Understanding the October 2015 Charleston Floods
A Symposium Report

Charleston Resilience Network
February 23, 2016
Acknowledgements

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Charleston Resilience Network

The City of Charleston • S.C. Dept. of Health and Environmental Control • S.C. Sea Grant Consortium
College of Charleston • SCANA Corporation • Charleston Water System
Berkeley-Charleston-Dorchester Council of Government • Charleston County
National Oceanic and Atmospheric Administration

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Symposium Executive Summary

Due to its low-lying coastal location, the Charleston, South Carolina region is susceptible to a range of hazards, including flooding due to the isolated and combined effects of relative sea level rise, inundating precipitation and storm surge associated with tropical storms. In the decades following the landfall of Hurricane Hugo (1989), improvements have been made in emergency management and land use planning. However, without adequate consideration for future planning needs and assertive intervention, the Charleston region’s ability to absorb and recover from catastrophic events will be diminished. Effective long-term regional preparedness and resilience planning requires a concerted and coordinated effort among governmental entities, private industries, and owner/operators of critical infrastructure.

The Charleston Resilience Network (CRN) strives to foster a unified regional strategy and provide a forum to share information, educate stakeholders, and enhance long-term planning decisions that result in the implementation of effective pre-hazard mitigation strategies and post-hazard recovery efforts. On February 23, 2016, the CRN hosted a symposium in partnership with the National Academy of Sciences (NAS) Resilient America Roundtable to examine the Charleston region’s resilience through the lens of the major rainfall and flooding event that occurred in October 2015. At the Symposium, a diverse range of stakeholders assembled to share information and lessons learned across key sectors, as well as discuss practices, partnerships, and opportunities to enhance resilience to similar future events. Key topic areas discussed were: Public Safety and Health; Business and Economic Impacts; Critical Infrastructure / Lifelines; and, Moving Forward. Technical presentations included a meteorological overview of the October rainfall event, presentation of models depicting future flooding potential for the area and enhanced mapping and analytical capabilities that will support planning.

The October 2015 flooding event, while not a hurricane, brought extensive flooding with historic rainfall amounts across a large portion of South Carolina. On Thursday, October 1, the National Weather Service (NWS) in Charleston began forecasting rainfall amounts in excess of 10 inches for much of southeastern South Carolina. By Friday, October 2, it became clear that this event would not only be record breaking, but could be historic, potentially producing damaging and even life-threatening flooding. In addition, high tides due to the recent perigean spring tide, or “King Tide”, and persistent onshore winds exacerbated flooding along the coast, particularly in downtown Charleston and outer low-lying areas. Storm total amounts of 15 to 25 inches or rain were common across the tri-county area of Charleston, Dorchester, and Berkeley Counties with isolated maximum amounts in excess of 25 inches recorded in Charleston and Berkeley Counties.

According to the 3rd National Climate Assessment, global sea level is projected to rise between 0.8 to 6.6 feet by 2100, with a probable range between 1 to 4 feet. These projections are based upon extrapolation of existing trends, ocean warming and thermal expansion and polar ice melt. The tidal gauge at the U.S. Custom House in Charleston has been measuring sea level since the 1920s, indicating that sea level in Charleston Harbor has risen approximately one (1) foot over the past 100 years. Higher frequency, low impact coastal flooding from astronomical high tides is occurring more often, causing societal disruption, and challenging the region’s infrastructure such as the storm water system, and parts of the region’s transportation network. Recent reports by the National Oceanic and Atmospheric Administration (NOAA) list Charleston in the top 10 cities experiencing
nuisance flooding, with the expectation that the number of “blue sky” flooding events will reach at least 30 days per year by 2020.

The theme throughout the symposium was resiliency realized through collaboration. The Charleston region has benefitted from the work of many institutions and organizations on resiliency issues in the past; it needs to continue to take advantage of the multitude of resources available. This coordinated effort should utilize the latest science, especially climate and flooding data, and information such as state-of-the-art design standards to inform decision-making. All data and information should be refined within the scope of the region’s needs and to the correct spatial scales to be integrated and applied at the municipal (i.e. parcel) level. Planners and decision-makers in the Charleston region need to continue thinking further into the future and intervening assertively, particularly where flooding from predicted tides, storms and sea level rise is inevitable.

