Managing Dynamic Coasts: Adapting U.S. Coastal Zone Management to Climate Change

By Sandra S. Nichols and Carl Bruch

Climate change is transforming coastal zones and the impacts are expected to become increasingly significant. While current laws governing coastal zone management were not written with climate change in mind, they can play an important role in an adaptive response. Below, the authors offer a number of policy responses that may prove useful in an uncertain future.

Already, climate change impacts are impossible to ignore and are predicted only to intensify. Adapting to climate change means changing how society manages water, biodiversity, agriculture, forests, land use planning, and coastal zones. An adaptive society needs legal systems that are capable of adapting to the new reality of climate change. This legal reform should address four aspects of climate change response: (1) building resilience to anticipated effects; (2) enhancing adaptive capacity of the governance system; (3) providing early warning of emerging threats; and (4) ensuring effective emergency response to specific incidents.

While there is a fair amount of experience—albeit without the climate change overlay—in developing and implementing laws that enhance resilience, early warning, and emergency response, there is relatively limited experience in structuring legal frameworks around adaptive management. Adaptive management is generally understood to entail: the development and adoption of a provisional measure (a law, policy, institutional arrangement, management decision, etc.); ongoing monitoring; periodic assessment of the collected information; modification of the legal and institutional frameworks, as appropriate; and continuing the cycle of management actions, monitoring, assessment, and revision.

This four-pillared framework broadly represents the changes necessary to adapt coastal zone management to climate change. Incorporating these four concepts into various sectors, however, will require considering specific contexts including the built environment, ecological and natural resources, and public health considerations.

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Policy Responses for the Built Environment

When considering how to prepare coastal communities and states to adapt to the effects of climate change, decisionmakers must consider both existing infrastructure and infrastructure that will be built. Policy responses may also depend on whether infrastructure is public or private.

Observation, Monitoring, and Assessment

Preparing the built environment for climate change requires understanding impacts, such as sea level rise (SLR), as they are happening. An integrated sea-level observation system enables comprehensive surveillance, monitoring, documentation, and dissemination of information, such as rates and locations of SLR, for emergency response systems or for the development of adaptive management systems.

National, state, regional, and local authorities should be involved in the development of SLR observation systems and policy responses, but broader—statewide or regional—authorities should take the lead. When assessing public and private infrastructure vulnerabilities, taking a broad view is important because when looked at from a particular community’s perspective, much of the infrastructure is likely to be critical. After identifying vulnerable infrastructure, authorities can categorize and assess threats and impacts and then formulate strategies to prioritize responses.

Comprehensive Planning

It is much easier and financially more efficient to consider climate adaptation when designing new construction than to retrofit or move existing construction. While there are often significant constraints on what can be done to adapt the existing built environment for climate change, coordinated, integrated “safe growth” can make the future built environment significantly more resilient and able to adapt to changing conditions if authorities plan accordingly. For example, the comprehensive plan for the town of Nags Head, North Carolina, directs construction to reduce vulnerability to storms. Planning can provide an opportunity to address a wide range of potential responses to impacts from climate change—from protection to accommodation to retreat—by integrating plans for hazard-related factors such as stormwater and flooding into broader comprehensive or capital planning tools. Given the uncertainty of climate impacts and effects on infrastructure, planners can help prepare by developing, in advance, a system for deciding how to deal with infrastructure under various scenarios.

Coordination and consistency will contribute to the effectiveness of frameworks for integrating all of the elements of the climate adaptation process. So, while local governments are planning authorities, an appropriate state agency or coalition could spearhead planning reform by conducting a technical review and assessment of coastal local governments’ planning guidelines and measures, determining how best to coordinate across the levels of government, and providing technical assistance, grants, and support for local GIS mapping. Planning reform must be accompanied by appropriate amendment to state and local law to introduce an adaptive approach, if such an approach is not already provided for.

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Zoning

As an enforceable aspect of land use planning, zoning is key to effective climate adaptation. Zoning tools can include specialized easements, construction restrictions, and directing policy through prioritization.

Erosion control easements are legal agreements between a landowner and a land trust or government agency that restricts development in erosion-prone areas. Such easements can be over the entire property or just the shoreline and can be written to prohibit all development or any particular kind. Rolling easements apply along a shoreline to prevent landowners from holding back the sea without restricting landward development. Landward of the mean high water line, which delineates the boundary of state-owned submerged lands, beaches can be privately owned, but they may still be subject to a public beach easement that allows the public free and unrestricted access to and use of the beach. Because shoreline stabilization structures cannot be erected, sediment transport remains undisturbed and wetlands and other important tidal habitat can migrate naturally. This approach assures that there will always be dry or intertidal land for the public to walk along, preserving lateral public access to the shore. By allowing landward development, rolling easements are less prone to takings claims.

