

2019-2020 IMPACTS AND ACCOMPLISHMENTS

WEATHER AND CLIMATE RESILIENCE



IMPACTS

Folly Beach Adopts Suite of Ordinances to Improve Flood and Weather Resilience

Sarah Watson, S.C. Sea Grant Consortium

Recap: The city council of Folly Beach, South Carolina, with technical assistance provided by the S.C. Sea Grant Consortium, adopted a suite of land use and building code ordinances and marsh and beach management plans to improve the community's resilience to sea-level rise and other coastal hazards.

Relevance: The City of Folly Beach is a small barrier island community that faces a variety of coastal hazards, including sea-level rise (SLR). The city has worked with the S.C. Sea Grant Consortium (Consortium) for several years on understanding SLR risks and developing a comprehensive SLR action plan. In May 2018, council passed a six-month waterfront building moratorium. The city used this time to identify and discuss a suite of land use, zoning, and building code ordinances that would improve resilience in the near and long term (<https://www.cityoffollybeach.com/city-departments-services/building-planning-and-business-licenses/planning-documents/>).

Response: The city requested technical assistance from the Consortium on applying SLR projections to a suite of ordinances and building codes to improve the community's resilience. Folly Beach held multiple public hearings and discussions about the proposed ordinances, and in January 2019, the ordinances were formally introduced. As part of our outreach to coastal communities, the Consortium, in collaboration with Elko Consulting and the Carolinas Integrated Sciences and Assessments (CISA) program provided technical assistance on understanding how SLR affects community function. The Consortium made multiple public presentations about SLR to the planning commission and city council and led discussions on what the hazards mean to the island now and in the future. The Consortium also provided technical assistance on the development of a marshfront management plan, which was a key recommendation in a 2017 SLR plan.

Results: The city adopted the suite of eight land-use, zoning, and building code ordinances formally in April and May 2019. The city also formally adopted the Marsh Management Plan, which is the first of its kind in S.C., in May 2019.

Folly Beach Uses Story Map Created by S.C. Sea Grant Consortium to Help Prepare for Hurricane Dorian

Landon Knapp and Sarah Watson, S.C. Sea Grant Consortium

Recap: S.C. Sea Grant Consortium staff developed a Story Map for the City of Folly Beach illustrating flooding at various levels at a parcel level. The Story Map was initially for a public engagement event held in July 2019. As the city prepared for Hurricane Dorian, Consortium staff worked with city staff to interpret and translate for flooding potential due to the storm and connect what was illustrated with National Hurricane Center forecasts.

Relevance: S.C. Sea Grant Consortium has developed a long-term working relationship with the City of Folly Beach,

a barrier island municipality, regarding climate change and sea-level rise preparedness. The city requested S.C. Sea Grant Consortium's assistance to hold a flood engagement event at a family fun night in July 2019. This resulted in the development of a Story Map with high resolution bathtub mapping illustrating how the city would flood during specific water levels. In September 2019, as Hurricane Dorian was forecast to affect the city, city staff reached out to Consortium staff for assistance in translating the flood model to National Hurricane Center (NHC)/National Weather Service (NWS) forecasts.

Response: As the region was in the middle of an evacuation, S.C. Sea Grant Consortium staff helped interpret the flood map and connect the model with existing city emergency plans and policies. Consortium staff, while in the process of preparing to evacuate themselves, was able to do this remotely and connect with city staff and the city's engineering consultant to help them translate the datums used in the modeling, help city staff understand how the flood model could be used to interpret highly localized impacts based on the weather forecasts, and help connect to the proper NHC and NWS resources.

Results: The City of Folly Beach was prepared for the impacts of Hurricane Dorian through understanding the NOAA science and forecast products related to the storm and interpreted to their planning and mapping.

S.C. Sea Grant Consortium Provides Technical Assistance and Support for the City of Charleston's Dutch Dialogues Effort

M. Richard DeVoe, Sarah Watson, and Landon Knapp, S.C. Sea Grant Consortium

Recap: The City of Charleston partnered with the Water Institute and the Dutch Embassy to host a research and visioning event that would provide the city a new way to examine flooding problems. The S.C. Sea Grant Consortium worked with the College of Charleston to provide various data products and participated in the workshops, providing feedback and technical guidance.

