



# 2018-2019 IMPACTS AND ACCOMPLISHMENTS

## WEATHER AND CLIMATE RESILIENCE

### IMPACTS

#### Consortium Partners with City of North Charleston on First Community Flood Engagement

**Sarah Watson, S.C. Sea Grant Consortium**

**Recap:** The S.C. Sea Grant Consortium (Consortium) partnered with the City of North Charleston to host the city’s first-ever flood expo, which incorporated maps from new flood modeling and services from multiple entities to help residents learn how to reduce their risk and improve preparedness.

**Relevance:** Flooding during the record-breaking 2015 rain event and associated with tropical systems in 2016 and 2017 hit residential communities in North Charleston particularly hard. The Consortium and its partners worked with city officials to coordinate the city’s first flood expo to introduce residents to resilience efforts and mitigation resources available to them. At the same time, residents at the expo helped Consortium partners ground-truth detailed flood maps.

**Response:** The Consortium and Carolinas Integrated Sciences and Assessments (CISA) worked with the City of North Charleston and the College of Charleston to plan and put on an expo-type engagement event for residents of neighborhoods near Filbin Creek. The event included 35 other partners that provided resources and services to residents to learn about flood risks, reduce their individual risks, improve personal resilience, and provide feedback to the College of Charleston’s flood model and to the city regarding problems and expectations. Nearly 70 residents and stakeholders attended the event.

**Results:** The City of North Charleston used the event to highlight flooding issues throughout city government and used the final report from the event to springboard efforts within the city to begin planning for flood risks. The mayor highlighted the topic and specifically named the Consortium in the State of the City address in January 2019.

## Folly Beach Develops and Proposes a Suite of Ordinances to Improve Flood and Weather Resilience

**Sarah Watson, S.C. Sea Grant Consortium**

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

**Relevance:** The City of Folly Beach is a small barrier island community that faces a variety of coastal hazards, including SLR. The city has worked with the Consortium for several years on understanding risks and developing a comprehensive SLR action plan. In May 2018, 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.

**Response:** 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:** Following the city council's adoption of the SLR plan in 2017, council passed a six-month waterfront building moratorium in May 2018. 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/>). Folly Beach held multiple public hearings and discussions about the proposed ordinances, and in January 2019, the ordinances were formally introduced and went into effect during the formal adoption process that continued well into 2019. City officials continue to be engaged in projects and programs with the Consortium.

## ACCOMPLISHMENTS

### Flood Preparedness Event Connects Town of Mount Pleasant Residents with Local Officials

**Sarah Watson, S.C. Sea Grant Consortium**

Town of Mount Pleasant officials want to help residents improve resilience to weather and climate-related hazards. The S.C. Sea Grant Consortium (Consortium) planned, developed, and co-hosted a neighborhood-level flood education expo on November 8, 2018 as part of broader resilience outreach efforts and also to test various engagement methods rooted in risk communication best practices. The event served multiple purposes, including to ground-truth Consortium-funded research and to help the Town of Mount Pleasant develop a highly localized community hazard preparedness model.

The event drew 17 town employees and 35 residents and stakeholders attended. This work is funded through a NOAA Regional Coastal Resilience Grant and is connected to the development of a parcel-level flood model that links tidal and stormwater to give a more realistic view of what happens during storms. The Town of Mount Pleasant will use the design of the event the Consortium created in multiple other neighborhoods as part of an expanded coastal hazards outreach and engagement effort.

## Outreach Rooted in Effective Risk Communication Educates S.C. Residents about Weather and Climate Hazards and Resilience

### **Sarah Watson, S.C. Sea Grant Consortium**

S.C. Sea Grant Consortium (Consortium) climate resilience outreach educated 934 residents and stakeholders about flooding risks, sea level rise, and extreme weather while also teaching some stakeholders how to improve their risk communication methods. Presentations ranged from in-depth work sessions for stormwater management extension personnel in Beaufort County to short presentations for interested residents in coastal communities.

The Consortium assisted with training 32 community stakeholders on risk communication best practices and spoke to the Folly Beach planning commission and the Harbor Island homeowner's association about sea level rise and coastal hazards. The consortium also spoke at five regional and national conferences about engagement work in S.C., including the Restore America's Estuaries summit, the Carolinas Climate Resilience Conference, the S.C. Association of Hazard Mitigation annual conference, and the Extension Disaster Education Network annual conference. The Consortium also participated in a multi-day hazard expo hosted by Charleston County.

