



2012

Hazard Resilient Coastal Communities  
Hurricane Research, Outreach and Technical Support

Hurricanes and other coastal storms carry the threat of disaster, placing people and property at risk along the nation's coasts. These dynamic forces, combined with potential climate change impacts and population growth along our coastlines, have tremendous implications for the economic and environmental health of our coastal areas. Coastal residents must understand these risks, learn how to reduce their vulnerability, and understand how to respond quickly and effectively.

[NOAA Sea Grant](#) works to:

- Promote widespread understanding: Assess short and long-term risk for residents and businesses and ensure that forecast and other information is available and useful to help save lives.
- Prepare Communities: Help communities plan to reduce risk; pinpoint vulnerabilities and use technologies to prepare for and mitigate hazards.
- Respond to coastal catastrophes: Make products and services available to support crisis decision-making, mobilize the Sea Grant network to provide rapid response strategies, and partner with emergency responders.

Below is a sample of the work being done through NOAA Sea Grant programs.

[Florida Sea Grant](#)

Protecting homes from hurricane damage is a key focus for Florida Sea Grant. Through a variety of research investments and technical product development and support, Sea Grant works to prevent millions of dollars in annual damage in Florida. Examples of this work include:

- **Sea Grant research focuses on making homes safer and more hurricane resilient**  
More than \$16 billion in damages occurred when Hurricane Wilma struck South Florida in October 2005. The majority of this damage was to roofs. Many older residential structures near the coast do not have roofs designed to survive the impact of major hurricanes. Sea Grant is investigating effective and economical ways of mitigating the effects of strong winds on roofs in order to reduce losses from hurricane events.
  - Researchers use "[Wall of Wind](#)" facility to develop new design standards to protect structures from hurricanes

Sea Grant researchers are using a new state-of-the art, Wall of Wind (WoW) laboratory, the first major full-scale facility dedicated to hurricane research and damage mitigation.

- The facility makes it possible to estimate the amount of wind pressure a roof is able to sustain by taking into account roof elements such as tiles and shingles, the effect of which is otherwise neglected in conventional testing.
  - Experimental studies are assessing the effectiveness of aerodynamic devices in reducing wind effects over the corners and edges of roofs. This research helped to develop a new product that can substantially reduce or prevent hurricane-induced damage to new and existing roofs. The aerodynamic edge product is now patented by industry partner Weather Predict Consulting Inc., and is estimated to create/sustain about 150 jobs when the product is commercialized. The product could help save \$5 billion in losses due to hurricane damage.
  - Sea Grant researchers have also applied for a provisional patent for a new Fiber Reinforced Polymers (FRP) Tie System (an enhanced roof-to-wall fastening system that will help hold roofs in place during hurricanes). This product could save an estimated \$25 million in annual damage claims within Florida alone.
- **Sea Grant develops enhanced modeling framework for storm surge and coastal inundation forecasting**

Technologies currently in use for hurricane and surge/inundation characterization, forecasting and protection are urgently in need of improvement. To meet the demand for more accurate storm surge models, Sea Grant demonstrated and validated a new storm surge and inundation forecasting system (CH3D-SSMS) in northeast Florida using data obtained during Tropical Cyclone Fay. This new system is expected to enhance storm surge and inundation forecasting and mapping in the U.S. and elsewhere.

    - Sea Grant researchers are also developing an Education Virtual Appliance which offers advance modeling for emergency managers. The researchers have also developed a plan to engage stakeholders to help evaluate the Education Virtual Appliance modeling technology, and compare output scenarios from several commonly-used modeling applications. The researchers are developing a public education strategy on the topics of storm surge and coastal inundation hazards that will be posted on the web.

### **Georgia Sea Grant**

While not common, the coast of Georgia is vulnerable to hurricanes. Georgia Sea Grant is funding research to develop information on the history of hurricanes in Georgia including where and how often they have impacted the Georgia coast.