Several key points framed the Symposium’s discussion:

- Partnerships and relationships are critically important to successful planning, response and recovery efforts.
- Public and private sector leaders and managers must:
  a. Leverage resources, information, tools, technologies, and people from all sectors of the area and in conjunction with State and Federal partners to optimize future decision making.
  b. Build an environment where stakeholders and planners learn from the available research, others’ experience, and related training.
  c. Develop effective messaging strategies, including the communication of technical information, risk analysis and efforts needed to prevent, mitigate, and respond.
  d. Create situational awareness within every community by directly addressing the multiple audiences involved, understanding of the pathways to reach those audiences, and the most effective communication methods to reach them.
  e. Deliver the resilience message proactively, consistently, and continuously to the community so that the public better understands vulnerabilities and how to prepare and respond.
  f. Instill that responsibility for the future success of the area starts with stakeholders taking ownership to be a part of the resiliency planning and implementation.

The Charleston Resilience Network works to foster a unified strategy and provide a forum to share information, educate stakeholders and enhance long-term planning decisions that result in the implementation of effective pre-hazard mitigation strategies and post-hazard recovery efforts. As an initial step, S.C. Sea Grant Consortium, on behalf of the CRN, received a Regional Coastal Resilience Grant from the National Oceanic and Atmospheric Administration (NOAA) to help community leaders plan for and adapt to the area’s increasing flood challenges through the development of more robust and localized flooding models that can be used to plan infrastructure improvements in the Charleston, S.C. region. CRN invites everyone, public and private sector stakeholder organizations, that participated today and those that read this report to join this conversation at www.charlestonresilience.net
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Symposium Introduction

The Charleston, South Carolina (SC) region is comprised of Berkeley, Charleston, and Dorchester Counties and is home to over 700,000\(^1\) individuals. The average growth rate is estimated at 12 percent making it one of the fastest growing metro areas according to the U.S. Census Bureau.\(^2\) The economy of Charleston is strong and diverse, with concentrations in tourism, shipping, manufacturing and emerging technologies. Each of these sectors, along with the individuals employed therein, depend on the region’s roads, bridges, water management, energy, and other critical infrastructure assets and facilities for successful daily operation and during emergencies.

Due to its low-lying coastal location, the Charleston region is susceptible to a range of hazards, including flooding due to the isolated and combined effects of relative sea level rise, inundating precipitation and storm surge associated with tropical storms. In the decades following the landfall of Hurricane Hugo (1989)\(^3\), improvements have been made in emergency management and disaster planning such as comprehensive emergency management planning that includes: the National Incident Management System, the National Response Framework, and National Disaster Recovery Framework; mitigation planning and projects to reduce risk; better building codes; intelligent traffic management systems; formalization of state-to-state mutual aid; and better integration with National Guard/military personnel throughout the region. However, chronic hazards continue to challenge the region’s ability to safeguard and maintain the infrastructure that is vital to economic prosperity and social well-being. Without adequate consideration for future planning and incremental intervention in the coming years, the Charleston region’s ability to absorb and recover from catastrophic events will be diminished. Effective long-term regional preparedness and resilience planning requires a concerted and coordinated effort among governmental entities, private industries, and owner/operators of critical infrastructure.

In 2012, the National Academies of Science (NAS), Engineering and Medicine published Disaster Resilience: A National Imperative\(^4\) where resilience was defined as “The ability to prepare and plan for, absorb, recover from, or more successfully adapt to actual or potential adverse events.” In this report, the writers shifted the resilience paradigm from post-event recovery activities to emphasis on pre-event planning and other actions a community can take before a disaster happens. Enhancing a community’s resilience in this way allows it to better respond to anticipated or unanticipated disasters and recover from them more quickly by reducing disaster losses.

