USING CLIMATE EXTENSION TO ASSIST COASTAL DECISION-MAKERS WITH CLIMATE ADAPTATION

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Introduction

Coastal managers need accessible, trusted, tailored resources to help them interpret climate information, identify vulnerabilities, and apply climate information to decisions about adaptation on regional and local levels. For decades, climate scientists have studied the impacts that short term natural climate variability and long term climate change will have on coastal systems. For example, recent estimates based on Intergovernmental Panel on Climate Change (IPCC) warming scenarios suggest that global sea levels may rise 0.5 to 1.4 meters above 1990 levels by 2100 (Rahmstorf 2007; Grinsted, Moore, and Jevrejeva 2009). Many low-lying coastal ecosystems and communities will experience more frequent salt water intrusion events, more frequent coastal flooding, and accelerated erosion rates before they experience significant inundation. These changes will affect the ways coastal managers make decisions, such as timing surface and groundwater withdrawals, replacing infrastructure, and planning for changing land use on local and regional levels. Despite the advantages, managers' use of scientific information about climate variability and change remains limited in environmental decision-making (Dow and Carbone 2007). Traditional methods scientists use to disseminate climate information, like peer-reviewed journal articles and presentations at conferences, are inappropriate to fill decision-makers' needs for applying accessible, relevant climate information to decision-making. General guides that help managers scope out vulnerabilities and risks are becoming more common; for example, Snover et al. (2007) outlines a basic process for local and state governments to assess climate change vulnerability and preparedness. However, there are few tools available to support more specific decision-making needs.

A recent survey of coastal managers in California suggests that boundary institutions can help to fill the gaps between climate science and coastal decision-making community (Tribbia and Moser 2008). The National Sea Grant College Program, the National Oceanic and Atmospheric Administration's (NOAA) university-based program for supporting research and outreach on coastal resource use and conservation, is one such institution working to bridge these gaps through outreach. Over 80% of Sea Grant's 32 programs are addressing climate issues, and over 60% of programs increased their climate outreach programming between 2006 and 2008 (National Sea Grant Office 2008). One way that Sea Grant is working to assist coastal decision-makers with using climate information is by developing effective methods for coastal climate extension. The purpose of this paper is to discuss climate extension methodologies on regional scales, using the Carolinas Coastal Climate Outreach Initiative (CCCOI) as an example of Sea Grant's growing capacities for climate outreach and extension.

Climate extension

Climate outreach involves communicating information on climate variability and change in ways that increase public understanding of climate science and assisting stakeholders with integrating climate information into decision-making processes. Outreach strategies may include, but are not limited to, communication through traditional and new media, formal and informal education efforts, and decision support. In practice, climate extension involves all of these activities, but extension is distinguished by a focus on applying knowledge of climate variability and change to help stakeholders improve their decision-making processes and quality of life. Common extension methodologies include reports, newsletters, workshops, demonstration projects, decision support tools, and applied research. To date, much of the focus in climate extension has been on agriculture (Fraisse et al. 2009). However, climate either directly or indirectly affects nearly all sectors and segments of coastal economies, warranting a broader application of climate extension strategies. With roughly one third of Americans living in coastal counties (Karl, Melillo, and Peterson 2009), coastal climate extension has the potential to provide significant benefits.

Climate extension along the Carolina coasts

The coasts of North and South Carolina are vulnerable to the effects of natural climate variability and long term climate change. Recent stressors, such as the droughts of 1998-2002 and 2006-2009 and flooding events associated with hurricanes and coastal storms, have had significant impacts on water management, infrastructure, and coastal erosion. Expressions of climate variability, like El Nino Southern Oscillation (ENSO) phases, and longer term climate change, like sea level rise, interest managers in the region. These stressors make the Carolinas an ideal

location for piloting climate extension strategies through the CCCOI. The CCCOI is a partnership between the South Carolina Sea Grant Extension Program, North Carolina Sea Grant, and the Carolinas Integrated Sciences and Assessment Center (CISA) at the University of South Carolina. The CCCOI aims to develop the capacity of N.C. and S.C. Sea Grant to inform and educate coastal decision makers of the implications of climate variability and change for major coastal issues including erosion, invasive species, land use change, salt-water intrusion, health of fisheries, agriculture, tourism, coastal community development, and natural hazards. Additional objectives include providing tailored, decision relevant information on the implications of climate variability and change to coastal decision makers and increasing the capacity of the Sea Grant network regionally and nationally to research and deliver outreach programs on the impacts of climate variability and change for coastal stakeholders. The two Sea Grant Extension Program partners bring a history of trusted extension programming for a broad network of decision-makers to the CCCOI. As NOAA's Regional Integrated Sciences and Assessment (RISA) program for North and South Carolina, CISA provides the CCCOI with a link to university faculty who are researching climate impacts and applications for decision-making. A jointly sponsored Sea Grant regional climate extension specialist (CES) acts as a critical link between the three CCCOI partners. The CES identifies coastal decision-makers' needs for climate information, then works with CISA and the Sea Grant programs to deliver that information to users in ways that inform and educates them about climate variability and climate change and helps them to apply tailored, relevant coastal climate information to decision-making. To this end, the CES both develops traditional extension programming and participates in research projects by incorporating outreach into the research process.

