adaptation

Adaptation Tool Kit:

Sea-Level Rise and Coastal Land Use

How Governments Can Use Land-Use Practices to Adapt to Sea-Level Rise

GEORGETOWN CLIMATE CENTER
A Leading Resource for State and Federal Policy

Jessica Grannis

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Foreword

Rising sea levels in the foreseeable future present new challenges now for coastal land use planning. Local governments, which bear the largest responsibility for coastal planning, long have struggled with balancing strong demand for increasing development with protection of fragile environmental and cultural resources. State governments, too, have sometimes created special planning and regulatory bodies to address coastal issues at a larger scale. Now these same governments, in a time of diminished revenues, must consider the threats that substantial sea-level rise pose to current planning, existing development, and beleaguered ecological systems. These threats include inundation, flooding, enhanced storm surges, loss of infrastructure, destruction of wetlands and beaches, and increased risks for public health and safety. Although taking regulatory initiatives to adapt to predicted future threats can be difficult politically, it also can conserve resources, mitigate crises, and protect ecosystems.

This Tool Kit, prepared by the estimable Jessica Grannis with assistance from students in Georgetown Law's Harrison Institute for Public Law, provides local and state governments and their citizens with practical knowledge to help adapt to sea-level rise in a prudent and balanced manner. After laying out the problem in clear terms, based on current scientific consensus, the Tool Kit offers a menu of generally used legal devices that can reduce future harms. Although some approaches may require the cooperation of state or federal government (and nearly all would benefit from such cooperation), a strong theme of the Tool Kit is that local governments have significant legal authority and tools now to plan for future changes. It also recognizes that not all tools are available in or suitable for all communities, and so anticipates and supports choice of approaches by each local and state government. It seeks to empower, not direct or judge.

The Georgetown Climate Center commissioned and oversaw the preparation of this Tool Kit as part of its effort to support adaptation to climate change by states and local governments. Future Tool Kits are being developed for promoting adaptation in other sectors: for example, looking at policy tools to address urban heat. Such tools can assist with both mitigating and adapting to climate change. Additional information can be found on our Center's website. We appreciate the support of our adaptation funders, Rockefeller Foundation and Kresge Foundation, and to our core supporters, Rockefeller Brothers' Fund and the Emily Hall Tremaine Foundation, who make our work possible.

Peter Byrne, Faculty Director Vicki Arroyo, Executive Director

Author's Note

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The Georgetown Climate Center intends to update this Tool Kit to provide analysis of new tools and new examples. We will continue to receive comments from government officials, planners, regulators, academics, and others in order to ensure that this study reflects the real-world experiences of practitioners on the ground. We will revise and publish future versions of the Tool Kit incorporating expert feedback. This study presents analysis by the author; it does not represent Georgetown University or any state or local agency.

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Executive Summary

Climate change is happening. Past greenhouse gas emissions have committed us to decades of rising temperatures and seas. Recent studies, factoring in ice-sheet melt, estimate that we may experience an average of up to 6 feet of sea-level rise across the globe over the next century. The potential physical and fiscal impacts of sea-level rise (SLR) are stark. We are already seeing increasing erosion of our beaches and the inundation of low-lying wetlands. Physically, SLR will intensify impacts from storm surge, flooding, and erosion. Fiscally, governments will need to spend large amounts of money on emergency response and to rebuild flooded infrastructure. Valuable government tax base and significant private investment will literally fall into the sea. And, if governments fail to plan for these impacts, legal fallout is a certainty.

Governments have powerful reasons to begin planning and adapting now. Emergent ad-hoc responses to climate impacts will put people, property, and scarce financial resources at risk. However, governments need not invent entirely new methods to address these impacts. State and local governments have an assortment of tools that they have used to address other land-use problems (such as flooding and sprawl) that they could refashion and use to adapt. This Tool Kit describes 18 different land-use tools that can be used to preemptively respond to the threats posed by SLR (see Table 1 on the next page). This Tool Kit focuses on land-use tools that could be used to adapt to impacts to the built environment (public and private coastal development and infrastructure).

In order to devise a comprehensive strategy, governments will need to determine which tools to employ given their unique socio-economic and political contexts. To this end, we also provide policymakers with a framework for decision making. We analyze each tool by (1) the type of power exercised to implement it (planning, regulatory, spending, or tax and market-based tools); (2) the policy objective that it facilitates (protection, accommodation, planned retreat, or preservation); and (3) the type of existing or potential land uses that the tool can be used to adapt (critical infrastructure, existing development, developable lands, and undevelopable lands). Finally, we provide a top-level analysis of the trade-offs between tools—the economic, environmental, and social costs and benefits, and the legal and administrative feasibility of implementing each tool.

TABLE 1: *Synopsis of SLR Adaptive Tools*

Tool Number	Adaptation Measure	Description	Implementation to Address SLR
PLANNING TOOLS			
1	**Comprehensive Plans**	Provide the long-range planning tool used to guide future development in a community.	Considering SLR in comprehensive plans is the first step by which local governments can begin to incorporate adaptive strategies into their communities' land-use decision-making framework. Studies and evidence used to amend comprehensive plans can serve as the evidentiary support needed to amend zoning ordinances.
REGULATORY TOOLS			
2	**Zoning and Overlay Zones**	Provide the legal framework that governs the use and development of land in a community. Zoning maps divide the community into different districts based upon the types of uses that are permitted (e.g., residential, commercial, or industrial). Then, within each zone the ordinance specifies the design requirements that govern development (e.g., setbacks, building heights, building densities). Overlay zones superimpose additional regulations on an existing zone based upon special characteristics of that zone (e.g., floodplains and historic districts).	As a necessary predicate to implementing most land-use tools, local governments will need to amend their zoning ordinances to designate areas that are vulnerable to impacts and to impose special regulations on those areas. Special regulations could prohibit or limit expansion or major renovation to existing structures and rebuilding of damaged structures. Governments could create zones based upon their adaptation goals (protection, accommodation, retreat, or preservation).
3	**Floodplain Regulations**	As a requirement to participate in the National Flood Insurance Program (NFIP), local governments must impose minimum regulation on development in floodplains (generally delineated as the 100-year floodplain). Typically structures in these areas must be constructed to minimize flood damage (e.g., elevated).	Governments could impose additional restrictions on development in floodplains above NFIP minimum standards. Governments could impose use restrictions in the 100-year floodplain (e.g., limit permitted uses to low-density, large-lot residential, agricultural, or recreational uses). Governments could also begin to impose design requirements in the 500-year floodplain (e.g., requirements that structures be elevated).
4	**Building Codes and Resilient Design**	Establish requirements for building construction to maximize protection from flooding (e.g., elevation and construction techniques and materials).	Governments can extend building code regulations to properties in the 500-year floodplain and require that new structures be designed to be more resilient to flood impacts. Governments can require that structures in the 100-year coastal floodplain be further elevated or strengthened to account for increased coastal flooding from SLR over the life of the structure.

TABLE 1: *Synopsis of SLR Adaptive Tools [continued]*

Tool Number	Adaptation Measure	Description	Implementation to Address SLR
5	**Setbacks/Buffers**	Require that development be set back a distance from a baseline, typically a shoreline feature (e.g., high water mark, bluff crest, or vegetative line). Require landowners to leave, in their natural state, portions of property that support natural and beneficial functions (such as wetlands that prevent runoff and flooding).	Governments could establish or increase mandatory setbacks from the coast, establish setbacks based upon projected shoreline position using calculations of increased flood and/or erosion rates, or create a tiered setback system permitting smaller structures with less of a setback and requiring greater setbacks for larger development. Governments could require that development adjacent to the shore leave buffers to provide natural protection to development while allowing for upland migration of beaches and wetlands.
6	**Conditional Development and Exactions**	Impose special conditions as a condition of a development permit. Conditions can be designed to mitigate the impacts of development, and can take the form of impact fees, land-use restrictions, and dedications of lands for public purposes.	Governments can use conditions to restrict landowners' rights to build hard coastal protection, require removal of structures that come to be inundated as the shoreline recedes, require dedication of coastal buffers, require impact fees to pay for emergency response costs or to mitigate impacts from coastal armoring, or require that structures have greater levels of flood protection.
7	**Rebuilding Restrictions**	Limit a property owner's ability to rebuild structures destroyed by natural hazards, such as flooding.	Governments can limit when and how structures are rebuilt by prohibiting reconstruction, requiring that structures be rebuilt using resilient design techniques, or conditioning redevelopment on a landowner's agreement not to armor in the future.
8	**Subdivision and Cluster Development**	Require the concentration of development in desirable areas using subdivision ordinances. These programs allow developers to increase densities in specified areas in exchange for the developer's agreement to designate open space.	Governments could encourage concentration of development in upland areas and require dedication of vulnerable areas as open-space and flood buffers.
9	**Hard-Armoring Permits**	Use permitting processes to regulate the construction of hard-engineered structures that provide flood and erosion control.	It may be necessary to harden the coast where there is considerable existing development or critical infrastructure. However, governments can limit hard armoring along vulnerable coastlines with sensitive ecosystems, require that the armoring be constructed to protect against storm surge combined with increased sea levels, and require mitigation where armoring is permitted.
10	**Soft-Armoring Permits**	Facilitate "soft" coastal protection projects that replenish or mimic natural buffers, such as beach nourishment, living shorelines, or wetlands restoration.	Governments could create permitting programs to require the use of soft-armoring techniques where feasible in order to lessen environmental impacts of shoreline armoring.
11	**Rolling Coastal Management/ Rolling Easement Statutes**	Combine different land-use regulations that serve to ensure that coastal development does not impede the natural inland migration of coastal resources.	Rolling coastal management statutes can limit new development in at-risk coastal areas, limit or prohibit the construction of hard-coastal armoring, require removal of structures that come to encroach on public lands due to erosion, and require real estate disclosures.

TABLE 1: *Synopsis of SLR Adaptive Tools [continued]*

Tool Number	Adaptation Measure	Description	Implementation to Address SLR
SPENDING TOOLS			
12	**Capital Improvement Programs (CIPs)**	Guide future investments in public infrastructure based upon projections of the community's growth.	Governments can use CIPs to site new infrastructure out of harm's way, discontinue maintenance and repair of infrastructure that is repetitively damaged, or relocate or retrofit existing infrastructure to be more resilient to SLR.
13	**Acquisitions and Buyout Programs**	Acquire property at risk from flooding or other hazards. Structures are typically demolished and the property is restored. Undeveloped lands are conserved as open space, public parks, or for natural resources.	Governments could extend floodplain buyout programs to properties threatened from SLR and could prioritize for acquisition vulnerable properties with high natural resource value. Governments could prioritize for acquisition lands with potential to serve as flood buffers for existing development and potential to serve as corridors for migrating beaches and wetlands.
14	**Conservation Easements**	Provide a flexible mechanism by which public entities can preserve land in its natural state while allowing land to remain in private ownership. Landowners grant an easement agreeing to restrict development of the land often for compensation or tax benefits.	Governments could prioritize acquisition of easements on properties vulnerable to SLR and acquire conservation easements to ensure preservation of lands that could serve as flood buffers, habitat, or migration corridors.
15	**Rolling Conservation Easements**	Adapt conservation easements to provide a rolling boundary that is designed to preserve the ability of the shoreline to migrate inland.	Rolling easements could be used to purchase any rights that landowner may have to construct coastal armoring and to require owners to remove structures that become threatened by rising seas and erosion while allowing for some upland development of the property.
TAX AND MARKET-BASED TOOLS			
16	**Tax incentives**	Encourage preferred development patterns and can take the form of preferential assessment programs, tax abatements, and tax credits.	Governments can encourage conservation of vulnerable properties by taxing properties at a lower rate based upon its restricted "use value;" encourage relocation or retrofit of flood-prone properties by providing a one-time tax credit; or encourage upland infill development by providing tax credits or streamlined permitting.
17	**Transfer Development Rights**	Restrict development in one area ("sending area") and allow for the transfer of development rights to another area more appropriate for intense use ("receiving area").	Governments could restrict development in vulnerable areas and allow for transfer of development rights to upland parcels where development will be out of harm's way.
18	**Real Estate Disclosures**	Require sellers of real estate to disclose certain property defects to prospective buyers prior to close.	Governments can compile and disseminate information about a property's vulnerability to SLR, or require sellers to disclose if a property is located in an area vulnerable to SLR.

I. Introduction

Statement of the Problem

Climate Change Impacts

Climate change is happening.[1] Regardless of today's mitigation efforts, past emissions levels have committed us to decades of rising seas.[2] Recent estimates project that global sea levels may rise an average of approximately six feet over the next century.[3] These estimates are based on new studies factoring in ice sheet melt dynamics that were not considered by previous studies generated by the Intergovernmental Panel on Climate Change (IPCC).[4] These estimates also do not account for regional variability; impacts will be worse in certain parts of the United States because of land subsidence and other factors.[5]

The potential physical and fiscal impacts of sea level rise (SLR) are stark. Physically, SLR will inundate large areas of the coast and exacerbate flooding and erosion.[6] Climate change is also anticipated to increase the intensity of large storm events (such as hurricanes and nor'easters), which will drive storm surge further inland.[7] Rising seas will inundate and drown existing wetlands and erode coastal beaches and barrier islands.[8] Species that live in these vulnerable habitats will be threatened.[9]

Fiscally, governments may be forced to spend large amounts of money on emergency response, insurance payouts,[10] and rebuilding flooded infrastructure. Economic activities may be disrupted. Valuable government tax base and significant private investment may literally fall into the sea.

For example, the Virginia Middle Peninsula Planning District Commission completed an analysis of the economic impacts that one foot of SLR will cause to its constituent counties. In one small town, New Point Comfort, it estimated that one foot of SLR will destroy 72 homes and their septic systems and a quarter mile of road, causing $17.8 million in damage.[11] Across all six counties within the District, it estimated between $212 million and $249 million of damage.[12] If these costs are extrapolated across all 29 coastal counties, Virginia is facing roughly $5 billion in damage from one foot of SLR (a rate below the lowest scenario of SLR for the state).

What is less clear is how people will respond to these threats. Historically, landowners facing flood risks have built protective structures, to the detriment of natural resources. In Florida, after being battered by Dennis, a category 3 hurricane, landowners demanded the right to protect themselves from the sea. Feeling the pressure, local governments permitted temporary protective measures, which resulted in the construction of 15-foot steel sea walls along 26 miles of the Florida coast.

Landowners became embroiled in lawsuits against local, state, and federal officials. State officials were forced to intervene because sea walls have the effect of compounding flood risk; they erode beaches and drown the wetlands that serve as natural buffers. The U.S. Fish and Wildlife Service also intervened because the sea walls were preventing endangered sea turtles from reaching their nesting beaches.[13]

As shown in Florida, reactive, ad hoc responses to impacts can provoke lawsuits between landowners seeking to protect their private property and public entities seeking to preserve natural resources. Landowners whose land values are diminished challenge new land-use regulations by arguing that government has "taken" their property without just compensation (so called "takings challenges").[14] Litigation can also be provoked between landowners, as one owner's protective structure exacerbates flooding and erosion to adjacent properties and causes damage. To avoid these potential conflicts, it is imperative that governments begin planning and adapting now.

How Governments Can Respond to Impacts

The recent hurricanes in the Gulf Coast demonstrated the dangers of an unplanned response to natural hazards. SLR will increase the vulnerability of coastal communities to hazards such as flooding and hurricanes. This could pose serious economic, social, and environmental consequences. How society responds to SLR may exacerbate these consequences if we fail to implement measures to adapt to the inevitable physical changes that we are beginning to see along our coasts.[15] In order to make a plan to adapt, policymakers will need to choose from a wide variety of potential responses—each with its own costs and benefits.

Government responses can be categorized in two ways: (1) reactive or proactive responses and (2) structural or non-structural responses.

Government responses can be categorized in two ways: (1) reactive or proactive responses and (2) structural or non-structural responses.[16] Communities that respond proactively have more flexibility. First, reactive responses are actions that a government takes *after* impacts have already occurred. Reactive response can include rebuilding restrictions, requirements that rebuilt structures be retrofit to be more resilient to impacts, and buyouts of lands with damaged structures.[17]

Reactive responses also frequently utilize *structural solutions.* Traditionally, property owners have managed flood and erosion with engineered structures like the sea walls ("armoring") built in Florida.[18] However, decision makers are increasingly recognizing the limitations and impacts of armored solutions. Armoring is costly to build and maintain and can increase flooding and erosion of neighboring properties. Armoring can increase risks from catastrophic failure because it facilitates development in vulnerable areas (as demonstrated by the failure of levees in New Orleans during Katrina).[19] Armoring also has damaging environmental impacts to beaches and wetlands.[20]

Alternatively, a proactive response involves advance planning and implementation of measures that are designed to preemptively mitigate the negative consequences from natural hazards and human responses to those hazards. By engaging in proactive planning, governments can facilitate the use of *non-structural* solutions to protect against risks.[21] Non-structural solutions include using land-use measures to ensure that development is more resilient to flooding and erosion, and to reduce the cost and difficulty of a long-term retreat strategy.[22]

Proactive non-structural solutions are often more cost effective over the long term and less environmentally damaging than reactive responses.[23] Communities can use these tools to limit their exposure to hazards, save lives, limit public expenditures on armoring and emergency response, and protect valuable natural resources that provide natural flood protections and other environmental services.[24] Although implementing proactive measures may cost more in the short term, over the long term, as impacts increase, proactive adaptation can yield significant cost savings.[25]

While beneficial, changing long-term land-use patterns requires significant advance planning.[26] In order to effectively reduce risks, governments will need to determine their vulnerabilities, identify appropriate responses, and

begin altering how they regulate development now. In the aftermath of a disaster, decision makers face significant political pushback against new regulations. This Tool Kit will help policymakers identify and weigh different solutions so that they can plan for and begin to adapt to SLR before impacts occur.

The Difficulty of Adaptation Planning

Recognizing the risks posed by climate change, many coastal state and local governments have begun or completed plans to adapt.[27] However, these plans expose the numerous obstacles facing decision makers. Many plans propose broad adaptation policies, but lack specific guidance on how adaptation policies can be implemented on the ground. State and local governments are facing significant budget shortfalls and often cannot dedicate staff to address adaptation planning on top of their ordinary work load.[28]

Adaptation planning is challenging for many reasons. Climate science is technical and complex; global climate models consider a multitude of variables to project future scenarios. The projected rate of SLR varies under each scenario; and the rate and degree of SLR will depend on the rate of future greenhouse gas emissions, the rate of increases in temperature, and ice sheet melt, among other things.

Additionally, some areas of the coast will be much more vulnerable to SLR impacts than others. Some areas of the coast are particularly low-lying or have highly erosive beaches.[29] SLR will vary based upon local conditions—groundwater withdrawal, extraction of oil and gas, and other geologic factors are causing land to subside in certain regions.[30] As a result, scientists are uncertain about the extent of SLR and the time period over which it will occur, especially at local and regional levels.[31]

FIGURE 1: *Sea Walls (Dothan, Alabama)*

The sea wall on the right reflects wave energy and exacerbates erosion on the adjacent properties. Source: Advanced Coastal Technologies, LLC, Dothan, Alabama. Used with permission.

Although there are reams of reports written about the science of climate change, its impacts, and potential responses, little of this information is written or organized to help decision makers actually make decisions on the ground. Most reports are technical and focus on impacts from a global or national perspective. Few, however, help decision makers understand how their particular locality will be affected. Even fewer help them effectively identify and evaluate which policy options to adopt in their local context.

The Difficulty of Implementing Adaptive Measures

Decision makers face even more barriers when moving from the planning stages to actually beginning to *implement* adaptive actions. Politically, decisions affecting property rights are always controversial. Property owners facing increased flooding and loss of land expect to be able to protect their property and their investments. However, governments that fail to require adaptation will be requiring the community as a whole to pay for the costs of protecting some coastal properties. Taxpayer money will need to be used to provide emergency response to flooded communities and to rebuild flooded infrastructure.[32] Private protective measures may destroy natural resources that provide important public benefits. Beaches and wetlands serve as natural flood buffers[33] and habitats for endangered species. Wetlands also filter polluted runoff. The public uses beaches for recreation, and beaches generate significant tourist revenues. When implementing adaptation measures, governments will have to balance these public and private trade-offs.

Legally, governments face even more challenges. In order to implement a particular measure, governments face many legal questions:

- Does the government have adequate legal authority to take action?
- Is this action consistent with other state, and federal laws?
- Are there federal, state or other entities with competing powers or overlapping jurisdiction over impacted resources?
- Could implementation of a policy prompt litigation and could a community be liable for failing to act?
- Is this action constitutional? Could this action be challenged as a regulatory taking under the Fifth Amendment?[34]

These legal uncertainties are stymieing government action.

This Tool Kit seeks to help governments overcome these challenges by identifying existing land-use tools. Adapting to climate change will not require governments to reinvent how they regulate. State and local governments already use a multitude of tools to manage development in their communities. These tools have been used to effectively address other land-use problems, such as urban sprawl and flooding. Governments may be able to minimize the complexities of adapting by using existing powers in new ways.[35]

Purpose and Methodology

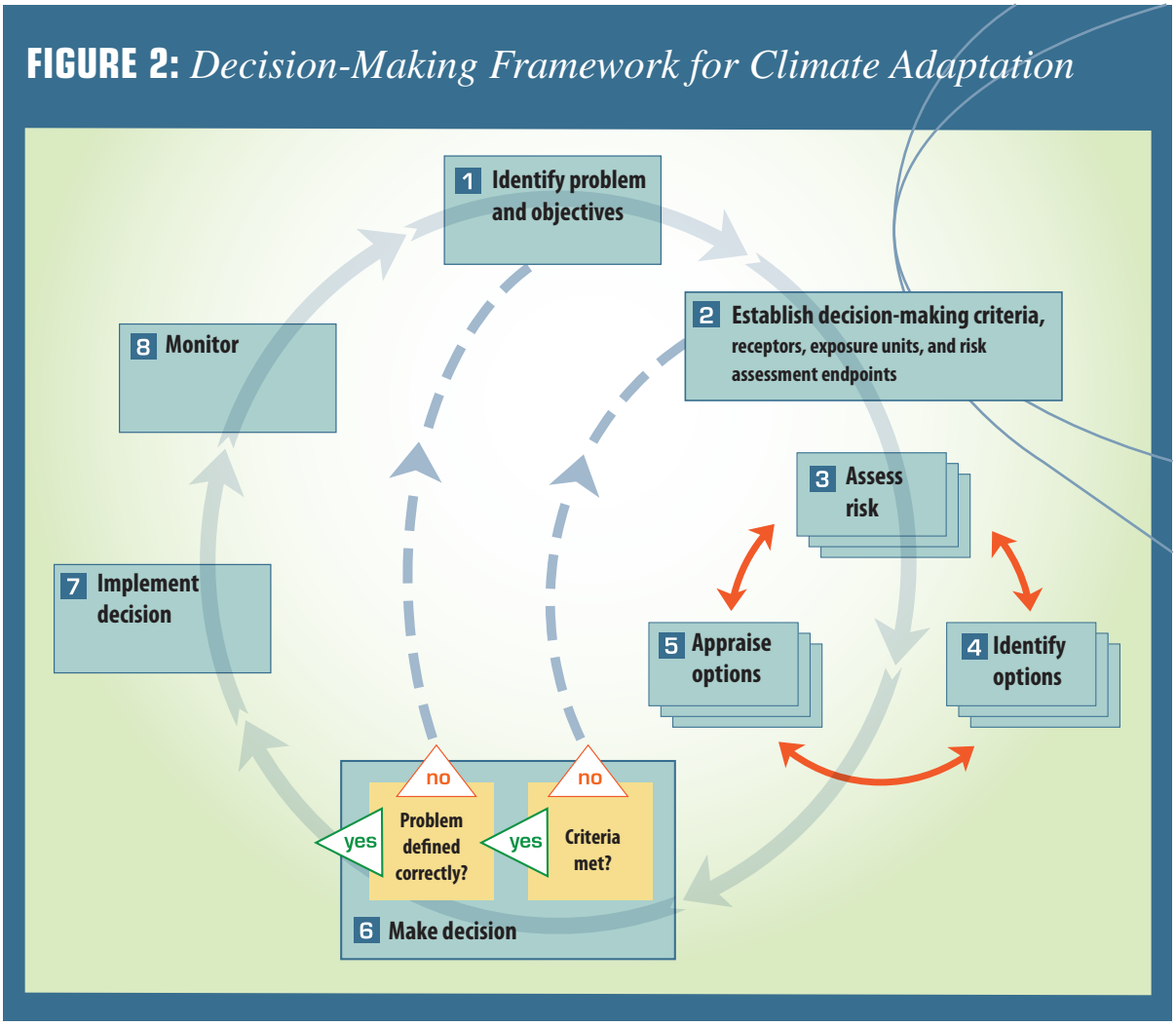
This Tool Kit is designed to help policymakers manage the complexity of adaption by identifying and organizing adaptation tools. The purpose of this Tool Kit is to help state and local planners identify potential responses after they have assessed their jurisdictions' risks and vulnerabilities to SLR. We identified 18 tools by surveying the recommendations in state adaptation plans and federal reports. We focused on land-use tools that could be used to adapt to impacts to the built environment (public and private coastal development and infrastructure). For each tool, we describe the tool, how it can be used to facilitate adaptation, the sources that have proposed use of the tool for adaptation purposes, and examples of programs that have implemented the tool. Most of the example programs were designed to address *other* land-use problems, such as flooding or sprawl, and were not specifically designed to address SLR (with a few exceptions). Finally, we provide a top-level analysis of the advantages and disadvantages of each tool to help state and local decision makers begin to evaluate trade-offs.

This document is designed for state and local decision makers.[36] Although climate change is a global phenomenon, adapting to its impacts will occur primarily at a state and local level.[37] Local governments (often with state-level oversight and support) are charged with making the basic land-use decisions needed to protect the health, safety, and welfare of their citizens. These powers will be essential to implementing responses to climate change.[38]

By identifying the recommended tools, we hope to provide policymakers with a clear layout of the options available to them. This document is not intended to be a complete analysis of *all* the potential responses to SLR. It is a starting point. In developing plans and deciding how to implement different policy options, state and local governments will need to evaluate the trade-offs between options and begin to implement chosen options.

Figure 2 demonstrates the process policymakers go through in developing climate adaptation plans.[39] In the planning stage (stage 4), this Tool Kit will help policymakers to identify the options to consider. It also will help them begin to choose between options (stage 5) and determine which tools to implement in their particular local context. For governments that have completed a plan, this Tool Kit can help policymakers figure out potential obstacles they may face in implementing measures on the ground (stage 7). For example, this Tool Kit can help entities figure out if they already have legal authority to implement a tool, or if they need to seek additional authority from their legislature or governing body.

FIGURE 2: *Decision-Making Framework for Climate Adaptation*



Source: United Kingdom Climate Impacts Programme (UKCIP). Used with Permission.

Framework for Decision-Making

In Chapters II through V, we provide a detailed description of each tool. However, identifying the potential responses is only half the battle. To create a coherent response, decision makers will need to decide which tools to implement given their jurisdictions' unique geographic, political, and legal context. Therefore, in this section we provide a framework to help decision makers compare different policies as they consider local needs. We have organized the various tools based upon different factors relevant to state and local decision makers:

- Advantages and disadvantages (economic, environmental, social, administrative, and legal).
- The type of power exercised to implement the tool (planning, regulatory, spending, or tax and market-based).
- The community's coastal adaptation goals (protection, accommodation, retreat, or preservation).
- The state of development on the land that is at risk (critical infrastructure, developed lands, developable lands, or undevelopable lands).

Advantages and Disadvantages

Decision makers will need to evaluate the trade-offs among policies. For each tool, we provide an overview of the advantages and disadvantages that may support or hinder its implementation. We analyze each tool in terms of the following ***evaluation criteria***.[40] These criteria will help decision makers evaluate which policies they want to implement based upon how they value the trade-offs:

Decision makers will need to evaluate the trade-offs among policies.

Economic criteria—how well the tool maximizes long-term economic benefits (both public and private) and minimizes economic costs, considering the costs to implement (build and maintain); how well the tool minimizes loss of taxable land and critical infrastructure (see definition below); and how well the tool minimizes economic disruption.