The Charleston Resilience Network (CRN) formed in 2014 as a volunteer-based effort composed of

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\(^1\) U.S. Census Bureau estimates for July 1, 2015 http://www.census.gov/quickfacts/table/PST045215/45019.45035.45015


\(^3\) At several points throughout the Symposium, speakers referred to Hurricane Hugo as being a past focusing event that heavily influenced the region’s disaster, storm water management, and land use planning. A short synopsis of that storm is provided in Appendix C to better understand this prior event and the drivers for planning leading up to the October 2015 event.

public and private sector stakeholder organizations within the Charleston metropolitan area. CRN members have a collective interest in the resilience of the region, its critical infrastructure, and socio-economic continuity in the face of episodic (i.e. hurricanes) and chronic hazards (i.e. relative sea level rise, coastal flooding, etc.). Initially, the CRN partners included the S.C. Sea Grant Consortium, City of Charleston, Charleston County, Charleston Water System, S.C. Department of Health and Environmental Control’s Office of Ocean and Coastal Resource Management (DHEC-OCRM), SCANA Corporation and the Berkeley-Charleston-Dorchester Council of Governments. The CRN works to foster a unified strategy and provides a forum to share information, educate stakeholders, and enhance long-term planning decisions that result in the implementation of effective pre-hazard mitigation strategies and post-hazard recovery efforts to build resilience throughout the region.

On February 23, 2016, the CRN hosted a symposium focusing on the Charleston region’s resilience through the lens of the major rainfall and flooding event that occurred in October 2015. At the Symposium, a diverse range of stakeholders came together to share information and lessons learned across key sectors, as well as discuss practices, partnerships, and opportunities for increased resilience to future rainfall and flooding events. The audience included practitioners and representatives from local government (city and county), the private sector, utilities, transportation, health, emergency response and recovery, along with academia.

Speakers and panelists from the Charleston region presented information and organizational experiences based on the events from the October rainfall event. As part of a community pilot partnership with the Charleston region, members of the NAS Resilient America Roundtable moderated each panel session. Each panelist was asked to present:

- Personal and organizational background
- Examples of what worked during the event including previous actions or projects that lessened the damage
- Examples of unanticipated problems
- Examples of best practices, lessons learned and recommendations to increase resilience in anticipation of future events

The four panels convened focused on:

- Public Safety and Health
- Business and Economic Impacts
- Critical Infrastructure / Lifelines
- Moving Forward

Other invited experts gave presentations on:

- Meteorological overview of October event
- Future flooding potential in the area
- Lowcountry Hazards Center Projects and Activities in Support of Future Planning

This report summarizes the Symposium’s presentations, discussions, and answers to audience questions, including how the October 2015 flooding event was different from previous experiences and how tidal and storm-related flooding will impact the region in the future.

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5 The Symposium Agenda is located in Appendix A
6 In various professional circles, the event was referred to differently through the lens of that discipline. From a meteorological lens, the October event was a rainfall event. From an emergency management/ disaster response lens, the October event was a flooding event. In the appropriate sections throughout this report, the event will be described as the appropriate discipline describes it.

7 [http://sites.nationalacademies.org/pga/resilientamerica/index.htm](http://sites.nationalacademies.org/pga/resilientamerica/index.htm)
Setting the Stage: October Rainfall Event Overview

Ron Morales, the Warning Coordination Meteorologist (WCM) at the Charleston, S.C. National Weather Service (NWS) Office, presented a meteorological overview of the October rainfall event. In his position, he ensures the NWS Office in Charleston, S.C. provides its customers and partners with high quality weather, hydrologic, and climate forecasts and warnings.

The October 2015 rainfall event, while not a hurricane, brought extensive flooding with historic rainfall amounts across a large portion of South Carolina. Closest comparison rainfall occurred in September 1989 when Hurricane Hugo made landfall north of Charleston near Sullivan’s Island, with rainfall amounts up to 10.2 inches, storm surge up to 20.2 feet, and sustained wind gusts of 85 miles per hour. Since then, environmental and climate change, resulting sea level rise, and population growth across the region have increased the area’s susceptibility and risk to more intensive and extreme events.

Mr. Morales noted that the rainfall event that occurred from October 1 - 5, 2015 was generated by the presence of a nearly stationary low pressure system over South Carolina, which helped to focus the lifting of very moist air over a stalled front near the coast. The clockwise circulation around this stalled low center over the region directed a narrow plume of tropical moisture northward and then westward across South Carolina beginning on Thursday, October 1. The outer circulation of Hurricane Joaquin, situated well off the coast, may have helped to ensure a nearly steady stream of tropical moisture into the system. Sea surface temperatures in the Atlantic were approximately 1.5-2.5°C (3-4.5°F) warmer than average, which also contributed to higher evaporation rates over the Atlantic and fed more moisture into this weather system. Finally, the juxtaposition of the upper and lower jet streams provided the right conditions to squeeze out the maximum amount of moisture over portions of South Carolina.