Flooding causes substantial disruption in S.C. coastal communities. Understanding flood risks, how flooding may change in the future, what communities can do to reduce risks, and how to more effectively communicate about these risks is essential to improving hazard resilience. The Consortium developed and delivered presentations of varying length and content detail to an array of multi-disciplinary audiences, ranging from coastal homeowners and residents to decision-makers and municipal staff.

## S.C. Sea Grant Consortium Assists National Weather Service with Local Knowledge on Flooding and Hurricane Florence Effects

### **Sarah Watson, S.C. Sea Grant Consortium**

The Consortium assisted the National Weather Service (NWS) with local knowledge and outreach on flooding effects in the Charleston forecasting region and served as a consultant on the Hurricane Florence service assessment.

Tidal flooding causes substantial disruption in S.C. coastal communities. Understanding what floods when helps the NWS better understand how to issue advisories and warnings. Connecting the NWS with S.C. Sea Grant Consortium's partners and on-the-ground knowledge helped the NWS better understand tidal flooding effects as municipal infrastructure upgrades reduce flooding in areas and as the NWS works toward potentially changing thresholds for advisories and warnings.

The Consortium also provided expert local context during interviews for the Hurricane Florence service assessment, which helped the NWS better understand root causes of problems and best practices unveiled by the event. The S.C. Sea Grant Consortium provided dozens of photographs taken during high impact coastal floods, and the images were used by the NWS to understand flooding thresholds. The Consortium assisted the Hurricane Florence Service Assessment team by identifying key stakeholders to interview, sitting in on interviews and asking questions that NWS team members from outside the region would not have known to ask. The Consortium then helped NWS team members synthesize key findings from the interviews.

The Consortium also assisted with outreach connected to the CoCoRaHS program, helping connect potential new participants with the program.

## S.C. Sea Grant Consortium and Charleston Resilience Network Foster Collaboration in Region Through a Series of Coffee Hours

### **Vanessa Martin, S.C. Sea Grant Consortium**

The Charleston region is prone to a variety of natural hazards, including severe flooding, earthquakes, hurricanes, and sea level rise. As such, there are many organizations in the region with initiatives and projects that focus on increasing the resilience of the area, especially with respect to flooding. If these initiatives and projects are going to be successful in the long run, we must focus on collaboration between organizations.

To this end, the Charleston Resilience Network, a multi-sector network organized by 28 committee members representing 21 organizations from state and federal agencies, academia, non-governmental organizations, and small businesses, hosts bi-monthly coffee hours to provide professionals an opportunity to share what they are doing within the realm of resilience, and to offer ways other organizations can collaborate with them or volunteer for various initiatives.

Held early mornings before typical business hours, the coffee hours allow attendees to hear up to three resilience-focused presentations, after which attendees are encouraged to network. During this reporting period, four Coffee Hour events were held with an average attendance of 23 individuals and a total attendance of 93 individuals. The coffee hours are organized by the S.C. Sea Grant Consortium's Charleston Resilience Program coordinator.

## S.C. Sea Grant Consortium and Charleston Resilience Network Foster Collaboration in the Charleston Region Through the Charleston Resilience Network Expo

### **Vanessa Martin, S.C. Sea Grant Consortium**

The Charleston region is prone to a variety of natural hazards, including severe flooding, earthquakes, hurricanes, and sea level rise. As such, there are many organizations in the region with initiatives and projects that focus on increasing the resilience of the area, especially with respect to flooding. If these initiatives and projects are going to be successful in the long-run, we must focus on collaboration between organizations.

To this end, the Charleston Resilience Network (CRN) hosted a Network Expo to provide professionals an opportunity to share what they are doing within the realm of resilience and to offer ways other organizations can collaborate with them or volunteer for various initiatives. The gathering of 45 representatives from some of CRN's more than 200 participating organizations aimed to foster a unified strategy and provide a forum to share science-based information, educate stakeholders, and enhance long-term planning decisions that result in resilience. Event participants were encouraged to network freely while viewing exhibitions from 10 community resilience leaders from the private, university, and non-governmental organization sectors. This Network Expo was organized by the S.C. Sea Grant Consortium's Charleston Resilience Program coordinator.

## S.C. Sea Grant Consortium Solicit Concepts for Flooding Resilience Web Applications Via a Hackathon Event

### **Vanessa Martin and M. Richard DeVoe, S.C. Sea Grant Consortium**

The Charleston region is prone to a variety of natural hazards, including severe flooding, earthquakes, hurricanes, and sea level rise. As such, there are many web-based resources for the region that focus on increasing the resilience of the area, especially with respect to flooding. Despite this, there is no centralized portal to route Charleston stakeholders to these disparate tools and resources. For these online resilience resources to be most successful, efforts should be made to document and aggregate all Charleston-relevant flooding resources in a centralized portal.