Relevance: The City of Charleston is highly vulnerable to flooding from a variety of sources. Some parts of the city already are seeing frequent saltwater flooding due to sea-level rise and other parts of the city experience frequent freshwater flooding from heavy rain due to hydrology changes from decades of development. The city and the Charleston Resilience Network worked to bring the Dutch Dialogue team to Charleston, partnering with the Historic Charleston Foundation, The Nature Conservancy, and others.

Response: The Consortium assisted the College of Charleston with providing data products developed through other research that assisted the Dutch Dialogues team with understanding and visualizing flood vulnerabilities in the study areas selected by the city. The Consortium also participated in kick-off meetings and a week-long charrette held in July 2019, providing feedback and input as requested.

Results: The City of Charleston adopted the vision developed by the Dutch Dialogues team and the city also received two grants through the National Fish and Wildlife Foundation to implement several recommendations identified in the plan. The Consortium is a partner on both grants.

NOAA Resilience Grant Flood Modeling and Engagement

Sarah Watson and Landon Knapp, S.C. Sea Grant Consortium

Recap: The S.C. Sea Grant Consortium received a NOAA Regional Coastal Resilience Grant in 2016 on behalf of the Charleston Resilience Network to develop a parcel-level flood model and conduct neighborhood-level engagement

activities to ground-truth data and educate residents about flood risks. The flood methodology developed through the College of Charleston and the Consortium has been transferred to other parts of coastal S.C. In this reporting year, the Consortium conducted engagement events in Folly Beach and the Eastside neighborhood in the City of Charleston.

Relevance: The Charleston region is highly vulnerable to tidal flooding and flooding from heavy rain. Municipalities in the region need specific local data to better understand under what conditions flooding occurs so they can plan and respond effectively.

Response: As part of a NOAA Regional Coastal Resilience Grant and on behalf of the Charleston Resilience Network, S.C. Sea Grant Consortium and College of Charleston developed a flood modeling methodology over several years. The Consortium ground-truthed the methodology using a variety of methods, including community member participation at four engagement events because residents have much more on-the-ground knowledge of how and when flooding occurs in their neighborhoods. The first two events, which combined flood risk mitigation information with the ground-truthing, were held in 2018 and the final two were held in the City of Folly Beach and the Eastside neighborhood in the City of Charleston in July 2019. The Folly Beach event was a joint project with the city, bringing the mapping to a family fun night in a city park, with about 20 residents interacting with the maps. The Eastside event was planned in close coordination with the City of Charleston and served a community that has severe flooding problems, with about 10 residents attending.

Results: The flood modeling methodology developed was presented eight times at professional conferences spanning three states and six separate venues to a total of over 250 people. The infrastructure and streamlined methodology developed during the course of the project in the City of Charleston, S.C. facilitated the reproduction of this assessment for the City of Beaufort, S.C. at a fraction of the cost and time required for the initial project. Tidal and sea-level rise flooding and precipitation-based flood models, in addition to the necessary data inputs such as elevation and land cover classifications, were produced from scratch for the City of Beaufort at a cost to the city under \$15,000 and total time from implementation to final report and products of six months. These figures are at several scales of magnitude smaller than the initial project. The project provided the city with a comprehensive vulnerability assessment to flood hazards, which was presented to City Council and published on the city's website for public access.

Providing Coordination and Technical Assistance for the Beaufort County Sea Level Rise Task Force

Sarah Watson and Landon Knapp, S.C. Sea Grant Consortium

Recap: Beaufort County reconvened a Sea Level Rise Task Force and requested technical assistance from S.C. Sea Grant Consortium staff to further resilience planning and policy implementation. The Consortium helped translate sea-level rise and climate change science into local decision-making, helped facilitate meetings with local governments, and gave presentations to local elected officials. The Consortium also developed mapping analyses to assist task force members with decision-making.