On Thursday, October 1, the NWS in Charleston began forecasting rainfall amounts in excess of 10 inches for much of southeastern South Carolina. Throughout the day, confidence increased in the likelihood of an extremely heavy rainfall event,
which would produce widespread and significant flooding. Rainfall started in the afternoon hours, mainly impacting locations along and near the Charleston County coast. By Friday, October 2, it became clear that this event would not only be record breaking, but could be historic, potentially producing damaging and even life threatening flooding. There was an extended lull in rainfall for most of Friday before a large band of heavy rainfall pushed into the area during the late afternoon. Periods of moderate to heavy rain then continued through the weekend. Storm total amounts of 15 to 25 inches were common across the tri-county area of Charleston, Dorchester, and Berkeley counties with isolated maximum amounts in excess of 25 inches recorded in eastern Charleston and Berkeley counties. In addition, high tides due to the recent perigean spring tides, or “King Tides” and persistent onshore winds exacerbated flooding along the coast, especially in downtown Charleston. The most significant flooding occurred in areas along and near smaller creeks and streams, especially those that were tributaries to larger rivers such as the Edisto, Ashley, Cooper, and Santee. Flash flooding was prevalent and led to significant damage to numerous properties and roads, with many people having to be rescued by emergency personnel. In addition to impacting thousands of homes and businesses, flood waters also damaged many of the area’s roads and bridges, causing significant travel disruptions that lasted for days. Mr. Morales stated that the modeling used during this event predicted the correct amount of rainfall, including 1,000 year and 500 hundred year rainfall amounts; however, the modeling was not accurate in predicting precisely where the worst rainfall amounts would occur.

**Future Needs for Consideration:**
- Improvements in mapping and modeling to more accurately depict rainfall patterns and flood prone areas throughout the region.

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Panel: Public Safety and Health

Moderator:
Ellis Stanley
Ellis Stanley Partners/NAS Resilient America Roundtable

Panelists:
Captain Brian Ambrose
Charleston Police Department
Chief Karen Brack
Charleston Fire Department
Carl Benton
Charleston County EMS
Louise Welch Williams
American Red Cross Lowcountry Region

The Public Safety and Health Panel included response professionals whose missions span saving lives, protecting property and the environment, and meeting basic human needs during and after emergencies occur. Charleston Police Department, Charleston Fire Department, Charleston County Emergency Medical Services, and the American Red Cross were invited to discuss what their organizations did to prepare for and respond to the October rainfall event along with sharing lessons learned and any best practices.

The Low Country S.C. Chapter of the American Red Cross\(^\text{10}\) serves the counties of Charleston, Beaufort, Berkeley, Colleton, Dorchester, Georgetown, Hampton, Jasper, and Williamsburg. As a part of their Congressional charter, the American Red Cross (ARC), a non-profit organization, provides care and shelter during emergencies while ensuring other missions such as safe, lifesaving blood and blood products are available. The ARC relies upon volunteers and donations to complete their full mission. Because of their national charter, the ARC frequently has the ability to convene state and local partners particularly for specific training opportunities to build relationships but recognize that nurturing spontaneous partnerships is also necessary to complete their mission.

Louise Welch Williams, regional Chief Executive Officer of the Palmetto S.C. Region of the American Red Cross, explained that their preparations began Wednesday with telephone calls to the national and state Headquarters. Based upon those telephone calls, the ARC was able to move resources into the area in anticipation of shelter openings and other needs commonly encountered during a disaster. Once the State Emergency Operations Center (EOC) and various county EOCs were stood up, the Red Cross staffed the ARC seat in each. Primarily for this event, ARC provided mass care opening over 30 shelters state wide, 17 in the Lowcountry. Ms. Williams further described strong existing relationships with local emergency management and first responders as being influential in their success during every incident but especially the October flooding event. During this event, the Red Cross experienced intermittent challenges in delivering blood to the local hospitals; however, contingencies have been addressed in planning processes since. Post event, the local ARC is focusing on expanding their volunteer base and ensuring that all volunteers meet the national ARC strict training requirements and guidelines in preparation for another event.

