“Win-Win” Climate Change Adaptation Strategies: Lessons Learned From Sea Grant Coastal Processes and Hazards Programming

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Executive Summary

Climate change and sea-level rise education and adaptation are important action items for national Sea Grant Network. The education component requires a balanced approach to the science but can be accomplished using traditional Sea Grant education and extension methods. In contrast, encouraging adaptation for climate change and in particular, sea-level rise, can often be more effectively presented in the context of other coastal hazards. Communicating climate change and sea-level rise risk is hampered by the state of the existing science and distant threat timelines extending over the next century. The scientific debate has unfortunately also become politically polarized.

A closer scrutiny of the risks reveals that many coastal adaptation actions appropriate for long-term planning are identical to those employed to manage or mitigate severe and more immediate impacts of other coastal hazards. If Sea Grant is to effectively present adaption options, it should recognize that the most convincing reasoning to take specific actions should be given priority in extension efforts. Climate change and sea-level rise will usually be on the list of justifications but are often less compelling threats than other appropriately presented coastal hazards.

This paper describes the science and timeline limitations of climate change and sea-level rise as justifications for implementing adaptation actions. Examples of other coastal hazard risks that make a more compelling case for individuals and communities to take the same measures are provided. Several adaptation actions already in common application are described, including financial incentives to encourage implementation.

By attempting to encourage individual and community adaptation actions using coastal climate change and sea-level rise as the sole or even primary justification, Sea Grant risks losing an opportunity to make a more compelling and effective case using more immediate, severe and recognized coastal hazards.

Introduction

Climate change is a crosscutting theme that will apply to virtually all of Sea Grant's traditional research, education and extension programming areas. Preparing communities for climate change is a challenge given the uncertainties and long timeframes associated with the impacts. Sea Grant audiences are more likely to implement adaptation strategies that address existing problems with current or immediate impacts and provide benefits regardless of whether current predictions of future climate change are correct. These approaches are often called "win-win" or "no regrets" because they help improve community resiliency to shorter term hazards, while enhancing a community's ability to adapt to longer term climate change impacts.

Sea Grant's long established field of coastal processes and hazards is somewhat unique in that it has been dealing with issues usually associated with climate change, such as sea-level rise and unpredictable, variable natural hazards along the coast, and incorporating them into programming efforts for decades. Lessons learned from this experience can provide valuable insights for climate adaptation specialists in selecting effective extension programming strategies and in identifying and overcoming barriers to adaptation. Improved communications between the natural coastal processes/hazards and the climate change communities of practice will ultimately enrich and strengthen Sea Grant research, extension and outreach efforts. In the spirit of improving communications, this document discusses some of the challenges associated with climate change adaptation programming along with suggestions for addressing these challenges based on the experiences of coastal processes and hazards specialists.

Background

A clear and growing consensus in the scientific community ascertains that the Earth's climate is changing and that man's activities are contributing to, if not largely responsible for, this rate of change. This consensus follows decades of research focusing on identifying trends and reducing uncertainty in the causes of climate change and future predictions (Barron 2009). Interest has increased regarding development of

mitigation and adaptation strategies for the impacts expected as a result of recent climate predictions.

A significant amount of attention has focused on the topics blended into climate change (e.g. sea-level rise and coastal hazards), and their related impacts and consequences to coastal environments and communities. The most recent Intergovernmental Panel on Climate Change Assessment report (IPCC 2007), as well as the devastating impacts from 2005-2008 hurricanes (e.g. Katrina, Rita and Ike), have spurred new interest in developing mitigation and adaptation strategies for climate change, sea-level rise and other coastal hazards.