Construction setbacks, which restrict how far from the water construction is permitted, are another regulatory tool used to protect structures from erosion. Like rolling easements, setbacks also seek to protect shoreline dynamics and help to maintain lateral beachfront access. The type of setback, including how and where they are established, can vary widely. Establishing setback lines can be controversial if the setback renders some properties unbuildable and, depending on the impacts of the restriction, could be viewed as a taking. One way to reduce takings claims is to ensure waterfront lots are sufficiently deep to allow for relocation as the shore retreats. In particularly flat coastal areas, however, it may not be feasible to ensure that waterfront lots are sufficiently deep, and in most coastal areas, waterfront lots are already subdivided into smaller units.

In the long run, zoning approaches based on dynamic current conditions, such as rolling easements, are more likely to be more effective than those that base standards on conditions existing at the time the regulation is established. Maps created at any given time will eventually be out of date. Zoning approaches will need to be truly adaptive to be responsive to climate change impacts.
Competing demands and political realities may make it impossible to employ all resiliency-building tools across our entire coastal zones. In choosing where to focus protection of land to reduce climate impacts, decisionmakers can maximize benefits by considering what other benefits can be gained by the same actions. Zoning can include scientific and technical criteria to prioritize preservation of land that improves resilience to impacts of climate change and is also ecologically or economically valuable. Using appropriate selection criteria, zoning for priority protection can be initiated with an assessment to identify undeveloped lands that will be critical for targeted conservation and coordinated response to SLR and its associated effects.17

**Building Codes**

Appropriate building codes can make our built environment safer from predicted climate impacts by addressing a range of issues including building elevation, foundation design, moisture-entrapment, and damage from debris. Any effective effort to update codes to respond to climate change will have to be ongoing and adaptive. Codes will have to be periodically re-evaluated for effectiveness in new and evolving circumstances. To account for the lifespan of newly constructed buildings, evaluation of codes in light of threats associated with climate change will involve looking many decades into the future and trying to predict impacts. Where deficiencies are found, the codes, regulations, and laws will have to be updated.

Effective implementation and enforcement, especially in light of continuing adaptation, will require ongoing training of enforcement personnel and education of the building community and property owners. Such an effort will be most effective if led at the state level using an integrated approach involving the participation of all stakeholders in the construction process.18

**Notification of Buyers**

Awareness of threats will be essential for resilience and effective emergency response. Homeowners therefore need to be aware of potential threats. While this information can be shared through a general education campaign or as a notice on real estate listings, the information will be the most meaningful to potential purchasers at the time of the real estate transaction. A disclosure requirement, building on similar existing requirements for lead paint and radon, would have the advantage of being targeted to an individual property at the time of the transaction.19 The disclosure could take various forms, including generic notification that the property is in a zone vulnerable to SLR, a more specific notification to the buyer that the particular property has experienced flooding or storm damage in the past, or a warrantee that it has not had such impacts.

This notification would put the purchaser on notice of the potential effects of SLR. As such, it would inform and may influence investor-backed expectations, a factor in takeovers determinations. Awareness of this information would not likely prevent sales, but it could affect the ultimate sales price to reflect increased risk of SLR and of regulatory measures.

**Insurance**

While the past has historically served as a good indicator of future events when calculating the risks associated with insurance coverage, climate change introduces new and uncertain risks into these calculations.20 In effect, climate change voids the historical record. Scientists caution that intense weather events may become more predictable in only one sense: “They will become a lot more severe, and quite possibly more frequent.”21

Private insurance and reinsurance companies serve as the backbone of the economic institutional framework that makes it possible for people to recover from damage caused by intense weather events.22 Most insurance companies in the United States have responded to the challenges posed by climate change with financial strategies to reduce risk in coastal areas.23 Risk is reduced by raising premiums, increasing deductibles, limiting coverage, or discontinuing coverage altogether.24 States are stepping in to fill coverage gaps, but they are assuming an enormous risk by doing so.25 Consequently, states are increasingly appealing to the federal government for help. Coastal states, led by Florida, are lobbying for a national catastrophe fund that would allow state funds and private insurers to buy lower-cost reinsurance from the federal government to limit their exposure to disasters.26