The City of Charleston Fire Department\(^\text{11}\) operates twenty fire companies located throughout the peninsular City and incorporated areas of West Ashley, James Island, John’s Island, and Daniel Island/Cainhoy. Chief Brack described strong pre-existing relationship foundations with police, emergency medical services, and the ARC during

\(^{10}\) http://www.redcross.org/local/sc/about-us/locations/lowcountry-sc

daily incidents that led to successful decision making and actions during the October rainfall event. The CFD also has a strong relationship with the US Coast Guard Sector Charleston that includes regularly scheduled training opportunities. Chief Brack credited the solid use of the Incident Command System (ICS) for all activities from daily routine responses to large crowd events that contributed to effective disaster management of the October rainfall event.

On Wednesday, Chief Brack began contacting adjoining jurisdictions and state agencies to discuss resources and ensure that existing mutual aid agreements would operate seamlessly during the impending event. The CFD primarily performed rescue operations including assisting people from vehicles in flood waters and stranded in homes that were either flooding or surrounded by flood waters not expected to recede for several days. During Saturday night, CFD units rescued 88 people, many with pets, from their homes who had not heeded prior evacuation warnings. In cases where CFD rescue resources were unavailable during peak call volume, the CFD utilized mutual aid resources through the prior confirmed mutual aid agreements with outlying response partners.

The Charleston Police Department (CPD)\(^\text{12}\) is divided into teams that address nine areas of responsibility that include five patrol teams, community outreach, special units, investigations bureau, and central business district. On Wednesday before the event start, the CPD began implementing the City’s All-Hazards Plan; an emergency response plan based upon historic experiences and prior event observations. Officers worked with the Public Works Department to put up barricades in areas known to flood and went door-to-door in those neighborhoods to advise residents to voluntarily evacuate. CPD implemented ICS early and credited the regular use of ICS by Charleston’s public safety disciplines to ensuring smooth management and response during the rainfall event. During the four day event, CPD leadership realized that future response efforts will require boats, low profile boats, trailers, and specialized training, especially in swift water rescue.

Additionally during the two days prior to the event, CPD leadership communicated with employees regarding the scheduled implementation of extended shifts in anticipation of the rainfall event. These communications included information on family preparedness that was also shared across all City government departments for dissemination to their employees. At this time, the CPD Public Information Officer (PIO) began communication to the public pre-event through multiple media methods including social media such as Facebook and Twitter storm predictions, risks, warnings, road closings, and other event related information. The PIO continued coordinating the messaging in these media throughout the event and over the next week.

Charleston County Emergency Medical Services (CCEMS)\(^\text{13}\) provides medical care and transportation to hospital emergency departments for citizens and visitors to Charleston County. The service regularly staffs 14 full-time medic stations strategically located throughout the county, three supervisors per shift, and several "Power Squad" ambulances that respond during high call volumes. During the October rainfall event, CCEMS deployed 15 units and three supervisors representing a slight increase over normal operations. Deployment for this event was based upon zones in anticipation of potential for flooding. Early during the event, CCEMS utilized a modified dispatch system in order more efficiently handle the call volume while units maintained

\(^{12}\) http://www.charleston-sc.gov/police

\(^{13}\) http://www.charlestoncounty.org/departments/ems/index.php
constant communications with dispatch to keep up with road closures. When call volume increased beyond the number of available units, the CCEMS utilized mutual aid agreements with other jurisdictional and private sector emergency medical services to fill gaps. In the months since, analysis of the event confirmed the need for increased staffing; the personnel budget increases dramatically in August 2016 to better serve the community daily and during events of this magnitude.