Relevance: Beaufort County is comprised of sea islands, barrier islands, and tidal creeks that extend far inland. It has substantial vulnerabilities to flooding and sea-level rise. As such, the county has worked with the Consortium since 2012 on sea-level rise planning. The Consortium developed, in partnership with the Carolinas Integrated Sciences and Assessments, a sea-level rise action plan for the county in 2015. The recommendations from the plan were incorporated in the county's comprehensive plan. As the county revises its comprehensive plan, it wanted to

highlight how sea-level rise planning could be further implemented and integrated.

Response: Consortium staff participated and facilitated meetings, gave presentations to local governing bodies, and helped provide expert guidance on how to incorporate sea-level rise projections into local codes and ordinances. Staff also used sea-level rise data layers developed during the City of Beaufort Flood Vulnerability Assessment to analyze the parcel impacts in Beaufort County, S.C. due to sea-level rise. Consortium staff collaborated with the Information Technology Department of Beaufort County to perform spatial intersections of high-resolution flood layers and property parcel data sets obtained from the county. The Consortium leveraged its longstanding relationship with the College of Charleston's Lowcountry Hazards Center to perform the data processing of the analysis, as the demands were too great for the county to perform in-house.

Results: The county is developing a new Sea Level Rise Action Plan that highlights specific steps the county can take to increase resilience throughout county policy. The task force now includes members from all municipalities with the goal that all municipalities will adopt a similar plan for regional cohesion. The mapping analysis resulted in an easy-to-use database of properties impacted by increasing levels of sea-level rise in Beaufort County, S.C., and the database is being utilized to guide the promulgation of two new ordinances restricting development in hazard-prone areas.

ACCOMPLISHMENTS

Adding Stakeholder Input to U.S. Army Corp of Engineers' South Atlantic Coastal Study

Landon Knapp, S.C. Sea Grant Consortium

Recap: Engineers, managers, and planners designing solutions to mitigate the impact of coastal flooding from storm surge in South Carolina will rely on technical data in the U.S. Army Corps of Engineers' (USACE) South Atlantic Coastal Study (SACS). The S.C. Sea Grant Consortium devised a web application to gather input from local experts and municipal officials and expand the study's data collection points to include chronic flooding locations.

Relevance: The impact of tidal flooding on coastal communities of South Carolina has grown in recent years, with three of the highest-recorded tide heights having occurred between 2015-2017. To aid communities with technical data to inform "coastal storm damage solutions to reduce wave attack, provide flood protection, and create robust environments that can provide a buffer to coastal flooding," the USACE is conducting a study to produce these data products. While the regional effort is designed to provide highly detailed and technical information, those data are provided for points on a map distributed across the entire Southeast U.S. and not necessarily coinciding with areas on the ground where they are needed most.

Response: S.C. Sea Grant Consortium developed a web application to display the locations the USACE planned to collect data and provided a simple point and click method of adding locations based on local expert knowledge. The application was designed for use by non-technical personnel and opened to administrators throughout coastal South Carolina to allow them to add areas they would like to have technical data coming out of the study. Consortium staff additionally used the results of a tidal flood modeling initiative in Charleston County to add collection points near critical infrastructure and residences likely to experience impacts based on those flood maps.

Results: Using the custom web application, administrators and Consortium staff added 175 additional points for data collection by the USACE study. Points were added in five of the eight counties in the coastal zone of South

Carolina and included areas with known tidal flooding issues, roads, and other infrastructure critical to municipal operations and emergency management, and areas where administrators desired knowledge on the extent and depth of the flood hazard. Results from this study will provide highly detailed and technical data to municipal staff for their use in mitigating flood hazards in the areas of highest need.

City of Beaufort, S.C. Flood Vulnerability Analysis

Landon Knapp and Sarah Watson, S.C. Sea Grant Consortium

Recap: In response to a request from the City of Beaufort, S.C. for help developing a comprehensive approach to addressing flooding issues, S.C. Sea Grant Consortium formed a collaborative team with the Carolinas Integrated Sciences and Assessments and the College of Charleston to model flood hazards and develop a report detailing the vulnerabilities of critical infrastructure.