But before the liability is simply passed down the line, authorities have the opportunity to consider how the insurance industry can contribute to lowering the risk. If states gather information on existing insurance programs, assess the potential hazards and the threats they pose, and evaluate how the insurers and reinsurers are currently managing those risks, states can develop strategies for managing the risks and uncertainties posed by climate change, thereby allowing them to avoid bankruptcy when the risks manifest themselves as impacts. Such a study could also help the insurance industry promote sound environmental management goals and shape the relationship between insurance and changing building and design standards.27

As expert managers of risk, insurance companies can be extremely influential in persuading policymakers to undertake proactive measures.28 A national network of investors, environmental organizations, and other public interest groups working with companies and investors to address sustainability challenges, called CERES, published a list of 10 proactive strategies available to the insurance industry, including promoting loss prevention, encouraging risk-reducing behavior, financing climate protection improvements, investing in climate change solutions, building awareness, leading by example, and disclosing risks.29

In addition to traditional private homeowner insurance, the U.S. government offers federal disaster relief through the National Flood Insurance Program (NFIP). While a primary concern regarding the NFIP has been simply keeping the program sufficiently funded to continue functioning, allowing it to continue without re-examining its basic premise and effectiveness is irresponsible.30 In its current form, the NFIP creates a moral hazard by enabling people to choose to live in places that put a burden on society. Instead, the program should update flood maps regularly, discontinue grandfathering and the allowance of variances, and remove disincentives for states to take responsibility for hazard management.31

**Erosion Control Measures**

Approaches for responding to coastal erosion include natural de-
fenses, managed retreat, soft defenses, and coastal armoring. Natural defenses, such as coastal wetlands, provide critical buffers to protect land by reducing tidal amplitude, dissipating wave energy, storing excess water, and reducing sea wall maintenance costs. Intertidal systems provide not only biodiversity and ecosystem services, but also protection from erosion.

Managed realignment or retreat, including the landward relocation of flood defenses and restoration of intertidal habitat to protect shoreline development against coastal erosion and inundation, allow the natural coastal processes of erosion and accretion to occur. Under this approach, communities avoid future coastal development in particularly vulnerable places if possible, or attempt to configure coastal development in a sustainable way, taking into account the migration of coastal systems over time. If managed retreat is chosen as an option, long-term planning and coordination are crucial to avoid a chaotic abandonment of coastal assets and the societal disruption that it would entail.

Soft defenses include beach nourishment, dune restoration, and shoreline stabilization using vegetation. Beach nourishment is a longstanding practice of pumping aggregate onto a beach to offset erosion. One drawback to this strategy is the ecological impact of collecting the sand. Opponents argue that it is responding to a symptom, not the underlying cause, of erosion. A less controversial form of soft defenses is dune restoration. Dunes, often vegetated with salt-resistant, deep-rooted plants, trap and store sand and provide a natural buffer against erosion; they shelter beachfront development and reduce the threat from high-water events.

The final category of response to erosion, coastal armoring, has a long history. Coastal armoring aims to reduce land loss by erecting hard structures that are environmentally and economically unsustainable. Because landowners are often more familiar with coastal armoring strategies than other approaches, they may assume that a hard defense is the only way to prevent the loss of property. Permitting policies may inadvertently promote this practice by making it easier and faster to obtain the permits required for coastal armoring than those required for alternative approaches. And, in spite of the detrimental impacts, coastal armoring may be the only viable option when vital infrastructure is facing immediate threat.

The presumption in favor of methods that are sustainable and that improve ecosystems dictates a preference against hard responses to erosion. This preference must be included in any reforms of law, policy, and practice related to protection of the built environment and must be reflected in both planning and permitting programs. Connecticut already has a ban on using hard defenses, while Maryland expresses a regulatory preference for soft measures. One approach is to require permit applicants to demonstrate that their preferred erosion control alternative is the least disruptive to the shoreline and any buffer area. In order to guide applicants, relevant state agencies can develop a set of prioritized erosion control methods and practices. Finally, authorities can assist landowners by developing guidelines on preferred shoreline and buffer management practices that support adaptive strategies for responding to climate change.

**Policy Responses for Ecological and Natural Resources**

Adaptive and integrated approaches are already used in the management of many natural resources. Paired with legally required performance standards and robust stakeholder involvement, these adaptive approaches can provide a policy model for effectively responding to climate change. An initial step for improving the resilience of ecological and natural resources is to conduct baseline studies on the current condition of resources, trends, and expected impacts.

