Building Resilient Coastal Communities:

Counties and the Digital Coast

DIGITAL COAST

CELEBRATING 75 YEARS

NACo National Association of Counties

The Voice of America's Counties • 1935-2010

Building Resilient Coastal Communities:
Counties and the Digital Coast

CELEBRATING 75 YEARS NACo National Association of Counties
The Voice of America's Counties • 1935-2010

DIGITAL COAST

About the National Association of Counties

The National Association of Counties (NACo) is the only national organization that represents county governments in the United States. Founded in 1935, NACo provides essential services to the nation's 3,068 counties. NACo advances issues with a unified voice before the federal government, improves the public's understanding of county government, assists counties in finding and sharing innovative solutions through education and research, and provides value-added services to save counties and taxpayers money. For more information about NACo, visit *www.naco.org*.

To request copies of this publication or other materials about the NACo's Digital Coast Project, please contact:

Carrie Clingan
Senior Associate
Community Services Division
Phone: 202.942.4246
Email: *cclingan@naco.org*

This issue brief was published in January 2010 and made possible through support from the Mississippi Department of Environmental Quality, Memorandum of Agreement No. 09-00974. It was written by Carrie Clingan, NACo Community Services Senior Associate and by Cindy Wasser, Community Services Assistant with contributions and editing by Lori Cary-Kothera, Physical Scientist at the National Oceanic and Atmospheric Administration's Coastal Services Center (NOAA-CSC). The 2007 NACo survey referred to in this brief was conducted by Pedro Flores, Abigail Friedman and Erik Johnston. Emily Pollock performed the graphic design and layout. Photographs and graphics were provided by NOAA-CSC. Any opinions in this publication are those of the contributors and do not necessarily reflect the views of the Mississippi Department of Environmental Quality, NOAA-CSC or NACo.

Acknowledgements

NACo wishes to thank the following organizations for their partnership in the Digital Coast and their contributions to the development of this publication:

The Association of State Floodplain Managers (ASFPM)

The Coastal States Organization (CSO)

The National Atmospheric and Oceanic Administration's Coastal Services Center (NOAA-CSC)

The National States Geographic Information Council (NSGIC)

The Nature Conservancy (TNC)

The Digital Coast Project and Partnership

Our coastal counties face considerable challenges in fostering the growth of resilient communities. Counties have distinctive needs when dealing with changes in sea or lake level, temperature and frequent storm events. These challenges center on the availability of reliable, unbiased data and tools to adapt policies meeting the changing faces of our coasts. With over 4/5 of the United States population residing on the coast, these policies will shape the lives of many Americans in the next few decades.

In 2007, the National Association of Counties (NACo) queried county officials and staff about the issues that they face as coastal managers. The information received, detailed in the NACo/NOAA-CSC Coastal County Geospatial Needs Questionnaire Analysis Report, outlined a number of significant challenges that coastal counties confront as sea level rise, erosion and changes in lake level impact community resiliency. With this information, as well as information county representatives shared at the Digital Coast Forum in November of 2007 and feedback from NACo committees, NACo has represented the unique interests of counties in the Digital Coast Partnership. This partnership includes NACo, the National Oceanic and Atmospheric Administration's Coastal Services Center, The Nature Conservancy, the Association of State Floodplain Managers, the National States Geographic Information Council and the Coastal States Organization. This partnership leverages resources and expertise from each of these organizations to create user-driven tools mitigating the effects of a changing climate.

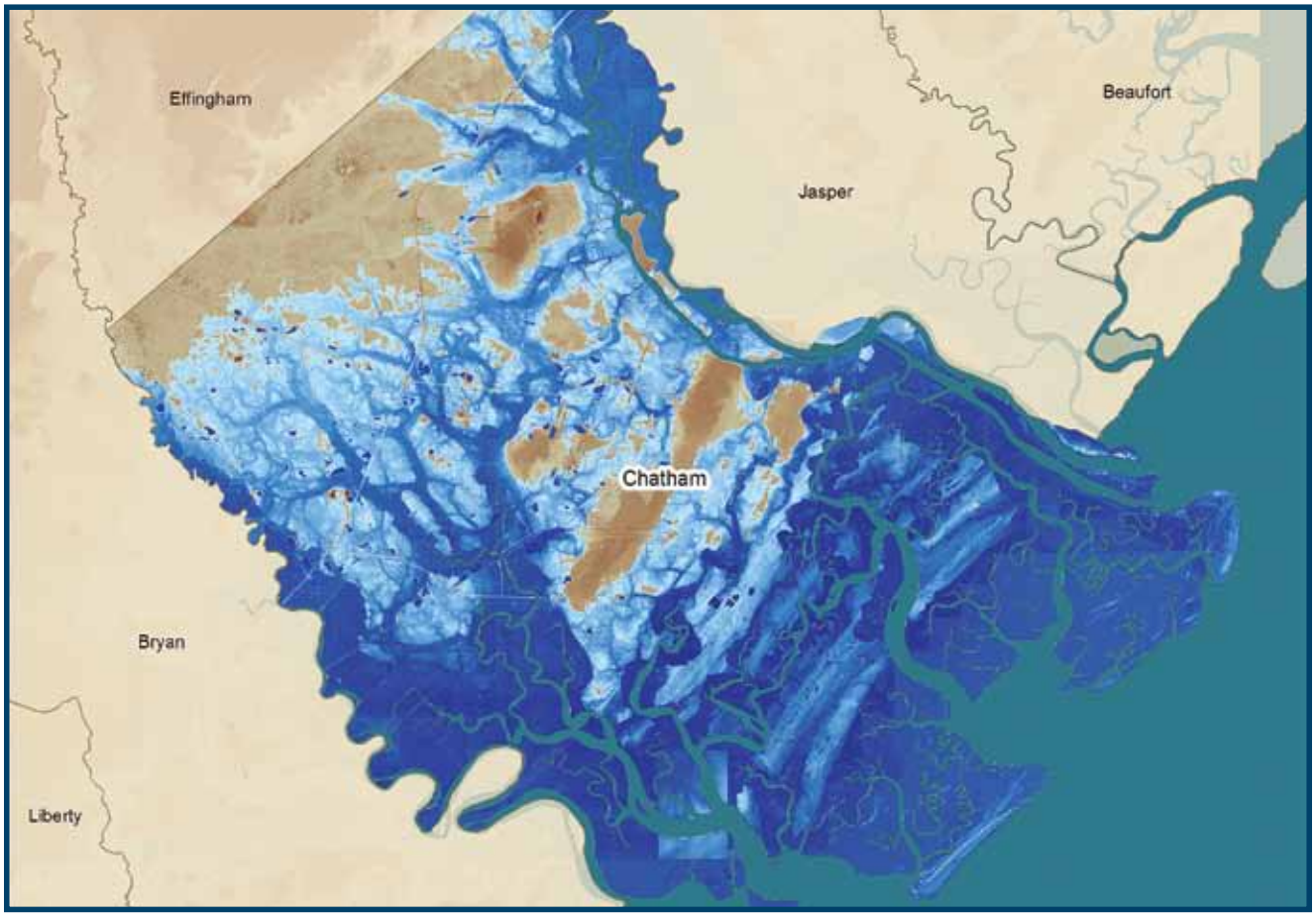
The Digital Coast partnership has enjoyed great success assisting the Coastal Services Center to develop tools, programs, workshops and assessments to help counties access greater resources to combat the effects of climate change using the stated needs of elected county officials, county managers and other county staff. In this issue brief, we highlight many of the Digital Coast resources that counties use to address coastal flooding, habitat conservation and land use. More resources, tools and data are available through the Digital Coast website: *http://www.csc.noaa.gov/digitalcoast/.*