A variety of historical measurements across multiple scales, including global temperatures, mean trends in CO_2 concentration levels, and tide gauge records, clearly indicate that climate is warming and sea levels are rising. There is also evidence that climate has changed throughout geologic time and today's climate change isn't a unique phenomenon but rather the norm — it is the rate of change and probable causes that are likely unique. There is increasing scientific consensus that the effects are likely to be accelerating and measurable within decadal timeframes. While selected studies suggest that climate change will exacerbate hazards and associated impacts (e.g. higher sea levels resulting in more floods, possible changes in storm frequencies and/or intensities), many acknowledge that we don't really know yet what climate change means, especially on a regional/local scale, where most decisions are made. In a 2009 editorial in *Science,* the director of the National Center for Atmospheric Research stated: "The United States lacks sufficient investment in the sciences required for moving beyond climate science to define impacts and vulnerabilities" (Barron 2009). The paucity of reliable information on impacts associated with climate change and how these impacts may affect the vulnerability of coastal communities makes it difficult, if not impossible, for today's local decision-makers to address problems that they may face in the future due to a changing climate. Sea Grant specialists have been working with these audiences on coastal processes and hazards problems for decades.

Some of the most pressing coastal hazards and processes issues faced by state/local governments, coastal communities, and individual property owners today include storm surge and flooding (short-term flooding), tsunamis, inundation of low-lying areas (long-term flooding), and coastal erosion (due to dwindling sediment supply, sea-level rise and storms). Devastation from disasters related to coastal hazards will continue to occur, and the associated impacts and losses may have little to do with climate change (Pielke et al. 2008). Travis (2009) suggests, "in this case, standard hazard planning and mitigation, if pursued more vigorously, will make communities not only more resilient to current extremes, but also to climate change, however it plays out."

Climate change is real, and it is evident that we need to document ongoing changes related to a warming climate, rising sea levels and potential impacts on our coasts, to develop better tools to illustrate the consequences of future changes, and to convey those consequences to the public. In most areas, climate change will not create entirely new coastal hazard problems but may exacerbate the ones we already face. Threats posed by climate change and accelerated sea-level rise will likely play a role in encouraging increased mitigation of current hazards. *The topic of climate change should certainly be embedded into future planning strategies and public education, but we must recognize that nearly all communities place greater importance on existing and near-term coastal hazards.*

In fact, there may be instances when pointing to climate change impacts such as accelerated rates of sea-level rise as primary causative agents of past and present shoreline change may not be truly representative of sound science and best available information. By narrowly focusing on a single and potentially minor factor related to coastal erosion and shoreline retreat, factors such as sediment supply, wave/current energy, inlets, and hard-structure impacts will likely be overlooked. If sediment budgets and coastal processes are not considered in the evaluation process, the result could be poorly defined, designed and implemented mitigation and/or adaptation strategies. As identified at the June 2010 Sea Grant roundtable discussion session, a research/data gap in coastal processes science is historical shoreline response to sea-level rise.

However, until those data are available, a singular focus on sea-level rise to draw attention to eroding coasts may not be the best way to address real issues.

In considering, developing and implementing adaptation strategies, the Sea Grant network needs to recognize that the uncertainties associated with climate change and sea-level rise, lack of knowledge related to specific local impacts, and the extended timeframes over which these changes are expected to occur impose significant limits when trying to get people to act today. It is critically important to recognize that one of the most effective ways to develop hazard-resilient coastal communities is not to focus on climate change and potential impacts of possible future sea-level rise scenarios, but rather to identify more immediate and more certain reasons to take the exact same actions. This can be accomplished through continued development of long-term coastal hazard management and mitigation strategies based on a quantitative understanding of existing regional coastal processes and associated hazards and the effect climate change may have in the future. However, it is imperative that this information be presented in temporal and spatial scales that are meaningful and useful to local decision-makers.

The Problem

While climate change and sea-level rise may be the most important coastal issues we face over the next century, the inexact science coupled with ambiguous and far-off consequences make using those issues to market specific actions a very hard sell for a large portion of the public. Despite a widespread, increasing awareness of the need for preventative action, and a growing interest from government agencies, NGOs, the private sector, and others in providing training and financial incentives for adaptation initiatives, there are still major constraints that limit the effectiveness of marketing climate change and sea-level rise adaptation strategies.