Environmental criteria—how well the tool minimizes impacts on natural resources, ecosystems, and the environment (including water quality, wetlands, and habitat); maximizes benefits to natural resources, ecosystems, and the environment; and reduces greenhouse gas emissions ("mitigation co-benefits").[41]

Social criteria—how well the tool maximizes protection of people; maximizes protection of public health, safety, and welfare; minimizes potential loss of life; minimizes disruption of public services; minimizes impacts to cultural resources; maximizes protection of vulnerable low-income populations; equitably distributes the economic costs and benefits between private individuals and the public; and minimizes social disruption.[42]

We also evaluate each tool based upon two ***governance criteria*** that examine threshold questions necessary to determining whether a government can feasibly implement a tool:

Administrative criteria—how easily the tool can be implemented considering technical feasibility, fiscal capacity, administrative capacity, administrative complexity, and political feasibility; how flexible the tool is in response to a range of climate change scenarios and hazards; [43] and whether there are existing programs or sources of funding that can support implementation of the tool.

Legal criteria—whether the tool can be implemented using existing authorities; whether there are potential legal barriers or liabilities; and whether the tool helps avoid potential liabilities.[44]

For each tool, we provide a top-level qualitative analysis of the advantages and disadvantages using the following coding:

Advantageous (+)	The tool maximizes benefits and is feasible.
Neutral (~)	The tool may present some disadvantages or some feasibility problems.
Disadvantageous (!)	The tool may be difficult to implement because of costs or infeasibility.

This chart is designed to give policymakers a framework for evaluating options; it is not intended to be scientific, but merely didactic. The costs and benefits and feasibility of a particular tool will vary based upon the particular geographic, political, and legal characteristics of the jurisdiction trying to implement the tool. A tool that faces obstacles in one community may be supported in another. Therefore, decision makers will need to evaluate each tool within their own particular local context.

TABLE 2: *SLR Responses and Evaluation Criteria*

Potential Responses	Evaluation Criteria			Governance Criteria	
	Economic	Environmental	Social	Administrative	Legal
PLANNING TOOLS					
1. Comprehensive Plans*	*	*	*	*	*
REGULATORY TOOLS					
2. Zoning and Overlay Zones*	*	*	*	*	*
3. Floodplain Regulations*	*	*	*	*	*
4. Building Codes and Resilient Design	~	~	~	~	+
5. Setbacks/Buffers	~	+	~	~	~
6. Conditional Development and Exactions	~	+	+	~	~
7. Rebuilding Restrictions	~	+	~	~	~
8. Subdivisions and Cluster Development	+	+	~	~	+
9. Hard-Armoring Permits	!	!	~	~	~
10. Soft-Armoring Permits	~	~	~	~	~
11. Rolling Coastal Management / Rolling Easement Statutes	~	+	~	~	!
SPENDING TOOLS					
12. Capital Improvement Programs	~	+	~	~	~
13. Acquisitions and Buyout Programs	!	+	~	~	+
14. Conservation Easements	+	+	+	~	~
15. Rolling Conservation Easements	~	~	+	!	!
TAX AND MARKET-BASED TOOLS					
16. Tax and Other Development Incentives	~	+	+	~	~
17. Transferable Development Credits	+	+	+	!	+
18. Real Estate Disclosures	~	~	~	~	~

* Local governments typically must adopt a comprehensive plan and zoning ordinance (tools 1 and 2) in order to regulate land use in their communities and, for communities participating in the NFIP, a floodplain ordinance to regulate development in areas vulnerable to flooding (tool 3). In order to implement any of the adaptive measures discussed in this Tool Kit, local governments will need to update these plans and ordinances. Because these are essential elements of regulating, we do not analyze their advantages or disadvantages. Instead, we provide strategies for how local governments can incorporate consideration of SLR into these legal frameworks to both facilitate adaptation generally and as a necessary predicate to the use of the other discretionary tools (tools 4-18).[45]

Organization by Power

In order to create a politically palatable adaptation strategy, governments will need to employ a combination of regulatory measures and market-based incentives.[46] Regulatory measures may provide the most expedient solution, but they can also be perceived as unfair by regulated parties. Governments may have difficulty building political will to impose such measures.[47] While market-based incentives can be more politically palatable, they are often more expensive and difficult to administer than regulatory measures.[48] Therefore, we classify each tool based on the type of *power* exercised to implement it: (1) planning tools, (2) regulatory tools (e.g., zoning, subdivision, building ordinances), (3) spending tools, and (4) tax and market-based tools.[49]

In order to create a politically palatable adaptation strategy, governments will need to employ a combination of regulatory measures and market-based incentives.

The first two sections identify tools implemented through ***planning*** and ***regulatory powers***. Local governments are charged with regulating the use and development of land in their communities.[50] They use a combination of planning and regulatory tools:

- ***Comprehensive plans*** (sometimes called general plans or master plans) establish the general guidelines for how a community aspires to develop over time. In most jurisdictions, comprehensive plans do not have the force of law,[51] but are legally implemented through zoning ordinances.
- ***Zoning ordinances*** specify the particular uses that are permitted in different districts (e.g., residential, commercial, or industrial); and the design requirements for development in each district (e.g., building size, height, location, and floor space).[52]
- ***Subdivision ordinances*** govern the division of large tracts of land into separate lots and the design requirements for the development of each lot. Unlike traditional zoning regulations, subdivision ordinances often require developers to provide for the necessary infrastructure to support the new development.[53]
- ***Building codes*** specify how structures are built; they specify the building standards and the materials that must be used, among other things.[54]

State and local governments can also promote adaptation through their ***spending powers***. By strategically directing funding for infrastructure (e.g., roads, sewers, and utilities), governments can greatly influence how their communities develop. Rather than expand infrastructure in undeveloped coastal areas, governments can encourage development in already urbanized areas by expanding and retrofitting existing infrastructure.[55]

Finally, governments can encourage "smart" or "safe" development through ***incentives***.[56] Preferential tax assessments can be used to encourage landowners to preserve vulnerable properties that are not currently developed. Tax credits can be used to encourage property owners to retrofit or relocate structures above current regulatory minimums. Local governments can also allow developers to build extra units ("density bonuses")[57] when they build in already developed upland areas that are supported by infrastructure ("infill development"). Incentives can be used as a politically neutral tool to encourage adaptation as an alternative to compelling adaptation through regulatory measures.

Some of the tools discussed are a hybrid between regulation and incentive. For example, local governments offer density bonuses through a regulatory permitting process. However, instead of compelling a certain type of land use, they offer an incentive to developers to encourage a desirable type of development. Similarly, local

governments implement transfer development credit (TDC) programs through zoning ordinances, but TDCs use market mechanisms, similar to density bonuses, to encourage development in certain desirable areas. Real estate disclosures can also be mandated through regulations, but their purpose is to allow buyers to make informed investment decisions.

Organization by Goal

In order to implement a comprehensive strategy, policymakers will need to establish their overall adaptation goals for different regions, areas, and types of property. For example, where SLR threatens dense development, decision makers may choose to adopt a protection policy (allowing armoring) even though that policy may have detrimental environmental impacts. However, in an area with sparse residential development, a decision maker may opt for a planned retreat strategy, choosing to relocate structures upland. Therefore, each tool is identified based upon the type of goal it would promote: (i) protection, (ii) accommodation, (iii) retreat, or (iv) preservation.[58]

- ***Protection goal***—prioritizes protecting people, property, and infrastructure from SLR impacts; protection policies typically use hard-engineered solutions to prevent impacts.

TABLE 3: *SLR Responses by Adaptation Goal*

Potential Responses	Goals			
	Protect	Retreat	Accommodate	Preserve
PLANNING TOOLS				
1. Comprehensive Plans	✔	✔	✔	✔
REGULATORY TOOLS				
2. Zoning and Overlay Zones	✔	✔	✔	✔
3. Floodplain Regulations	✔	✔	✔	✔
4. Building Codes and Resilient Design			✔	
5. Setbacks/Buffers			✔	✔
6. Conditional Development and Exactions		✔	✔	
7. Rebuilding Restrictions		✔		
8. Subdivisions and Cluster Development			✔	✔
9. Hard-Armoring Permits	✔	✔	✔	
10. Soft-Armoring Permits		✔	✔	
11. Rolling Coastal Management / Rolling Easement Statutes		✔		
SPENDING TOOLS				
12. Capital Improvement Programs	✔	✔	✔	✔
13. Acquisitions and Buyout Programs		✔		✔
14. Conservation Easements		✔		✔
15. Rolling Conservation Easements		✔	✔	
TAX AND MARKET-BASED TOOLS				
16. Tax and Other Development Incentives		✔	✔	✔
17. Transferable Development Credits		✔	✔	✔
18. Real Estate Disclosures		✔	✔	

- ***Accommodation goal***—allows continued development of new structures but manages risks by conditioning development to require that structures be built or retrofit to be more resilient to SLR impacts and by limiting shoreline armoring.
- ***Planned retreat goal***—limits armoring, discourages development and redevelopment in threatened areas, *and* plans for the eventual relocation of structures inland, as properties become threatened by SLR.
- ***Preservation goal***—preserves and enhances lands for natural resource and habitat values; for lands at risk from SLR, the preservation objective could limit development of land surrounding wetlands and beaches to allow for their inland migration as the seas rise.

Organization by Existing and Potential Land Uses

In choosing tools, policymakers will also need to consider the characteristics and state of development of the individual properties or areas that are at risk. Areas where there is critical infrastructure or existing development pose different challenges and require different solutions than undeveloped areas. Therefore, we classify each tool based upon its utility given the existing or potential uses for the land: (1) critical infrastructure, (2) developed lands, (3) developable lands, and (4) undevelopable lands.[59]

Policymakers will also need to consider the characteristics and state of development of the individual properties or areas that are at risk.

- ***Critical infrastructure*** is infrastructure that a government defines as "critical" to the health, safety, and convenience of its community. Critical infrastructure could include highways, bridges, public transport, airports, ports, water treatment facilities, and other structures that provide important public services.[60] In these cases, policymakers will likely have to consider the valuable services provided by the infrastructure and confront the trade-offs between the economic and environmental costs of protecting that infrastructure or phasing out its use over time.
- ***Developed lands*** (residences, businesses, etc.) have existing non-critical public and private development. In these areas, policymakers may wish to allow some degree of protection, but they may also consider planned retreat options (e.g., limits on armoring or rebuilding).
- ***Developable lands*** (such as subdivided parcels) are currently undeveloped but have high potential for future development in the near term. In these areas, policymakers will need to determine what areas can sustain development, what limitations they can place on development, and what areas they should seek to preserve.
- ***Undevelopable lands*** (e.g., floodways, beaches, wetlands) have less potential for development because of various regulatory restrictions and are likely to remain undeveloped in the future. Policymakers may wish to focus exclusively on preserving and enhancing the ecosystem and habitat values of these areas or surrounding areas.

TABLE 4: *SLR Responses and Status of Development*

Potential Responses	Existing and Potential Land Use			
	Critical Infrastructure	Developed Areas	Developable Areas	Undevelopable Areas
PLANNING TOOLS				
1. Comprehensive Plans	✔	✔	✔	✔
REGULATORY TOOLS				
2. Zoning and Overlay Zones	✔	✔	✔	✔
3. Floodplain Regulations	✔	✔	✔	✔
4. Building Codes and Resilient Design	✔	✔	✔	
5. Setbacks/Buffers	✔		✔	
6. Conditional Development and Exactions		✔	✔	
7. Rebuilding Restrictions	✔	✔		
8. Subdivisions and Cluster Development			✔	
9. Hard-Armoring Permits	✔	✔		
10. Soft-Armoring Permits		✔	✔	
11. Rolling Coastal Management / Rolling Easement Statutes		✔	✔	
SPENDING TOOLS				
12. Capital Improvement Programs	✔	✔	✔	
13. Acquisitions and Buyout Programs		✔	✔	✔
14. Conservation Easements			✔	✔
15. Rolling Conservation Easements		✔	✔	
TAX AND MARKET-BASED TOOLS				
16. Tax and Other Development Incentives		✔	✔	✔
17. Transferable Development Credits		✔	✔	
18. Real Estate Disclosures		✔	✔	

II. Planning Tools

1. Comprehensive Plans

Policy Goal: All

Type of Land Use: All

Note: For a description of goals and uses, see pp. 13-14.

Comprehensive plans (sometimes called "master plans" or "general plans") are a powerful tool by which local governments guide development. Comprehensive plans are a long-range planning tool. They present a community's vision for its desired future development over 15 to 20 years. In the plan, local governments map present conditions by identifying the location and character of lands and facilities. Based upon studies of population growth and development trends, a plan designates areas for future development, preservation, and proposed public improvements, among other things. Plans typically do not have a direct legal effect,[61] but they are implemented through a legally enforceable zoning ordinance and maps.[62]

Implementation of Comprehensive Plans in a SLR Context

As a first step to implementing adaptation tools, local governments will need to amend their comprehensive plans. Comprehensive plans can be a powerful tool by which local governments can begin to incorporate recommendations from adaptation plans into the local framework for making land-use decisions.[63] Through comprehensive plans, local governments can accomplish the following:

- Establish the degree of SLR and time period to be considered when making land-use decisions (e.g., one foot by 2035).
- Study and identify potential SLR impacts (e.g., erosion, flooding, high wind, wave action, and storm surge).
- Assess vulnerabilities (by area, number, and type of structures, occupancies, and types of impacts).
- Designate areas requiring special protection (such as wetlands, beaches, and floodplains). For example, planners can designate "retreat zones" where landowners could be subject to limits on armoring and rebuilding.
- Site future public infrastructure outside of vulnerable areas (such as roads and water treatment facilities).
- Identify the specific land-use tools that will be used to respond to SLR threats in different areas.
- Create a schedule for implementation.[64]

Studies used to assess vulnerabilities will then serve as the evidentiary justification when local governments amend their zoning ordinances to implement specific adaptive responses. When re-zoning property, studies completed to update the plan will show the specific threats to public health and safety posed by SLR. They can also be used to build public support for measures by demonstrating the community's vulnerabilities.

Local governments could also consider recommendations from other state and local plans developed to comply with different federal programs. Several federal statutes require the preparation of plans in order to be eligible to receive federal grants, and governments can consider SLR in these plans. For example, the Coastal Zone Management Act (CZMA) establishes a voluntary federal-state partnership where the National Oceanic and Atmospheric Administration works closely with states and territories to develop and implement coastal management programs (CMPs). CMPs are designed to balance competing demands on coastal resources, such as economic development and conservation.[65] The CZMA explicitly calls on state governments to consider SLR in their CMPs.[66] Some states require local governments to adopt shoreline plans or local coastal plans that are consistent with the state's CMP.[67]

The Federal Emergency Management Agency (FEMA) also offers competitive grants to state and local governments to help them develop Hazard Mitigation Plans (HMPs). Using HMPs, governments develop a framework to lessen or avoid damages from natural disasters, such as floods and storms (disasters that may be exacerbated by SLR). Once governments have adopted a HMP, they are eligible to receive additional funds in the event of a disaster to implement mitigation activities. Projects can include property acquisition and structure demolition or relocation, structure elevation and retrofitting, and minor localized flood reduction projects.[68]

Local governments could include recommendations developed in CMPs and HMPs into their comprehensive plans to ensure that the recommendations get implemented when land-use decisions are made.[69]

States can also help local governments incorporate an SLR into their comprehensive plans in several ways. Legislatures can amend their enabling statutes to specifically authorize or require local governments to consider climate impacts in comprehensive and other plans. Because the full effects of SLR may not be felt for several decades, legislatures could encourage or require that local governments use an extended planning time frame (e.g., planning for future development over the next 50 years, rather than the current practice of only planning for the next 10 to 20 years). State agencies could provide guidance about what impacts local governments should plan for and what strategies they should consider in their comprehensive plans. State governments could facilitate better planning by developing inundation models and maps and establishing state-wide or regional estimates of projected SLR over specific time-frames.

States can also help local governments incorporate SLR into their comprehensive plans in several ways.

State and Federal Sources Proposing Use of Comprehensive Plans in SLR Context

The ***California Climate Adaptation Strategy*** ("Adaptation Strategy") recommends that local governments "in coordination with the Coastal Commission … begin to develop amended [local coastal plans] that include climate change impacts,"[70] and that local governments and regional organizations begin to coordinate "to provide for regional adaptation planning."

The ***Florida Governor's Action Team on Energy and Climate Change*** ("Action Team") recommends that its "local, state, and regional comprehensive plans should be amended, based on best available data, to include goals, objectives, and policies that will prepare the state for adapting to the future impacts of climate change, such as SLR."[71]

The ***Maryland Commission on Climate Change Adaptation and Response Working Group*** ("Working Group") recommends that the state "require the integration of coastal erosion, coastal storm, and [SLR] adaptation and response planning strategies into existing state and local policies and programs." It further

recommends amending the state's planning enabling statute to "expand sensitive areas and/or add a [SLR] Planning Element under county comprehensive plans and/or local hazard mitigation plans."[72]

In a report to the ***North Carolina Coastal Resources Commission***, the Ocean Policy Steering Committee recommended that the state "add a [SLR] component to [state] land use plan guidelines," specifically requiring "characterization of how local governments will address the relocation of oceanfront properties should [SLR] continue at its present rate or at an increased rate."[73]

The ***Washington Coastal and Infrastructure Working Group*** ("Working Group") recommends "updat[ing] Washington's land use and shoreline planning and permitting statutes and rules to reflect the new imperative of [SLR] and climate change," and to "ensure that these issues are incorporated into [the state's] long-range land use, habitat protection, capital facilities and hazard mitigation plans and associated regulatory framework."[74] Without changes to statutes, Washington agencies and local governments are looking at how to integrate consideration of adaptation planning into existing programs, such as the Shoreline Management Act and the Shoreline Master Program.[75]

The Environmental Protection Agency (EPA) and the ***National Oceanic and Atmospheric Administration*** (NOAA) recommend that communities consider "link[ing] community hazard mitigation plans to community comprehensive plans, incorporate into zoning, capital expenditure plans, and other local land-use management tools."[76] EPA further suggests that state and local governments "expand the planning horizons of land-use planning to incorporate longer climate predictions."[77]

Examples of Programs Implementing Comprehensive Plans

The ***California Coastal Act*** requires local governments to adopt local coastal programs that, among other things, ensure that new development minimizes risk in areas of high geologic and flood hazard, does not contribute to erosion, does not require construction of armoring, and does not substantially alter natural landforms.[78]

The ***Maryland Department of Natural Resources*** (MD-DNR) is working with three of the state's most vulnerable counties (Dorchester, Somerset, and Worchester) to help them incorporate SLR in their comprehensive plans and zoning ordinances.[79] In its guidance to Dorchester County, MD-DNR recommends that the county plan for 3 feet of SLR over the next century and use a 25-year planning time frame.[80] The Guidance recommends that the county amend its comprehensive plan to limit subdivisions in vulnerable areas, promote infill in upland areas, restrict rebuilding of damaged structures to the existing footprint, and require increased freeboard (i.e., the feet above flood level that a structure must be elevated to protect against uncertainty in flood height levels),[81] among other things.[82]

III. Regulatory Tools

2. Zoning and Overlay Zones

Policy Goal: All

Type of Land Use: All

Note: For a description of goals and uses, see pp. 13-14.

The primary power that local governments use to control development is zoning. Local governments adopt zoning maps that divide the community into different districts (or zones) based upon the types of uses that are permitted (e.g., residential, commercial, or industrial). The zoning ordinance then specifies the different regulations that govern development within that zone. For example, the zoning ordinance will specify how far structures need to be set back from the street, the density of development allowed, and how large structures can be.[83]

One method of zoning employed by local governments is overlay zoning. Overlay zones allow local governments to superimpose additional regulatory requirements on an existing zone to add supplemental regulation in areas with special characteristics. They allow greater flexibility because they do not require the locality to disrupt existing zoning classifications. In order to create an overlay zone, local governments must (1) establish the purposes for creating the district, (2) map the district, and (3) establish the regulations to achieve the purposes for creating the district.[84] Many localities already use overlay zones to protect areas with unique natural resources (e.g., beaches, wetlands, and barrier islands) or cultural resources (e.g., historic properties).

Implementation of Zoning and Overlay Zones in a SLR Context

Local governments could create a "SLR overlay zone" for areas most vulnerable to impacts. Within the SLR overlay zone, the locality could impose special regulations. Overlays can prohibit or condition the expansion of major renovations to existing structures; prohibit or condition the rebuilding of damaged structures; or require that rebuilt structures be elevated.[85]

Depending upon their adaptation goals for different areas, local governments could also create different overlay zones such as the following:

- ***Protection zones***—areas with critical infrastructure and dense urban development, where the locality will permit coastal armoring; local governments could require that soft-armoring techniques be employed where feasible.
- ***Accommodation zones***—areas where local governments will allow new development but may limit the intensity and density of new development, limit hard shoreline armoring, and require that structures be designed or retrofitted to be more resilient to flood impacts.

- ***Retreat zones***—areas where local governments will prohibit hard armoring, will limit or prohibit rebuilding of damaged structures, or require the removal or relocation of structures that become inundated. Local governments can combine regulations with incentives and encourage landowners to relocate structures upland through tax benefits, acquisitions, or conservation easement programs.
- ***Preservation zones***—areas where local governments will seek to preserve and enhance important natural resources, ecosystems, habitats, or flood buffers.[86]

State and Federal Sources Proposing Use of Zoning and Overlay Zones in SLR Context

The ***Virginia Governor's Commission on Climate Change*** ("Governor's Commission") recommends that local governments "revise zoning and permitting ordinances to require [that] projected climate change impacts be addressed in order to minimize threats to life, property, and public infrastructure and to ensure consistency with state and local climate change adaptation plans."[87]

The ***Oregon Coastal Management Program*** recommends "using land-use planning processes to address climate change—add consideration of climate change as a key element in current planning and permitting process."[88]

Examples of Programs Implementing Zoning and Overlay Zones

The Chesapeake Bay Critical Area law uses overlay zones to protect and restore water quality and habitat. The law creates overlay zones that regulate development adjacent to the bay based upon the status of development in three types of areas: (1) intensely developed areas—developed areas with little habitat that are the preferred location for new development, (2) limited development areas—lightly developed areas where any new development must protect habitat, and (3) resources conservation areas—predominantly wetlands where only limited residential development is permitted.[89]

A model shoreline overlay zoning ordinance, including setback and vegetation buffer requirements, can be found at the Michigan Land Use Institute's Model Great Lakes Shoreline Protection Overlay Zoning Ordinance.[90]

3. Floodplain Regulations

Policy Goal: All

Type of Land Use: All

Note: For a description of goals and uses, see pp. 13-14.

Local governments could also use their powers to regulate floodplains in order to implement adaptive measures. The National Flood Insurance Program (NFIP) inspired many local governments to adopt special floodplain regulations. Participation in the NFIP is voluntary and is based on an agreement between local communities and the federal government. The agreement calls for communities to adopt and enforce floodplain management ordinances that meet minimum program requirements for regulating new construction in "special flood hazard areas" (SFHAs) [91] as mapped by the Federal Emergency Management Agency (FEMA), the agency charged with administering the NFIP. In exchange, federal flood insurance is made available to landowners in those communities.[92]

FEMA uses historical flood data to develop flood insurance rate maps (FIRMs). FIRMs divide the floodplain into different zones based upon the zone's susceptibility to flooding. In order to be eligible for the program, FEMA requires

that local governments impose additional regulations in SFHAs, high-risk areas that would be inundated by a flood having a one-percent chance of occurring in any given year based upon historical data (this flood is also referred to as the "base flood" or the "100-year flood").[93] Special flood hazard areas (SFHAs) include A-Zones and V-Zones. V-Zones are coastal floodplains that are subject to more severe damage from storm-induced velocity wave action. V-Zones are thus more strictly regulated and subject to a different insurance rate structure. A-Zones are upland areas or riverine floodplains that are vulnerable to the 100-year flood, but are not subject to wave action. FEMA also designates areas *outside* of SFHAs that may be at risk in events larger than the base flood, but FEMA does not require additional regulations in these areas. These areas, designated as X-Zones (shaded) on flood insurance rate maps (FIRMs), represent the "500-year floodplain" or the areas that have between a 1 and 0.2-percent annual chance of flooding based upon historical data.[94]

To participate in the NFIP, local governments must regulate development in floodplains. Many local governments simply adopt FEMA's model floodplain ordinance and impose only minimum regulations on development in SFHAs. In general, FEMA only requires communities to impose *design* requirements on development in SFHAs.[95] Structures must be elevated to or above base flood levels, anchored, and constructed with materials resistant to flood damage.[96] For a more detailed description of the building code regulations required in SFHAs, see Tool No. 3.

A more protective solution would be to limit the uses that can be permitted in vulnerable areas ("use restrictions").[97] At this time, the NFIP does not require local governments to impose use restrictions in SFHAs, except in the regulatory floodway.[98]

Currently, the NFIP does not account for future SLR impacts.[99] Because FEMA uses only *historical* flood data to determine an area's vulnerability to flooding, a practice that assumes static climate conditions,[100] most local regulations may not accurately manage for the increased risks posed by SLR.[101] SLR will inundate low-lying coastal areas and will increase the frequency and geographic extent of flood events caused by storm surge.[102] Climate change also may increase the intensity of extreme storm events (such as hurricanes and nor'easters) and is expected to increase the frequency, intensity, and amount of precipitation in certain areas, which will increase flood risks outside of coastal zones.[103]

In order to fully protect against the risks posed by SLR, most jurisdictions will need to update their current practices of managing development in floodplains.

In order to fully protect against the risks posed by SLR, most jurisdictions will need to update their current practices of managing development in floodplains.[104] The NFIP does not preempt localities from more strictly regulating floodplains within their jurisdiction.[105] In fact, local governments are encouraged to impose more stringent regulations (such as use restrictions) through NFIP's Community Rating System (CRS), discussed in more detail on the next page. Through the CRS, communities that impose more strict regulations can qualify homeowners in their communities for insurance premium discounts.[106] Communities may be able to use CRS premium discounts to increase political support for new floodplain regulations.

Implementation of Zoning and Overlay Zones in a SLR Context

Because FEMA conducts extensive analysis of flood hazards to generate FIRMs, local governments could use designated SFHAs as a starting point to begin to increase regulation of development in floodplains. Localities could also use FEMA's 500-year designation to begin to regulate development in vulnerable areas that are not currently subject to floodplain regulations. In these areas, localities could impose design requirements that are currently only required in the 100-year floodplain (such as requiring that structures be elevated).

Local governments could also implement use restrictions to begin to limit development in highly vulnerable coastal areas.

Local governments could also implement use restrictions to begin to limit development in highly vulnerable coastal areas (such as high hazard V-Zones). For example, localities can limit the intensity of permitted development to allow only limited residential, recreational, or agricultural uses in these zones.

Localities could also limit public expenditures to build or maintain infrastructure in the 100-year and the 500-year floodplains. (See the discussion of Capital Improvement Programs in Chapter IV).

State and Federal Sources Proposing Use of Zoning and Overlay Zones in SLR Context

The ***Florida Action Team*** recommends that the state "reduce or eliminate the potential for damage from flooding by requiring all new or substantially renovated buildings to be elevated." The plan recommends that buildings be designed to have only a 0.5 percent chance of flooding in any year for the life of the structure.[107]

The ***New Jersey Department of Environmental Protection*** recommends that the state "assess flood control zoning approaches," "design standards and planning for roads … and other infrastructure to cope with floods."[108]

The ***Washington Working Group*** recommends that the state use "flood hazard planning to address SLR and other climate change-related risks." Specifically, the Working Group recommends that the state update "eligibility and rating criteria for hazard planning … in recognition of the growing awareness of [SLR] risk to our coastal communities," and review "funding levels for local grant programs … to assure that there is adequate funding to respond to the emerging need for [SLR] planning."[109]

EPA suggests that state and local governments consider "redefin[ing] riverine flood hazard zones to match projected expansion of flooding frequency and extent." EPA acknowledges that this option may be difficult to implement because of "impacts on flood insurance" and because it would "require changing zoning ordinances."[110]

Examples of Programs Implementing Policy

Chatham County, Massachusetts, revised its zoning ordinance to prohibit residential development in the 100-year floodplain. The County justified the regulations on the grounds that development poses risks to adjacent parcels during storm events and poses dangers to rescue personnel during evacuations. Permissible uses under the ordinance include recreational, agricultural, and commercial fishing.[111] The Massachusetts Supreme Court found that the regulation did not cause a taking of private property because it did not prevent all economic use of regulated properties.[112]

The Association of Floodplain Managers has compiled a useful ***No Adverse Impacts Toolkit***[113] detailing floodplain management activities that communities can implement to increase their resilience to flood impacts and avoid potential liability. The no adverse impacts model of managing floodplains is based on the premise that one person's development should not adversely impact adjacent properties.