Sea Level Rise and Tools to Address Flooding

Officials and county staff identify inundation and flooding as their chief concerns. Inundation or flooding events are among the most frequent, costly and deadly coastal hazards impacting coastal communities in the U.S. In fact, riverine and coastal inundation cause the highest number of natural hazard-related deaths. With coastal states supporting 81% of the U.S. population and generating 83% of U.S. gross domestic product, the potential for catastrophic loss from inundation events is great. Local changes in climate and sea level will exacerbate future inundation risks on all four of America's coasts. An increase in storm events, erosion and sea level rise also present a myriad of issues for county officials to address.

Atlantic Coast: Protecting Developed Shores

Along the Atlantic, insured coastal properties in Maryland, Delaware, New Jersey, New York and Connecticut exceed one trillion dollars. As a growing population constructs homes and buildings, protection against and recovery after coastal hazards becomes more costly for local communities. Researchers have estimated the cost of protecting the developed sheltered shores of the U.S. Northeast and Mid-Atlantic coasts (for a moderate 50 centimeter sea-level rise) would approach $2.7 billion, over half the cost of protecting all United States shorelines.[1] Similarly, as storm events and flooding



Chatham County,Georgia- Inundation after category 4 hurricane

damage homes, businesses and water quality, East Coast counties may experience significant drops in local tourism revenue.

Gulf Coast: Adapting to New Sea Levels and Severe Storms

In the Gulf, vulnerable barrier islands, lagoons, marshes and deltas dominate the coast. NOAA has classified 42 percent of the mapped shoreline as very high to moderate risk of sea-level changes. The area around New Orleans experiences the greatest changes in relative sea-level rise, where the rates can be as much as 10 mm/year. (By comparison, east of Louisiana, the rate of relative sea level rise is about 2 mm/year.[2]) Coastal Louisiana experiences the greatest wetland loss in the nation. Delta wetlands now disappear at an average rate of 17 square miles per year, or about 50 acres per day[3].

According to climatologists, the risk of tropical storms and hurricanes has increased and continues to concern Gulf Coast counties. Hurricane activity in the Atlantic Basin (which includes the Gulf of Mexico) has increased five-fold when comparing 1995-2000 figures to the previous 24 years (1971-1994).[4] Hurricanes and winter storms cause major disturbance along the Gulf Coast. Frequent storm events generate waves, which permanently erode this region's barrier islands and shrink the area of coastal land. Barrier island chains in the northern Gulf of Mexico already experience this disintegration due to sediment transport and sea level rise.[5] Some regions of the Gulf Coast, such as the Mississippi River Delta and the Florida panhandle, already see some of the nation's highest rates of wetlands loss, largely because of deteriorating coastal landscapes and coastal wetlands

Pacific Coast: Defending Vulnerable Regions from Coastal Flooding

Sea-level rise will increase the frequency and magnitude of flood events in Pacific Coast areas presently at risk. The present floodplain will expand, placing new areas at risk. The California Climate Change Center estimates that a 1.4 m sea level rise would place a total of 480,000 Californians at risk for a 100-year flood event. A large number of low-income people and elderly populations remain most vulnerable to these changes. The current population residing in the 100 year floodplain may see the chance of flooding increase to one-in-ten-year storm levels. Without adaptation, these storms will overwhelm current coastal defense structures.[6] Researchers estimate the cost of protecting the developed sheltered shores of the U.S. West Coast (for a moderate 50 centimeter sea-level rise) through 2100 would be approximately $88 billion.[7] They also estimate the cost of replacing property at risk of coastal flooding under current sea-level rise scenarios in California alone at nearly $100 billion.[8]

Great Lakes: Adjusting Rising Water Temperature

In the Great Lakes, higher water temperatures will decrease the duration and extent of ice cover, exacerbating shoreline erosion. This causes special concern, because the number of severe storms, floods and extreme events could double in frequency by the end of the century.[9] Lakes in Northern Wisconsin near Ashland and in Vilas County are losing an average of 5-6 days of ice cover per decade, while lakes in southern Wisconsin lose an average of 9 days of ice cover each decade. By 2090, climatologists predict most of Lake Erie to be ice-free nearly 100 percent of the winter.[10] Besides contributing to flooding and erosion, decreased ice cover and heavier rainfall events reduce water quality.