The City of Charleston Emergency Management Division (CEMD) is organized within the Charleston Police Department with the Emergency Management Director reporting directly to the Chief of Police. For CEMD, the rainfall event coupled with high tide presented unique challenges to the City. The Division’s actions started approximately three days in advance of the event’s peak through coordination with CPD, CFD, County EMS, and the local hospitals especially in terms of pre-staging response assets in areas before flooding began. The City developed a proactive communications strategy to alert citizens of risk events. Part of this planned strategy was emergency personnel knocking on doors in areas determined to be most at risk of flooding to inform businesses and citizens of the risk and need to evacuate voluntarily. The strategy also included proactive public information messaging where CPD sent regularly timed email alerts about bad weather and expected high tides with associated peak effect times. The coordinated group of CPD, CFD, and City PIOs released updates throughout the flooding event via multiple media platforms including the television, print, Twitter, the City's Facebook account, and the City’s website. The City government also implemented a plan to close access to the downtown Charleston peninsula, which includes the city's historic district, if the safety of citizens was at risk. This was implemented on Saturday. To accomplish this, Charleston City Council passed an emergency ordinance Saturday affirming public safety officials’ authority to close roads, streets, highways or other public right-of-ways determined to be a danger for flooding. On Sunday, the City, opened limited access to the Charleston peninsula only via exit 221 from I-26 Eastbound and the Meeting Street exit on the Ravenel Bridge on US 17. This limited access was intended for residents and business owners to check on their properties. Essential personnel required to report to work at medical facilities or public safety agencies on the peninsula were allowed access to the area throughout the incident by providing appropriate issued identification. More than 60 City streets were closed at the peak of the incident. One of the problems encountered was that Saturday's rain and flooding led to several water rescues in downtown Charleston of people who tried to drive through standing water. This led to more than 66 vehicles that were “flooded out” having to be towed between midnight Thursday and Sunday afternoon with more than 150 disabled vehicles still left on city streets. Additionally, the City handed out more than 5,000 sandbags to citizens preparing for the heavy rainfall and flooding. The CEMD Director added that the bulk of the work and evacuations from Saturday to Sunday were not on the peninsula, but in West Ashley and on Johns Island.

Best Practices:

- Incorporation of ICS by all response partners during normal daily response operations led to successful management and outcomes during this event.
- Emphasis on pre-existing relationships and daily collaboration between all response partners led to successful outcomes despite challenges encountered.
- Existing mutual aid agreements functioned seamlessly during the event.
**Challenges:**

- Citizens did not heed evacuation warnings.
- Drivers continued to drive through flood waters.
- Shortfalls in alternate resource requirements necessary for rescue and shelter of citizens with disabilities, pets, etc.
- For a short period of time the ARC experienced difficulty in delivering blood to local hospitals timely.
- Rapidly changing water level conditions impeded responder access at times.

**Future Needs for Consideration:**

- Modify dispatching protocols and establish their implementation early or in anticipation of an event of this size to improve responses.
- Utilize unique regional resources and formalize relationships with their owners; for example, utilize harbor pilots and assets to ferry hospital personnel during disasters.
- Continue to map flood prone areas throughout the region and delineate between tidal coastal flooding and rainfall flooding, where possible.
- Through their ongoing initiatives propose the Charleston Sea Level Rise Task Force take identified flooding projections and overlay to regional mapping to drive future discussions and regional planning.
- Cross train between police, fire and emergency medical service departments on swift water rescue.
- Track and apply for more grant opportunities especially for funding of disaster and related specialized training needs that are frequently minimized or cut from normal operating budgets. Efforts may require assignment of a grants coordinator position.
- More accurate mapping of expected norms of flooding in the current built environment with an ability to model flooding based upon change in climate, seal level rise, and alterations in the built environment.
- Application of these best practices, challenges and needs to better inform the region’s all-hazards planning especially against an earthquake scenario.
Panel: Business and Economic Impacts

**Moderator:**
Gerald McSwiggan
U.S. Chamber of Commerce Foundation/
NAS Resilient America Roundtable

**Panelists:**
Perrin Lawson
Charleston Convention and Visitor’s Bureau
Tracy Ray Harbour
Small Business Administration
Frank Knapp
S.C. Small Business Chamber of Commerce
Donald Waters
FEMA Region IV Insurance

Disasters affect individuals and businesses in a community. While public safety addresses the immediate needs of life and property during a disaster, the days following the initial impact begin to focus on returning the community to normal, especially the local economy, so as to minimize the long term impacts. After a disaster, the business community experiences two types of shocks: first, the initial dip in demand for services and products; and, the second shock happens when businesses cannot receive the necessary supplies to continue. In the case of Charleston S.C., the peninsula is a popular tourist area with small retail businesses and the immediate surrounding region is populated with tourist attractions that were affected by the October rainfall event. This panel examined the impacts to the local economy in the months following the event.