The S.C. Sea Grant Consortium (Consortium), the College of Charleston Department of Computer Science, and Charleston-based software company BoomTown hosted a hackathon event at

the BoomTown office to support the development of information-delivery products designed to empower Charleston stakeholders to make informed, proactive decisions in the face of coastal hazards and create a more knowledgeable and resilient community. Funding and support for this event were provided by the U.S. Department of Homeland Security, National Protection and Programs Directorate, Office of Infrastructure Protection, through the National Infrastructure Protection Program Security and Resilience Challenge, which is implemented by the National Institute for Hometown Security.

This event was attended by 136 individuals from various sectors of the Charleston community. Consortium staff gave three presentations during the event. Seven teams of two to six members competed to develop the winning web resource for Charleston flooding resilience. The winning team was hired to further develop their web resource for public release in Summer 2019. This event was organized by the Consortium's Charleston Resilience Program coordinator.

## S.C. Sea Grant Consortium Hosts a Focus Group to Gather Information On Multi-Hazard Indices and Tools for Coastal Resilience

### **Kelsey McClellan and M. Richard DeVoe, S.C. Sea Grant Consortium**

The Charleston region is prone to a variety of natural hazards, including severe flooding, earthquakes, hurricanes, and sea level rise. As such, a clear understanding of the various multi-hazard indices and tools that exist is critical for the implementation of successful resilience efforts in the region. To understand the current community knowledge base with regards to multi-hazard resilience indices and tools, efforts must be made to solicit and document diverse stakeholder information on the topics.

The S.C. Sea Grant Consortium (Consortium) hosted a focus group to identify the community needs and state of knowledge with regards to multi-hazard indices and tools implemented in the Charleston region for coastal resilience. Forty-two stakeholders from federal, state, and local agencies, the local private sector, and neighborhood organizations participated in a series of engagement exercises (i.e. interviews and discussions) to identify their awareness and understanding of hazard-related issues, level of preparedness, and critical infrastructure information needs. Two presentations were given by Consortium staff.

The synthesized results from this event informed the scope a Charleston flooding resilience web resource under development with an anticipated public release of Summer 2019. Funding and support for this event were provided by the U.S. Department of Homeland Security, National Protection and Programs Directorate, Office of Infrastructure Protection, through the National Infrastructure Protection Program Security and Resilience Challenge, which is implemented by the National Institute for Hometown Security. This event was organized by the Consortium's Charleston Resilience Program coordinator.

## S.C. Sea Grant Consortium Helps Create Public Health Risk Assessments of Vulnerable Water Infrastructure in Coastal Cities

**Susan Lovelace, S.C. Sea Grant Consortium**

Coastal infrastructure is becoming increasingly vulnerable to hazards including extreme precipitation events, stronger storm surge, riverine flooding, and rising seas. Despite the intimate connection between infrastructure and public health, few local communities have made the effort to bring the public works, emergency management, and public health sectors together to assess the susceptibility of their most vulnerable populations to health risks.

The S.C. Sea Grant Consortium (Consortium) and its partners developed a manual, *Susceptibility of Public Health Impacts from Flooded Water, Wastewater and Public Health Infrastructure* (January 2019), and a tool to assist communities with their assessment. Developed through interview, survey, and field testing with the local health, emergency management, public works, and planning sectors, table-top exercises in Charleston (2017) and in Morehead City (2018) brought together participants from these sectors to test a protocol and a tool to assess the exposure, vulnerability, and susceptibility of their community to a storm scenario based on past storms and anticipated sea level rise. The tool also allows communities to easily identify actions they can take to improve their resilience.

This approach promoted discussion across the health, water utilities, emergency management, and planning sectors, and interactions revealed the value of working together to solve problems and increase resilience. The manual and tool are available from the Consortium online and through a workshop. This project was funded by NOAA's Climate Program Office FY15 Federal Funding Opportunity in the Coastal and Ocean Climate Applications (COCA) competition Supporting Resilient Coastal Communities and Ecosystems in a Changing Climate: Understanding climate-related human health risks within the coastal environment.

## Consortium Provides Leadership to Extension Disaster Education Network

**Susan Lovelace, S.C. Sea Grant Consortium**

The S.C. Sea Grant Consortium provides leadership to the Extension Disaster Education Network (EDEN) through the executive committee, sharing best practices at the annual meeting, and providing resilience-related risk communications training via EDEN professional development webinars for delegates. The Assistant Director for Development and Extension serves as the liaison for the Sea Grant Extension Assembly to the EDEN Executive Committee, participating in executive team meetings and serving on the professional development committee.