Digital Coast Tools: The Coastal Inundation Toolkit

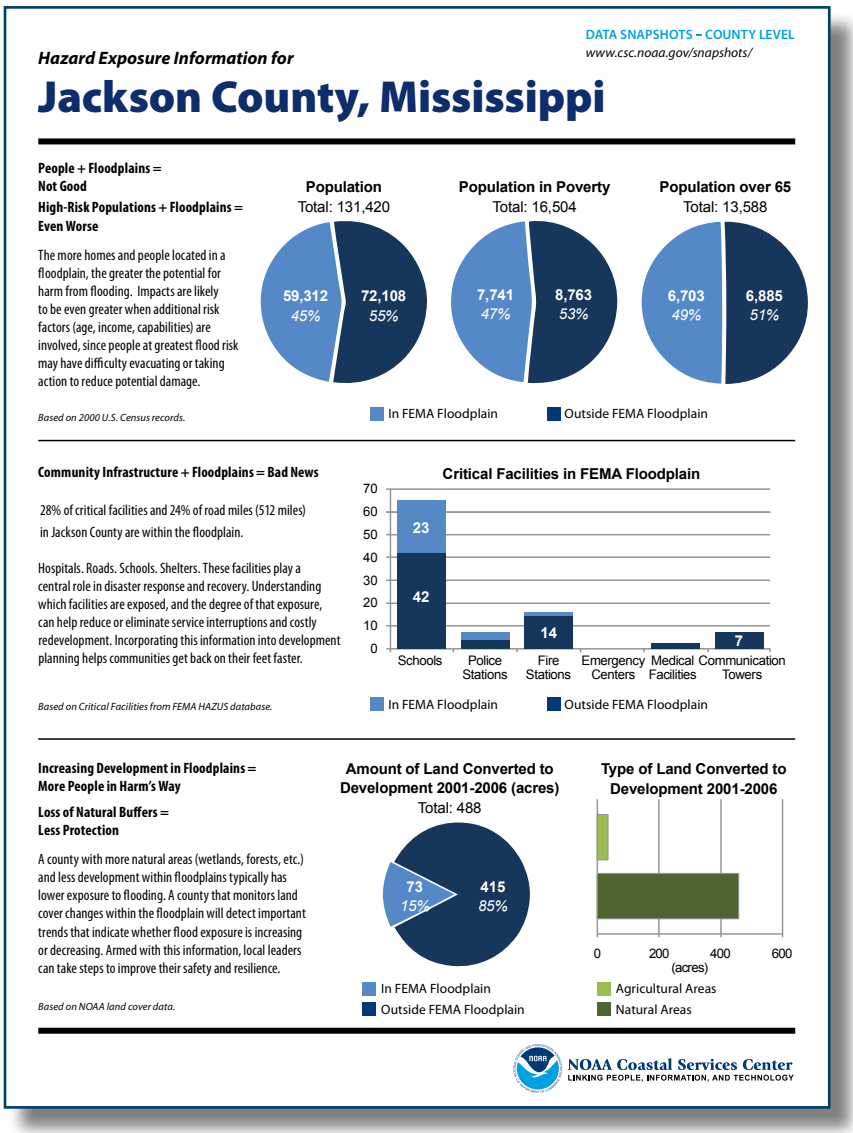
The Digital Coast offers several key tools for counties as part of the Coastal Inundation Toolkit to assist counties with planning and abatement of inundation. These tools help counties evaluate and visualize inundation changes with their local infrastructure and aid residents in creating plans for adaptation. The Coastal Inundation Toolkit is designed to help communities determine their coastal flooding vulnerability and what steps they can take to reduce this risk. Several featured resources within the toolkit include: County Snapshots, Coastal Risk Roadmap Training and CanVis. These tools help local officials understand what impacts these changes will have on areas of their county.

The County Snapshots tool provides county officials with a quick look at a county's demographics, infrastructure and land use patterns within the flood zone. This information helps local planners better assess and plan for potential inundation events. A map and pull-down menus let users pick

the coastal county of interest and the instrument provides a report for download that can be saved or printed. The easy-to-use format produces a great learning and communications tool for local officials and their constituents.

Each individual snapshot examines the percentage of the population living in the county's floodplain. The snapshot breaks down this population and displays two subcategories: the population below the poverty line and the population over 65. These populations experience increased barriers to communication and evacuation in an emergency. The second aspect of the hazard exposure information displayed in the snapshot is the critical facilities currently built inside the floodplain. This graph displays hospitals, roads, schools and other facilities playing a central role in disaster response and recovery. When counties explore all the options available to them in an emergency, they can incorporate this key information into planning to recover faster and avoid costly actions.

County Snapshots also include the percent and type of land converted to development in recent years. Natural areas provide a buffer to flooding because plants absorb water and release it slowly during a storm event, lessening the impact on nearby roads, homes and other infrastructure. Wetlands, especially, help mitigate flooding events. Armed with information about land conservation and development trends, county leaders can plan strategic green infrastructure to abate the impacts of storm events and floods. The County Snapshot provides a gateway to education for county officials on what to do next. This instrument outlines the critical steps to implementing flood mitigation techniques to protect vital infrastructure from inundation.



County Snapshot

Once a community identifies local inundation risks, they then need to bring in other stakeholders and decision makers to assess how current and future hazards and threats will impact a community's people, places and natural resources. NOAA's Coastal Services Center's Roadmap Training can help communities design and implement local workshops for identifying vulnerabilities and exploring practical, locally relevant planning and policy solutions. These hands-on workshops lead local officials, community leaders and other key stakeholders through a facilitated evaluation of current and future conditions and an interdisciplinary process to integrate relevant risk information into existing local planning and decision-making. The workshops focus on helping communities initiate a collaborative process to incorporate existing and future hazard and climate concerns into their current land use, natural resources, transportation, community development planning and policy decisions.