Relevance: The City of Beaufort is at risk to tidal flooding, storm surge, and high-intensity rain events, which have increased in frequency and severity in recent years as local sea-level rise has reached 0.13 inches per year. Recognizing these threats, city administrators reached out to S.C. Sea Grant Consortium staff with the goal of developing a comprehensive approach to addressing flooding issues in the city.

Response: S.C. Sea Grant Consortium staff formed a collaborative team with researchers at our member institutions dedicated to understanding how vulnerable the City of Beaufort's assets are to tidal- and precipitation-based flooding. The highest-resolution base data products ever generated for the area were created to power flood models developed to identify exposure vulnerabilities to each flood hazard. An assessment was conducted for the entire city as well as for areas identified by city staff as "challenged" with known drainage issues. Flood maps and mapping data sets were delivered to city staff.

Results: A final report was produced by the project team, led by Consortium staff, detailing the methods and results of the vulnerability assessment as well as the historical and projected future trends of climate change hazards for the area. The full report has been published on the city's website (<http://www.cityofbeaufort.org/494/November-2019-Flood-Vulnerability-Assess>) as well as the Consortium's website (<https://www.scseagrant.org/flood-vulnerability-assessment-city-of-beaufort-sc>). The city invited Consortium staff to present the results of the study to a City Council work session and assist them as they take steps to address flood vulnerabilities. A news article was published detailing the report and the upcoming work session, which resulted in an attendance of approximately 60 people. The city agreed to openly share flood maps and data produced for this analysis with Beaufort County to guide a task force aimed at promulgating regulations for development restrictions in areas vulnerable to sea-level rise impacts.

Providing Expertise to Guide Charleston, S.C. All-Hazards Vulnerability and Risk Assessment

Landon Knapp, S.C. Sea Grant Consortium

Recap: S.C. Sea Grant Consortium provided expert consultation and foundational data sets in flood hazard assessment and facilitated engagement with subject matter experts in earthquake vulnerability assessment at our member institutions to inform an all-hazards vulnerability and risk assessment performed for the City of Charleston, S.C.

Relevance: Due to its geographic location and low relief, the City of Charleston is vulnerable to a wide range

of environmental hazards, from sea-level rise and high-intensity rain events to major earthquakes. In order to incorporate these hazards into the city's planning and management, a vulnerability and risk assessment was conducted, which the city views as its best chance to unify all facets of its operations around mitigating these threats.

Response: S.C. Sea Grant Consortium staff worked with the consultants hired by the City of Charleston to ensure the highest quality data and methodologies were employed during the project. Consortium staff provided flood hazard data sets which were produced during previous initiatives and brought in experts at a member institution, the College of Charleston, to advise on the earthquake hazard for the area. Those data and consultations exchanged between the consultants, Consortium staff, and experts at our member institutions were critical in the successful completion of the Vulnerability Assessment and the lasting utility of its results.

Results: This report has not been released yet but is expected in the coming year.

Developing a City of Charleston Flood Monitoring Application

Landon Knapp, S.C. Sea Grant Consortium

Recap: S.C. Sea Grant Consortium staff worked with technical experts at the College of Charleston to develop and host a flood monitoring application to allow users to collect photos and document characteristics of flood waters in the City of Charleston, S.C. to better inform flood mitigation efforts.

Relevance: The City of Charleston, S.C. benefits from a wide array of initiatives aimed at mitigating the recurrent flooding stemming from sunny-day tidal floods and "rain bombs" overwhelming stormwater infrastructure. What is lacking among the entities working in the city, based on requests received by the Consortium, is a way to check the accuracy of data and computer simulations of flooding against actual flood events that have occurred on the peninsula.

Response: Working with technical experts at the College of Charleston, S.C. Sea Grant Consortium staff developed a flood monitoring application designed to allow residents of the City of Charleston to upload photos of flooding from their hand-held devices from anywhere in the city in real time. The application was designed to be easy-to-use by anyone interested in contributing information and allows the option of additionally contributing contextual information such as cleanliness of flood waters or condition of adjacent storm drains. A professor at the College of Charleston is recruiting and maintaining students to participate in photo collection. Data are being used to validate flood models produced collaboratively between the Consortium and the College of Charleston and will be shared with any entity interested in the final products. More information on the application and its use can be found in an article detailing its release (<https://today.cofc.edu/2019/09/16/lowcountry-hazards-center-project-aims-to-dry-up-area-flooding/>).