For example, current extension projects under development include planning to reproduce the concept of local climate study groups (LCSGs) modeled on the Kitchen Table Climate Study Group (KTCSG) of McClellanville, SC. The purpose of this grassroots group is to support its members as they teach themselves about climate change. This group has been effective in its mission so far, but they found it required a significant amount of work to locate credible information about climate, analyze it, and apply it to questions of local climate change impacts. Sea Grant and its partners are working with the KTCSG to streamline this process in ways that reduce the potentially prohibitive amount of research required by a potential leader to start a new group. The CES and other partners will work to update the most useful science-based information and assemble it in ways that streamline the process of starting a LCSG. The project aims to establish two new LCSGs in the Carolinas within the next year. This will further longer term goals of increasing climate literacy in the Carolinas and helping decision-makers begin to engage with climate adaptation planning.

Current research-outreach projects in the Carolinas include research on coastal adaptation priorities, future impacts of climate change and sea level rise on salt-water intrusion in the Yadkin-Pee Dee basin of South Carolina, and tools for coastal managers to explore vulnerabilities and risks of sea level rise and other climate impacts on Sullivan's Island, SC. Partner institutions, including CISA, the United States Geological Survey, the SC Department of Health and Environmental Control Office of Coastal Resource Management, and other researchers at the University of South Carolina, Clemson University, and Coastal Carolina University, lead the development of applied research aimed at answering stakeholder needs for information about local climate impacts. For each of these projects, the CES will develop workshops and outreach programs based on research results. For the Yadkin-Pee Dee and Sullivan's Island projects, the CES plays a larger role by working with stakeholders to ensure that the final research products answer questions and support decision-making needs.

Sea Grant's role in climate extension and outreach

The CCCOI is only one example of the ways Sea Grant is working to assist coastal users with interpreting and using climate information. In 2009, several of Sea Grant's outreach professionals, including extension agents and specialists, communication specialists, and educators, formed the Sea Grant Climate Network (SGCN), a grassroots organization devoted to increasing the effectiveness of Sea Grant climate programming and outreach nationwide. Formally recognized by the Assembly of Sea Grant Extension Program Leaders, the SGCN maintains an online presence through its social networking site on Ning (http://sgccnetwork.ning.com/). SGCN priorities include promoting regional opportunities, such as the workshops and projects funded by the Sea Grant-NOAA Regional Team Climate Engagement grants, and preparing fact sheets on regional climate outreach capabilities. The SGCN also plans on building and maintaining links to NOAA Sectoral Applications Research Program (SARP) research projects with Sea Grant investigators in Oregon, South Carolina, and Wisconsin. In November 2009, approximately 150 people attended the first SGCN workshop and webcast, "Climate Adaptation in Coastal Communities: A Network Approach to Outreach." Attendees used the concepts learned during presentations on climate science, communication strategies, vulnerability and adaptation assessment, and climate policy to collaborate with five

community decision-making partners on developing low-cost projects that will be completed in their communities over the following year. Through these activities, the SGCN is expanding Sea Grant's capacity to provide climate extension, communication, and educational resources to the nation's coasts.

Conclusion

For coastal decision-makers to begin adapting to climate change, they will need assistance in accessing and using climate information. Boundary institutions that provide climate extension, such as Sea Grant, are one resource for helping managers to bridge the gap between science and its applications. Climate extension is a developing field focused on increasing knowledge of climate variability and change and on applying climate information to improve stakeholders' decision-making processes. By working to develop and improve climate extension approaches, Sea Grant is increasing its capacity to assist coastal users with understanding and applying climate information to adaptation decisions. The CCCOI pilot partnership is well on its way to ensuring that stakeholders in the Carolinas have timely access to information on climate variability and change and meaningful assistance in applying that information to practical decision-making.

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