During the workshops, participants design and apply the risk assessment process directly to their local communities. Participants identify coastal hazards and climate risks and determine spatial

CanVis: Before Additional Structures

CanVis: After Structures Added

techniques and data resources appropriate for their community's capabilities. They then evaluate key vulnerability and resilience characteristics of built infrastructure, natural resources, society, culture and the economy. Participants explore methods and techniques to reduce inundation impacts and consider how to integrate relevant information products and assessment results into existing planning and decision-making processes.

NACo's 2007 survey revealed the need to engage citizens and stakeholders in proactive solutions to flooding and storm events. CanVis software can aid groups in visualizing and planning for inundation. CanVis is an easy-to-use, free visualization program allowing users to "see" potential impacts such as coastal development or sea level rise. Users input their own digital imagery or utilize the software's existing object libraries to show before and after simulations of land use. The software's library of images creates the ability to visualize what an area might look like with an extra 50 centimeters of water or with a hardened or softened shoreline for example. Municipalities have used the software to brainstorm new ideas and policies, undertake project planning and make presentations to citizens as well as other officials and staff.

County officials can use these tools to help communicate what land use changes will look like without relying on architect or developer drawings. Digital Coast provides the software and object libraries at no cost to users, and users adapt the images they create to visualize before-and-after pictures in coastal areas as well as inland areas. The coastal object libraries contain ready-made items. These growing libraries contain a large number of specific items like trees, docks or wind turbines, but CanVis allows users to create their own objects to add to their personal libraries. If a specific item is not in the current object libraries, the user can contact the Coastal Services Center, who will create one for the user.

Officials in the Town of Falmouth, Massachusetts had concerns about the aesthetic and natural resource impacts of an increasing number of docks on Green Pond. They needed a tool that could illustrate dock and pier "build out" under existing regulations. They also wanted to show the visual outcome of proposed changes to current dock and pier regulations. Local leaders used CanVis to combine dock objects, photography and Google Earth imagery into simulated illustrations of cumulative impacts, which they showed at planning and town meetings.

Inundation and flooding pose significant concern to our coastal counties, as evidenced in the 2007 findings and present trends nation-wide.

Digital Coast tools, including County Snapshots, Roadmap Training and CanVis, assist county planners and coastal policy-makers to better understand flooding vulnerability and map predicted flood areas. Armed with this information, counties can better prepare and respond to flood events, higher tides and severe storms.

- **County Snapshots** help decision makers to understand the exposed areas in their county to identify and coordinate specific plans to mitigate inundation effects.
- **Roadmap Training** helps counties design and implement local workshops engaging stakeholders to identify vulnerabilities and explore practical policy solutions.
- **CanVis** provides a simple, cost-effective approach to visualizing changes, thus streamlining the planning process and involving more stakeholders in the planning process.

Restoring Coastal Functions with Habitat Prioritization Tools

In NACo's 2007 survey, habitat restoration and protection ranked number one among coastal issues challenging county respondents. County leaders identified several issues impacted by habitat loss and a need for greater investment in protecting habitats and restoring natural areas for multiple uses. These uses include spawning and development for vital fisheries, water quality improvement, green infrastructure and recreational use for healthier communities.

Digital Coast Tools: MarineMap[11] and Habitat Priority Planner

Throughout the Digital Coast project, partners have helped create tools for better management of habitats directed toward county usage. The MarineMap and Habitat Priority Planner tools assist local governments managing and restoring natural areas, protecting species, encouraging recreation and helping to mitigate wetland loss. Protecting and restoring these areas safeguards them so that fish communities will thrive despite rising sea levels, sinking Great Lake levels and severe storm events.

During episodes of gradual sea level increase, wetlands and salt marshes keep pace with rising water levels. Marshes accumulate and build soil at the same rate as water level rises while plant species adjust gradually by moving progressively inland. However, if sea level rises significantly faster than the rate at which the marsh can respond, the marsh will drown. With the right conditions, coastal marshes can survive rising sea levels. The marsh must accumulate and build soil at the same rate that the water level rises. Very often, however, especially along the highly populated east coast shore, development impairs the natural processes enabling wetland adaptation.

The inundation of marsh ponds creates interior marsh ponds detrimental to coastal communities. Interior ponds provide additional areas where sediment washes away, destroying the plant base. Some regions of the Gulf Coast, such as the Mississippi River Delta and the Florida panhandle, already experience some of the nation's highest rates of wetlands loss, largely because of deteriorating coastal landscapes and coastal wetlands. Coastal Louisiana experiences the greatest wetland loss in the nation

The California Marine Life Protection Act Initiative

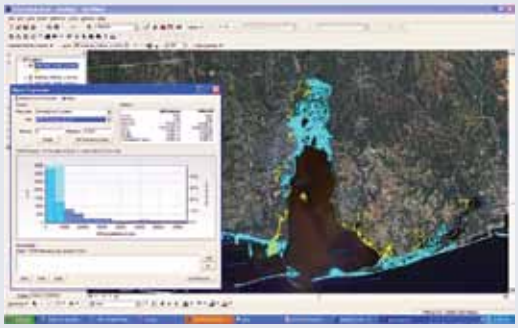
Digital Coast tools can help local governments mitigate damage to habitat for wildlife and fisheries. In 1999, the Marine Life Protection Act (MLPA) directed the State of California to design and manage a network of marine protected areas in state waters to safeguard marine life, habitats, ecosystems and natural heritage regions, as well as to improve recreational, educational and study opportunities provided by marine ecosystems.

The members of the California Marine Life Protection Act Initiative, a public-private partnership designed to help the State of California implement the MLPA, work to identify the best locations to establish the Marine Protected Areas (MPAs) using MarineMap. MarineMap is an open source, Web-based tool that assists stakeholders involved in designed marine protected areas. Users can visualize oceanographic, biological, geological and human dimensions of ocean and coastal areas.

The Habitat Priority Planner In Action

This tool has been used in several communities to set priority plans. In Alabama, more than sixty organizations banded together to update the habitat protection and restoration priorities for two coastal Alabama counties. The group assembled the needed information including habitat data, land use data, habitat stressor information and other local data sets and then identified key spatial data gaps for the future. Using this data, project teams identified and mapped habitat protection priorities.

