Basta, 2018).



Source: FEMA Region II Coastal Analysis and Mapping

Much of New Jersey's coastal development occurred prior to recognition of the threat of increasing damages from potential sea-level rise or recurrent flooding. Monitoring and modeling of climate conditions have demonstrated that the state can expect the trend of increasing rainfall frequency and intensity to continue, and sea-level rise to increase the frequency and extent of extreme flooding associated with coastal storms.[5] The risk of repetitive flood or storm damage for coastal communities is continuing to rise, and it may not be sustainable for municipalities to use limited resources for rebuilding in certain high hazard areas. Local measures can be taken to prevent future losses by adopting appropriate land-use policies. A municipal master plan can identify high risk areas and prohibit redevelopment in those areas after they have been destroyed by storms or affected by chronic erosion. Development setbacks that account for potential sea-level rise can be established, and redevelopment can be directed to centers outside of high hazard areas, where overlay zoning can require mitigation standards for redevelopment in areas that are affected by storms or chronic flooding.

Municipal adoption of restrictive redevelopment standards is a recommended strategy in a climate adaptation report prepared for Durham, New Hampshire (Pimental, 2013), and in a coastal resilience initiative report prepared for the City of Portsmouth, New Hampshire (CPPD et al., 2013). The Durham report was developed with the expectation that the local planning board would use the findings and recommendations as resource and guidance in the Durham Master Plan update, and it was also included as an appendix in the 2017 Durham Hazard Mitigation Plan. Because Durham has already limited flood risk significantly by preserving more

[5] USGCRP 2017

than a quarter of the town for open space; is not located directly on the shoreline; does not experience extensive repetitive loss; and has not been hit with an event resulting in massive damage, local officials have not yet integrated this recommendation into the Durham Master Plan. If Durham does experience high loss or damage, however, the town is equipped with updated information to help it implement this recommendation, and the report is included in the appendix of the master plan for reference. A main benefit of the report at the time was that it served as a stepping stone for local government and stakeholder engagement and action in Durham (Pimental, 2018).

The first climate adaptation master plan chapter adopted in New Hampshire was passed by the City of Dover, New Hampshire, planning board in February 2018 (DPCD, 2018). Dover is working on a variety of projects to implement actions identified in the adaptation chapter, including updates to conservation scoring and criteria in preservation funding, and allocation of dedicated funding to integrate adaptation planning into municipal decision making (Pimental, 2018).

The City of Portsmouth, New Hampshire, is considering for adoption at an upcoming 2019 city council meeting a municipal floodplain overlay zone ordinance (Britz, 2018). The Portsmouth floodplain overlay zone sets mitigation standards for redevelopment by requiring structures in areas affected by storms and chronic flooding to be elevated two feet above base flood elevation for a remodel of 50 percent or greater and for new construction. Because the city is of a historic character, the town is also developing a historic ordinance that incorporates resilience incentives into historic renovation. Incentives may include waived fees or certain approvals granted for remodels that retain historic components while increasing resilience; or incentives for elevation of structures at a neighborhood scale that would retain a consistent cultural or historic character (Britz, 2018).

Urban Flooding has Social Implications

In April 2018, FEMA released a report on the affordability of flood insurance and provided data on the distribution by income of those purchasing insurance under the NFIP. The data indicated that low-income households are less likely to purchase flood insurance than higher-income households, even though low-income families are more likely to live in high-risk flood zones (low-income was defined as less than 80 percent of the area median income). The data indicated that slightly more than 50 percent of households located in the 100-year floodplain (SFHA) that did not have insurance were low-income. It also stated that of those households in the SFHA that had NFIP insurance, only 26 percent were low-income. The Natural Resources Defense Council noted that median income of households without flood insurance was only $40,000, and, "with the average policy costing $1,098 per year, those that can least afford to pay for flood insurance are those who can least afford to be without, given a high level of risk."

FACTORS TO CONSIDER

Efforts to restrict coastal development can be resisted by property owners, community members, developers or builders' groups. Beach properties often represent a significant portion of the tax base in coastal communities, and members of coastal communities can also have a strong "identity connection" to shoreline development or a strong attachment to property rights. Economic and cultural complexities are not necessarily contradictory to restrictive coastal redevelopment standards, and they should be integrated into the planning process through ample public education and participation. Maps depicting municipality-specific sea-level rise projections and future risk are not only key for land-use planning but are also an indispensable means to inform and engage communities in the adaptation planning process. Discrepancy may exist between FEMA flood hazard area maps and projected flood risk maps. Effort should be made to update regulatory maps as appropriate, and all property

owners in the projected flood risk areas should be encouraged/required to comply with the zoning standards, regardless of participation in the National Flood Hazard Insurance Program.

APPLICATION IN NEW JERSEY

New Jersey is a home-rule state in which municipalities have local jurisdiction to regulate land use. Although the MLUL statute does not include climate adaptation or resilience as a required or discretionary component of a municipal master plan, it does provide the framework for municipalities to integrate adaptation and resilience planning and regulation into local ordinances, a capital improvement program, development application submission and review procedures, and a master plan map to guide development. The restrictive redevelopment strategy is an ordinary municipal administrative function. Depending on the local governance structure, the mayor or committee would adopt a restrictive redevelopment standard ordinance developed or reviewed by the planning board, overseen by the planning board as part of the building permitting process and enforceable by the zoning officer.

CO-BENEFITS

- Protection of natural resilience buffers and habitat
- Restoration of dunes and environmentally sensitive areas
- Enhanced shoreline recreation and tourism opportunities
- Reduced harm to homes, businesses, infrastructure and people
- Reduce cost associated with rebuilding existing or constructing new public services and infrastructure
- More efficient and effective evacuation, improving public safety

MEASURES OF EFFECTIVENESS

- Percent sea-level rise hazard area undeveloped; higher percentage undeveloped area scores higher
- Proportion of post-damage area redeveloped versus converted to natural area; lower proportion redeveloped scores higher
- Number of municipalities with coastal redevelopment ordinances on the books and enforced; goal should be all tidally influenced municipalities
- Number of times a coastal property is redeveloped post-damage; provides transparency and tracks efficiency of resource allocation toward resilient redevelopment, potentially prompting policy to limit to the number of times redevelopment is permissible on a property

FUNDING SOURCES

Although no direct funding exists for municipal planning or regulatory functions, funding for planning reports and assessments may be available from one of the three municipal planning organizations: Delaware Valley Regional Planning Commission, South Jersey Transportation Authority, and the North Jersey Transportation Planning Authority. Federal funding sources may include: the Federal Emergency Management Agency, the National Oceanic and Atmospheric Administration, the Department of Housing and Urban Development, and others. Competitive grant opportunities are also available from various organizations to promote climate adaptation and resilience in local communities.

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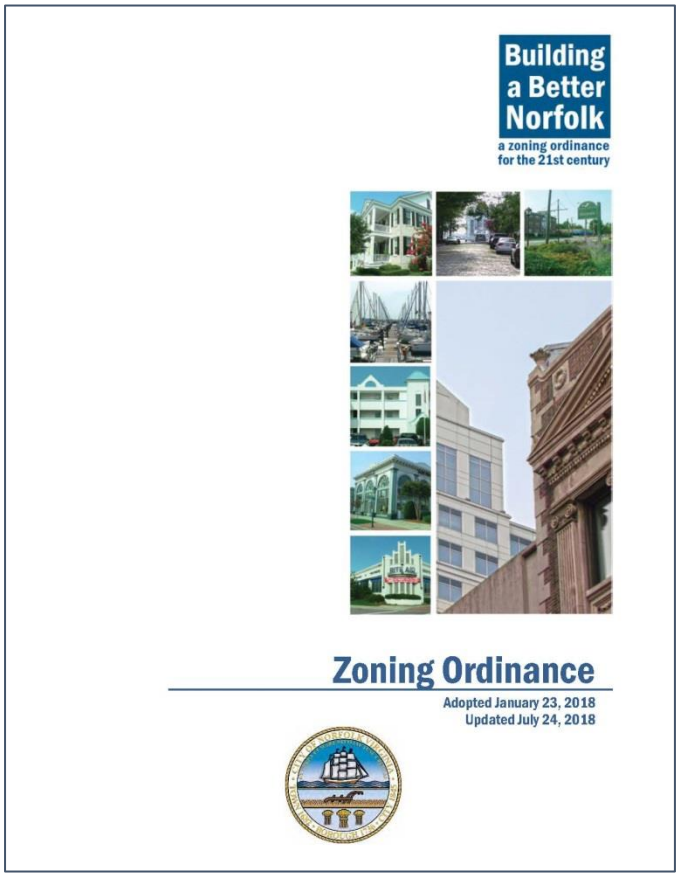
3. Resilient Quotient System – Norfolk, VA

ACTION

Harness market forces to encourage land owners and developers not to build in high-risk, flood-prone areas. Prohibit redevelopment in areas destroyed by storms or chronic flooding.

DESIRED OUTCOME



In January 2018, the City of Norfolk, Virginia, adopted a new zoning ordinance that is intended specifically to enhance flood resilience and shift new, more intense development to higher ground. The zoning ordinance became effective on March 1, 2018, The new zoning regulations are a direct outgrowth of a planning process the city initiated in 2013 that resulted in two documents, PlaNorfolk2030 and NorfolkVision2100, that were intended to establish strategies to respond and adapt to sea-level rise and flooding impacts anticipated through the rest of the century. The zoning ordinance requires that construction within FEMA's 1 percent flood zone be elevated at least three feet above the base flood elevation. If the structure will be located in the 0.2 percent floodplain, it must be flood-proofed to 1.5 feet above the 0.2 percent flood elevation. The ordinance also establishes a Coastal Resilience Overlay (CRO) zone requiring the use of permeable surfaces for all parking spaces and stormwater infiltration techniques for all development within the district. The ordinance also establishes an Upland Resilience Overlay (URO) that promotes transit-oriented, walkable, bikeable development in neighborhoods outside flood hazard areas.

In addition to the zoning ordinance elements described above, the city's new ordinance introduces a ***resilience quotient system***, which awards developers points for adopting measures that promote flood risk reduction, stormwater management, and energy resilience (*see sidebar description on the following page of how the system works*).

Article 3 of Virginia's State Code - Chapter 22. Planning, Subdivision of Land and Zoning (§15.2-2230), requires local planning commissions to review a municipality's comprehensive plan at least once every five years. As a result, no extra costs were involved in embedding the resilience quotient system in the city's new zoning ordinance; it was included as part of the city's mandated comprehensive plan review cycle. The planning office did incur some additional cost to hire a design consultant to calibrate the value of the resilience points for different kinds of development and different resilience techniques. For example, some techniques are more expensive for a developer to incorporate in a project's design or have a larger impact on

achieving resilience and should, perhaps, be worth more points. The design consultant was hired to sort out these nuances based on feedback from developers and on observed results

No new authority was needed for the city to adopt and enact the resilience quotient system, as noted above; it was incorporated into the regularly scheduled process to update and rewrite its zoning code and is part of the city's land-use regulatory authority. As described in the accompanying sidebar, participation in the scoring system is a requirement. However, the ordinance does include several exceptions that the city's attorney indicated will help to safeguard the municipality against a developer's lawsuit contesting the provisions. To opt out of the resilient quotient system, however, a builder would have to explain in detail how the proposed project addresses stormwater management, flood risk, and energy resilience. The assumption is that in most cases a prospective developer would find it easier to submit to the point system. Accumulating resilience points is an "alternative minimum requirement" – and is viewed as an easier approach for developers to do things they would have to do anyway according to the zoning code.

How the Resilience Quotient System Works

The city applies the system to all proposed development projects, including single-family residential development. All applications are subject to site plan review, *except* gold-level LEED-certified buildings; expansion of buildings where the cost of construction is less than 50 percent of the appraised value; or where applicants simply meet the city's standards of conditions.

For applications subject to the resilience quotient standards, seven review criteria are applied: reducing risks from flooding; managing stormwater; promoting energy resilience, including the use of alternative energy; conserving water resources and protecting water quality; supporting multiple modes of mobility, specifically including walkability and bikeability; developing in a manner that promotes healthy and safe environments and lifestyles; and providing inclusionary dwelling units within mixed-income residential or mixed-use developments. The number of points that must be earned in each category depends on the size and number of units included in the development proposal. For example, smaller developments of five or fewer units must earn four points, one each per component; larger developments of 200 or more units must earn 10 points, two per component.

It is noteworthy that the city's zoning ordinance also offers incentives for extinguishing development rights in the Coastal Resilience Overlay district. Points are earned in the Upland Resilience Overlay zone by extinguishing development rights, either by acquiring open space conversation easements or restricting densities of development in the CRO.

FACTORS TO CONSIDER

Perhaps unsurprisingly, the biggest obstacle to enacting the resilience quotient system came from resistance expressed by builders. Earning resilience points creates additional costs for them because they have to add new features to their projects to address flood risk. Developers can't recoup costs for such measures by charging buyers extra. To help address these objections, the city hired a design consultant to help establish a factual basis for how much flood protection and energy resilience techniques actually cost. To help overcome objections, the city sought developers' involvement as it calibrated point values for each type of resilience strategy/technique

The planning department needed buy-in from political leadership. The city council is very pro-environment so it wasn't difficult to obtain support (but this might be a hurdle in municipalities where elected officials are not as pro-environment). The planning department also needed the city attorney's backing to make sure the point system is legally defensible.

APPLICATION IN NEW JERSEY

In New Jersey Article 12 – Reexamination of Municipal Plans and Regulations, Section 40:55D-89 of the MLUL – requires municipalities to reexamine their master plans every 10 years. Although the review interval is considerably longer than Virginia's, reexamination does offer New Jersey municipalities the same opportunity to reconsider their land-use and development regulations and possibly adopt a resilience quotient system modeled after Norfolk's. There appear to be no regulatory restrictions that would preclude a New Jersey municipality from incorporating such a system, based on achieving resilience.

CO-BENEFITS

- More responsible (compact, mixed-use, transit- and pedestrian-oriented) development in upland areas
- Application of improved stormwater management and water conservation techniques within and outside floodplain areas
- Increased affordable housing options

MEASURES OF EFFECTIVENESS

As is the case for many of the resilience strategies evaluated for this report, because the provisions of Norfolk's resilience quotient system have been in effect for only a short period of time, the city has yet to establish methods to measure the effectiveness of its new regulations.

FUNDING SOURCES

Since New Jersey's MLUL requires municipalities to reexamine their master plans and land-use regulations on a recurring cycle, municipalities could allocate local resources to incorporate development regulations modeled after Norfolk's resilience quotient system into local zoning codes at these intervals. Norfolk's experience confirms that the costs of developing these regulations would not be significantly greater than the locality would ordinarily incur in the course of a typical master plan/zoning ordinance update.

Alternatively, the state could reinstate the smart growth planning grants programs that, in the early 2000s, provided many New Jersey municipalities with financial assistance and technical guidance that encouraged effective planning initiatives. As the state begins development of a new Coastal Resilience Plan (CRP), it should incorporate this very useful program into whatever implementation strategies it will propose to accomplish CRP goals and objectives.

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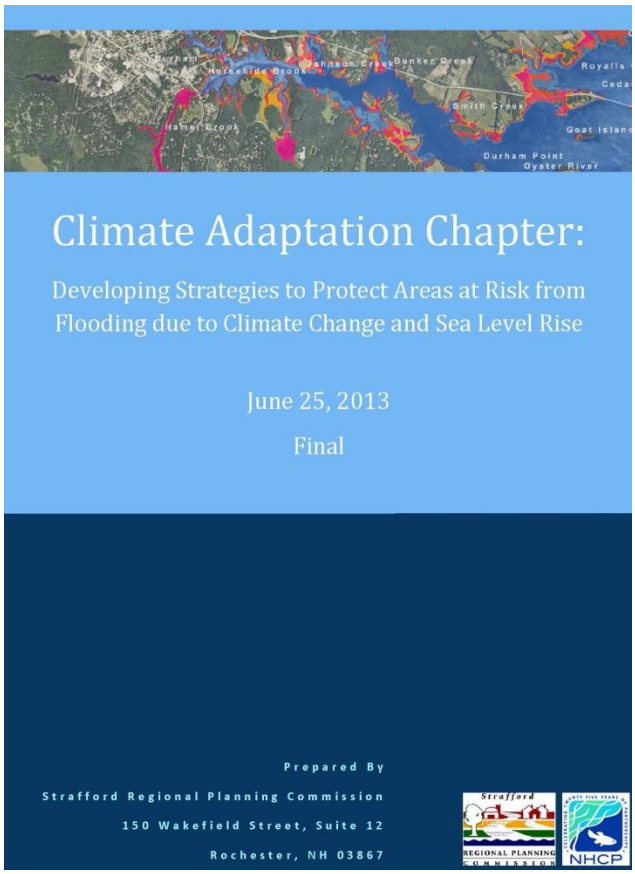
c. Case Studies - Ecological

4. Shoreland Protection Districts – Durham, NH

ACTION

Prohibit hardening of river and estuary shorelines. Maintain natural shoreland habitat; retain storm and sea level rise buffers; sustain ecosystem function; stabilize shoreline.

DESIRED OUTCOMES



Efforts to stabilize the shoreline with "hard" structures such as bulkheads, seawalls, revetments or other physical structures can have deleterious impacts on critical habitats and adjacent shorelines (Miller et al., 2016). Hardening of a beach also prevents natural beach migration and can ultimately lead to increased erosion and net loss of beach area (USACE, 1995), which, paradoxically, puts built structures behind the hardened shoreline at greater risk (Newkirk et al., 2018). Beach hardening also has social consequences, including, reduced access, recreation, and view-shed benefit; high installation and maintenance costs; and limited adaptability to risks associated with dynamic shorelines and the uncertainties of sea-level rise (Newkirk et al., 2018).

Ecosystem-based approaches to climate change and sea-level rise adaptation can be more cost-effective, flexible and co-beneficial than the shorter-term, often more expensive approach of shoreline hardening (Jones et al., 2012; Sutton-Grier et al., 2018). Narayan et al. showed that wetlands helped the Northeast avoid $625 million of direct regional flood damage by Hurricane Sandy and estimated that wetlands in New Jersey reduced damages in the state by an average of 27 percent - nearly $430 million (2017). The study also demonstrated that communities with few wetland areas, but that are upstream of substantive wetlands, also benefit from reduced storm surge impact (Narayan et al., 2017).

A shoreland protection overlay district (SPOD) is a regulatory mechanism to prevent shoreline hardening and promote restoration and enhancement of natural coastal ecosystems such as dunes, marshes, or tidal flats. A natural shoreland can provide both ecosystem services and resilience for a community (Gittman et al., 2014; Lowe et al., 2013; Möller et al., 2014; Shepard et al., 2011). The cost-effectiveness is realized by lower investment costs and reduced risk, along with greater adaptability over time as conditions change. By comparing pre- and post-Sandy conditions, Longenecker et al. demonstrated the resilience of tidal marshes on Edwin B. Forsythe National Wildlife Refuge and found that they were not only resistant to ecosystem change by Hurricane Sandy but could also achieve a rapid return to pre-storm conditions (2018).

Anti-hardening regulation assigns risks of coastal development to property owners rather than to the public and incentivizes risk reduction actions (Kittinger & Ayers, 2010). Hardening the shoreline transfers erosion risk to the public in the form of beach loss and reduced storm protection; however, anti-hardening regulation prompts the property owner to respond to erosion risk, potentially by retreating, and allows for dynamic shoreline response to coastal disturbance (Kittinger & Ayers, 2010). Although flooding or a storm event may not affect every property in the community, the cost of flood risk does affect the whole community by consuming federal and local tax dollars to protect coastal structures; hurting local businesses and economies; and impeding transportation and public infrastructure networks.

Pursuant to the MLUL New Jersey municipalities have the authority to regulate land use through formulation of a comprehensive master plan that guides physical development and by enacting zoning laws consistent with the master plan (Harrison and John-Basta, 2018).

Adoption of a SPOD is a recommended strategy in a climate adaptation report prepared for the Town of Durham, New Hampshire (Pimental, 2013). The climate adaptation report was developed with the expectation that the local planning board would use the findings and recommendations as resource and guidance in the Durham Master Plan update, and it was also included as an appendix in the 2017 Durham Hazard Mitigation Plan. The "Land Use, Future Conservation Lands, and Natural Resources" section of the climate adaptation report recognizes the need to sustain the ecological function of natural resources to benefit from the ecosystem services they provide, with the main mechanisms being fee purchases, easements or more stringent regulations. Permitted land uses in the SPOD must not alter the surface condition or configuration of the land or obstruct or alter the natural flow or infiltration of surface water or groundwater, and they must comply with the regulations of the SPOD, which include guidelines for vegetation; well installation and monitoring; and pier, dock or other structure maintenance, replacement or expansion. Conditional-use permits must be granted for underlying zoning district uses, and certain detrimental uses are prohibited in the SPOD (Pimental, 2013). A SPOD protects the health, safety, and general welfare of the public by reducing risk, protecting water quality, limiting potential for pollution, and conserving natural beauty and quality of the shoreland.

The SPOD recommendation has not yet been adopted in the Town of Durham because the geography of the town is not immediately coastal, municipal standards are already more stringent than state standards, and there is currently no need for hardened structures on the town's shorelines. However, in recognizing the future risks of sea-level rise, the Town of Durham adopted an amendment to their existing flood hazard overlay district to include what it called Advisory Climate Change Risk Areas (Article XV, ch. 175), which are recognized as areas likely to flood due to future sea-level rise (Pimental, 2018). The advisory amendment recommends development be built two feet above base flood elevation in these areas, acknowledging that these additional flood-prone areas may be added to FEMA special flood hazard areas in the future. The elevation requirement is currently not mandatory; however, this is the only regulatory framework in New Hampshire that sets elevation standards outside the FEMA flood zone (Pimental, 2018).

FACTORS TO CONSIDER

Anti-hardening regulation is most appropriate for coastal communities dealing with frequent or extreme flooding events or projected to experience them. Although a community may not currently be at risk of severe or frequent flooding, adaptation planning should consider the long-term impacts of climate change and sea-level rise, and the potential extent of future risk. Shorelines are dynamic environments and regulations for flood-risk reduction should maintain appropriate setbacks and buffers to allow for shoreline migration. In the absence of

preservation or conservation mechanisms for shoreline properties, other restrictions such as impervious surface limits or a restriction on the number trees that can be removed should promote further the enhancement of natural ecosystem function. Considering the high potential for climate change to hinder shoreland ecosystem productivity, restoration or living shoreline stabilization may be necessary to prepare a natural area to serve as a sea-level rise buffer, with reinforcement that will give the ecosystem time to build up to a level that can sustain future sea levels and temperatures. In addressing the diminishing ability of San Francisco's tidal marsh and wetland network to buffer against future conditions, Lowe et al. argue for a new restoration paradigm that incorporates provisions for long-term sea-level rise, and they outline the cost-effectiveness of doing so (2013).

There may be cases where a hybrid approach is necessary; for example, if wave energy is too high to rely on natural areas, or where hardening is the only option that will prevent flooding of a neighborhood that is not willing or able to relocate. In these cases, site-specific evaluation will have to determine whether the long-term benefits of hardening the area outweigh the costs to the public and potential dangers to public safety when communities remain in harm's way.

Hardening a shoreline can have the desired community sea-level rise protection outcome, but these projects are often highly technical and costly. An assessment of whether the same level of protection can be accomplished by natural systems, which can be significantly less expensive to establish and maintain, should be normalized. Part of that cost-benefit assessment could factor in potential losses in tax revenue incurred by designating a SPOD; however, those losses may be offset by the beneficial long-term ecosystem functions provided by a natural system, along with dynamic sea-level rise protection. There is a need for further analysis into the factors that support one approach over the other. When assessing relative returns on investment, it should be recognized that hard structures lose strength and capacity over time, while healthy, natural ecosystems become stronger over time.

Research to quantify flood-reduction benefits that natural areas provide is lacking and difficult to apply across scales and locations. The Department of Forest Resources and Environmental Conservation at Virginia Tech is conducting a study to measure the effects of forests on the capture, storage and removal of rainwater and runoff (The Nature Conservancy, 2018). By identifying the benefits of forests for flood management, the city of Virginia Beach will understand better how current forest resources fit into a flood reduction plan and should be targeted for conservation, and where potential reforestation could be strategically located. Coastal communities may need to perform similar studies to target a SPOD such that it will maximize flood mitigation performed by natural areas if conservation resources are limited.

Park and recreation agencies increasingly have a role in identifying climate benefits that natural areas provide; however, most of these agencies do not have a sustainability plan and do not track the cost savings of sustainable actions (NRPA, 2018). According to a recent National Park and Recreation survey of nearly 400 park and recreation agencies, although more than half implement green infrastructure to reduce stormwater runoff and flooding, only 17 percent of surveyed agencies specifically implement climate adaptation or mitigation activities, and most (80 percent) do not measure the financial impact of their investments (NRPA, 2018). Without reliable measures of the cost-effectiveness and flood reduction of climate adaptation or mitigation activities, it is more difficult to manage resources for this purpose and to solicit the necessary funding to do so.

Sutton-Grier et al. (2018) identify key challenges to implementing nature-based strategies, including: lack of research and understanding of design standards or long-term performance; absence of performance metrics; the need for performance monitoring and measurement during and after storm events to assess how these systems respond to extreme conditions; and incorporation of socio-ecological indices to inform more efficient and appropriate siting of

natural infrastructure approaches. The authors also note that permitting and zoning regulations, particularly U.S. Army Corp of Engineers permitting policies that prioritize built infrastructure over green infrastructure approaches, can be prohibitive to this approach; and that Federal Emergency Management Agency funding in some cases can only be applied to rebuilding rather than upgrading resilience infrastructure (Sutton-Grier et al., 2018).

APPLICATION IN NEW JERSEY

Protection of waterways and wetlands is regulated by the state, although municipalities are empowered to enact stricter standards. The development of coastal areas is regulated by the Department of Environmental Protection Division of Land Use Regulation through the Coastal Area Facility Review Act (N.J.S.A. 13:19-1 *et seq.*) (CAFRA), the Wetlands Act of 1970 (N.J.S.A. 13:9A-1 *et seq.*), the Waterfront Development Law (N.J.S.A. 12:5-1 *et seq.*) and the Coastal Zone Management Rules (N.J.A.C. 7:7). Grants of formerly tide-flowed areas and licenses and leases of existing tidelands in the state are overseen by the Tidelands Resource Council.

New Jersey is a home-rule state in which municipalities have local jurisdiction to regulate land use. Although the MLUL does not include climate adaptation or resilience as a required or discretionary component of a municipal master plan, it does provide the framework for municipalities to integrate adaptation and resilience planning and regulation into local ordinances and zoning. Adoption of a shoreland protection overlay district is an ordinary municipal administrative function. Depending on the local governance structure, the mayor or committee would adopt a shoreland protection overlay ordinance developed or reviewed by the planning board, overseen by the planning board as part of the building permitting process and enforceable by the zoning officer.

CO-BENEFITS

- Improved surface water quality and reduced pollution
- Maintained flora and fauna habitat
- Enhanced recreation and tourism opportunities
- Enhanced fisheries habitat and travelways

MEASURES OF EFFECTIVENESS

- Percent sea-level rise hazard area with development encumbrance; higher percentage encumbered area scores higher
- Extent of post-storm coastal damage in areas with SPOD versus areas without; cost and/or number of properties experiencing damage expected to be lower in region with SPOD
- Coastal erosion/accretion rates in areas with SPOD compared to areas influenced by hardened structure; overall lower erosion and higher accretion rates expected in SPOD area
- Storm surge and wave activity comparison between areas with a SPOD versus areas without; storm surges expected to reach less developed areas, and wave activity expected to be reduced in SPOD areas
- Measures of elevation, vegetation coverage, degradation and key food web species to sustain and build the natural buffer system
- Ecosystem performance measures

FUNDING SOURCES

The New Jersey Shore Protection Program funds projects "to protect public and private property and infrastructure from coastal storm damage, erosion and shoreline migration, and sea-level rise." The Shore Protection Fund (N.J.S.A. 13:19-16 *et seq.*) distributes funding for New Jersey's beach nourishment program. Federal or state funding sources may be available through this program. Local contribution is a minimum of 25 percent of construction costs for state projects, along with engineering design costs. For federal projects, the federal government pays 65 percent of construction costs, and local and state governments pays 25 percent and 75 percent, respectively, of the remaining construction costs. Municipalities and counties are eligible, but funding priority is currently given to projects with federal matching funds.

The Nature Conservancy Living Shoreline Grants Program in New Jersey provides competitive grant funding for the design, permitting or construction of nature-based coastal stabilization and resilience projects.

The New Jersey Green Acres program implements the state's Blue Acres floodplain acquisitions and provides funds to purchase properties that have been damaged, or may be damaged, by storms or storm-related flooding, or that may buffer or protect other lands from such damage.

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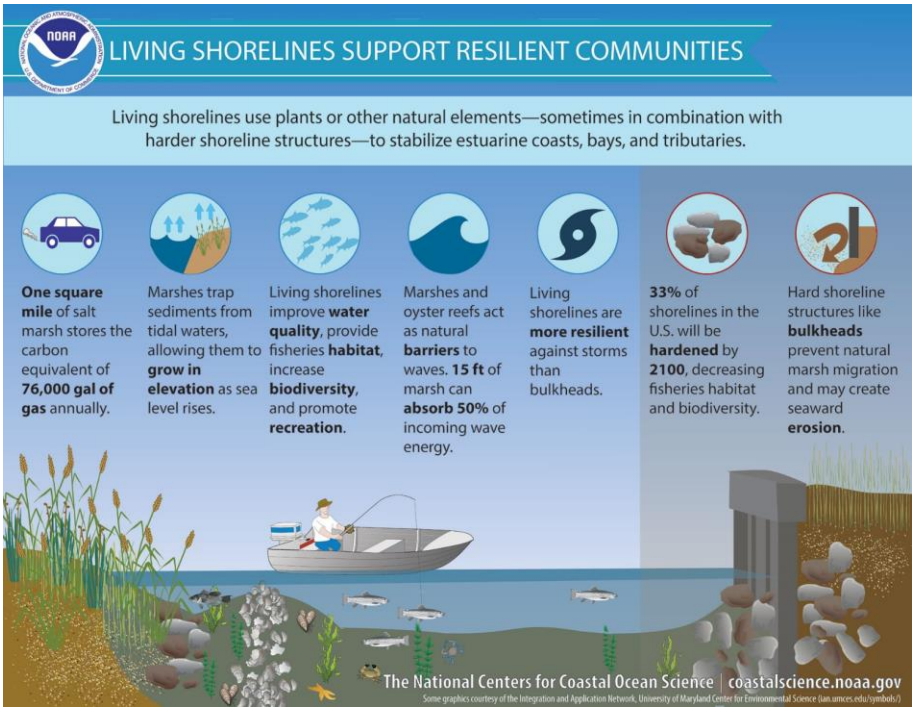
5. Created Shoreline Protection – Palm Beach County, FL

ACTION

Build a natural feature to reduce the impacts of sea-level rise

DESIRED OUTCOME



Living shorelines are broadly described as structures that incorporate natural vegetation or other living and natural material to serve as the land-water continuum (or interface) and stabilize the shoreline while simultaneously providing ecosystem services. These "soft" structures are sometimes combined with "hard" structures such as oyster reefs, rock sills or anchored wood, and they are typically applied along low-energy sheltered shorelines such as estuaries, bays or tributaries (NOAA, 2015). Living shorelines can support greater ecosystem biodiversity, have been shown to be effective at reducing erosion, can attenuate wave force (Anderson et al., 2011; Currin, 2019; Gittman et al., 2016; Mariko and Devon, 2018; O'Donnell, 2017), and can mitigate climate change (Davis, J. L. et al., 2015).