The ***FEMA Community Rating System***, a sub-program of the NFIP, provides incentives to encourage localities to increase regulations in floodplains above the minimum requirements of the NFIP. Homeowners in participating communities receive discounts on their flood insurance premiums. To qualify for the program, communities must undertake activities to mitigate flood losses. Activities include enacting higher regulatory standards for development in floodplains than the minimums required by the NFIP (e.g., requiring that buildings be elevated above the base flood elevation, so called "freeboard" requirements).[114]

4. Building Codes and Resilient Designs[115]

Policy Goal: Accommodation

Type of Land Use: Critical Infrastructure, Developed and Developable Areas

Note: For a description of goals and uses, see pp. 13-14.

Building codes can be used to regulate the construction of structures to maximize their capacity to withstand flooding. The NFIP currently requires that construction in SFHAs meets minimum *design* requirements. Design requirements are different in different zones (V-Zones have more restrictive requirements than A-Zones) and are different for different types of development (non-residential structures must be designed to a higher standard than residential structures). Under NFIP minimums, new construction[116] must meet the following requirements:[117]

- ***Residential structures in A-Zones***—The lowest floor of the structure (including the basement) must be raised to or above the base flood elevation (BFE).[118] Buildings can be elevated on fill, piers, or columns, or extended foundation walls such as on a crawl space. Areas below the lowest floor can be useable space (such as parking space) but must be designed to allow flood waters to exit. Buildings must also be anchored to the foundation to prevent movement of the structure during flood events. Mechanical, electrical, and plumbing devices must also be elevated above the BFE.[119]
- ***Non-residential buildings in A-Zones***—Because it is not always practicable to elevate businesses, non-residential structures can either be elevated (pursuant to the residential standards detailed above) or floodproofed to one foot above BFE. Floodproofed structures must be designed to be watertight using special coatings and sealings to make the walls impermeable to floodwater, and mechanical, electrical, and plumbing equipment (such as toilets) must be elevated or protected against flood damage.[120]
- ***V-Zones***—Design requirements are more onerous in V-Zones because structures in these areas are subject to damaging coastal wave action. Structures in V-Zones must be built on pilings or columns so that the lowest floor is elevated above the base flood elevation including storm surge. If the landowner enclosed areas below the BFE (with storm surge), the walls must be designed to break away in storm events without causing loss of structural integrity. Structures in V-Zones *cannot* be floodproofed or elevated on fill. Structures must also be specially anchored to withstand wind and wave action.[121]

Communities are also encouraged to impose regulations that exceed NFIP minimums through the Coomunity Rating System (described on p. 21). For example, communities that require structures to be elevated above the base flood elevation (so called "freeboard" requirements") can make homeowners in their communities eligible for insurance premium discounts.

Governments typically regulate the construction and design of structures through state or local building codes. These codes are based on model building codes that governments then amend to ensure that the codes address local needs.[122]

Implementation of Building Codes and Resilient Design in a SLR Context

In order to adapt to SLR, governments could extend building code requirements to currently unregulated areas that may become vulnerable to flooding in the future, such as applying A-Zone requirements in the 500-year floodplain (X-Zones (shaded)). Local governments could apply more restrictive V-Zone design requirements in coastal A-Zones.[123] Or, they can take advantage of CRS benefits and update building codes to require that structures in A-Zones be built or retrofit to be more resilient to flooding from SLR.[124] For example, freeboard requirements could be added or increased so that building elevations consider future SLR over the life of the structure (including potential storm surge height).[125]

In order to adapt to SLR, governments could extend building code requirements to currently unregulated areas that may become vulnerable to flooding in the future.

State and Federal Sources Proposing Use of Building Codes and Resilient Design in SLR Context

The ***California*** Adaptation Strategy recommends that "if agencies do plan, permit, develop or build any new structures in hazard zones, agencies should employ or encourage innovative engineering and design solutions so that the structures are resilient to potential flood events or can be easily relocated or removed." The Strategy further recommends that state agencies collaborate with local governments to consider amending building codes "to require that coastal development incorporate features that are resilient to [SLR] (e.g., require that development begin on the second floor)."[126]

The ***Florida Action Team*** recommends amending its building code to "incorporate design criteria for buildings to resist future loads that may result from the impact of climate change-exacerbated hazards during a minimum service life of 50 years."[127]

The ***Maryland Working Group*** recommends that local governments review building codes and consider strengthening requirements for structures in vulnerable areas, such as "requir[ing] two or more feet of freeboard for structures located in tidally influenced floodplains," requiring special foundations that are more resilient to erosion and wave impacts, and requiring use of flood-resilient construction materials, among other things.[128]

The ***Massachusetts Coastal Hazards Commission*** recommends that its Board of Building Regulations and Standards ("Board") "explore coastal construction options, consider mechanisms to address incremental renovations and expansions, and encourage the use of strategies to maintain the form and function of natural resources." The Commission further recommends that the Board and other state agencies "encourage local building inspectors and conservation agents to work together to provide understandable advice to homeowners and commercial property owners about what can and cannot be built on coastal lots."[129]

The ***U.S. Agency for International Development*** (USAID) recommends altering building standards to "delineate the minimum technical and safety requirements for the design and construction of residential and commercial structures."[130]

Examples of Programs Implementing Building Codes and Resilient Design

The ***My Safe Florida Home Program*** provided inspection services to homeowners to help them identify ways in which they could retrofit their homes to make them more resilient to storm damage. Homeowners received up to $5,000 in state matching funds to implement mitigation measures.[131] The program expired in 2009 and has not been refunded by the legislature. Florida also enforces a state-wide building code that requires sturdier foundations, reinforced roofs, and impact-resistant window and door treatments (such as storm shutters).[132]

FEMA, through a competitive grant process, provides financial assistance to local governments to (1) retrofit homes that have been repetitively damaged by floods, (2) elevate structures, (3) move structures, and (4) demolish damaged homes.[133] FEMA also maintains guidance for construction of buildings in coastal high hazard areas.[134]

TABLE 5: *Advantages and Disadvantages of Building Codes and Resilient Design*

Evaluation Criteria	
Economic	Resilient design techniques are easier to require for new development,[135] but can be more costly when retrofitting existing development. FEMA offers flood insurance premium discounts for houses built with freeboard, which may increase the cost effectiveness of implementation.[136] Studies have shown that, within a short period of time, insurance premium reductions can pay for the costs of elevating structures.[137] However, developers and homeowners may nonetheless resist calls to install design features that increase the cost of structures.[138]
Environmental	In order to minimize the adverse environmental impacts of coastal development, resilient design requirements would need to be coupled with prohibitions on hard coastal armoring.
Social	While resilient design requirements allow some development in vulnerable areas, they can significantly reduce flood damage.[139] However, they may not sufficiently protect communities in extreme storm events with added storm surge from SLR.
Governance Criteria	
Administrative	Design requirements may be difficult to administer because to implement them cost effectively, local governments will need to know how SLR will impact their communities, including how it will increase base flood elevations, over what geographic area, and over what time period. Enforcement can also be a challenge for local building inspectors and requires technical capacity.
Legal	Local governments have been using design requirements to reduce flooding impacts to coastal development since the inception of the National Flood Insurance Program of 1968. Governments have tended to favor design requirements over use restrictions because they survive constitutional challenge.

5. Setbacks/Buffers

Policy Goal: Accommodation and Preservation

Type of Land Use: Critical Infrastructure and Developable Areas

Note: For a description of goals and uses, see pp. 13-14.

Setbacks are building restrictions that establish a distance from a boundary line where land owners are prohibited from building structures. In urban areas, the boundary line is typically a street.[140] In waterfront areas, the boundary line is often the tide line.[141]

Buffers (or buffer zones), similar to setbacks, require landowners to leave undeveloped portions of their property that provide important natural processes. For example, coastal buffers often prohibit landowners from building on or immediately adjacent to wetlands and sand dunes. These natural features buffer flood impacts, preserve views, provide recreational opportunities, and serve as important habitat. Wetlands also provide important water filtration benefits.[142] Buffer zones ensure that adjacent development does not impact these natural processes.[143]

Setbacks and buffers can be established through zoning ordinances, subdivision ordinances, and/or floodplain ordinances. Some state-level coastal management statutes also establish special setbacks or buffer areas in coastal areas. Floodplain and coastal setbacks are typically designed to keep development away from portions of the property that are vulnerable to flooding and erosion.[144]

There are several different mechanisms for establishing setbacks and buffers:

- ***Fixed mandatory setbacks*** require that all structures, including sea walls, be set back a specific distance from a predetermined point (e.g., 100 feet from the mean high tide line or the vegetation line).[145]
- ***Erosion-based setbacks*** are determined by a projected shoreline position that assumes a specific increase in sea level and erosion rates over a specific time frame such as the life of the structure (e.g., sixty times the annual rate of erosion).[146]
- ***Tiered setbacks*** require a lesser setback or buffer for smaller structures and a greater setback for larger structures that are more difficult to move if they become damaged and put more people at risk.[147]

Implementation of Setbacks/Buffers in a SLR Context

To incorporate considerations of SLR, local governments could require that coastal setbacks or buffers be established based upon a projected shoreline position that assumes specific increases in sea level or erosion rates over the life of the structure.[148] Local governments or state agencies could require that new development along dynamic coastal shorelines evaluate potential impacts to the development from a specific rate of SLR. Governments could limit development where the development cannot include sufficient setbacks to mitigate impacts from SLR over the life of the structure.[149]

Local governments can create buffer zones along coastal areas to ensure that vulnerable beaches and wetlands have room to migrate inland as sea levels rise. Buffer zones, like setbacks, can be determined based upon erosion and SLR rates for that area over a specified time frame. More extensive buffers could be required in areas with sufficient buildable space, in areas that have important natural resources, or in areas that could be part of a migration corridor. Larger buffers could be required for large-scale development projects.

State and Federal Sources Proposing Use of Setbacks/Buffers in SLR Context

The ***California Adaptation Strategy*** recommends that local governments consider using "mandatory construction setbacks … to prohibit construction and significant redevelopment in areas that will likely be impacted by [SLR] within the life of the structure."[150] The Strategy encourages all levels of government to consider "creating additional buffers and setbacks for new construction to minimize the risks to people and property and to protect coastal resources such as natural habitat and recreational areas." The plan further recommends that state agencies collaborate with local jurisdictions to encourage them to consider establishing "additional buffer areas … in some places to protect important cultural and natural resource assets."[151]

The ***Florida Action Team*** recommends that the state undertake a "comprehensive reevaluation" to consider, among other things, "the adequacy of existing coastal setbacks" and whether setbacks are adequately protecting the state's beaches and sand dunes.[152]

The ***Maryland Working Group*** recommends modifying existing buffer provisions by "expanding the distance of vegetated buffers in areas experiencing significant erosion (two or more feet per year)."[153]

The ***South Carolina Shoreline Change Advisory Committee*** recommends that the state "promote natural shoreline migration, wetland transgression, improved water quality, and reduced exposure to erosion and storm damage through the use of shoreline vegetative buffers." The plan recommends that the state require "25-foot minimum vegetated buffer … for all new non-beachfront shoreline development in the … coastal zone."[154]

The ***Virginia Governor's Commission*** recommends that its state and local agencies establish "mandatory setbacks to discourage development in vulnerable coastal areas."[155]

EPA also recommends use of setbacks as a "soft" adaptation option.[156]

Examples of Programs Implementing Setbacks/Buffers

The ***California Coastal Act*** requires local governments to adopt local coastal programs (LCPs). LCPs must establish buffer areas for new development that protect coastal waters, estuaries, wetlands, streams, and environmentally sensitive habitat areas.[157]

The ***Chesapeake Bay Preservation Act*** (CBPA) allows local jurisdictions to require that development adjacent to the Bay include a 100-foot buffer measured inland from the edge of wetlands, shores, or streams.[158] Bay jurisdictions could use these buffers to protect against flood risks and water quality impacts posed by SLR by increasing buffer widths to account for future inundation and erosion.[159]

The ***Maine Sand Dune Rules*** require that structures greater than 2,500 square feet be set back a distance calculated based upon the future shoreline position considering two feet of SLR over the next 100 years.[160]

North Carolina allows for a tiered setback based upon the size and type of structure. The setback is determined by the vegetative line and the annual average rate of erosion. Smaller structures (less than 5,000 square feet) must be set back 30 times the erosion rate; larger structures must be set back 60 to 90 times the erosion rate based upon the size of the structure.[161]

The ***South Carolina Beach Front Management Act*** prohibits new erosion control structures or buildings larger than 5,000 square feet seaward of a setback line. The line must be "40 times the average annual erosion rate or not less than 20 feet" from the crest of the first seaward sand dune (the "baseline"), whichever is greater.[162]

Maui, Hawaii, has strict setback requirements that vary to avoid potential takings challenges. A new standard requires structures to be set back 50 times the annual erosion rate plus 20 feet or adhere to previous setback requirements (25 feet for 100-foot lots, or 40 feet for lots larger than 100 feet), whichever is greater. To avoid potential takings challenges, the regulation allows for a variance if, after imposition of the setback, the lot does not have 30 feet of buildable space.[163]

North Carolina requires a 30-foot buffer for development along estuarine shorelines.[164]

TABLE 6: *Advantages and Disadvantages of Setbacks/Buffers*[167]

Evaluation Criteria	
Economic	Setbacks and buffers can extend the life of the structure, provide natural protection, and offer a less expensive alternative to hard- and soft-armored solutions. However, they also limit the amount of property that can be developed and can, therefore, limit a property's development value.[166] Because setback policies are not flexible, they may prohibit "too much or too little development" given the uncertainty of the rate of SLR.[167]
Environmental	Where there is enough room for inland migration, buffers and setbacks can be used to effectively preserve ecosystems, habitat, and water quality.[168]
Social	Setbacks may only be a short-term solution; they delay the need for protection where the parcel is large enough to allow for significant distance between the development and the coast, but they will be less effective over the long term as SLR inundates broad areas of low-lying land.[169]
Governance Criteria	
Administrative	Many jurisdictions already have some kind of regulation requiring setbacks or buffers and are, therefore, familiar with the burdens required to administer the regulations. Erosion-based setbacks are more difficult because the local jurisdiction must have scientific data of erosion rates, and in a SLR context the jurisdiction must have information on projected increased sea-level and erosion rates.[170] In order to implement a buffer zone, jurisdictions need to map the areas with natural features where buffers will be required and update those maps periodically to account for changes in sea level and erosion rates.
Legal	Most local governments have authority to require setbacks or create buffer zones. While setbacks are typically calculated in a manner to provide for sufficient buildable space, setbacks calculated to fully account for SLR could present potential taking challenges if they prohibit all economically viable use of the property.[171] If application of the full setback would not allow any development on the property, local governments can use the variance process to allow for smaller setbacks.

6. Conditional Development and Exactions

Policy Goal: Planned Retreat and Accommodation

Type of Land Use: Developed and Developable Areas

Note: For a description of goals and uses, see pp. 13-14.

Regulators often impose special conditions when issuing development permits for new development and substantial redevelopment (i.e., renovation or expansion of existing structures). Regulators typically impose conditions when granting a special-use permit or subdivision permit. Special-use permits allow regulators to allow more intense development ("special uses") if the landowner agrees to certain measures to mitigate the impacts of those special uses. Regulators must have a statutory basis for imposing the condition: the zoning ordinance will specify the special uses that may be permitted and the mitigation measures to be required as a condition of the permit.[172] For example, a zoning ordinance may allow development of an apartment complex in a single-family residential zone if the developer agrees to provide additional setbacks or dedicate open space. The development permit is then recorded so that the conditions bind future owners.

Regulators also impose conditions when approving subdivisions.[173] Subdivisions impose costs on communities because they require new infrastructure and public services. Conditions are sometimes used to recoup these costs. For example, subdivision permits will often require the developer to fund or build the new infrastructure needed to support the development (roads, schools, open space, utilities, etc.).[174]

Conditions can take the following forms:

- ***Impact fees*** seek to recoup costs associated with the new development, such as increased infrastructural costs (e.g., maintenance of public streets, water, and sewer systems) or costs to mitigate impacts caused by the new development.[175]
- ***Land-use restrictions*** allow a landowner to pursue a more intense use of the land if he or she agrees to restrict land to that use in the future through a recorded easement (or servitude).[176] For example, in a district zoned for forestry purposes, a landowner may be permitted to use the land for a farm if he or she records an easement restricting the future use of the land to agricultural purposes.[177]
- ***Dedications*** require a landowner to dedicate lands for public purposes, such as roads, utilities, and open space.

Conditions that require a landowner to convey a property interest are a special kind of condition called an *exaction*. Exactions are typically negotiated between the landowner and the local government in exchange for a development permit. Because courts are concerned about the coercive potential of exactions, they review such requirements as potential regulatory takings.[178] Courts apply a special takings test requiring (i) an "essential nexus" between the purpose for the exaction and the impact that the exaction seeks to mitigate,[179] and (ii) a "rough proportionality" between the exaction and the impact of the proposed development.[180] To try to avoid these types of challenges, local governments can limit the discretion of regulators to condition permits and specify the types of mitigation measures that will be required when certain special uses are permitted.

Implementation of Conditional Development and Exactions in a SLR Context

To address SLR, regulatory bodies could impose some of the following types of conditions when issuing development permits in areas that are vulnerable to SLR:[181]

- ***Restrictions on hard armoring***—The landowner agrees not to build hard-coastal armoring in the future to protect structures from flooding. Regulator could instead plan for and authorize in the permit conditions the use of soft-armoring alternatives to protect the development.[182]
- ***Removal requirements***—The landowner agrees to remove structures when they become inundated as the tide line recedes. As the seas rise, the boundary between private lands and public beaches (the tide line) will be pushed inland. This type of condition allows landowners to develop property but with the expectation that development will eventually have to cede to the rising seas.[183]
- ***Dedications***—The landowner dedicates an easement to preserve natural buffers, floodways, or to provide public access. Dedications, especially dedications for public access, may be subject to heightened judicial scrutiny, as described above.
- ***Impact fees***—The developer is required to pay a fee to cover the costs of potential emergency response, future armoring, to mitigate impacts to natural resources from future armoring, or to flood proof infrastructure that services the new development.[184]
- ***Flood protection requirements***—The developer must design the new development and its supporting infrastructure to be more resilient to flood impacts. For example, permits could require that roads be elevated and that sewer lines be flood proofed.[185]

State and Federal Sources Proposing Use of Conditional Development and Exactions in SLR Context

The ***California Adaptation Strategy*** recommends that agencies like the Coastal Commission "consider requiring applicants to address how [SLR] will affect their project, include design features that will ensure that the project objectives are feasible and that the project will not be rendered unusable or inoperable over its lifespan, that critical habitat is protected, and that public access is provided, where appropriate."[186]

The ***Virginia Governor's Commission*** encourages private owners of infrastructure "to conduct a climate change vulnerability assessment and develop a climate change adaptation plan as a condition for approval of any required permits."[187]

Examples of Programs Implementing Conditional Development and Exactions

The ***California Coastal Commission*** often conditions approval of coastal development permits on a landowner's agreement not to build hard armoring and to dedicate access to the coast.[188]

TABLE 7: *Advantages and Disadvantages of Conditional Development and Exactions*

Evaluation Criteria	
Economic	Because conditions are often negotiated between landowners and regulators, they can be used to effectively achieve the benefits of coastal development while mitigating some of its costs. However, conditions can also increase the costs of development, reduce the structure's life, or reduce the buildable space of the lot. Using conditions can also result in inconsistent application for different development projects in different regions of the coastal zone; this type of uncertainty may make it difficult for developers to plan and finance projects.
Environmental	Conditions could be an effective way of protecting natural resources. Landowners could be required to dedicate easements to protect natural resources, limit hard armoring to allow for the inland migration of wetlands and beaches, or use only soft techniques to protect structures.
Social	Conditions could be used to ensure that the size and location of development is appropriate given the threat of SLR.
Governance Criteria	
Administrative	Conditional permits can be more difficult to administer than a standard permit because they require the regulator to engage in a case-by-case analysis of each project. Regulators must often separately negotiate the permit and design conditions that serve to mitigate the impacts of the development. Zoning ordinances must carefully specify the facts and conditions to be weighed when the permit is issued in order to ensure that the conditions protect specific public interests (e.g., protection against flooding or preservation of natural resources).
Legal	Many local governments already have authority to impose conditions when granting special-use permits or subdivision permits. However, the zoning ordinance may not allow regulators to consider criteria relevant to SLR, such as flooding and erosion, and regulators may be limited in the types of conditions they may exact.[189] Therefore, governments may need to update enabling statutes and zoning ordinances so that regulators can impose additional restrictions on vulnerable areas, specify the types of conditional uses that will be permitted in vulnerable areas, and specify the types of mitigation measures that will be required. Exactions must comply with heightened constitutional takings requirements. Local governments may be able to justify SLR exactions on the grounds that they protect natural resources, preserve public access to the coast, and promote safety from flood risks.[190]

7. Rebuilding Restrictions

Policy Goal: Planned Retreat

Type of Land Use: Critical Infrastructure and Developed Areas

Note: For a description of goals and uses, see pp. 13-14.

Rebuilding restrictions limit a property owner's ability to rebuild structures destroyed by natural hazards such as flooding. Rebuilding restrictions can prohibit redevelopment[191] or require that it be more resilient to flooding impacts (e.g., requiring redevelopment to be elevated or set back from the coast). Similarly, retrofitting requirements can be imposed on existing structures when, for example, a landowner applies for a permit to renovate or expand a structure.

FEMA uses the 50 percent "substantial damage" rule to govern rebuilding. Structures that were erected prior to creation of the NFIP are grandfathered, meaning they do not have to comply with NFIP's minimum design requirements (e.g., elevation to or above the base flood elevation). Under the 50 percent rule, buildings must be rebuilt to conform to NFIP minimum standards if they are damaged to such an extent that the costs of repair will exceed 50 percent of the pre-damage market value of the structure.[192]

Another mechanism by which local governments can implement rebuilding restrictions is through downzoning certain vulnerable areas (i.e., reducing densities or permitted uses in the district where the property is located). After a local government has downzoned an area, existing structures can remain, but they become "nonconforming," meaning that if a building is destroyed or damaged, reconstruction has to conform to the current zoning and building requirements for new construction (which are likely to be more stringent).

Implementation of Rebuilding Restrictions in a SLR Context

Jurisdictions could use rebuilding restrictions to facilitate adaptation to SLR by downzoning vulnerable areas. If structures in those areas are subsequently damaged by flooding, jurisdictions could limit reconstruction using the following approaches:[193]

- ***Allow limited rebuilding***—Landowners are allowed to build smaller, more resilient structures to replace older, damaged structures; or landowners could be required to provide for additional setbacks.
- ***Totally prohibit rebuilding***—Landowners are prohibited from rebuilding destroyed properties when they are located in identified flood- or erosion-prone areas;[194] or landowners are prohibited from rebuilding structures that have been repetitively damaged.[195]
- ***Allow reconstruction with conditions***—Landowners are allowed to rebuild properties largely as they were but with the condition that they will not build protective armoring or that they will remove structures when threatened by erosion or inundation. Regulators could then prohibit rebuilding if the structure is subsequently damaged or destroyed.[196]

State and Federal Sources Proposing Use of Rebuilding Restrictions in SLR Context

The ***California Adaptation Strategy*** recommends that local governments consider restricting rebuilding "when structures are damaged by SLR and coastal storms."[197]

The ***Florida Action Team*** recommends that the state "undertake a comprehensive reevaluation" of its "post-storm redevelopment policies in light of SLR scenarios."[198] The plan establishes a goal to "substantially reduce or eliminate currently developed building sites subject to repetitive flood loss events." The plan recommends that counties and municipalities that have sites that have flooded "three or more times in the last 10 years … target those sites for future use conversion to reduce the human risk or the potential for property damage." [199]

EPA recommends that governments (1) treat as non-conforming those structures that are vulnerable to 100 centimeters of SLR over the next 100 years, (2) prohibit expansion or intensification of current uses, but (3) allow ordinary maintenance and repair if damage to structures does not exceed 50 percent.[200]

Examples of Programs Implementing Rebuilding Restrictions

Maine's Sand Dune Rules limit reconstruction of buildings damaged by storm events. A permit is required if the structure is damaged by more than 50 percent of its appraised value. Rebuilding must comply with strict design and planning requirements, which in many instances severely limits reconstruction.[201]

South Carolina's Beach Front Management Act requires that a building that is damaged beyond repair (more than two-thirds damaged) be moved as far landward on the lot as possible if rebuilt. In addition, the structure cannot be enlarged when rebuilt. This restriction applies if the structure is located between the baseline (crest of the first sand dune) and a setback line (a distance from the baseline that is 40 times the average annual rate of erosion).[202]

TABLE 8: *Advantages and Disadvantages of Rebuilding Restrictions*

Evaluation Criteria	
Economic	This deferred approach allows property owners to continue to use their property with no immediate restrictions. Rebuilding restrictions phase out high-risk uses over time and provide long-term costs savings. However, tax revenues would be affected when structures are damaged and rebuilding is restricted.
Environmental	This measure could be used to ensure that structures are removed as they begin to encroach on wetlands and beaches, and to create space to allow for the upland migration of wetlands.
Social	Rebuilding restrictions phase-out high-risk uses over time and provide long-term protections to people and property. However, rebuilding restrictions typically are not triggered unless a structure is significantly damaged and, therefore, the restrictions have limited utility in proactively protecting people and property from flood risks. Rebuilding restrictions could be coupled with real estate disclosures (see Tool No. 18) to inform buyers of potential future development restrictions. Governments could also couple rebuilding restrictions with financial incentives to cushion the economic hardship on landowners who have to relocate.
Governance Criteria	
Administrative	Pursuant to current NFIP minimum standards, rebuilding restrictions are only triggered when structures are "substantially damaged." Local building inspectors often have difficulty enforcing these restrictions because of technical challenges in determining the costs to repair and the pre-damage market value of the structure. Valuation involves establishing technical criteria for assessing structural damage, and officials typically do not have access to insurance claims data for specific properties.[203] Local governments also face political resistance from affected property owners when they enforce restrictions (e.g., large-scale rebuilding after a severe storm). To avoid local pressures, state governments could enact legislation to prohibit local governments from permitting rebuilding of repetitive loss structures (i.e., structures that have been repeatedly damaged by flooding and have made multiple insurance claims for property damage).[204] Governments could establish post-disaster building moratorium rules to give officials time to evaluate and plan redevelopment in vulnerable areas.[205]
Legal	Although landowners often challenge rebuilding restrictions under the takings clause, courts have upheld rebuilding restrictions in many jurisdictions. Rebuilding restrictions allow landowners to continue economic uses of their property until impacts occur. By instituting rebuilding restrictions in advance of impacts, governments can give landowners time to adjust their economics expectations for continued use of the property and, thus, potentially avoid takings challenges.[206]

8. Subdivisions and Cluster Development

Policy Goal: Accommodation and Preservation

Type of Land Use: Developable Areas

Note: For a description of goals and uses, see pp. 13-14.

States often impose special regulations that govern the subdivision of a large parcel into smaller parcels (typically into three or more lots). Unlike zoning ordinances, that regulate development on individual parcels, subdivision ordinances regulate how large tracts of land are subdivided into individually saleable lots. Because it can be a lengthy, time consuming, and expensive process, the ordinance will specify the rules for obtaining approval of a subdivision so that developers have assurances that if they comply, their subdivision will be approved. The ordinance ensures that the entire tract is designed and developed to conform to and integrate with existing development in the community. For example, subdivision ordinances will often specify the exact width and dimension of roads within the subdivision to ensure that they integrate with existing roads. Similar to zoning ordinances, subdivision ordinances will also specify minimum lot sizes, development densities, and the size and location of structures allowed on each individual lot. Finally, the ordinance will often impose affirmative obligations requiring the developer to install or pay for the infrastructure needed to service the development (such as requiring the dedication of land for roads and the installation of utilities such as power and sewer lines).[207]

Subdivision ordinances can also be used to encourage certain types of beneficial development. So-called cluster development ordinances (or conservation subdivision ordinances) encourage developers to concentrate development in desirable areas on the tract while preserving the remaining areas as open space.[208] For example, if an ordinance requires a one-acre minimum lot size, a clustered development program may permit half-acre minimum lots. In a 100-unit subdivision, the developer would be permitted to cluster the same number of units or more on 50 acres in exchange for creation of 50 acres of open space. Planners can maximize habitat and ecosystem benefits by requiring advance approval of the location of protected open space.[209] Clustering can be mandatory or promoted through incentives (such as density bonuses or permit streamlining).