For local officials, creating an interactive map remains the ultimate goal of this project. This map functions as a spatially based priority habitats atlas for the county. Local stakeholders in each area will gain access to the map to help them identify and prioritize habitat protection actions that contribute to local and regional targets. This conservation planning effort is just one of many planning efforts underway to help protect and instill resiliency along coastal Alabama. Leaders in the region understand that they can best address complex coastal issues when the planning efforts of diverse agencies, organizations and stakeholders come together.



In Coastal South Carolina, this tool has also helped map conservation areas by identifying priority habitat. The Edisto Island Preservation Alliance wanted to conserve their rural and agricultural way of life through community-driven initiatives. The group worked with the county to help update the comprehensive plan. During the development of the plan, HPP was used to visualize the community's scenic, historical, and natural resources as well as to identify data gaps. Using the information and maps from this effort, the group protected over 50% of the area and also successfully abolished a legal loophole allowing development without a public process.

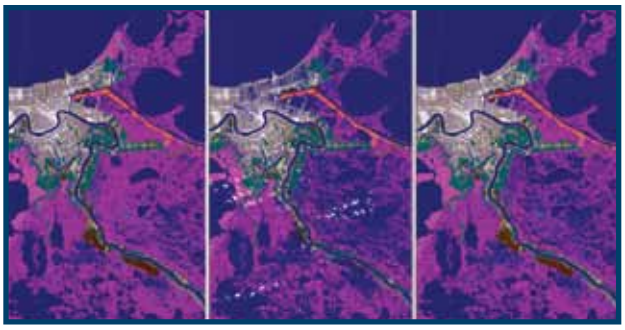
with delta wetlands now disappearing at an average rate of 17 square miles per year, or about 50 acres per day[12].

Coral reefs provide valuable benefits to the environment and economies of Hawaii and most U.S. territories in the Caribbean and Pacific, including support for fisheries, tourism and coastal protection. Recent warm ocean temperatures, polluted rainwater runoff and diseases have caused unprecedented declines in coral reefs. NOAA estimates that the direct economic costs of worldwide coral reef loss at hundreds of billions of dollars.[13]

MarineMap supports a consensus-driven process by allowing stakeholders to visualize geospatial data layers, draw prospective MPA boundaries and attribute regulatory information, assemble prospective MPA boundaries into groups, share MPA information on boundaries and groups with other users. The tool also generates statistics and charts to evaluate MPA using science-based guidelines and shares results with users in a discussion forum. MarineMap capabilities include drawing MPA concepts and assigning attributes.

The Digital Coast Habitat Priority Planner (HPP) aids local officials in making decisions about habitat conservation, land use planning and climate change. The tool takes away much of the subjective nature of the process by providing a means of obtaining critical habitat analyses that are consistent, repeatable and transparent. This GIS tool uses land cover data and allows users to easily test various ideas and "what if" scenarios on the fly, making it ideal to use in a group setting where policy-makers and GIS specialists can explore policy options and effects.

Local government GIS specialists can help coastal counties to develop protected areas though the use of these tools. These areas will help counties to



Land cover data, such as these C-CAP images, helps counties analyze change over time.

grow and restore threatened habitat including coral reefs, salt marshes and other wetlands so these habitats can continue to sow benefits for local communities. Land cover data also helps regions recover from severe storm events. Hurricane Katrina heavily impacted the Breton Sound region in Louisiana in 2005. Dramatic flooding and subsequent loss of emergent wetlands remain the most prominent of the observed changes in the weeks after Katrina. In less than one year, Louisiana lost over 150 square miles of marsh land and experienced an increase of over 200 square miles of open water.

To quickly and accurately assess the potential impacts or recovery related to an event, such as a Hurricane Katrina, managers need information of pre-existing on-ground conditions. Researchers analyzed flood conditions in the two week period following Katrina in conjunction with existing 2005 land cover data. Analysts then identified areas impacted after the storm and assessed how those areas recovered by the spring of 2006. Future land cover updates can help to assess longer-time recovery and habitat losses in a range of habitats after storm events.

According to climatologists, the risk of tropical storms and hurricanes has increased and continues to concern Gulf Coast counties. Hurricane activity in the Atlantic Basin (which includes the Gulf of Mexico) increased five-fold when comparing 1995-2000 figures to the previous 24 years (1971-1994).[14] Hurricanes and winter storms cause major disturbance along the Gulf Coast. Frequent storm events generate waves, which permanently erode this region's barrier islands and shrink the area of coastal land. Barrier island chains in the northern Gulf of Mexico already experience this disintegration due to sediment transport and sea level rise.[15]

Besides contributing to flooding and erosion, heavier rainfall events reduce water quality. In developed areas, stormwater rushes quickly to storm drains or water bodies, carrying pollutants and sediment. Lowered oxygen levels from warmer temperatures and polluted runoff may eliminate much of the habitat available for trout and other cold-water fishes, amphibians and waterfowl. The Gulf Coast already experiences a large hypoxic zone threatening Gulf ecosystems for much of the year. This destruction has real costs for local fisheries, which support huge numbers of families and businesses in our coastal counties.

Counties can utilize geospatial data sets describing terrain, land cover and soil physiography to assess risk to water quality from these sources. However, many watershed assessment models remain complex and require significant overhead in data preparation and consolidation. The Michigan Tech Research Institute (MTRI) realized the need for an ecologically-relevant, lightweight and adaptable tool to analyze wetland distribution and patterns in a local watershed. MTRI currently tests an emerging watershed evaluation system using Counties and Coastal Change Analysis Program (C-CAP) land cover data to analyze buffer effectiveness, summarize catchment and develop fragmentation statistics. The analysis program will allow MTRI to target stressed areas for conservation programs and further assessment.

The Digital Coast tools provide a range of options for county officials to mitigate the effects of sea level rise and severe storm events by helping local governments to map, prioritize and protect strategic natural resources. With these tools, counties can better prepare for the land use changes needed to alleviate the negative impacts of these events.