Compared to harder (a.k.a. grey) structures such as bulkheads, which can be undermined by wave energy when they are not high enough to provide protection from inundation or storm surge, living shoreline (a.k.a. green or soft) infrastructure can be more resilient and less impacted as storm waters are distributed over the natural land area (NOAA, 2015 and Smith et al., 2018) and consequently provide greater protection to life and property (Arkema et al., 2013). Waves can crash over seawalls or bulkheads and cause damage to the structure and increased erosion, but waves can roll over living shorelines to dissipate wave energy as it is absorbed by the vegetation. Furthermore, living shorelines can accommodate natural shoreline migration or elevation through accretion of sediment.

Living shorelines can also be more cost-effective in terms of both installation and maintenance, although project-specific cost analyses would be needed to determine relative affordability and cost-effectiveness (Pontee et al., 2016). Living shoreline installation fees can range from less than $1,000 to approximately $5,000 per linear foot, and maintenance costs are typically less than $100 per linear foot annually. This compares to the installation and maintenance costs of a bulkhead at about $2,000 - $5,000 and $101 - $500, respectively, per linear foot (USACE, 2016).

Image 1: Snook Island Natural Area Restoration Project

One of the benefits of living shorelines is that they can be implemented at various scales, even for specific properties or by homeowners. However, shoreline stabilization along the entire length of a vulnerable area, rather than on a piecemeal, parcel-level basis, will provide greater resilience for the community and potentially offer greater return on investment. An example of a large-scale living shoreline project is the Snook Islands Natural Area Project (SINAP), which was initiated by Palm Beach County to create four new islands in an area of disturbance by using 1.2 million cubic yards of sand dredged from an island 10 miles away (PBC, 2015). A history of dredging, filling and bulkhead installation had eliminated more than 80 percent of the living shorelines of the Lake Worth Lagoon. This project restored 100 acres of wetland habitat in the lagoon by filling deep holes that had been created during the 1920s as a result of dredging and filling along the edge of the lagoon. The 20-mile-long Lake Worth Lagoon is the largest estuary in the county, and this project restored 1.2 linear miles of habitat. Since the 1920s, sedimentation in the deep holes in the Lagoon created oxygen-deprived dead zones. Filling the holes to wetland elevation with some submerged land created suitable habitat for seagrass beds and eliminated erosion risk for the shoreline. Non-native plants were removed from five acres of shoreline, 1.7 acres of existing mangrove fringe was restored, 11 acres of mangroves and 3.8 acres of salt marsh were planted along the shoreline and on the new islands, 2.2 acres of oyster reefs were created, and 50 acres of shallow sub-tidal habitats were restored to promote seagrass colonization.

This project was so successful that the county, which conceived of the plan, is exploring whether this strategy can be implemented elsewhere (Carson, 2018). The new islands have provided protection to the shoreline by dissipating wave energy and demonstrating resilience against several hurricane events (Carson, 2018). The restoration and creation of natural habitat has reduced shoreline erosion successfully, makes armoring unnecessary and has eliminated the need to replace a seawall that had failed prior to the project implementation. , The U.S. Army Corps of Engineers provided most of the $17 million for creation of the islands and oversaw the contract for moving the sand. The City of Lake Worth was a cooperative partner, and the project involved county, regional, state and federal entities.

The project follows two recommendations of the South East Florida Climate Change Regional Compact (CCRC):

- NS-7: Promote coastal natural systems - Promote the protection and restoration of coastal natural systems and the creation of living shorelines at the regional scale. Identify specific locations and general conditions that could utilize living shorelines in place of, or in combination with, seawalls. Write regulations encouraging the use or integration of living shorelines where feasible.

- NS-13: Respond to beach erosion - Develop and implement long-term, sustainable, regional solutions to beach erosion and sediment supply. Align local and regional beach erosion

prevention efforts with the Florida Department of Environmental Protection's Strategic Beach Management Plan (SBMP) for the Southeast Atlantic Coast Region.

FACTORS TO CONSIDER

Living shorelines need to be designed properly and located with consideration of site-specific factors, including native vegetation, wave energy, adjacent shorelines and the need to balance resilience with social expectations of shoreline features (Pontee et al., 2016). While entirely "soft" materials are more suitable for low-energy shorelines, hybrid green/grey (or soft/hard) structures may be appropriate for moderate-energy environments. Design specifications should also be based on the level of risk and protection needed at a particular location, with consideration of long-term sea-level rise and climate change scenarios. Natural systems should be considered before hybrid designs, and the design should develop in consultation with regulatory, contractor, stakeholder and coastal specialist (e.g. biologist) representatives (NOAA, 2015).

Although high wave-energy environments are typically not appropriate locations for soft living shoreline structures to be counted on to reduce erosion or withstand storm surge, nature-based approaches can still be applied to dynamic, higher-energy coastal shorelines. Development of dunes through natural or artificial processes has been shown to provide reliable protection against wave energy and storm surges in New Jersey (Kelly, 2014 and Barone et al., 2014).

While the resilience benefits of nature-based shoreline stabilization are widely acknowledged, there is a lack of research to quantify effectiveness and enable development of standard design guidelines (O'Donnell, 2017). Work is, however, under way in this regard (Pontee et al., 2016). Natural systems can also be complex or sensitive, and any disturbance or project should consider potential impacts on existing ecological relationships, habitats or natural resource features. Federal or state natural resource management regulatory agencies will likely need to be involved.

Shoreline hazard mitigation will depend not only on where shoreline stabilization is most appropriate in terms of reducing impacts of wave energy and storm surge, but also where people will benefit from reduced risk. And investment in shoreline stabilization based largely on property values may overlook the potential for this approach to protect vulnerable populations (Arkema, 2013).

APPLICATION IN NEW JERSEY

Protection of waterways and wetlands is regulated by the state, although municipalities are empowered to enact stricter standards. The development of coastal areas is regulated by the N.J. Department of Environmental Protection Division of Land Use Regulation through CAFRA, the Wetlands Act, the Waterfront Development Law and the Coastal Zone Management Rules. Grants of formerly tide-flowed areas and licenses and leases of existing tidelands in the state are overseen by the Tidelands Resource Council.

Most living shoreline projects in New Jersey are under the jurisdiction of the Coastal Zone Management Rules (N.J.A.C. 7:7), and regulatory requirements for proposed projects are handled by Land Use Management's Office of Policy Implementation. General permit 24, at N.J.A.C. 7:7-6.24, was specifically designed to authorize habitat creation, restoration, enhancement, and living shoreline activities.

Beach nourishment may be part of a living shoreline design, and beach nourishment projects are implemented along the New Jersey shoreline by the Division of Coastal Engineering and

the U.S. Army Corps of Engineers. Sand is delivered to a beach and spread mechanically over large areas. Re-nourishment projects are initiated to replenish eroded sand after considerable loss to a nourished beach has occurred over time.

Land ownership may be an obstacle in New Jersey if acquisition is necessary for installation or maintenance of living shoreline projects. Vegetation coverage along New Jersey's coast is highly dependent on ownership and land use (Kelly 2014). Even if the land is not privately owned, property owners may be opposed to projects that limit their view or access.

There are, however, opportunities for enhancing coastal protections by changing spatial patterns of land uses of the beach to allow for living shorelines to be created or develop naturally (Kelly, 2016). Municipal beach or shore management plans can promote establishment of soft coastal infrastructure by restricting human activity to enhance dune formation and establishment of vegetation along shorelines. Local hazard mitigation plans can also identify activities that will lead to living shoreline creation and greater resilience.

The U.S. Army Corps of Engineers Nationwide Permit 54, effective through 2022, recognizes living shorelines and makes it easier for homeowners to build natural coastal infrastructure by eliminating the need for individual permits if the project meets the nationwide criteria.

CO-BENEFITS

- Habitat for fisheries, other natural resources and natural ecosystems
- Improved water quality
- Carbon sequestration
- Reduced shoreline erosion and greater accretion compared to hard structures
- Recreation opportunities

MEASURES OF EFFECTIVENESS

- Vegetation coverage
- Organism abundance (e.g. new oyster growth)
- Biodiversity
- Shoreline change rates
- Wave energy

FUNDING SOURCES

The Shore Protection Fund (N.J.S.A. 13:19-16 et seq.) distributes funding for New Jersey's beach nourishment program. Federal or state funding sources may be available through this program for projects that incorporate beach nourishment into the design. Local contribution is a minimum of 25 percent of construction costs for state projects, along with engineering design costs. For federal projects, the federal government pays 65 percent of construction costs, and local and state governments pays 25 percent and 75 percent, respectively, of the remaining construction costs. Municipalities and counties are eligible, but funding priority is currently given to projects with federal matching funds.

The Nature Conservancy Living Shoreline Grants Program in New Jersey provides competitive grant funding for the design, permitting or construction of nature-based coastal stabilization and resilience projects.

The NOAA Community-based Restoration Program and state Sea Grant programs administer funding that may be used for living shorelines projects. NOAA also periodically receives one-time supplemental storm or disaster recovery funding that may be used for creating living shorelines, such as the Hurricane Sandy Recovery and Rebuilding Supplemental Appropriations.

The National Coastal Zone Management Program and the Sea Grant College Program can provide direct technical assistance, training or public education, and can develop guidance and manuals to support the implementation of living shorelines at a regional level. The National Marine Fisheries Service and the Restoration Center can provide technical advice and guidance on project design and permitting.

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6. Beach Stabilization Using Biopolymers – Progreso, Mexico

ACTION

Apply protein polysaccharide biopolymer (PPB) on beaches to reduce sand displacement.

DESIRED OUTCOME

An experiment is under way in Progreso on the Yucatan Peninsula in Mexico, to field-test a microorganism-produced protein polysaccharide biopolymer (PPB) to increase sand cohesion. The objective of this trial initiative is to decrease beach erosion, stabilize the shoreline and ultimately restore the beach. Initial results suggest that the treatment could increase beach resilience and could be used in conjunction with beach renourishment projects. Dune vegetation was also enhanced by the use of the PPB formula.

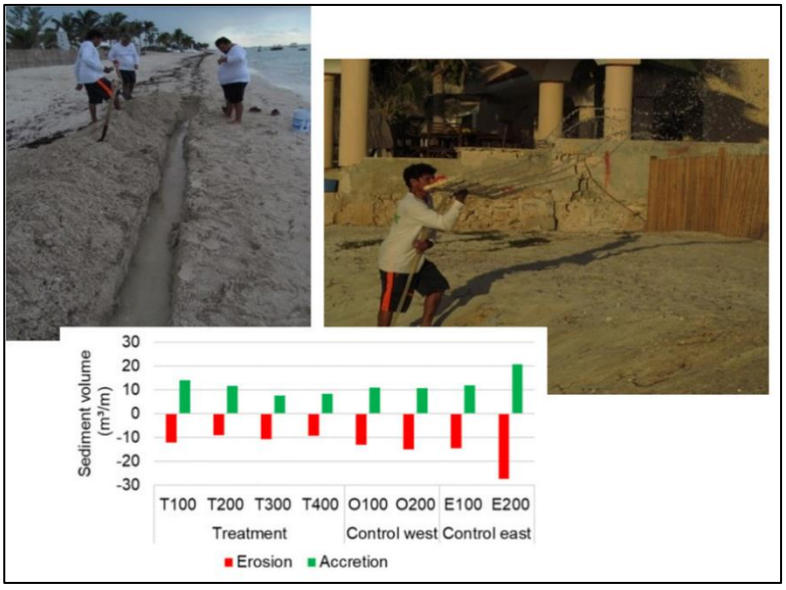

Image 2: Test application of PPB in Progreso Mexico, Source: SESI Consulting Engineers

Beach erosion is generally addressed by one of two techniques: structural hardening of the shoreline or nature-based land management. Application of a substance, such as a biopolymer, to increase sand cohesion is a form of geotechnical engineering that may enhance natural processes or provide enough beach stability to help jumpstart restoration. PPBs are glue-like substances produced naturally by microorganisms and are being explored as a means to increase sand cohesion to stabilize shorelines (Ocaña et al. 2018).

Sand cohesion stabilizes dynamic shorelines by reducing the displacement of sand during wave cycles and potentially during storm events. The morphology of a shoreline naturally changes over time as beaches experience erosion and accretion (sedimentation) cycles in which sand is repeatedly carried away and redeposited. On a global scale, eroded coastal land over the past three decades is twice the surface of gained land (Mentaschi et al. 2018). Application of a sticky substance like a PPB to sand on beaches can limit the sand displacement distance and make more sand available for accretion, thereby reducing shoreline erosion and loss (Ham et al. 2018). Natural beach environments increase coastal resilience (NOAA 2015), and PPBs could potentially be used to reduce sand mobility and provide stability for more effective beach nourishment.

FACTORS TO CONSIDER

Although synthetic polymers have been used extensively to stabilize soil in construction, agriculture and arid lands management, biopolymers are considered an alternative technology; and their application to sandy beaches is not thoroughly researched. Without long-term studies, it is impossible to estimate the success of this approach in terms of lasting erosion control. The intent of the PPB treatment is to increase long-term resilience of the beach by acting as a catalyst for natural beach stabilization. Limited pilot projects have only shown it to be successful in the short term. This technology can't replace dune replenishment and

restoration or other resilience measures, but it could be part of an overall plan by reducing shoreline erosion.

An important aspect of uncertainty is what effect the introduction of an organic substance would have on ecological systems, particularly degradation processes. Although a pilot study in Mexico found PPB beach application to have positive impact on nesting turtle outcomes (Dahmani, 2018), little is known about how it could alter food web interactions or other ecosystem relationships. Coastal Zone Management Rules would apply to project sites, and approvals and permitting would likely be required – potentially from the New Jersey Department of Environmental Protection, U.S. Environmental Protection Agency, New Jersey Division of Fish and Wildlife and the U.S. Army Corps of Engineers.

Initiation of this approach requires a site-specific pilot study in which a representative portion of a larger area of coastline is tested and monitored after PPB application and compared to a non-treated area, to determine the proper dosage and application schedule for the larger area. This process takes about a year and requires the expertise of a consultant team to design and monitor the study and interpret the results. However, there is a cost-sharing opportunity because several municipalities with similar beach composition and characteristics can partner on the pilot project (Dahmani 2018). Once the design and dosage are determined by the pilot project, the substance can be applied in dug trenches or sprayed on a raked beach using equipment and labor that are already utilized by municipal beach management.

APPLICATION IN NEW JERSEY

Beach nourishment projects are implemented along the New Jersey shoreline by the Division of Coastal Engineering and the U.S. Army Corps of Engineers. Sand is delivered to a beach and spread mechanically over large areas. Renourishment projects are initiated to replenish eroded sand after considerable loss to a nourished beach has occurred over time.

Most beach restoration projects in New Jersey must comply with the Coastal Zone Management Rules (N.J.A.C. 7:7). It is unclear how a project of this type would align with the specifications of the rule and definitions of a living shoreline or nature-based shoreline stabilization.

CO-BENEFITS

- Multi-jurisdictional planning and cost-sharing
- Increased energy efficiency by making re-nourishment projects more effective through enhanced sand retention and dune restoration
- Carbon capture through dune restoration and the planting of native species
- Enhanced beach resilience by increasing net sediment balance as beach width increased
- Habitat creation for invertebrate species through dune restoration

FUNDING SOURCES

The Shore Protection Fund (N.J.S.A. 13:19-16 et seq.) distributes funding for New Jersey's beach nourishment program. Federal or state funding sources may be available through this program. Local contribution is a minimum of 25 percent of construction costs for state projects, along with engineering design costs. For federal projects, the federal government pays 65% of construction costs, and local and state governments pays 25 percent and 75 percent,

respectively, of the remaining construction costs. Municipalities and counties are eligible, but funding priority is currently given to projects with federal matching funds.

The Nature Conservancy Living Shoreline Grants Program in New Jersey provides competitive grant funding for the design, permitting or construction of nature-based coastal stabilization and resilience projects.

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d. Case Studies - Economic

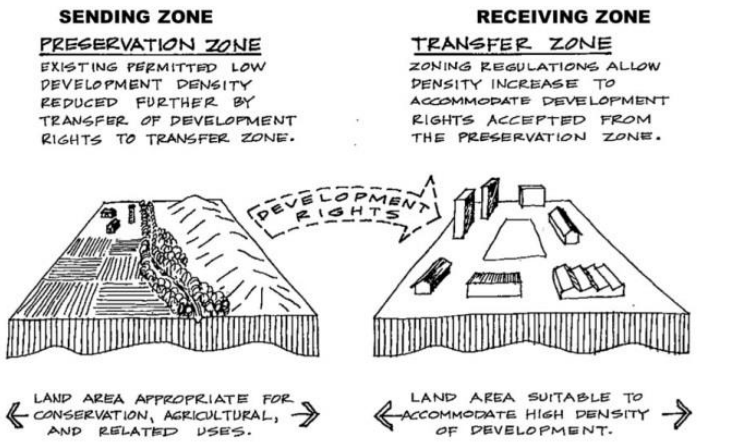
7. Transfer of Development Rights – Norfolk, VA

ACTION

Encourage non-water-dependent land uses to be located in areas suited to development and out of high-risk, flood-prone locations.

DESIRED OUTCOME

The basic premise of a Transfer of Development Rights (TDR) program is that development potential (rights) can be moved from one property to another. The program currently being considered by the City of Norfolk is voluntary and incentive-based. At the present time, a market does not exist for the exchange of development rights. Before the program can be implemented, the city would have to establish and maintain one in order for a TDR program to function.



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The Code of Virginia currently authorizes localities to adopt sending and receiving districts designed to protect working farm and forestland. However, Norfolk would need to enact several code changes to implement a development rights transfer program. The approach the city is considering is a variation of a true TDR program. Under Norfolk's approach, a developer would be allowed to buy and convert development rights in higher-risk areas into resilience points that would be applied to projects in lower-risk areas, based on the city's Resilience Quotient System (see Strategy 3). Under this approach, the number of resilience points a project would need to accumulate to be permitted in an upland, lower-risk area could be reduced by its developer buying development rights from landowners in higher-risk areas.

Norfolk's planning department and its consulting team devised the resilience TDR idea and then obtained approval for the concept from the city's attorney. The planning department originally wanted to implement a conventional TDR program, but there are no viable receiving areas in city. In addition, the city imposes few restrictions on density, so it's difficult to entice developers to pay for density bonuses. Representatives of the city's planning department indicated that Virginia enacted TDR at the urging of Arlington County, where density bonuses do work.

The resilience-based TDR is still largely aspirational, but the city is working with a local land conservation group studying how it could work. The city anticipates that the land trust group would manage a land bank, which would act as an intermediary between a property owner who sells development rights and the developer who buys them. The city would play no role in these transactions. The land trust would identify eligible parcels and market the development rights to developers.

Under Virginia's current state code, there are no obstacles that would bar a developer from purchasing development rights. However, the option to do so has not been publicized so it is relatively unknown, and the structure to assure its operation on the private side is not yet in place. In anticipation of bringing the program online, however, the city did include provisions for its implementation in the comprehensive rewrite of its zoning ordinance that was enacted

in March 2018. Section 3.9.19 of the ordinance, URO: Upland Resilience Overlay, explains how it would work.

FACTORS TO CONSIDER

Norfolk's biggest challenge to establishing the resilience TDR program is overcoming internal technical hurdles. Presently, there is little outside awareness of the program, other than in the environmental community that vigorously supported it, so there is little if any opposition to overcome. To implement the program, the planning department merely needs to determine what legal hurdles they might encounter, and then obtain the city attorney's approval. According to planning department staff, the city attorney is not opposed to the program but wants to be sure that it will work and is legally defensible.

APPLICATION IN NEW JERSEY

New Jersey has had longstanding experience with TDR programs. According to a 2009 report, the general concept of TDR was first introduced in 1961 in an article by Gerald Lloyd published by the Urban Land Institute. Statewide TDR was introduced in the New Jersey State Legislature in the mid-1970s. At the municipal level, TDR programs were attempted in 1975 in Hillsborough Township (Somerset County) and Chesterfield Township (Burlington County). Although these initial efforts were not successful, they laid the foundation for adoption of the TDR program by the New Jersey Pinelands Commission in 1981, one of the most successful and oldest such programs in the country. According to a report issued by the Pinelands Commission in June 2018, a total of 67,507 acres of ecologically sensitive and agricultural lands and farmlands have been preserved through the program since its inception.

Adoption of the Pinelands Development Credit program was followed in 1989 by the establishment of the Burlington County TDR pilot project, and two successful programs in Chesterfield and Lumberton townships. Success of the Burlington County pilot projects led to the March 2004 passage of the State Transfer of Development Rights Act, N.J.S.A. 40:55D-137 *et seq*. Each of these programs is discussed more fully below. These programs shaped development of the State TDR Act and the TDR provision of the Highlands Water Protection and Planning Act.

As a result of New Jersey's long and successful track record with TDR, the program holds considerable potential to serve as a vehicle to refocus coastal development from high-risk areas to areas more suited to growth. However, according to a report by New Jersey Future, the current rules governing TDR (N.J.S.A.40:55D-137 *et.seq*.) are complex; expensive to administer; require extensive, detailed, up-front planning and real estate market analysis; and require compliance with multiple state requirements all of which considerably discourage use of this technique. To enhance its appeal, planning review under TDR regulations needs to be streamlined and collaborative partnership with the state needs to be fostered to help guide the process at the local level. Coordination among state permitting authorities for infrastructure and development in receiving areas must be improved. Financial and technical assistance, incentives, and education should be offered to help overcome hurdles and encourage municipal participation. Given the potential impacts of sea-level rise and climate change, it will also be essential to create and perhaps mandate regional sending and receiving areas, particularly for those areas that do not have available, buildable alternatives, such as along New Jersey's barrier islands.

CO-BENEFITS

- Natural resources protection and preservation

- Breaking repetitive-loss cycle
- Opportunity to reimagine community form and promote, compact, mixed use, pedestrian-oriented communities

MEASURES OF EFFECTIVENESS

Norfolk is presently working with a local land conservation group to evaluate how a TDR program specifically intended to achieve resilience would work. The program is not yet operational so measures to determine effectiveness have not been put in place.

FUNDING SOURCES

Unlike Norfolk, an effective structure, through which a resilience TDR program could be administered readily in New Jersey, is already in place: the Pinelands Development Credit (PDC) Bank. The PDC Bank is an independent state agency that serves as the processing agency for the Pinelands Development Credit Program. Since the bank is an established entity, no new administrative structure would be needed. Establishing a state-wide TDR Bank along the lines of the Pinelands Development Credit Bank could eventually lead it to become self-funding: Property owners selling credits purchased by interested developers would lead to minimal or no additional funds needed.

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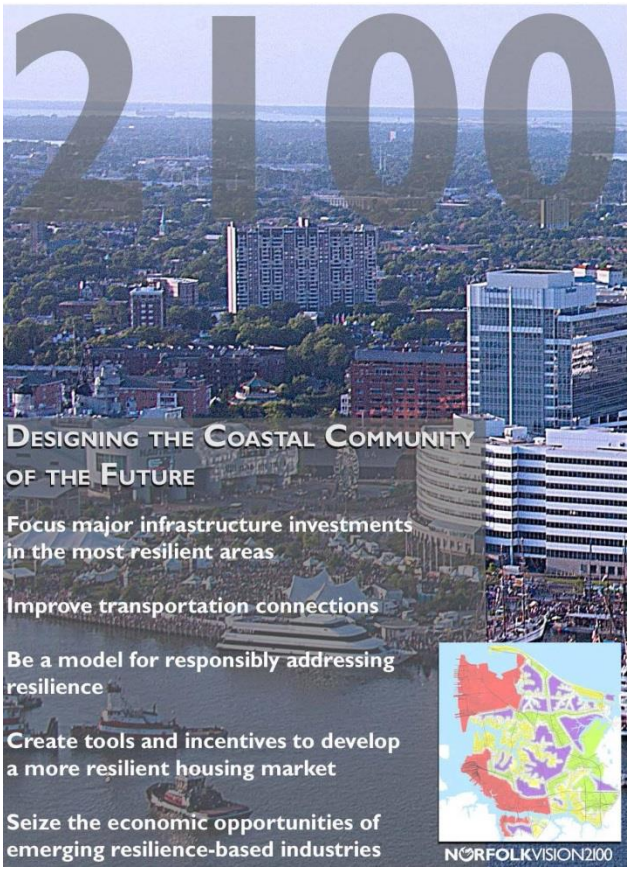
8. Align Infrastructure Placement/Expenditures with Resilience – Norfolk, VA

ACTION

Prioritize infrastructure in resilient areas and reduce public expenditures in vulnerable areas

DESIRED OUTCOME

Reduced flood and storm loss; efficient use of resources.



Many coastal communities will need to prioritize which areas are most important to fortify against rising sea levels and from which areas they should disinvest. Cultural, economic and historical identities associated with waterfront locations ensure that these climate choices will not be easy, but they must be made. Furthermore, they must be made in the context of aging infrastructure, the ongoing need for costly investments, and vulnerable populations, and with an eye toward economic vitality.

A planning strategy promoted by the Norfolk Vision 2100 plan prioritizes infrastructure projects in higher-density centers where key economic assets and mixed-use development should be concentrated, and is an action item throughout the adopted plan, most specifically for the "Citywide - Designing the coastal community of the future" component. In Norfolk, a 2011 light rail alignment cost $318 million for construction of 7.4 miles, and the cost of at least one future extension may exceed $1 billion. With that kind of expenditure, it is obvious that risk should be a factor in allocation for infrastructure projects. The plan identifies four types of development areas, each with specific action plans based on the level of flood or storm risk. Low-risk areas of the city are recognized as having potential for high density, mixed-use, mixed-income and transit-oriented development. The plan recommends that these areas be transformed into new urban centers so that the city can persist beyond sea-level rise projections. Other areas include established neighborhoods with frequent flooding, neighborhoods with less risk of coastal flooding, and areas with key economic assets – each with a set of actions to guide appropriate kinds of investments.

This strategy is intended not only to reduce loss of infrastructure in high-risk areas, but also to create economic opportunity through enhancement of "economic engine" areas, which are those areas that hold key economic assets. The strategy does not necessarily recommend abandoning waterfront areas, but it does recommend prioritizing which areas should be targeted for various types of investment to achieve long-term viability of the city and efficient use of limited resources. Targeting infrastructure investment to the most resilient areas, or increasing resilience in areas with high investment, can offer a catalyst to energize and promote

vitality in the places where investments can endure a changing climate and coast. Viability is critical for long-term public investments such as schools, water treatment facilities or transportation infrastructure because people rely on these systems for their daily activities or livelihoods.

Mechanisms proposed in the plan for guiding land use to align with resilience include zoning and incentive programs that "encourage more development in areas at lower risk of flooding, discourage new and higher-intensity development in areas at greater risk of flooding, and encourage developments that deconcentrate poverty, resulting in mixed-income neighborhoods" (City of Norfolk, 2016).

FACTORS TO CONSIDER

Some neighborhoods may object to being subject to a new, different set of planning goals than those under which they previously were operating. For example, in the case of the Norfolk plan, resistance arose from a wealthy neighborhood that was no longer being considered for a flood wall because it was not the most cost-effective way for the city to reduce risk (Sharp, 2018). Public outreach and education should be extensive and highly visible to garner support from the public and the municipal leaders.

To be effective, this strategy should be incorporated into the zoning code and re-examined on a regular basis. Master plans should also be updated to align with the zoning set forth in the strategy, and the visions described in plans need mechanisms to be implemented. Municipal adoption of the plan and the zoning code on which it is based is necessary. Places that do not have a history or culture of planning may be less receptive to this strategy, especially if they are not used to integrating planning initiatives directly into existing governmental activities and processes (Headwaters Economics, 2012).

Because there are various climate scenarios, and knowledge about climate change or suitable adaptation is continuing to evolve, plans and policies should be adaptive and incorporate an iterative process that allows for changes as new information and circumstances arise. The pace of this strategy should also correspond with the timing of adaptation scenarios: It would be of little use if the timeline for this strategy exceeded the projected inundation timeline.

APPLICATION IN NEW JERSEY

Land-use patterns in New Jersey can be dictated by code and influenced by incentives. Pursuant to the MLUL, New Jersey municipalities have the authority to regulate land use through formulation of a comprehensive master plan that guides physical development and by enacting zoning laws consistent with the master plan (Harrison and John-Basta, 2018).

CO-BENEFITS

- Enhanced economic opportunity in investment target or key asset areas
- Mixed-use center creation
- Greater investment in and use of public transportation

MEASURES OF EFFECTIVENESS

- Cost of flood damage per zone
- Development density per zone
- Investment per zone

- New business per zone
- Mixed income and use per zone

FUNDING SOURCES

Although no direct funding exists for municipal planning or regulatory functions, funding for planning reports and assessments may be available from one of the three municipal planning organizations: Delaware Valley Regional Planning Commission, South Jersey Transportation Authority, and the North Jersey Transportation Planning Authority. Federal funding sources may include the Federal Emergency Management Agency, the National Oceanic and Atmospheric Administration, the Department of Housing and Urban Development, and others. Competitive grant opportunities are also available from various organizations to promote climate adaptation and resilience in local communities.

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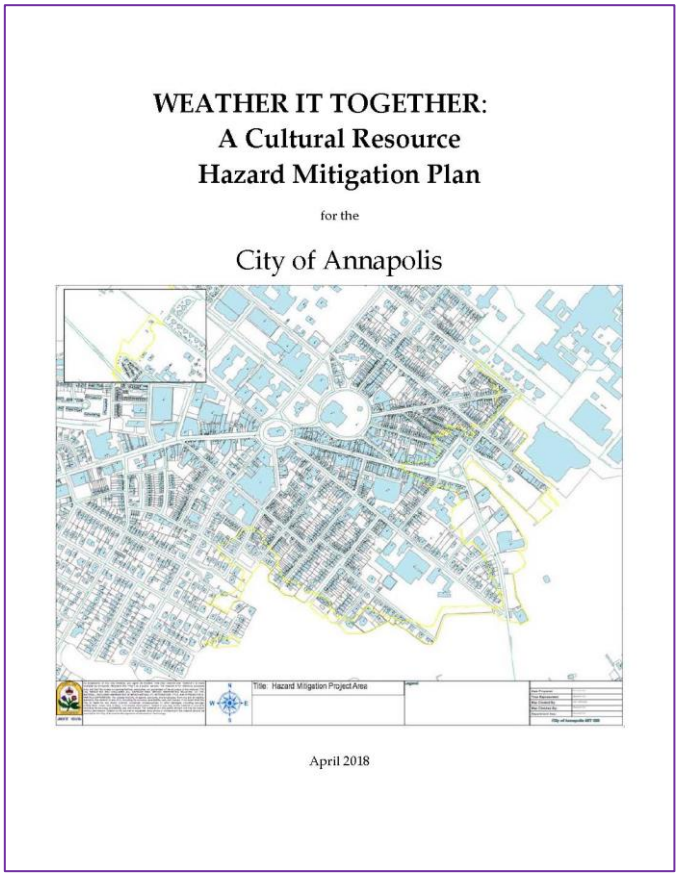
Sharp, Jeremy (2018) Personal communication on November 30, 2018.

9. Flood Adaptation Tax Credit – Annapolis, MD

ACTION

Create incentives to encourage owners to retrofit historic structures to incorporate flood-proofing techniques in flood-prone areas.