Results: A flood impacts application was created and used both for research at the College of Charleston and by the City of Charleston to locate areas of concern.

S.C. Sea Grant Consortium Partnership to Develop and Deliver High-Resolution Land Use/Land Cover Data Products for the Coast of South Carolina

Landon Knapp and Sarah Watson, S.C. Sea Grant Consortium

Recap: Staff of the S.C. Sea Grant Consortium collaborated with the College of Charleston and National Oceanic and

Atmospheric Administration's Coastal Change Analysis Program (C-CAP) team to develop the highest-resolution land cover data ever created for the coast of South Carolina in order to power environmental modeling in the state.

Relevance: Geospatial modeling, and flood hazard modeling in particular, in the coastal lowcountry of South Carolina requires high-resolution mapping products to perform accurately. Despite the need for those data, one of the most foundational base data sets for hazard modeling, land use/land cover, had never been made publicly available at a resolution fine enough for high-resolution mapping in the area.

Response: A collaboration was formed between the S.C. Sea Grant Consortium, the College of Charleston's (CofC) Lowcountry Hazards Center (LHC), and the National Oceanic and Atmospheric Administration's Coastal Change Analysis Program (C-CAP) to develop and deliver the highest-resolution land use/land cover data products ever created for the coast of South Carolina. The collaborative team designed a work flow that relies on significant contributions from the C-CAP staff as well as the Consortium and the CofC to develop a composite final product for use by the general public. Using newly acquired software for the project and adapting techniques developed by the C-CAP team, staff at the Consortium and the CofC are developing one-meter resolution land cover data for the eight counties in the coastal zone of South Carolina.

Results: These data enhance the resolution of any prior product 30-fold and will be made available on NOAA's Digital Coast in the fall of 2020.

S.C. Sea Grant Consortium Fosters Professional Engagement through the Southeast and Caribbean Climate Community of Practice

Sarah Watson, S.C. Sea Grant Consortium

Recap: The S.C. Sea Grant Consortium organized, with partners, the 2019 Southeast and Caribbean Climate Community of Practice Workshop. Sixty-eight attendees learned and discussed issues related to climate change impacts in the region. The Consortium led an interactive session titled "What Does Adaptation Look Like," which was intended to give participants the opportunity to brainstorm specific steps for implementing resilient measures.

Relevance: The Southeast and Caribbean Climate Community of Practice (CCoP) brings together individuals from local, state, and federal governments, academia, non-profit organizations, and the private sector in the Southeast U.S. (NC, SC, GA, FL, and Puerto Rico) to apply climate science and assess how coastal communities and ecosystems can adapt to the impacts of climate variability and change. The S.C. Sea Grant Consortium (Consortium), in partnership with the Carolinas Integrated Sciences and Assessments (CISA) program, has fostered momentum for the CCoP since 2014.

Response: The Consortium assisted the CCoP with hosting an in-person workshop April 1-3, 2019, which was held in Wrightsville Beach, N.C., with 68 attendees.

Results: Attendees learned about the latest science of how climate change is and will impact the Southeast and Caribbean region, discussed lessons learned and best practices in preparing for, responding to, and recovering from extreme events, including hurricanes Florence, Irma, Maria, and Matthew, discussed opportunities for incorporating climate adaptation strategies into medium- and long-term planning, and explored communications strategies for engaging community members about extreme events. The Consortium led an interactive session titled "What Does Adaptation Look Like," which was intended to give participants the opportunity to brainstorm specific steps for implementing resilient measures. The workshop final report is found here: <https://seaccop.files.wordpress>.

com/2019/05/2019-final-workshop-report-.pdf.