Implementation of Subdivisions and Cluster Development in a SLR Context

Governments can use clustered development programs to ensure that new development is more resilient to SLR and less harmful to natural resources. Subdivision ordinances could be used to encourage the concentration of development in upland areas or other areas at lower risk of impacts and to restrict development in low-lying areas vulnerable to erosion and flooding. Regulators could ensure that open space is protected to serve as flood buffers and habitat through recorded conservation easements. By clustering, developers can also reduce the cost and size of any armoring that may be required in the future to protect the development.[210]

State and Federal Sources Proposing Use of Subdivisions and Cluster Development in SLR Context

The ***California Adaptation Strategy*** encourages "all levels of government … to consider … clustering new development in areas considered to have a low vulnerability to sea-level rise."[211] The plan also points to the mitigation co-benefits that can be achieved by clustering development.[212]

The ***Maryland Working Group*** recommends that the state "align State Smart Growth strategies … to reflect population growth and development patterns in relation to areas vulnerable to [SLR] and coastal hazards."

EPA recommended that the state of Maine require that new development that is likely to be affected by 200 centimeters of SLR over the next century "meet performance standards for cluster development designed to minimize the costs of protection should the 100 cm [SLR] estimate be too low."[213]

Examples of Programs Implementing Subdivisions and Cluster Development

Chatham County, Georgia, enacted a Conservation Subdivision Ordinance that allows developers to increase the density of a development project by 10 percent if 40 percent of the acreage is set aside for conservation space.[214]

The ***Minnesota Planning Environmental Quality Board*** and the ***American Planning Association***[215] have developed model Conservation Subdivision Ordinances. These model ordinances are designed to encourage subdivisions that promote: (i) high density development that maximizes efficient use of transportation and other public services, and (ii) the conservation of natural resources, habitat, and open space.

FIGURE 3: *Site Plan of Development Preserving Natural Flood Buffers.*

Source: NOAA, Ocean and Coastal Resource Management. Used with permission. http://coastalmanagement.noaa.gov/initiatives/shoreline_ppr_easements.html

TABLE 9: *Advantages and Disadvantages of Subdivisions and Cluster Development*

Evaluation Criteria	
Economic	Clustered development requirements can be a cost-neutral tool to ensure that large development projects preserve valuable natural resources. These requirements use incentives to encourage clustered siting and to encourage land conservation. Clustered development may also preserve the value of parcels because landowners may be willing to pay more for the amenities provided by preserved natural features. Some developers may, however, suffer a slight diminution in the value of their development because clustering reduces lot sizes.
Environmental	Clustered development programs can use subdivision permits to create large natural buffers and have been used successfully to preserve land for natural resource values. They can be coupled with "smart growth" policies to encourage more efficient use of infrastructure and transportation, thereby helping to reduce greenhouse gas emissions.
Social	Clustered development programs use natural defenses to protect property from flooding but may require significant buildable space to ensure protection over the long term.
Governance Criteria	
Administrative	While governments have implemented clustered development ordinances to address other land-use problems, they are more complex to administer than a typical subdivision ordinance. Planners must determine what land should be preserved and what areas are appropriate for increased density. They must also ensure that the permitting process appropriately manages development incentives. Creating clustered development programs can be politically controversial because they shift development densities and can impact property values in affected areas. These programs are most effective in regulating subdivisions of substantial acreage and thus may be of limited utility in areas that are already highly developed.
Legal	By clustering development in upland areas, governments can increase the resiliency of development while allowing for full economic use of property, thereby reducing the potential for takings challenges. Many jurisdictions have already developed clustered development programs to promote other land-use objectives; these programs could be used as models to implement a program to address SLR.

9. Hard-Armoring Permits

Policy Goal: Protection, Planned Retreat and Accommodation

Type of Land Use: Critical Infrastructure and Developed Areas

Note: For a description of goals and uses, see pp. 13-14.

Typically, governments and private landowners have tried to control flooding in coastal areas through shoreline armoring. Armoring uses hard-engineered structures to protect coastal development from flooding and erosion. Hard armoring can be built onshore or offshore and includes bulkheads, sea walls, revetments, dikes, tide gates, storm surge barriers, and groins.[216]

Regulators, however, are increasingly moving away from use of hard structures because of impacts on surrounding properties and natural resources. Armoring can increase flooding and erosion on neighboring property and destroy beaches and wetlands that provide natural flood protections and other ecological services.[217] They also encourage development in vulnerable areas and can increase risks to people and property in the event of catastrophic failure.[218]

Implementation of Hard-Armoring Permits in a SLR Context

As SLR causes more coastal lands to become inundated, governments may need to develop policies to regulate hard shoreline armoring. With increased rates of SLR, experts estimate that the long-term environmental and social costs of armoring may outweigh the short-term economic benefits for private landowners in some areas.[219] In deciding when to armor, decision makers will need to balance many trade-offs, such as the degree of threat to people and property, cost to build, value of the threatened property or infrastructure, long-term costs to maintain, environmental impacts, the physical conditions of the property (such as geology and elevation), aesthetics, and impacts to public access.[220]

If regulators decide to permit hard armoring, they should account for future SLR when reviewing the design and construction of protective structures. Currently, most regulators require that armoring be designed to withstand, at a minimum, a 100-year flood event, which is calculated based upon historical flood conditions. Therefore, these protection devices may be insufficient to protect against overflow in the event of an extreme flood event combined with increases in sea level.[221]

Regulators could also use conditions to require landowners to mitigate the impacts of permitted hard armoring. For example, landowners could be required to pay impact fees to mitigate damages to natural resources (such as the loss of the ecological services provided by wetlands and beaches).[222]

Governments could also develop criteria to require the removal of armoring under certain circumstances, such as when armoring is damaged by storms or when it comes to encroach on public lands as the foreshore erodes.[223]

State and Federal Sources Proposing Use of Hard-Armoring Permits in SLR Context

The ***Florida Action Team*** articulated a goal to "reduce and discourage future reliance on bulkheading/hardening to stabilize estuarine and beach shorelines. Shoreline hardening should be considered only after a full and cumulative assessment of short- and long-term impacts to coastal resources and coastal ecosystems."[224]

The ***Massachusetts Coastal Hazards Commission*** recommends that the state "develop a standardized benefit-cost analysis model … to justify projects that fully compares the capital, societal, and natural resource benefits and costs of proposed shoreline protection projects and appropriate alternatives."[225]

In its report, the ***North Carolina Ocean Policy Steering Committee*** questions "whether it will be economically and practically feasible to provide adequate protection to all shoreline areas, or whether some portions of the … shoreline must be left to the effects of climate change and coastal storms."[226]

Examples of Programs Implementing Hard-Armoring Permits

South Carolina prohibits construction of new erosion control structures seaward of a setback line and prohibits repairs of "[e]xisting sea walls … if the degree of damage to the structure exceeds 50 [percent]."[227]

East Hampton, New York, amended its zoning ordinance in 2007 to create a coastal erosion overlay district that prohibits the construction of new hard coastal armoring in certain areas. The ordinance requires projects within the district to be designed to control or prevent flooding and erosion using natural features of the coastline. In certain areas, erosion control structures can be built, but they require a special natural resources permit.[228]

Several states have limited or banned the use of hard armoring in certain vulnerable areas of the coast, including: ***Maine, North Carolina, Rhode Island,*** and ***Texas***.[229]

The ***California San Francisco Bay Conservation and Development Commission*** has proposed requirements that, where permitted, shoreline protection projects be built to withstand a 100-year flood event taking into account projected SLR for the life of the structure.[230] The ***California Coastal Commission*** generally prohibits new development that requires armoring or that would substantially alter natural landforms; permits are conditioned on the landowner's agreement not to build hard shoreline protection.[231]

TABLE 10: *Advantages and Disadvantages of Hard-Armoring Permits*

Evaluation Criteria	
Economic	Hard armoring is often favored because it has been the traditional method for protecting existing development. However, these techniques are costly to construct and maintain,[232] and they can decrease property values of neighboring properties.[233] Armoring may be appropriate in some areas where expensive critical infrastructure or intensely developed areas are at risk. Many coastal communities, however, will not be able to afford to protect all developed areas along their coast. Armoring can also obstruct public access to the coast and may cause economic impacts to fisheries and tourist-related industries.
Environmental	Hard-armoring techniques create many environmental impacts. Sea walls prevent upland migration of wetlands and contribute to the erosion of beaches.[234]
Social	Traditionally, hard structures were considered to be the most protective measure to prevent flooding.[235] However, armoring can deflect wave energy, exacerbating erosion on adjacent properties. Armoring also tends to spur development behind the protective structure and can, therefore, put more people at risk in the event of catastrophic failures.[236] Hard armoring can also obstruct public access to the coast and deprive segments of the population of this important recreational resource.
Governance Criteria	
Administrative	Currently, all states have some form of permitting process regulating coastal armoring. However, in order to balance property protection with preservation of natural resources, governments may need to amend these laws to appropriately balance public and private interests. Once armoring is permitted, the community is locked into a protection policy because landowners make investments based on the assurance that their property will continue to be protected.[237]
Legal	Hard armoring is limited in some states. Other states seeking to limit hard armoring may need to enact specific legislation. Governments, in some instances, can also be sued for permitting armoring where the armoring causes flooding to neighboring property.[238]

10. Soft-Armoring Permits

Policy Goal: Planned Retreat and Accommodation

Type of Land Use: Developed and Developable Areas

Note: For a description of goals and uses, see pp. 13-14.

In recognition of the impacts caused by hard coastal armoring, many jurisdictions have begun encouraging use of soft-armoring techniques. Soft armoring creates man-made barriers that replenish or mimic natural buffers or elevate land so that structures are less vulnerable to flooding, storm surge, and erosion. Examples of soft armoring include beach renourishment, dune creation, revegetation, wetlands restoration,[239] and living shorelines.[240]

Implementation of Soft-Armoring Permits in a SLR Context

Soft armoring will need to be designed to withstand SLR impacts. In order to ensure that soft armoring is sustainable given different SLR scenarios, local governments must consider how SLR, increased flooding, and erosion will affect the shoreline. Construction of soft armoring may not be feasible in all areas; it requires consideration of geological conditions, flood dynamics, and risks to property from coastal flooding. Soft armoring also requires consistent maintenance to sustain its flood control benefits.[241]

State and Federal Sources Proposing Use of Soft-Armoring Permits in SLR Context

The ***Massachusetts Coastal Hazards Commission*** recommends that the state "implement a program of regional sand management … that promote[s] nourishment as the preferred alternative for coastal hazard protection." The Commission further recommends that the state develop a process to improve coordination with the U.S. Army Corps of Engineers, state agencies, and municipalities and "achieves permit requirements in a timely manner, so as to ensure that all dredged material suitable for beach nourishment will be placed on adjacent or nearby eroding public beaches."[242]

The ***South Carolina Shoreline Change Advisory Committee*** finds that the state's "current regulations and permitting procedures for estuarine shorelines are not adequate to ensure the protection of the state's salt marsh-tidal creek ecosystems. The placement of erosion control structures (e.g., bulkheads) may result in undesirable cumulative impacts, and in cases where erosion control structures are approved, alternatives to traditional bulkheads may be preferred."[243]

The ***Virginia Governor's Commission*** recommends that the Virginia Marine Resource Commission "adopt shoreline protection policies that emphasize the use of living shorelines and seek to avoid shoreline hardening … where feasible" in order to "allow for the potential migration of tidal wetlands and increase coastal resiliency."[244]

EPA suggests that governments prohibit hard armoring or replace hard armoring with living shorelines, thus allowing for shoreline migration.[245]

Examples of Programs Implementing Soft-Armoring Permits

The ***Florida Beach and Shore Preservation Act*** allows for expenditure of public funds to restore "critically eroded beaches."[246] To preserve the public's investment in newly restored beaches, the Act requires that the boundary line between public and private lands be fixed based upon the historic location of the mean high tide line.[247] When the boundary line is fixed, it ceases to roll with the tides, so long as the state continues to maintain the restored beach.[248] These provisions of the statute recently survived a constitutional takings challenge in the case *Stop the Beach Renourishment, Inc. v. Florida Department of Environmental Protection*, 130 S. Ct. 2592 (2010).

The ***Maryland Living Shoreline Protection Act*** requires landowners to use soft-armoring techniques "where feasible." State agencies are developing maps showing where soft armoring is feasible and regulations to govern permitting of shoreline protective structures. Landowners must demonstrate that soft armoring is not feasible before they will be issued a permit for a hard-protective structure.[249]

North Carolina is considering similar legislation for its estuarine shorelines; hard armoring is banned along the coast but is presently allowed landward of wetlands.[250] The North Carolina Estuarine Biological and Physical Processes Work Group and Division of Coastal Management prepared recommendations to help the state develop new estuarine shoreline stabilization regulations and permitting guidelines. The recommendations categorize different types of estuarine shorelines (e.g., swamp forest, marsh, low-sediment bank) based upon how well each maximizes ecosystem functions (e.g., storm buffer, filtration of runoff, habitat). The report then recommends different types of shoreline stabilization methods (e.g., land planning, beach fill, vegetation control, groins, sills) in consideration of the potential impacts of each method on the different types of shoreline.[251]

TABLE 11: *Advantages and Disadvantages of Soft-Armoring Permits*

Evaluation Criteria	
Economic	Soft armoring can be less expensive than hard armoring but requires regular maintenance and monitoring. Beaches need a constant source of sediment and, therefore, may require expensive renourishment.[252] Wetlands restoration projects can be expensive, and designing restoration projects to withstand SLR impacts may add to the expense of restoration and maintenance.
Environmental	Soft armoring preserves beaches and wetlands that provide habitat and important natural flood control processes. Wetlands filter runoff and serve as habitat for wildlife including endangered species. Beach renourishment, however, can have negative environmental impacts and harm habitats as sea floors must be dredged to provide sand.[253]
Social	Where there is sufficient space, natural features can effectively buffer flood and storm impacts. Soft-armoring solutions may not, however, be effective in all areas; for example, beach renourishment may not be economically feasible in areas subject to significant erosion.[254] Wetlands must also be restored to maximize flood protection value and restoration may not be feasible in low-lying areas that will become inundated. Landowners often do not have confidence that soft-armoring will adequately protect their lands from flooding and erosion, even though a recent Virginia Institute of Marine Science (VIMs) study has shown that in some environments soft armoring is as protective as hard.[255]
Governance Criteria	
Administrative	In order to ensure adequate protection of property, governments may need to develop permitting criteria to determine the feasibility of implementing soft armoring in particular locations and to provide requirements for long-term maintenance. Because many jurisdictions already have processes for permitting hard armoring, it may be difficult to get regulators to shift to soft-armoring alternatives. Regulators may lack expertise or training in these techniques.[256] Soft armoring can also require an Army Corp of Engineers (ACOE) permit because it can involve the placement of fill in navigable waters. The ACOE has streamline permitting for many small-scale hard projects but more intense environmental review and other procedural requirements may pose a barrier to implementation of soft alternatives.[257] Soft armoring may not be feasible in some areas due to hydro-geological conditions.[258]
Legal	Most states will likely have to enact specific legislation encouraging use of soft armoring and establishing permitting requirements. Governments will also need to comply with ACOE permitting requirements. Governments seeking to preserve public investments in beach renourishment projects may also face special constitutional challenges.[259]

11. Rolling Coastal Management/Rolling Easement Statutes

Policy Goal: Planned Retreat and Accommodation

Type of Land Use: Developed and Developable Areas

Note: For a description of goals and uses, see pp. 13-14.

Experts and academics use the term "rolling easements" to refer to a broad collection of land-use policies. The policies can be implemented using different mechanisms, but they all have the same purpose—to ensure that coastal development does not impede the inland migration of coastal resources.[260] Rolling easements can be created using three mechanisms: state-level statutes[261] (what we define as "rolling coastal management statutes"), "rolling" conservation easements (see Tool No. 15), and conditions imposed in development permits (see Tool No. 6).[262]

In each form, land-use restrictions are imposed by reference to the tide line or other natural feature (e.g., dune crest or vegetative line). Restrictions are said to "roll" because the reference feature dynamically fluctuates with natural coastal processes. For example, governments often use the mean location of the mean high tide line (MHTL) to determine setback distances and other development restrictions.[263] The restrictions seek to ensure that natural coastal features can continue to migrate (or roll) inland as the seas rise, a process that is prevented where landowners build sea walls and other obstructions.

In each form of rolling easement, similar land-use restrictions are imposed. Coastal armoring is limited and landowners are required to remove structures that come to encroach on public lands (typically lands seaward of the mean high tide line). In the first form (rolling coastal management statutes), the legislature enacts a statute imposing these restrictions on all coastal areas or certain portions of the coast. The second and third forms of rolling easements are parcel specific. In the second form (rolling conservation easements), the government acquires a conservation easement and records these terms to limit development on an individual parcel. In the third form (permit conditions), the local government imposes these terms (on an individual landowner or developer) as conditions of a development permit, which is then recorded to perpetually bind the property.

This section will focus on the first form, rolling coastal management *statutes*. Several states have enacted such statutes: Texas, South Carolina, Rhode Island, and Maine. These statutes are grounded in the common law public trust doctrine. Under the public trust doctrine, each state owns coastal lands up to a reference line (typically the MHTL) and holds these lands in trust for the benefit of the public (so called tidelands).[264] These statutes codify the public's interest in state tidelands and limit coastal development to protect the public's interest in these lands.

Implementation of Rolling Coastal Management/Rolling Easement Statutes in a SLR Context

To ensure that coastlines can continue to migrate inland as the seas rise, rolling coastal management statutes typically include a combination of policies, including

- limitations on new development in at-risk coastal areas,
- limitations on construction of hard armoring (see Tool No. 9),
- removal requirements for structures that come to encroach on public lands, and/or
- real estate disclosure requirements (see Tool No. 18).[265]

Because armoring cannot be erected and obstructing development cannot be maintained, wetlands and tidal habitats can migrate naturally, thus ensuring that these lands are preserved for public purposes.[266]

Rolling coastal management statutes are more broadly effective than the other parcel-specific options (conservation easements and exactions). The land-use restrictions apply to all coastal development projects covered by the statute and, therefore, governments are not required to record any instruments or negotiate separately with individual property owners.

In order to enact a statute that will survive legal challenge, legislators should make specific findings about the environmental, health, and safety benefits achieved by the land-use restrictions. Legislators should make findings about the danger flooding poses to coastal development, the threat flooded structures pose to adjacent properties, and the damage that sea walls and coastal development cause to public trust lands (beaches and wetlands). Statutes designed only to protect public access may be subject to challenges similar to those launched against the Texas Open Beaches Act (discussed on the next page).

State and Federal Sources Proposing Use of Rolling Coastal Management/ Rolling Easement Statutes in SLR Context

Many state governments and federal agencies have proposed use of "rolling easement" policies to address SLR. However, these sources often refer to "rolling easements" generally and do not specify the manner by which the policy should be implemented—whether through a statutory mechanism (described on the previous page) or through programs to acquire or exact rolling conservation easements.

The ***California Adaptation Strategy*** recommends that state agencies coordinate with local governments to consider "policies and funding to facilitate easements to (a) relocate developments further inland, (b) remove development as hazards encroach into developed areas, or (c) facilitate landward movement of coastal ecosystems subject to dislocation by SLR and other climate change impacts."[267]

Florida, New Jersey and ***Virginia*** also recommend that the state consider rolling easement-type policies.[268]

EPA proposes the use of rolling easements as a wetlands protection policy in order to "maintain water quality" and "sediment transport."[269] EPA also recommends that governments adopt policies requiring the removal of existing structures and the restoration of the site to its natural condition if "waters rise to touch the structure for six consecutive months."[270]

Examples of Programs Implementing Rolling Coastal Management/Rolling Easement Statutes

The ***Maine Sand Dune Rules*** combine limits on upland development and prohibitions against sea walls to create a rolling coastal management statute. The Rules provide that "a project may not be permitted if, within 100 years, the property may reasonably be expected to be eroded as a result of changes in the shoreline such that the project is likely to be severely damaged after allowing for a [two-]foot rise in sea level over 100 years."[271] In order to obtain a development permit, project applicants must provide data to show how the project will be impacted by two feet of SLR. New sea walls are prohibited in areas expected to suffer severe damage within 100 years. Existing sea walls may be repaired or otherwise modified if they are relocated landward, or if they are otherwise made less damaging to the dune system. In addition, structures that come to be located on an intertidal zone (i.e., seaward of the mean high tide line) for a period of six consecutive months must be removed.[272]

The ***South Carolina Beachfront Management Act*** articulates a "40-year retreat policy," which establishes the state's preference for preserving the coastline by requiring the gradual relocation of development away from the coast. To effectuate this goal, the Act requires an erosion-based setback and prohibits construction of new coastal armoring.[273]

The ***Texas Open Beaches Act*** was the first statute to recognize a true "rolling easement." The constitutionality of the Act's easement, however, has been called into question by a 2010 Texas Supreme Court decision, *Severance v. Patterson*.[274] Enacted in 1959, the Act codified public rights to access dry-sand beaches (the land between state-owned tidelands and the mean vegetation line (MVL)) based upon historic public use of those lands.[275] Historically, courts interpreted the Act as creating a "rolling" public access easement—when a major storm event caused the MVL to migrate inland, the easement was found to also migrate inland. To protect the ability of the public to access the beach, the Act prohibited hard armoring that would obstruct public access. Also, the Act permitted the state General Lands Office to require the removal of structures that came to be located seaward of the MVL.[276] Landowners were offered up to $50,000 in financial assistance to relocate or remove encroaching structures.[277] The Act recently suffered a significant setback when the Texas Supreme Court held that Texas common law does not support the notion of a public access easement over dry-sand beach that "rolls" landward in a perceptible and dramatic storm event (a so-called "avulsive event" as distinguished from gradual, imperceptible erosion).[278] However, the court's analysis focused on the act's creation of a "rolling" public access easement. Other jurisdictions may be able to cure some of the defects of the Texas statute by crafting a rolling coastal management statute that is designed not only to protect public access, but also to preserve public trust lands and to avoid public and private nuisances. The Texas Supreme Court also reheard arguments in this case on April 19, 2011; so the matter has not been dispositively decided.

FIGURE 4: *Shoreline Before and After Hurricane Ike (Galveston, Texas)*

These photos shows the movement of the vegetative line before and after Hurricane Ike.
Source: U.S. Geological Survey - Bolivar Peninsula, Galveston, Texas. Used with permission.

TABLE 12: *Advantages and Disadvantages of Rolling Coastal Management/ Rolling Easement Statutes*

Evaluation Criteria	
Economic	This deferred approach is less costly than a total prohibition of coastal development. Rolling coastal management statutes allow coastal property owners to continue their beneficial economic use of property since development restrictions are often not triggered until rising seas cause structures to become inundated or encroach on public lands (impacts that may be decades in the future). However, these types of policies could negatively impact the values of regulated coastal properties when first enacted.
Environmental	These statutes protect public trust lands by ensuring that development does not inhibit the ability of the shoreline to migrate inland as the seas rise.
Social	Because these measures allow for some coastal development, they provide a flexible mechanism to balance private property interests with public interests in coastal areas. Rolling easement policies can combine both deferred measures, such as requiring the removal of structures damaged by flooding, with more proactive measures, such as real estate disclosures to discourage coastal development.
Governance Criteria	
Administrative	In order to create a statute, policymakers will need to decide what combination of policies to enact in their specific jurisdiction. Administration of rolling easements can be difficult when regulators try to enforce sea wall prohibitions and removal requirements.[279]
Legal	Most states would need to adopt new legislation incorporating rolling easement policies into their coastal development laws. It has been argued that rolling coastal management statutes may be an effective way to limit redevelopment in the future and avoid potential takings challenges. The statutes do not prohibit all economic use of coastal properties, but simply balance public and private interests in coastal lands. Also, by providing advance notice to coastal property owners, governments can set private expectations that structures will need to be removed in the future if SLR inundates coastal lands.[280] However, rolling coastal management statutes are relatively recent inventions in the law and are, therefore, mostly untested. Statutory provisions, such as removal requirements, may come under increasing judicial scrutiny as states begin to enforce the terms of the statutes, like the recent successful challenge to the Texas Open Beaches Act (discussed on the previous page).[281] The rights of coastal property owners are unsettled and vary state by state.[282] Therefore, states must craft statutes with careful consideration of their own unique common law principles regarding the public trust doctrine, nuisance, rights of ocean-front property owners, and the laws of erosion and avulsion (i.e., sudden shifts in deposits of sand due to storm events).[283] States may be able to avoid takings challenges by making explicit findings that the statute is designed to prevent public and private nuisances (such as adjacent flooding and erosion) and to protect public trust lands.

IV. Spending Tools

12. Capital Improvement Programs

Policy Goal: All

Type of Land Use: Critical Infrastructure, Developed and Developable Areas

Note: For a description of goals and uses, see pp. 13-14.

Many states require their local governments to prepare Capital Improvement Programs (CIPs). For proposed investments in public improvements (such as roads and sewers, for example), CIPs budget for, and site, future public improvements based upon projections of the community's growth.[284]

Implementation of Capital Improvement Programs in a SLR Context

Legislatures could require their local governments to consider future sea-level rise when developing CIPs. This could be a powerful tool to discourage investment in infrastructure projects that may be vulnerable to SLR. Through CIPs, governments could site new infrastructure out of harm's way, discontinue maintenance and repairs to infrastructure that is repetitively damaged, and relocate or retrofit existing infrastructure to be more resilient to SLR.[285]

State and Federal Sources Proposing Use of Capital Improvement Programs in SLR Context

The ***Maryland Working Group*** recommends that "planning efforts for new or modified capital projects, such as transportation planning, stormwater management, and infrastructure siting … assess [SLR] and storm surge vulnerability." Maryland further recommends that the "design of future public projects, including roads, bridges, tunnels, landfills, water, and wastewater treatment plants, etc., should consider the effects of climate change and [SLR]. In addition, standards should be developed for the modification of existing facilities in response to [SLR]."[286] More specifically, in its guidance to Dorchester County, the Maryland Department of Natural Resources recommended that the county "provide for the termination of maintenance on roads where the cost to maintain exceeds the Fair Market Value of the properties it serves."[287]

The ***North Carolina Ocean Policy Steering Committee*** recommends "development of a 'worst-case scenario' State-level planning document that establishes general policies and guidelines for identifying … areas and infrastructure [that] may no longer be supported through public funds." Such a plan will apply in the event that SLR "progress[es] at a rate that would make it unwise and uneconomical to continue to maintain certain areas and infrastructure on threatened barrier-island segments."[288]

The ***Virginia Governor's Commission*** recommends that "the Commonwealth … establish policies that discourage expenditure of public funds on development of public infrastructure in areas highly vulnerable to climate change effects, especially [SLR] and increased risk of flooding from intense precipitation events." The plan further recommends that state agencies and local governments account for climate change impacts in "planning, project design, and prioritization of all critical infrastructure projects for funding, as well as infrastructure management, operations, and maintenance" in coastal areas vulnerable to SLR and storm surge.[289]

The ***Washington Working Group*** recommends that the state "include best available data on [SLR] in design of new coastal facilities and major repair projects" and that the state consider SLR when funding local projects.[290]

EPA recommended that the state of Maine "develop a written capital investment policy to discourage an irreversible commitment of public resources for new infrastructure or structures in areas likely to be affected by accelerated [SLR], except to the extent necessary to support continued economic viability and efficient functioning of water-dependent uses."[291]

Examples of Programs Implementing Capital Improvement Programs

The ***Maryland Growth Act*** and ***Smart Growth Initiative*** promote infill development by targeting state funding of infrastructure to already developed areas. The law requires local governments to designate "Priority Funding Areas" appropriate for future growth. Within these areas, the law encourages local governments to promote mixed-use development, site development around infrastructure, and preserve open space.[292]

The ***Federal Coastal Barrier Resources Act*** prohibits federal agencies from funding the development of infrastructure on barrier islands. Although state and local entities can still fund and permit development in these areas, the Act prohibits federal support for these activities.[293]

TABLE 13: *Advantages and Disadvantages of Capital Improvement Programs*

Evaluation Criteria	
Economic	By requiring consideration of SLR in CIPs, governments could ensure that scarce public funds are not wasted developing infrastructure that will be at risk of damage from flooding and erosion in the near future. Using CIPs, local governments can plan for and budget for the significant additional investment that may be required to relocate or retrofit existing infrastructure. However, by discouraging development in coastal areas, governments may sacrifice some additional tax revenues.
Environmental	By not building public infrastructure or facilities, governments could discourage development of vulnerable coastal areas that provide important natural services. Governments could also relocate or retrofit infrastructure that is currently obstructing tidal flow to restore areas to their natural floodplain function.
Social	Use of CIPs to discourage private development in vulnerable areas, limits the number of people and structures at risk of SLR impacts. However, communities that lose transportation services provided by infrastructure may experience economic and social disruption.
Governance Criteria	
Administrative	It may be politically difficult to limit investments, especially to discontinue repairs of existing infrastructure that segments of the populace rely on (such as streets). Planners may also have to develop criteria to determine when to discontinue expenditures, such as when the costs of repair exceed the benefits.[294]
Legal	Governments typically have varying degrees of discretion to determine where to invest public funds. However, government liability for disinvestment (i.e., abandoning or limiting maintenence) is unclear, especially for roadways. Governments could be liable for abandoning roads when abandonment causes abutting landowners to lose their right of access.[295] Governments may also face liability for failing to retrofit or relocate public utilities that, if flooded could cause impacts to neighboring landowners.[296] Governments may also have a duty to maintain roads depending on how they funded the construction. For example, governments are statutorily required to maintain roads built with federal funds [(citation: 23 U.S.C. S116 (West 2010)].