- **Reconstructing Georgia's Hurricane Record: A 260-year GIS Database of Coastal Impact**

A cursory examination of historical hurricane records suggests that the 18th and early 19th centuries are rife with examples of hurricanes wreaking havoc in areas such as Savannah, Brunswick, and St. Mary's. Work by Georgia Sea Grant-funded researchers will examine historical hurricanes including many weaker storms may have posed significant flooding/storm surge hazards to residents living along the coast.

- [\*\*Paleotempestology of Coastal Georgia: A Study of Spatial and Temporal Variability of Hurricane Activity along the Coast of Georgia\*\*](#)

In a related study, a Sea Grant researcher is asking how likely it is that a coastal city such as Savannah or Brunswick will be directly hit by a catastrophic storm of category 4 or 5 hurricane on the Saffir-Simpson scale. The vulnerability of US coastal environments (including coastal Georgia) to hurricane impacts continues to grow significantly due to population migration and the accompanying economic investments, growth in coastal property and wealth, and development of tourism. This question, and the research results, are important because of their implications for insurance underwriting, real estate values, tourism development, and emergency planning along the coast.

#### [\*\*University of Hawaii Sea Grant\*\*](#)

- Hawaii Sea Grant received \$1 million from NOAA Coastal Storms program for Pacific Region projects focusing funds and resources in coastal communities to help reduce and mitigate the risk of coastal storms and weather hazards. <http://seagrant.soest.hawaii.edu/csp>
- [\*\*Handbook helps residents prepare for natural hazards\*\*](#)  
Hawaii communities are exposed to multiple natural hazards that include hurricanes, tsunamis, earthquakes, and floods. Many homeowners are not prepared for dealing with these hazards and lack the necessary knowledge and information on emergency planning and preparedness. Sea Grant developed the [\*Homeowner's Handbook to Prepare for Natural Hazards\*](#), a guidebook that outlines effective ways to significantly lower serious risks to lives and property prior to a natural hazard event. Over 40,000 copies have been distributed directly to the community. Hawaii Sea Grant has also worked with other state Sea Grant programs (e.g., Mississippi-Alabama, Delaware, Texas, Louisiana, and Florida) to develop their own state-specific version(s) of the handbook.
- [\*\*Hawaii Sea Grant and partners hold hazard preparedness workshops\*\*](#)  
The University of Hawai'i Sea Grant College Program helped to initiate and organize a series of six statewide hazard preparedness workshops in 2011 that were held with the assistance of the NOAA National Weather Service, Pacific Tsunami Warning Center, Coastal Storms Program, American Red Cross and State and local civil defense for all the islands. At the events, topics covered included hurricane risk, emergency supplies, evacuation planning, and tips to strengthen the house based on the most likely damage from a hurricane. Many of the concepts were from the Homeowners Handbook to Prepare for Natural Hazards. [Workshops for 2012](#) are currently being scheduled.
- [\*\*Guidebook helps children prepare for hurricanes\*\*](#)  
In partnership with NOAA's National Weather Service in Honolulu, Hawaii Sea Grant published a children's hurricane preparedness book titled "The Three I'o Brothers and the Big Bad Hurricane." The book uses the pueo (Hawaiian owl) to teach hurricane preparedness. In the book, a pueo teaches the three I'o (Hawaiian hawks) about the dangers of a hurricane and what they need to do in order to be safe. Books were accepted for circulation and shipped to over 300 public elementary school libraries and throughout the State of Hawai'i public library system. The book was also featured at the 2011 Hurricane Season Press Conference hosted at the Central Pacific Hurricane Center.