Panel on Emotional Well-Being for Climate Workers is Transferred to Feature in *Eos*, *Science News* by AGU (American Geophysical Union) and a *Union Session* at AGU Conference

Sarah Watson, S.C. Sea Grant Consortium

Recap: The S.C. Sea Grant Consortium organized and sponsored a special session at the Climate Predictions Applications Sciences Workshop (CPASW) on emotional well-being and empathy fatigue.

Relevance: As climate change and related effects become more pronounced, those working in the weather climate enterprise are experiencing an increasing rate of burnout and emotional fatigue related to their jobs. Preliminary research by Susanne Moser, Ph.D., has found that nearly 90 percent of extension and climate first-responder professionals report experiencing burnout compared with only 40 percent of those in other professions.

Response: The Consortium organized and sponsored a special session at the Climate Predictions Applications Sciences Workshop (CPASW) in June 2019 on emotional well-being and empathy fatigue. The session included a keynote address by Moser, who is leading a multi-disciplinary project called the Adaptive Mind, which in part is to help study and then train climate extension professionals in addressing emotional well-being involving their jobs. The panel comprised of a range of people working in the field, including a climate scientist, an extension specialist, and meteorologists for private enterprise and a federal agency. The team followed up by writing an article for the AGU's journal, *Eos*, addressing how those in the weather climate enterprise can begin to develop support systems and address the growing emotional drain from this work. The team was invited and presented the content in a Union Session panel at the 2019 AGU annual meeting in San Francisco.

Results: The article, "The Emotional Toll of Climate Change on Science Professionals," was published in *Eos* December 6, 2019. The Union Session panel was held at the AGU annual meeting, December 9, 2019 in San Francisco.

Examining Impacts of Climate Change on Vulnerability and Function of Stormwater Ponds in Coastal South Carolina

Shaowu Bao, Coastal Carolina University

Recap: A two-phase study by S.C. Sea Grant Consortium researchers developed a model for simulating and forecasting coastal and inland rainfall and flood events and the impact on stormwater management ponds (SMPs). The model simulations indicate that the highest risk SMPs along the South Carolina coast are Winyah Bay, Mt. Pleasant, Charleston Harbor, and Hilton Head Island. Statewide, the risk increases from approximately 208 SMPs at risk from high tide flooding to more than 1,700 at risk from a 100-year storm surge.

Relevance: Stormwater management ponds (SMPs) are recognized as serving both water quantity and water quality through collecting the first flush of rainwater runoff and sediment and contaminants. The SMPs function of stormwater control and flood protection, however, may be challenged under future climate-change scenarios, especially sea-level rise (SLR). The combined effect of projected SLR and more extreme rainfall is anticipated to amplify both the effect of SLR on the extent of inundation and inland flooding caused by rainfall. Little has been studied to date about the ability of stormwater ponds to mitigate potentially increased flooding from SLR and rainfall.

Response: Through a two-phase mini-proposal, S.C. Sea Grant Consortium researchers at Coastal Carolina University assessed how projected SLR and increased rainfall due to climate change may impact the state's residential stormwater ponds.

Results: Phase one resulted in development of an atmosphere-ocean-hydrology-hydraulic coupled model for simulating and forecasting coastal and inland rainfall and flooding events. Phase two simulated SLR inundations and the impacts on SMPs affected during non-storm and storm conditions were assessed. Statewide, under current climate conditions, a non-storm high tide could inundate approximately 208 SMPs. The number would increase sharply for stronger hurricanes, reaching more than 1,700 SMPs for a 100-year storm surge. SMPs near Winyah Bay, Mt. Pleasant, Charleston Harbor, and Hilton Head Island are at the greatest risk from future SLR scenarios..

S.C. Sea Grant Consortium Researchers Visualize Sea-Level Rise Impacts to Stormwater Ponds

Jean Ellis and Erik Smith, University of South Carolina

Recap: An online stormwater pond visualization tool (<http://arcg.is/0m1Ob8>) was developed by S.C. Sea Grant Consortium researchers to predict impacts of sea-level rise (SLR) out to 2045 given current stormwater pond distribution. There is tremendous variability among counties with respect to the percentages of ponds vulnerable to SLR, as well as the rate at which pond vulnerability increases with increasing SLR, and that residential ponds tend to be proportionately more vulnerable than other pond types.