DESIRED OUTCOME

The City of Annapolis's Weather It Together Cultural Resources Hazard Mitigation Plan acknowledges that rising sea levels present clear risks to the city's many distinctive historic and cultural assets. The plan notes that "In the early 1960s, the downtown area experienced nuisance flooding at high tide only three days a year. Currently, flooding occurs between 30 and 40 days a year. By 2030, according to a study by the Union of Concerned Scientists (UCS), the city can expect to flood every other day, and by 2045, downtown is expected to flood every single day. The Cultural Resources Hazard Mitigation Plan was prepared in response to this growing threat. The plan includes resilience strategies the city is in the process of developing, as well as strategies it is planning but has yet to implement. A plan to expand the applicability of the city's historic tax credit is one of the strategies that is in the development phase. A successful city-level historic tax credit program - administered by the city's planning and zoning commission, historic preservation commission, and finance department - is presently in place, but it does not yet include flood adaptation as one of the qualifying building modifications. The new strategy would expand credit eligibility to include qualifying flood adaptation modifications.

Image 3: Annapolis Historic Dock Area

Work to develop the Cultural Resources Hazard Mitigation Plan began as part of a city planning process. With many vacancies and planned developments around the historic City Dock area, the city needed to decide how to balance historic preservation with growth. Meanwhile, ongoing tidal flooding and related problems were becoming increasingly common. The city bulkhead needed to be repaired and

replaced. One of the important streets in downtown had to be shut down periodically due to nuisance flooding, resulting in more traffic congestion on Main Street. In addition, the threat of hurricanes loomed large after Hurricane Isabel in 2003. The city set out to prepare a hazard mitigation plan, as required by FEMA for national disaster funding. And because of Annapolis's large historic district, the city needed to conduct a cultural landscape inventory.

Several departments, including planning and zoning, public works, historic preservation, and emergency operations, collaborated to develop the Cultural Resources Hazard Mitigation Plan. City-held public events were conducted to advise residents of the planning process, and the heads of different departments that were contributing to the plan attended these events to present a unified front. Appendix F of the plan lists the various meetings that encompassed the city's coordination and community engagement efforts between 2013 and 2017. Consultants, archaeologists, architects, historians, environmentalists, GIS experts, the Army Corps, and the National Park Service all contributed to the creation of the plan.

How the Flood Adaptation Tax Credit Works

A completed project submits an application for the tax credit, including invoices itemized for what expenses qualify. The planning and zoning department reviews all applications for completeness and adherence to design guidelines and submits a report to the Historic Preservation Commission. The Historic Preservation Commission reviews the report and agrees or disagrees with the conditions, "just like any other planning commission." There is a cap of $50,000 for each individual project within a fiscal year, and $150,000 across the whole city. Once the dollar value is approved, the application is submitted to the department of finance and they process the credit. Because taxes are paid at the county level, the county applies it to the person's property tax bill. Builders/developers learn about what qualifies and what doesn't during the pre-application process.

Appendix H of the plan is a matrix that lists all the adaptation strategies the city plans to implement, along with the goals, objectives of each, and an assessment of how achievable each strategy is. Breaking the plan into its incremental elements enabled the city to identify the most important "low-hanging fruit" strategies, which are being addressed first. Initial priorities included increasing the bulkhead height completed in 2016). The Community Rating System (CRS) is also a critical priority. It allows people to apply for reductions in flood insurance.

FACTORS TO CONSIDER

Annapolis currently has a successful historic tax credit program. As is typically the case, property owners who seek to rehabilitate a structure within the historic district must obtain approval from this Historic Preservation Commission for even small changes, such as to a window, door, or mailbox. While the city's program has been in place for years, it did not receive many applications in the past. The city started to promote the program by including information about it on certificate of approval permit applications (for example, "This project may qualify for a historic tax credit").

Once the program was promoted, the number of applications the city received increased considerably. For the first time, in fiscal year 2017 the program met its city-wide cap of $150,000. Since it demonstrated a significant achievement, the city advertised this accomplishment widely. The city's planning staff indicated that the program is already approaching the cap for fiscal year 2018.

As mentioned above, the city's historic tax credit program does not yet include flood adaptation as a qualifying expense, although the planning department intends to expand the program to cover such modifications. This expansion would not break precedent. The program's list of eligible modifications program has already been expanded to include safety

measure such as installing sprinklers for fire suppression. In addition to expanding the list of eligible improvements, the city wants to increase the total program tax credit cap.

Expanding the city's historic tax credit program to include renovations to add flood vents and flood-proofing will require concurrence of the Annapolis Historic Preservation Commission. According to the city's planning director, the preservation community is especially interested in preserving building exteriors. Flood-proofing these buildings would have to include interior treatments. Qualifying flood adaptation measures could include raising habitable space (for example, by raising the floor), which would allow water to seep in and seep out. Windows can be vented, allowing water to enter without creating pressure that would destroy them. Flood-proofing basement foundations, and possibly ground-level portions of the building, might be acceptable to the Historic Preservation Commission. However, elevating buildings may not qualify (this has yet to be determined) because it would modify the historic view-shed. The commission, as well as the city council, would have to approve any changes to the tax credit program.

APPLICATION IN NEW JERSEY

New Jersey's Historic Preservation Office (HPO), an arm of the New Jersey Department of Environmental Protection, provides New Jersey's communities with technical assistance, training, and other resources for historic preservation through a variety of programs and tax incentives. The Investment Tax Credit (ITC) program administered by the National Park Service through the HPO has promoted reinvestment in historic buildings since 1976. As is the case with most historic tax incentives, the objective of the program is to leverage private investment in historic properties through income tax credits for qualified rehabilitation projects. However, as in Annapolis, the scope of eligible rehabilitation of the New Jersey Rehabilitation Sub-code would need to be expanded to encompass flood adaptation measures.

CO-BENEFITS

- Preserve community identity, cultural heritage
- Leverage public incentives to encourage private investment

MEASURES OF EFFECTIVENESS

As noted above, the City of Annapolis is presently in the process of developing the historic district flood adaptation tax credit program. The program is not yet operational so measures to determine effectiveness have yet to be applied.

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10. Special Tax District – San Francisco, CA

ACTION

Enact a tax per parcel within the jurisdiction of a restoration authority established by the state Legislature.

Image 4: California Coastal Wetlands

DESIRED OUTCOME

In 2016, San Francisco Bay area voters approved Measure AA, a $12 per year parcel tax, the first regional parcel tax encompassing multiple counties of the state, to create revenue for the restoration of wetlands surrounding the San Francisco Bay. According to an October 2016 article published in News Deeply,[6] the groundwork for Measure AA was laid in 2008, when the state legislature created the San Francisco Bay Restoration Authority (SFBRA), which is staffed by the State Coastal Conservancy and the San Francisco Estuary Partnership.

The SFBRA's initial role was to persuade voters to fund restoration of the tidal wetlands systems and wildlife habitat in the San Francisco Bay and along its shoreline. To achieve this objective, shortly after its formation, the Authority set about to evaluate alternative funding strategies. A report issued in July 2009 on the Authority's behalf examined special taxes; property-related fees and benefit assessments; user and regulatory fees; development impact fees; and gifts and grants. The report also evaluated various state and federal funding options. The SFBRA preferred a tax measure, but as options were being weighed the Great Recession hit, devastating the economy nationwide. The Authority decided to wait to seek public action because it was clear that a proposal to adopt a tax measure in the prevailing economic climate was doomed to failure. Finally, in June 2016, the measure was placed on a state ballot and passed with 70 percent of the vote throughout the Bay area. It is estimated that the tax will bring in approximately $500 million over the 20 years of its lifespan. The tax is authorized by the San Francisco Bay Restoration Authority (SFBRA) and was levied to: reduce trash, pollution and harmful toxins; improve water quality; restore habitat; protect communities from floods; and increase shoreline public access (SFBRA, 2016).

Taxes levied on special districts are used to pay for public improvements that benefit the landowners within the special district. Landowners outside the district are not subject to the tax. The district boundaries do not necessarily follow municipal, county or state boundaries – which makes this strategy very useful for regional natural resource or hazard areas. This funding mechanism is often considered more transparent and easily understood than impact fees (NAHB, 2014).

[6] Water Deeply is an independent digital media project dedicated to covering the water crises in California and the American West.

Although modest on a per-parcel scale, the San Francisco Bay restoration tax has enabled ecological restoration projects around the bay by providing a reliable source of funding for planning, design and construction. The SFBRA administers requests for grant proposals, and staff, review and present the competitive grant applications to the SFRBA board, which authorizes funding for specific projects (Davenport, 2018).

FACTORS TO CONSIDER

Although a special tax could be interpreted as a "user fee," framing this strategy as a "tax" will likely elicit anti-tax rhetoric and opposition. Some may argue that although the tax is a modest amount ($12 per year in the case of the SFBRA), properties with lower assessments or greater distance from the bay are paying a disproportionate amount relative to parcels with higher property values or those located closer to the bay. To assess various options for funding the function of the SFRBA, the advisory committee worked with diverse stakeholder groups and performed public polling and research (Davenport, 2018).

A mechanism would be needed to transfer the property tax installment to the restoration agency, and there may be a delay in funding availability. For example, property tax collected on behalf of the SFBRA is directed to the Metropolitan Transportation Commission, which is a regional planning agency, and deposited into a bank account set up specifically for the SFBRA (Davenport, 2018). Revenue from the tax should then be distributed based on an appropriate formula. For example, 50 percent of the money from the SFBRA tax is available to all communities in the district, with the remaining being distributed proportionally based on factors such as population density (Davenport, 2018).

The amount of the tax should also be consistent with the goal. In the case of the SFBRA, flood protection is considered a secondary benefit of the parcel tax because the amount of funding is enough to restore the wetlands, but not enough to do large-scale flood protection for the area. It became evident during initial polling that voters cared more about water quality and habitat than about flooding, but this may be indicative of the variable flood risk experienced throughout the restoration area (Davenport, 2018).

A restoration agency with jurisdiction and taxing authority would be designated by the state Legislature, and multiple partners may be involved in campaigning for passage of the special tax, including nonprofits, several local jurisdictions and state representatives. Passing the tax, administering the grant money made available through the tax, and developing restoration projects would require ongoing collaborative relationships.

APPLICATION IN NEW JERSEY

New Jersey authorizes municipalities to designate special improvement districts to collect a fee on commercial properties and/or businesses to provide a reliable funding source for spending determined by the stakeholders (acting through a municipally-assigned District Management Corporation) to enhance downtown areas as per N.J.S.A. 40:56-65. The designated improvement district provides a means for businesses to pool resources and determine investments to the area that they comprise. A Rutgers survey conducted four months after Hurricane Sandy did indicate widespread support for government policies to reduce the likelihood of severe damage from future hurricanes. However, unlike San Francisco Bay area voters, only a small fraction of those surveyed were willing to contribute to a fund to pay to implement those policies. Hopefully this attitude is beginning to change as more residents in coastal areas experience regular flooding and sea-level rise impacts first-hand.

CO-BENEFITS

- Greater public awareness
- Ecological services
- Enhanced fishing and other natural resource-based industries

MEASURES OF EFFECTIVENESS

- Number and type of projects completed in the special district area with the fund
- Area of habitat restored over time (acres per year)
- Population density served by projects
- Vulnerable populations served by projects
- Sea-level rise and wave height monitoring
- Flood damage (dollars)

FUNDING SOURCES

This strategy is a funding mechanism. There may be staff and consultant fees involved with researching, developing and implementing the special district boundary and tax. State planning grants or coastal resilience programs could serve as potential funding sources.

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11. Foster Emerging Resilience-based Industries – Norfolk, VA

ACTION

Create incentives and provide support to industries that specialize in resilience solutions and technologies. Accelerate innovation in solutions that will build resilience

DESIRED OUTCOME

The City of Norfolk, Virginia's Office of Resilience is supporting an initiative to incorporate economic opportunity into resilience planning by launching the resilience innovation hub, RISE. As a nonprofit, RISE, previously the Coastal Resilience Laboratory and Acceleration Center, aims to solve coastal resilience problems by facilitating a process by which businesses can develop and demonstrate scalable innovations for communities to adapt to the impacts of climate change, while leveraging the necessity to adapt as a way to promote economic growth and job creation. The idea is that the technologies and industries that will need to develop as communities adapt to become more resilient to sea-level rise and climate change can serve as an economic engine to help sustain a vibrant and equitable business community. The city's strategy also includes workforce development components that attempt to create career pipelines and pathways, particularly for low-income residents. Partnered with a reinvestment in and revitalization of neighborhoods, the approach aims to create and sustain a vibrant coastal community that is fundamentally grounded in resilience.

RISE serves as a bridge between the large-scale institutions in the region that are in need of resilience solutions and the entrepreneurs who can offer innovative products and services (Morris, 2018). Through competitive funding opportunities, the organization can improve the process by which large institutions procure the services of businesses that offer climate resilience solutions. It can also encourage smaller, innovative businesses to develop solutions for large institutions and participate in the requests for proposals process from which they would normally be excluded.

Much of the conversation around the economics of coastal resilience focuses on cost-benefit analyses and the economic value of adopting various adaptation strategies. Consideration of the economic opportunity presented by the challenges of climate change enables communities to frame their investments and visioning with a realistic eye toward the future. Coastal communities have little choice but to respond to current and projected sea-level rise and storm risks, and this perspective enables them to do so in a way that also promotes economic growth and viability.

FACTORS TO CONSIDER

An approach intended specifically to promote new, start-up resilience-based businesses that depends on partnership with large institutions (e.g. local governments, hospitals, utilities) may require those institutions to rethink their business practices (Morris, 2018). For example, the requirement to award contracts only to the lowest bidder might discourage small businesses that may not have the advantage of scale from participation; or city engineers may have to be coaxed to consider a range of alternative-technology solutions rather than resorting to standard grey-infrastructure approaches; or a city attorney may have to be encouraged to overcome fears regarding "open and fair" bidding processes (Morris, 2018).

APPLICATION IN NEW JERSEY

Many of New Jersey's coastal communities rely heavily on tourism and do not have highly diversified economies. For that reason, creation of a new industry hub for the coastal region could spur economic growth and enhance economic sustainability. And the vast array of New Jersey's academic institutions are already well-positioned to serve as resilience business incubators.

The RISE center is fueled by the actions of a nonprofit organization and is not part of any government entity. Establishment of a non-government entity to administer the initiative does not require jurisdictional authority and has several benefits, including the ability to evaluate a broader range of solutions compared to a standard institutional procurement process; consideration of regional solutions that may not be fiscally optimal at the municipal scale; and development of procurement relationships with private institutions seeking resilience solutions.

CO-BENEFITS

- Job growth
- Workforce development and education enhancement
- Resilience awareness and cultural acceptance
- Diversified economy

MEASURES OF EFFECTIVENESS

- Resilience projects funded (number and dollars)
- Economic growth in the resilience industry sector
- Level of institutional risk (dollars, critical facilities, infrastructure)
- Poverty measures
- Employment measures
- Number of start-up companies

FUNDING SOURCES

Initial funding to create the RISE center came from a Department of Housing and Urban Development grant, with matching funds from the Commonwealth of Virginia. It is uncertain how the organization will acquire continued operational funding, but it may come from the state or from the small innovator businesses that are using the resource (Morris, 2018).

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e. Case Studies - Social

12. Voluntary Climate Change Relocation – Shishmaref, AK

ACTION

Relocate populations in jeopardy of flood inundation due to sea-level rise and/or coastal erosion. "Climigration" is defined as the point when inhabitants must resort to relocation because a community is no longer sustainable due to ecological changes.

DESIRED OUTCOME

Rising sea levels and subsidence are presenting a growing and potentially existential risk in an increasing number of places around the globe including: Kiribati in the Pacific Ocean; the Village of Sidney, New York; Princeville, North Carolina; Carteret Islands in Papua New Guinea, Jean Lafitte, Louisiana, and Easter Island, Chile, to name a few. Some places will eventually be under water and no longer viable. Many communities along New Jersey's coast are likely to experience similar risks as sea levels rise and coastlines erode. For some of these communities facing the most severe flood risks, relocation may become one of the few viable, durable responses.

Alaska, which is particularly vulnerable to the impacts of rising temperatures associated with climate change, offers many useful lessons. Land areas along Alaskan coastlines are undergoing severe erosion, glaciers are receding rapidly, permafrost is disappearing, and major storms batter settled areas regularly. These impacts threaten native communities. Alaska's Institute for Justice is currently working with 15 coastal villages to consider community-wide relocation. One example is Shishmaref, located on the west coast of Alaska, where residents voted to relocate their entire village because land is eroding at an alarming rate. The village's residents have experienced erosion on the island since the 1950s. However warmer air and sea temperatures from global climate change has begun to melt the sea ice pack that is the island's only buffer against severe storm surges, at a pace that is unprecedented, and the island is losing three to five feet of shoreline a year.

Shishmaref is expected to face extreme storm events in the upcoming years as changes in the climate occur and melting shore ice provides a decreasing amount of storm, wave and erosion protection. The community elected to relocate in 2002 however the process did not advance beyond the planning stage because of inadequate funding and a lack of consensus between the community and government agencies on where the community should relocate. After fourteen years of inaction,

Image 5: Shishmaref, AK

on August 16, 2016 the community held a second vote to either relocate the village to one of two nearby sites or protect it in place. In a narrow 94–78 margin, the vote to relocate passed.

FACTORS TO CONSIDER

According to research conducted by Robin Bronen, executive director of Alaska's Institute for Justice, who is working with the 15 villages noted above and who was interviewed for this case study, the key question vulnerable coastal communities need to consider in response to sea-level rise risks is – ***at what point in time is it no longer possible to provide residents with protection?*** Ms. Bronen stressed that climate-induced migration must protect social, economic and cultural human rights of individuals in the short and long term, particularly for socially vulnerable populations. In addition, the process must account for community political and economic viability. But for this approach to be effective, relocation cannot be mandated through external authority. Each affected resident must arrive at a personal conclusion that relocation is necessary (see "Communication is the Key" sidebar).

Ms. Bronen emphasized that a new institutional framework to implement relocation is needed that will protect people who live in high-risk areas but that will enable federal, state, local and tribal governments to shift their efforts from protection in place to managed retreat as increasing numbers of communities become unsustainable due to climate risks.

Ms. Bronen pointed out that erosion and sea-level rise impacts are *not* considered as hazardous events under the Stafford Act, the statutory authority for Federal disaster response. As a result of this oversight, no federal funding is available to address these impacts. Land collapse (erosion, permafrost loss, major storms) has to be recognized in state disaster plans.

Communication is the Key

Communication and engagement are the essential ingredients of an effective relocation strategy. The extent of community involvement depends upon whether residents at risk accept that relocation is necessary and agree/volunteer willingly to participate. To accomplish this, the Alaska Institute for Justice (AIJ) implemented an innovative, effective, and widely applicable technique: It created a *community-based social-ecological monitoring and assessment process* that involved training residents to use simple erosion and permafrost monitoring devices. This enabled the people who were most at risk of flood inundation to continuously track climate-related impacts personally, and, on a first-hand basis, assess and document decreasing arctic sea ice, thawing permafrost, and repeated extreme weather events.

According to an article by Robin Bronen of AIJ, "People needed to believe that they cannot be protected in situ and that relocation is not implemented for discriminatory reasons as a pretext to allow the land on which they live to be used for a different purpose, such as commercial development. If people perceive the threat to their lives and livelihoods as high by staying where they are, they may be more likely to consider relocation."

Self-assessments helped residents understand how their locality was being affected by global and regional climate-induced environmental changes and appreciate the need for an appropriate strategy to respond to them. Each community in Alaska is unique, and each has different approaches to address the problem, but community-based environmental monitoring cuts across the differences. Community-based environmental monitoring became the safe space within which to consider the difficult topic of relocation.

APPLICATION IN NEW JERSEY

The program to purchase property and relocate residents in New Jersey who are at risk of flood inundation is referred to as Blue Acres. The program, which was initiated in 1995 and is administered by the New Jersey Department of Environmental Protection (NJDEP), focuses on purchasing properties that have been damaged by flooding or may be prone to damage by

storms and storm-related flooding. Flood-prone structures that are purchased with public funds are then demolished and the remaining land is converted into municipally or county owned open space.

Participation in New Jersey's Blue Acres Program is voluntary, as is the case with most buyout programs; however, the program has established no criteria to enable it to prioritize where it focuses its efforts. As sea-level rise accelerates it will become increasingly important to establish a meaningful method to target purchases, particularly given the extensive number of high-value properties along the coast that are at risk compared to the limited funds available. Until the state sets acquisition priorities, it is possible that New Jersey could expend its entire acquisition budget purchasing property and still not reduce coastal vulnerability. For this reason, the program should establish future-looking, risk-based criteria that rely on the best available scientific projections of sea-level rise and flood risk to set boundaries for where buyouts should be focused. Within targeted flood-prone areas priority should be given to acquiring properties that have experienced repetitive loss from storm damage. Setting priorities in this manner will assure that scarce resources are focused in areas of greatest need and the acquisition program makes meaningful progress toward disrupting the cycle of flood-rebuild-flood that has characterized storm recovery in New Jersey.

Inadequate funding is not the only reason the Blue Acres program has not purchased more coastal properties. Local elected officials have also expressed considerable resistance to participation due to the fear of a declining tax base. For this reason, it is necessary to couple acquisition initiatives with funding strategies that equitably distribute costs and benefits and help to buffer local tax revenue losses, as described in the Funding Sources section, below.

Relocation Is Hard

A quote from an August 2018 article in Scientific American captured effectively the difficult nature of relocation noting: "The U.S. has occasionally experimented with retreat on a tiny scale by offering voluntary buyouts to waterlogged families. The outcome is rarely promising. "Buyouts are extremely expensive, extremely disruptive, and many of the attempts have not gone well," says Craig Fugate, former administrator of the Federal Emergency Management Agency (FEMA). "They invoke fear among citizens in every political stratum, bringing to mind land grabs, racist resettlement projects, class warfare, and, depending on your ideology, either federal overreach or federal abandonment. Because they require coordination among politicians, homeowners, lawyers, engineers, banks, insurers and all levels of government, they are enormously complicated to execute, even poorly. At their worst, buyouts break up community support systems, entrench inequality and leave a checkerboard of blighted lots in their wake. At their best, they avoid these things and still displace people from their homes."cx

CO-BENEFITS

- Stop the repetitive- and severe-repetitive loss cycle common in New Jersey's coastal communities
- Create and expand open space areas for marsh migration/shoreline protection

FUNDING SOURCES

Few if any New Jersey municipalities have the financial capability to purchase flood-prone, high-risk properties, and any that contemplate buyouts require state assistance. The state's ongoing Blue Acres Program is presently the principal source of buyout assistance. After Hurricane Sandy, this program administered New Jersey's $300 million allocation of federal Community Development Block Grant-Disaster Recovery (CDBG-DR) funds. With these funds, the Blue Acres Program purchased homes in flood-prone areas at pre-storm value. However, Blue Acres funding is insufficient to support the scale of acquisition that will be needed to

protect New Jersey coastal communities. As noted in the introduction to this report, a current Rutgers study indicates that almost 334,000 parcels of land, approximately 10 percent of all parcels throughout the state, are located in FEMA flood zones, many of which are located in currently designated CAFRA centers. These parcels represent over $174 billion in land value and improvement value. If it was necessary to purchase even a small portion of the most at-risk parcels in these areas, the cost would dwarf presently available funding. Consequently, it will be necessary to consider self-renewing funding mechanisms to expand the state's acquisition capacity and minimize the state's potential budget obligation. To do so, New Jersey should explore new bonding alternatives that are currently coming online, such as social impact bonds; disaster/catastrophe bonds; or environmental impact bonds (used to considerable advantage by DC Water to build innovative green infrastructure for stormwater management). Parametric insurance is yet another financing option for vulnerable coastal municipalities. Payments under parametric insurance are based on the occurrence of a triggering event, such as a hurricane, not on a damage assessment. Although these instruments have not been used to fund coastal acquisition to date, they are well-suited for this purpose.

The state should also consider establishing a state revolving fund, as envisioned in the proposed State Flood Mitigation Revolving Fund Act of 2017. Under the bill, states would have a permanent, independent source of low-cost financing that could be used to undertake acquisition for flood mitigation without the red tape associated with other federal disaster mitigation programs.

New Jersey should also create incentives for towns and residents to participate in acquisition. If the Blue Acres Program were retooled to focus on future risk rather than existing damage it would require a combination of incentives to encourage municipalities and residents to participate. These incentives could include a combination of programs to transfer development rights (see **TDR Case Study 7**, above), for example, mirroring the New Jersey Pinelands Development Credits Program; county and/or state assistance in maintaining new preserved open space once properties are acquired and razed; revenue-sharing strategies, such as those that have been used in the New Jersey Meadowlands to help ease the tax-loss burden in towns where a significant number of properties need to be acquired; homeowner bonuses to encourage acquisition of properties in blocks; and incentives to encourage owners of purchased properties to live elsewhere within the same municipality. New York Rising provided an example of such incentives. The program offered homeowners a 5 percent In County Replacement Dwelling Incentive, a 10 percent Enhanced Buyout Incentive to relocate from high risk areas, and a 10 percent group-buyout Incentive.

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13. Empower Vulnerable Communities – Southeast Florida RCCC

ACTION

Guide and support municipalities and counties in the Southeast Florida Regional Climate Change Compact region to create equitable climate policies, programs, and decision-making processes that consider local socioeconomic and racial inequities and ensure all can participate and prosper.

DESIRED OUTCOME

In 2010, Broward, Miami-Dade, Monroe, and Palm Beach counties joined together to create the Southeast Florida Regional Climate Change Compact. Representatives from these jurisdictions recognized that the effects of climate change, including sea level-rise and flooding, cause considerable economic and social disruption. The compact acknowledged that climate change will continue to expose the region to more frequent and severe weather events. Future hurricanes will likely be much larger, result in greater amounts of precipitation, and be more intense than the storms of the past. The region will experience greater extremes in drought and intense rainfall events, and average temperatures are expected to increase, creating the potential for longer and hotter heatwaves.

RCAP: Realizing that these climate change impacts are not constrained by political boundaries, the objective of the Climate Change Compact is to coordinate local and regional climate change mitigation and adaptation initiatives across county lines. The compact set about developing a climate action plan in order to prepare the region, through coordinated and interdisciplinary risk reduction and emergency management planning and investment, for the inevitable shocks and stresses of a changing climate. In 2012, through its collaboration, the compact developed the Regional Climate Action Plan (RCAP), its guide for coordinated climate action. The objective of the RCAP was to reduce greenhouse gas emissions and build climate resilience. The plan, which had a five-year horizon, outlined recommendations and guidelines for implementation, and shared best practices that local entities can follow to act in line with the regional agenda. These recommendations, guidelines and practices fall into 12 policy areas:

1. *Agriculture*: Ensure the continued viability of agriculture in Southeast Florida in the face of climate change through policies and actions that encourage sustainable production, remove barriers to production, promote economic incentives, improve water reliability, and promote best management practices.
2. *Compact Coordination*: Strengthen coordination and collaboration in Southeast Florida on climate change issues by building the capacity of the compact to meet evolving regional needs.
3. *Energy and Fuel*: Reduce consumption of electricity and fuel and increase renewable energy capacity to increase regional resilience, reduce greenhouse gas emissions, and improve emergency management and disaster recovery.
4. *Natural Systems*: Implement monitoring, management, and conservation programs designed to protect natural systems and the services they provide to society while improving their capacity for climate adaptation.
5. *Public Health*: Build capacity to mitigate climate-related public health risks in Southeast Florida on a proactive basis
6. *Public Outreach and Engagement*: Build public awareness of the climate-related risks facing Southeast Florida and the opportunities for early, coordinated action to address these risks.

7. *Public Policy and Advocacy*: Guide and influence all levels of government to address climate change in relevant policies, programs, and legislation.
8. *Regional Economic Resilience*: Establish a regional resilience strategy involving elected and business leadership, inclusive of funding mechanisms, to guide, incentivize, protect, and promote public and private investments and the economic integrity of the region.
9. *Risk Reduction and Emergency Management*: Prepare for the inevitable shocks and stresses experienced in Southeast Florida through coordinated and interdisciplinary risk reduction and emergency management planning and investment.
10. *Social Equity*: Guide and support municipalities and counties in the compact region to create equitable climate policies, programs, and decision-making processes that consider local socioeconomic and racial inequities and ensure all can participate and prosper.
11. *Sustainable Communities and Transportation*: Adapt to the impacts of climate change and reduce greenhouse gas emissions by reshaping where and how to build and move from place to place.
12. *Water*: Advance the water management strategies and infrastructure improvements needed, in parallel with existing water conservation efforts, to mitigate the potential adverse impacts of climate change and sea-level rise on water supplies, water and wastewater infrastructure, and water management systems, inclusive of regional canal networks, pumps, control structures, and operations.

RCAP 2.0: In December 2017, the compact published RCAP 2.0, designed as a digital tool with an easily accessible, web-based interface. This new version was built upon the principles and focus areas of the original plan. However, one of the principal features distinguishing the update is its focus on social equity and its racial justice recommendations. The plan acknowledges that communities of color and low-income areas are disproportionately exposed to heat, flooding, and pollution risks, meaning extreme weather events often hit them hardest. RCAP 2.0 aims to help leaders in the four-county region reduce climate change threats while tackling the historic racial and economic inequities that put low-income areas and communities of color most at risk from pollution and a changing climate.

RCAP 2.0 noted that as communities across Southeast Florida attempt to build a sustainable, resilient, and prosperous region, public policy must produce benefits that are shared by all residents. The compact recognized that climate vulnerabilities are exacerbated by inequities and injustice. RCAP 2.0 seeks explicitly to address the socioeconomic challenges to building resilience in high-vulnerability, often limited-income communities and/or communities of color. These groups have socioeconomic vulnerability because they lack the resources to be able to mitigate hazards or move away from them. The plan also acknowledges that many residents within the region's high-vulnerability communities also may have been left behind by recent economic booms, resulting in increased challenges to achieving the financial stability needed to weather safely the more intense storms, heat, and floods fueled by climate change.

In defining the obstacles faced by vulnerable populations, the compact embraced the Southeast Florida Regional Partnership's definition of equity, as outlined in the Seven50: SE Florida Prosperity Plan:

> ***Equity**: Just and fair inclusion. The goals of equity must be to create conditions that allow all individuals and communities to reach their full potential to the benefit of the individual and the larger regional community. An equitable region is one in which all can participate and prosper in their communities and in the regional economy, and where benefits and burdens are shared fairly.*

In response to the compact's awareness of the particular challenges of addressing climate resilience in vulnerable communities, RCAP 2.0 includes a new Social Equity section. This section aims to build the capacity of leaders of socially vulnerable populations to be part of the conversation and decision-making process for climate policies and initiatives. The Social Equity goal of the Regional Climate Action Plan aims to

> *[g]uide and support municipalities and counties in the Compact region to create equitable climate policies, programs, and decision-making processes that consider local socioeconomic and racial inequities and ensure all can participate and prosper.*

This goal attempts to address socioeconomic and other disparities associated with resiliency planning resulting in disproportionate impacts to certain populations by preparing local community leaders for the task of interpreting and communicating climate resilience information to their communities and soliciting meaningful feedback. The Social Equity section of RCAP 2.0 outlines seven policy, infrastructure planning, and community engagement recommendations local governments should enact as they work toward the goal, including:

- Make equity an "integral part of policy making at every level of government" and a key objective when "developing plans, budgets, and in prioritizing and designing climate projects."
- "Prioritize investments in infrastructure that enable economic mobility, health, and safety," such as green infrastructure and transit that is accessible from affordable housing, schools, and community spaces.
- Engage communities effectively, remove barriers to participation, and support community leadership in planning processes related to preparedness and infrastructure design

FACTORS TO CONSIDER

The Southeast Florida Regional Climate Change Compact, which encompasses an area approximately 1,100 square miles greater than the state of New Jersey, was the first regional collaborative in the country formed to address climate change issues. Since its establishment, several regional collaboratives have formed. The representative from the compact interviewed for this case study stressed that the compact's Regional Climate Action Plan does ***not*** mandate local action. The plan is meant to serve as guidance for municipal and county governments, agencies, regional councils, regional resource management districts, and other local planners and practitioners. The plan identifies vulnerabilities and integrated policy initiatives to guide climate mitigation and adaptation efforts that each jurisdiction in the region can elect to implement. Recognizing that decisions on the timing and approach are best determined by each local government, the RCAP is a framework for concerted regional action at the local level, not a set of directives for specific projects or programs. Participating municipalities are invited to customize their individual implementation action plans.