## [Louisiana Sea Grant](#)

- **Sea Grant website provides residents with hurricane resources**  
The [Louisiana Hurricane Resources](#) website, hosted by the Louisiana Sea Grant College Program, provides visitors with access to a wealth of data concerning storm preparedness and recovery, as well as archived information about Hurricanes Katrina and Rita.
- **Program Encourages 4-H Students to Prepare for a Resilient Future**  
Resilient Future is an education/outreach project Louisiana Sea Grant offer in schools to not only teach children about how to prepare for sea level rise, but also fortify for storm surge.
- **Geographic impacts of hurricanes**  
This video presents a hurricane mapping activity designed to show the geographic reach of Hurricanes Katrina and Rita. The three and a half minute video shows how the relative area affected by the two hurricanes could impact other parts of the country if they were struck by a similar natural disaster.
- **Louisiana uses Hawaii product to help educate**  
The Louisiana Sea Grant Law & Policy Program published the 250-page [Louisiana Hazard Mitigation Guidebook](#) to explain issues from zoning and structure siting to construction methods and legislation that can be employed to build more hazard-resistant communities. It is based on a similar guidebook published by Hawaii Sea Grant. Sea Grant representatives held workshops for Louisiana citizens and government officials to help them understand and implement the strategies outlined in the guidebook and to emphasize the importance of community planning. Videos of the workshops and copies of the guidebook are archived online and available free of charge. The guidebook is being used as a classroom text at Baton Rouge Community College and at Louisiana State University's Paul M. Herbert Law Center
- **Outreach program shows vulnerability to flooding**  
“[The Next Storm Surge](#)” outreach series graphically demonstrates community and individual susceptibility to hurricane flooding. Louisiana Sea Grant Extension agents and disaster and GIS specialists conducted vulnerability assessments for eight of the state's coastal parishes. Using computer modeling and real-world data collected on the ground after hurricanes, they prepared maps showing the extent of potential flooding under various storm scenarios. They superimposed images of flood waters on photographs of local businesses and landmarks to help residents visualize predicted impacts. More than 2,000 people attended the program at local libraries, and most attendees viewed the presentations as a wake-up call. Maps and printed materials remained on display for library patrons after each program to extend the project's impact. One regional bank moved its electronic operations center further inland after bank officials viewed one “Next Storm Surge” presentation and realized their vulnerability.
- **Workshops help communities and local governments plan for increased tropical storms**  
Sea level rise and other climatic changes are projected to increase the vulnerability of Louisiana's coastline to tropical storms by the end of this century. Because the cities and parishes with a wider array of armaments stand a better chance of combating and mitigating future natural hazards, a multi-disciplinary team from Louisiana Sea Grant is helping local policy makers fortify and prepare their communities through a series of workshops. Sea Grant Law & Policy Program members, Marine Extension personnel, and other specialists are educating leaders about sea level rise, the use of Geographic Information Systems (GIS) data to evaluate

storm surge and sea level rise risk, risk perception and communication, and best practices in preparedness. The program also addresses the legal liability of local governments if officials fail to act or act without consideration of pending hazards, and it emphasizes the importance of preparation and planning that increase community resilience while maintaining each community's cultural identity. In addition to workshops, the program provides a toolkit on CD to help policy makers incorporate what they learned into the development and decision making process.

### Maine Sea Grant

- [Sea Grant wave forecast model predicts dangerous conditions](#)  
On Maine's 3,000 mile coastline, surface waves can be the most energetic elements of the physical oceanography affecting coastal communities and habitats. Information about wave conditions has many applications, including the safety of boat or ship operations, the transport of pollutants in the water, the siting of aquaculture activities, and coastal engineering. Building on previous Maine Sea Grant-funded wave modeling studies, Texas A & M researcher Vijay Panchang developed a detailed atlas of fine-resolution wave climates in coastal Maine and a computerized wave prediction system for forecasting wave heights. Wave forecasts now cover all of coastal Maine, providing 48-hour forecasts of wave height, peak period, and wave direction. The complete dataset has been transferred to the US Geological Survey in Augusta.
- [Property Owner's Guide helps Maine residents learn about storm resilience](#)  
Maine Property Owner's Guide to Managing Flooding Erosion and Other Coastal Hazards is a web-based tool for property owners to identify the type of coastal landscape where they live (rocky shore, sandy beach, marsh) and the associated storm-related hazards. Property owners can evaluate existing and potential threats, and explore options for making their homes more resilient to waves, flooding, erosion, and sea-level rise, as well as how to respond when property is damaged during hurricanes and nor'easters. The guide contains information about state and federal rules and permitting for coastal zone activities, and links to maps and other resources.