13. Acquisitions and Buyout Programs

Policy Goal: Planned Retreat and Preservation

Type of Land Use: Developed, Developable Areas, and Undevelopable Areas

Note: For a description of goals and uses, see pp. 13-14.

State and local governments can use public funds to acquire land for conservation purposes and to promote public health and safety. Governments can acquire both developed and undeveloped parcels. Acquisition programs can be used to purchase lands for public purposes, such as to create open space, public parks, public highways, or other infrastructure.[297] Governments can prioritize for acquisition undeveloped lands that are vulnerable to development and that provide important ecological benefits. Governments can also acquire developed properties that have been damaged by flooding or other hazards. Structures on the property can be demolished, and the property conserved as open space.[298]

Acquisition programs are typically voluntary; the landowner must consent to sell to the government. Funds to acquire land through these types of programs are raised through taxes, fees, or the sale of government bonds. *Eminent domain* powers can also be used to condemn properties to prevent against hazards to health, safety, and welfare. This section focuses on acquisitions of property in fee simple;[299] however, governments can achieve similar objectives through acquisition of conservation easements (see Tool No. 14).

Implementation of Acquisitions and Buyout Programs in a SLR Context

Acquisition programs could be used to address SLR as follows:

- State and local governments (or private land trusts or non-profit organizations) could acquire undeveloped property at risk from SLR in order to conserve natural resources, such as wetlands and beaches, provide upland migration corridors, preserve habitat, or provide flood buffers for existing development.
- Floodplain buyout programs could be extended to properties threatened by future SLR; governments can preemptively acquire developed properties in order to remove at-risk structures and restore floodplain function.

To optimize use of scarce public funds, purchasers may need to prioritize properties for acquisition based upon the threat to the property from flooding, habitat value of the property, capacity of the property to allow for inland migration of wetlands or beaches, and the buffer potential of the property to protect existing development against storm surge or erosion.[300]

Governments may also need to consider the *future* natural resource value of properties slated for acquisition. For example, as the seas rise, existing wetlands may drown and adjacent dry land may become inundated. Although some dry lands may not have current natural resource value, preservation may nonetheless be justified because the land could provide room for wetlands to migrate inland in the future.

State and Federal Sources Proposing Use of Acquisitions and Buyout Programs in SLR Context

The ***Florida Action Team*** recommends that the legislature "place a priority on coastal land acquisition through the Florida Forever program" (an existing statute that authorizes several state agencies to acquire interests in land for conservation purposes). The Action Team further recommends that "acquisition efforts … be strategically targeted to protect coastal resources, reduce insured risk, and reduce the impacts of climate change on both ecosystems and communities."[301]

The ***Massachusetts Coastal Hazards Commission*** recommends that the state "conserve coastal land and minimize loss through acquisition of storm-prone properties from willing sellers in fee* or through conservation restrictions and easements." They further recommend that coastal communities use property taxes generated by the state Community Preservation Act to fund acquisition of storm-prone properties.[302]

The ***South Carolina Shoreline Change Advisory Committee*** recommends that the state establish "coastal land acquisition and protection mechanisms … as part of long-term retreat strategies, and to ensure that sufficient space is afforded for short-term beach/dune erosion cycles. This policy recommendation focuses on programs for the voluntary acquisition of priority high risk coastal properties." The plan recommends that the state acquire undeveloped lands for preservation purposes, acquire developed lands in high-risk areas during redevelopment, and use funds to relocate development out of high-risk areas.[303]

EPA supports acquisition of threatened coastal lands for conservation purposes. As an alternative to a pure acquisition program, EPA recommends use of a land exchange program whereby owners of threatened property can trade their land for government-owned land that is upland from the floodplain.[304]

Examples of Programs Implementing Acquisitions and Buyout Programs

The ***California Coastal Commission*** is coordinating with the State Coastal Conservancy to facilitate acquisition of property in high-risk areas.[305] This program is illustrative of coordination between different public agencies (and between public and private groups) to fund and implement acquisition programs.

Through its ***Florida Forever*** program, Florida has acquired 638,600 acres of land at a cost of $2.62 billion. Funding for the current program is near depletion. Experts recommend that the state include SLR as a funding criterion in any successor program.[306]

Maryland is taking climate change into consideration when establishing priorities for acquiring property for conservation. For coastal properties, the Department of Natural Resources is looking at the property's suitability as habitat and for upland migration of wetlands.[307]

The ***New Jersey Coastal Blue Acres Program*** authorized use of $15 million in bond funding for grants and loans to municipalities and counties to acquire lands in coastal areas for recreation and conservation purposes. Priority lands include those that have been damaged by storms, that may be prone to storm damage, or that buffer or protect other lands from storm damage.[308]

New York has incorporated consideration of SLR in its ***Open Space Conservation Plan***. A recommended action in the plan is to "[d]evelop a long-term statewide program to prioritize high risk floodplain areas for conservation through acquisition and easement. Include plans to facilitate tidal wetland migration in response to sea-level rise."[309]

The ***Washington Department of Ecology*** is evaluating ways to integrate SLR into grant-funded acquisitions of estuaries in partnership with NOAA's Coastal and Estuarine Land Conservation Program.

FEMA funds buyouts of property at risk of flooding through competitive grants to state and local governments under its Hazard Mitigation Assistance (HMA) programs. Grants can be used to acquire, demolish, or relocate threatened properties. To be eligible, localities must show that the buyout is cost effective and reduces the future risks from

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*Fee title is the most common way to hold real property; the landowner has absolute ownership of the land. (Black's Law Dictionary 426, 6th ed., 1991)

flooding. Buyouts must be voluntary, and homeowners are offered the appraised fair market value of their home, before it flooded.[310]

The ***NOAA Coastal and Estuarine Land Conservation Program*** (CELCP) provides matching federal funds to state and local governments to fund acquisitions of coastal properties.[311] Properties that receive funding must first be identified in a state coastal and estuarine land conservation plan and states must nominate the projects to be selected from a competitive national process administered by NOAA. Eligible properties must be coastal or estuarine and must "have significant conservation, recreation, ecological, historical, or aesthetic values, or [be] threatened by conversion from their natural or recreational state to other uses, giving priority to lands which can be effectively managed and protected and that have significant ecological value."[312]

The ***U.S. Fish and Wildlife Service National Coastal Wetlands Conservation Grant Program*** "provides matching grants to States for acquisition, restoration, management or enhancement of coastal wetlands." The federal government will provide as much as 75 percent of funding for projects in states that have dedicated funds for the conservation of wetlands or other natural areas.[313]

TABLE 14: *Advantages and Disadvantages of Acquisitions and Buyout Programs*

Evaluation Criteria	
Economic	Property acquisitions can be expensive, local governments lose the tax revenue from acquired land, and the value paid will likely not be fully discounted for the future risk of flood impacts because of the uncertainties of climate change.[314] The government is typically required to pay the appraised fair market value of the property upfront before the danger of flooding is realized. The government also has to hold and manage lands after acquisition.[315] State and local governments, however, may be able to leverage federal programs to support acquisition programs.
Environmental	By prioritizing acquisition of properties that have high natural resource or flood buffer value, governments can maximize environmental protections. Governments can also acquire at-risk properties with structures and restore those properties to provide natural flood protections and other ecosystem services.[316] Acquisitions also ensure that properties are preserved as open space in perpetuity.
Social	By acquiring properties that serve as natural flood buffers, governments can maximize protection of adjacent developed areas and preemptively relocate vulnerable households.[317] However, it is often difficult to get full participation in voluntary buyout programs. Lack of full participation can create a checkerboard effect: some parcels are acquired and converted but other parcels remain developed. The checkerboard effect can cause blight in the community and makes it more difficult to restore the ecological services provided by the acquired lands.
Governance Criteria	
Administrative	It can be difficult for governments to determine how to set acquisition priorities. The viability of acquisition programs may also be politically tenuous because taxpayers may not want to spend scarce public funds.[318] Additionally, when governments acquire land, they must expend additional public funds holding and managing acquired lands. Coastal managers may need to consider how acquired lands may be impacted by SLR, since some lands purchased with public funds may become inundated over time.
Legal	Acquisition programs are easy to implement because most state legislatures have delegated authority to one or multiple public entities to acquire real property for open space and other conservation purposes.

14. Conservation Easements

Policy Goal: Planned Retreat and Preservation

Type of Land Use: Developable and Undeveloped Areas

Note: For a description of goals and uses, see pp. 13-14.

Conservation easements (sometimes called open space easements) are a special kind of easement created to preserve property in its natural state. Conservation easements are used to preserve property for habitat, open space, recreation, historic values, and farmland, among other things. They are typically sold or donated by landowners to state or local agencies or non-profit land trusts.[319] Many conservation easement statutes require that the purchase or donation of the easement be voluntary, in which case the landowner is either paid for the easement or receives a tax benefit for the donation. Conservation easements are useful because they allow the property to remain in private ownership, but the landowner agrees to limit development on the land pursuant to the terms of the easement.[320] The easement is recorded and binds all future owners of the property.

Implementation of Conservation Easements in a SLR Context

Conservation easements could be used to prevent development in areas that are vulnerable to SLR. Similar to acquisition programs, agencies could prioritize vulnerable properties and purchase conservation easements across parcels that have particular utility as habitat or natural buffers, or where ecosystems can migrate inland as the seas rise. These conservation easements could include specific covenants to limit the impacts of SLR, including prohibiting shoreline armoring, specifying the type of shoreline stabilization allowed, prohibiting removal of vegetation, and restricting land uses or activities on the parcel that could contribute to erosion or impair natural shoreline processes.[321]

State and Federal Sources Proposing Use of Conservation Easements in SLR Context

The ***North Carolina Steering Committee*** recommends "amending [its] conservation tax credit program to make the donation of unbuildable or threatened lots a more appealing option to homeowners."[322] The committee recommends that the state reevaluate its existing conservation easement programs to ensure that properties in vulnerable areas are eligible to receive tax credits and to ensure that property owners have sufficient incentive to sell or dedicate easements.

Examples of Programs Implementing Conservation Easements

The ***Maryland Environmental Trust*** administers a conservation easement program that covers, among other areas, wetlands and "undisturbed natural areas."[323] This program could be used to acquire additional conservation easements along the coast to reduce development in flood-prone areas.

The ***NOAA Coastal and Estuarine Land Conservation Program*** (CELCP) also provides matching federal funds to state and local governments to purchase conservation easements from coastal property owners.[324]

TABLE 15: *Advantages and Disadvantages of Conservation Easements*

Evaluation Criteria	
Economic	Conservation easements are less costly than acquiring full title to property, but they still require governments to use taxpayer funds to acquire easements in advance of flooding. Acquiring easements is more efficient and cost effective than outright acquisition of the entire parcel because the purchaser need only purchase the rights necessary to conserve the property. Because the landowner retains title to the property, state and local governments do not need to use public resources to maintain the property.[325] Furthermore, the landowner can continue to make economic use of the property (e.g., through agriculture or forestry) so long as those uses are consistent with the requirements of the easement.[326] Some dedications qualify for federal tax deductions, and state governments can also encourage landowners to dedicate easements by offering state tax incentives (see Tool No. 16).
Environmental	Governments can prioritize acquisition of properties that provide important habitat and ecological benefits. Easement terms require that the land be preserved as open space in perpetuity. Conservation easements can also be used to preserve lands to allow for the upland migration of coastal resources as sea levels rise.
Social	Similar to acquisition programs, conservation easement programs can be used to preserve properties that serve as important flood buffers to adjacent development. Conservation easements provide a voluntary and flexible mechanism by which governments can compensate landowners and preserve property for floodplains and other environmental benefits.
Governance Criteria	
Administrative	Conservation easements are more politically popular than regulations because they essentially allow for the transfer of development rights from private landowners to the government. The utility of this tool is limited, however, because enabling statutes often limit acquisitions to voluntary sales.[327] Therefore, the government may not be able to prevent all development in all vulnerable areas. Governments must find an appropriate entity (a public entity or a nonprofit land trust) to hold and monitor the easement and enforce its terms.
Legal	State and local governments' authority to acquire conservation easements is clear: nearly all 50 states have enacted statutes enabling acquisition of conservation easements.[328] Because these statutes broadly allow for creation of easements that impose both affirmative and negative obligations, the types of restrictions imposed can vary greatly between individual easements. A relatively recent creation in the law, conservation easements have not been fully tested in the courts. As burdened lands change hands and entities seek to enforce the terms of their easements, these easements may come under increasing judicial scrutiny, and courts may refuse to enforce some terms.[329] Easement holders must also have the finances and the institutional capacity to litigate these claims.

15. Rolling Conservation Easements

Policy Goal: Planned Retreat and Accommodation

Type of Land Use: Developed and Developable Areas

Note: For a description of goals and uses, see pp. 13-14.

Because conservation easement enabling acts are written so broadly, state and local governments could use these authorities to create innovative "rolling" conservation easements. Enabling statutes typically authorize the creation of conservation easements that impose both negative obligations (preventing an owner from engaging in certain activities on his or her land) and affirmative obligations (granting the easement holder rights to use the property for certain purposes).[330] This gives governments broad authority to individually craft easement terms. Governments could create easements that allow limited development in upland portions of a lot while preventing certain activities along the shoreline.[331] The easement could cover the entire property or just the shoreline. The easement could prohibit all development or merely particular kinds of development. Such a "rolling" conservation easement would be distinct from a traditional conservation easement because it would allow for continued upland development and use (i.e., a rolling easement would not require that the whole parcel be preserved in its "natural state") but would provide for the eventual termination of that use over time as the seas rise and lands become inundated.

Implementation of Rolling Conservation Easements in a SLR Context

One type of rolling easement policy is to acquire conservation easements that ensure that coastal development does not impede the migration of coastal resources as the seas rise. These easements would protect public trust lands by preventing development that could erode or degrade public lands. The easement would "roll" because the easement terms would be triggered as the tide line migrated inland as the seas rise.

These easements would be unlike traditional conservation easements, which typically prohibit all development on burdened parcels. By contrast, rolling easements would allow for limited development of upland portions of the parcel but would prohibit armoring and other development that could obstruct tidal processes. As the tide line recedes, the easement terms would require that structures be removed when they come to encroach on public lands.

This approach is an innovative and flexible way of balancing public and private interests in coastal lands. Private landowners receive up-front compensation for agreeing to limit development in the future. Meanwhile, they can continue to develop and use their property until the rising seas threaten their development (impacts that may be decades in the future). In exchange, the government receives assurances that coastal development will not be maintained in a manner that will threaten public resources.[332]

State and Federal Sources Proposing Use of Rolling Conservation Easements in SLR Context

Many state governments and federal agencies have proposed use of "rolling easement" policies to address SLR. These sources often refer to "rolling easements" generally and do not specify the manner by which the policy should be implemented (see p. 44). None of the sources specifically propose acquisition of rolling conservation easements that are parcel specific.

Examples of Programs Implementing Rolling Conservation Easements

The author is unaware of any public entities or private land trusts that have created "rolling" conservation easements with terms similar to those suggested by this section.

TABLE 16: *Advantages and Disadvantages of Rolling Conservation Easements*

Evaluation Criteria	
Economic	Rolling conservation easements could be even more cost effective than acquiring traditional conservation easements because the purchase price should be discounted based upon the landowner's ability to continue his or her economic use of the property and because the easement will not be enforced until the impacts of SLR are realized.[333] However, valuation may be difficult given the uncertain impacts of climate change.
Environmental	Rolling easements could be used to ensure that coastal resources can migrate inland without being impeded by armoring or development. However, the terms of the easement would only bind the specific parcel covered by the grant. Therefore, the environmental benefits provided by the easement would terminate as that parcel becomes inundated. (The easement terms would not bind the next inland property.)
Social	Rolling easements can preserve properties that provide important ecological benefits, while not unnecessarily limiting private rights to develop upland portions of a parcel. Landowners can still develop parcels and are compensated for preserving shoreline features that provide natural protections to their development.
Governance Criteria	
Administrative	Because these types of easements have not yet been tested and there are no examples of them, rolling conservation easements may be more difficult to administer than traditional conservation easements. Rolling easements may not be eligible for the same tax exemptions that are available to landowners who dedicate conservation easements and thus may be less attractive to landowners.[334] Finally, the easement value may be difficult to assess because the terms of the easement may allow for significant development of upland portions of the property, and restrictions may not be enforced for many decades.[335]
Legal	Although conservation easement statutes are written broadly to preserve flexibility, the use of these statutes to create "rolling" conservation easements may be problematic because no one has used a conservation easement in this manner. Governments will need to analyze their enabling legislation to ensure that they are empowered to create this type of easement.[336] Also, these easements may be legally challenged in the future when governments seek to enforce their terms. These challenges may not be raised for several decades and may be raised by subsequent owners. Therefore, to use this tool, governments will need to craft the easement terms carefully to ensure that public funds are not used to acquire easements that may some day be unenforceable.

V. Tax and Market-Based Tools

16. Tax and Other Development Incentives

Policy Goal: Planned Retreat, Accommodation and Preservation

Type of Land Use: Developed, Developable and Undeveloped Areas

Note: For a description of goals and uses, see pp. 13-14.

Tax policy can influence the use and development of land. Landowners are typically assessed taxes based upon the current appraised value of their real estate—the value of the land, its improvements, and its development potential (i.e., fair market value).[337] This method of assessment tends to spur development in coastal areas because landowners are assessed taxes based upon the land's market value, which considers its development potential, not just its current use. Because land values have dramatically increased along the coast, the taxes on a property with a small residence may greatly exceed the property's rental value. Those landowners are often forced to sell or develop their property for more economically viable competing uses.[338]

By altering this form of taxation, governments can use tax incentives to encourage preferred development patterns (for example, redevelopment of blighted areas, limitation of urban sprawl, or preservation of farmland). The following three types of programs offer tax incentives:

- ***Preferential assessment programs*** offer lower tax assessments to landowners who agree to preserve their property. Preferential assessment programs take into account restrictions on a property's development potential in order to encourage particular uses (such as historic or environmental preservation). Taxes are assessed based upon the property's current use value, not its potential use value. In this way, preferential assessment programs remove the incentive of property owners to develop property to keep pace with property tax increases.[339]
- ***Tax abatement (or deferment) programs*** freeze, for a specified period of time, increases in property taxes if the property is used for a particular preferred purpose (e.g., if the property is preserved for historic purposes). The deferred taxes do not have to be paid unless the property becomes ineligible under the program's guidelines (e.g., a historic structure is destroyed and the property is subsequently redeveloped).
- ***Tax credit programs*** provide a one-time credit against business, personal income, or property tax. These programs are often used to encourage redevelopment of urban blighted areas. Localities create "incentive zones" where developers are offered different incentives in order to encourage redevelopment projects in those areas.

Conservation easements provide examples of tax incentives. The federal government provides a tax deduction to landowners who donate an easement on their land "exclusively for conservation purposes."[340] The grant of the easement qualifies as a charitable donation. Donating landowners can deduct 30 percent of the appraised value of the easement from their federal income tax. When the donating landowner dies, 40 percent of the value of land subject to the conservation easement can also be excluded from the landowner's estate for tax purposes.[341] In addition, some

states offer a preferential tax assessment that reduces the donating landowner's state property taxes based upon the diminution in the property's value caused by the restrictions imposed by the easement. [342]

Local governments can also offer other types of non-tax incentives, such as permitting and density incentives. By offering fast-track review or reducing permit application fees, governments can encourage development of certain types of preferred projects. Local governments can also encourage infill development in upland urban areas by offering density incentives.[343] Developers who build in certain preferred areas or who cluster development are allowed to increase the number of units per lot.

Implementation of Tax and Other Development Incentives in a SLR Context

Incentive programs could be used to discourage development in areas likely to be threatened by SLR. Such programs could take the following forms:

- ***Relocation/retrofit tax incentives***—Governments could provide a one-time tax credit to property owners who move structures out of at-risk areas (either relocating on the same or a different parcel) or retrofit structures to be more resilient to flooding. Tax credits should be offered when the landowner exceeds the minimum standards required by existing ordinances (i.e., the minimum required setbacks or building elevations).
- ***Siting incentives***—Governments could provide tax incentives or density bonuses to encourage developers to site new development in lower-risk areas of a lot or a subdivision. For example, infill tax incentives could be used to encourage clustering of development in already urbanized upland areas.
- ***Conservation tax incentives***—Governments could offer preferential assessments to landowners who agree to conserve their property for flood control or open space purposes. Landowners who donate easements would be assessed lesser property taxes based upon the loss of value caused by the easement terms limiting uses of the property.

State and Federal Sources Proposing Use of Tax and Other Development Incentives in SLR Context

The ***California Adaptation Strategy*** generally recommends that state and local governments identify "federal, state and local funding or tax incentives to relocate out of hazard areas."[344]

The ***Florida Action Team*** recommends "encourag[ing] the landward siting and relocation of structures and public facilities in areas adjacent to receding shorelines through ... tax incentives."[345]

Examples of Programs Implementing Tax and Other Development Incentives

New York offers a ***Green Building Tax Credit*** to property owners who make "green" improvements to their buildings. Eligible improvements include increasing the energy efficiency of buildings, using newer appliances, and using green building materials (such as recycled materials).[346] The Green Building Tax Credit may be a useful model for creating a tax credit program to encourage landowners to retrofit structures to be more resilient to flood impacts.

The ***North Carolina Conservation Tax Credit Program*** provides a one-time tax credit to landowners who voluntarily agree to preserve their property for conservation purposes. Landowners may receive a tax credit of 25 percent of the fair market value of the property donated for conservation purposes to apply against their state income tax.[347]

The ***South Carolina Omnibus Coastal Property Insurance Reform Act*** provides a tax rebate to homeowners who purchase supplies to retrofit homes to be more resilient to storms.

Virginia has one of the most generous tax incentive programs in the country. Landowners who donate conservation easements can deduct up to 40 percent of the value of the easement from their state income tax. Credits can also be sold and used by others who have a greater tax burden and, therefore, can receive greater financial benefits from the credit. Unused portions of a credit can be carried over for up to 10 consecutive taxable years.[348]

TABLE 17: *Advantages and Disadvantages of Tax and Other Development Incentives*

Evaluation Criteria	
Economic	Tax incentive programs can serve as a cost effective way of encouraging desirable development while avoiding more costly regulatory or spending measures. However, they may reduce the government tax base and may reduce funds available for other government programs or services. Governments should consider limiting use of tax incentives to encourage activities that go above and beyond regulatory requirements so that landowners do not develop expectations that they will be compensated whenever development restrictions are imposed.
Environmental	When used to further strategies such as infill growth, tax incentives can work hand in hand with other "smart growth" strategies to promote denser development, direct development away from ecologically sensitive lands, and reduce greenhouse gas emissions. Conservation incentives can be used to preserve land that serves as important flood buffers.
Social	To reduce the vulnerability of new and existing development to future flooding, siting and relocation incentives could be used as an alternative to regulatory mechanisms. Tax incentives are often more politically popular because landowners and developers receive financial incentives to counteract any additional costs that may be required to relocate or retrofit structures.
Governance Criteria	
Administrative	While tax incentives are a politically neutral way of influencing development, administration can be difficult because planners need to coordinate with tax assessors, who appraise real estate for taxation purposes. Tax incentive programs also require planners to consider the different types of development patterns they seek to encourage and tailor the incentive program to encourage those uses.[349]
Legal	Most state and local governments have existing authority to offer various tax incentives. Decision makers should review the statutes authorizing these programs to ensure that they allow governments to offer incentives that address SLR.

17. Transferable Development Credits (TDC)

Policy Goal: Planned Retreat, Accommodation and Preservation

Type of Land Use: Developed and Developable Areas

Note: For a description of goals and uses, see pp. 13-14.

Transferable development credits (TDCs)—also called transferable development rights or TDRs—create market incentives to shift development to areas where development is preferred.[350] Through zoning ordinances, local governments designate areas where they want to discourage development ("sending areas"). The ordinance allows property owners in these areas to sever development credits (monetized by the level or development the base zoning ordinance would allow, such as five units per acre) and to sell them to areas where the local government wants to encourage development ("receiving areas").[351] The buyer can then use the credit to exceed development densities, floor areas, or building heights in receiving areas. The property owner of the restricted parcel receives financial compensation for forgoing development and preserving his or her property. In order to ensure that property in the sending area is conserved, a permanent conservation easement is recorded against the sending property in conjunction with the sale of the development credit.[352]

Purchase of development rights (PDRs) are similar to TDCs except that they are typically purchased by public entities or private parties and then retired, rather than used to increase development in a receiving area.[353] In this way, they function like a conservation easement.

Local governments can also offer tax rebates to compensate landowners for development credits. Rather than use the TDC, the owner of the credit can receive a real estate tax abatement (see Tool No. 16) equal to the fair market value of the development credit.[354]

Implementation of Transferable Development Credits in a SLR Context

A TDC program could be designed to address sea-level rise. Local governments could amend zoning ordinances to (1) restrict development in vulnerable areas and designate them as "sending areas"; (2) designate inland "receiving areas" where development is appropriate and increased density is desirable; and (3) establish and calibrate a development credit market in a manner that gives affected landowners an incentive to transfer their development rights rather than build on threatened properties.[355]

State and Federal Sources Proposing Use of Transferable Development Credits in SLR Context

The ***Florida Action Team*** recommends that state agencies consider use of planning tools to "maximize opportunities to protect the beach/dune system, coastal wetlands, and other coastal resources in an era of rising seas" including tools "to encourage the landward siting and relocation of structures and public facilities in areas adjacent to receding shorelines through … transfer of development rights."[356]

EPA suggests that governments consider using "transferable development rights to compensate landowners for development restrictions (used in conjunction with land-use regulations)."[357]

Examples of Programs Implementing Transferable Development Credits

Dade County, Florida, has used TDCs to preserve over 100,000 acres of everglades outside of the Everglades National Park. Properties adjacent to the park flood periodically and, therefore, cannot be developed. To provide some financial compensation, the county allocated owners Severable Use Rights (or TDCs) that can be sold to increase the intensity or density on upland parcels.[358]

Malibu, California, provides a useful example of a coastal area that has successfully implemented a TDC program. Much of Malibu is located along a steep highly erosive mountainous range overlooking the Pacific Ocean. Many small lots were created in Malibu prior to the enactment of subdivision regulations. Many of the old lots were inappropriate for development because they were inaccessible to roadways and could not support septic systems. To prevent development of these substandard lots, Malibu required developers to acquire and extinguish a TDC from a substandard lot before they can get approval for a new subdivision.[359]

Montgomery County, Maryland, downzoned portions of the county to allow only one unit per 25 acres. Affected landowners forgo developing their parcels and sell one TDR for every five acres preserved. Areas near the District of Columbia and along transportation corridors were designated as receiving areas. Rural portions in the northwest of the county were designated as sending areas for the purpose of preserving them for agricultural uses. The program encourages participation by allowing developers to increase densities only by using a TDR. Additionally, public investment in capital improvements (such as roads and utilities) is limited in sending areas.[360]

The ***New Jersey Pinelands program*** is a regional TDC program involving 60 different jurisdictions. As of 2000, the program had preserved 20,000 acres of environmentally sensitive property. The program is administered by a state agency, the Pineland Commission, and utilizes a development credit bank to facilitate transfer of credits and ensure a floor price for credits. The Pinelands program is unique because it was started with federal support. In 1978, Congress created the Pineland National Reserve. In order to receive federal funds to acquire land for the Reserve, the state was required to create a regional planning commission to direct preservation of the area.[361] Although more difficult to design and administer, regional TDC programs have the benefit of conserving more acreage while creating a larger market for development credits.