APPLICATION IN NEW JERSEY

The Social Equity goals, policies, and strategies outlined in the Southeast Florida Regional Climate Change Compact's RCAP 2.0 are equally applicable to New Jersey's socially and economically vulnerable populations. Effective methods to communicate climate change risks and engage residents, particularly vulnerable populations, to consider the need for action has been a considerable and long-standing obstacle hindering effective local-level resilience planning. The policies, programs, decision-making processes, and communication techniques outlined in the RCAP 2.0 can be adopted as public engagement, communication, education and

outreach strategies to guide any local-level resilience planning initiative in New Jersey. New Jersey communities should also consider applying the effective communication technique developed by the Alaska Institute for Justice described in the "*Communications is the Key*" sidebar in **Case Study 12**, above.

CO-BENEFITS

- Increased public awareness of the implications of climate risks
- Increased public involvement in resilience strategies, risk preparedness

MEASURES OF EFFECTIVENESS

The Southeast Florida Regional Climate Change Compact has identified the guiding principles of its Social Equity initiative, but the program is still largely aspirational and not yet operational, so measures to determine effectiveness have not been put in place.

FUNDING SOURCES

Public participation is an essential determinant of the acceptance and success of municipal resilience plans and is fundamental to the master planning process. However, assuring widespread public involvement on the part of all communities, particularly socially vulnerable populations, has been a long-standing challenge to the efficacy of the planning process. The policies encompassed in the RCAP 2.0 Social Equity element offer an effective model that can help to address this challenge. Costs to implement these policies are likely to be minor and could be absorbed in the funding municipalities typically allocate to master plan updates. Although, as noted in case study 1 above, reinstating New Jersey's Smart Growth Planning grant program could provide incentives and guidance to overcome any local-level reluctance to conducting robust public communication and outreach efforts.

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- www.mbrisingabove.com for Miami Beach
- http://www.southeastfloridaclimatecompact.org/ for the Compact
- https://www.americanprogress.org/issues/green/reports/2018/02/08/446124/social-equity-key-southeast-florida-rcap-2-0/

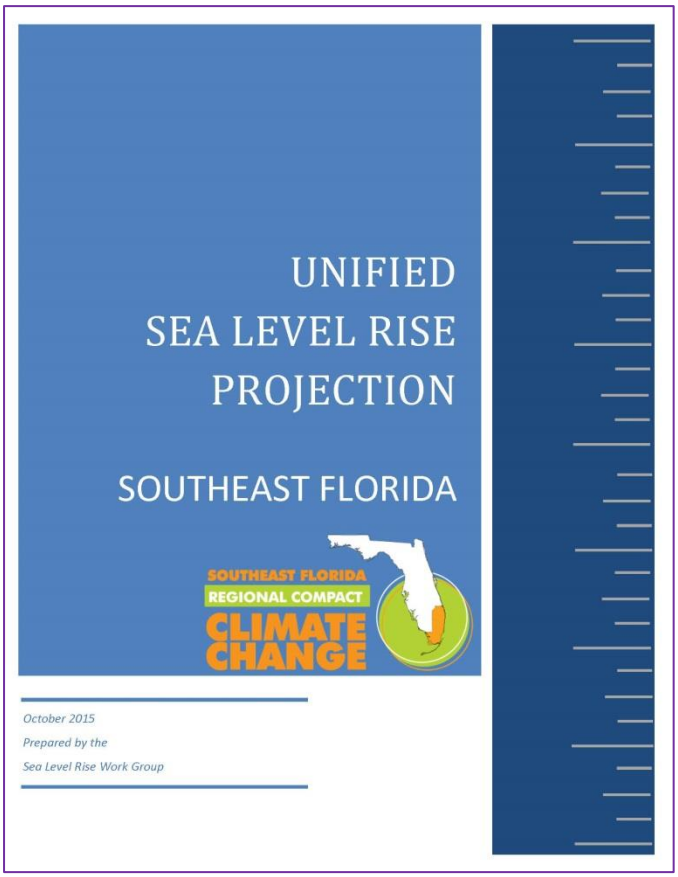
Examples of regional climate change collaboratives
https://www.georgetownclimate.org/reports/lessons-in-regional-resilience.html

f. Case Studies – Communication/Outreach/Education

14. Unified Sea Level Projections – Southeast Florida RCCC

ACTION

Guide and support municipalities and counties in the compact region to create equitable climate policies, programs, and decision-making processes that consider local socioeconomic and racial inequities and ensure all can participate and prosper.



DESIRED OUTCOME

In 2010, the Southeast Florida Regional Climate Change Compact's Steering Committee organized the first Regional Climate Change Compact Technical Ad-hoc Work Group. The work group's objective was to develop a unified sea-level rise projection for the Southeast Florida region for use by the counties and partners participating in the compact. Its primary use was for planning, to aid in understanding of potential vulnerabilities to sea-level rise and to provide a basis for outlining adaptation strategies for the region. The work group reviewed existing projections and scientific literature and developed a unified regional projection for the period from 2010 to 2060, which it released in 2011 (Compact, 2011). The projection highlighted two planning horizons: 1) by 2030, sea-level rise was projected to be three to seven inches above the 2010 mean sea level; and 2) by 2060, sea-level rise was projected to be nine to 24 inches above the 2010 mean sea level. In anticipation of the release of the United Nations Intergovernmental Panel on Climate Change Fifth Assessment Report (IPCC, 2013), the sea-level rise work group recommended a review of the projection four years after its release.

In September 2014, the compact reconvened the Sea-level Rise Work Group for the purpose of updating the unified regional projection based on global projections, guidance documents and scientific literature released since its original regional projection (Compact, 2011). The updated report, released in October 2015, contains a summary of the projections and publications reviewed and discussed, the methodology for deriving the projection, the recommended unified regional projection, and additional recommendations from the Sea Level Rise Work Group.

The objective of the Unified Sea Level Rise Projection for the Southeast Florida region remains consistent in that the projection is intended for use by the climate compact counties and partners for planning purposes to aid in understanding of potential vulnerabilities and to provide a basis for developing risk-informed adaptation strategies for the region. For the 2015 update, the starting point for all sea-level rise projections has been shifted from 2010 to 1992. This allows for direct use of local tide station information to convert projections into local water

surface elevations for flood vulnerability studies and is consistent with current guidance from the U.S. Army Corps of Engineers and the National Oceanographic and Atmospheric Agency (NOAA). The Unified Sea Level Rise Projection for Southeast Florida has also been extended to 2100 in recognition of the need for longer-range guidance for major infrastructure and other long-term investments now being planned.

According to the compact's 2015 report, in the short term, sea-level rise is projected to be six to 10 inches above the 1992 mean sea level by 2030 and 14 to 26 inches above it by 2060. In the long term, sea-level rise is projected to be 31 to 61 inches above the 1992 level by 2100. For critical infrastructure projects with design lives in excess of 50 years, the report recommends the use of the upper curve with planning values of 34 inches in 2060 and 81 inches in 2100. The National Aeronautics and Space Administration Jet Propulsion Laboratory (2015) has reported that average global sea level has risen almost three inches between 1992 and 2015 based on satellite measurements. The report indicates that sea-level rise in South Florida has been of similar magnitude over the same period (NOAA, 2015) but is anticipated to outpace the global average due to ongoing variations in the Florida currents and Gulf Stream.

FACTORS TO CONSIDER

The Unified Sea Level Rise Projection is intended for use by a variety of audiences for short- and long-term planning, infrastructure siting and design. The compact suggests that potential audiences include elected officials, urban planners, architects, engineers, developers, resource managers and public works professionals.

One of the key values of the projection is the ability to associate specific sea-level rise scenarios with timelines. When used in conjunction with vulnerability assessments, these projections inform the user of the potential magnitude and extent of the impact of sea-level rise at a general timeframe in the future. The projections are presented as a likely range for sea-level rise values at specific planning horizons. The report acknowledges that providing a range instead of a single value may present a challenge to users such as engineers, who seek to provide a design with precise specifications. The report encourages public works professionals and urban planners to work with the engineers and with policy makers to apply the projection to each project based on the nature, value, interconnectedness, and life cycle of the infrastructure proposed.

The compact recommends that elected officials use the projections to inform decision-making related to adaptation policies, budget impacts associated with design features which address planning for future sea-level rise, capital investments, especially those associated with drainage and shoreline protection, and land-use decisions.

APPLICATION IN NEW JERSEY

The impacts from sea-level rise associated with climate change are clearly not constrained by municipal boundaries or political jurisdictions. However, the land-use decisions required to respond to these impacts are dictated by the local elected officials from each of New Jersey's 565 municipalities. To help assure that decisions made by each municipal governing body, the strategies they elect to pursue, and the programs they enact coalesce to respond effectively to our changing climate, it is essential to start from a common understanding of the risks these local-level decisions, strategies, and programs are designed to confront. This is why it is necessary to adopt uniform sea-level standards and why this particular strategy, unlike others evaluated in this report, will only be effective if adopted at the state level. In order to keep New Jersey's communities and residents safe from potential storms and flooding, as well as protect infrastructure and taxpayers' money, the state must establish uniform, forward-looking sea-

level rise standards and guidelines to serve as the common starting point for all local, and county, mitigation planning.

The New Jersey Climate Adaptation Alliance Science and Technical Advisory Panel (STAP) has issued sea-level rise projections for New Jersey in a report entitled Assessing New Jersey's Exposure to Sea-level rise and Coastal Storms. Currently, just about every institution, organization, or agency working in the field of resiliency in New Jersey is relying on these projections and applying them in the course of the work they undertake. The state can incorporate the same science-based projections into all of its land-use policies and provide coherent, uniform guidance for municipal hazard mitigation planning. In addition, considerable work has already been performed by NJDEP's Office of Coastal Land Use Planning in conjunction with its NJ FRAMES project to develop a coastal flood exposure assessment methodology based on a range of water-level event scenarios. This framework is similar in concept to the approach outlined in Florida's Unified Sea Level Rise Projection report.

CO-BENEFITS

- Uniform planning standards are more likely to result in municipal planning, land-use policies and projects that will have regional benefits.
- Will foster common understanding of climate change risks.
- State-level standards will help to dispel local-level reluctance to assess sea-level rise risks and identify response strategies.
- Uniform standards will help to avoid uncoordinated, individual responses (such as inappropriately placed sea walls and bulkheads) that result in unintended adverse impacts on neighboring communities.

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15. Flood Risk Disclosure – Durham, NH

ACTION

Advise potential property buyers about sea-level rise risk and flood exposure potential

DESIRED OUTCOME

The intended outcome of flood risk disclosure is to encourage purchase of flood insurance; communicate location of flood-prone, sea-level rise areas; identify mitigation measures for properties; planned retreat.

Dissemination of flood exposure information is critical to protecting people and property. Information about flood history or future flood vulnerability helps prospective property buyers make better investments, alerts property owners and renters of their risk, and could potentially dissuade some from buying or renting in flood-prone areas, leading to an eventual decline in flood-vulnerable development.

Flood risk is most often communicated in the context of the National Flood Insurance Program (NFIP) that is administered by the Federal Emergency Management Agency (FEMA). Regulatory FEMA flood insurance rate maps (FIRMs) identify special flood hazard areas (SFHAs), which are areas where flood insurance is required for federally backed mortgages. In SFHAs, local jurisdictions must enforce local zoning ordinances that restrict floodplain development and improve floodplain management. The NFIP program was established in 1968 to reduce flood damages and the costs associated with relief or recovery, and ensures that flood-prone properties are able to obtain insurance (Adler & Scata, 2019). The FIRMs are not an ideal source of flood risk communication because they are designed to implement the requirements of the NFIP and do not show true flood risk; do not identify all areas that are prone to flooding; and do not denote future flood-prone areas due to sea-level rise (Kousky, 2017; Kunreuther et al., 2018; Wing et al., 2018). These regulatory maps can be out of date (DHS, 2017), and they can create a false sense of safety in areas that are flood-prone but do not fall within the SFHA.

Even within the bounds of a FEMA SFHA, not all property owners are aware of their flood potential, and not all properties are protected by flood insurance. This is because insurance is not required for unmortgaged properties. Property owners who are not required to have flood insurance may not be aware that most homeowner's insurance policies do not include flood damage, and so can be caught by surprise when flood damage does occur. There is also no federal or New Jersey requirement to disclose flood risk or flood coverage to renters, who may be less apt to research flood history or prepare for damage to the home.

Data availability is not the obstacle to implementing flood disclosure policies for properties in the NFIP because FEMA tracks claims data for these properties and identifies which are classified as "repetitive loss" or "severe repetitive loss" based on the dollar amount and number of claims filed. Because sharing repetitive-loss information is prohibited by the Privacy Act of

1974, property owners or prospective buyers are not made aware that these properties are at greater risk of repetitive flood damage, even though the information is amassed. Further, the NFIP data do not capture all properties in the SFHA with flood potential or risk. For properties not in the NFIP, historical records of flood damage are not compiled at all, suggesting that a more comprehensive and transparent flood tracking and communication mechanism would exist at the local scale.

In the case of property transfers, real estate agents can perhaps alert property buyers most effectively about flood history or potential. An assessment of the FEMA Community Rating System (CRS), which incentivizes municipal flood mitigation actions through a point system that earns reductions to NFIP premiums for property owners (FEMA, 2017), acknowledged that the CRS program does offer points for real estate agent disclosure of flood hazards and flood insurance purchase requirements in the SFHA, but also recommends that municipalities should earn additional points by establishing a searchable website of flood hazard information available to real estate agents and also to individuals; and for other practices that encourage real estate agents to identify and disclose flood information about properties (Dewberry & Davis, 2005). Flood information made available through the municipality, for example as a requirement of attaining a certificate of occupancy, would also provide accessibility to renters.

As part of Durham, New Hampshire's non-regulatory education and outreach strategy in a 2013 climate adaptation report, it was proposed that the location of possible sea-level rise areas be disclosed to potential buyers (Pimental, 2013) based on local mapping of sea-level rise projections. Disclosure of sea-level rise areas goes beyond communicating flood history because it is a better indicator of future flood exposure in the context of climate change, and a disclosure requirement through real estate agents would provide greater transparency for property buyers. The recommendation has not been adopted in Durham because there is not an effective mechanism by which to transfer this information (no specific inspections are required to complete the sale, for example), and the real estate industry has not been engaged in sea-level rise communication efforts (Pimental, 2018). In New Hampshire, towns are not permitted to take actions without explicit consent from the state, however, a state statute in the Shoreland Quality Act allows for "innovative land use" within a state shoreline protection overlay district.

Flood disclosure that occurs as a consequence of the requirements of the NFIP does not meet the goals of a municipality to protect people and property. Adler & Scata (2019) propose that disclosure laws to track costs of repairs and damages should accompany state or local ordinances that lower the damage threshold at which rebuilding, or renovation must incorporate mitigation actions (such as elevation) to address the build-flood-rebuild cycle of flood-prone areas.

Flood risk disclosure should include historical flooding, extent of damage, and future potential risk for each property; be readily accessible and understandable by current property owners, prospective buyers and renters; be integrated into the real estate business; and accompany information about insurance and rebuilding costs that are incurred from flood damage.

FACTORS TO CONSIDER

Flood zone designation is associated with lower property values and does convey some level of risk to potential buyers (Bin et al., 2008). Real estate agents may be reticent to support flood disclosure if it means fewer properties being sold, or lower property values, which will affect their profit. However, real estate agents are advised to communicate flood risk in order to avoid potential liability (CRES, 2019).

Timing of disclosure is relevant. Studies show that most potential buyers are not aware that a property is in a FEMA flood zone until after they have made a bid or when they are about to close (Kunreuther et al., 2018; Pope, 2008). Even when individuals are alerted of potential flood risk, there is a tendency to be myopic (think only in the present) or disregard the past (Kunreuther et al., 2018); therefore, flood risk disclosure should be coupled with education about potential personal loss or damage.

Flood risk changes over time, especially in coastal areas, and people need to be updated by an effective mechanism. Flood risk disclosure at the time of property transfer does not inform current property owners or renters of their current risk. Further, risk is a factor of both potential and impact, and there are few resources for individuals to assess adequately the level of impact from flooding, future sea-level rise or storm surge risk. A recent study shows that U.S. homeowner's insurance rates have been rising up to almost 50 percent in the last 10 years, due largely to property damage (ValuePenguin, 2019), which suggests that increasing flood risk may increasingly factor into property investment decisions.

To implement a flood risk disclosure policy, governments will need to develop costly sea-level rise maps to determine what properties are vulnerable, and help sellers, buyers and real estate agents understand sea-level risethe maps (Grannis, 2011).

Because people may choose to invest in flood-prone properties even after being informed of the risk, to achieve reduction of community risk, it may be appropriate to couple flood risk disclosure information with information about other land-use regulations that restrict use of the property (Grannis, 2011).

APPLICATION IN NEW JERSEY

There is no federal mandate that requires flood risk disclosure, and New Jersey is one of the 21 states that do not have a statutory or regulatory flood disclosure requirement (NRDC, 2019), which puts the burden on local governments to communicate flood exposure and flood risk effectively to the community.

Although sellers of property in special flood hazard areas (SFHA) must disclose any known defects at the time of sale, flood history or damage is not a required disclosure for real estate transactions. Prospective buyers or renters could do their own due diligence by searching for FEMA flood maps or other flood risk maps online or requesting flood information from the municipality, but this is not an intuitive process that yields readily available or easily interpreted results. Some towns are distributing flood exposure resources via their websites or other means, primarily as public awareness and education activities that are rewarded by the CRS program; however, it is not standard practice to incorporate information about historical property damage or future sea-level rise to communicate potential costs or future flood potential.

The state Hazard Mitigation Plan (Tetra Tech, 2104) denotes the use of loss estimates in local mitigation plans and the state's responsibility to provide information about losses to prioritize mitigation of repetitive-loss properties; however, loss estimates are determined solely based on FEMA repetitive-loss properties data. There are no statewide data sets that identify other properties that have incurred flood damage.

The New Jersey Resilient Coastal Communities Initiative has developed a Getting to Resilience Tool (NJRCCI, 2015) to assist communities with understanding, planning for, and preparing for sea-level rise. It is a self-assessment tool that can help municipalities communicate flood risk to their communities. There are also a number of sea-level rise projection mapping tools available, including NJ Adapt NJFloodMapper, NJ Adapt Flood Exposure Profiler, Climate Central Surging

Seas Risk Finder, The Nature Center Coastal Resilience Decision Support System, and the NOAA Sea-level rise Viewer, among others.

CO-BENEFITS

- Real estate market stabilization
- More informed community expected to respond better to flood hazards and reduce stress on emergency services
- Database to assess distribution of flood risk and extent of flood damage. Data can be used, for example, to determine where response and resources may be needed in high-hazard areas or high-damage areas, or where public investment in built infrastructure is less economic
- More equitable distribution of risk
- Greater willingness to participate in buy-out programs

MEASURES OF EFFECTIVENESS

- Number of flood disclosure statements filed with the town as part of a real estate transfer, relative to the number of properties identified as being at risk
- Analysis of whether flood damage tracking aligns with mapped flood risk areas
- Number of website visits on municipal information sites or real estate property descriptions that convey flood risk

FUNDING SOURCES

There are no direct funding sources for implementation of municipal ordinances. Grant funding may be available through federal, state or county hazard mitigation programs, or municipalities could seek partnerships with universities or nonprofit organizations to develop risk maps and compile information. Real estate businesses may be willing to incorporate notifications or flood hazard information into their property search database to alert potential buyers.

The New Jersey Office of Emergency Management (NJOEM) assists local mitigation planning efforts and helps jurisdictions obtain hazard mitigation planning grants, specifically for development of local hazard mitigation plans (Tetra Tech, 2014). NJOEM may be able to provide assistance to obtain funding for development of a flood exposure and risk database as a local hazard mitigation action.

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Part 3: FURTHER CONSIDERATIONS

a. Process and Content

The New Jersey Future project team initiated this research project by performing a broad-brush web and literature search to identify innovative and/or successful resiliency strategies that are presently being employed at the local or regional level throughout the country. The objective of this task was to determine what strategies municipalities are planning or have implemented to increase their resilience to flood risk, what reasons they have for undertaking these strategies, and how these local or regional entities measure how/when/whether they are more resilient as a result. The project team identified more than 350 strategies that are being implemented in 76 cities and/or regional areas throughout the country (see **Appendix 1**). The search was intended to be illustrative of noteworthy projects rather than to be exhaustive of all resilience initiatives, which, because of the dynamic, rapidly expanding and evolving nature of the field of resilience, would be neither practical nor feasible.

Once the list was assembled, the project team evaluated the strategies to determine which initiatives stood out as particularly innovative. The list was culled to 15 strategies, each of which fell into one the six typology categories. Representatives of the respective municipalities or regional organizations were contacted to arrange interviews in order to obtain a more detailed, first-hand understanding of how the strategy is being implemented, what process was required to enact it, what magnitude of costs were involved in developing the strategy, whose buy-in was needed to authorize implementation, and whether the strategy is achieving its desired goals. An introductory email was sent to each prospective interviewee and an informant template was developed to guide the interviews. Each of these framing documents is included as exhibits in **Appendix 2**. Following completion of the interviews, the project team conducted detailed research on each of the 15 selected strategies in order to prepare each case study presented in **Section 2**.

b. General Barriers

There are several barriers to acceptance of the imperative to respond to risk associated with climate change. These hurdles influence the level of difficulty and resistance that is likely to be encountered in trying incorporate any given resilience strategy into municipal plans, land-use regulations, policies, and investments. These barriers include:

1. On their own, individual municipalities are incapable of addressing fully the issues associated with tidal flooding and sea-level rise that affect the coast of the entire state, or storm events that are unconstrained by political boundaries. However, in the absence of statewide policies, standards or response strategies, municipalities in New Jersey have largely been left to develop their own adaptation or mitigation initiatives. Despite the continuing desire to live close to the ocean and indications that property values, at least currently, continue to appreciate, the fear of potential disinvestment and resulting tax revenue loss makes local officials reluctant to take remedial action. As a result, there has been little appetite to confront climate risks publicly; to consider and fund all but the least disruptive resilience strategies; to reshape coastal development policies, regulations or patterns; or to engage in relocation initiatives.
2. The lack of a shared understanding of risk, combined with varying levels of risk tolerance, is hindering effective response to the threats that come with sea-level rise. Because the state has yet to establish official, forward-looking sea-level rise projections, communities that are attempting to establish municipality-wide design standards have needed to set their own sometimes disparate targets, and the lack of regional coordination is likely to result in confusing, inconsistent, costly, and possibly unsafe remediation approaches.

3. The absence of reliable funding, state-wide standards, and technical assistance discourages municipal officials from serious consideration of difficult risk response planning.

4. Residents of coastal communities have deeply embedded social and cultural connections to the shore. In many cases, they occupy homes and own properties that have been passed among family members for generations, and that represent the majority of family wealth. There is resistance to considering resilience initiatives that would alter the character of a community, diminish the ability to continue the tradition of passing homes to succeeding generations, or result in a loss of property with so many memories and traditions and so much value.

c. The SRPR, S&RCC Report, S&RCC Municipal Options Report

Prior to undertaking this research project, New Jersey Future prepared three related reports which, when considered together, offer a body of recommendations that can serve as a model for local resilience planning and companions to this Local Options/Local Actions Report.

Strategic Recovery Planning Reports (SRPRs) were prepared on behalf of six communities participating in New Jersey Future's Local Recovery Planning Manager Program (LRPM).[7] Each report included a vulnerability and risk analysis that was intended to relate convincingly the potential impacts of rising sea levels. These parcel-based mapping analyses predicted depths of inundation throughout each community under 2050 sea-level rise projections, then modeled resulting structural damage, and calculated both the property owners' financial exposure and the towns' related potential tax revenue losses. This level of detail is essential in helping communities to appreciate the economic risks of future flooding and sea-level rise, and to reach a realistic determination of how and where to allocate scarce personnel and financial resources. New Jersey Future's LRPM program experiences were chronicled in "*In Deep*", a report released in 2015.

Sustainable and Resilient Coastal Communities (S&RCC) Report: After completing the SRPRs, New Jersey Future took advantage of the opportunity to continue land-use and resiliency planning work with two coastal communities through the Sustainable and Resilient Coastal Communities Grant Program. Through this program, the New Jersey Department of Environmental Protection (NJDEP) Office of Coastal and Land Use Planning (OCLUP) sought to assess its requirements for designating centers under the Coastal Areas Facility Review Act (CAFRA)[8] and to align the designation process with updated priorities of the Coastal Zone Management Program to account for the risks sea-level rise and land subsidence. Through the S&RCC project, NJDEP sought to fund a pilot comprehensive planning approach that would identify actions municipalities could take to respond to coastal hazards while protecting New Jersey's coastal resources. The intent was to use project outcomes to inform potential changes in the Coastal Zone Management Rules (N.J.A.C. 7:7), which regulate the use and development of the state's coastal resources and ensure that coastal hazard risks are addressed. The project was also intended to provide a model for actions all coastal communities can take to examine land-use and infrastructure development decisions in response to risks associated with projected sea-level rise. The report included detailed descriptions of 16 specific strategies and implementation options to reduce vulnerability and improve resilience. In December 2017, New Jersey Future released the comprehensive S&RCC report, which was highlighted as a feature publication by the United Nations Office for Disaster Risk Reduction.[9]

[7] SRPR sample report: https://www.njfuture.org/wp-content/uploads/2015/10/Strategic-Recovery-Planning-Report-Tuckerton-4-15-15.pdf

[8] NJ CAFRA rules https://www.state.nj.us/state/planning/docs/cafraact.pdf

[9] For the full S&RCC report see http://www.njfuture.org/2017/12/13/resilient-coastal-communities-report/

Municipal Options Report: The third in the report series that began with the 2015 SRPRs, recounted efforts undertaken in the second phase of the S&RCC project and was the culmination of vulnerability and risk analyses. This resulting project report, released March 2018, described specific actions and strategies that Little Egg Harbor Township and Tuckerton Borough can take, including recommended master plan changes and zoning regulation amendments, to enhance resilience – described in detail in the report appendix. These recommendations can serve as an example of provision amendments that would apply to communities throughout the state that seek to integrate resilience strategies into local land-use plans, zoining regulations and capital improvement plans.

d. Things We Learned

- A plan is key to ensure coordinated, thoughtful actions. The majority of strategies New Jersey Future explored are the products of broad-based climate-change plans.
- Municipalities or regions that are implementing innovative resilience initiatives are carrying out many actions simultaneously. For example, three noteworthy, distinctly different strategies are being developed or currently implemented in Durham, NH.
- Collaboration and cooperation are possible. The Southeast Florida Regional Climate Change Compact was established through a cooperative effort of officials from four adjacent counties who saw a need for concerted response to climate impacts. Although this was the first such regional model, several others are being organized throughout the country.
- The field of resilience is constantly evolving and is likely to expand rapidly. As climate change accelerates and the impacts of climate-change risk become increasingly apparent, a sense of urgency to respond effectively is growing and more strategies are being tested and applied.
- Local officials are likely to start with the easy-to-accomplish, less disruptive strategies, but a modest start will help to build confidence and support for harder steps that will become necessary down the road.
- For the most part, the local or regional entities we contacted had yet to established methods to measure the impacts of the strategies they were implementing. In many cases, the strategies were only recently enacted, and it is too early to see, or measure, results. However, measures of effectiveness have been identified in the few instances where they are in place and have been suggested by this report's authors for many of the other case studies included in **Section 2**.

e. An Important First Step: Revise the MLUL

The Municipal Land Use Law (N.J.S.A. 40:55D:1) (MLUL) is New Jersey's enabling legislation for municipal land-use planning and zoning. Provisions in the MLUL outline the process for preparing a municipal master plan and the required and optional plan contents. According to the MLUL, a municipal master plan *must* include a statement of objectives and principles and a land-use element. A master plan *may* include a housing element; a circulation plan element; a utility service plan element; a community facilities plan element; a recreation plan element; a conservation plan element; an economic development plan element; a historic preservation element; an appendix containing the technical foundation for the master plan; a recycling plan element; a farmland preservation plan element; a development transfer plan element; an educational facilities plan element; and/or a green buildings/environmental sustainability plan element.

The MLUL does not currently include provisions for considering risks associated with sea-level rise and climate change as part of a master plan, nor does it outline what an assessment of vulnerability or appropriate adaptation or mitigation strategies in response to such risks should entail. As a fundamental first step towards encouraging and supporting municipal resilience initiatives, the MLUL needs to be revised to acknowledge explicitly that New Jersey's climate is changing and that municipal master plans should reflect these changes, evaluate the possibility of risk, and consider response strategies. To ensure local-level risk assessment consistency, the MLUL should also be revised to require that the state provide municipalities with the most current science-based natural hazards projections. **Appendix 3** provides recommended revisions to the MLUL that would accomplish these objectives.

Part 4: ADDITIONAL RESEARCH NEEDED

a. Techniques and Strategies

As the Local Options/Local Actions report was being completed, several recent articles and reports were discovered, or strategies that are considered in contexts other than resilience were identified, which should be considered for future research.

1. *Climate emergency declaration*: On December 11, 2018 an article was published describing the City of London's declaration of a climate emergency in order to accelerate the city's efforts to transform its economy to carbon-neutrality by 2030. With this declaration London became the 11th city worldwide to commit to emergency actions to eliminate greenhouse gas emissions and enact other local policies to create a just transition and avoid the catastrophic consequences of irreversible climate change. London followed three cities in Australia and six cities and counties in the United States, including Hoboken, New Jersey, that have declared a climate emergency. The objective of these declarations is to emphasize clearly the urgent need for actions and marshal all available resources to respond to climate risks at the scale of the crisis.