### Massachusetts Institute of Technology Sea Grant

- [Sea Grant assesses coastal wetlands to protect habitat](#)  
Prevention of sudden wetland dieback (SWD) is key to maintaining and restoring vital wetland areas that form a protective barrier against hurricanes and tidal surges, and also provide essential habitat for marine species. A team of researchers surveyed and inspected tidal wetlands along Connecticut's Long Island Sound and along Cape Cod, Massachusetts, for overall health and for signs of SWD. Researchers also sampled and mapped sites with symptomatic and asymptomatic plants, attempting to identify organisms that contribute to SWD and to confirm pathogenicity on healthy *Spartina alterniflora*. They then tested how stressors, such as drought, flooding, and salinity, affect the susceptibility of *Spartina* to known pathogens, and implemented an outreach program through presentations, town meetings, publications and a website to inform the public of SWD.

### Mississippi-Alabama Sea Grant

- [Sea Grant increases communities' capacity to prepare for and respond to hazardous events](#)  
As the number of people moving to the Gulf coast increases, so does the risk of exposure to flooding, hurricanes and other storm-related events. Although experience has shown that more homes and people located in the floodplain equals more exposure and potential for people to

be in harm's way, many coastal residents are complacent when asked about their preparation for the coming storm season. Recognizing that communities need support and assistance in determining their risk and resilience, Sea Grant created the [Resilience Index](#) as a self-assessment tool to provide community leaders with a simple and inexpensive method of predicting if their community will reach and maintain an acceptable level of functioning and structure after a disaster. The Resilience Index was completed by 16 coastal communities in Florida, Alabama, Mississippi, Louisiana and Texas. These communities assessed their strengths and vulnerabilities prior to future storm events. Two communities have applied for a grant to address one of the vulnerabilities they identified in the Index.

- **Parish saves \$1.3 million using financial health analysis coupled with storm cost predictions**  
Measuring the expected cost of future natural disasters helps local decision makers anticipate the proper levels of emergency funding and other support their community may need in order to be more financially resilient during and after future natural disasters. Sea Grant measured the financial health of several Southeast Louisiana parish governments using common accounting financial indicators, and compared each community's financial health against accepted financially healthy "rules of thumb" levels before and after Hurricane Katrina. Next, an estimate of the one-, four-, 20-, and 50-year expected costs of a tropical storm and hurricane were estimated for a case study parish (Tangipahoa) and selected Southeast Louisiana parishes. The expected costs used historical cleanup debris removal costs for recent storms combined with parish-level probabilities of sustained winds from a tropical event. Coupling these results allowed researchers and parish decision makers to identify cost saving opportunities. The results of the analysis were used by Tangipahoa Parish to save \$1.3 million in interest expenses. Additional parishes will be provided similar assistance in year two of this project.
- **TV show explains why floods are worsening and how mindful planning can decrease flooding**  
"But it never flooded here before!" is a 30-minute television show about flooding in the Gulf of Mexico region. It discusses ways reduce flooding, such as drainage infrastructure, more greenspace, pervious surfaces. It also stresses the need for flood insurance, the benefits of elevating home and more. It has already reached 58,400 viewers in the Houston, Texas, area. It will air four more times this summer and is expected to reach another 116,000 viewers.
- **Project integrates hazard mitigation into local planning to support community resilience**  
Comprehensive planning is usually the responsibility of a planning or zoning department and emergency managers conduct hazard mitigation planning. If local governments are going to make sound planning decisions related to future growth, hazard impacts and coastal resilience must be incorporated into the comprehensive planning process and the planning documents. This project will move toward integration by compiling of all Comprehensive Plans, Capital Improvement Plans and Hazard Mitigation Plans from Mississippi's six counties and 15 municipalities in the study area. Using a matrix, Investigators will review each Comprehensive Plan and Capital Improvement Plan for hazard mitigation principles by identifying connections and gaps between the plans. They also will develop recommendations on how to specifically link hazard mitigation principles to the comprehensive plans.
- **Project to determine best practices when reseeded neighborhoods with nonprofit rebuilding after coastal storms**  
The Phoenix of New Orleans (PNOLA) arose in Mid-City in response to community needs after Katrina, and was one of the first nonprofit organizations to return to New Orleans. The Mid-City