Several of these constraints and weaknesses include:

- **Uncertainty** (data, models, impacts, timeframes)
  - ***Data***. Attempts to identify expected accelerating trends in sea level are constrained by highly variable data and relatively short periods of record. As climate and sea level have always been widely varying and local conditions are even more volatile from year to year / decade to decade, trends cannot be reliably observed until well into the transition. According to the National Ocean Survey, up to 50 years of water-level measurements may be required to reliably detect an increase in the rate of sea-level rise simply due to natural variability. Additionally, as noted by Moser (2008), while sea-level rise can be considered one of the most certain impacts of climate change, it is also one of the most difficult impacts to measure and predict. This difficulty is illustrated by a recent study of tide gauge records in the United States and around the world that found the rate of sea-level rise over the last several decades appears to be slightly decreasing rather than increasing as might be expected with global warming (Houston and Dean 2011).

  - ***Models***. Climate modeling is now and will remain for the foreseeable future a highly inexact predictive tool. The uncertainty is very high and the error bars will not get much better anytime soon. Additionally, the inadequate spatial scale of climate scenarios produced from coarse resolution global climate model output must be downscaled to provide regionally relevant information. Regional climate reports, assessments, and climate centers (e.g. NOAA, DOI/USGS, and U.S. Global Change Research Program) are working to provide guidance on the proper use and extent of downscaling as supported by the science, to provide datasets in easy-to-use formats for the non-climate scientist, and to provide an accurate portrayal of uncertainty. However, many of the facts and relationships that are important to understanding climate change science and modeling may change over the coming decades and centuries, and will likely remain uncertain for years to come (CCSP 2009).

- ***Impacts***. There is a general lack of locally reliable quantitative data or information on specific impacts related to potential climate change. There are few facts that can be used by community officials and coastal managers to make defendable decisions, especially where significant expenditures and jurisdictional control on private property may be involved. Frequently, these audiences do not have information on the processes and impacts affecting their specific localities to make informed decisions.

- ***Timeframes***. The benefits of climate change/sea-level rise adaptation may not become visible for many years (at least decades to centuries), and may only become noteworthy when compared to other communities that didn't adapt. Implementation costs will be competing with other short-term priorities. It is human nature to be concerned with the present and near-term future, and political actions are often driven by election terms. Long time scales and immediacy of other coastal problems preclude many (or any) meaningful impacts for climate change programming for coastal audiences.

- **Obstacles** (contradictory reporting, political beliefs and election timeframes, limited resources)
  - ***Contradictory reporting.*** The presentation of advancing climate science can be expected to result in contradictory statements in the press as specific issues are analyzed and re-analyzed. That iterative process is how science improves, but the public is confused by the apparent inconsistencies. For example, the October 8, 2009 *Wall Street Journal* ran the following headline: *The Earth Cools, and Fight Over Warming Heats Up: Many Scientists Say Temperature Drop From Recent Record Highs Is a Blip, While a Few See a Trend; Inexact Climate Models* (Ball 2009). Another article on the front page of the *New York Times* on March 29, 2010, entitled *Among Weathercasters, Doubt About Warming* (Kaufman 2010) reported that only half of the television weather forecasters, who are major providers of weather-related information to the public, believed global warming was occurring and a quarter agreed

with the statement “Global warming is a scam” according to a recent survey (Maibech *et al*. 2010). Social science studies of hurricane evacuation decisions have found that individuals are most likely to take the recommended action when all sources make the same recommendation. Where recommendations conflict, a common response is no action. Climate adaptation is experiencing the same inaction. Although the scientific consensus may be growing, the American public’s belief in climate change is diminishing. A recent Pew survey found that the number of people who believe climate change is occurring actually decreased from over 70 percent to 57 percent between 2008 and 2009. Obviously, this declining belief, which conflicts with the consensus of the scientific community, poses serious obstacles to getting people to think about, much less act upon, adaptation.

- ***Political beliefs and election timeframes****.* Some communities and elected officials comment/suggest that information about climate change and sea-level rise is too uncertain to be used for decision-making. At present, it’s often difficult to provide local or even regional policy-relevant information on climate change and sea-level rise that local leaders can understand and act upon. Moreover, elected officials are often faced with competing issues that are more pressing and immediate when considering political timeframes (i.e. terms of office).

