NATIONAL PERSPECTIVES ON CLIMATE CHANGE ADAPTATION: A PANEL DISCUSSION OF CLIMATE CHANGE ADAPTATION EFFORTS IN DIVERSE COASTAL REGIONS OF THE UNITED STATES

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Introduction

Climate change has rapidly emerged as a significant threat to coastal areas around the world. While uncertainty regarding distribution, intensity, and timescale inhibits our ability to accurately forecast potential impacts, it is widely accepted that changes in global climate will result in a variety of significant environmental, social, and economic impacts. Coastal areas are particularly vulnerable to the effects of climate change and the implications of sea-level rise, and coastal communities must develop the capacity to adapt to climate change in order to protect people, property, and the environment along our nation's coasts. The U.S. coastal zone is highly complex and variable, consisting of several regions that are characterized by unique geographic, economic, social and environmental factors. The degree of risk and vulnerability associated with climate change can vary greatly depending on the exposure and sensitivity of coastal resources within a given area. The ability of coastal communities to effectively adapt to climate change will depend greatly on their ability to develop and implement feasible strategies that address unique local and regional factors. A wide variety of resources are available to assist coastal states in developing their approach to climate change adaptation. However, given the complex and variable nature of the U.S. coastline, it is unlikely that a single set of guidelines can adequately address the full range of adaptation needs at the local and regional levels. This panel seeks to address some of the unique local and regional issues facing coastal communities throughout the U.S. including anticipated physical, social, economic and environmental impacts, existing resources and guidelines for climate change adaptation, current approaches to climate change adaptation planning, and challenges and opportunities for developing adaptation strategies.

Climate Change Adaptation in Hawaii

The Hawaiian Islands are located in the central Pacific Ocean and are home to approximately 1.3million residents. Hawaii is known for its pristine coastal waters, vibrant coral reefs, and world-renowned beaches. The economy of Hawaii relies heavily on input from tourism with approximately 7million annual visitors generating approximately $11billion in visitor expenditures in 2008 (Hawaii DBEDT, 2008).

There are approximately 750 miles of coastlines in the State of Hawaii consisting of sandy beaches and steep coastal bluffs. Hawaii's coastal areas and populations are particularly vulnerable to the impacts of climate change due to high concentrations of development in low-lying coastal areas, social dependence on imported goods, and economic dependence on tourism. Hawaii faces a variety of climate-related threats driven by four primary factors: increases in greenhouse gases, increasing air temperatures and water vapor, increasing ocean temperatures, and sea-level rise. Ocean acidification threatens the health and vitality of Hawaii's coral reef systems which are essential to Hawaii's tourism and fisheries industries. Altered rainfall and runoff patterns may result in increased sedimentation due to flooding, as well as potential impacts to Hawaii's agriculture industry. Changes in the frequency and intensity of tropical storms and hurricanes will likely result in increased disaster losses in low-lying coastal areas. Increasing ocean temperatures present several threats to Hawaii's diverse ecosystems such as coral bleaching and disease, increased incidence of coral of fish disease, decreased biodiversity, and changes in the distribution of native and invasive marine species. One of the greatest emerging climate-related threats in Hawaii is sea-level rise which presents a variety of potential negative impacts including threats to port facilities that provide life-sustaining imports, damage to fragile coastal ecosystems, and impacts to coastal freshwater aquifers. Sea-level rise will also increase exposure to coastal hazards including coastal storms and erosion resulting in further instability and/or loss of sandy beaches, and increased losses during coastal flooding events.

The State of Hawaii has recently adopted several policies that seek to seek to address the anticipated impacts of climate change. In 2007, the Hawaii State Legislature created a policy that calls for the reduction of statewide

greenhouse gas emissions to 1990 levels by 2020. The policy further established a Greenhouse Gas Emissions Reduction Task Force to prepare a work plan and regulatory scheme to achieve the statewide greenhouse gas emissions limits. In 2009, the Legislature passed SB 266, which establishes a Climate Change Task Force to scope the current and potential impacts of climate change trends in the State, estimate the costs of these impacts, and make recommendations on measures to address or mitigate the effects of climate change.

The University of Hawaii Sea Grant College Program has established the Center of Excellence for Island Climate Adaptation and Policy (ICAP) which serves as a two-way conduit between the university and island communities to catalyze climate change adaptation and resiliency. ICAP is currently engaged in a variety of climate-related activities including the development of a report to the people of Hawaii entitled "The Effects of Climate Change on Hawaii's Ocean and Coastal Resources". ICAP is also conducting community workshops to increase awareness and educate the public about climate adaptation alternatives.

Climate Change Adaptation in Maine

When imagining the Maine waterfront, the rocky coast comes to mind but sand beaches are a major economic driver in the state, exhibiting some of the most intensely developed and visited areas in Maine. Generating approximately $10 billion in annual economic activity, $3 billion in earnings, and employing 140,000 people, tourism is Maine's largest industry. Tourist spending related to beaches is estimated to be over $500 million, supporting the employment of over 8,000 people. Sand beaches are also the state's most vulnerable coastal ecosystem threatened by the effects of climate change. All of Maine's sand beaches are eroding, and sea level rise predictions in the range of two feet (as adopted for planning purposes by the State) would result in shoreline retreat of approximately 600 feet along sand beaches (Marine Law Institute et al. 1995).