district is unique in that PNOLA is the sole nonprofit organization directly assisting with home rebuilding; this has made it possible to analyze the effects of one charitable organization with long-term presence in a defined area. Through an established community- university partnership between PNOLA, the University of South Alabama and the University of Central Arkansas, this project will combine PNOLA's records of Mid-City rebuilding with GIS layers of elevation, flooding and city building permits to gain insight into the recovery process in Mid-City. Researchers hypothesize that the houses rebuilt with a local nonprofit organization's assistance, "seed" houses, resulted in positive spillover effects to neighboring houses that did not receive assistance from PNOLA, and that the distribution of PNOLA-assisted homes influenced the properties of their spillover effects. Researchers, planners, nonprofit groups and residents alike will want to know how rebuilding has progressed both spatially and over time, and how the resources of external groups can be used efficiently to speed rebuilding and recovery.

- **Gulf of Mexico Coastal Training Program Initiative to increase resilience in communities**  
Local governments often do not have resources or expertise to cope with complex environmental land use and hazard mitigation issues for long-term planning horizons. Principal investigators in this project are addressing coastal community preparedness, recovery, risks and vulnerability by focusing on needs for adaptation as the next step in resilience planning. The Gulf Coast National Estuarine Research Reserve (NERR) Coastal Training Program coordinators are working with a regional coordinator and use the Coastal Resilience Index (CRI) with follow-up training and technical assistance to aid Gulf Coast decision-makers in their efforts to assure community resilience in the face of storms, disasters and a changing climate. Several organizations are administering the CRI but do not have the capacity to offer follow-up training and technical assistance.
- **Measuring the relative financial vulnerability of municipal governments to tropical natural disaster risk**  
Local governments share a burden in financing both emergency operations and cleanup and debris removal from tropical natural disasters. In recent studies conducted by project investigators, it was shown that while county (parish) governments did not find significant differences in financial health changes based on population of the county, case study analyses from these projects suggested that fiscal health of municipalities varies greatly by size and storm vulnerability. With the likely reduction in future federal government reimbursement levels, local governments will have to become more financially resilient. This research is seeking to identify how vulnerable these municipal governments are to future tropical natural disasters and identify financial thresholds needed for them to be financially resilient to increased emergency and debris removal costs from future storms. This project calculates existing financial health ratios of coastal municipal governments in Gulf Coast counties. These ratios are then adjusted based on projected out-of-pocket costs to local governments from a future tropical natural disaster scenario and compared to existing rules of thumb for fiscally healthy governments. The financial ratios are then applied to a parametric model to test for key factors driving changes in fiscal health and to understand how they differ from existing county government studies.
- **"Weathering the Storm and Rolling with the Punches"**  
Mississippi-Alabama Sea Grant sponsors Explore a Seashore educational programs for families, adults and older children at the University of Southern Mississippi Gulf Coast Research Lab's Marine Education Center. In May 2012, there was a session, "Weathering the Storm and Rolling

with the Punches.” Participants learn how local habitats respond to seasonal storms and long-term changes in sea level. Also, they used internet simulations to explore the resilience of their communities and visited a Biloxi community where professional architects and planners help residents to live close to nature for the benefit of both.