- ***Limited Resources****.* Moser (2008) identified additional state/local barriers to taking action on climate change impacts: political hesitancy, slowly emerging leadership from state agencies, communities struggling to deal with current problems, monetary and staff constraints, little extra capacity for climate change, and lack of both perceived importance and perceived solution options.

There are clearly major components of mitigation and adaptation that must use climate change as the primary justification (e.g. international cooperation and carbon banking).

However, in many cases the same action that is appropriate for climate change adaptation can be justified by much stronger science and for a more immediate need. With the marketing limitations associated with climate change, we should always look for the most compelling reasons to encourage individuals to increase resiliency. It is prudent to ensure that local authorities (e.g. policy, planning, building, and decision-making officials) are provided with site-specific data, best-practice information, and guidance to strengthen their capability to manage coastal hazards.

Marketing freeboard

An example of how effective marketing of the concept of "freeboard" or higher floor elevations to mitigate inundation hazards follows. One obvious adaptation for a predicted rise in sea level and possible changes in flood inundation levels is to add freeboard — that is to choose to build the floor of a house located in or near the floodplain higher than the minimum required elevation. Freeboard is a hazard mitigation strategy that takes care of an immediate coastal hazard threat, but is also a direct and indirect adaptation measure for climate change.

Floor elevation is known to be the single most important flood damage determinate for most buildings affected by both coastal and riverine floods. Adding freeboard for predicted sea-level rise and/or increases in storm severity due to climate change over the lifetime of the building is a seemingly small but very important step to minimize flood losses for both the builder and any future owner of the house. Climate change is never the best incentive for adding freeboard.

- National building standards require design for a 100-year flood (1% per year). However, accumulating over the 70-year average lifetime of a house, the risk of higher flooding is a 50% chance, like flipping coins, heads or tails. Is that a safe standard for something as important as your house?
- There is no safety factor built into minimum floor elevation requirements. What happens if water levels are 1 inch higher? Stillwater flooding results in the loss of carpets, flooring, insulation, wiring and duct work in the floors. In hurricane waves, an entire house can be lost.

- Floodplain maps are based on existing conditions. Changes in land-use and development patterns (e.g. increase in impervious surfaces such as roofs and parking lots) will increase runoff and raise the flood levels. One N.C. community re-ran its flood model based on their land-use plan and found that future development raised predicted flood levels by as much as 5 feet.
- After every extreme storm event, there is a window of opportunity to use nearby local buildings as examples of better construction practices. For those rebuilding on parts of the Texas coast since Hurricane Ike, one only needs to look at the existence of the neighboring houses to observe that freeboard made the difference between survival with minimal damage versus severe damage/failure. Financial incentives for freeboard are already in place. The National Flood Insurance Program currently offers discounts for freeboard: In the AE-zone up to 60% off the annual premium (saving $750 every year) and in the VE-zone savings up to 67% ($3,500) every year. In addition, the NFIP Community Rating System offers incentives to communities that adopt freeboard requirement for new construction, roughly a 1% discount for each foot of freeboard up to 3 feet. Every policy in the community receives the CRS discount.

Freeboard alone will not solve all of the potential problems from sea-level rise and climate change. However, it is one of the more important adaptation actions that yields immediate results and has been proven to make buildings safer and communities more resilient. It is important to convince individuals, communities and others managing development that adding freeboard is the right thing to do. Where applicable, any of the five justifications above makes a better case for the same action than uncertain predictions for changing climates and rising seas. The best way to make a convincing case to reduce risks is to describe all of the available justifications that apply to the decision-maker, starting with the most immediate and local focus.