Relevance: Stormwater ponds are constructed systems engineered to meet the stormwater management requirements associated with development or other land disturbing activities. They are designed to receive and retain a substantial portion of the hydrologic flow before being discharged into coastal water bodies, and are by far the most frequently used stormwater management practice in coastal S.C. Understanding the relationship between stormwater ponds and future coastal inundation is critical so people can understand risk and make informed decisions about future development.

Response: Through a two-phase mini-proposal, S.C. Sea Grant Consortium researchers at the University of South Carolina updated a stormwater pond inventory in the Charleston and Myrtle Beach areas, including both elevation and NOAA sea-level rise (SLR) data to ultimately provide an online visualization tool predicting impacts of SLR out to 2045 given current stormwater pond distribution.

Results: The tool (<http://arcg.is/0m1Ob8>) displays 11 mapped scenarios of SLR from current sea level to 10 feet, viewable from county-scale to individual pond scale. Various scales allow the user to determine under which sea-level rise scenarios ponds are impacted, defined as disruption to the hydraulic head of the pond, because at that point stormwater mitigation is no longer occurring. Study results indicate there is tremendous variability among counties with respect to the percentages of ponds vulnerable to SLR, as well as the rate at which pond vulnerability increases with increasing SLR, and that residential ponds tend to be proportionately more vulnerable than other pond types.

S.C. Sea Grant Consortium Researchers Analyze Multi-Hazard and Multi-Impact Data for Stormwater Pond Managers

Erfan Goharian, University of South Carolina

Recap: Coastal natural hazard vulnerability maps are a low-cost and viable management alternative for assessing

the impacts of sea-level rise on stormwater management ponds.

Relevance: In South Carolina, floods are multi-hazard, multi-impact, and multi-day events. Within the interactions of inland flooding, coastal flooding, and sea-level rise (SLR), stormwater management ponds play a significant regulatory role as the primary best management practices (BMP) utilized in regional flood control programs. While stormwater management ponds intended to reduce flood hazard, their functionality within multi-hazard and multi-impact contexts is still relatively unknown, especially in the coastal areas.

Response: Through a two-phase mini-proposal, S.C. Sea Grant Consortium researchers at the University of South Carolina proposed to better understand historical trends of inland flooding and SLR; identify the effects of inland and coastal floods and SLR on stormwater pond management; and identify variable effects of flood hazards on ponds.

Results: Researchers generated coastal natural hazard vulnerability maps that describe geographic locations and classes of ponds that are most at risk to SLR and provide useful information for land-use decision-making and infrastructure development in coastal environments to maintain the ecosystem services these ponds provide. If one foot of SLR is achieved by 2050, it is expected that Charleston and Beaufort will lose over 3% and 4% of their total number of ponds, respectively. For both counties, these losses will consist mainly of ponds in rural and residential areas.

S.C. Sea Grant Consortium Researchers Analyze Economic Impacts of Natural Resources in Coastal Counties

Puskar Khanal and Thomas Straka, University of South Carolina

Recap: S.C. Sea Grant Consortium-funded researchers estimated total value of ecosystem services provided by tidal marshes in coastal South Carolina alone at \$4.3 billion annually.

Relevance: Very few studies have attempted to quantify economic contributions of coastal marshes, wetlands, and tidal creeks to communities, businesses, and individuals in South Carolina. It is critical to have recent data and analysis related to economic and societal values of salt marshes to support initiatives that would encourage additional protection and preservation of coastal marshes and wetlands in South Carolina.

Response: S.C. Sea Grant Consortium researchers proposed identifying and assessing the status of key ecosystem services provided by S.C.'s coastal marshes and wetlands and estimating gross economic value provided by the coastal marshes and wetlands in South Carolina.

Results: The study estimated the total value of ecosystem services provided by tidal marshes in South Carolina at \$4.3 billion annually. It also established baseline economic impact information for the forestry sector in the eight coastal counties in South Carolina, and related factsheets are available for download at <https://www.clemson.edu/extension/timber-market/>. Additionally, forestry economic impact models for the eight coastal counties will be made available.