- **How accelerated sea-level rise may affect tidal marshes, storm surge**

Mississippi-Alabama Sea Grant funded researchers predicted changes in salt marsh distribution and areal extent and their impact on storm surge under different sea-level-rise scenarios through 2100 in the lower Pascagoula River (Mississippi). Scientists applied the Sea Level Affecting Marshes Model (SLAMM) to predict changes of salt marshes and Advanced CIRCulation model (ADCIRC) to predict storm surge. The research improved the accuracy for the predicted distribution of salt marsh under sea-level rise by applying the local accretion rates determined by isotope analysis on sediments, best available local sea-level-rise predictions and best available LiDAR-derived elevation data. The research also improved the accuracy of storm surge prediction by considering tidal marsh changes due to accelerated sea-level rise.

- **[New York Sea Grant](#)**

- **[Research on "Fighting Back the Waves" in New York City](#)**

["Fighting Back the Waves,"](#) a story that appeared in the Wall Street Journal in May 2011, offers insight into what New York City and other major cities around the world are doing (and not doing) to prepare for future inundation threats from extreme storm events and climate change. Featured in the article is a Stony Brook University Oceanography professor and member of The Stony Brook Storm Surge Research Group, which has been funded principally by New York Sea Grant since 2002 to work on storm surge science, coastal defense systems and policy issues related to regional protection of the City and Long Island. According to the Research Group, the New York Metropolitan region is vulnerable to coastal flooding and large-scale damage to city infrastructure from hurricanes and nor'easters. Much of this region - an area of about 100 square miles - lies less than three meters above mean sea level. Within this area lies critical infrastructure such as hospitals, airports, railroad and subway station entrances, highways, water treatment outfalls and combined sewer outfalls at or near sea level. In addition to being at risk for large, damaging storms that can produce unusually large storm surges resulting in severe flooding, the frequency and severity of these storms has the potential to be increased by the impact of global warming and sea level rise. According to the research, the damage done by a 100 year storm now will equal the damage done by a 25 or 50 year storm later in the century if sea level rise accelerates.

- **[New York Sea Grant creates Hurricane Education webpage](#)**

Hurricanes can occur in the northeast as Hurricane Irene showed us in 2011. New York Sea Grant has developed a storm-ready page to provide information to the public on preparing for severe storms as well as links to other resources and agencies.

- **[Storm surge model shows its value after Irene](#)**

Stony Brook Storm Surge Research Group, which has been funded principally by New York Sea Grant since 2002 to work on storm surge science, coastal defense systems and issues related to regional protection of NYC and Long Island, modeled storm surges during Hurricane Irene. Their work accurately showed the intensity and timing of Irene-related surges in the region. They have also studied the possibility of protecting the metropolitan NYC area from powerful storms through the use of storm surge barriers.



## North Carolina Sea Grant

- **Wind insurance mitigation credits reduce insurance costs, increase public safety**

Property owners pay high insurance premiums for coverage in wind zones near the oceanfront. Incentives for building owners to increase wind resistance would also increase overall safety on barrier islands during coastal storms because of less flying debris. In North Carolina, Sea Grant encouraged the State's Joint Underwriting Association to consider mitigation credits for property owners who construct more wind-resistant buildings, and provided written recommendations to the Joint Select Committee on the Potential Impact of Major Hurricanes on the North Carolina Insurance Industry. This work led to a 2009 decision by the North Carolina General Assembly to require that the Department of Insurance consider mitigation credits for wind-resistant features for coastal homeowners and commercial insurance coverage. The North Carolina Rate Bureau proposed mitigation credits in 2010. As a final step, the State's Insurance Commissioner implemented increased credits as an optional rating for all wind insurance coverage in the state and will offer 5 to 24 percent credits on 2011 policies. Potential savings would apply to wind coverage on approximately 200,000 coastal policies, with premiums of approximately \$300 million annually. Many existing buildings will be eligible for the lower wind insurance rates. Sea Grant is a partner in plans to promote wind-mitigation upgrades of existing buildings so that the property owners can qualify for higher credits. Many new coastal buildings are expected to be designed for the highest credits. When state officials accepted Sea Grant's recommendations to establish wind-resistance mitigation credits on coastal insurance policies, the result was increased safety and lower premiums for property owners who took the recommended actions.