Massachusetts developed a Transfer of Development Rights Model Bylaw. The bylaw provides examples of two different approaches to creating a TDR program. The first approach focuses on restricting development in sending areas for more rural communities that do not have the capacity to support additional densities. The second approach focuses on providing bonuses in receiving areas for suburban communities that can support more intense or dense uses in specific areas.[362]

TABLE 18: *Advantages and Disadvantages of Transferable Development Credits*

Evaluation Criteria	
Economic	TDC programs allow governments to downzone and conserve threatened properties. They also provide affected landowners some economic benefit through private transactions.[363] The cost of conserving the property is shifted to willing private developers because the developer who receives the building bonus pays the affected landowners for their forgone development. By creating a market for development credits, TDC programs can also avoid large government expenditures to preserve threatened properties.[364]
Environmental	TDC programs can preserve vulnerable ecosystems and complement "smart growth" policies, increasing density around existing infrastructure to provide important mitigation co-benefits.
Social	TDC programs can be an effective means of limiting development to preserve natural flood buffers while providing affected property owners with some economic benefit. Landowners typically view TDC programs as a more equitable way of regulating development because they are compensated for forgone development.[365]
Governance Criteria	
Administrative	TDC programs have proven to be difficult to design and administer and, as a result, have not been implemented by many jurisdictions.[366] Localities must figure out what areas should be preserved and where to allow for increased densities.[367] One of the main challenges is correctly calibrating the market so landowners have an incentive to sell their development rights.[368] To be effective, TDC programs often require local governments to downzone both sending areas and receiving areas—sending areas to ensure that the land remains undeveloped and receiving areas to ensure that there is a market for increased density and the TDCs. Downzoning often sparks political opposition because citizens oppose development restrictions or increased densities.[369] TDC programs have the most utility in developable areas, but they could be used innovatively to prohibit redevelopment in areas damaged by flooding.
Legal	TDC programs have successfully been used to insulate land-use regulations from takings challenges. The development credit is viewed as part of the retained property rights of the landowner, and courts consider the development credit when assessing the potential economic use of the property.[370]

18. Real Estate Disclosures

Policy Goal: Planned Retreat and Accommodation

Type of Land Use: Developed and Developable Areas

Note: For a description of goals and uses, see pp. 13-14.

State and federal laws require sellers of real estate to disclose certain information (e.g., special taxes levied on a property and the presence of lead-based paints) to potential buyers either before or at the time of transfer. Disclosure laws also require sellers to disclose natural hazards that can put property at risk, such as location in a known flood hazard area. The purpose of these disclosure laws is to ensure that buyers are fully informed about the conditions of the property prior to its purchase, which allows them to adjust their market decisions according to the risks.[371]

Implementation of Real Estate Disclosures in a SLR Context

Similar laws could be enacted to require disclosure concerning property that is vulnerable to flooding and erosion from SLR. Implementation of this policy could take two forms:

- ***Government dissemination***—Governmental bodies (e.g., state or local agencies) could compile data, erosion maps, inundation models, and other relevant information and make this information accessible to potential property buyers and developers.[372]
- ***Mandate private disclosures***—Governments could require sellers to disclose to potential buyers that a property is located in an area vulnerable to SLR.[373]

To implement a policy requiring disclosure of future risks, governments will need to determine what properties are vulnerable. Governments may need to develop maps and models of how different SLR scenarios will impact their locality to identify the properties subject to the disclosure requirements. Governments may also need to help sellers and buyers understand SLR maps and the scientific data used to create maps and models. Landowners could also be required to disclose any regulations that restrict development of the parcel (such as setbacks and removal requirements).[374]

State and Federal Sources Proposing Use of Real Estate Disclosures in SLR Context

The ***Florida Action Team*** recommends "consider[ing] a Full Disclosure Law that alerts buyers of coastal property about erosion rates, storm history, SLR concerns, and other relevant information."[375] The plan also recommends that insurance companies be "encourage[d] … to provide policyholders with greater disclosure about climate risk. Insurance companies need to adequately inform their customers and shareholders about the risks climate change poses to the insurance business and the ability of the industry to pay policyholders' claims."[376]

The ***Maryland Working Group*** recommends that the state "develop a Maryland [SLR] Disclosure and Advisory Statement to inform prospective coastal property purchasers of the potential impacts that climate change and [SLR] may pose to a particular piece of property."[377]

The ***South Carolina Shoreline Change Advisory Committee*** recommends that the state "establish stronger rules for real estate disclosure to provide coastal property buyers information of the potential perils associated with developing or purchasing property seaward of the [state's] oceanfront setback line. The intent is to ensure that buyers receive proper warning if the property under consideration is subject to special regulations concerning beach erosion, and if the property currently or previously used erosion control methods to address chronic erosion or storm-related damage."[378]

The ***Washington Working Group*** recommends consideration of different mechanisms to "inform property purchasers and investors regarding [SLR] risk that may affect coastal property," such as "real estate disclosure forms provided to purchasers, and public information on emerging insurance industry responses to [SLR] and other climate change impacts."[379]

Examples of Programs Implementing Real Estate Disclosures

California requires sellers to disclose if they are selling residential property that is located in a natural hazard area. Sellers must disclose if the property is located in a special flood hazard area as designated by flood insurance rate maps, or if the property may flood in the event of a dam failure, designated by the state Office of Emergency Services.[380]

Connecticut is "developing a coastal hazards website to provide information, including maps and data, to the public and government officials about coastal hazards. This will include information about how climate change may modify these hazards."[381] In addition to providing information to the public about emerging coastal hazards, this approach will encourage state and local officials to gather evidence of SLR hazards to strengthen other land-use regulation.

In ***North Carolina*** proposed legislation would require the state's Coastal Resources Commission to file in each county's court a report detailing coastal erosion hazards. It would also require coastal property owners to provide coastal hazard assessments to all potential buyers.[382] This approach would require action by both government bodies and private entities.

The ***South Carolina Beachfront Management Act*** requires sellers of property located seaward of a setback line to disclose (i) the current erosion rate for the area, and (ii) that the property may be subject to statutory setback restrictions.[383]

TABLE 19: *Advantages and Disadvantages of Real Estate Disclosures*

Evaluation Criteria	
Economic	To determine what areas are vulnerable to impacts and where disclosures will be required, governments will need to develop costly SLR maps and models. Disclosure requirements may also reduce the value of affected properties and, thus, impact the government tax base.
Environmental	Disclosures may discourage new development in vulnerable areas. However, their utility relies on private investment decisions; landowners may choose to develop on coastal properties despite the risks. To effectively mitigate risks to coastal resources, disclosure requirements may need to be coupled with other land-use regulations.
Social	Notifying potential buyers of the risks of purchasing property in flood-prone areas could lead to less development in these areas as market forces discourage investment. Disclosures could also encourage potential buyers to build or retrofit structures to be more resilient to flooding impacts. However, this deferred approach will not directly increase flood protection. Instead, it helps private parties to make informed decisions based upon disclosed risks.
Governance Criteria	
Administrative	Jurisdictions would need to decide what conditions would trigger a notification requirement. State governments could make SLR maps and models developed for state planning purposes available to the public. However, governments may be hesitant to require sellers to disclose SLR risks given the scientific uncertainty regarding future impacts.
Legal	Requiring sellers to disclose SLR hazards would likely require new legislation or amendments to existing laws.

Conclusion

Although the threats posed by SLR and other climate change impacts may seem daunting, state and local governments have many tools that they can use to preemptively address these threats. Governments can incorporate adaptation into their existing frameworks for regulating land use and development in their communities. They can combine regulatory tools and market-based incentives to create politically palatable strategies. They also can begin to reevaluate where to spend public funds and where to invest in public infrastructure.

This Tool Kit introduces state and local government decision makers to some of their policy options as they consider how to adapt built environments to SLR impacts. Although this is not a comprehensive listing of the options available, it provides a useful and practical start for governments looking to plan and implement adaptive measures. Once governments understand the various ways they can use land-use practices to adapt to sea-level rise, they will be able to make sound decisions about the tools at their disposal and begin to develop a comprehensive strategy to address sea-level rise.

We hope to update this Tool Kit on a regular basis to keep pace with the rapidly evolving adaptation landscape. Subsequent versions may include (1) additional tools, (2) recommendations from newly released adaptation plans, (3) new case studies, and (4) new methods of organizing tools. We encourage users of this Tool Kit to report back on its utility at the planning and implementation phases of their adaptation process.

Endnotes

1. U.S. Global Change Research Program (USGCRP), *Global Climate Change Impacts in the United States at 9 (2009) available at* http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts [hereinafter *Global Climate Change Impacts in the U.S.].*
2. *Id*. at 11.
3. To prepare for the Copenhagen Accords, the University of New South Wales Climate Change Research Centre (CCRC) in Sydney, Australia, prepared the *Copenhagen Diagnosis* as an interim report to synthesize the most up-to-date science on impacts from climate change. Ian Allison et al., *The Copenhagen Diagnosis, 2009: Updating the World on the Latest Climate Science* at 37-38 (2009) [hereinafter *Copenhagen Diagnosis*]. The report was developed because scientific understanding of climate science and impacts rapidly evolved after the publication of the report pf the Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2007: Synthesis Report, Summary for Policymakers* at 7 (2007) [hereinafter *2007 IPCC Report*]. Although often cited and used as a baseline to conduct vulnerability assessments, the 2007 IPCC SLR estimates were considered by experts to be conservative because they did not account for continental ice sheet melt. *Id*. at 8. IPCC estimates between 0.18 and 0.59 meters (1 to 3 feet) of SLR over the next century. The next IPCC report is not due for completion until 2013.
4. Martin Vermeer & Stefan Rahmstorf, *Global Sea Level Linked to Global Temperature,* Proc. Natl. Acad. Sci. U.S.A. 106, 21527 (2009); *see also* Stefan Rahmstorf, *A Semi-Empirical Approach to Projecting Future Sea-Level Rise*, 315 Science at 369 (Jan. 19, 2007) (melting of continental glaciers and ice sheets could cause sea levels to rise several feet more than IPCC estimates).
5. U.S. Climate Change Science Program (USCCSP), *Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region – Synthesis and Assessment Product 4.1* at 18 (Jan. 2009) [hereinafter *SAP 4.1*]. The mid-Atlantic region is sinking due to tectonic shifts, glacial adjustments, and subsidence caused by the removal of groundwater; USGCRP, *Global Climate Change Impacts in the U.S*. at 149.
6. USCCSP, *SAP 4.1* at 13-15, 21; USGCRP, *Global Climate Change Impacts in the U.S*. at 149-150.
7. USCCSP, *SAP 4.1* at 21-23; USGCRP, *Global Climate Change Impacts in the U.S*. at 149-150.
8. USGCRP, *Global Climate Change Impacts in the U.S*. at 150; James Titus, *Rising Seas, Coastal Erosion, and the Takings Clause: How to Save Wetlands and Beaches Without Hurting Property Owners*, 57 Md. L. Rev. 1279, 1284-1285 (1998); *see also* USCCSP, SAP 4.1 at 21-23; Sandra S. Nichols & Carl Bruch, *New Frameworks for Managing Dynamic Coasts: Legal and Policy Tools for Adapting U.S. Coastal Zone Management to Climate Change,* 1 Sea Grant L. & Pol'y J. 19, 23 (June 2008). Impacts to wetlands will depend on the rates of SLR and the potential for inland migration. Some wetlands may be able to accrete at rates that allow them to keep pace with SLR; others may be able to migrate inland where adjacent land is undeveloped and not armored. The National Oceanic & Atmospheric Administration (NOAA), Office of Ocean & Coastal Resource Management, *Adapting to Climate Change: A Planning Guide for State Coastal Managers* at 88(2010), *available at* http://coastalmanagement.noaa.gov/climate/docs/adaptationguide.pdf (last visited Sep. 9, 2010) [hereinafter *Planning Guide*].
9. USCCAP, *SAP 4.1* at 74, 83; USGCRP, *Global Climate Change Impacts in the U.S*. at 150.
10. Nichols & Bruch, 1 Sea Grant L. & Pol'y J. at 21-22.
11. Middle Peninsula Planning District Comm., *Middle Peninsula Climate Change Adaptation: An Assessment of Potential Anthropogenic and Ecological Impacts of Climate Change on the Middle Peninsula,* app. 2 at 2 (2009).
12. *Id.,* app. 2 at 34.

13. John Gibeaut, *Up Against the Sea Wall,* ABA Journal (Jul. 2006), *available at* http://www.abajournal.com/magazine/article/up_against_the_seawall/ (last visited Jun. 11, 2010).

14. The Fifth Amendment to the Constitution (the "Takings Clause") provides that private property cannot be taken "without due process of law; nor shall private property be taken for public use, without just compensation." U.S. Const. amend. V. The Fourteenth Amendment applied this prohibition to the states, "nor shall any State deprive any person of life, liberty, or property, without due process of law." U.S. Const. amend XIV, § 1.

15. *See* U.S. Federal Emergency Management Agency (FEMA), *North Carolina Sea Level Rise Risk Management Study: Potential Impacts, Risk Assessment and Management Strategies* (Oct. 2009), *available at* http://www.ncsealevelrise.com/About-the-Study [hereinafter *NCSLR Risk Management Study Plan].*

16. *See e.g.,* USGCRP, *Global Climate Change Impacts in the U.S.* at 152.

17. *See e.g.,* Land Use Law Center, Pace University School of Law ("Pace Land Use Law Center"), report prepared for the Nature Conservancy of Long Island, *Local Land Use Response to Sea Level Rise* at 43-47 (undated), *available at* http://www.csc.noaa.gov/digitalcoast/inundation/_pdf/Pace_Final_Report.pdf (last visited May 5, 2011) [hereinafter *Local Land Use].*

18. USCCSP, *SAP 4.1* at 13.

19. John S. Jacobs & Stephanie Showalter, Sea Grant, *The Resilient Coast: Policy Frameworks for Adapting the Built Environment to Climate Change and Growth in Coastal Areas of the U.S. Gulf of Mexico* at 9, 21-22 (2007) [hereinafter *The Resilient Coast: The Built Environment*]; *see generally* National Research Council (NRC), *Report In Brief: Mitigating Shore Erosion on Sheltered Coasts* at 1-4 (2007), *available at* http://www.nap.edu/catalog.php?record_id=11764 [hereinafter *Mitigating Shore Erosion*].

20. *See generally* USCCSP, *SAP 4.1* at 98-102; *see also* Richard G. Lathrop & Aaron Love, Grant F. Walton Center for Remote Sensing & Spatial Analysis, Rutgers University, *Vulnerability of New Jersey's Coastal Habitats to Sea Level Rise* at 2 (Jan. 2007); Victor S. Kennedy et al., Pew Center on Global Climate Change ("Pew"), *Coastal and Marine Ecosystems & Global Climate Change: Potential Effects on U.S. Resources* at 14-18 (Aug. 2002), *available at http://www.pewclimate.org/docUploads/marine_ecosystems.pdf.* (last visited Jul. 15, 2010); Nichols, 1 Sea Grant L. & Pol'y J. at 23.

21. USCCP, *SAP 4.1* at 94; *NRC, Mitigating Shore Erosion* at 103-104.

22. See discussion of "retreat" tools at USCCSP, *SAP 4.1* at 93-97.

23. *See generally* U.S. Environmental Protection Agency (EPA), *Anticipatory Planning for Sea-Level Rise Along the Coast of Maine* at 5-1 – 5-2 (Sep. 1995), *available at* http://www.epa.gov/climatechange/effects/coastal/SLRAnticipatory.html (last visited Aug. 5, 2010) [hereinafter *Maine].*

24. *Cf.* Brower, David J. Brower et al., *Reducing Hurricane and Coastal Storm Hazards Through Growth Management: A Guidebook for North Carolina Coastal Localities* at 29-30 (Jul. 1987) [hereinafter *NC Guidebook]*; *see e.g.,* Amy K. Snover et al., Center for Science in the Earth System (The Climate Impacts Group), University of Washington, prepared in association with and published by ICLEI – Local Governments for Sustainability, *Preparing for Climate Change: A Guidebook for Local, Regional and State Government* at 27-28 (Sep. 2007), [hereinafter *Guidebook for Locals*].

25. For a discussion of the long-term costs to each state from climate change impacts, see the fifty state reports prepared by the American Security Project, *Pay Now, Pay Later* (2010) *available at* http://www.secureamericanfuture.org/pay-now-pay-later/ (last visited May 4, 2011).

26. Jacobs, *The Resilient Coast: The Built Environment* at 28-30.

27. Terri Cruce, Pew, *Adaptation Planning – What State and Localities Are Doing* at 3 (Aug. 2009), *available at* http://www.pewclimate.org/publications/workingpaper/adaptation-planning-what-us-states-and-localities-are-doing (last visited Jul. 21, 2010).

28. *See e.g.,* ICLEI, *Guidebook for Locals* at 30-31.

29. S*ee e.g.,* U.S. Geological Service (USGS), *National Assessment of Coastal Vulnerability to Sea-Level Rise: Preliminary Results for the U.S. Pacific Coast, available at* http://pubs.usgs.gov/of/2000/of00-178/pages/res.html (last visited May 5, 2011).

30. USGCRP, *Global Climate Change Impacts in the U.S.* at 149.

31. *See generally* National Research Council of the National Academies (NRC), *America's Climate Choices—Adapting to the Impacts of Climate Change* at 47-52, 113-117 (prepublication copy 2010) [hereinafter *America's Climate Choices—Adapting].* Given these local variations, many adaptation planners are assessing their community's vulnerabilities and planning based upon a range of climate scenarios. For an example of scenario-based planning, see Swinomish Indian Tribal Community, Office of Planning & Community Development, *Swinomish Climate Change: Initiative Climate Change Adaptation Action Plan* at 27 (October *2010), available at* http://www.swinomish-nsn.gov/climate_change/Docs/SITC_CC_AdaptationActionPlan_complete.pdf (last visited May 5, 2010); see also Swinomish Indian Tribal Community, Office of Planning & Community Development, *Swinomish Climate Change: Initiative Impact Assessment Technical Report* (Oct. 2009); *available at* http://www.swinomish-nsn.gov/climate_change/Docs/SITC_CC_ImpactAssessmentTechnicalReport_complete.pdf (last visited May 5, 2011).

32. *See* Massachusetts Coastal Hazards Commission, *Preparing for the Storm Recommendations for Management of Risk from Coastal Hazards in Massachusetts* at 17 (May 2007), *available at* http://www.mass.gov/czm/chc/recommendations/chc_final_report_2007.pdf [hereinafter "*MA Preparing for the Storm].*

33. *See generally* James M. Wright, Floodplain Management Principles and Current Practices, *ch. 8, Floodplain Natural Resources and Functions* (2008) *available at* http://training.fema.gov/EMIWeb/edu/fmpcp.asp (last visited Apr. 19, 2011) [hereinafter Floodplain Management Principles].

34. *See* note 14, supra.

35. Although this Tool Kit identifies potential policy tools that could be used to adapt to SLR, this document does not examine whether a particular jurisdiction may *legally* implement a tool. State agencies and local governments may only take actions where they have been authorized to do so by their state legislatures by a statute (or home rule charter for local governments). *See* Barlow D. Burke*, Understanding the Law of Zoning and Land Use Controls* at 5 (2009) [hereinafter *Understanding Zoning*]. Most local governments have authority to use land-use tools in some form. However, in order to implement a particular tool, local governments will need make sure that the authorizing statute empowers them to use the tool in a manner to address SLR. *See* Andrew Silton & Jessica Grannis, Georgetown Climate Center, *Virginia Case Study - Stemming the Tide: How Local Governments Can Manage Rising Flood Risks* (Review Draft 3 – May 2010), *available at* http://www.georgetownclimate.org/adaptation/files/Va-Case-Study.pdf (last visited Jul. 13, 2010). Where governments do not have authority, they may need to seek additional powers from their state legislatures. *See also* John R. Nolon, *Disaster Mitigation Through Land Use Strategies*, 37 Envtl L.Rptr. 10681, 10688-10690 (2007).

36. Local governments can be municipalities or counties. Local governments can usually also create planning commissions to advise the governing body and promote the orderly development of the community. This Tool Kit collectively refers to these different entities as "local governments" or "localities." Legislatures also delegate some land-use powers to different state agencies. State and local entities are sometimes collectively referred to as "governments". This document presumes that different state and local entities have certain authorities to (1) regulate land use through planning and zoning, (2) acquire interests in property, and (3) exercise discretion when funding capital improvement projects.

37. *See* ICLEI, *Guidebook for Locals* at 27.

38. *See Id.*

39. U.K. Climate Impacts Programme (UKCIP), *Identifying Adaptation Options* at 2 (2008)*, available at* http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=23&Itemid=127 (last visited Aug. 9, 2010); *see also* NRC*, America's Climate Choices—Adapting* at 122.

40. *See* NOAA*, Planning Guide* at 52; *cf.* Massachusetts Department of Environmental Management (MA-DEM), *Natural Hazard Mitigation Planning: A Community Guide* at 26 (Jan. 2003)*, available at* http://www.mass.gov/dcr/stewardship/mitigate/hazguide.pdf [hereinafter *Natural Hazard Mitigation Planning]; see also* NRC*, America's Climate Choices—Adapting* at 124-133; NRC, *Mitigating Shore Erosion* at 121; FEMA, *NC SLR Risk Management Study Plan* at 8.

41. For a discussion of all three evaluation criteria, see Titus, 57 Md. L. Rev. at 1322-1327 (comparing the economic efficiency of rolling easement and setback policies versus a business as usual approach). *See also,* IPCC Response Strategies Working Group, Report of the Coastal Zone Management Subgroup, *Strategies for Adaptation to Sea Level Rise* at 22-23 (Nov. 1990) [hereinafter *Strategies*]; *see* UKCIP, *Identifying Adaptation Options* at 15.

42. ACOE, *Shore Protection Projects* at ch. 3 V-3-15 (Jun. 2006), *available at* http://chl.erdc.usace.army.mil/Media/1/9/7/CEM_Part-V_Chap-3.pdf (last visited Sep. 7, 2010).

43. NOAA, *Planning Guide* at 35-36; *see Titus,* 57 Md. L. Rev. at 1328-1334 (discussion of administrative feasibility questions comparing a setback policy to a rolling easement policy (discussed below)); *see also* Massachusetts Department of Environmental Management, *Natural Hazard Mitigation Planning* at 26.

44. *See e.g.,* IPCC*, Strategies* at 19-20.

45. *See* NRC*, Mitigating Shore Erosion* at 110-111.

46. *See generally* EPA, *Maine* at 6-1— 6-2.

47. *See* Titus, 57 Md. L. Rev. at 1329-1330.

48. *See Id.* at 1330.

49. *See* Jacobs*, The Resilient Coast: The Built Environment* at 16.

50. State agencies often provide oversight to local regulation of land use.

51. Pace Land Use Law Center, *Beginner's Guide to Land Use Law* at 12 (undated), *available at* http://www.pace.edu/lawschool/files/landuse/LandUsePrimer.pdf (last visited Jun. 17, 2010) [hereinafter *Land Use Law Primer].*

52. Daniel R. Mandelker, *Land Use Law* at 109 (4th ed. 1997) [hereinafter *Land Use Law*]; see also Brower et al., *NC Guidebook* at 92.

53. *See* Burke, *Understanding Zoning* at 223-224.

54. Brower et al., *NC Guidebook* at 43-44.

55. *See* EPA, NOAA, ICMA, & Rhode Island Sea Grant, *Smart Growth for Coastal Communities* at 32 (Sep. 2009)*, available at* http://coastalsmartgrowth.noaa.gov/smartgrowth_fullreport.pdf (last visited Jul. 19, 2010) [hereinafter *Smart Growth].*

56. *See generally,* EPA et al., *Smart Growth* at 8, 32-33.

57. *Id.* at 13.

58. *See* James E. Neuman, Pew, *Sea Level Rise & Global Climate Change: A Review of Impacts to U.S. Coasts* at 17 (Feb. 2000), *available at* http://www.pewclimate.org/docUploads/env_sealevel.pdf (last visited Jul. 21, 2010) [hereinafter *SLR Review of Impacts*]. (Pew divides adaptation goals into protection, planned retreat and accommodation. Pew includes what we have defined as "preservation" measures under protection. We classify preservation as a separate goal because protection measures (i.e., measures to protect development such as armoring) tend to adversely impact natural resources. Therefore, we have defined "preservation" measures as those that are designed to protect or enhance natural resources. *See also* IPCC, *Strategies* at 6-9.

59. *See* Teresa Concannon et al., Report to EPA, Georgia, in *The Likelihood of Shore Protection along the Atlantic Coast of the United States. Volume 2: New England and the Southeast* at 291-294 (2010) [hereinafter *Georgia*]; California Department of Natural Resources, A Report to the Governor of the State of California in Response to Executive Order S-13-2008, *2009 California Climate Adaptation Strategy* at 74-75 (2009), *available at* http://www.energy.ca.gov/2009publications/CNRA-1000-2009-027/CNRA-1000-2009-027-F.PDF (last visited Jul. 19, 2010) [hereinafter *CA Adaptation Strategy*]; FEMA.

60. NOAA, *Planning Guide* at 32.

61. *But see* Florida's State Comprehensive Planning Act of 1972, Fla. Stat. Ann. ch. 186 (West, 2010) and the Local Government Comprehensive Planning and Land Development Regulation Act, Fla. Stat. Ann. ch. 163 (West, 2010), which require local governments to adopt comprehensive plans that are consistent with state and regional plans. Every local ordinance and every permitting decision must also be consistent with the comprehensive plan and citizens have standing to challenge a land-use decision that is inconsistent with the plan. *See generally* Roy R. Carriker, Univ. of Fla., IFAS Extension, *Comprehensive Planning for Growth Management in Florida* (Jul. 2006), *available at* http://edis.ifas.ufl.edu/pdffiles/FE/FE64200.pdf (last visited Sep. 13, 2010).

62. *See generally* Mandelker, Land Use Law at 42, 77-78; *see also* Virginia Chapter of the American Planning Association (VA-APA), *Managing Growth and Development in Virginia: A Review of the Tools Available to Localities* at 7-8 (Oct. 2009), *available at* http://apavirginia.org/documents/legislation/Growth%20Tools%20Revised%2010-09_final.pdf (last visited Jul. 16, 2010) [hereinafter *VA Managing Growth];* Pace Land Use Law Center, *Land Use Law Primer* at 11-12.

63. Nichols & Bruch, 1 Sea Grant L. & Pol'y J. at 27-28.

64. *See generally* Thomas T. Ankersen et al., presentation to the Charlotte Harbor National Estuary Program, *Comprehensive Plan Policies, Land Development Regulations, and a Parcel-Specific Implementation Strategy to Address Sea-Level Rise Impacts in Florida* (May 27, 2010), *available at* http://www.law.ufl.edu/conservation/projects/coastal.shtml (last visited Aug. 9, 2010) [hereinafter *Comprehensive Plan Policies*].

65. Through the Coastal Zone Management Program, NOAA provides financial and technical assistance to states to help them implement and improve their coastal management programs, including preparing for and responding to sea-level rise. Some states use this CZMA funding to support adaptation planning and other related activities at the local level.

66. 16 U.S.C. § 1451 ("Because global warming may result in a substantial sea level rise with serious adverse effects in the coastal zone, coastal states must anticipate and plan for such an occurrence.").

67. *See e.g,.* California Coastal Act, 20 Cal. Pub. Res. Code § 30500.