Measures for increasing adaptivity in management will be similar for many ecological and natural resources. These entail, for example, enhancing monitoring and assessment requirements in resource planning, including developing and assessing criteria to track the impacts of climate change. One of the central features of adaptive management—one that is often not adequately accounted for in existing legal frameworks—is a process for revising management actions to respond to lessons learned in the assessment process. If the resource begins to show signs of stress or decline, management methods need to be reconsidered.

Forests are managed by federal, state, and private authorities, so legal and policy regimes will differ depending on the jurisdiction. In federal and state forests, planning tools can adopt management actions that use the adaptive approach and improve resilience. On private land, regulation is more limited and incentives can play an important role.

Managers of near-shore marine resources such as those used by the seafood industry can begin to prepare for impacts from climate change by gathering information about the current status of populations in order to monitor and assess how they are faring as conditions change. Authorities should conduct industry studies for various seafood species to determine, for example, whether appropriate responses to damage to populations will require repopulation from other sources such as aquaculture practices or whether native populations should be reinforced before such events take place. In certain instances, climate-induced changes may stress economically important marine resources that more dramatic measures may be necessary.

The most effective step for minimizing harm to agricultural activities in coastal areas is to prevent further establishment of such enterprises in vulnerable areas and to encourage progressive and orderly relocation through planning and zoning efforts. Education
and incentives can be used to either induce farmers to relocate or to change their practices to those that will increase their own resilience and not compound impacts to others.

Mangroves, salt marshes, and other coastal wetland systems may migrate inland as sea level rises in relation to the seaward margin. On developed or armored coasts, however, wetlands cannot move inland because human-made features block their spread.49 So while wetlands can protect against the impacts of climate change, they are also threatened by “coastal squeeze.”50 In order for wetlands to migrate as sea-level rises, the area landward should—to the extent possible—be free of physical barriers such as sea walls, roads, and buildings. Planning efforts must factor in corridors for wetlands to migrate; the presumption against hard defenses will also be important. Locations where there are corridors that will provide for wetland migration in the case of sea-level rise should be prioritized for protection.

Several technical options are available to combat the threat that salinization of aquifers poses to water supply in coastal areas.51 The economic viability of each method depends on many factors including the nature of the local hydrological system, local water use and development patterns, and climate variability.52 Policies determining the most appropriate methods and promulgation of any necessary regulations, using an adaptive approach, can help water management authorities be prepared to protect underground water resources as sea level rises.53

As the primary natural resource managers in most cases, states will most likely be responsible for performing effective prevention, control, and eradication of invasive species under changing climatic conditions. There are many uncertainties about precisely how climate change will affect ongoing invasive species management activities.54 Managers can begin to adapt invasive species management activities to projected altered climate conditions by incorporating climate change considerations into leadership and coordination activities; identifying new invasive species threats as they emerge; identifying ecosystem vulnerabilities and improving resilience; evaluating the efficacy of control mechanisms under changing conditions; and managing information systems to include considerations of changing conditions.55 State invasive species management authorities can incorporate climate change-driven stressors56 into their existing management frameworks and adapt current frameworks to reflect these new stressors. This involves adapting policy design to incorporate climate change-related variables, as well as adapting existing prevention, control and management, and restoration activities to take into account the climate-related ecological changes.

**Policy Responses for Protecting Public Health**

To appropriately prepare for the public health risks associated with increased intensity of natural disasters and changes in infectious disease patterns, we must consider different aspects of these risks: they are diverse, global, and likely irreversible over human time-scales; they are vast; they will be inequitable due to the fact that those likely to be most impacted are not those most responsible; and many health impacts are avoidable.57 Safeguarding public health from climate change impacts will not require new interventions, but renewed political commitment and financial resources to strengthen key functions of environmental management, surveillance, and response.58

**Conclusion**

Much work remains to reform environmental governance frameworks to adapt to climate change. We must research lessons learned to date in building resilience and adaptive capacity; identify, describe, share, and pilot-test adaptation strategies and governance structures; share and, where appropriate, scale up particular successful approaches; and build capacity to develop, implement, monitor, and reform laws, regulations, and institutions to adapt to climate change.

One way or another, we will learn to adapt to climate change. The choice is whether we undertake progressive measures now or wait until disaster compels us later. Pay now, or pay more later. The good news is that there are numerous measures that can be taken now, many of them “no-regrets” measures. Moreover, with growing public attention to climate change, there is a political window within which communities, states, and the federal government can undertake these measures.

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**Endnotes**

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Restoring native wildlife habitats and capturing carbon represents a “win-win” for the Service and its partners. Expanding terrestrial carbon sequestration activities will be an increasingly important part of the FWS’ conservation work.

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