- **Flood warning information, maps help protect coastal communities**

Flooding is the number one weather-related killer in the US. For example, Hurricane Floyd produced catastrophic flooding in Eastern NC. Sometimes floodwaters cause long-lasting effects, including potentially high levels of fecal bacteria in drinking or bathing water. Outreach programming is essential to ensure researchers can provide needed information to weather forecasters, emergency managers and coastal residents. Several Sea Grant programs are working with the [NOAA National Severe Storms Laboratory \(NSSL\)](#) and other partners on a multi-faceted project focusing on the Tar-Pamlico and Neuse river basins affected by Floyd. The project — The [Coastal and Inland-Flooding Observation and Warning \(CI-FLOW\)](#) — provides a research and demonstration program to evaluate/test new technologies and techniques to produce accurate and timely identification of inland, coastal and flash floods. Sea Grant links CI-FLOW researchers with information providers and the coastal public. Sea Grant also participated in a team that updated state flood maps, with a focus on oceanfront counties with barrier islands. In concert with NSSL and National Weather Service forecast offices, Sea Grant has helped developed an interactive procedure to improve and enhance the usefulness of results from the CI-FLOW model. Utilizing web-based displays, the team has determined the most important variables and the optimum display methods for forecasters to use this information when predicting potential flood conditions in tropical storm event scenarios.

- **Researchers Work with NC Emergency Managers**

North Carolina Sea Grant researchers provide leadership in professional development training for state and local emergency managers and N.C. offices of the National Weather Service. The ultimate goal is to better prepare the public for tropical storms and hurricanes. Between conferences, the team's website -- <http://www.ecu.edu/riskcomm> -- provides information to officials and the public, including results of NCSG studies that led East Carolina University researchers to these ongoing partnerships with emergency managers. That study found that traditional sources for emergency information -- including television, radio and family/friends -- often were more trusted than the Internet websites. Also, about 10 percent of the population will not follow evacuation recommendations. More than 60 percent seek additional information when making a decision regarding evacuation. North Carolina has 20 counties in the coastal region that are considered most likely to have direct impacts from hurricanes and tropical storms.

- **Researchers determined that structural damage starts once waves reach floor joists**

Hurricane Ike destroyed several thousand small buildings in the Bolivar Peninsula in Texas — but left some structures intact. Sea Grant researchers partnered with scientists from Notre Dame University and the U.S. Geological Survey to determine why some buildings were destroyed while others were untouched. The team measured the elevation of the buildings found that serious structural damage starts once waves reach the floor joists in a building. By the time waves reach the top of the floor joists, the wood-frame building is often destroyed. However, the buildings that were elevated above the wave heights survived the storm. Sea Grant and its partners have combined to develop a database of about 2,000 homes that were surveyed after the storm. The results suggest that choosing a higher floor elevation is a primary safety factor for new construction in hurricane-resilient communities in coastal regions in North Carolina, around the country and beyond. The project was funded by the N.C. Division of Emergency Management.

- **North Carolina Sea Grant worked with partners during Hurricane Irene**

Sea Grant leveraged its relationships and connections to respond to North Carolinians' needs before, during and after for Hurricane Irene.

- **Wave gauges:** Before Irene, Sea Grant worked with partners to deploy wave gauges along the coast to record wave heights during the storm. After the storm, Sea Grant collaborated with the N.C. Floodplain Mapping Program and the N.C. Geodetic Survey to survey the gauges. The U.S. Geological Survey has incorporated the wave gauge data on their website, thus enabling better modeling for future storms.
- **CI-FLOW:** NOAA, Sea Grant and the National Severe Storms Lab collaborated with university researchers to develop and improve the Coastal and Inland Flooding Observation and Warning project, or CI-FLOW. This program models the water-related effects of a coastal storm. During Irene, some NWS forecasters incorporated information from this experimental system into their storm predictions.
- **Community response:** A Sea Grant extension specialist was a member of the Saltwater Connections Resource Team that had been reviewing needs of Hatteras Island communities prior to the storm, and continued to work with the communities after Irene hit. The project provided a framework for the communities to note the change in needs. Saltwater Connections grew out of a Sea Grant research project.