2. *Vertical forests*: An unconventional green infrastructure concept, Vertical Forests, could be integrated in municipal resilience design standards. The objective of this strategy is to incorporate more trees and plant life in urban architecture to absorb carbon dioxide and boost oxygen output. According to C40, a network of the world's megacities committed to addressing climate change, cities occupy about 2 percent of the world's land mass but consume two-thirds of the world's energy, and account for more than 70 percent of the global carbon emissions that contribute to climate change.[10] The design proposal recently conceived for Manhattan incorporates both trees and greenhouses. If 15 of his 1,000-foot vertical forest buildings were constructed in the city, Stefano Boeri, the project designer said that together they would have the same number of trees that are found within the 840 acres of Central Park.[11]

Image 6: Bosco Verticale, Milan

3. *Green infrastructure*: The application of green infrastructure can be extremely effective in managing storm water in communities plagued by regular flooding. The USEPA notes that as the climate continues to affect different areas of the country, green infrastructure can help to improve community resilience. In June 2018, New Jersey Future introduced its New Jersey Green Infrastructure Municipal Toolkit, a website dedicated to green infrastructure planning. The toolkit is an interactive, online resource that offers detailed information, expert guidance and a variety of resources that cities and towns can use to make green

[10] These figures are supported by the 2010 The International Bank for Reconstruction and Development/The World Bank study entitled Cities and Climate Change: An Urgent Agenda

[11] Source: https://www.nytimes.com/2018/12/13/us/stefano-boeri-vertical-forests-cities-conference.html, Laura Testino, 12-13-18

infrastructure a mainstream stormwater management strategy in public- and private-sector development projects.

For the past several years, New Jersey Future has been working with state agencies to update and improve rules, manuals, standards, and programs to facilitate and create incentives for the use of green infrastructure. On December 3, 2018, the New Jersey Department of Environmental Protection announced its proposal to change the state's stormwater management rules (N.J.A.C. 7:8), updating the requirement for how property owners meet the rule's minimum design and performance standards by requiring the use of green infrastructure, rather than recommending it as an option.

Streets encompass typically more than 70 percent of city-owned public space. If properly planned, non-structural management practices can be incorporated within a street right-of-way that mimic the natural water cycle to capture, filter, reuse and/or absorb stormwater and ensure that streets remain usable and safe during storm events. In addition to stormwater management, green streets reduce heat-island impacts and improve air quality by removing and sequestering airborne carbon dioxide.

4. *Chief resilience officer*: Many cities and a growing number of counties, universities, businesses, and states now have chief resiliency officers (CROs) whose mission is to develop comprehensive climate adaptation strategies and resiliency implementation plans that respond to their organization's unique set of risks and long-term vision and goals. In government, the cabinet-level position of CRO coordinates across relevant agencies to build the capacity of the city, county, or state and its communities, businesses, and residents to survive major weather events. Additionally, government CROs work across these agencies to achieve goals of coastal protection and restoration, protecting state investments and infrastructure, and ensuring equitable outcomes for residents facing climate change risk.

   Government CROs typically report directly to the chief executive as chief resiliency advisor and serve as point person for planning and coordinating of all resiliency efforts under that executive. In this role, CROs work across government agencies and departments to streamline preparedness efforts, conserve resources, and avoid duplication, while promoting interdepartmental and agency collaboration among various resiliency projects and plans. CROs also play a critical role in ensuring representatives from the private sector, nonprofits, and civil society are included in resiliency efforts. Additionally, government CROs ensure that resiliency and climate adaptation remain departmental priorities when considering new projects, and that any such projects fit within the city's or state's comprehensive resiliency strategy.

   The chief resilience officer is the centerpiece of 100 Resilient Cities' vision, its City Resilience Strategy. The 100 Resilient Cities initiative provides financial and logistical guidance to establish a CRO to lead a city's resilience efforts; technical support to develop a holistic resilience strategy that reflects each city's distinct needs; access to an innovative platform of private-sector and nonprofit organization services to support strategy development and implementation; and inclusion in the 100 Resilient Cities Network to share knowledge and best practices with other member cities.

b. Research Questions

At the conclusion of the Sustainable & Resilient Coastal Communities Report, New Jersey Future's project team identified several areas where additional research was needed. Many of

the questions raised in that report, and listed below, remain relevant to the foregoing case studies:

1. Can towns legally withhold services and infrastructure investment in selected areas? Must they continue to invest ever-increasing amounts of money to maintain services to areas regularly inundated by flooding and/or those that are projected to flood regularly?
2. Are towns obligated to provide stormwater management infrastructure?
3. Do New Jersey municipalities have sovereign immunity from tort claims? (For example, would a resident in a town that has not upgraded infrastructure to address sea-level rise have the right to sue that town for compensation for flood damages?)
4. Is a decision to upgrade a system subject to government discretion or is it a nondiscretionary "operational" function? (Florida courts have held that municipalities have a duty to reasonably maintain existing roads but do not have an obligation to upgrade them.) How have courts defined discretionary vs. nondiscretionary municipal obligations to provide essential services?
5. When, due to sea-level rise, a stormwater system is no longer capable of preventing flooding in areas it once protected, has the local government failed to "reasonably maintain" the system and, therefore, breached a municipal obligation? What is the town's potential liability for providing drainage services?
6. Are damages that occur regularly that are sufficient to deprive a property owner of reasonable use of his or her land equivalent to a compensable taking? If towns have a duty to act but don't, does such inaction present grounds to bring a constitutional taking claim?
7. If municipalities use declining tax revenues as a benchmark to warrant changes in land use to respond to risks associated with rising sea levels or accelerating or permanent flood inundation, how should they calculate a least two critical variables:
   - the tipping point when assessed values are no longer sufficient to offset the costs of services; and,
   - the increment of lost revenues a municipality can no longer sustain?

   What procedures should municipalities employ readily to conduct sensitivity analyses to evaluate how different values of lost revenues will affect operating costs – what inputs need to be considered and what outputs will be needed as the basis for decision-making? To employ this strategy, it will be important to vet the analysis variables and the decision tipping points with local elected officials, professional staff, and community residents.
8. A decision to retreat, fortify, or adapt in areas that are experiencing increasing risk of flooding due to sea-level rise and climate change is discretionary. Infrastructure and capital investment decisions that are influenced by these decisions are enormous. Often, governments do not have adequate methods to evaluate costs and benefits of resiliency infrastructure improvements over time. For example, when does the cost to elevate bulkheads exceed the "value" of the protection they provide? What is the period of protection that a given protection technique is likely to provide? Does the cost of protection exceed the benefit of retreat? More research is needed to develop both quantitative and qualitative measures to assure a better-informed public, improved capital investment planning, and more cost-effective decision-making.
9. A thorough analysis of the short- and long-term costs and benefits of each of the options described in **Section 2** is needed to evaluate the full set of positive and negative implications that will be associated with their implementation. Building coastal resilience will be extremely costly, take a considerable amount of time to accomplish, and will certainly be controversial. It will be necessary to begin the process of change with a detailed

and rigorous assessment of the economic implications. This analysis should include an assessment of how the options should be planned, managed, and implemented and which organization, agency, or institution should be responsible for their administration in New Jersey. Although the experience gained from implementing many of the case studies included in this report can offer clues to the magnitude of implementation costs, many are in the planning stage or have only recently been implemented.

10. Additional research is needed to explore new approaches to financing acquisition of property in areas at risk from rising sea levels and changing climate. The current market value of such at-risk property along New Jersey's coastline is far greater than the amount of money that has been budgeted to plan for and acquire property through current state programs. New and alternative methods to generate sufficient funding will be essential.

11. In order to determine whether strategies a community elects to adopt and implement help to move the municipality closer toward resilience, it will be necessary to develop methods to measure whether they are effective. A 2014 presentation developed by Susan Cutter, a highly regarded geographer and disaster researcher who works for the University of South Carolina, notes that resilience measures can help to assesses and prioritize needs and goals to establish baselines; monitor progress and recognize successes (and failures); help to understand costs and benefits; and evaluate the effects of different policies and approaches. Ms. Cutter noted that measurements need to be simple and well-documented, address multiple hazards, be adaptable and scaleable - and the process to apply them must be open and transparent. In the course of developing this report it became clear that more research is needed to develop resilience metrics that achieve these complimentary objectives, particularly in light of the breakneck speed that new strategies are being devised.

ABOUT THE AUTHORS

About New Jersey Future

New Jersey Future is a nonprofit, nonpartisan organization that brings together concerned citizens and leaders to promote responsible land use policies. The organization employs original research, analysis and advocacy to build coalitions and drive land-use policies that help revitalize cities and towns, protect natural lands and farms, provide more transportation choices beyond cars, expand access to safe and affordable neighborhoods and fuel a prosperous economy.

The Authors

David Kutner PP AICP, Planning Manager

David manages New Jersey Future's land use planning work, emphasizing initiatives to create healthy, active communities for all ages. He is working with municipalities throughout the state to introduce them to the relationship between the built environment and health by considering the connection among land-use development, affordable housing options, and age-friendly places. David has also worked extensively with coastal communities vulnerable to sea-level rise. For the past 5 years he has managed New Jersey Future's Local Recovery Planning Manager program, providing ongoing and direct assistance to municipalities seeking to rebuild from the devastating damage of Hurricane Sandy. His work has focused on helping communities recover from extensive storm damage but also encouraging them to consider the implications of projected sea-level rise and how they might plan for and respond to the challenges of impending flood inundation risks due to a changing climate. He is a licensed professional planner with more than 30 years of land use and environmental planning experience. He has worked as a private planning consultant and held positions in local, county, and state planning agencies in New Jersey, Massachusetts, New York, Pennsylvania, and Florida.

Tanya Rohrbach, Community Planner

Tanya uses her experience ensuring accuracy and targeted approaches to land-use initiatives to help communities implement smart planning policies and practices that foster resilient and vibrant places for all community members. Her main focus areas include climate change adaptation and aging-friendly neighborhoods. Prior to joining New Jersey Future, she was a senior planner in the Somerset County Planning Division, where she managed the division's GIS initiatives, supervised GIS staff and assisted with development of regional plans and policies. She was responsible for data analyses to perform regional wastewater planning, flood risk research, and transportation assessments, and to provide local technical assistance. Tanya also has experience working at New Jersey land trusts, where she identified and prioritized lands for preservation at local and regional scales. She holds a Master of Science degree in Geography and a B.A. in Biology, both from Rutgers University.

Emily Eckart, Development and Communications Coordinator

Emily creates blog content, manages social media accounts, updates the website, maintains databases, and provides event and development support for New Jersey Future. Prior to joining the organization, she coordinated course materials for Harvard Kennedy School's degree and executive education programs. She holds a B.A. with a concentration in music from Harvard University. She is currently completing a master's degree program in sustainability through Harvard Extension School.

Tim Evans, Director of Research

Tim Evans is responsible for the original research and data analysis that support New Jersey Future's policy development and ensures that all of the organization's products and media communications are quantitatively accurate and defensible. He frequently provides data and advice to colleague organizations, serving as an informal research consultant to the smart growth community at large. His analysis and commentary have been featured by a wide range of state and national media outlets. He holds a B.S. in mathematics from Ursinus College, an M.S. in statistics from the University of Virginia, and a master's in city and regional planning from the Bloustein School of Planning and Public Policy at Rutgers University. Prior to joining New Jersey Future, he worked for six years as a mathematical statistician for the Bureau of the Census in Washington, D.C.

Project Tracking Sheet

Strategy	Jurisdiction (state, county, local)	Juridiction Name	State	Objective	Hazard Type (e.g. sea-level rise, other flooding, forest fire, drought, heat island, extreme weather)	Resilience Metrics (Y/N)	Metrics Description	Status (e.g. planned/underway/complete)	Adaptation or Mitigation	Data Source 1	Data Source 2
Launch a resilience dashboard	Local	Norfolk	VA	Create a resilience module that integrates key data, improves city's ability to respond to citizens, and aids planning efforts	Climate change	N		Complete	Adaptation	https://www.norfolk.gov/DocumentCenter/View/27257#page=47	
Communicate with other nations to learn about creative solutions to flooding	Local	Norfolk	VA	Dialogue between Dutch and US officials to explore solutions to flooding	Flooding	N		Complete	Adaptation	https://www.norfolk.gov/DocumentCenter/View/27257#page=32	
Collectively create vision for city's future	Local	Norfolk	VA	Define the city's future through a collaborate visioning process	Climate change	N		Complete	Adaptation	https://www.norfolk.gov/DocumentCenter/View/27257#page=29	
Assist property owners with pre-disaster preparedness	Local	Annapolis	MD	To prepare property owners for action	Flooding	N		Planned	Adaptation	https://www.annapolis.gov/DocumentCenter/View/10064/Consolidated-CRHMP-Report-April-2018#page=204	
Lead a community design meetings to develop adaptation alternatives for public space	Local	Annapolis	MD	To involve the community in adaptation decisions for public space	Flooding	N		Planned	Adaptation	https://www.annapolis.gov/DocumentCenter/View/10064/Consolidated-CRHMP-Report-April-2018#page=204	
Collect and disseminate data about socioeconomic impacts of floods in risk areas	Local	Annapolis	MD		Flooding	N		Planned	Adaptation	https://www.annapolis.gov/DocumentCenter/View/10064/Consolidated-CRHMP-Report-April-2018#page=204	
Provide training on costs/benefits of National Flood Insurance Program	Local	Annapolis	MD	Educates residents about National Flood Insurance Program	Flooding	N		Planned	Adaptation	https://www.annapolis.gov/DocumentCenter/View/10064/Consolidated-CRHMP-Report-April-2018#page=204	
Ineractive "story map" to show residents about the city's flood resilience efforst	Local	Annapolis	MD	An interactive website/map/story that teaches peole about the city's efforts	Flooding	N		Complete	Adaptation	https://annapolis.maps.arcgis.com/apps/MapSeries/index.html?appid=a8e43f5101d14748a037603e2a120520&folderid=70b9f5d6e4f54a2bae08ad3becbce954	
Community adaptation toolkit	Local/State	New Hampshire	NH	provides tools for NH communities to adapt to climate change including planning, communications, funding, etc.	Climate change	N		Complete	Adaptation	https://www.des.nh.gov/organization/divisions/air/tsb/tps/climate/toolkit/adaptation.htm	
State guidance for municipalities	Local/State	Maine	ME	Provides an overview of strategies for municipalities	Climate Change	N		Complete	Adaptation	https://www.maine.gov/dacf/municipalplanning/docs/CAGS_01_Overview.pdf	
Sea Rise (interactive flood mapper)	local/private	South Carolina Aquarium [in Charleston]	SC	Use environmental and population overlays to discover what sea rise means for your community	Sea level rise, other flooding	N		Complete	Adaptation	https://searise.scaquarium.org/?_ga=2.132482446.1286216398.1536252106-1300891471.1536252106	
Disclose location of possible sea level rise areas to potential buyers	Local	Durham	NH	Educates potential buyers about possible sea level rise risks	Sea level rise	N		Planned	Adaptation	https://web.archive.org/web/20160702174616/http://www.ci.durham.nh.us/sites/default/files/fileattachments/administration/climate_adaption_proposed_plan.doc.pdf	
Unified Sea Level Rise Projection	regional	Broward, Miami-Dade, Monroe, and Palm Beach Counties	FL	establishes a unified sea level rise projection for the Southeast Florida region, for use by the Climate Compact Counties and partners for planning purposes to aid in understanding of potential vulnerabilities and to provide a basis for developing risk informed adaptation strategies for the region	Sea level rise, other flooding	N		complete (adopted 2015); 45 municipalities incorporated projections into their local plans and 17 incorporated them into local planning and project maps as of 2016	Adaptation	http://www.southeastfloridaclimatecompact.org/wp-content/uploads/2017/12/2015-Compact-Unified-Sea-Level-Rise-Projection.pdf	
Coordinate saltwater intrusion mapping	local	21 municipalities (so far) in South Florida	FL	Ensure consistency in efforts to map saltwater intrusion across the region to create better information and improve management decisions for protecting regional freshwater aquifers; utilize saltwater intrusion models and validated data to identify wellfields and underground infrastructure at risk of contamination or infiltration by saltwater due to rising sea levels	Sea level rise	N		underway - 21 South Florida municipalities have completed so far	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/coordinate-saltwater-intrusion-mapping/	
Identify at-risk populations and infrastructure	local	13 municipalities (so far) in South Florida	FL	Perform local vulnerability analyses to identify and quantify infrastructure and populations at risk under various sea level rise scenarios and other climate change scenarios.	Sea level rise, other flooding	N		underway - 13 South Florida municipalities have completed so far	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/identify-risk-populations-infrastructure/	
Advanced Hydrologic Modeling	local	Broward County	FL	generate scenarios illustrating the likely impacts of sea level rise and extreme flooding on the region's water supply and flood control systems, to capture the attention of policymakers and residents and generate a lot of discussion about adaptation choices	Sea level rise, other flooding	N		Underway	Adaptation	http://www.southeastfloridaclimatecompact.org/case-studies/advanced-hydrologic-modeling/	
Outreach to coastal municipalities	Local/State	New Hampshire	NH	State outreach to 17 coastal one municipalities to relay recommendations and assess readiness	sea level rise, extreme weati	N		Underway	Adaptation	http://www.nhcrhc.org/setting-sail/	
Foster public awareness of the impacts of climate change on the region's natural systems and ecosystem services	local	25 municipalities (so far) in South Florida	FL	Conduct public opinion research of various stakeholders' values to effectively communicate how they will be affected by climate change; Develop local communications strategies around climate impacts on ecological sites that have community recognition or significance	Sea level rise, other flooding	N		underway - adopted by 25 South Florida municipalities so far	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/ns-1/	
Flood Awareness Workshop	local	Boynton Beach	FL	an educational workshop for the public to learn about flood risks including storms, high tides, and sea level rise. The workshop will answer questions about flooding and city services, and will provide a forum for the public to interact with experts and view the newly revised FEMA flood insurance	sea level rise, extreme weather, other flooding	N		completed	Adaptation	http://www.southeastfloridaclimatecompact.org/event/city-boynton-beach-flood-awareness-workshop/	
Flood safety education (similar to above)	local	Durham	NH	Educates citizens about safety during floods, including dangers of driving on flooded roads	sea level rise, extreme weather, other flooding	N		Planned	Adaptation	https://web.archive.org/web/20160702174616/http://www.ci.durham.nh.us/sites/default/files/fileattachments/administration/climate_adaption_proposed_plan.doc.pdf	
Flood education for citizens and city staff	local	Annapolis	MD	Educates citizens and staff about flood adaptation and disaster preparedness	Other flooding	N		Planned?	Adaptation	https://www.annapolis.gov/DocumentCenter/View/10064/Consolidated-CRHMP-Report-April-2018#page=204	
Municipal King Tide Toolkit	local	Fort Lauderdale	FL	to provide other coastal municipalities with communication concepts, terminology, information, and outreach examples based on Fort Lauderdale's experience with flooding due to seasonal extreme high tides,	sea level rise, extreme weather, other flooding	N		completed	Adaptation	http://www.southeastfloridaclimatecompact.org/wp-content/uploads/2016/06/KingTideToolkit.pdf	
Collaboration b/t regional and local staff to guide town through NOAA adaptation road map	Regional/Local	Durham	NH	Partnership to educate town staff and plan a series of community workshops	Sea level rise	N		Planned	Adaptation	https://web.archive.org/web/20160702174616/http://www.ci.durham.nh.us/sites/default/files/fileattachments/administration/climate_adaption_proposed_plan.doc.pdf	
Encourage homeowners to purchase flood insurance	Local	Durham	NH	Outreach program	sea level rise, extreme weather	N		Planned	Adaptation	https://web.archive.org/web/20160702174616/http://www.ci.durham.nh.us/sites/default/files/fileattachments/administration/climate_adaption_proposed_plan.doc.pdf	
Distribute flood protection safety pamphlets to homeowners in high-risk areas	Local	Durham	NH	Educates homeowners about their risks	Sea level rise, extreme weather	N		Planned	Adaptation	https://web.archive.org/web/20160702174616/http://www.ci.durham.nh.us/sites/default/files/fileattachments/administration/climate_adaption_proposed_plan.doc.pdf	
Create coastal flood monitoring program	Local	Portsmouth	NH	Track flooding so city can be more responsive over time; warn residents	Sea level rise, other flooding	N		Planned	Adaptation	http://www.planportsmouth.com/crj/CRI-Report.pdf	

Strategy	Jurisdiction (state, county, local)	Juridiction Name	State	Objective	Hazard Type (e.g. sea-level rise, other flooding, forest fire, drought, heat island, extreme weather)	Resilience Metrics (Y/N)	Metrics Description	Status (e.g. planned/underway/complete)	Adaptation or Mitigation	Data Source 1	Data Source 2
Review recommendations with coastal stakeholders	Local	Portsmouth	NH	Review climate report recommendations and findings	Sea level rise, extreme weat	N		Planned	Adaptation	http://www.planportsmouth.com/cri/CRI-Report.pdf	
Communicate health impacts of climate change	Local	Portsmouth; Keene	NH	Emphasize personal responsibility and preparedness	Climate change	N		Planned	Adaptation	http://www.planportsmouth.com/cri/CRI-Report.pdf	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINA
Educate public about personal choices and their contribution to climate change	Local	Portsmouth	NH	Encourage better choices about consumption, travel, and sustainable practices	Climate change	N		Planned	Adaptation	http://www.planportsmouth.com/cri/CRI-Report.pdf	
Train city staff in hazard mitigation	Local	Portsmouth; Keene	NH	Train city staff on hazard mitigation and environmental and health outcomes of their particular expertise	Climate change	N		Planned	Adaptation	http://www.planportsmouth.com/cri/CRI-Report.pdf	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINA
Educate public about how wetlands conservation is a climate adaptation strategy	local	Keene	NH	Develop guides and public outreach presentations	Sea level rise, extreme weat	N		Planned	Adaptation	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf	
Improve reliability of emergency communications during severe weather	local	Keene, Baltimore	NH, MD	Inventory phone land lines; identify vulnerabilities and options	Extreme weather	N		Planned	Adaptation	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=23
Increase community communication during emergencies	local	Keene	NH	Devise and coordinate a county-wide emergency communication system	Extreme weather	N		Planned	Adaptation	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf	
Educate public about responding to extreme weather	local	Keene	NH	Increase awareness of resources, shelters, policies, etc.	Extreme weather	N		Planned	Adaptation	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf	
Train public and staff about future diseases and vectors	Local	Keene	NH	Educate about how disease is spreading via climate change; increase funding for training and monitoring	Climate change	N		Planned	Adaptation	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf	
Use social media for emergency messaging, public health updates, and tidal flooding updates	local	12 municipalities (so far) in South Florida	FL	Utilize relevant social media to regularly disseminate public emergency messages, such as updates on public health or tidal flooding; consider non-internet public communication alternatives due to power outages, such as community boards at public spaces	Extreme weather	N		underway - 12 South Florida municipalities have adopted so far	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/use-social-media-effectively/	
Connect with high-vulnerability populations	local	Southeast Florida Regional Compact (aspirational only)	FL	Connect with members from highly vulnerable populations to build trust and inform emergency management planning; identify and connect with existing community leaders that serve as representatives of their community's needs, including faith leaders, school officials, leaders of community organizations, and cultural group leaders; include representatives from vulnerable communities in emergency management	Extreme weather	N		recommendation only	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/connect-with-high-vulnerability-communities/	
Community living shorelines guide	Local/State	New Jersey	NJ	A guide that provides guidance on key factors for creating a living shoreline	Sea level rise, extreme weat	Y	self-assessment through web tools	Complete	Adaptation	https://www.conservationgateway.org/ConservationPractices/Marine/crr/library/Documents/Community%20Resource%20Guide%20for%20Planning%20Living%20Shoreline%20Projects.pdf	
Dune vegetation management	Local	Avalon, Stone Harbor	NJ	Protect the dune system to dissipate coastal storm energy	Sea level rise, extreme weat	N		underway	Adaptation	http://www.avalonboro.org/news/dune-vegetation-plan/Website%2012_16_09%20Dune%20Veg%20Mgmt%20Plan.pdf	http://stoneharbornj.org/wp-content/uploads/2013/05/Dune-Vegetation-Management-Plan.pdf
Technical assistance to municipalities to evaluate at-risk culverts	Local/State	Ellsworth, Lincolnville	ME	Researchers helped two coastal municipalities evaluate their damage to culverts and how to respond	Sea level rise, extreme weat	N		Complete	Adaptation	https://umaine.edu/mitchellcenter/the-new-normal-culverts-in-maine-stressed-to-the-limit/	
Map tool for predicting risk	Regional/Private	Long Island	NY	Interactive web map that provides decision support for meeting resilience objectives related to natural solutions	Sea level rise, extreme weat	Y		Complete	Adaptation	https://www.conservationgateway.org/ConservationPractices/Marine/crr/library/Documents/Ferdana_et_al_Coastal_Resilience_in_IUCN_10_03.pdf	
Foster innovation, development, and exchange of ideas for managing water	local	Southeast Florida Regional Compact	FL	Develop and share new water management information, methods, technical capabilities, and trends addressing key climate variability and sea level rise concerns through collaborations with state and federal agency partners and academic institutions; establish a method for a periodic exchange of ideas between water resource managers, policymakers, stakeholders, scientists, and researchers	Sea level rise	N		underway - adopted by 22 South Florida municipalities so far	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/foster-innovative-water-management/	
Community outreach about potential zoning changes	Local	New York City	NY	Acquired input from coastal communities for updating special zoning regulations in the floodplain	Sea level rise	N		Complete	Adaptation	https://www1.nyc.gov/site/planning/plans/flood-resilience-zoning-text-update/flood-resilience-zoning-text-update.page	
Municipal Resilience Guide	Local/State	New Jersey	NJ	A compendium of resources for helping municipal officials plan for and implement strategies to mitigate coastal hazards	Sea level rise, extreme weather	N		Underway	Adaptation	Emailed document from David	
Coastal vulnerability index mapping	Local/State	New Jersey	NJ	Provides coastal communities with accessible info about hazard mitigation and emergency planning	Sea level rise, extreme weather	N		Complete	Adaptation	https://www.nj.gov/dep/cmp/czm_cvi.html	
Online coastal hazard profiler	Local/Private/State	New Jersey	NJ	Website that provides information and assessment tools for the general	Sea level rise, extreme	N		Complete	Adaptation		
Build-out analyses	Local	Pittsgrove, Barnegat Bay Watershed, Cohansey Watershed	NJ	Helps communities envision what it would look like if all lands were built out under existing zoning regulations		N		Complete	Adaptation	https://www.nj.gov/dep/wqmp/docs/20151019-salem-appdx-c.pdf	http://www.anjec.org/pdfs/SG_Planning.pdf
Climate adaptation scenario planning	Local	Jersey City	NJ	Identifies and evaluates potential threats of climate change to a	Sea level rise, extreme	N		Complete	Adaptation	https://philiporton.files.wordpress.com/2014/06/jc-report-v6_02142015.pdf	http://scc.ca.gov/files/2013/04/Scenario-
Tool for assessing municipal vulnerabilities	Local	New Jersey	NJ	Assists local officials to identify gaps in their current resilience practices	Sea level rise, extreme	N		Complete	Adaptation	http://www.prepareyourcommunitynj.org/	
Expand partnerships and resources to further innovation in water resource management	local	22 municipalities (so far) in South Florida	FL	Cultivate partnerships with regional, federal, and state agencies and professional associations with expertise in integrated water resource planning as sources of important research, including the U.S. Army Corps of Engineers Institute for Water Resources, USGS, EPA, NOAA, and water	Climate change in general	N		underway - 22 South Florida municipalities have adopted so far	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/expand-partnerships-and-resources-for-innovation/	
Advanced Hydrologic Modeling	local	Broward County	FL	Use hydrologic models to generate scenarios illustrating the likely impacts of sea level rise and extreme flooding on the region's water supply and flood control systems	Sea level rise, other flooding	N		underway - 14 constituent municipalities have participated so far	Adaptation	http://www.southeastfloridaclimatecompact.org/case-studies/advanced-hydrologic-modeling/	
Resilience Initiative For Coastal Education (RICE)	local/private	South Carolina Aquarium [in Charleston]	SC	to move beyond elite scientific and policy discussions and make the topic of resilience accessible to everybody, providing individuals with the information they need to keep their families and communities safe	sea level rise, storm surge	N		underway	Adaptation	http://scaquarium.org/conservation/resilience/	
Increase coordination and info sharing across jurisdictions	Local	Baltimore, Annapolis	MD	Coordinate efforts to enable mitigation of cross-border impacts	Sea level rise, other flooding	N		Planned	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=43	
Hazard awareness program	local	Baltimore	MD	Increase citizen preparedness with ongoing outreach program	Extreme weather, other floo	N		Planned	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=75	