Other Tools

Sea Grant coastal hazards specialists also use a number of other “tools” or data sources to provide stakeholders with information they can use to make decisions

regarding coastal hazard and erosion mitigation strategies. In some cases, these same tools can be used to encourage win-win or no regrets adaptation strategies that will help address climate change impacts while dealing with present-day problems. At the roundtable workshop held in June 2010, Sea Grant coastal processes and hazards specialists identified the tools and techniques they use to help coastal communities deal with coastal hazards. Some of the tools include:

*Historic Relative Sea-Level Rise***.** NOS tide gauges usually provide the most complete and reliable record of relative sea-level rise. These data are useful in helping audiences see that sea level has been rising for some time (for most areas) and gives them a better idea of the impacts and time scales that may be associated with climate change and accelerated sea-level rise.

Storm Surge and Recurrence Intervals. Storm surge elevations and recurrence intervals are available from the flood insurance studies conducted by FEMA. Although the quality of these data are variable depending on the location and time the area was last updated, FEMA is in the process of a massive map modernization program that should provide improved and updated information for most areas. NOS tide-gauge records and other instruments run by state and local entities can provide valuable historical data. These data can serve as a baseline or "best case" scenario and can be used with projections of future sea-level rise to give audiences a better idea of what future conditions may be.

Historical Shoreline Change Rates. Frequently calculated by state or local governments or academic institutions, these rates incorporate multiple factors, including the effect of relative sea-level rise over the period of record. Although based on past and existing conditions, present shoreline change rates can serve as a baseline and provide a believable "low estimate" for future planning. The U. S. Geological Survey (USGS) has undertaken the National Assessment of Historical Shoreline Change that calculates short- and long-term rates for the country's ocean and Great Lakes shorelines.

Most of this information is available online either as Open-File reports (New England and Mid-Atlantic Coasts) or in GIS format (http://coastal.er.usgs.gov/shoreline-change/).

Information Needs to Improve Extension Climate Programming

Obviously, reducing the uncertainty associated with climate change and its attendant impacts is a major priority if stakeholders are to begin implementing adaptation strategies. NOAA and Sea Grant have made major commitments to address climate change and provide decision-makers with better information to develop the most appropriate adaptation strategies. At the 2010 Sea Grant coastal processes roundtable, coastal processes/hazards specialists also identified information needs related to coastal hazards and climate change that are crucial to developing effective extension programming. In addition to better estimates of the magnitude and timing of an accelerated sea-level rise, reliable information on how climate change may influence the frequency and intensity of coastal storms is needed. While the effort needed to fill these information gaps is beyond the resources available to Sea Grant, there are other areas related to coastal processes and hazards and climate change where Sea Grant could begin to generate the information and technologies that would help promote behavior changes. Some of these areas include:

- Develop and encourage the implementation of methodologies for coastal hazard vulnerability analysis and risk assessment that can incorporate a range of sea-level rise scenarios that can be employed at the local level. Ideally, these methodologies would also allow for cost benefit/analysis for different mitigation measures and strategies under various sea-level rise scenarios.
- Identify and evaluate innovative flooding and erosion mitigation measures for estuarine areas that are more environmentally compatible and adaptable to potential changes in the rate of sea-level rise.
- Develop a better understanding of shoreline response to sea-level rise. Because sea level is only one factor affecting how the shoreline behaves, a quantitative understanding of the relative effect of accelerated sea-level rise on shoreline change rates, sediment budgets and geomorphic processes is important.

- Encourage the collection and dissemination of oceanographic and climatic data at a resolution that can be used to help identify and select the most effective adaptation strategies at a local level.

Conclusion: Practical and Achievable Solutions

With nearly any audience, there is usually eye rolling when issues of climate change and sea-level rise are mentioned, yet most everyone will acknowledge that there is obviously no benefit in waiting to see if projected changes attributed to climate change will impact a specific coastal region. Natural coastal hazards are already taking a toll on communities, and it is not difficult to convince key stakeholders that specific coastal hazard risks are real and present dangers. These hazards can be assessed (e.g. via flood-hazard and erosion-hazard risk maps) and actions can be identified to significantly reduce and minimize associated risks. When we know the appropriate actions or directions for mitigation and adaptation, we need to look for the most compelling reasons available to market the action, those that will raise awareness and build confidence in the fact that adaptation is feasible, practical, and, in the long run, economical. Many anticipated climate change-related damages can be avoided through appropriate management of current risks posed by coastal hazards while recognizing that future conditions may become more severe.