## Rhode Island Sea Grant

- **Rhode Island adopts guidelines for hurricane-proof building**  
Sea Grant, in collaboration with the Rhode Island Coastal Resources Management Council (the state's Coastal Zone Management agency), fostered adoption of policy and construction guidelines within the Rhode Island Builders Association, insurance, and real estate industries, to support the nation's first Coastal Zone Management Policy. The policy adapts construction guidelines to accommodate accelerated sea level rise resulting from climate change.
- **"Smart Growth" manual guides coastal development nationwide**  
Sea Grant, in collaboration with NOAA and US EPA, published and disseminated nationally the manual, [\*Smart Growth for Coastal and Waterfront Communities\*](#). This document provides guidance to coastal communities for planning based on smart growth principles that will help hurricane-proof coastal areas as well as aid in adapting to the impacts of changing climate.

## South Carolina Sea Grant

- **Beach Erosion and Research Monitoring (BERM) Program minimizes risk to people and property**  
South Carolina's beaches and coastal areas drive the state's tourism economy and are vital to maintaining economic well-being and coastal heritage. Shorelines are ever-changing with potentially large impacts to private property owners and local/state government. To help provide sound scientific information about coastal sediment dynamics and shoreline change, Sea Grant partners with Coastal Carolina University and local, state, and federal coastal management organizations to: manage a research and monitoring program documenting coastal management and shoreline change; and, conduct Regional Sediment Management studies which aim to pool resources to solve engineering problems, improve the environment and save money. BERM Program information is utilized by the state's beachfront management agency to determine setback distances for shoreline development and about 4,000 habitable structures within and near setback zones. Data collected by the BERM Program is incorporated into the U.S. Army Corps of Engineer's eCoastal enterprise GIS to enable data-sharing across management agencies and disciplines. The successful partnerships developed by the BERM Program have resulted in a cost-effective solution to data acquisition and interpretation, and increased resource communication and sharing across agencies. The BERM Program is providing coastal decision-makers with scientific information documenting shoreline change and the impacts of natural and anthropogenic forces. This information is critical to minimizing risks and reducing damage to people and property along the South Carolina coast.
- **Predicting residential building destruction from hurricane-borne debris**  
A South Carolina Sea Grant researcher is studying the impacts of wind-borne debris from hurricanes to determine if stricter regulations on building code (such as Florida Building Code regulations) should apply in South Carolina coastal regions. The project will: characterize the hurricane wind hazard of the coastal South Carolina regions using a current state-of-the-art hurricane simulation procedure; develop a framework for predicting failures of the building envelope, which includes the foundation, roof, walls, doors, and windows, due to damage from wind-borne debris and ultimately to assist in designing a hurricane-resistant home.

- **Roofs of Homes Strengthened by Tougher Building Codes**

Sea Grant researchers at Clemson University have created a computer model to test whether stronger building codes have improved the structural integrity of housing in coastal South Carolina. Builders in coastal areas are now required by code to attach a home's roof sheathing to rafters with additional nails, which is said to help prevent roof losses. The scientists created a model to test this; a model that simulates a Hurricane Hugo-sized (~Category 4) catastrophic storm hitting northern Charleston County the same location where Hugo made landfall in 1989. The massive storm was directed into a simulated subdivision including a few dozen homes built under today's more rigorous coastal construction code. The same storm was also directed through a similar simulated neighborhood but with homes built under typical construction practices of 1989. This Sea Grant research clearly demonstrates that current tougher building codes have made roofs stronger in high winds. If another storm the size of Hugo hit the coast today, there would be less roof failure and less debris because of improved roof construction practices.