- **MarineMap** assists stakeholders in designing and mapping marine protected areas.
- **Habitat Priority Planner** aids local officials in making decisions about habitat conservation, land use planning and climate change.
- **Counties and Coastal Change Analysis Program** assists county staff and officials to analyze buffer effectiveness, summarize catchment and develop fragmentation statistics.

Protecting our Coastal Economies with Land Use Planning Tools

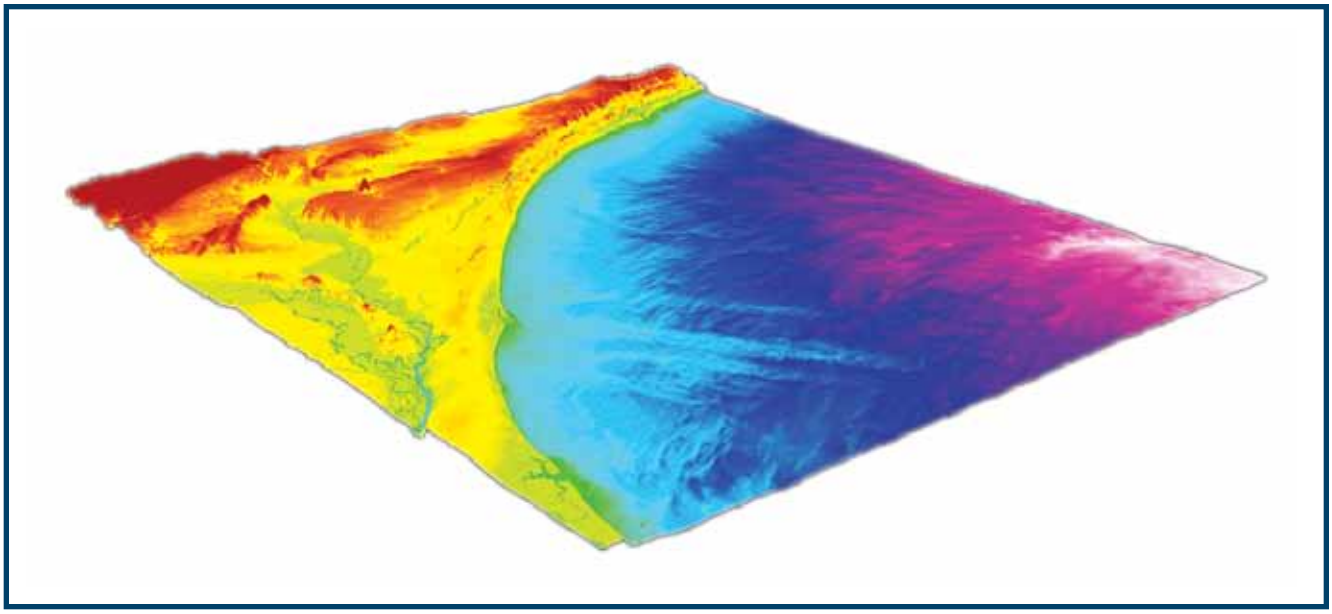
Environmental changes associated with sea level rise, such as warmer water temperatures, flooding, increased storm frequency and lowered Great Lake water levels, pose significant financial strain on our local industries and county governments. In the next few decades, these changes may cost counties millions of dollars in lost revenue because of reduced fish catches, loss of tourism, damaged property, increased shipping and material costs and reductions in available potable water.

Digital Coast Tools: Exploring Available GIS Data

To help prevent large financial losses, counties can plan for these changes by using Geographic Information System (GIS) tools to map and identify natural areas at risk. In NACo's 2007 questionnaire, county coastal managers categorized natural damage prediction models as their most commonly used GIS tools and identified land use decision instruments as highest on the types of mechanisms needed to mitigate the effects of sea level rise. The continued use of these decision-support tools, plus the utilization of Digital Coast data like the C-CAP data, will help local governments prepare and respond effectively to environmental changes.

NACo's 2007 findings also revealed that few coastal managers have utilized this type of bathymetric elevation data. Bathymetric data reveals the depth of coastal water relative to sea level and helps identify habitats, depths for shipping and infrastructure much like topographic data identifies heights for land areas. A combination of topographic and bathymetric elevation data helps localities predict which areas will be impacted by environmental changes.

One of the major challenges to using topographic and bathymetric data is difficulty locating existing data sets, as there are many entities that collect these datasets for a variety of reasons. The Topographic and Bathymetric Data Inventory, available through Digital Coast, provides an inventory of publicly available data sets and collects data quality information to help users determine if the data set will be appropriate for their issue. The inventory already includes regional information for the



Myrtle Beach: bathymetric elevation data

Suffolk County Uses Modeling to Address Conservation

Several counties have already begun to take advantage of these online resources. Suffolk County, New York has utilized Sea, Lake and Overland Surges from Hurricanes (SLOSH) models to consider the impact of flooding based on sea level rise scenarios and local conditions. Local decision makers utilized the results of this analysis to address the conservation of economic and ecological resources through land use policy. The SLOSH model from the National Hurricane Center provides flooding scenarios for coastal storms.

In Suffolk County, several environmental and coastal research organizations partnered to identify conservation areas to enhance biodiversity and reduce hazard exposure. The organizations utilized the Future Scenarios Mapper, SLOSH and HAZUS data models to combine hazard information with ecological data to identify these areas. The team then presented analysis results related to planning, zoning and permitting decisions in an interactive web mapping tool, which stakeholders access when considering land use policy options.

Gulf of Mexico, the Southeast US (Florida Keys to Delaware), Lake Ontario and Hawaii. These data sets are useful to address issues related to flooding, beach nourishment, erosion and other processes occurring along the land-water interface. Bathymetric data allowed managers of the Apalachicola Bay in Franklin County, Florida to develop current oyster and sediment maps to guide future planning.