68. Authorized through the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), FEMA provides competitive grant opportunities to implement long-term hazard mitigation projects through its Hazard Mitigation Assistance programs. Only communities that have adopted FEMA-approved hazard mitigation plans are eligible to apply. 42 U.S.C. §§ 5133, 5165, 5170c (West 2010); s*ee* FEMA, *Hazard Mitigation Assistance Unified Guidance* at 11-14 (Jun. 2010), *available at* http://www.fema.gov/government/grant/hmgp/index.shtm (last visited Aug. 14, 2010); *see also* FEMA, *National Flood Insurance Program—Program Description* at 16 (2002) [hereinafter *NFIP Description*]. EPA conducted a study in Iowa of how state and local governments can incorporate considerations of climate change in their HMPs. The study is currently out in draft.

69. *See* EPA et al., *Smart Growth* at 13, 29.

70. *CA Adaptation Strategy* at 76-77.

71. Florida Governor's Action Team on Energy and Climate Change, *Florida's Energy and Climate Change Action Plan—Phase 2,* app. F at 8 (2008), *available at* http://www.flclimatechange.us/ewebeditpro/items/O12F20128.PDF (last visited Jul. 19, 2010) [hereinafter *FL Action Plan].*

72. Maryland Commission on Climate Change Adaptation and Response Working Group, *Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change Phase I: Sea-level Rise and Coastal Storms,* ch. 5 at 9 (2008) [hereinafter *MD Comprehensive Strategy*].

73. Joseph Kalo et al., North Carolina Coastal Resources Law, Planning and Policy Center submitted to North Carolina Coastal Resources Commission, *Developing a Management Strategy for North Carolina's Coastal Ocean* at 14 (Apr. 2009) [hereinafter *NC Management Strategy*].

74. Washington Planning and Adaptation Working Groups, *Leading the Way: Preparing for the Impacts of Climate Change in Washington* at 133 (2008) [hereinafter *WA Leading the Way*].

75. Washington Department of Ecology, *Shoreline Master Program Handbook [app. A], Addressing Sea Level Rise in Shoreline Master Programs, available at* http://www.ecy.wa.gov/programs/sea/shorelines/smp/handbook/sea_level_guidance.pdf (last visited May 5, 2011).

76. EPA et al.*, Smart Growth* at 29.

77. EPA, Climate Ready Estuaries Program, *Synthesis of Adaptation Options for Coastal Areas* at 17 (2009)*, available at* http://www.epa.gov/cre/downloads/CRE_Synthesis_1.09.pdf (last visited Aug. 15, 2010), [hereinafter *Synthesis of Adaptation Options]; see also* ICLEI*, Guidebook for Locals* at 26-31; NRC, *America's Climate Choices—Adapting* at 122-123.

78. *See 20* Cal. Pub. Res. Code § 30253.

79. Wanda Diane Cole, Maryland Eastern Shore Resource Conservation & Development Council, *Sea Level Rise: Technical Guidance for Dorchester County,* a special report prepared at the request of the Maryland Department of Natural Resources (Mar. 2008) [hereinafter *Dorchester Technical Guidance*]; URS and RC Quinn Consulting, Inc., *Somerset County Maryland Rising Sea Level Guidance,* a special report prepared at the request of Somerset County, Annapolis, MD (2008); CSA International Inc., *Sea Level Rise Response Strategy Worcester County, MD,* a special report prepared at the request of Worcester County, MD Department of Comprehensive Planning (Sept. 2008); *see also* U.S. Government Accountability Office (GAO), Report to the Chairman, Select Commitee on Energy Independence and Global Warming, H. R., *Climate Change Adaptation – Strategic Federal Planning Could Help Government Officials Make More Informed Decisions* at 24-25 (Oct. 2009) [hereinafter *Strategic Federal Planning*].

80. *Dorchester Technical Guidance* at 7, 31.

81. *See* FEMA, *Freeboard definition, available at* http://www.fema.gov/plan/prevent/floodplain/nfipkeywords/freeboard.shtm (last visited Aug. 13, 2010); Massachusetts, StormSmart Connect, *Using Freeboard to Elevate Structures Above Predicted Floodwaters, available at* http://ma.stormsmart.org/before/regs/using-freeboard-to-elevate-structures-above-predicted-floodwaters/ (last visited May 4, 2011).

82. *Dorchester Technical Guidance* at 32-33.

83. *See* note 52, *supra.*

84. Center for Land Use Education, College of Natural Resources at the University of Wisconsin Stevens Point, *Planning Implementation Tools – Overlay Zones* (Nov. 2005), *available at* ftp://ftp.wi.gov/DOA/public/comprehensiveplans/ImplementationToolkit/Documents/OverlayZoning.pdf (last visited Aug. 14, 2010).

85. *Dorchester Technical Guidance* at 33-34, 41-42.

86. *See generally* Ankersen, *Comprehensive Plan Policies.*

87. *VA Climate Change Action Plan* at 35.

88. Oregon Coastal Management Program, Department of Land Conservation and Development, *Climate Ready Communities: A Strategy for Adapting to the Impacts of Climate Change on the Oregon Coast* at 5 (Jan. 2009).

89. *See* Md. Code Ann., Nat. Res. § 8-1802 (West through 2009); *see also* Critical Area Commission for the Chesapeake and Atlantic Coastal Bays, *Bay Smart: A Citizens Guide to Maryland's Critical Area Program* at 28-38 (Sept. 07), *available at* http://www.dnr.state.md.us/criticalarea/download/baysmart.pdf (last visited Jun. 23, 2010).

90. Michigan Land Use Institute, *Model Language to Assist Local Governments in Adopting a Great Lakes Shoreline Protection Overlay Zone* (May 25, 2001), *available at* http://www.mlui.org/downloads/ordinance.pdf (last visited Aug. 14, 2010).

91. 44 C.F.R. § 59.2(b).

92. FEMA, *Answers to Questions About the National Flood Insurance Program* at 1 (Mar. 2010), *available at* http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=1404 (last visited May 4, 2011) [hereinafter *Answers to Questions About NFIP]; see also 3-18* Zoning & Land Use Controls, § 18.01 (LEXIS 2010).

93. The 100-year designation was chosen because it was seen to provide a high level or protection without imposing overly onerous requirements on property owners. FEMA, *NFIP Description* at 5; Wright, Floodplain Management Principles, *ch. 13 Regulatory and Design Standards for Reducing Losses* at 13-1.

94. FEMA, *Answers to Questions About NFIP* at 31.

95. *See* discussion of building code methods; *see also* Jacob, *The Resilient Coast: The Built Environment* at 11.

96. 44 C.F.R. § 60.3 (Thomson Reuters through 2010); *see also* FEMA, *NFIP Description* at 12-17; Wright, Floodplain Management Principles, *ch. 13 Regulatory and Design Standards for Reducing Losses* at 13-3.

97. *See* James Fraser *et al.,* the Center for Urban & Regional Studies, University of North Carolina at Chapel Hill, report prepared for FEMA and the National Science Foundation, *Implementing Floodplain Land Acquisition Programs in Urban Localities* at 7-8 (Dec. 2003), *available at* http://people.vanderbilt.edu/~james.c.fraser/publications/Floddplain%20Project%20Report.Final.pdf (last visited Jul. 20, 2010) [hereinafter *Floodplain Land Acquisition].*

98. The regulatory floodway is the channel of the watercourse and adjacent lands that must be kept free of encroachments to allow for the discharge of waters from the base flood without increasing flood levels by more than one foot. NFIP minimum regulations require local governments to prohibit any development in the regulatory floodway that would increase flood levels in the community during a 100-year flood. FEMA, *Floodway, available at* http://www.fema.gov/plan/prevent/floodplain/nfipkeywords/floodway.shtm (last visited Apr. 25, 2010); Wright, Floodplain Management Principles, c*h. 13 Regulatory and Design Standards for Reducing Losses* at 13-2.

99. FEMA is in the process of completing a study on how SLR may impact the NFIP; this study is due out in fall of 2011. FEMA is also participating in a pilot study of how SLR will impact the state of North Carolina; the *North Carolina Sea Level Rise Risk Management Study* is expected to be released in 2011. The study will evaluate increases in coastal flooding from SLR and increased frequency of storm events in the state. It will identify North Carolina's vulnerabilities and will propose risk management strategies that could be employed by the state to reduce or avoid those flood risks. North Carolina Division of Emergency Management, *North Carolina Sea Level Rise Risk Management Study, available at* http://www.ncsealevelrise.com/Home (last visited Sep. 15, 2010); see also FEMA, FEMA Grants $5 Million for Sea Level Rise Study in North Carolina, available at http://www.fema.gov/news/newsrelease.fema?id=47583 (last visited Sep. 15, 2010).
100. USCCSP, *SAP 4.1* at 126; *see also* Nichols & Bruch, 1 Sea Grant L. & Pol'y J. at 30-32.
101. FEMA, *Projected Impact of Relative SLR on the National Flood Insurance Program* at 2 (Oct. 1991) [hereinafter *Projected Impact SLR on NFIP*]; USCCSP, *SAP 4.1* at 129-132.
102. *See generally* USCCSP, *SAP 4.1* at 21-23.
103. USGCRP, *Global Climate Change Impacts in the U.S.* at 24.
104. *See e.g.,* Zoë Pfahl Johnson, Maryland Department of Natural Resources, Coastal Zone Management Division (MD-DNR), *A Sea Level Rise Response Strategy for the State of Maryland* at 28 (Oct. 2000), *available at* http://www.dnr.state.md.us/bay/czm/sea_level_rise.html (last visited Jul. 29, 2010) [hereinafter *SLR Response Strategy for Maryland*].
105. *See* 42 U.S.C. § 4022(b)(1)(A) (creating the Community Rating System to encourage local governments to reduce flood risks beyond the minimum NFIP criteria); *see also* 44 C.F.R. § 60.1(d).
106. *Id*.
107. *FL Action Plan,* app. F at 29.
108. New Jersey Department of Environmental Protection, *Meeting New Jersey's 2020 Greenhouse Gas Limit: New Jersey's Global Warming Response Act Recommendations Report* at 89 (Dec. 2009) [hereinafter *NJ Recommendations*].
109. *WA Leading the Way* at 134.
110. EPA, *Synthesis of Adaptation Options* at 14.
111. *See* Wes Shaw, Mass. Stormsmart Coasts, *Fact Sheet 3, Case Study – A Cape Cod Community Prevents New Residences in Floodplains* (Apr. 2008), *available at* http://www.mass.gov/czm/stormsmart/resources/stormsmart_chatham.pdf (last visited Jun. 23, 2010).
112. *See* Gove v. Zoning Board of Appeals of Chatham, 831 N.E. 2d 865, 871-875 (MA 2005).
113. *See generally* Association of State Floodplain Managers (ASPFM), *No Adverse Impact: A Toolkit for Common Sense Floodplain Management* (2003), *available at* http://www.floods.org/NoAdverseImpact/NAI_Toolkit_2003.pdf (last visited Jan. 11, 2011).
114. 42 U.S.C. § 4022(b)(2); *see also* FEMA, *NFIP Program Description* at 31-33; FEMA; *Community Rating System: A Local Official's Guide to Saving Lives, Preventing Property Damage and Reducing the Cost of Flood Insurance* (Apr. 2006), *available at* http://www.fema.gov/library/viewRecord.do?id=3655 (last visited May 4, 2011).
115. In adaptation parlance, the term "resilience" is used to describe both the actual physical construction of structures and also how the totality of a community is developed. This section addresses only the design of individual structures, not the community as a whole.
116. These design requirements also must apply to existing structures when a building is rebuilt after it is "substantially damaged" (see discussion of rebuilding restrictions) or when a building is "substantially improved" (i.e., cost of the renovation of the structure is greater than 50 percent of the structure's pre-renovation fair market value). *See* French & Associates, Ltd, *Managing Floodplain Development* 8-11 – 8-14.
117. NOAA, *Planning Guide* at 74.
118. The base flood elevation (BFE) is the "computed elevation which floodwater is anticipated to rise during the base flood." For regulatory purposes the base flood is the 100-year storm event. Structures must typically be elevated one-foot above the BFE; this elevation is called "freeboard". FEMA, *Base Flood Elevation, available at* http://www.fema.gov/plan/prevent/floodplain/nfipkeywords/base_flood_elevation.shtm (last visited Aug. 19, 2010).

119. Wright, *Floodplain Management Principles* at 13-3; *see also* French & Associates, Ltd., *Managing Floodplain Development Through the National Flood Insurance Program, Home Study Course* at 5-27 – 5-36 (Mar. 1998) *available at* http://www.fema.gov/pdf/floodplain/is_9_complete.pdf (last visited May 5, 2011) [hereinafter *Managing Floodplain Development*].

120. French & Associates, Ltd, *Managing Floodplain Development* at 5-36 – 5-41.

121. French & Associates, Ltd, *Managing Floodplain Development* at 5-47 – 5-52.

122. Jacobs, *The Resilient Coast: The Built Environment* at 18-19. The IBC and IRC are developed by a non-profit organization called the International Code Council (ICC) and are updated periodically. For more information see the ICC website at http://www.iccsafe.org. Wright, *Floodplain Management Principles* at 13-5 – 13-6.

123. FEMA, *Design and Construction in Coastal A-Zones (Dec. 2005), available at* http://www.fema.gov/pdf/rebuild/mat/coastal_a_zones.pdf (last visited May 4, 2011).

124. *See* GAO, *Natural Hazard Mitigation: Various Mitigation Efforts Exist but Federal Efforts Do Not Provide a Comprehensive Strategic Framework* at 31-33 (2007), *available at* http://www.gao.gov/new.items/d07403.pdf [hereinafter *Natural Hazard Mitigation*].

125. Maryland Commission on Climate Change Adaptation and Response Working Group, *EBEI-8, Building Code Revisions and Infrastructure Design Standards* at 1-2 (Mar. 3, 2008), *available at* http://www.mdclimatechange.us/ewebeditpro/items/O40F16619.pdf (last visited Aug. 20, 2010); *see also* Pew, *SLR Review of Impacts* at 21.

126. *CA Adaptation Strategy* at 74, 77.

127. *FL Action Plan,* app. F at 28.

128. *MD Comprehensive Strategy,* ch. 5 at 12-13; *see also Dorchester Technical Guidance* at 31-33.

129. *MA Preparing for the Storm* at 16.

130. U.S. Agency for International Development (USAID), *Adapting to Coastal Climate Change: A Guidebook for Development Planners* at 41 (May 2009), *available at* http://pdf.usaid.gov/pdf_docs/PNADO614.pdf (last visited Jul. 22, 2010).

131. Florida Department of Financial Services, *My Safe Florida Home, available at* http://mysafefloridahome.com/ (last visited Aug. 25, 2010); Wharton, *Managing Large Scale Risks* at 276; *see also* GAO, *Natural Hazard Mitigation* at 38.

132. 2007 Fla. Building Code ch. 16 (2009), *available at* http://www2.iccsafe.org/states/florida_codes/ (last visited Jul. 22, 2010).

133. *See generally* FEMA, *Hazard Mitigation Assistance Unified Guidance* (2010), *available at* http://www.fema.gov/library/viewRecord.do?id=4225 (last visited Feb. 14, 2011); FEMA, *Homeowner's Guide to Retrofitting* at 2-18 – 3-14.

134. FEMA, *Coastal Construction Manual* (FEMA 55); *available at* http://www.fema.gov/rebuild/mat/fema55.shtm#2 (last visited Jun. 22, 2010).

135. USCCSP, *SAP 4.1* at 144-1455 (Elevating a new house by a couple feet only increases construction costs by 1 percent.).

136. 42 U.S.C. § 4022(b)(2).

137. *See* StormSmart, *Using Freeboard, supra.*; *see also* NOAA *Planning Guide* at 75.

138. GAO, *Natural Hazard Mitigation* at 45. (Design features can add 10 to 15 percent to the cost of building, and appraisers often do not consider the mitigation features when appraising a home's value.)

139. Wharton, *Managing Large Scale Risks* at 269, 293. (In Florida claims were reduced by 60 percent where structures were built in compliance with stricter building codes. Wharton estimates that Florida could reduce hurricane losses from a 100-year storm event by 61 percent or $51 billion by enforcing stricter building codes.) *See also* The H. John Heinz III Center for Science, Economy & the Environment ("Heinz") and Ceres, *Resilient Coasts: A Blueprint for Action* at 1 (2009) [hereinafter *Blueprint for Action*].

140. 1 Zoning & Planning Deskbook § 3:6 (2d ed. 2009).

141. FEMA, *Setback, available at* https://www.fema.gov/plan/prevent/floodplain/nfipkeywords/setback.shtm (last visited Jul. 29, 2010).

142. South Carolina Department of Health and Environmental Control, Final Report of the Shoreline Change Advisory Committee, *Adapting to Shoreline Change —A Foundation for Improved Management and Planning in South Carolina* at 122 (April 2010) [hereinafter *SC Adapting to Shoreline Change*].

143. *See* GAO, *Natural Hazard Mitigation* at 34; *see e.g., Dorchester Technical Guidance* at 12.

144. NOAA, *Planning Guide* at 71.

145. 83 Am. Jur. 2d Zoning and Planning § 141 (Thomson Reuters 2010).

146. USCCSP, *SAP 4.1* at 95.

147. *See* EPA, *Maine*, at 6-11; NOAA, *Construction Setbacks, available at* http://coastalmanagement.noaa.gov/initiatives/shoreline_ppr_setbacks.html (last visited June 4, 2010).

148. *See* Titus, *57* Md. L. Rev. at 1311; *see also* Pew, *SLR Review of Impacts* at 20.

149. *See e.g.,* Maine Sand Dune Rules, CMR 06-096-355 § 5(C). ("A project may not be permitted if, within 100 years, the property may reasonably be expected to be eroded as a result of changes in the shoreline such that the project is likely to be severely damaged after allowing for a two foot rise in sea level over 100 years.")

150. *CA Adaptation Strategy* at 77.

151. *CA Adaptation Strategy* at 73, 77.

152. *FL Action Plan*, app. F at 18.

153. *MD Comprehensive Strategy,* ch. 5 at 9.

154. *SC Adapting to Shoreline Change* at 123, 132.

155. *VA Climate Change Action Plan* at 37.

156. *See* EPA, *Management Goal: Maintain Shorelines Utilizing "Soft" Measures, available at* http://www.epa.gov/CRE/shorelinessoft.html (last visited Jul. 13, 2010).

157. *See* 20 CA Pub. Res. Code § 30231.

158. 9 VA Admin. Code § 10-20-80(B)(5) (enumerating criteria required by VA Code Ann. § 10.1-2107).

159. *See e.g.,* MD-DNR, *SLR Response Strategy for Maryland* at 29.

160. *See* ME Admin Code. 06-096 ch. 355, § 5 (2010).

161. NC Admin. Code tit. 15A, r. 7H.0306 (2010); *see also* NOAA, *Construction Setbacks, available at* http://coastalmanagement.noaa.gov/initiatives/shoreline_ppr_setbacks.html (last visited Jul. 21, 2010); *see also* North Carolina Department of Environment and Natural Resources, Division of Coastal Management, Coastal Management News, *Revised Oceanfront Setback and Static Line Rules Become Effective Today* (August 11, 2009) *available at* http://dcm2.enr.state.nc.us/news/2009%20releases/setbacks.html (last visited Apr. 25, 2011).

162. SC Code Ann. § 48-39-280 – 290 (2009).

163. Maui Planning Commission, *Shoreline Rules,* title MC-12, subtitle 02, ch. 203, *available at* http://www.co.maui.hi.us/documents/Planning/CZMP/SSA%20Rules.PDF (last visited Jul. 21, 2010); *see also* Dennis Hwang and Maxine Burkett, University of Hawaii Sea Grant College Program, Center for Island Climate Adaptation and Policy, *Shoreline Impacts, Setback Policies and Sea Level Rise* at 5 (April 2009), *available at* http://www.soest.hawaii.edu/seagrant/communication/pdf/GG-10-01.pdf (last visited Aug. 14, 2010); NOAA *Construction Setbacks*, note 163, *supra*.

164. 15A NC Admin. Code 7H.0209 (West 2010).

165. For a discussion of the advantages and disadvantages of buffers, see discussion of Maryland's Critical Area Program. MD-DNR, SLR *Response Strategy for Maryland* at 29-30.

166. Titus, 57 MD L. Rev. at 1322-1323.

167. *Id.* at 1327.

168. *SC Adapting to Shoreline Change* at 134.

169. USCCSP, *SAP 4.1* at 99; *see* ICLEI, *Guidebook for Locals* at 106; *see e.g., Dorchester Technical Guidance* at 14.

170. NOAA, *Construction Setbacks, supra* note 163.

171. *Id.; see also* Nichols & Bruch, 1 Sea Grant L. & Pol'y J. at 29; Pew, *SLR Review of Impacts* at 20.

172. VA-APA, *VA Managing Growth at 30.*

173. For a more detailed description of the regulation of subdivisions see section regarding clustered development.

174. Burke, *Understanding Zoning* at 223.

175. VA-APA, *VA Managing Growth* at 41-42.

176. Such land-use restrictions are called negative easements (or servitudes) because their terms prevent a landowner from doing an activity on his or her land. By contrast, affirmative easements grant a neighbor the right to use the landowner's land or a portion of his or her land for a particular purpose. For example, a view easement is a negative easement because it prevents one neighbor from building a structure on his property so as to obstruct the view shed of a neighboring property. An access easement is an affirmative easement because the landowner grants a neighbor the right to cross over his property to access an adjacent parcel. Bernhardt, *Real Property In a Nutshell* at 197.

177. Burke, *Understanding Zoning* at 244.

178. EPA, *Maine* at 6-12 – 6-14.

179. Nollan v. California Coastal Commission, 483 U.S. 825 (1992). (The Supreme Court found a taking where there was no "essential nexus" between the exaction, a public access easement, and the stated purpose for the easement, to mitigate the obstruction of ocean views.)

180. Dolan v. City of Tigard, 512 U.S. 374 (1992). (The Supreme Court found that a permit condition that required the dedication of a bike path constituted a taking because the City did not show that the condition was "roughly proportional" to the impact that it sought to mitigate, traffic impacts.)

181. These types of exactions impose one form of "rolling easement" policy. *See* Titus, 57 MD L. Rev. at 1309,1357-1358; *see also* Meg Caldwell, *No Day at the Beach: SLR, Ecosystem Loss, and Public Access Along the California Coast,* 34 Ecology L.Q. 533, 564-66 (2007).

182. EPA, *Maine* at 6-12.

183. *Id.*

184. *See* Brower et al., *NC Guidebook* at 118-119; for a discussion of some of the limits of impact fees see Burke, *Understanding Zoning* at 233-235.

185. Brower et al., *NC Guidebook* at 118.

186. *CA Adaptation Strategy* at 75.

187. *VA Climate Change Action Plan* at 35.

188. Caldwell, 34 Ecology L.Q. at 565-566; *see also* 20 CA Pub. Res. Code § 30000 et seq.

189. *See* VA-APA, *VA Managing Growth* at 31, 40, 43.

190. *See* Caldwell, 34 Ecology L.Q. at 568-569.

191. EPA, *Maine* at 6-11. Where redevelopment is totally prohibited, local governments are particularly at risk to takings challenges. A court may consider such a prohibition to be a total economic deprivation and, therefore, a *per se* taking. To survive such a challenge, local governments should ensure that the down-zoned property has some economically beneficial use (such as agricultural or recreational use). Additionally, local governments should determine whether allowing redevelopment would impinge on the state's public trust interests in tidelands or would cause a nuisance. If so, local governments should make clear findings to that effect in the statute or ordinance and when denying redevelopment permits.

192. French & Associates, Ltd, *Managing Floodplain Development* at 8-18 – 8-22; Floodplain Management Principles, ch. 13 *Regulatory and Design Standards for Reducing Losses* at 13-4.

193. *See* Pew, *SLR Review of Impacts* at 20.

194. EPA, *Maine* at 6-11.

195. For a discussion of the problems with the NFIP's repetitive loss program, see Rawle O. King, Congressional Research Service, RL32972, *Federal Flood Insurance: The Repetitive Loss Program* at 19-25 (Jun. 2005).

196. *See e.g.,* EPA, *Maine* at 6-12; *see also* Titus, *57* MD L. Rev. at 131 n.125.

197. *CA Adaptation Strategy* at 77.

198. *FL Action Plan,* app. F at 18.

199. *FL Action Plan,* app. F at 30.

200. EPA, *Synopsis of Anticipatory Planning for Sea-Level Rise Along the Coast of Maine, available at* http://epa.gov/climatechange/effects/coastal/SLRAnticipatory.html (last visited Sep. 26, 2010).

201. ME Admin Code. 06-096 ch. 355, § 5; *see also* EPA*, Maine* at 5-7.

202. SC Code Ann. § 48-39-270(11) & § 48-39-290(B); *see also* EPA*, Maine* at 6-12.

203. American Institutes for Research (AIR), The *Evaluation of the National Flood Insurance Program Final Report* at 24 (Oct. 2006), *available at* http://www.fema.gov/library/viewRecord.do?id=2573 (last visited May 5, 2011).

204. Wharton Risk Management & Decision Processes Center ("Wharton"), University of Pennsylvania, *Managing Large Scale Risks in a New Era of Catastrophe* at 288 (2007), *available at* http://opim.wharton.upenn.edu/risk/library/Wharton_LargeScaleRisks_FullReport_2008.pdf (last visited Jul. 22, 2010) [hereinafter *Managing Large Scale Risks*].

205. *See* Pace Land Use Law Ctr., *Local Land Use* at 80-82.

206. Esposito v. South Carolina Coastal Council, 939 F.2d 165, 170 (4th Cir. 1991) (holding that a taking does not occur when a regulation today removes from the bundle of property rights the right to rebuild a house should it ever be destroyed by a storm, because existing uses can continue and the impact on those uses is speculative). *See, e.g.,* Oswalt v. County of Ramsey, 371 N.W.2d 241, 246 & n.3 (MN Ct. App. 1985) (holding that municipalities can phase out a nonconforming use without paying compensation and that limiting repairs of partially destroyed structures is an acceptable method to phase out nonconforming uses, but declining to decide whether a regulation prohibiting the reconstruction of houses in a floodplain is a taking.) *See also* Titus, 57 MD L. Rev. at 1375.

207. Burke, *Understanding Zoning* at 223; Roger Bernhardt et al., *Real Property in a Nutshell* at 442-445 (4th ed. 2000).

208. Brower et al., *NC Guidebook* at 116-117.

209. *See* 5 Rathkopf's The Law of Zoning and Planning § 90:49 (4th ed. 2009); *see also VA-APA, VA Managing Growth* at 23-24; University of Illinois Extension, *Cluster/Conservation Development, available at* http://urbanext.illinois.edu/lcr/cluster.cfm (last visited Jul. 15, 2010).

210. Brower et al., *NC Guidebook* at 116-117.

211. *CA Adaptation Strategy at 73.*

212. *Id.* at 77.

213. EPA, *Maine* at 7-11.

214. Chatham County, Conservation Subdivision Regulations § 7.7 (Dec. 2, 2008), *available at* http://www.chathamnc.org/Index.aspx?page=440 (last visited Jul. 21, 2010); s*ee discussion at* Georgia Quality Growth Partnership, *Quality Growth Toolkit, available at* http://www.dca.state.ga.us/toolkit/toolkit.asp (last visited Jul. 21, 2010).

215. Minnesota Planning & Environmental Quality Board, *From Policy to Reality: Model Ordinance for Sustainable Development* (Sept. 2000), *available at* http://www.mnplan.state.mn.us/pdf/2000/eqb/ModelOrdWhole.pdf (last visited Aug. 20, 2010); American Planning Association, *Model Residential Clustered Development Ordinance* (Mar. 2006), *available at* https://myapa.planning.org/smartgrowthcodes/pdf/section47.pdf (last visited Aug. 18, 2010).

216. USCCSP, *SAP 4.1* at 88-93; *see* IPCC*, Strategies* at 8; *see also* EPA*, Management Goal: Maintain Shorelines Utilizing "Hard" Measures*, *available at* http://www.epa.gov/CRE/shorelineshard.html (last visited Aug. 19, 2010).

217. NRC, *Mitigating Shore Erosion* at 95. Mobile, Alabama, armored 30 percent of the coast causing the loss of approximately 10-20 acres of intertidal area, wetlands, and 4-8 miles of shoreline. *See also* Rebecca Stamski, Monterey Bay National Marine Sanctuary, *The Impacts of Coastal Protection Structures in California's Monterey Bay National Marine Sanctuary* at 3-12 (Feb. 2005) [hereinafter *Impacts of Coastal Protection Structures*].

218. *See* note 19, *supra* (for a complete listing of sources regarding the environmental impacts of sea walls); *see also* NRC, *Mitigating Shore Erosion* at 80.