Consortium staff also attend the annual meeting to share results of the project valuable to both Sea Grant and U.S. Department of Agriculture Extension programs. Staff present webinars and serve as consultants to delegates as needed. During the October 16-18, 2018 annual meeting in

College Station, Texas, the Climate and Resilience Specialist shared a presentation entitled “Engaging Neighborhoods to Better Plan for Flooding Disasters ” and the Assistant Director presented a poster with examples of Sea Grant College Programs’ regional resilience activities around the nation.

## S.C. Sea Grant Consortium Researchers Examine Impacts of Climate Change on Vulnerability and Function of Stormwater Ponds in Coastal South Carolina

**Shaowu Bao, Coastal Carolina University**

Stormwater ponds (SWPs) are designed to manage water quantity and water quality through collecting the first flush of rainwater runoff, along with sediment and contaminants. However, the efficiency and effectiveness which SWP offer in stormwater control and flood protection 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 SWPs to mitigate potentially increased flooding from SLR and rainfall. Through a two-phase mini-proposal, S.C. Sea Grant Consortium researchers at Coastal Carolina University are assessing how projected SLR and increased rainfall due to climate change may impact the state’s residential SWPs. Phase one has resulted in development of an atmosphere-ocean-hydrology-hydraulic coupled model for simulating and forecasting coastal and inland rainfall and flooding events. The effect of the SWPs has been parameterized in the model system based on previous survey data and a two-year simulation that included two recent major hurricanes.

Simulation results were validated against U.S. Geological Survey streamflow gauge data, and indicate that the amount of water entering river channels decreased slightly with the presence of SWPs. Basin-scale impacts on water budgets and streamflow was not drastic, though local-scale impacts were significant. This is reasonable for a river basin such as the Waccamaw River, whose surrounding land use is mostly rural and forested. Researchers will continue to test the model in the next project phase.

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

**Jean Ellis and Erik Smith, University of South Carolina**

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 we can understand risk and make informed decisions about future development.

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 sea level rise (SLR) data to ultimately provide an online visualization tool predicting impacts of SLR out to 2045 given current stormwater pond distribution. The tool 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 SLR scenarios ponds are impacted, defined as disruption to the hydraulic head of the pond, because at that point stormwater mitigation is no longer occurring. Phase II of the study will model future proliferation of ponds in the visualization tool and develop a trend analysis.

## S.C. Sea Grant Consortium Researchers Analyze Multi-hazard and Multi-impact Data for Stormwater Pond Managers

**Erfan Goharian, University of South Carolina**

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 are intended to reduce flood hazard, their functionality within multi-hazard and multi-impact contexts is still relatively unknown, especially in the coastal areas.

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. Analysis of historical data demonstrates that SLR has an increasing trend while rainfall is stationary overall, and also projects that an increase from one foot to five feet in SLR will result in a ten-fold increase in the number of ponds that will be submerged.

## S.C. Sea Grant Consortium Partners with the College of Charleston to Enhance Coastal Resilience Programming to Meet Growing Community Demand

**M. Richard DeVoe, S.C. Sea Grant Consortium**

Over the past five years, the S.C. Sea Grant Consortium's efforts to address the growing needs of our coastal communities in light of chronic (e.g., sea level rise) and episodic (hurricane; storm) hazards related to flooding have been constrained due to limited professional staff and time.

Recent efforts have required a significant focus on the resilience issues of Charleston, S.C., limiting our ability to reach out the communities north and south of the city.

With the availability of \$50,000 in recurring funds made available by the National Sea Grant Organization, the Consortium worked to enhance and expand its ability to serve the needs of the stakeholders throughout the coastal region of South Carolina through the establishment of a new full-time Coastal Resilience Program Specialist (CRPS) position. As with the Consortium's current Climate and Resilience Specialist (CRS), a joint position supported by Sea Grant and Carolinas Integrated Sciences and Assessments, the Consortium sought to develop a partnership with one of its member institutions to jointly support this position. Upon discussions with the College of Science and Mathematics at the College of Charleston, the Consortium and College of Charleston entered into a cooperative agreement on June 12, 2018 to support the new position.

Landon Knapp was hired as the Consortium's new Coastal Resilience Program Specialist, with offices at the Consortium and at the College of Charleston's Lowcountry Hazards Center.