Gulf and Pacific Coasts: Protecting Vital Shellfish Industries

Warmer coastal waters reduce dissolved oxygen levels because warmer water holds less oxygen than cooler water. Several important fishery species such as crab, shrimp, oyster and flounder may not survive in some regions past the end of the century due to changes in river and coastal water temperatures. Along the Pacific Coast, warmer Pacific Northwest river temperatures and temperature changes in the northern Pacific Ocean will disrupt critical salmon populations.

Coastal changes pose particular threats to Gulf Coast oyster farmers. Oyster waters must have a high enough salt content to provide appropriate nutrients to the oysters but still have sufficient freshwater input. Salt water pushed over the oyster reef contributes to long-term decline. As the fisheries transition, local oyster fishermen will compete for diminishing shellfish and over-harvest the oysters. Even a small reduction in efficiency will cause some Gulf Coast fishermen to stop fishing.[16] Shifts in the fishing industry will significantly impact tax revenues and social service demands for these Gulf Coast communities. In Louisiana alone, fisheries contributed roughly $20 billion to the gross national product and employed about a million people in coastal counties.[17]

The Pacific Northwest estuaries support more than 90% of the nation's harvest of wild and hatchery-raised salmon.[18] The combined effects of altered productivity and overfishing have already led to declines in salmon populations both in the U.S. and in international fisheries. The United States has spent more money to rebuild the salmon population than it has on any other endangered species. In 2004 alone, the U.S. invested $350 million in salmon restoration efforts.[19]

Atlantic Coast: Shielding Coastal Shores

The Long Island shores of New York State (Suffolk County) are highly developed. Private citizens own most of the coastal property located only inches above sea level. Sea level rise threatens billions of public and private money in this area. Long Island stakeholders have indicated a need to visualize and understand how they can make informed decisions about marine conservation, land protection and coastal development. The Nature Conservancy will

provide more on this project about the community's coastal lessons learned in phase 2 of the Coastal Inundation Toolkit in early 2010.

Great Lakes: Adjusting to New Economies

Converse to the United States' other coasts, Great Lake levels may drop as much as 1.5 meters, or five feet, over the coming century[20]—the largest reduction since the 1930s Dust Bowl.[21] Since the Great Lakes coastal communities were built for the relatively narrow range of lake levels seen over the last two centuries, this change will significantly impact these counties by affecting shipping costs in the region.

Shipping costs throughout the Great Lakes region will increase as lake-level decreases because harbor and channel dredging needs will rise. When other modes of transportation (rail and truck) compete with Great Lakes shipping, the loss of one inch of draft can create a serious disadvantage for Great Lakes carriers and ports. Current reductions in Great Lakes levels have already impacted the commercial shipping economy.[22]

Future increases in storm intensity and frequency could also increase the price of domestically-sourced fuels along the Gulf coast as well. Between 2000 and 2005, 20 to 50% of all U.S. domestic natural gas and crude oil production occurred in the Gulf of Mexico. The frequency and magnitude of major storms significantly stress these industries. In 2009, shipping ports in Gulf states accounted for nearly 50% of all waterborne cargo entering and leaving the United States.[23] The cost of shipping cargo increases when severe storms alter ship traffic and river port accesses.

A Gulf Coast sea-level rise of 1-3 feet during the 21st century will also significantly stress coastal infrastructure, transportation, public sanitation and more. The large number of homes and communities built on barrier islands are particularly vulnerable and costly to replace. As hurricanes and flooding events intensify, coastal managers will oversee more evacuations. These changes may disproportionately impact low-income populations and elderly communities.

Digital Coast Tools: Landscape Data and Analysis

Digital Coast land cover data helps planners and coastal managers in these regions see and predict potential impacts from land use scenarios and management options. NOAA's C-CAP data, accessed at no cost to the user, allows coastal counties to document the size, shape and location of landscape features to develop land use strategies. GIS specialists update the data every five years; the multiple dates for land cover data allows for local managers to document landscape changes. Most areas of the country have data available for 1996, 2001 and 2006. NOAA specialists are currently developing an online tool to help counties analyze changes in their counties land cover through the Digital Coast.

County leaders can combine hazard information with ecological data to identify potential conserva-

Franklin County, Florida Maps Areas of the Apalachicola Bay

In Florida, localities used bathymetric data to map areas of the Apalachicola Bay in to determine the best possible ways to protect threatened oyster populations. Along Apalachicola Bay, Florida (Franklin County), between 60 to 85 percent of the local population derives its income directly from the $130 million-a-year seafood industry. Recent drought and competition for freshwater resources have caused costly losses to local communities. The Apalachicola River carries water more than 300 miles from Georgia's Lake Lanier into the bay, providing the delicate balance of freshwater and saltwater that oysters need to thrive. Researchers and local GIS specialists mapped Apalachicola Bay using side-scan sonar, interferometric swath bathymetry, seismic reflection acoustic techniques and video imagery. This data provided essential elevation information for the sea floor that planners and local officials used to model potential inundation events to protect the fishery.

tion areas that can enhance biodiversity and reduce hazard exposure with existing tools. New tools may also assist local governments to plan these areas. NOAA's Coastal Services Center's Community Vulnerability Assessment Tool (CVAT) aids counties in analyzing community exposure and vulnerability to hazards, such as saltwater intrusion. Saltwater intrusion will accelerate and worsen by sea level rise. As saline water moves inland into freshwater aquifers, groundwater becomes contaminated with salts and unsuitable for water-supply and irrigation. Saltwater intrusion remains a concern for all the coasts and has already proven costly to counties in Central and Southern California. HAZUS, the Federal Emergency Management Agency's loss estimation tool, helps to estimate flood damage impacts.

When asked to describe ways in which counties examine land use decisions with respect to the coastal environment, most counties identified vehicles that address the link between land use and coastal resources. The Digital Coast partnership has developed tools and projects to connect land use and coastal management with data and instruments. These tools help counties mitigate sea level rise, lake level decline, storm surges and salt water intrusion.