Strategy	Jurisdiction (state, county, local)	Juridiction Name	State	Objective	Hazard Type (e.g. sea-level rise, other flooding, forest fire, drought, heat island, extreme weather)	Resilience Metrics (Y/N)	Metrics Description	Status (e.g. planned/underway/complete)	Adaptation or Mitigation	Data Source 1	Data Source 2
Designate community leaders and orgs that can assist during hazard events	Local	Baltimore	MD	Leverage community resources to protect Baltimore resident from natural hazards	Extreme weather, other floo	N		Planned	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=76	
Public education on chemical storage	Local	Marshfield	MA	Informs residents about proper storage of chemicals and propane tanks to prevent non-point source pollution	Other flooding	N		Planned	Adaptation	https://scholarworks.umass.edu/cgi/viewcontent.cgi?referer=http://www.adaptationclearinghouse.org/resources/marshfield-massachusetts-2013-master-plan-climate-change-adaptation-chapter.html&httpsredir=1&article=1022&context=larp_grad_research#page=43	
Public education on herbicides and pesticides	Local	Marshfield	MA	Informs residents about alternatives to herbicides and pesticides to prevent non-point source pollution	Other flooding	N		Planned	Adaptation	https://scholarworks.umass.edu/cgi/viewcontent.cgi?referer=http://www.adaptationclearinghouse.org/resources/marshfield-massachusetts-2013-master-plan-climate-change-adaptation-chapter.html&httpsredir=1&article=1022&context=larp_grad_research#page=43	
Social vulnerability assessment	Local	Marshfield	MA	Assesses vulnerability of different populations within the town	Climate change in genera	N		Complete	Adaptation	https://scholarworks.umass.edu/cgi/viewcontent.cgi?referer=http://www.adaptationclearinghouse.org/resources/marshfield-massachusetts-2013-master-plan-climate-change-adaptation-chapter.html&httpsredir=1&article=1022&context=larp_grad_research#page=15	
Biophysical vulnerability assessment	Local	Marshfield	MA	Assesses vulnerability of different sites in town based on elevation, topography, or proximity to hazard	Climate change, flooding	N		Complete	Adaptation	https://scholarworks.umass.edu/cgi/viewcontent.cgi?referer=http://www.adaptationclearinghouse.org/resources/marshfield-massachusetts-2013-master-plan-climate-change-adaptation-chapter.html&httpsredir=1&article=1022&context=larp_grad_research#page=15	
Provide cooling stations	Local	Marshfield	MA	Provides publicly accessible cooling stations to vulnerabile residents during heat waves	Heat island	N		Planned	Adaptation	https://scholarworks.umass.edu/cgi/viewcontent.cgi?referer=http://www.adaptationclearinghouse.org/resources/marshfield-massachusetts-2013-master-plan-climate-change-adaptation-chapter.html&httpsredir=1&article=1022&context=larp_grad_research#page=45	
Neighbor check-in program	Local	Marshfield	MA	Creates a town phone tree and check-in program to check up on vulnerable residents during heat waves	Heat island	N		Planned	Adaptation	https://scholarworks.umass.edu/cgi/viewcontent.cgi?referer=http://www.adaptationclearinghouse.org/resources/marshfield-massachusetts-2013-master-plan-climate-change-adaptation-chapter.html&httpsredir=1&article=1022&context=larp_grad_research#page=45	
Land acquisition	Local	Boston	MA	Ensure permanent protection of natural areas for climte change adaptation	sea level rise	N		Planned	Adaptation	https://www.boston.gov/sites/default/files/metro_boston_regional_climate_adaptation_strategy_report.pdf#page=79	
Keep list of flood prone and repetitive loss buildings for potential acquisitions	Local	Baltimore	MD	Update list of properties to help prioritize mitigation funding and potential future acquisitions	sea level rise, extreme we	N		Planned	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=54	
Equip emergency workers for natural hazards	Local	Baltimore	MD	Prepare emergency workers for hazards associated with disease outbreaks	Other	N		Planned	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=77	
Prepare for extreme heat hazards	Local	Baltimore	MD	Protect residents health and safety for hazards related to extreme heat	Heat island	N		Planned	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=79	
Anticipate disease outbreaks	Local	Baltimore	MD	Prepare for disease outbreaks as a result of extreme weather events	Extreme weather	N		Planned	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=79	
Consider retreat	Local	Boston	MA	Allow community to buy property or establish a Conservancy District to prohibit future development on existing parcels	Sea level rise	N		Proposed	Adaptation	https://www.boston.gov/sites/default/files/metro_boston_regional_climate_adaptation_strategy_report.pdf#page=85	
Retreat	Local	Rhode Island	RI	A policitically and legally complicated strategy that simply stops maintaining transportation facilities that flood	Sea level rise, flooding	N			Adaptation	http://www.planning.ri.gov/documents/sea_level/2016/TP167.pdf#page=26	
Do nothing	Local	Rhode Island	RI	Not recommended, but is listed as an option	Sea level rise, flooding	N			Adaptation	http://www.planning.ri.gov/documents/sea_level/2016/TP167.pdf#page=26	
Identify and protect vulnerable populations	Local	Boston	MA	Protect vulnerable neighborhoods, which are also likely to have the least resilience improvements like green infrastructure	Flooding	N		Planned	Adaptation	https://www.boston.gov/sites/default/files/metro_boston_regional_climate_adaptation_strategy_report.pdf#page=96	
Plan for public health consequences	State	New Hampshire	NH	Strategic plan for managing public health impacts related to climate change	Climate change in general				Adaptation	http://www.adaptationclearinghouse.org/resources/preparing-for-climate-change-a-strategic-plan-to-address-the-health-impacts-of-climate-change-in-new-hampshire.html	
Include vulnerability analyses in emergency management	local	15 municipalities (so far) in South Florida	FL	Integrate climate vulnerability analysis data, as well as climate adaptation planning and funding, into existing emergency planning and funding documents	Climate change in general	N		underway - 15 South Florida municipalities have adopted so far	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/integrate-climate-into-emergency-planning/	
Ensure the emergency management definition of "communities at risk" includes economically vulnerable people	local	8 municipalities (so far) in South Florida	FL	Develop a "communities-at-risk" map of limited-income and socially vulnerable populations, such as the elderly, using census data as well as local knowledge; create programs for vulnerable populations—those unable to easily prepare for or recover from an emergency, and those without access to personal transportation—to prepare for and prevent additional impacts, and prepare for and mitigate the need for additional	Extreme weather	N		underway - 8 South Florida municipalities have adopted so far	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/define-communities-at-risk/	
Connect with communities through local leaders	local	Southeast Florida Regional Compact (aspirational only)	FL	Build the capacity of existing and future leaders of socially vulnerable populations to ask, analyze, and communicate about their community's climate resilience	Climate change in general	N		recommendation only	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/connect-communities-local-leaders/	
Involve citizens in budget development	Local	Norfolk	VA	Annual convening of citizens to discuss what budget priorities should be	Climate change	N		Complete	Adaptation	https://www.norfolk.gov/DocumentCenter/View/27257#page=48	
Create investment funds for local business	Local	Norfolk	VA	Create four new investment funds to support local businesses and local neighborhood revitalization projects	Climate change	N		Underway	Adaptation	https://www.norfolk.gov/DocumentCenter/View/27257#page=45	
Use social impact bonds to finance programs for social and economic resilience	Local	Norfolk	VA	Finance social service programs with bonds	Climate change	N		Underway	Adaptation	https://www.norfolk.gov/DocumentCenter/View/27257#page=45	
Create new risk reduction bond	Local	Norfolk	VA	Design new catastrophe bond-like product that can promote project-based risk solutions. Would realize insurance benefits from infrastructure improvements and moetize physical and financial risk reductions associated with investments in resilient systems	Climate change	N		Underway	Adaptation	https://www.norfolk.gov/DocumentCenter/View/27257#page=44	
Conduct feasibility studies for raising structures and building barriers for infrastructure	local	Annapolis	MD	Studies feasibility of permanent structural and natural barriers, raising and redesigning public infrastructure, etc.	Sea level rise	N		Planned	Adaptation	https://www.annapolis.gov/DocumentCenter/View/10064/Consolidated-CRHMP-Report-April-2018#page=207	

Strategy	Jurisdiction (state, county, local)	Juridiction Name	State	Objective	Hazard Type (e.g. sea-level rise, other flooding, forest fire, drought, heat island, extreme weather)	Resilience Metrics (Y/N)	Metrics Description	Status (e.g. planned/underway/complete)	Adaptation or Mitigation	Data Source 1	Data Source 2
Finance city flood dock mitigation project	local	Annapolis	MD	Includes closure valuves, pumping stations, new stormwater drainage pipes, and lining of existing pipes	Flooding	N		Planned	Adaptation	https://www.annapolis.gov/DocumentCenter/View/10064/Consolidated-CRHMP-Report-April-2018#page=207	
Evaluate need for a flood adaptation property tax credit	local	Annapolis	MD	Considers creating a flood adaptation property tax credit in flood risk areas	Flooding	N		Planned	Adaptation	https://www.annapolis.gov/DocumentCenter/View/10064/Consolidated-CRHMP-Report-April-2018#page=207	
Extend historic property tax credit to include qualifying flood adaptation projects	local	Annapolis	MD	Includes qualifying flood adaptation projects for properties within the historic district	Flooding	N		Planned	Adaptation	https://www.annapolis.gov/DocumentCenter/View/10064/Consolidated-CRHMP-Report-April-2018#page=207	
special taxation district to drain flooding	county	Flagler County	FL	special taxation district to pay for stormwater infrastructure in a coastal area that experiences flooding	other flooding	N		approved	Adaptation	https://flaglerlive.com/99363/marineland-acres-assessments/	
Establish a flood control district	Local	Harris County	TX	Uses a dedicated property tax to fund flood damage reduction plans, plan implementation, and infrastructure maintenance	Other flooding	N		Complete	Adaptation	https://www.hcfcd.org/about/	
Limit public infrastructure investment	local	New York	NY	Avoid building infrastructure in high risk areas	Sea level rise	N		Complete	Adaptation	https://www.njfuture.org/wp-content/uploads/2017/12/New-Jersey-Future-Resilient-Coastal-Communities-Project-Report-2017.pdf#page=102	
Transfer of development rights	Local	Pinelands	NJ	Gives landowners the ability to transfer the right to develop their property to areas where development is preferred	Sea level rise	N		Complete	Adaptation	https://www.njfuture.org/wp-content/uploads/2017/12/New-Jersey-Future-Resilient-Coastal-Communities-Project-Report-2017.pdf#page=107	
Transfer of development rights	Local	Boston	MA	Preserves natural areas for flood protection	Sea level rise	N		Planned	Adaptation	https://www.boston.gov/sites/default/files/metro_boston_regional_climate_adaptation_strategy_report.pdf#page=78	
Transfer of development rights	Local	Norfolk	VA	allows landowners to sell development rights from their land to a developer or other interested party who can then use these rights to increase the density of development at another designated location (in	sea level rise, other flooding	N		Underway	Adaptation	https://www.norfolk.gov/DocumentCenter/View/27768	
purchase of development rights programs	local	Southeast Florida Regional Compact (aspirational only)	FL	Maintain or create agriculture purchase of development rights programs	not specified -- existing programs are focused on agriculture, not climate change	N		recommendation only	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/ag-5/	
purchase of development rights programs	state	Georgia	GA	protect agricultural lands, and environmental and cultural resources	climate change	N		complete	Adaptation	https://www.njfuture.org/wp-content/uploads/2017/12/New-Jersey-Future-Resilient-Coastal-Communities-Project-Report-2017.pdf#page=105	https://glcp.georgia.gov/about-us
purchase or transfer of development riths	local	Boone County	KY	Feasibility study of PDF and TDR for Kentucky as a growth management tool to protect natural and cultural resources		n			Adaptation	https://www.boonecountyky.org/document_center/PlanningCommission/PDRTDR.pdf	
Special tax district	Local	San Francisco	CA	Finances structural protection initiatives via a special property tax district	Sea level rise, extreme weat	N		recommendation	Adaptation	https://www.njfuture.org/wp-content/uploads/2017/12/New-Jersey-Future-Resilient-Coastal-Communities-Project-Report-2017.pdf#page=113	https://ballotpedia.org/San_Francisco_Bay_Restoration_Authority_%E2%80%9CClean_and_Healthy_Bay%E2%80%9D_Parcel_Tax,_Measure_AA_(June_2016)
Establish funding strategies to provide for equitable infrastructure investment	local	Southeast Florida Regional Compact (aspirational only)	FL	Identify, create, pursue, and establish funding strategies, including foreign and green investments, needed at the regional and local scale to ensure organized and timely investment in the infrastructure improvements that safeguard the public, the region's diverse communities, and shared economies in the face of sea level rise and other climate impacts	Sea level rise, extreme weat	N		recommendation only	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/establish-equitable-investment-strategies/	
Incentivize development and redevelopment to integrate adaptive strategies into design plans	Local	Portsmouth	NH	Adapt existing buildings in vulnerable areas rather than demolishing them, esp. for historic buildings	Sea level rise, other flooding	N		Planned	Adaptation	http://www.planportsmouth.com/cri/CRI-Report.pdf	
Support research of environmental pollution and contaminants	Local	Portsmouth	NH	Support universites and environmental groups	Climate change	N		Planned	Adaptation	http://www.planportsmouth.com/cri/CRI-Report.pdf	
Support existing sustainable technologies	Local	Portsmouth	NH	Support existing technologies and policies that result in cleaner and more sustainable resources	Climate change	N		Planned	Adaptation	http://www.planportsmouth.com/cri/CRI-Report.pdf	
Cost-benefit analysis of maintaining critical infrastructure in vulnerable areas	Local	Portsmouth	NH	Determine expected costs of maintaining and reinforcing critical infrastructure in vulnerable areas; municipalities may require additional	Sea level rise, other flooding	N		Planned	Adaptation	http://www.planportsmouth.com/cri/CRI-Report.pdf	
Support local business and agricultural ventures	Local	Keene	NH	Develop a micro/business incubaor program focused on agriculture and related products	Climate change	N		Planned	Adaptation	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf	
Create job training and loan programs for people who lose their jobs due to climate change	Local	Keene	NH	Establish retraining, scholarship, and loan programs	Climate change	N		Planned	Adaptation	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf	
Prioritize adaptation investments to reduce the impact of flooding and sea level rise on transportation infrastructure, particularly on evacuation routes	local	18 municipalities (so far) in South Florida	FL	Identify vulnerable roadways and bridges using the Florida Department of Transportation Sea Level Scenario Sketch Planning Tool; determine the current resilience of evacuation routes by mapping them against projected climate impacts, and redesign any evacuation routes that are threatened by potential climate impacts; integrate climate adaptation into the standards for designing transportation infrastructure	Sea level rise, other flooding	N		adopted by 18 constituent municipalities so far	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/prioritize-adaptation-investments/	
Cost-benefit analysis of adaptation options	Local	Queens, NYC	NY	Evaluate projects based on estimated benefits and costs	Sea level rise, other flooding	N		Complete	Adaptation	http://resilient-cities.iclei.org/fileadmin/sites/resilient-cities/files/docs/TNC_Howard_Beach_Report.pdf	http://opim.wharton.upenn.edu/risk/library/ZAlliance-decisiontools-WP.pdf
Strategic Buyout Of Extreme Flood-Prone Homes	local/regional	Houston	TX	buyout homes and remove people from harm's way; the additional land will be used for improved conveyance as well widening bayous and	Other flooding	N		recommendation only	Adaptation	http://houstonstronger.net/resources/	
Focus major infrastructure investments in the most resilient areas	local	Norfolk	VA	Schools, water treatment facilities, recreation centers, and libraries are all examples of long-term municipal investments, many having 100-year plus lifespans. Locational priority for such facilities should be given to those areas not at great risk of long-term flooding.	Sea level rise, other flooding	N		underway	Adaptation	https://www.norfolk.gov/DocumentCenter/View/27768	
Develop bridge loan at infrastructure bank to provide upfront money for stormwater grant recipients	Local/state	Rhode Island	RI	Provide upfront capital to communities and organizations who are RIDOT and RIDEM reinbursement stormwater grant recipients	Other flooding	N		recommendation only	Adaptation	http://climatechange.ri.gov/documents/resilientrhody18.pdf#page=13	
Required storm fund for investor-owned utilities	Private/State	Rhode Island	RI	Requires investor-owned utilities to manage a storm fund to recover storm restoration expenses as a result of extraordinary storms	Extreme weather	N		Underway	Adaptation	http://climatechange.ri.gov/documents/resilientrhody18.pdf#page=15	
Require drought management plan to account for climate change	local	Baltimore	MD	Increase drought preparedness	Drought	N		Planned	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=69	

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Enhance building codes for floodplains and waterfronts to cope with flooding and future effects of climate change	Local	Baltimore	MD	Amend building codes to protect buildings during floods and encourage voluntary retrofits	Sea level rise, other flooding	N		Planned	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=51	
Modify urban landscaping requirements	Local	Baltimore	MD	Increase resilience via landscaping such as vegetative surfaces and permeable surfaces	Other flooding	N		Planned	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=41	
Vary freeboard requirements depending on use and zone	Local	Hoboken	NJ	Requires critical facilities to have higher elevation than non-critical ones	Sea level rise, flooding	N		Complete	Adaptation	https://www.njfuture.org/wp-content/uploads/2017/12/New-Jersey-Future-Resilient-Coastal-Communities-Project-Report-2017.pdf#page=85	
Amend Historic Preservation Ordinance to incorporate an expedited post-disaster design review process	Local	Annapolis	MD	Expedites review of properties in disaster declaration area	Flooding	N		Planned	Adaptation	https://www.annapolis.gov/DocumentCenter/View/10064/Consolidated-CRHMP-Report-April-2018#page=207	
Revise/create regulations to protect coastal resources	Local	Boston	MA	Protect shorelines and marine resources	Climate change	N		Planned	Adaptation	https://www.boston.gov/sites/default/files/metro_boston_regional_climate_adaptation_strategy_report.pdf#page=80	
Update master planning, zoning and development ordinances	Local	Ventnor City	NJ	Update regulations as required by MLUL	Sea level rise, extreme weat	N		Planned	Adaptation	http://eac.rutgers.edu/wp-content/uploads/Ventnor-Climate-Adaptation-Plan-9.8.15.pdf	
Coastal overlay zone	Local	Greenwich	CT	Gives highest priority to water-dependent uses and facilities in shorefront areas	Sea level rise	N		Complete	Adaptation	https://www.njfuture.org/wp-content/uploads/2017/12/New-Jersey-Future-Resilient-Coastal-Communities-Project-Report-2017.pdf#page=93	
Natural Resources Protection Act	regional	Broward, Miami-Dade, Monroe, and Palm Beach Counties	FL	Restricts development in a coastal sand dune system (among other environmental protections)	Sea level rise, extreme weat	N		Complete	Adaptation	https://www.maine.gov/dep/land/nrpa/	
Vulnerability assessments and planning by executive order	local	Fort Lauderdale	FL	Calls upon state agencies to help municipal and county governments conduct assessments	Sea level rise, extreme weat	N		Underway	Adaptation	http://www.dnrec.delaware.gov/energy/Documents/2016%20Climate%20Action%20Progress%20Report/Climate%20Action%20in%20Delaware%202016%20Progress%20Report.pdf	
Adaptation Action Areas (AAAs)	State		FL	identifies areas experiencing coastal flooding due to extreme high tides and storm surge that are vulnerable to the related impacts of rising sea levels for the purpose of prioritizing funding for infrastructure needs and	Sea level rise, extreme weat	N		adopted 2014	Adaptation	http://www.southeastfloridaclimatecompact.org/case-studies/adaptation-action-areas-fort-lauderdale-case-study/	
Fostering regulatory, multi-agency approaches	State	Maine	ME	Foster regulatory approaches that utilize multi-agency and public/private collaboration to address climate adaptation	Climate change	N		Planned	Adaptation	http://www.adaptationclearinghouse.org/resources/people-and-nature-adapting-to-a-changing-climate-charting-maine-s-course.html	
Incorporate sea level rise projections into municipal planning documents	Local	Newmarket	NH	Plan future infrastructure projects based on timeframe of use matched with sea level rise projections	Sea level rise	N			Adaptation	https://www.newmarketnh.gov/planning-board/pages/newmarket-master-plan	
Incorporate risk-reduction strategies into planning	local	20 municipalities (so far) in South Florida	FL	Incorporate strategies to reduce risk and economic losses associated with sea level rise and flooding into local comprehensive plans, post-disaster redevelopment plans, building codes, and land development regulations.	Sea level rise, other flooding	N		adopted by 20 constituent municipalities so far	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/incorporate-risk-reduction-strategies-into-planning/	
Increase setbacks for septic systems	Local	Newmarket	NH	Increase shoreline setback requirements for septic systems to protect water quality during floods	Sea level rise, extreme weat	N			Adaptation	https://www.newmarketnh.gov/planning-board/pages/newmarket-master-plan	
Zoning changes to protect infrastructure	Local	Newmarket	NH	Limit vulnerability through future zoning changes	Sea level rise, extreme weat	N			Adaptation	http://www.adaptationclearinghouse.org/resources/town-of-newmarket-new-hampshire-master-plan.html	
Use zoning, subdivision and site planning regulations to designate and regulate high-risk areas	Local	Durham	NH	Specify the conditions for land use and development in order to mitigate future losses from sea level rise	Sea level rise	N		Planned	Adaptation	http://www.adaptationclearinghouse.org/resources/durham-new-hampshire-hmp-climate-adaptation-chapter-developing-strategies-to-protect-areas-at-risk-from-flooding-due-to-climate-change-and-sea-level-rise.html	
Extend coastal flood hazard overlay district	Local	Durham; Portsmouth	NH	Use existing Flood Hazard Overlay District as the framework for extending development and building regulations to lessen vulnerability of new buildings	Sea level rise	N		Planned	Adaptation	http://www.adaptationclearinghouse.org/resources/durham-new-hampshire-hmp-climate-adaptation-chapter-developing-strategies-to-protect-areas-at-risk-from-flooding-due-to-climate-change-and-sea-level-rise.html	http://www.planportsmouth.com/cri/CRI-Report.pdf
Incorporate new floodplain maps	Local	Durham	NH	Produce new floodplain maps for coastal communities	Sea level rise	N		Planned	Adaptation	http://www.adaptationclearinghouse.org/resources/durham-new-hampshire-hmp-climate-adaptation-chapter-developing-strategies-to-protect-areas-at-risk-from-flooding-due-to-climate-change-and-sea-level-rise.html	
Consider raising floodplain standards above FEMA minimum	Local	Portsmouth	NH	Protect residents, property, and infrastructure by raising floodplain standards	Sea level rise, other flooding	N		Planned	Adaptation	http://www.planportsmouth.com/cri/CRI-Report.pdf	
Require new road/stream crossings to comply with new guidelines	Local	Durham	NH	Calculate design storm conveyance requirements of bridges/culverts based on updated data	Sea level rise	N		Planned	Adaptation	https://web.archive.org/web/20160702174616/http://www.ci.durham.nh.us/sites/default/files/fileattachments/administration/climate_adaption_proposed_plan.doc.pdf	
Establish new requirements for road, street grade, and first floor elevation	Local	Portsmouth	NH	Adopt stricter building and infrastructure standards within highly vulnerable areas	Sea level rise, other flooding	N		Planned	Adaptation	http://www.planportsmouth.com/cri/CRI-Report.pdf	
Restricted redevelopment standards in vulnerable areas	Local	Durham; Portsmouth	NH, SC	Would prohibit redevelopment of areas destroyed by storms or chronic erosion in order to prevent future losses	Sea level rise, extreme weat	N		Planned	Adaptation	http://www.adaptationclearinghouse.org/resources/durham-new-hampshire-hmp-climate-adaptation-chapter-developing-strategies-to-protect-areas-at-risk-from-flooding-due-to-climate-change-and-sea-level-rise.html	http://www.planportsmouth.com/cri/CRI-Report.pdf https://www.njfuture.org/wp-content/uploads/2017/12/New-Jersey-Future-Resilient-Coastal-Communities-Project-Report-
Establish setbacks in high-risk areas that account for potential sea level rise	Local	Durham	NH	Establish setbacks in high-risk areas that account for potential sea level rise	Sea level rise, extreme weat	N		Planned	Adaptation	https://web.archive.org/web/20160702174616/http://www.ci.durham.nh.us/sites/default/files/fileattachments/administration/climate_adaption_proposed_plan.doc.pdf	
Adopt stricter setbacks for certain areas	Local	Portsmouth	NH	Create beneficial setbacks in undeveloped or sparsely developed areas	Sea level rise, extreme weat	N		Planned	Adaptation	http://www.planportsmouth.com/cri/CRI-Report.pdf	
State and county level setback laws	Local/State	Hawaii	HI	coastal management laws require shoreline setbacks, and counties can set stricter requirements	sea level rise	N		Complete	Adaptation	https://www.njfuture.org/wp-content/uploads/2017/12/New-Jersey-Future-Resilient-Coastal-Communities-Project-Report-2017.pdf#page=88	
Evaluate strategies for reducing vulnerability and municipal expenditures in high-risk areas	Local	Portsmouth	NH	Reduce risk by reducing development density in vulnerable areas	Sea level rise, extreme weat	N		Planned	Adaptation	http://www.planportsmouth.com/cri/CRI-Report.pdf	
Coastal erosion overlay district in zoning code	Local	East Hampton	NY	Protect's town's natural shoreline and coastal resources	Sea level rise, flooding	N		Complete	Adaptation	https://www.njfuture.org/wp-content/uploads/2017/12/New-Jersey-Future-Resilient-Coastal-Communities-Project-Report-2017.pdf#page=88	
Increase long-term community resilience and disaster recovery through distributed renewable energy and battery storage systems	Local	Southeast Florida Regional Compact (aspirational only)	FL	Provide electric power backup by promoting distributed solar, battery storage, microgrids, and other techniques of distributed production and storage; prioritize power at emergency command centers, shelters, senior living centers, and multifamily affordable housing units	extreme weather	N		recommendation only	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/promote-renewable-energy-and-storage/	
Protect resilience of electricity system	Local	Baltimore	MD	Protect and support resilient energy systems	Sea level rise, extreme weat	N		Underway	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf	

Strategy	Jurisdiction (state, county, local)	Juridiction Name	State	Objective	Hazard Type (e.g. sea-level rise, other flooding, forest fire, drought, heat island, extreme weather)	Resilience Metrics (Y/N)	Metrics Description	Status (e.g. planned/underway/complete)	Adaptation or Mitigation	Data Source 1	Data Source 2
Ensure backup power generation for critical facilities and infrastructure	Local	Baltimore	MD	Backup hospitals, nursing homes, police, fire, etc., especially if located in high-risk areas	Extreme weather, other floo	N		Underway	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=18	
Manage compressed liquified natural gas sites and fueling stations before and during hazards; improve resiliency in related infrastructure	Local	Baltimore	MD	Prevent disruptions in liquid fuel supply during storms and other events	Extreme weather, other floo	N		Underway	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=19	
Integrating Climate Change & Water Supply Planning	local	Southeast Florida Regional Compact (aspirational only)	FL	Ensure all water resource policy, planning, and management decisions are consistently aligned with the latest unified sea level rise projections, regional climate scenarios for planning (e.g., storm surge, design storm events), and hydrologic models used in adaptation planning, from local to regional scales	Sea level rise, other flooding	N		recommendation only	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/ensure-water-resource-scenario-consistency/	
Inventory water and wastewater infrastructure	local	4 municipalities (so far) in South Florida	FL	Coordinate among city and county government public works agencies, water utilities, and other operators of water infrastructure to develop and maintain local and regional inventories of existing potable water supply wellfields, treatment and distribution systems, wastewater treatment and collection infrastructure, and septic tanks and drain fields; assess the potential for climate change impacts on each component of water infrastructure and develop adaptation strategies for affected systems, including infrastructure that may require replacement, reinforcement, or	Sea level rise, extreme weat	N		adopted by 4 constituent municipalities so far	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/inventory-water-and-wastewater-infrastructure/	
Increase resilience of wastewater systems	local	Baltimore	MD	Mimimize system disruptions by protecting vulnerable wastewater systems	Sea level rise, other flooding	N		Planned	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=35	
Increase resilience and structural stability of drinking water systems	local	Baltimore	MD	Protect residents' health through enhanced drinking water supply systems	Extreme weather, other floo	N		Planned	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=37	
Evaluate pipes ability to withstand heat and cold	local	Baltimore	MD	Protect the water system through structural and infrastructural upgrades	Extreme weather	N		Planned	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=39	
Modified substantial damage and improvement thresholds and calculations	Local	Longport, Pompton Lakes	NJ	Municipaliy lowers the substantial damage or improvement threshold to less than 50% of a structure's pre-damage market value in order to increase resilience of the community building stock	Sea level rise, extreme weat	N		Complete	Adaptation	https://www.njfuture.org/wp-content/uploads/2017/12/New-Jersey-Future-Resilient-Coastal-Communities-Project-Report-2017.pdf#page=96	
Integrate combined surface and groundwater impacts into the evaluation of at-risk infrastructure and the prioritization of adaptation improvements	local	34 municipalities (so far) in South Florida	FL	utilize a combination of inundation maps and stormwater models to identify areas and infrastructure at increased risk of flooding; evaluate the potential impacts of changes in groundwater levels on wastewater and stormwater systems (including septic systems, wastewater collection, and conveyance and storage systems), with consideration of water quantity and quality (including public health-related metrics)	Sea level rise, other flooding	N		adopted by 34 constituent municipalities so far	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/integrate-surface-and-groundwater-impacts-in-planning/	
stricter base flood elevation requirements	local	Houston	TX	all new structures within the danger zone must be built 2 feet above the 500-year flood plains	Extreme weather, other floo	N		complete - adopted April	Adaptation	https://www.courthousenews.com/houston-passes-new-flood-plain-construction-rules/	
Update state land use plan to include climate change and resilience	State	Rhode Island	RI	Update plan to include climate change, resilience, stormwater management needs and practices	Climate change, flooding	N		Recommendation only	Adaptation	http://climatechange.ri.gov/documents/resilientrhody18.pdf#page=13	
Comprehensive rewrite of zoning code	local	Norfolk	VA	To develop the most resilient zoning code in America that will be a model	Flooding	N		Complete	Adaptation	https://www.norfolk.gov/DocumentCenter/View/27257#page=34	
increased freeboard in floodplains	local	Norfolk	VA	requires that construction in the 100-year floodplain be elevated at least 3 feet above the 100-year base flood elevation, and construction in the 500-year (0.2% chance) floodplain, to be elevated or floodproofed to 1.5 feet above the 500-year flood elevation	Sea level rise, other flooding	N		complete - effective March 2018	Adaptation	http://www.adaptationclearinghouse.org/resources/building-a-better-norfolk-a-zoning-ordinance-of-the-21st-century.html	
permeable pavement and stormwater infiltration requirements	local	Norfolk	VA	Coastal Resilience Overlay (CRO) zone requirements include the use of permeable surfaces on new parking spaces and stormwater infiltration	Sea level rise, other flooding	N		complete - effective March 2018	Adaptation	http://www.adaptationclearinghouse.org/resources/building-a-better-norfolk-a-zoning-ordinance-of-the-21st-century.html	
Resilience Quotient System	local	Norfolk	VA	developers earn points for adopting different resilient measures (including elevating mechanical equipment, installing systems to detain a certain amount stormwater on site, and installing systems that allow connection of generators, solar, wind or other locally generated power sources during power outages) that promote flood risk reduction, stormwater management, and energy resilience; new developments are required to meet different resilience point values based on the development type (e.g., residential, non-residential, mixed-use) and development size	Flooding	N		complete - effective March 2018	Adaptation	http://www.adaptationclearinghouse.org/resources/building-a-better-norfolk-a-zoning-ordinance-of-the-21st-century.html	
flood-resistant building standards	local	Norfolk	VA	Incorporating design elements such as waterproofed first floors and building materials that can withstand water infiltration helps to create neighborhoods that can better withstand the impacts of sea level rise.	Sea level rise, other flooding	N		underway	Adaptation	https://www.norfolk.gov/DocumentCenter/View/27768	
Install green infrastructure in alleyways to mitigate flooding	Local	Nashville, Chicago, Detroit	TN, IN, MI	Install green infrastructure in underutilized alleys to absorb flood water	Other flooding	N		Complete	Adaptation	https://daily.jstor.org/to-battle-floods-cities-revive-their-long-forgotten-alleyways/	
Use watershed plans to identify impervious surface that can be removed	Local/State	Rhode Island	RI	Improve stormwater management	Other flooding	N		Recommendation	Adaptation	http://climatechange.ri.gov/documents/resilientrhody18.pdf#page=13	
Alternative road de-icer	local	Marshfield	MA	Protect town's water from non-flooding-realted nonpoint source salination by treating roads with something other than salt during winter storms	Other	N		Planned	Adaptation	https://scholarworks.umass.edu/cgi/viewcontent.cgi?referer=http://www.adaptationclearinghouse.org/resources/marshfield-massachusetts-2013-master-plan-climate-change-adaptation-chapter.html&httpsredir=1&article=1022&context=larp_grad_research	
Use natural predators for mosquitos	Local	Marshfield	MA	Uses fish to eliminate mosquito larvae, reducing the need for harmful spraying of pollutants	Disease	N		Planned	Adaptation	https://scholarworks.umass.edu/cgi/viewcontent.cgi?referer=http://www.adaptationclearinghouse.org/resources/marshfield-massachusetts-2013-master-plan-climate-change-adaptation-chapter.html&httpsredir=1&article=1022&context=larp_grad_research#page=44	
Support a stream maintenance program	local	Baltimore	MD	Maintain streams to protect stormwater systems and provide other benefits	Sea level rise, other flooding	N		Planned	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=42	