Private ownership of the coast brings an added dimension to the complexity of coastal resource management. Most of Maine's shoreline is privately owned, and access to the shore is correspondingly limited. In Maine, unlike most other coastal states, a private landowner may own the intertidal zone, the land area between mean high and mean low tide lines. Globally, coastal cities are facing the threat of rising sea levels, with coasts in the Northeastern United States likely to face more significant increases in level than other areas. Climate change impacts are experienced locally and will be addressed locally. Maine has been the focus of considerable research effort to identify and characterize climate change impacts, vulnerabilities, and adaptation strategies. A recent study developed by the University of Maine's Climate Change Institute, Maine's Climate Future: An Initial Assessment (2009) finds that sand beaches, bluffs, and vegetated wetlands comprising 50 percent of the coastline are highly vulnerable to erosion and inundation exacerbated by rising seas. Coastal property and infrastructure currently at risk of severe storms and other weather related effects face increased risk of damage with higher sea levels. Local transportation and development planners, homeowners, and businesses along Maine's coast are already beginning to grapple with these issues and require data, decision tools, capacity, and resources to design effective adaptation strategies and take adaptive action.

Following the report Maine's Climate Future, the Maine Legislature approved a Climate Change Stakeholder Adaptation Committee to compile data and information on climate change impacts and opportunities for Maine. That report, presented to the legislature February 2010, will hopefully launch the development of economic studies and a working adaptation plan for the state.

Maine Sea Grant working in partnership with UMaine Extension and other partners completed a social science research project funded by NOAA in collaboration with Oregon Sea Grant. The purpose of this study was to identify the barriers coastal property owners and municipal officials in Maine face in taking action to prepare for the impacts of climate variability and to develop educational and informational materials and strategies concerning these issues. The ultimate goal of the project is to elicit behavioral changes that will result in coastal communities that are more resilient to climate variability at all scales.

This research has assisted in the development of an NSF EPSCoR Maine Sustainability Solutions research project to further investigate vulnerabilities to climate change and community assets in two pilot coastal communities, one urban and one rural. Through a focused analysis of the stakeholder information needs, decision calendars, and weather/climate-related vulnerabilities, a spatial and temporal mapping of knowledge and information gaps, and tools to support adaptation strategies will be developed.

Finally, a proposed Signs of the Seasons: Maine Phenology Project is being developed with a unique partnership among state, regional, and national entities, including practitioners of informal education, climate research, community extension, and communications to collect data on the seasonal cycles of plants and animals. Engagement of coastal and inland citizens engaged in environmental monitoring will contribute to an understanding of adaptation to a changing climate first hand while contributing to the scientific collection of data.

Climate Change Adaptation in Oregon

The Oregon coast comprises 363 miles of diverse shore types including basalt headlands, pocket beaches, cliff backed beaches, river spits, and the largest expanse of coastal sand dunes in North America. The Columbia River bounds Oregon's northern border and is the fourth largest river in the US, and has the greatest flow of any North American river draining into the Pacific. Smaller rivers drain the coastal range along the entire length of the state, with two draining basins extending all the way to the Cascade Mountains. Oregon's beaches are highly-dynamic environments, changing frequently to varying conditions and extreme events. The Oregon coast is also affected by tectonic uplift from our location on a subduction zone. The northern tip and the southern third of the coast are rising a few mm per year, while the central third is not. Thus, as sea level rises, the central Oregon coast becomes more vulnerable to the impacts of storms. Several erosion "hotspots" have emerged in recent decades. These often occur in the southern end of littoral cells and typically in conjunction with El Nino winters.

Just over 200,000 people live on the Oregon Coast, but that number is growing. The economy is still dependent somewhat on natural resources for employment, but the largest contributions to personal income are retirement payments and investment income. The economy is increasingly a function of lifestyle-driven settlement and services. There is increasing demand for coastal properties and beach front businesses. As the relatively limited buildable lands are developed, property owners are increasingly employing engineering techniques to build on previously undesirable sites.

The trend of increasing development on marginal sites puts stationary structures in dynamic zones. In addition to development pressure bringing structures to the edge of the coastal zone, the ocean is becoming more dynamic. Winter wave heights have on average, and especially their extremes, been increasing over the past 30-50 years. Several communities are dealing with emergency rip rap projects to protect property. The village of Neskowin, OR is situated on the north side of Cascade Head in a small pocket beach. A row of homes are now built on the long beach foredune, with the original small village set behind the dune in a low wetland area. Increasing extreme erosion events have resulted in emergency rip rapping of nearly the entire beachfront with massive boulders. Still, extreme winter wave heights regularly overtop this structure. In addition to the property damage, the beach itself becomes more dangerous for beachcombers. In the entire length of rip rap there now exists only a few points of access or egress. Tragedies have occurred. Another aspect of the hazard is that the armored foredune protects the lower village behind it. If the rip rap is breached the ocean water will flood into the village. Thus, the homes in the village have a vested interest in maintaining the rip rap on the foredune properties.

Residents of Neskowin have formed the Neskowin Beach Hazards Committee which is chaired by a Tillamook County commissioner and includes people and resources from a variety of related agencies. The goal of the group is to learn more about the nature of the hazards and identify ways to protect property and increase human safety. A NOAA SARP grant was recently awarded to update the coastal erosion models and hazard maps for the north coast of Oregon and SW Washington, and to conduct hazard vulnerability assessments for communities in the region. The Department of Land Conservation and Development (DLCD) has also received a grant to support the development of an adaptation planning process with the Tillamook County Planning Department. The Committee will identify what options exist to achieve their goals and how to fund them. This experience will likely be repeated in other communities as the collision between dynamic coastlines and increasing development continues.

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