- **SLOSH Models** estimate the impact of flooding based on sea level rise scenarios and local conditions.
- **Topographic and Bathymetric Data Inventory** provides an inventory of publicly available data sets and collects data quality information.
- **Community Vulnerability Assessment Tool** aids counties in analyzing community exposure and vulnerability to hazards, such as saltwater intrusion.
- **HAZUS** helps counties estimate flood damage impacts.

Moving Forward with Digital Coast

Counties along our coasts still face significant challenges to building resilient communities. Many of the challenges identified in NACo's 2007 survey still remain paramount to coastal managers today and in the coming years. NACo continues to work towards a vast online resource to aid local governments dealing with sea level rise, erosion and lake level change to improve community resiliency. The tools we have detailed in this brief identify resources within the emerging Digital Coast, but we also recognize that the unique needs of coastal counties change rapidly.

Our coasts are home to over 80% of the US population, supporting industries, homes and habitats. Threats to this vital resource cannot be ignored or undercounted. NACo is proud to represent the interests of counties in this partnership by gaining feedback from the people on the ground dealing with these issues every day. If you are a county official or staff member using the Digital Coast, we would like to hear from you. Please contact NACo staff to share your experiences so we can continue building a useful, clear resource for addressing coastal management issues.

References (Endnotes)

1 Brown, Scott et al. Greenhouse Effect and Sea Level Rise: The Cost of Holding Back the Sea. 1991. Coastal Management vol. 19.

2 Thieler, E. Robert, Jeff Williams, and Erika Hammar-Klose. National Assessment of Coastal Vulnerability to Sea-Level Rise: Preliminary Results for the U.S. Gulf of Mexico Coast. 1999. *http://Pubs.usgs.gov/of/of99-593*.

3 Twilley, Robert. Coastal Wetlands and Global Climate Change: Gulf Coast Wetland Sustainability in a Changing Climate. Pew Center on Global Climate Change, 2007.

4 Twilley, Robert. Coastal Wetlands and Global Climate Change: Gulf Coast Wetland Sustainability in a Changing Climate. Pew Center on Global Climate Change, 2007.

5 Northern Gulf of Mexico (NGOM): Ecosystem Change and Susceptibility Project. U.S. Geological Survey. 2009. *http://ngom.usgs.gov/index.html*.

6 Crook, Stephen. Estimating the Economic Impacts of Coastal Hazards and Climate Changes in the Low Elevation Coastal Zone of Monterey Bay. 2008. *http://www.mbari.org/education/internship/08interns/08papers/Crook.pdf*.

7 Brown, Scott et al. Greenhouse Effect and Sea Level Rise: The Cost of Holding Back the Sea. 1991. Coastal Management vol. 19.

8 Cooley, Heather et al. The Impacts of Sea-Level Rise on the California Coast. California Climate Change Center. 2009. *http://www.pacinst.org/reports/sea_level_rise/report.pdf*.

9 Alden, Marianne, Linda Mortsch, and Joel Scheraga. Climate Change and Water Quality in the Great Lakes Region. A Report prepared for the Great Lakes Water Quality Board of the International Joint Commission. 2003.

10 Abrams, Robert, Noah Hall, and Bret Stuntz. Climate Change and Freshwater Resources. 2008. Natural Resources and Environment, vol. 22, no: 3.

11 Marine Life Protection Act Initiative. MarineMap Decision Support Tool. 2009. *http://marinemap.org/*

12 Twilley, Robert. Coastal Wetlands and Global Climate Change: Gulf Coast Wetland Sustainability in a Changing Climate. Pew Center on Global Climate Change, 2007.

13 Coastal Areas and Marine Resources: The Potential Consequences of Climate Variability and Change. A Report of the NOAA's National Coastal Assessment Group, 2001.

14 Twilley, Robert. Coastal Wetlands and Global Climate Change: Gulf Coast Wetland Sustainability in a Changing Climate. Pew Center on Global Climate Change, 2007.

15 Northern Gulf of Mexico (NGOM): Ecosystem Change and Susceptibility Project. U.S. Geological Survey. 2009. *http://ngom.usgs.gov/index.html*.

16 Coastal Areas and Marine Resources: The Potential Consequences of Climate Variability and Change. A Report of the NOAA's National Coastal Assessment Group, 2001.

17 USGS. Climate Change Impacts on the Gulf Coast Workshop. 2003. *http://www.usgcrp.gov/usgcrp/nacc/gulfcoastworkshop.htm*.

18 National Oceanic and Atmospheric Administration. Chapter 4: Regional Analyses of Restoration Planning. 2001. *http://era.noaa.gov/pdfs/chap4.pdf*.

19 "Efforts to Save Salmon May be Undone by Climate Change." Biology/Ecology. May 12, 2009.

20 National Oceanic and Atmospheric Administration. Coastal Areas and Marine Resources: The Potential Consequences of Climate Variability and Change: Great Lakes. A Report of the NOAA's National Coastal Assessment Group, 2001.

21 Beavers, Rebecca, E. Robert Thieler, and S. Jeffress Williams. Vulnerability of U.S. National Parks to Sea-Level Rise and Coastal Change. United States Geological Survey. 2005. *http://pubs.usgs.gov/fs/fs095-02/fs095-02.html/* Pendleton, Elizabeth, E. Robert Theiler, and S. Jeffress Williams. Coastal Change-Potential Assessment of Sleeping Bear Dunes, Indiana Dunes, and Apostle Islands National Lakeshores to Lake-Level Changes. Open-File Report 2005-1249. 2007.

22 USGS. US National Assessment of The Potential Consequences of Climate Variability and Change: Regional Paper: Great Lakes. 2003. *http://www.usgcrp.gov/usgcrp/nacc/education/greatlakes/greatlakes-edu-3.htm*.

23 Twilley, Robert. Coastal Wetlands and Global Climate Change: Gulf Coast Wetland Sustainability in a Changing Climate. Pew Center on Global Climate Change, 2007.

25 Massachusetts Avenue, NW / Suite 500 / Washington, DC 20001 / 202.393.6226 / fax 202.393.2630 / www.naco.org