Strategy	Jurisdiction (state, county, local)	Juridiction Name	State	Objective	Hazard Type (e.g. sea-level rise, other flooding, forest fire, drought, heat island, extreme weather)	Resilience Metrics (Y/N)	Metrics Description	Status (e.g. planned/underway/complete)	Adaptation or Mitigation	Data Source 1	Data Source 2
Promote conservation of open space, wetlands, sea level rise boundary zones	Local	Durham; Keene	NH	Separate development from high-hazard areas	Sea level rise, extreme weat	N		Planned	Adaptation	https://web.archive.org/web/20160702174616/http://www.ci.durham.nh.us/sites/default/files/fileattachments/administration/climate_adaption_proposed_plan.doc.pdf	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf
Increase natural water storage capabilities	Local	Keene	NH	Create a watershed management plan; protect aquifer recharge; store greywater	Extreme weather	N		Planned	Adaptation	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf	
Update shoreland protection overlay district	Local	Durham	NH	Recommends prohibiting artifical hardening of estuary and river shorelines	Sea level rise	N		Planned	Adaptation	http://www.adaptationclearinghouse.org/resources/durham-new-hampshire-hmp-climate-adaptation-chapter-developing-strategies-to-protect-areas-at-risk-from-flooding-due-to-climate-change-and-sea-level-rise.html	
Protect habitats and migration routes	local	Keene	NH	Identifies routes, installs infrastructure for crossing	climate change in general	N		Planned	Adaptation	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf	
Align local goals with state wildlife plans	Local/State	Keene	NH	Aligns City policies to support goals of NH wildlife action plan	climate change in general	N		Planned	Adaptation	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf	
special taxation districts to fight coastal erosion	county	Flagler County	FL	special taxation districts to construct berms and seawalls to reduce erosion	Seal level rise, extreme weat	N		approved	Adaptation	https://flaglerlive.com/115712/taxing-districts-beaches/	
Dune Management Program	local	Miami Beach	FL	to foster and maintain a healthy, stable, and natural dune system; outlines specifications for restoring, enhancing, and maintaining the dunes, while addressing the needs of the community's various stakeholders; the specifications, which were developed through interdepartmental collaboration and used the best available research, have since been used to conduct restoration and maintenance work led by in-house staff, as well	erosion, sea level rise, and storm surge	N		adopted	Adaptation	http://www.southeastfloridaclimatecompact.org/case-studies/dune-management-program/	
Snook Islands Natural Area - creation of living shoreline	local	Palm Beach Co	FL	to enhance the shoreline and restore habitat adjacent to the Lake Worth Golf Course, Palm Beach County initiated the Snook Islands Natural Area project to create four new islands using sand dredged from a nearby island. Project construction resulted in 1.2 miles of living shoreline, including the restoration of 10 acres of mangroves, three acres of marsh, two acres of oyster reef, and nearly 50 acres of seagrass habitat.	erosion, extreme weather	N		completed -- but with approximately 65% of the lagoon shoreline armored, the county will continue the living shoreline initiative as funding becomes available	Adaptation	http://www.southeastfloridaclimatecompact.org/case-studies/snook-islands-natural-area/	
Create a living shoreline	local	Marshfield	MA	Install cost-effective plantings to create a natural way of maintaining shoreline	erosion, sea level rise	N		Planned	Adaptation	https://scholarworks.umass.edu/cgi/viewcontent.cgi?referer=http://www.adaptationclearinghouse.org/resources/marshfield-massachusetts-2013-master-plan-climate-change-adaptation-chapter.html&httpsredir=1&article=1022&context=larp_grad_research#page=30	
Integrate projected climate impacts on wildland fires into fire management strategies	local	11 municipalities (so far) in South Florida	FL	Integrate projected climate impacts on wildland fires into fire management strategies and support ecological adaptation measures that facilitate better fire management, including increasing landscape diversity and increasing biological diversity	wildland fires	N		adopted by 11 municipalities so far	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/ns-3/	
Promote coastal natural systems	local	9 municipalities (so far) in South Florida; Baltimore	FL	Promote the protection and restoration of coastal natural systems and the creation of living shorelines at the regional scale -- Identify specific locations and general conditions that could utilize living shorelines in place of, or in combination with, seawalls, and write regulations encouraging the use or integration of living shorelines where feasible	erosion, sea level rise, and storm surge			Southeast Florida Regional Compact website lists 9 municiplaities that have adopted	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/ns-7/	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=68
Adopt stricter standards for determining extent of 100-foot coastal wetlands buffer	Local	Durham; Portsmouth	NH	Protect critical areas to allow natural migration of saltmarsh landward		N		Planned?	Adaptation	http://www.planportsmouth.com/cri/CRI-Report.pdf	
Establish migration areas for tidal marsh and wetlands	Local	Portsmouth	NH	Inventory lands and work with landowners to establish migration areas	Sea level rise	N		Planned	Adaptation	http://www.planportsmouth.com/cri/CRI-Report.pdf	
Future construction to allow tidal flow as marsh migrates	Local	Portsmouth	NH	Allows future tidal flow which does not interrupt landward migration of marsh	Sea level rise	N		Planned	Adaptation	http://www.planportsmouth.com/cri/CRI-Report.pdf	
Adopt requirements regulating construction of hard, engineered structures that prevent floods and erosion	Local	Portsmouth	NH	Improve procedures and criteria for siting and design of hard armoring and soft armoring ("living shorelines"), as appropriate for different areas and development densities	Sea level rise, extreme weat	N		Planned	Adaptation	http://www.planportsmouth.com/cri/CRI-Report.pdf	
Grants for living shorelines	local/private	New Jersey	NJ	Develop nature-based solutions to coastal erosion using native vegetation and natural materials	Extreme weather	N		Underway	Adaptation	https://www.conservationgateway.org/ConservationPractices/Marine/crr/library/Documents/TNC%20Living%20Shorelines%20Invitation%20for%20Proposals%20-%20Spring%202018.pdf	
Monitoring framework for living shorelines	Local/state	New Jersey	NJ	Provides framework for choosing metrics, measuring metrics, and creating a monitoring plan	Sea level rise, extreme weat	Y	Includes detailed metrics table		Adaptation	https://www.conservationgateway.org/ConservationPractices/Marine/crr/library/Documents/Framework-Coastal-Wetland-Shoreline-Projects-New-Jersey.pdf	
Living shoreline guidance	Local/Federal			Provides guidance on how to select a shoreline	Sea level rise, extreme weat	Y	12 considerations for a living shoreline	Complete	Adaptation	https://www.conservationgateway.org/ConservationPractices/Marine/crr/library/Documents/NOAA%20_Guidance_for_Considering_the_Use%20of%20Living%20Shorelines%202015.pdf	
Living Shorelines	Local	Heislerville; Gandy's Beach	DE	Preserves wetlands with bioengineered and engineered structures that prevent erosion	Sea level rise, extreme weat	N		Complete	Adaptation	http://eac.rutgers.edu/wp-content/uploads/Ventnor-Climate-Adaptation-Plan-9.8.15.pdf	
Ecosystem service valuation framework	Local/private	Cape May	NJ	Case study of ecosystem restoration in Cape May	Sea level rise, extreme weat	Y	ecosystem serivces valuation	Complete	Adaptation	https://www.conservationgateway.org/ConservationPractices/Marine/crr/library/Documents/A%20Guide%20for%20Incorporating%20Ecosystem%20Service%20Valuation%20into%20Coastal%20Restoration%20Projects.pdf	
Design guidelines for living shorelines	Local/private	New Jersey	NJ	Provides engineering and regulatory guidance on engineering components of designing living shorelines	Sea level rise, extreme weat	Y	terrestrial, ecological, system, and hydrodynamic parameters table for selecting appropriate conditions	Complete	Adaptation	https://www.conservationgateway.org/ConservationPractices/Marine/crr/library/Documents/Living%20Shorelines%20Engineering%20Guidelines.pdf	

Strategy	Jurisdiction (state, county, local)	Juridiction Name	State	Objective	Hazard Type (e.g. sea-level rise, other flooding, forest fire, drought, heat island, extreme weather)	Resilience Metrics (Y/N)	Metrics Description	Status (e.g. planned/underway/complete)	Adaptation or Mitigation	Data Source 1	Data Source 2
Local living shoreline reports	Local/private	Pleasantville City, Linwood, Upper Township, Ventonor City, West Wildwood	NJ	Reports on findings from the Restoration Explorer tool for Pleasantville's development of a living shoreline	Sea level rise, extreme weat	N		Complete	Adaptation	https://www.conservationgateway.org/ConservationPractices/Marine/crr/library/Pages/default.aspx#geographies	
Beach erosion control with natural biopolymers	Local	Progreso	Mexico	Increase adhesion of sand particles to each other to slow beach erosion	Extreme weather	N		Underway	Adaptation	https://www.sesi.org/portfolio/beach-erosion-control-progreso-mexico/	
Create resilient flood control systems	local	8 municipalities (so far) in South Florida	FL	Determine the regional flood control system's performance under potential future climate conditions based on the U.S. Army Corps of Engineers' comprehensive assessment; develop a resilience strategy that will ensure existing levels of service are maintained or improved under future	other flooding, extreme wea	N		adopted by 8 municipalities so far	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/create-resilient-flood-control-systems/	
Expand surface water storage	local	17 municipalities (so far) in South Florida	FL	Develop regional and distributed surface water storage (e.g., C-51 reservoir and interconnected urban systems) to increase the potential for stormwater capture and reuse for water supply, aquifer recharge, flood management, and environmental benefits	other flooding	N		adopted by 17 municipalities so far	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/expand-surface-water-storage/	
increase reservoir capacity	local/regional	Houston	TX	protect property and citizens downstream from the peak runoff that occurs when large rain events occur	other flooding	N		recommendation only	Adaptation	http://houstonstronger.net/resources/	
Increase Bayou Conveyance	local/regional	Houston	TX	doubling the amount of floodwater conveyance for drainage systems in Harris County…controlling flooding is about getting as much water possible into the drainage systems, out to the bayous and into Galveston Bay as quickly and effectively as possible	other flooding	N		recommendation only	Adaptation	http://houstonstronger.net/resources/	
Galveston County Coastal Spine	local/regional	Houston/Galveston	TX	"Ike Dike" - a coastal barrier protecting the Houston/Galveston region from hurricane storm surge	storm surge	N		planned	Adaptation	http://www.tamug.edu/ikedike/	
enhanced stormwater reduction, green building techniques and green infrastructure development	local	Norfolk	VA	Innovative strategies like green roofs, rain gardens, permeable pavements, and bioswales are designed to capture and thereby clean rainwater where it falls, while rain barrels and cisterns collect rainfall for re-use and reduce runoff. Together, these strategies lead to a less concrete, more green cityscape. Through widespread implementation, they will add to the capacity of the City to effectively manage stormwater quantity and quality.	sea level rise, other flooding	N		underway	Adaptation	https://www.norfolk.gov/DocumentCenter/View/27768	
Expand the flood protection system	local	Norfolk	VA	extend flood protection, through a combination of hard (i.e. flood wall) and green infrastructure, to areas that are home to many key assets – like a vibrant and growing downtown, Naval Station Norfolk, and various ports and shipyards, universities, and medical facilities – that cannot be feasibly relocated or recreated elsewhere in the city, functionally keeping the water away from the key assets concentrated there	sea level rise, other flooding	N		underway	Adaptation	https://www.norfolk.gov/DocumentCenter/View/27768	
increase development density in areas to be covered by flood protection infrastructure	local	Norfolk	VA		sea level rise, other flooding	N		underway	Adaptation	https://www.norfolk.gov/DocumentCenter/View/27768	
Ensure water suppliers have contingency contracts	Local/State	Rhode Island	RI	Ensure major water suppliers have current contingency contracts for the purchase of emergency supplies and have established emergency interconnection/distribution process	Extreme weather	N		Recommendation only	Adaptation	http://climatechange.ri.gov/documents/resilientrhody18.pdf#page=11	
Increase communication between water suppliers and downstream municipalities	Local/State	Rhode Island	RI	Advance common goals and communication between water suppliers and downstream municipalities; ensure downstream flood mitigation	Sea level rise, other flooding	N		Recommendation only	Adaptation	http://climatechange.ri.gov/documents/resilientrhody18.pdf#page=11	
Assess vulnerability of coastal drinking water reservoirs	State	Rhode Island	RI	Assess vulnerability of near-coastal drinking water reservoirs	Sea level rise, other flooding	N		Recommendation only	Adaptation	http://climatechange.ri.gov/documents/resilientrhody18.pdf#page=11	
Ensure emergency water connections and supplies	State	Rhode Island	RI	Assists water suppliers in developing emergency programs to address supply vulnerability among small systems, and creates interceonnections to provide redudancy of supply	Other	N		Recommendation only	Adaptation	http://climatechange.ri.gov/documents/resilientrhody18.pdf#page=11	
Integrate climate change into transportation design, building and maintenance	local	Baltimore	MD	Integrate climate resiliency into transportation design, construction, reconstruction and maintenance	Sea level rise, other flooding	N		Underway	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=25	
Use GIS to map hazard areas, at-risk structures	Local	Durham	NH	Maps hazard areas to better understand and assess local vulnerability	Sea level rise, extreme weat	N		Planned	Adaptation	https://web.archive.org/web/20160702174616/http://www.ci.durham.nh.us/sites/default/files/fileattachments/administration/climate_adaption_proposed_plan.doc.pdf	
Inventory vulnerable buildings and infrastructure	Local	Durham	NH	Identify buildings and infrastructure that may be vulnerable to sea level rise	Sea level rise, extreme weat	N		Planned	Adaptation	https://web.archive.org/web/20160702174616/http://www.ci.durham.nh.us/sites/default/files/fileattachments/administration/climate_adaption_proposed_plan.doc.pdf	
Local utilites and critical facilities outside hazard areas	Local	Durham	NH	Decrease risk of service disruption	Sea level rise, extreme weat	N		Planned	Adaptation	https://web.archive.org/web/20160702174616/http://www.ci.durham.nh.us/sites/default/files/fileattachments/administration/climate_adaption_proposed_plan.doc.pdf	
Retrofit critical facilities to withstand predicted sea level	Local	Durham	NH	Critical facilities to be built 1 foot above the 500-year flood elevation or predicted sea level rise, whichever is higher	Sea level rise, extreme weat	N		Planned	Adaptation	https://web.archive.org/web/20160702174616/http://www.ci.durham.nh.us/sites/default/files/fileattachments/administration/climate_adaption_proposed_plan.doc.pdf	
Replace exterior building components with hazard-resistant materials	Local	Durham	NH	Helps buildings withstand intense storm events	Extreme weather	N		Planned	Adaptation	https://web.archive.org/web/20160702174616/http://www.ci.durham.nh.us/sites/default/files/fileattachments/administration/climate_adaption_proposed_plan.doc.pdf	
Vulnerability, impact and financial assessment	Local	Portsmouth	NH	Creates basis for future plans	Sea level rise, flooding	N			Adaptation	http://www.planportsmouth.com/cri/CRI-Report.pdf	
Consult with historic district commission to protect and preserve historic resources	Local	Portsmouth	NH	Evaluates options for protecting, preserving and managing historic resources within areas impacted by current and projected flooding	Sea level rise, other flooding	N		Planned	Adaptation	http://www.planportsmouth.com/cri/CRI-Report.pdf	
Evaluate Emergency Response to the sewer treatment plant in case of flood	Local	Portsmouth	NH	Ensure accessibility to plan is maintained and includes proper equipment for disaster response	Sea level rise, other flooding	N		Planned	Adaptation	http://www.planportsmouth.com/cri/CRI-Report.pdf	
Assess impacts of sea level rise on resident evacuation	Local	Portsmouth	NH	Update evacuation evaluation based on climate reports	Sea level rise, other flooding	N		Planned	Adaptation	http://www.planportsmouth.com/cri/CRI-Report.pdf	
Identify alternative evacuation routes	Local	Baltimore	MD	Protect residents by improving emergency capcaity of transportation systems	Other flooding	N		Planned	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=27	
Design and reconstruct roadways	Local	Keene	NH	Change design requirements for new and refurbished roadways	Sea level rise, other flooding	N		Planned	Adaptation	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf	

Strategy	Jurisdiction (state, county, local)	Juridiction Name	State	Objective	Hazard Type (e.g. sea-level rise, other flooding, forest fire, drought, heat island, extreme weather)	Resilience Metrics (Y/N)	Metrics Description	Status (e.g. planned/underway/complete)	Adaptation or Mitigation	Data Source 1	Data Source 2
Manage stormwater effectively	Local	Keene, Baltimore	NH, MD	Green streets and stormwater design requirements	Other flooding	N		Planned	Adaptation	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf	
Stormwater utility program	Local	Baltimore	MD	Raises funds for stormwater management and remediation projects	Other flooding	N		Underway	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf	
Improve stormwater management practices	local	Southeast Florida Regional Compact	FL	Undertake a comprehensive evaluation of stormwater improvements necessary to expand surface water storage, enhance water quality treatment, and reduce stormwater discharges in the delivery of flood protection needs and environmental priorities; improve stormwater management through distributed storage, integrated stormwater systems, and additional best management practices	sea level rise, extreme weather, climate change	N		workshop completed	Adaptation	http://www.southeastfloridaclimatecompact.org/event/rcap-implementation-workshop-stormwater/	
Increase energy security	Local	Keene	NH	Decrease energy supply interruption, increase resiliency of systems, and increase renewable energy	Extreme weather	N		Planned	Adaptation	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf	
Increase food security	Local	Keene, Baltimore	NH, MD	Develop a food security plan and increase local food production	Climate change	N		Planned	Adaptation	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf
Utilize unused or underutilized properties	local	28 municipalities (so far) in South Florida	FL	Conduct an assessment of unused or underutilized properties and develop an approach for utilizing such properties that enhances overall resilience goals; design resilience and adaptation projects for underutilized spaces based on the specific capacity of each space. Potential uses of unused spaces could include stormwater flow and storage, green space or urban	Extreme weather	N		adopted by 28 municipalities so far	Adaptation	http://www.southeastfloridaclimatecompact.org/recommendations/utilize-unused-or-underutilized-properties/	
Assess transportation vulnerability	local	Hampton Roads	VA	Describes anticipated impacts of climate change on transportation	Climate change	N		Complete	Adaptation	http://www.virginia.edu/crmes/fhwa_climate/files/finalReport.pdf	
Resilient design guidelines	local	Hoboken	NJ	Provides accessible guidance about flood-resilient design in advance of floods	Sea level rise, extreme weat	N		Complete	Adaptation	https://www.njfuture.org/wp-content/uploads/2017/12/New-Jersey-Future-Resilient-Coastal-Communities-Project-Report-2017.pdf#page=94	
Ensure structural stability of tunnels during seismic activity	Local	Baltimore	MD	Protect transportation network by safeguarding tunnels against seismic activity, which will be important during evacuations	Climate change	N		Planned	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=31	
Create a debris management plan for hazard events	Local	Baltimore	MD	Build resilience into solid waste and stormwater systems in order to handle debris	Other flooding	N		Planned	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=44	
Evaluate changes to road maintenance and construction materials based on climate change	Local	Baltimore	MD	Recognize future conditions that may require renovation or modification for road	Climate change	N		Planned	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=32	
Develop hazard protection for critical facilities	Local	Baltimore	MD	Prevent structural damage from damaging hospitals, fire stations, police stations, and hazardous material storage sites	Extreme weather, other floo	N		Planned	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=49	
Improve wind resiliency of new and existing structures	Local	Baltimore	MD	Adjust building codes to account for more intense storm events	Extreme weather	N		Planned	Adaptation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=55	
Archaeological assessment of vulnerable historic resources	Local	Annapolis	MD	Identifies vulnerable cultural resources and determines risk from flooding and other natural disasters	Flooding	N		Planned	Adaptation	https://www.annapolis.gov/DocumentCenter/View/10064/Consolidated-CRHMP-Report-April-2018	
Structural adaptations for bulkheads, seawalls, infrastructure	Local	Annapolis	MD	Protects assets from flood risk (at least temporarily)	Flooding	N		Planned	Adaptation	https://www.annapolis.gov/DocumentCenter/View/10064/Consolidated-CRHMP-Report-April-2018/#page=89	
Complete 3-D laser documentation of flood risk area	Local	Annapolis	MD	Document flood risk area using lasers	Flooding	N		Planned	Adaptation	https://www.annapolis.gov/DocumentCenter/View/10064/Consolidated-CRHMP-Report-April-2018/#page=207	
Block flood entry points with elevated waterfront parks and plazas	Local	Boston	MA	Block critical flood entry points and provide public open space with Harbor views	Sea level rise, flooding	N		Planned	Adaptation	https://www.boston.gov/sites/default/files/climatereadyeastbostoncharlestown_finalreport_web.pdf#page=22	
Elevated roadways and deployable flood walls	Local	Boston	MA	Short-term and affordable solutions	Sea level rise, flooding	N		Planned	Adaptation	https://www.boston.gov/sites/default/files/climatereadyeastbostoncharlestown_finalreport_web.pdf#page=53	
Promote maritime industries	Local	Boston	MA	Increase public support for maritime industries to upgrade their infrastructure and equipment	Sea level rise, flooding	N		Planned	Adaptation	https://www.boston.gov/sites/default/files/climatereadyeastbostoncharlestown_finalreport_web.pdf#page=24	
Increase water conservation	Local	Boston	MA	Conserve water to counteract the effects of drought and heat	Drought, Heat island	N		Planned	Adaptation	https://www.boston.gov/sites/default/files/metro_boston_regional_climate_adaptation_strategy_report.pdf#page=69	
Ensure access to food supplies	Local	Boston	MA	Protect food security as climate changes	Climate change	N		Planned	Adaptation	https://www.boston.gov/sites/default/files/metro_boston_regional_climate_adaptation_strategy_report.pdf#page=100	
Prepare for worsening air quality	Local	Boston	MA	Prepare population for increased air pollution and allergens	Other	N		Planned	Adaptation	https://www.boston.gov/sites/default/files/metro_boston_regional_climate_adaptation_strategy_report.pdf#page=100	
Protect agriculture and agri-tourism	Local	Boston	MA	Protect MA's agricultural economy	Change	N		Planned	Adaptation	https://www.boston.gov/sites/default/files/metro_boston_regional_climate_adaptation_strategy_report.pdf#page=108	
Develop a rapid housing recovery model	Local	Norfolk	VA	Create a new model to provide cities with tool to enhance housing production capacity	Flooding	N		Complete	Adaptation	https://www.norfolk.gov/DocumentCenter/View/27257#page=35	
Launch a resilience lab	Local	Norfolk	VA	Work to capture resilience market by connecting problems with solutions and products	Flooding	N		Complete	Adaptation	https://www.norfolk.gov/DocumentCenter/View/27257#page=38	
Design principles for flood resistant construction	Local	New York City	NY	Identifies key design principles to guide flood-resistant constrution in urban areas	Flooding	N		Complete	Adaptation	https://www1.nyc.gov/site/planning/plans/sustainable-communities/climate-resilience.page?tab=1	
Resilient design guidelines	Local	Hoboken	NJ	Identifies key design principles to guide flood-resistant constrution in urban areas	Flooding	N		Complete	Adaptation	http://betterwaterfront.org/wp-content/uploads/2016/05/Resilient-Buildings-Design-Guidelines.pdf	
Construction of resiliency parks	Local	Hoboken	NJ	Creates parks that provide public space and flood control measures	Flooding	N		Complete	Adaptation	http://nwpark-cityofhoboken.opendata.arcgis.com/	
Seawall and seawall repair	Local	Marshfield	MA	Dampens impact of waves	Extreme weather	N		Complete	Adaptation	https://scholarworks.umass.edu/cgi/viewcontent.cgi?referer=http://www.adaptationclearinghouse.org/resources/marshfield-massachusetts-2013-master-plan-climate-change-adaptation-chapter.html&httpsredir=1&article=1022&context=larp_grad_research#page=27	
Resurface impervious pavement	Local	Marshfield, Ipswich	MA	Resurfaces impervious pavement with pervious surfaces to help control stormwater runoff	flooding, extreme weather	N		Complete	Adaptation	https://scholarworks.umass.edu/cgi/viewcontent.cgi?referer=http://www.adaptationclearinghouse.org/resources/marshfield-massachusetts-2013-master-plan-climate-change-adaptation-chapter.html&httpsredir=1&article=1022&context=larp_grad_research#page=32	

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Building elevation	Local	Marshfield, Ipswich	MA	Elevates homes to protect them from flooding	flooding, extreme weather	N		Planned	Adaptation	https://scholarworks.umass.edu/cgi/viewcontent.cgi?referer=http://www.adaptationclearinghouse.org/resources/marshfield-massachusetts-2013-master-plan-climate-change-adaptation-chapter.html&httpsredir=1&article=1022&context=larp_grad_research#page=32	
Alternative transporatation during catastrophes	Local	Marshfield	MA	Identifies transportation alternatives (like bus service) during times of storm surge, etc.	flooding	N		Planned	Adaptation	https://scholarworks.umass.edu/cgi/viewcontent.cgi?referer=http://www.adaptationclearinghouse.org/resources/marshfield-massachusetts-2013-master-plan-climate-change-adaptation-chapter.html&httpsredir=1&article=1022&context=larp_grad_research#page=41	
Catchment filtration system	Local	Marshfield	MA	Filters stormwater to reduce contaminants in groundwater	flooding	N		Planned	Adaptation	https://scholarworks.umass.edu/cgi/viewcontent.cgi?referer=http://www.adaptationclearinghouse.org/resources/marshfield-massachusetts-2013-master-plan-climate-change-adaptation-chapter.html&httpsredir=1&article=1022&context=larp_grad_research#page=43	
Maintain potable water pressure	Local	Marshfield	MA	If aquifers become salinated, sacrifice certain wells to inject potable water into the ground to create pressure barrier between aquifer and seawater	Other	N		Planned	Adaptation	https://scholarworks.umass.edu/cgi/viewcontent.cgi?referer=http://www.adaptationclearinghouse.org/resources/marshfield-massachusetts-2013-master-plan-climate-change-adaptation-chapter.html&httpsredir=1&article=1022&context=larp_grad_research#page=43	Example of NJ specific risks? ex. coal ash, agricultural waste, toxic sites, nuclear plants
Secure propane tanks	Local	Marshfield	MA	Improves propane tank securement to protect them during storms, preventing pollution	flooding, extreme weather	N		Planned	Adaptation	https://scholarworks.umass.edu/cgi/viewcontent.cgi?referer=http://www.adaptationclearinghouse.org/resources/marshfield-massachusetts-2013-master-plan-climate-change-adaptation-chapter.html&httpsredir=1&article=1022&context=larp_grad_research#page=43	
Sewer district expansion	Local	Marshfield	MA	To avoid contamination of aquifer by septic systems, expand sewer district to residential areas	Other	N		Planned	Adaptation	https://scholarworks.umass.edu/cgi/viewcontent.cgi?referer=http://www.adaptationclearinghouse.org/resources/marshfield-massachusetts-2013-master-plan-climate-change-adaptation-chapter.html&httpsredir=1&article=1022&context=larp_grad_research#page=44	
Upgrade wastewater management system	Local	Marshfield	MA	Upgrade equipment in order to protect drinking water supply as flash flooding becomes more frequent	Flooding	N		Planned	Adaptation	https://scholarworks.umass.edu/cgi/viewcontent.cgi?referer=http://www.adaptationclearinghouse.org/resources/marshfield-massachusetts-2013-master-plan-climate-change-adaptation-chapter.html&httpsredir=1&article=1022&context=larp_grad_research#page=44	
Provide additional fuel storage capacity for wastewater systems	Local	Rhode Island	RI	Provide additional fuel-storage capacity at wastewater systems to maintain self-sufficient standby power during outages	Flooding, extreme weather	N		Recommendation	Adaptation	http://climatechange.ri.gov/documents/resilientrhody18.pdf#page=12	
Protect pumping stations from flooding	Local	Warwick	RI	Make vulnerable pumping stations resilient to flooding	Flooding	N		Complete	Adaptation	http://climatechange.ri.gov/documents/resilientrhody18.pdf#page=12	
Reconstruct protective berm for wastewater treatment facility	Local	Warwick, Narragansett	RI	Reconstruction of protective berm to increase its height, to protect treatment system from floods	Sea level rise, flooding	N		Complete	Adaptation	http://climatechange.ri.gov/documents/resilientrhody18.pdf#page=12	
Construct wet weather bypass	Local	Bristol	RI	"Not a desired strategy to protect the equipment but would be a preferred alternative to overflow within streets"	Sea level rise, flooding	N		Recommendation	Adaptation	http://www.dem.ri.gov/programs/benviron/water/pdfs/wwtfclimstudy.pdf#page=203	
Use wastewater treatment equipment that is repairable or replaceable	Local	Bristol	RI	Make sure spare equipment or parts are on hand; Create contingency plans on how to replace and who to call	Sea level rise, flooding	N		Recommendation	Adaptation	http://www.dem.ri.gov/programs/benviron/water/pdfs/wwtfclimstudy.pdf#page=203	
"Harden" wastewater treatment facilities with various methods	Local	Bristol, Narragansett	RI	Retain water with construction walls and dikes; waterproof by installing submersible pumps and water resistant electrical enclosures; install flood proof doors; temporary flood barriers	Sea level rise, flooding	N		Recommendation	Adaptation	http://www.dem.ri.gov/programs/benviron/water/pdfs/wwtfclimstudy.pdf#page=203	
"Harden" fuel terminals	Local	Rhode Island	RI	Ensure fuel terminals have taken hardening and resilience measures to protect facilities from storms	Extreme weather	N		Recommendation	Adaptation	http://climatechange.ri.gov/documents/resilientrhody18.pdf#page=16	
Develop petroleum set-aside program	Local/State	Rhode Island	RI	Ensures essential public needs are met during severe fuel shortage, such as hospitals, police, and fire stations	Extreme weather	N		Recommendation	Adaptation	http://climatechange.ri.gov/documents/resilientrhody18.pdf#page=16	
Relocate wastewater treatment facilities	Local	Bristol	RI	Elevate or relocate systems and equipment to higher points	Sea level rise, flooding	N		Recommendation	Adaptation	http://www.dem.ri.gov/programs/benviron/water/pdfs/wwtfclimstudy.pdf#page=203	
Armor certain transportation infrastructure	Local	Rhode Island	RI	Protect certain critical roads and transportation assets, with the caveat that this is not a long term solution and cannot be used all along the coast	Sea level rise, flooding	N		Recommendation	Adaptation	http://www.planning.ri.gov/documents/sea_level/2016/TP167.pdf#page=26	
Accommodate infrastructure in place	Local	Rhode Island	RI	Accommodate rising tides with increased culvert size, planning pavement materials to mimimize lifecycle cost, and enhance scour protection on bridges	Sea level rise, flooding	N		Recommendation	Adaptation	http://www.planning.ri.gov/documents/sea_level/2016/TP167.pdf#page=26	
Realign transportation assets	Local	Rhode Island	RI	Realign bus transportation routes, bike paths, and roads	Sea level rise, flooding	N		Recommendation	Adaptation	http://www.planning.ri.gov/documents/sea_level/2016/TP167.pdf#page=26	
Identify stormwater structures that flood	Local/State	Rhode Island	RI	Identify existing stormwater management structures that are subject to flooding and mitigate the impacts on this infrastructure and its performance	Sea level rise, flooding	N		Recommendation	Adaptation	http://climatechange.ri.gov/documents/resilientrhody18.pdf#page=13	
Strenthen resilience at ports	Local/State	Rhode Island	RI	Strenthen storm resilience and recover at ports through strategic partnerships and planning	Extreme weather	N		Recommendation	Adaptation	http://climatechange.ri.gov/documents/resilientrhody18.pdf#page=14	
Abandon transportation infrastructure	Local	Marshfield	MA	Abandon infrastructure in vulnerable or indefensible areas, and site new facilities in less vulnerable locations	Sea level rise, flooding	N		Planned	Adaptation	https://scholarworks.umass.edu/cgi/viewcontent.cgi?referer=http://www.adaptationclearinghouse.org/resources/marshfield-massachusetts-2013-master-plan-climate-change-adaptation-chapter.html&httpsredir=1&article=1022&context=larp_grad_research#page=41	
Seize the economic opportunities of emerging resilience-based industries	local	Norfolk	VA	Efforts to address resilience will lead to new technology and industry; facilitate the growth of this new industry by providing support, such as tax credits and other financial incentives.	Sea level rise, flooding	N		Planned	adaptation and mitigation	https://www.norfolk.gov/DocumentCenter/View/27768	
Evaluate seismic design enhancements	Local	Baltimore	MD	Increase resiliency to earthquakes and other seismic events		N		Planned	Adaptation?	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=56	
Climate Change Task Force	State	New Hampshire	NH	Established a Climate Change Task Force via executive order		N			Both	https://www.des.nh.gov/organization/divisions/air/tsb/tps/climate/action_plan/index.htm	
"Redland Raised" local produce branding initiative	local	15 municipalities (so far) in South Florida	FL	promotes the consumption of fresh, local produce and promotes the "buy local" program; "By purchasing locally grown foods, consumers can enjoy fresher, more nutritious foods and lower the greenhouse gas emissions associated with long-distance transportation of produce and food	greenhouse gas emissions in	N		underway - 15 municipalities signed on so far	Mitigation	http://www.southeastfloridaclimatecompact.org/case-studies/redland-raised/	