Climate change considerations alone are unlikely to stimulate or engender state or local government action. Efforts should be focused on engaging and encouraging coastal communities to strengthen and improve policies, legislation, enforcement and planning efforts towards adaption to and mitigation of existing coastal hazards. Awareness and identification of community assets and infrastructure at risk from coastal erosion, flooding/inundation, coastal storms, and related hazards (e.g. via a risk and vulnerability assessment) will most likely provide the impetus to change policy, regulation and behavior that would also begin to mitigate effects of expected climate change. Reliable data on existing local coastal processes and associated impacts, targeted information, public awareness, relevant technical tools, and training are essential for implementation of practical, affordable, and achievable initiatives that can range from strengthened

regulations (e.g. better building codes and strengthened codes of practice) to policy choices (planning and zoning changes, relocation of critical infrastructure away from vulnerable locations).

For the most part, a focus on relevant coastal processes and hazards minimizes uncertainty yet adapts to many of the same impacts of climate change and sea-level rise threats. This approach ultimately will result in an individual community's capability to develop adaptive management and no regrets — or win-win — response options for managing coastal risks. In order to maximize opportunities for funding and partnerships that will provide increased stakeholder benefits, the Sea Grant Network should consider steps such as:

1. Recognize that present uncertainties in climate science make it difficult for stakeholders to use climate change as the primary reason for implementing adaptation strategies.
2. Identify appropriate hazard mitigation actions and local climate adaptation strategies that could be recommended for implementation.
3. Develop the most convincing reasons to take those actions based on the best and most reliable existing scientific data, as well as the most compelling locally relevant factors. Include climate adaptation in this list, but prioritize the most compelling reasons. If climate is low on the list, this is a reflection of its marketing effectiveness, not necessarily its long-term importance.
4. Define data needs and develop reasonable action plans that are achievable at state/local government levels.
5. Strengthen ties between the scientific community, local/state/federal governments and as appropriate, include other affected or interested groups, including developers and nonprofit organizations.

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EPAâ€™s Climate Ready Estuaries works with the National Estuary Programs and the coastal management community to: (1) assess climate change vulnerabilities, (2) develop and implement adaptation strategies, and (3) engage and educate stakeholders. CRE shares NEP examples to help other coastal managers and provides technical guidance and assistance about climate change adaptation.Â This document shares some of the lessons learned from these CRE climate projects.Â â€¢ Mobile Bay National Estuary Program is working with the Mississippiâ€“Alabama Sea Grant Consortium, the Town of Dauphin Island, the Dauphin Island Water and Sewer Authority, and the Dauphin Island Park and Beach Board to improve Dauphin Islandâ€™s ability to adapt to climate change. EU Strategy on adaptation to climate change. The EU Strategy on adaptation to climate changeÂ³, which was adopted by the European Commission on 16 April 2013, includes specific actions on enhancing the resilience of infrastructure and mainstreaming climate adaptation into the regional and cohesion policy.Â The Climate Change Vulnerability and Risk Assessment is the process of managing climate adaptation issues for a project in order to improve the projectâ€™s resilience to climate change.Â Due regard should also be given where relevant to e.g. sea level rise, which is projected to continue beyond this century even with a stabilisation of global warming below 2Â°C. Risk = Likelihood x Impact. Adaptation Options, Appraisal, Planning. The â€œLessons Learnedâ€ attempts to capture our professional experience with implementation of NOAAâ€™s framework, and the information revealed during application of the additional steps. 1. The NOAA Framework. We found the broad, flexible approach of the NOAA Framework adaptable to meet each of our cityâ€™s needs, however, the trade-off was a lack of specificity.Â At the time of this study, Carlsbad had not selected action scenarios or adaptation strategies. Through discussion with Carlsbad planners, we were directed to adapt and apply Del Marâ€™s North Beach action scenarios.