219. USCCSP, *SAP 4.1* at 97.

220. *See generally* NRC*, Mitigating Shore Erosion* at 68-77, 99-102, 116; *see also MA Preparing for the Storm* at 23-26.

221. USCCSP, *SAP 4.1* at 101, 150 (Initially designing a structure to be resilient to a certain degree of SLR is cheaper than retrofitting an existing structure.) *See also* NRC, *Mitigation Shore Erosion* at 69.

222. In Ocean Harbor House Homeowners Association v. California Coastal Commission, the court upheld a $5.3 million mitigation fee imposed by the California Coastal Commission as a condition of permit to build a seawall. The court found that the mitigation fee was roughly proportional to the impacts based upon "projected economic losses to local businesses and the tourist industry." 163 Cal.App.4th 215 (2008).

223. *See e.g.,* ME Admin Code. 06-096 ch. 355, § 10 (2010).

224. *FL Action Plan,* app. F at 17.

225. *MA Preparing for the Storm* at 22.

226. *NC Management Strategy* at 2.

227. SC Code Ann. § 48-39-290(B)(2)(a)-(b) (2009).

228. Town of East Hampton, NY, *Adopted Resolution 2006-899 Coastal Erosion Overlay District Legislation,* amend ch. 255 East Hampton Town Code (Zoning) (2006), *available at* http://www.town.east-hampton.ny.us/coastal.pdf (last visited Jul. 22, 2010).

229. Under its Natural Resources Protection Act, the Maine Department of Environmental Protection adopted the Coastal Sand Dune Rules which prohibit new coastal armoring adjacent to sand dunes and limit repair of existing armoring. ME Admin Code. 06-096 ch. 355, § 5(E) (2010). Rhode Island has a complex regulatory framework that limits armoring based upon considerations of coastal features (wetlands, beaches, dunes, barrier islands, bluffs, rocky shores) and adjacent coastal uses (conservation, low-intensity, commercial, or water-dependent uses). Armoring is prohibited in most conservation areas and along coastal beaches. C.R.I.R. 04-000-010 § 300.7(D)(1)-(4). The Texas Open Beaches Act generally prohibits any "construction landward of and adjacent to a public beach" that would impact public access. TX Nat. Res. Code Ann. §§ 61.013(a) and 61.001(2); *see also* NC Gen. Stat. §§113A-100 et seq.

230. San Francisco Bay Conservation & Development Commission (SF-BCDC), *Draft Staff Report and Revised Preliminary Recommendation for Proposed Bay Plan Amendment 1-08 Concerning Climate Change* at 14 (Oct. 1, 2009), *available at* http://www.bcdc.ca.gov/proposed_bay_plan/bpa_1-08_cc_staff-rpt_11-05.pdf (last visited Jul. 22, 2010).

231. 20 Cal. Pub. Res. Code § 30235; Caldwell, 34 Ecology L.Q. at 560.

232. *See* EPA, *Synthesis of Adaptation Options* at 15; Pew, *SLR Review of Impacts* at 18; Stamski, *Impacts of Coastal Protection Structures* at 2-3.

233. EPA, *Synthesis of Adaptation Options* at 15; Caldwell, 34 Ecology L.Q. at 575; *see also* Pew, *SLR Review of Impacts* at 18.

234. USCCSP, *SAP 4.1* at 98-103.

235. *See* GAO, *Natural Hazard Mitigation* at 33.

236. NRC, *Mitigating Shore Erosion* at 4.

237. USCCSP, *SAP 4.1* at 103.

238. Jon A. Kusler, ASFPM, *A Comparative Look at Public Liability for Flood Hazard Mitigation* at 4 (2009), *available at* http://www.floods.org/PDF/Mitigation/ASFPM_Comparative_look_at_pub_liability_for_flood_haz_mitigation_09.pdf (last visited Jul. 20, 2010).

239. IPCC, *Strategies* at 8; *see also* Maryland Department of Natural Resources, *Shore Erosion Control: The Natural Approach* (Jul. 2005), *available at* http://www.dnr.state.md.us/CoastSmart/pdfs/SE_TheNaturalApproach.pdf (last visited Apr. 25, 2011);

240. Living shorelines often use a combination of different techniques to protect adjacent development—through revegetation and place of stones or sand fill. Living shorelines are designed to preserve natural processes and maintain hydrological connections between uplands and aquatic environments. Virginia Institute of Marine Science (VIMs), report for NOAA, *The Stability of Living Shorelines – An Evaluation* at 2 (Jun. 2007), *available at* http://ccrm.vims.edu/publications/pubs/livingshorelines_final_rpt.pdf (last visited May 5, 2011) [hereinafter *Stability of Living Shorelines*].

241. EPA, *Management Goal: Maintain Shorelines Utilizing "Soft" Measures*, *available at* http://www.epa.gov/cre/shorelinessoft.html#fn1 (last visited Aug. 19, 2010).

242. *MA Preparing for the Storm* at 20.

243. *SC Adapting to Shoreline Change* at 124.

244. *VA Climate Change Action Plan* at 34.

245. EPA, *Management Goal: Maintain Shorelines Utilizing "Soft" Measures, available at* http://www.epa.gov/CRE/shorelinessoft.html.

246. FL Stat. Ann. § 161.101.

247. *Id.* § 161.141.

248. *Id.* § 161.191.

249. MD Code Ann. Envir. § 16-201; *see also MD Comprehensive Strategy,* ch. 5 at 23-24.

250. USCCSP, *SAP 4.1,* app. 1 at 236.

251. North Carolina Estuarine Biological & Physical Processes Work Group. & North Carolina Division of Coastal Management, report prepared for the N.C. Coastal Resources Commission on Estuarine Shoreline Stabilization Subcommittee, *Recommendations for Appropriate Shoreline Stabilization Methods for Different North Carolina Estuarine Shoreline Types* (Aug. 2006), *available at* http://dcm2.enr.state.nc.us/Hazards/EWG%20Final%20Report%20082106-1.pdf (last visited Sep. 26, 2010).

252. Pew, *SLR Review of Impacts* at 19.

253. USCCSP, *SAP 4.1* at 96-99; *see also* NOAA, *Beach Nourishment – A Guide for Local Government Officials, available at* http://www.csc.noaa.gov/beachnourishment/html/human/socio/scitech.htm (last visited Jun. 30, 2010).

254. ICLEI, *Guidebook for Locals* at 106.

255. VIMs, *Stability of Living Shorelines* at 5.

256. See discussion of how soft-armoring permitting can be more difficult to administer than hard-armoring permitting because soft-armoring involves activities on lands subject to the jurisdiction of the U.S. Army Corps of Engineers (ACOE). NRC, *Mitigating Shore Erosion* at 114-115; *see also SC Adapting to Shoreline Change* at 129. The National Academies notes that the ACOE *Coastal Engineering Manual* includes 60 pages on hard armoring and only 3 pages on soft alternatives. NRC, *Mitigating Shore Erosion* at 103.

257. NRC, *Mitigating Shore Erosion* at 104-108.

258. EPA, *Synthesis of Adaptation Options* at 13.

259. In Florida, landowners challenged the state's Beach and Shore Preservation Act. They argued that by fixing the boundary line between public and private lands (a boundary that traditionally fluctuates with the tide line), the regulation deprived them of their rights to be adjacent to the water and to receive future accretions (deposits of sand that result from natural sedimentation processes). *Stop the Beach Renourishment, Inc. v. Florida Department of Environmental Protection. et al*., 130 S. Ct. 2592 (2010). Although the court found no taking, the court's finding was limited to an analysis of Florida's common law. *Id.* at 2611-2612. Whether or not similar statutory provisions would constitute a taking in another state would depend on that state's common law jurisprudence regarding the rights of ocean-front property owners and the public trust, among other things. For a discussion of the unique issues raised by the *Stop the Beach Renourishment* case, see J. Peter Byrne, *Rising Seas and Common Law Baselines: A Comment on Regulatory Takings Discourse Concerning Climate Change*, 11 VT J. Envtl. L 625 (Spr. 2010); *see also* John R. Nolon, *Rising Tides-Changing Title: Walton County v. Stop the Beach Renourishment* (2009). Pace Law Faculty Publications. Paper 602, available at http://digitalcommons.pace.edu/lawfaculty/602 (last visited Sep. 15, 2010) [hereinafter *Rising Tides*]. For a discussion of the littoral rights of ocean-front property owners, see Joseph J. Kalo, *North Carolina Oceanfront Property and Public Waters and Beaches: The Rights of Littoral Owners in the Twenty-First Century*, 83 NC L. Rev. 1427 (Sep. 2005).

260. The Texas courts coined the term "rolling easements" to define the easement created by the Texas Open Beaches Act. *See* Feinman v. State, 717 S.W. 2d 106 (TX App. 1986). The term was later used by Jim Titus of EPA to describe the collection of land-use policies that function to ensure that coastlines can migrate naturally inland as the seas rise, including "rolling" conservation easements and permit conditions. Titus, 57 MD L. Rev. at 1313, 1364-1368. However, the Texas Supreme Court has recently called into question the constitutionality of Texas's rolling easement provisions (see discussion of *Severance v. Patterson* at p. 43).

261. These types of policies could also be implemented through a local-level ordinance. Because the policies are designed to protect state owned tidelands, these types of statutes have typically been implemented through a state-level statute.

262. *See* Titus, MD L. Rev. at 1313, 1342-1347 (analyzing the takings implications of a permit condition that exacts a rolling easement); *Caldwell, 34* Ecology L.Q. at 564-66.

263. For example, in Virginia the tide line is measured using "the average elevation of low water observed over a specific 19 year period." Palmer v. Virginia Marine Resources Commission, 48 VA App. 78, 88 (2006).

264. *See* Titus, 57 MD L. Rev. at 1364-1368, 1292-1294; NRC, *Mitigating Shore Erosion* at 105.

265. S*ee generally* Titus, *57* MD L. Rev. at 1313, 1368-1379; s*ee e.g.,* Texas Open Beaches Act, TX Nat. Res. Code Ann. §§ 61.001-.178 (Thomson Reuters through 2010); NOAA, *Erosion Control Easements*, *available at* http://coastalmanagement.noaa.gov/initiatives/shoreline_ppr_easements.html (last visited Aug. 19, 2010).

266. *Id.*

267. *CA Adaptation Strategy* at 77.

268. *FL Action Plan,* app. F at 11; *NJ Recommendations* at 91; *VA Climate Change Action Plan* at 37.

269. EPA, *Synthesis of Adaptation Options* at 7.

270. EPA, *Maine* at 4-6

271. ME Admin. Code. 06-096 ch. 355, § 5 (West through 2010).

272. ME Admin. Code. 06-096 ch. 355, § 5 (2010).

273. SC Code Ann. §§ 48-39-280(A), 48-39-280(B) & 48-39-290(B)(2)(a).

274. --- S.W.3d ----, 2010 WL 4371438 (Tex., 2010), 54 TX Sup. Ct. J. 172.

275. The vegetation line is typically defined as the first line of stable vegetation occurring on a beach. *See* TX Nat. Res. Code Ann. § 61.001(5).

276. TX Nat. Res. Code Ann. §§ 61.001 *et seq. (Thompson Reuters through 2010).*

277. See discussion of the Texas Open Beaches Act at section 11, *supra; see also* NOAA*, Planning Guide* at 71.

278. *Severance* at 10-11.

279. *See e.g.,* Mikeska v. City of Galveston, 451 F.3d 376 (TX 2006). (The Open Beaches Act gives discretionary authority to the Commissioner of the state General Lands Office (GLO) to require removal of encroaching structures. When the GLO refused to require removal of damaged houses, the city tried to enforce the OBA by refusing to reconnect utilities to the houses. The court found that the plaintiffs could bring a substantive due process claim against the city because the city's denial of the landowners' request to reconnect utilities was unrelated to the purposes of the OBA, to protect public access to the coast.)

280. *See* Titus, 57 MD L. Rev. at 1332. 1389-1390.

281. See discussion of *Severance v. Patterson* at p. 65.

282. See discussion of unique common law issues raised by coastal land use regulations Nolon, *Rising Tides* at 3, 14-15.

283. *Id.* at 14-15.

284. VA-APA, *VA Managing Growth* at 15.

285. *See* Brower et al.*, NC Guidebook* at 144-148.

286. *MD Comprehensive Strategy,* ch. 5 at 9, 13.

287. *Dorchester Technical Guidance* at 42.

288. *NC Management Strategy* at 13.

289. *VA Climate Change Action Plan* at 35.

290. *WA Leading the Way* at 138.

291. EPA, *Maine* at 7-8.

292. MD Code State Fin. & Proc., § 5-7B-01 *et seq.;* (West through 2010) MD-DNR, *SLR Response Strategy for Maryland* at 32-33; *see also* Maryland Department of Planning, *Growing Smarter Maryland* at 2 (Jun. 2007), *available at* http://www.mdp.state.md.us/PDF/OurProducts/Publications/OtherPublications/growing_smarter.pdf (last visited Aug. 14, 2010).

293. 16 U.S.C.A. § 3501 *et seq.; see also* Jacobs, *The Resilient Coast: The Built Environment* at 12; Brower, *NC Guidebook* at 38-39.

294. See e.g., *Dorchester Technical Guidance* at 21.

295. *See generally* William B. Stoebuck, *The Property Right of Access Versus the Power of Eminent Domain*, 47 Tex. L. Rev. 733 (1969).

296. *See generally* Jon A. Kusler, report for ASFPM, *A Comparative Look at Public Liability for Flood Hazard Mitigation* (2009), *available at* http://www.floods.org/PDF/Mitigation/ASFPM_Comparative_look_at_pub_liability_for_flood_haz_mitigation_09.pdf (last visited May 5, 2011).

297. Brower et al., *NC Guidebook* at 121-122.

298. Fraser et al., *Floodplain Land Acquisition* at 7-8; *See* USCCSP, *SAP 4.1* at 95; *See* FEMA 317*, Property Acquisition Handbook for Local Communities* (October 1998) http://www.fema.gov/government /grant/resources/acqhandbook.s htm; Also see general description at http://coastalmanagement.noaa.gov/climate/docs/ch5adaptationstrategy.pdf p. 69.

299. Fee simple is the most common type of ownership of real estate: the government takes full ownership of the property. In contrast, governments can also acquire conservation easement where the government simply takes an interest in the property and the landowner retains title. *See* James Boyd et al., *The Law and Economics of Habitat Conservation: Lessons From an Analysis of Easement Acquisitions,* 19 Stan Env. LJ 209, 214-215 (2000).

300. *See* Nichols & Bruch, 1 Sea Grant L. & Pol'y J. at 29-30; NOAA, *Planning Guide* at 70.

301. *FL Action Plan,* app. F at17.

302. *MA Preparing for the Storm* at 14.

303. *SC Adapting to Shoreline Change* at 48-49.

304. EPA, *Synthesis of Adaptation Options* at 10; EPA, *Management Goal: Preserve Coastal Land/Development (Including Infrastructure)*, *available at* http://www.epa.gov/CRE/coastalland.html (last visited Aug. 20, 2010); *see also* Titus, 20 Golden Gate U. L. Rev. at 757.

305. Staff of the California Coastal Commission, *Overview of Sea-Level Rise and Some Implications for Coastal California* at 27 (June 1, 2001), *available at* http://www.coastal.ca.gov/climate/SeaLevelRise2001.pdf (last visited Aug. 20, 2010).

306. *See* Florida Atlantic University, Center for Urban and Environmental Solutions, *Florida's Resilient Coasts*: *A State Policy Framework for Adaptation to Climate Change* at 37 (2008), *available at* http://www.ces.fau.edu/files/projects/climate_change/Fl_ResilientCoast.pdf (last visited Aug. 20, 2010).

307. GAO, *Strategic Federal Planning* at 24.

308. New Jersey Department of Environmental Protection, *Coastal Blue Acres, available at* http://www.state.nj.us/dep/greenacres/blue.html (last visited Aug. 20, 2010).

309. New York Department of Environmental Conservation et al., *New York State Open Space Conservation Plan* at 18 (2009) *available at* http://www.dec.ny.gov/docs/lands_forests_pdf/osp09complete.pdf (last visited May 4, 2011).

310. *See* Fraser*, Implementing Floodplain Land Acquisition* at 7-8; 42 U.S.C. § 5170c; http://www.fema.gov/government/grant/hma/index.shtm.

311. NOAA, Office of Ocean and Coastal Resource Management, *Land Acquisition, available at* http://coastalmanagement.noaa.gov/land/welcome.html (last visited Aug. 24, 2010).

312. NOAA, Office of Ocean and Coastal Resource Management, *Coastal and Estuarine Land Conservation Program Final Guidelines* (Jun. 2003), *available at* http://coastalmanagement.noaa.gov/land/media/CELCPfinal02Guidelines.pdf (last visited Aug. 24, 2010).

313. Coastal Wetlands Planning, Protection and Restoration Act, 16 U.S.C. § 1394 (West 2010); *see also* U.S. Fish and Wildlife Serv. (USFWS), *National Coastal Wetlands Conservation Grant Program, available at* http://www.fws.gov/coastal/CoastalGrants/ (last visited Aug. 24, 2010); USFWS, *National Coastal Wetlands Conservation Grant Program Fact Sheet,* (Dec. 2009), *available at* http://www.fws.gov/coastal/CoastalGrants/docs/factsheets/2009/coastal_grant.pdf (last visited Aug. 24, 2010).

314. *See* EPA, *Synthesis of Adaptation Options* at 17; *see also* GAO, *Natural Hazard Mitigation* at 44; Brower et al., *see also NC Guidebook* at 123.

315. Fraser, *Implementing Floodplain Land Acquisition* at 7-8.

316. NOAA, *Planning Guide* at 69.

317. EPA, *Synthesis of Adaptation Options* at 11.

318. Fraser, *Implementing Floodplain Land Acquisition* at 9-11.

319. The use of conservation easements as a policy tool to address SLR will be limited by the provisions of the statute creating the property interest. Because conservation easements were not recognized at common law, states seeking to create this new property interest enacted "conservation easement enabling acts" starting in the 1950's. A property interest must be recognized under common law or created by statute in order to be enforceable. Frederico Cheever, *Public Good and Private Magic in the Law of Land Trusts and Conservation Easements: A Happy Present and a Troubled Future, 73* Denv. U. L. Rev. 1077, 1081, n. 31 (1996). Conservation easements are "negative in gross easements." They are *negative* because they limit the use of land to conservation purposes (i.e., impose a *negative* condition). They are *in gross* because they are held by state or local agencies or non-profit land trusts, unrelated to ownership of any adjacent parcel. Negative in gross easements were not recognized at common law, and in order to be enforceable this type of property interest had to be created by statute. *Id.* at 1081-1082.

320. NOAA, *Erosion Control Easement, available at* http://coastalmanagement.noaa.gov/initiatives/shoreline_ppr_easements.html (last visited Jun. 9, 2010).

321. *See* Titus, 57 MD L. Rev. at 1313-1317, 1385; *see also* Caldwell, 33 Ecology L.Q. at 550-551.

322. *NC Management Strategy* at 14.

323. Maryland Department of Natural Resources, *Maryland Environmental Trust, available at* http://www.dnr.state.md.us/met/index.asp (last visited Aug. 24, 2010).

324. NOAA, Office of Ocean and Coastal Resource Management, *Land Acquisition, available at* http://coastalmanagement.noaa.gov/land/welcome.html (last visited Aug. 24, 2010).

325. Boyd, 19 Stan Env. LJ at 214-215.

326 *Id.*

327. *See* Robert H. Levin, *Land Trust Alliance, A Guided Tour of the Conservation Easement Enabling Statutes* at 37-38 (Jan. 2010), *available at* http://www.landtrustalliance.org/policy/cestatutesreportnoappendices.pdf (last visited Aug. 24, 2010) [hereinafter *Guided Tour Conservation Easements*].

328. Forty-nine states and the District of Columbia enacted some form of the Uniform Conservation Easement Act; North Dakota has enacted a historic preservation enabling statute, but no comparable conservation easement statute exists. *Id.* at 7.

329. Jeff Pidot, Lincoln Institute, *Reinventing Conservation Easements: A Critical Examination and Ideas for Reform* at 8-9 (2005) [hereinafter *Reinventing Conservation Easements*]. This article provides a useful discussion of some of the problems with administering a conservation easement program and ensuring the efficient expenditure of public funds.

330. For a discussion of the difference between negative and affirmative obligations, see note 176, *supra*.

331. Conservation easements designed to protect natural shoreline processes are sometimes called "erosion control easements." *Id.*; *see also Nichols,* 1 Sea Grant L. & Pol'y J. at 28.

332. *See* Titus, 57 MD L. Rev. at 1387-1389; *see also* Caldwell, 33 Ecology L.Q. at 551-553.

333. Titus, 57 MD L. Rev. at 1322-1327 (discussion of economic efficiency of rolling easement policies).

334. Pidot, *Reinventing Conservation Easements* at 11.

335. Titus, 57 MD L. Rev., app. 1 at 1396.

336. A rolling easement would constitute a type of "negative in gross easement" that was not recognized at common law. *See* note 319, *supra*. However, public entities may be able to use their authority to acquire conservation easements as a statutory basis for creation of rolling easements. The enabling act in most states broadly authorizes creation of in gross easements to be held by public entities for conservation purposes. The easements can impose both affirmative and negative obligations, which would seemingly authorize use of covenants to limit development and require removal of structures. Finally, rolling easements would serve the conservation purposes required by the statutes because they serve to protect public trust lands for future recreational and ecological purposes. *See e.g.* VA Code Ann. § 10.1-1700.

337. Also called "ad valorem taxes." Ad valorem taxes are assessed based upon a percentage of the appraised value of the property. AMJUR STATELOCL § 18.

338. *See* Elizabeth Davis, Comment, *Preserving Municipal Waterfronts in Maine for Water-Dependent Uses: Tax Incentives, Zoning, and the Balance of Growth and Preservation,* 6 Ocean & Coastal L.J. 141, 144-147 (2001).

339. Davis, 6 Ocean & Coastal L.J. at 146-147.

340. 26 U.S.C. § 170(h).

341. 26 U.S.C. § 2031(c).

342. See discussion by Maryland Environmental Trust, *Tax Benefits of Donating a Conservation Easement, available at* http://www.dnr.state.md.us/mmet/taxbenefits.html.

343. Infill refers to underutilized areas within established urban areas. Governments can promote development in these areas to maximize the use of existing public infrastructure (such as transportation) and preserve open space. Infill incentives can take the form of direct financial assistance to developers, density bonuses, and/or expedited permitting processes. *See e.g.,* VA-APA, *VA Managing Growth* at 33-34. For an example of a comprehensive infill incentive program, see Orange County Florida Growth Management Department Planning Division, *Infill Master Plan* (2008), *available at* http://www.orangecountyfl.net/YourLocalGovernment/CountyDepartments/GrowthManagement/PlanningDivision/ResearchandIntergovernmentalCoordination/InfillandRedevelopmentInitiative.aspx (last visited Aug. 24, 2010).

344. *CA Adaptation Strategy* at 77.

345. *FL Action Plan,* app. F at 11.

346. NY Tax Law § 19 (McKinney through 2010); s*ee also* New York State Department of Environmental Conservation, *New York State Green Building Tax Credit Legislation Overview, available at* http://www.dec.ny.gov/energy/1540.html (last visited Jan. 20, 2010).

347. NC Gen. Stat. § 113A-164.11 (West through 2010); *see also NC Management Strategy* at 14

348. Virginia Department of Conservation & Development, *Virginia Income Tax Credits* (Dec. 2006), *available at* http://www.dcr.virginia.gov/land_conservation/documents/lctaxbro.pdf (last visited Sep. 26, 2010); Pidot, *Reinventing Conservation Easements* at 29.

349. *See* Davis, 6 Ocean & Coastal L.J. at 154.

350. TDCs are also referred to as Transfer of Development Rights or Severable Use Rights and are collectively referred to in this Tool Kit as "TDCs."

351. Timothy J. Lawrence, *Transfer of Development Rights, Ohio State University Fact Sheet: Community Development* at 1 (1998), *available at* http://ohioline.osu.edu/cd-fact/1264.html (last visited on Aug. 24, 2009) [hereinafter *TDRs Fact Sheet*]; *see generally*, Lincoln Institute of Land Policy ("Lincoln Institute"), *Transfer of Development Rights for Balanced Development* at 9-13 (May 1998), *available at:* http://www.rpa.org/pdf/transferdevelopment.pdf (last visited Jul. 20, 2010) [hereafter *TDRs for Balanced Development*]; *see also* VA-APA, *VA Managing Growth* at 36-37; Burke, *Understanding Zoning* at 200-203.

352. William Fulton et al., Brookings Inst., *TDRs and other Market-Based Land Mechanisms: How They Work and Their Role in Shaping Metropolitan Growth* at 7 (2004).

353. Rick Pruetz et al., *Transfer of Development Rights Turns 40,* American Planning Association Journal of Planning & Environmental Law, vol. 59, no. 6, p. 3 (Jun. 2007).

354. *See e.g.,* VA. Code Ann. §§ 15.2-2316.1 and 2316.2; VA-APA, *VA Managing Growth* at 37.

355. "Calibration" of the development credit market requires regulators to determine the appropriate value for the credits by balancing the market value of the lots in the sending area and the development value of the credits in the receiving area. Lincoln Institute, *TDRs for Balanced Development* at 17-18.

356. *FL Action Plan,* app. F at 10-11.

357. EPA, *Maine* at 6-2.

358. Miami-Dade County, FL, Code of Ordinances § 33B-11 *et seq.; see also* Lincoln Institute, *TDRs for Balanced Development* at 18-19.

359. Rick Pruetz, *TDR Program Profiles, Malibu Coastal Zone, California, available at* http://www.beyondtakingsandgivings.com/malibu.htm (last visited May 5, 2011).

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361. AFT, prepared for Boone County Planning Commission, *Purchase of Development Rights and Transfer of Development Rights Case Studies* at 15-27 (May, 2001) [hereinafter *TDR Case Studies*]; New Jersey Pinelands Commission, *New Jersey Pinelands Development Credit Program* (rev. Oct 16, 2009), *available at http://*www.state.nj.us/pinelands/infor/fact/PDCfacts.pdf (last visited Jul. 21, 2010); The New Jersey TDR Enabling Act is available at http://www.state.nj.us/agriculture/sadc/tdr/tdract/ (last visited Aug. 24, 2010). *See also* Lincoln Institute, *TDRs for Balanced Development* at 22-28.

362. Massachusetts Office of Energy and Environmental Affairs, *Smart Growth / Smart Energy Toolkit, Transfer of Development Rights Model Bylaw, available at* http://www.mass.gov/envir/smart_growth_toolkit/bylaws/TDR-Bylaw.pdf (last visited Aug. 21, 2010).

363. Jason Hanly-Ford et al., Cornell University, *Transfer of Development Rights Program: Using the Market for Compensation and Preservation, available at* http://government.cce.cornell.edu/doc/html/Transfer%20of%20Development%20Rights%20Programs.htm (last visited Jul. 20, 2010).

364. AFT, *Fact Sheet Transfer of Development Rights* at 2 (Jan. 2001), *available at* http://www.farmlandinfo.org/documents/27746/FS_TDR_1-01.pdf (last visited Aug. 24, 2010).

365. Burke, *Understanding Zoning* at 201.

366. For a discussion of factors that make for a successful TDC program from a survey of the 20 programs that have preserved the most land see Rick Pruetz et al., *What Makes Transfer of Development Rights Work? Success Factors from Research and Practice,* 75 J. Am. Plan. Assoc. 78 (Winter 2009).

367. *See e.g.*, VA-APA, *VA Managing Growth* at 38.

368. *Id.; see also* John C. Danner, *TDRs – Great Idea But Questionable Value*, The Appraisal Journal at 140-142 (Apr. 1997), available at http://lumlibrary.org/webpac/pdf/TAJ/TDRs.pdf (last visited Jul. 20, 2010).

369. *See e.g.,* GAO, *Natural Hazard Mitigation* at 44.

370. Penn Central Transportation Co. v. City of New York, 438 U.S. 104, 137 (1978).

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375. *FL Action Plan,* app. F at 18.

376. *FL Action Plan,* app. F at 42.

377. *MD Comprehensive Strategy,* ch. 5 at 16.

378. *SC Adapting to Shoreline Change* at 112.

379. *WA Leading the Way* at 135.

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