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Greenhouse Gas Inventory	local	West Palm Bea	FL	measure total energy consumption and GHG emissions from two categories: municipal government operations and the community at large	greenhouse gas emissions ir	Y	greenhouse gas emissions inventory	underway - 50 South Florida municipalities have adopted this strategy so far	Mitigation	http://www.southeastfloridaclimatecompact.org/case-studies/greenhouse-gas-inventory-five-year-update/	
Increase resource conservation in private buildings via educational outreach	Local	Baltimore	MD	Include info about utilities, water use, energy savings, hazardous materials, and electricity demand	Climate change	N		Planned	Mitigation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=59	
Reduce waste sent to landfill	Local	Burlington	VT	Implement residential organic recycling, require recycling bins, etc.	greenhouse gas emissions ir	N		Underway	Mitigation	https://www.burlingtonvt.gov/sites/default/files/CEDO/Sustainability/Climate%20Action%20Plan.pdf	
Implement energy conservation measures	Local	Boston	MA	Encourage clean energy and reduced energy usage to mitigate climate change	Climate change	N		Planned	Mitigation	https://www.boston.gov/sites/default/files/metro_boston_regional_climate_adaptation_strategy_report.pdf#page=70	
Promote renewable energy	local	Southeast Florida Regional Compact	FL	Promote renewable energy through policies and technological development in order to reduce greenhouse gas (GHG) emissions	greenhouse gas emissions ir	Y	GHG emissions reduction targets; percent renewable energy targets	adopted by 50 constituent municipalities so far	Mitigation	http://www.southeastfloridaclimatecompact.org/recommendations/ef-1/	
Support environmentally sustainable businesses	Local	Keene	NH	Provide favorable incentives for sustainable businesses to locate in Keene	Climate change	N		Planned	Mitigation	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf	
Increase competitiveness of local business	Local	Keene	NH	Support local business development	Climate change	N		Planned	Mitigation	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf	
Incentivize development of renewable energy resources	Local	Keene	NH	Encourage state to increase amount of renewable energy produces; engage energy providers	Extreme weather	N		Planned	Mitigation	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf	
Evaluate existing, disparate regulations related to natural resource protection and consider streamlining them	Local	Boston	MA	Preserve green space and protect water resources	Climate change	N		Planned	Mitigation	https://www.boston.gov/sites/default/files/metro_boston_regional_climate_adaptation_strategy_report.pdf#page=72	
Policies supporting local food production	Local	Burlington	VT	Develop zoning, planning, and economic development policies that support local food production	greenhouse gas emissions ir	N		Underway	Mitigation	https://www.burlingtonvt.gov/sites/default/files/CEDO/Sustainability/Climate%20Action%20Plan.pdf	
Increased energy efficiency in buildings	Local	Burlington	VT	Require new guidelines and certifications for new construction	greenhouse gas emissions ir	N		Underway	Mitigation	https://www.burlingtonvt.gov/sites/default/files/CEDO/Sustainability/Climate%20Action%20Plan.pdf	
Support legislation to mitigate source emissions	Local	Portsmouth	NH	Address climate change and other problems by reducing emissions	Climate change	N		Planned	Mitigation	http://www.planportsmouth.com/crj/CRI-Report.pdf	
Install solar panels	Local	Norfolk	VA	Installation of solar panels on a university student recreation center	Climate Change	N		Complete	Mitigation	https://sites.wp.odu.edu/odublast2018/climate-change-and-sea-level-rise/	
Valuation of ecological restoration benefits	Local/Private	Cape May	NJ	Analyzes social and economic benefits of ecosystem restoration	Sea level rise, extreme weat	Y	Dollar valuation of ecosystem services in flood damages avoided	Complete	Mitigation	https://www.conservationgateway.org/ConservationPractices/Marine/crr/library/Documents/Lower%20Cape%20May%20Meadows%20Ecological%20Restoration%20-%20Analysis%20of%20Economic%20and%20Social%20Benefits.pdf	
Ensure investments reduce greenhouse gas (GHG) emissions and increase the resilience of the transportation system to extreme weather and climate impacts.	local	32 municipalities (so far) in South Florida	FL	Give higher investment priority to local, state, and federal transportation infrastructure investments, programs, and services that will reduce GHG emissions and increase resilience and adaptability to climate change; incorporate climate and related performance metrics, such as reduced vehicle miles traveled (VMT) and increased mode split, in transportation	greenhouse gas emissions ir	Y	VMT; increased non-automobile mode share	adopted by 32 constituent municipalities so far	Mitigation	http://www.southeastfloridaclimatecompact.org/recommendations/increase-resilience-through-investments/	
direct new more intense development to higher ground	local	Norfolk	VA	Upland Resilience Overlay zone, applied to areas outside of flood hazard zones - the ordinance includes policies aimed to target redevelopment to create transit-oriented, walkable, and bikeable neighborhoods	Flooding	N		complete - effective March 2018	Mitigation	http://www.adaptationclearinghouse.org/resources/building-a-better-norfolk-a-zoning-ordinance-of-the-21st-century.html	
Use interconnected green corridors and parks to protect surrounding communities from hazards, as well as protecting watershed	Local	Baltimore	MD	Protect streams, trees, etc. for their mitigation effects	Climate change, other floodi	N		Planned	Mitigation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf#page=63	
Impervious suface assessment	Local	New Jersey	NJ	Impervious assessments and growth models help municipalities plan to reduce it	Other flooding	N		Complete	Mitigation	http://water.rutgers.edu/ImperviousCoverReductionProgram.html	http://water.rutgers.edu/Projects/NFWF/NFWF.html
Increase carbon storage through tree coverage	Local	Burlington	VT	Increase the urban tree canopy	greenhouse gas emissions ir	N		Underway	Mitigation	https://www.burlingtonvt.gov/sites/default/files/CEDO/Sustainability/Climate%20Action%20Plan.pdf	
Protect forests	Local	Keene	NH	Requires sustainable forest management plans	Climate change	N		Planned	Mitigation	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf	
Coastal restoration web app	Local/state	New Jersey	NJ	Web app that enables people to identify which nature-based techniques can best mitigate coastal erosion	Sea level rise, extreme weat	Y	Interactive map	Complete	Mitigation	https://www.conservationgateway.org/ConservationPractices/Marine/crr/library/Documents/UserGuide_RestorationExplorer_NJ.pdf	http://maps.coastalresilience.org/newjersey/
Promote compact mixed-use and infill development	Local	Burlington, VT; Keene, NH; Boston MA	VT, NH	Reduce GHG emissions by creating policies and incentives for mixed-use development	greenhouse gas emissions ir	N		Underway	Mitigation	https://www.burlingtonvt.gov/sites/default/files/CEDO/Sustainability/Climate%20Action%20Plan.pdf	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf
Shape development through transportation planning	local	18 municipalities (so far) in South Florida	FL	Employ transit-oriented developments and other planning approaches to promote higher-density development capable of supporting more robust transit.	greenhouse gas emissions ir	N		adopted by 18 municipalities so far	Mitigation	http://www.southeastfloridaclimatecompact.org/recommendations/shape-development-through-transportation-planning/	
Promote bicycle and pedestrian facilities	local	33 municipalities (so far) in South Florida	FL	Expand, connect, and complete networks of bicycle and pedestrian facilities, including those supporting access to transit.	greenhouse gas emissions ir	N		adopted by 33 municipalities so far	Mitigation	http://www.southeastfloridaclimatecompact.org/recommendations/promote-bicycle-and-pedestrian-facilities/	
Expand transportation demand management	local	10 municipalities (so far) in South Florida	FL	Expand the use of transportation demand management strategies to reduce peak period and single-occupant vehicle travel; pursue opportunities to increase use of carpools and vanpools, maximize use of available parking, and promote working remotely and/or telecommuting.	greenhouse gas emissions ir	N		adopted by 10 municipalities so far	Mitigation	http://www.southeastfloridaclimatecompact.org/recommendations/expand-transportation-demand-management/	
Reduce community vehicle emissions	Local	Burlington, VT; Keene, NH	VT, NH	Reduce GHG emissions by improving transportation options and infrastructure	greenhouse gas emissions ir	N		Underway	Mitigation	https://www.burlingtonvt.gov/sites/default/files/CEDO/Sustainability/Climate%20Action%20Plan.pdf	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINA

Strategy	Jurisdiction (state, county, local)	Juridiction Name	State	Objective	Hazard Type (e.g. sea-level rise, other flooding, forest fire, drought, heat island, extreme weather)	Resilience Metrics (Y/N)	Metrics Description	Status (e.g. planned/underway/complete)	Adaptation or Mitigation	Data Source 1	Data Source 2
Reduce municipal vehicle miles traveled	Local	Burlington	VT	Reduce miles traveled by 10% by establishing government alternative employee commuting program	greenhouse gas emissions ir	N		Underway	Mitigation	https://www.burlingtonvt.gov/sites/default/files/CEDO/Sustainability/Climate%20Action%20Plan.pdf	
Promote low-carbon transportation for freight	local	Southeast Florida Regional Compact (aspirational only)	FL	increase the use of low-carbon transportation modes for the movement of freight in the region; incorporate climate adaptation strategies and greenhouse gas (GHG) emission inventories into seaport and airport master plans and county and/or regional freight plans	greenhouse gas emissions ir	N		recommendation only	Mitigation	http://www.southeastfloridaclimatecompact.org/recommendations/promote-low-carbon-transportation-for-freight/	
Increase use of clean and renewable energy sources	Local	Burlington	VT	Install solar panels and develop methane gas capture on certain municipal buildings	greenhouse gas emissions ir	N		Underway	Mitigation	https://www.burlingtonvt.gov/sites/default/files/CEDO/Sustainability/Climate%20Action%20Plan.pdf	
General reduction of GHG emissions	Local/State	New Hampshire, Maryland, Baltimore	NH, MD	A collection of strategies for reducing greenhouse gas emissions	greenhouse gas emissions ir	N			Mitigation	https://www.des.nh.gov/organization/divisions/air/tsb/tps/climate/action_plan/documents/nhcap_final.pdf	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter-1_Introduction.pdf
Retrofit buildings for energy efficiency	Local	Baltimore	MD	Increase energy efficiency by upgrading and retrofitting existing buildings	Climate change	N		Underway	Mitigation	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf	
Low impact development techniques	Local	Boston	MA	Protect natural resources and functions while still allowing some development to occur	Climate change	N		Planned	Mitigation	https://www.boston.gov/sites/default/files/metro_boston_regional_climate_adaptation_strategy_report.pdf#page=89	
Communications and Outreach											
Climate change projections report	Local	New York City	NY	To communicate risks and projections of climate change effects	Sea level rise, extreme weat	N		Complete (2015)		https://www1.nyc.gov/site/orr/challenges/nyc-panel-on-climate-change.page	
StormSmart communities	Local/State	Massachusetts	MA	Helps local officials prepare for and protect their communities (state-led	Seal level rise, extreme weat	N		Complete		https://www.mass.gov/service-details/stormsmart-communities	
StormSmart properties	Local/State	Massachusetts	MA	Helps coastal property owners learn about reducing erosion and storm damage (state-led initiative)	Sea level rise	N		Complete		https://www.mass.gov/service-details/stormsmart-properties	
MA shoreline change project	State	Massachusetts	MA	Illustrates how MA's shore lines have shifted from mid-1800s to 2009	Sea level rise	N		Complete		https://www.mass.gov/service-details/massachusetts-shoreline-change-project	
MA sea level rise viewer	State	Massachusetts	MA	Includes interactive flooding maps	Sea level rise	N		Complete		https://www.mass.gov/service-details/massachusetts-sea-level-rise-and-coastal-flooding-viewer	
Natural Hazards Disclosure Act	State	California	CA	Requires disclosure if a property is within a hazard area for flood, dam inundation, fire, earthquake	Other flooding, forest fire	Y		Complete		https://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=CIV&division=2.&title=4.&part=4.&chapter=2.&article=1.7.	
Align research and extension with climate-related needs of agriculture	local	4 municipalities (so far) in South Florida	FL	Develop processes with extension services for regularly identifying the most pressing climate-related data and research needs for the agriculture industry; Facilitate sharing of climate-related agriculture research with local farmers and the agriculture industry; Prioritize academic research and agricultural extension services that align with needs for climate adaptation	not specified	N		underway		http://www.southeastfloridaclimatecompact.org/recommendations/research-agricultural-needs/	
Southeast Florida Resilient Redesign Workshop	local	Dania Beach	FL	to lay the foundation for planning and infrastructure investments as part of a community resilience strategy with design concepts that can be integrated into development and redevelopment opportunities; the primary design concepts focused on interconnectivity, urban densification in the most naturally resilient area, enhancement and multi-purposing of the natural infrastructure, and flood control.	sea level rise, severe storm and storm surge	N		completed			
Maine adaptation report	State	Maine	ME	Integrate current systems for environmental data monitoring	Sea level rise, other	N		Planned		http://www.maine.gov/tools/whatsnew/attach.php?id=369026&an=1	
Maine adaptation report: information and awareness	State	Maine	ME	Provide accessible information to citizens, businesses, etc. about climate change impacts	sea level rise, other	N		Planned		http://www.maine.gov/tools/whatsnew/attach.php?id=369026&an=1	
Climate change stories and videos	Private	New Jersey	NJ	Makes climate change information accessible to the public through videos	Climate change	N		Complete		http://www.njadapt.org/about.html	
Social										http://www.southeastfloridaclimatecompact.org/case-studies/resilient-redesign-dania-beach/	
Targeted Acquisition (Blue Acres)	State/Local	New Jersey	NJ	Gives landowners the option to apply for a buyout from the state	sea level rise, extreme weather			Underway		https://www.nj.gov/dep/greenacres/blue_flood_ac.html	https://www.njfuture.org/wp-content/uploads/2017/12/New-Jersey-Future-Resilient-Coastal-Communities-Project-Report-2017.pdf#page=100, More: https://www.nj.gov/dep/newsrel/2017/17_0080
Environmental Public Health Tracking Network	State	Delaware	DE	Compiles health, exposure, and hazard info and data to improve understanding of environmental changes and health	Other	N		Underway		http://www.dnrec.delaware.gov/energy/Documents/2016%20Climate%20Action%20Progress%20Report/Climate%20Action%20in%20Delaware%202016%20Progress%20Report.pdf	
Climate-ready workforce	State	Delaware	DE	Identifies best practices for health and safety of state agency outdoor workers	Sea level rise, extreme weat	N		Underway		http://www.dnrec.delaware.gov/energy/Documents/2016%20Climate%20Action%20Progress%20Report/Climate%20Action%20in%20Delaware%202016%20Progress%20Report.pdf	
Advanced search and rescue training	State	Delaware	DE	Trains state troopers and DE Air Rescue Team for emergency response	Extreme weather	N		Underway		http://www.dnrec.delaware.gov/energy/Documents/2016%20Climate%20Action%20Progress%20Report/Climate%20Action%20in%20Delaware%202016%20Progress%20Report.pdf	
Mental health consequences for community	Local	Little Egg	NJ	Health impact assessment uncovered consequences of extreme weather event to community mental health							
Voluntary relocation	Local	Shismaref	AK	Residents voted to relocate their small village, where land is eroding due to a lack of buffering ice	Other	N		Underway		https://www.thearcticinstitute.org/media-coverage-climate-change-relocation-alaska/	
Economic											
Extra/higher taxes for emergency services in areas of higher risk	Local	?	?								
Purchasing development rights (PDR)	Local	New Jersey	NJ, CA, HI, VA	Restricts future development of a parcel of land	Sea level rise	N		Complete in some states		https://www.njfuture.org/wp-content/uploads/2017/12/New-Jersey-Future-Resilient-Coastal-Communities-Project-Report-2017.pdf#page=105	
Capital improvement planning	Local	New Jersey, Balt	NJ, MD	Plans for infrastructure degradation due to sea level rise	Seal level rise, extreme weat	N		recommendation		https://www.njfuture.org/wp-content/uploads/2017/12/New-Jersey-Future-Resilient-Coastal-Communities-Project-Report-2017.pdf#page=111	https://planning-org-uploaded-media.s3.amazonaws.com/document/Annotated-Bibliography-Building-Coastal-Resilience.pdf
Incentives for improved energy efficiency in rental housing	Local/State	Delaware	DE	Incentivizes energy efficiency improvements	Extreme weather	N		Underway		http://www.dnrec.delaware.gov/energy/Documents/2016%20Climate%20Action%20Progress%20Report/Climate%20Action%20in%20Delaware%202016%20Progress%20Report.pdf	

Strategy	Jurisdiction (state, county, local)	Juridiction Name	State	Objective	Hazard Type (e.g. sea-level rise, other flooding, forest fire, drought, heat island, extreme weather)	Resilience Metrics (Y/N)	Metrics Description	Status (e.g. planned/underway/complete)	Adaptation or Mitigation	Data Source 1	Data Source 2
Green building incentive category in grants	Local/State	Delaware	DE	Adds incentives for LEED certification to Downtown Development District Grant Program	Extreme weather	N		Underway		http://www.dnrec.delaware.gov/energy/Documents/2016%20Climate%20Action%20Progress%20Report/Climate%20Action%20in%20Delaware%202016%20Progress%20Report.pdf	
Coastal resilience grant program	Local/State	Massachusetts	MA	Provides financial and technical support for local efforst	Sea level rise, extreme weat	N		Complete		https://www.mass.gov/service-details/coastal-resilience-grant-program	
Coastal resilience incentive zone program for municipalities	local/state	New Hampshire	NH	Allows municipalities to establish Coastal Resilience Incentive Zones, which grant property owners tax relief for qualified resilience measures	Sea level rise, extreme weat	N		Underway (started in 2017)		http://www.adaptationclearinghouse.org/resources/new-hampshire-coastal-resilience-incentive-zone-program-for-municipalities.html	
Grants and technical assistance for coastal municipalities	Local/State	New Hampshire	NH	Provides financial and technical support to NH's Great Bay municipalities	Sea level rise, extreme weat	N		Underway?		http://www.nhcrhc.org/setting-sail/	
Work toward qualifying for FEMA's community rating system	Federal/Local	Portsmouth	NH	Participate in FEMA's voluntary Community Rating System to earn points toward community discount on flood insurance premiums	Sea level rise, other flooding	N		Planned		http://www.planportsmouth.com/cri/CRI-Report.pdf	
Regulatory											
Green building standards	local	Palmetto Bay, FL; Keene, NH; Baltimore	FL, NH, MD	build the first village hall facility in Florida to achieve LEED Platinum certification	greenhouse gas emissions ir	N		complete		http://www.southeastfloridaclimatecompact.org/case-studies/village-hall-leed-platinum-certified-facility/	https://ci.keene.nh.us/sites/default/files/Boards/CCP/Keene%20Summary%20Report_ICLEI_FINAL.pdf
Rolling easements	Local			As land is eroded or falls under sea level, a rolling easement shifts landward onto beachfront property, providing a regulatory framework for protecting the shore from private ownership						http://papers.risingsea.net/downloads/takings.pdf	https://scholarship.shu.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=1140&context=student_scholarship, https://www.epa.gov/sites/production/files/doc
Community Risk and Resiliency Act	State	Delaware	DE	Requires state departments to incorporate climate and extreme weather considerations into planning and decisions	Sea level rise, extreme weat	N		Underway (signed in 2014)		https://www.dec.ny.gov/energy/102559.html	
Flood Resilience Zoning	State	Delaware	DE	Encourages flood-resilient building construction in floodplains	Sea level rise, extreme we	N		Complete		https://www1.nyc.gov/site/planning/zoning/districts-tools/flood-text.page	
Flood avoidance by executive order				Requires state agencies to avoid building within areas at high risk of flooding (current or future)	Sea level rise, extreme weat	N		Underway		https://dnrec.alpha.delaware.gov/energy-climate/climate-change/flood-risk-avoidance/	
Southeast Florida Regional Climate Change Compact	State		FL	to coordinate climate-change mitigation and adaptation activities across county lines; provides a set of recommendations, guidelines for implementation, and shared best practices for local entities to act in-line	Sea level rise, extreme weat	Y		adopted by 4 counties and 35 municipalities so far		http://www.southeastfloridaclimatecompact.org/about-us/what-is-the-compact/	
Statewide coastal commission	State	New Hampshire	NH	Establishment of a Coastal Risk and Hazards Commision for New Hampshire	sea level rise	N				http://www.gencourt.state.nh.us/legislation/2013/SB0163.html	
Requires state environmental dept to update projections	State	New Hampshire	NH	Requires dept. of environmental services to update sea level rise and storm surge projectsions regularly	sea level rise, extreme weatl	N				http://www.nhcrhc.org/wp-content/uploads/2016-CRHC-final-report.pdf	
Audit of existing state policies	State	New Hampshire	NH	Requires certain state agencies to audit existing policies in coastal areas	sea level rise, extreme weatl	N				http://www.nhcrhc.org/wp-content/uploads/2016-CRHC-final-report.pdf	
Ecological											
Use vacant land for green spaces	Local	Baltimore	MD	Transform vacant land into green spaces for economic, social, environmental benefits	Other flooding, extreme wea	N		Underway		https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf
Green infrastructure construction	Local, State	Boston, Delaw	DE, MA	Adds green infrastructure to a state-owned park to mitigate impacts of climate change	Sea level rise, extreme weat	N		Underway		http://www.dnrec.delaware.gov/energy/Documents/2016%20Climate%20Action%20Progress%20Report/Climate%20Action%20in%20Delaware%202016%20Progress%20Report.pdf	https://www.boston.gov/sites/default/files/metro_boston_regional_climate_adaptation_strategy_report.pdf#page=62
Track biological inidicators of change	State	Massachusetts	MA	Develops biological indicators to track changes in ecosystems and wildlife	Sea level rise, extreme weat	N		Underway		http://www.dnrec.delaware.gov/energy/Documents/2016%20Climate%20Action%20Progress%20Report/Climate%20Action%20in%20Delaware%202016%20Progress%20Report.pdf	
Coastal impoundments	county	Flagler County	FL	Provides a "climate smart" habitat for migratory birds	Extreme weather	N		Underway		http://www.dnrec.delaware.gov/energy/Documents/2016%20Climate%20Action%20Progress%20Report/Climate%20Action%20in%20Delaware%202016%20Progress%20Report.pdf	
Adjusting wildlife management plans	local	Miami Beach	FL	Updates management planning to consider effects of climate change	Sea level rise, extreme weat	N		Underway		http://www.dnrec.delaware.gov/energy/Documents/2016%20Climate%20Action%20Progress%20Report/Climate%20Action%20in%20Delaware%202016%20Progress%20Report.pdf	
Information on applying MA coastal wetlands regulations	local	Palm Beach Cour	FL	Provides information to conservation commissions for implementing Wetlands Protection Act	Sea level rise	N		Complete		https://www.mass.gov/service-details/applying-the-massachusetts-coastal-wetlands-regulations	
Wildlife adaptation plan	State	New Hampshire	NH	Recommends conservation strategies for NH's wildlife	climate change in general	N				http://www.adaptationclearinghouse.org/resources/new-hampshire-ecosystems-and-wildlife-climate-change-adaptation-plan.html	
Promote freshwater buffer landscapes	local	Southeast Florida Regional Compact (aspirational only)	FL	Promote the protection, restoration, and creation of freshwater wetlands, open space buffer areas, and connectivity between freshwater and estuarine waters	not specified	N		recommendation only		http://www.southeastfloridaclimatecompact.org/recommendations/promote-freshwater-buffer-landscapes/	
Maintain, create, and/or restore urban tree canopy	local	56 municipalities (so far) in South Florida; Baltimore	FL, MD	Identify and invest in salt-tolerant tree species that can withstand hurricanes and provide multiple ecosystem services, such as habitat for other native species; reduce the heat island effect	Extreme weather	N		adopted by 56 municipalities so far		http://www.southeastfloridaclimatecompact.org/recommendations/ns-14/	https://www.baltimoresustainability.org/wp-content/uploads/2015/12/Chapter5_StrategiesandActions.pdf
Support coral reef protection, restoration, and sustainable-use initiatives	local	6 municipalities (so far) in South Florida	FL	Develop or promote programs encouraging behavior that mitigates negative human impacts on coral reefs; develop or enforce local regulations that reduce negative human impacts on coral reefs	Extreme weather	N		adopted by 6 municipalities so far		http://www.southeastfloridaclimatecompact.org/recommendations/ns-8/	
Other											
Climate Action in Delaware	State	Connecticut	CT	A state-led initiative to reduce greenhouse gasses and pursue climate		N		Underway		http://www.dnrec.delaware.gov/energy/Pages/Climate-Framework.aspx	
Highway corridor evaluations	State	Delaware	DE	Evaluates a critical transportation corridor that is close to the coast	Sea level rise, extreme weat	N		Underway		http://www.dnrec.delaware.gov/energy/Documents/2016%20Climate%20Action%20Progress%20Report/Climate%20Action%20in%20Delaware%202016%20Progress%20Report.pdf	
Climate change adaptation assessment	State	New York	NY	A vulnerability assessment that considers effects of climate change on New York	Sea level rise, extreme we	N		Complete		https://www.nyserda.ny.gov/About/Publications/Research%20and%20Development%20Technical%20Reports/Environmental%20Research%20and%20Development%20Technical%20Reports/Response%20to%20Climate%20Change%20in%20New%20York	

Strategy	Jurisdiction (state, county, local)	Juridiction Name	State	Objective	Hazard Type (e.g. sea-level rise, other flooding, forest fire, drought, heat island, extreme weather)	Resilience Metrics (Y/N)	Metrics Description	Status (e.g. planned/underway/complete)	Adaptation or Mitigation	Data Source 1	Data Source 2
Municipal Resilience Planning assistance	Local		CT	UConn is developing tools to help municipalities plan for sea level rise and coastal flooding	Sea level rise, extreme we	N		Underway		https://circa.uconn.edu/projects/municipal-resilience-planning/	
Planning Maine's adaptation efforts	Local/State	Maine	ME	Develop and provide tools for local/regional authorities to implement adaptation planning	Sea level rise, extreme we	N		Planned		http://www.adaptationclearinghouse.org/resources/people-and-nature-adapting-to-a-changing-climate-charting-maine-s-course.html	
Public Infrastructure assessment	State	Maine	ME	Inventory and assess public infrastructure vulnerability. Includes water infrastructure, school buildings, residential housing, telecommunications, transportation, forests	Sea level rise, extreme we	N		Planned		http://www.maine.gov/tools/whatsnew/attach.php?id=369026&an=1	
Promote community use of electric vehicles	local	Delray Beach	FL	establish electric vehicle (EV) charging stations in the downtown area	greenhouse gas emissions in	N		complete		http://www.southeastfloridaclimatecompact.org/case-studies/electric-vehicle-charging-stations/	
Hazardous waste management plan				Find examples							

Informant Interview Template

RESILIENCE STRATEGIES

INFORMANT INTERVIEW TEMPLATE

Informant Contact Information

Strategy Description (what the strategy is intended to accomplish): _____

_____

_____

Web Link: _____

Interviewee Name: _____

Phone # _____ Email:_____

Interview Date:_____

1. Has the strategy achieve the desired goals? If so, why? If not, why? (in other words, what obstacles did you encounter in achieving acceptance)? How long did it take, was it costly, what was the source of funding?

Who answered this question: _____

Response: _____

_____

_____

_____

_____

_____

2. How is/was the strategy implemented? What authority enabled you to implement it (e.g. zoning changes, design standards, infrastructure siting requirements, special district designation, state enabling legislation, special taxing authority, ordinary municipal administrative function)?

Who answered this question: _____

Response: _____

_____

_____

_____

_____

_____

3. Whose buy-in was needed to implement the strategy and how did you achieve it (e.g. public information campaign)?

Who answered this question: _____

Response: _____

_____

_____

_____

_____

_____

4. Who implements the strategy (e.g. municipal planning staff, local resilience officer, municipal engineer, finance officer, outside consultant (if so what firm?))

Who answered this question: _____

Response: _____

_____

_____

_____

_____

_____

Additional Relevant Information – i.e. link to regulations/sample ordinance (if applicable):

Who answered this question: _____

Response: _____

_____

_____

_____

_____

_____

Hello,

We at New Jersey Future consider the coastal resilience work you are doing to be highly innovative and would very much like the opportunity to talk with you about your _____project. We are currently researching resilience strategies planned or implemented at the local and regional level across the country that could potentially help coastal communities in New Jersey adapt to sea level rise and other challenges faced by climate change. Our work, being performed in conjunction with the New Jersey Department of Environmental Protection, is intended to help create the framework for a coastal resilience plan New Jersey intends to develop over the next two years.

Please let me know when you have some time within the next two weeks to discuss your experiences with the _____ project. I'll also follow up with a phone call this week with the hope of arranging a time and date certain for a call. Below is a list of the questions I'd like to ask about your project.

Questions
1. Has the strategy achieved the desired goals?
2. How long did it take and was it costly?
3. How is/was the strategy implemented, what authority enabled you to implement it?
4. Whose buy-in was needed to implement the strategy and how did you achieve it?
5. Who has chief responsibility to implement the strategy?

I look forward to hearing from you. Thank you in advance for your help.

Proposed MLUL Revisions to Incorporate Resilience

PROPOSED MLUL Modification to Incorporate Resiliency Planning

40:55D-3 Definitions

Natural hazard refers to all atmospheric, hydrologic (e.g. extreme storms, heavy precipitation), geologic (especially seismic and volcanic), and wildfire phenomena that, because of their location, severity, and frequency, have the potential to affect humans, their structures, and/or their activities adversely including but not limited to: drought; sea-level rise; extreme temperatures; flooding, and air quality impacts associated with temperature changes.

Resilience: The ability to prepare for and adapt to changing conditions; and to withstand, respond to, and recover rapidly from disruptions

Article 3. Master Plan

40:55D-28 Preparation; contents; modification.

b. The master plan shall generally comprise a report or statement and land use and development proposals, with maps, diagrams and text, presenting, at least the following elements (1) and (2) and, where appropriate, the following elements (3) through (17):

17) A resiliency plan element that: a) analyzes current and future potential of community risks and vulnerability associated with natural hazards; (b) identifies critical facilities, utilities and roadways necessary for evacuation purposes and sustaining quality of life during a disaster that must be protected and maintained in an operational state; (c) analyzes the impact of community risk and vulnerability on each component and element of the master plan; (d) describes strategies and design standards that may be implemented to reduce and/or avoid risks associated with natural hazards; (e) includes specific policy statements on the consistency, coordination, and integration of the resiliency plan element to the existing or proposed county Natural Hazards Mitigation Plan, floodplain management plan, comprehensive emergency management plan, emergency response plan, post-disaster recovery plan, and the capital improvement plan.

e. The New Jersey Department of Environmental Protection shall provide all municipalities with the most recent natural hazards projections based on the best available science. This data shall be used by municipalities when preparing or updating their master plans.