The Charleston Area Convention & Visitors Bureau (CACVB) markets the Charleston region as an individual, meeting, incentive and group destination to the domestic and international markets. Perrin Lawson, Deputy Director of CACVB, explained that because of past area flooding experiences and related planning based upon those experiences, the local business community anticipated opening quickly post event. Despite the limited duration of this event once it received national media attention, the CACVB noted that the reporting focused on and remained focused upon worst case experiences in the region for several weeks which negatively impacted potential visitors’ perception of the area. Additionally, Columbia, S.C. and the surrounding Midlands region normally provide the primary base for visitor numbers to the Charleston region. However, because Columbia also was severely impacted by this event, the Charleston region’s economy experienced negative impacts for several months post event. This was due to lower visitor totals correlated to event-impacted Columbia residents not traveling following the event and the transportation issues between the two cities resulting from the event. The CACVB also noticed that many local businesses in the Charleston region continued to post worst-case information on social media long after the actual event had subsided and businesses were fully operational. These actions unintentionally mischaracterized the region’s recovery and return to near-normal operation. To fill visitor number gaps, the CACVB marketed nationally to areas with direct flights into Charleston International Airport that included the utilization of digital media with time stamps to show current conditions in the area. As a result of the event and these subsequent marketing efforts, the CACVB experienced a spike in call volume from businesses, travel agencies, and potential visitors asking for confirmation that the area was safe and open for business. Outside of the CACVB’s efforts to market the area, the influx of recovery workers eased some negative impact on local hotels and restaurants; however, retail

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business and tourist attractions were not beneficiaries of this traveler segment. Overall, the CACVB saw economic improvements to near normal levels within 30 days of the event. However, regional tourist attractions continued experiencing significant impacts of approximately 30 percent decreased visitor traffic for over four months.

The South Carolina Small Business Chamber of Commerce (SCSBC)\(^{15}\) is a statewide advocacy organization for small businesses. Mr. Knapp, President and CEO of the SCSBC, stated that because of past experiences in the Charleston area and effective coordinating efforts with the City, small businesses were able to reopen quickly following the October flooding event. However, he emphasized that during disaster events small businesses are affected differently than large business in that most small businesses will lose between 5 and 10 percent or more of monthly revenue if not open on a weekend.\(^{16}\) The October event began on a Thursday continuing through late Sunday which impacted at least one weekend of revenue for the peninsular small businesses. Because of the rainfall event, the Charleston Farmer’s Market, Charleston Greek Festival, and Oktoberfest also were cancelled. As noted during the CACVB presentation, outside perception of the area continued to be negatively impacted by national media coverage that continued to air video footage of peak flood effects for several weeks. This further reduced weekend revenues for small businesses for approximately one month following the rainfall event. Mr. Knapp explained that small business budgets normally are impacted more dramatically by routine overhead increases that naturally occur from year to year. Those budgetary impacts are compounded by lost revenue due to repeated threats or disasters. While most small businesses prudently have insurance for damaged inventory, many do not realize the need to carry lost revenue insurance due to disaster.

The U.S. Small Business Administration (SBA)\(^{17}\) is an independent agency of the federal government to aid, counsel, assist, and protect the interests of small business concerns, to preserve free competitive enterprise and to maintain and strengthen the overall economy of our nation. Ray Harbour, public affairs specialist for SBA’s Office of Disaster Assistance, explained that for Presidentially-Declared Disaster areas, SBA provides low-interest disaster loans to businesses of all sizes, private non-profit organizations, homeowners, and renters. These disaster loans can be used to repair or replace the items damaged or destroyed in a declared disaster such as: real estate, personal property, machinery and equipment, and inventory along with other business assets. SBA provides businesses low-interest, long-term loans for physical and economic damage caused by a declared disaster in these categories: home and personal property loans; business physical disaster loans; economic injury disaster loans; and military reservists’ economic injury loans. Specifically SBA offers the following two types of loans\(^{18}\) to businesses without penalty if the business opts to prepay:

- **Physical Disaster Loans:** Businesses of all sizes and private, nonprofit organizations may apply for a Physical Disaster Loan of up to $2 million to repair or replace damaged real estate, equipment, inventory and fixtures. The loan may be increased by as much as 20 percent of the total amount of physical loss, as verified by the SBA, to protect the property against future

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\(^{15}\) [http://scsbc.org/](http://scsbc.org/)

\(^{16}\) [http://www.fema.gov/protection-your-businesses](http://www.fema.gov/protection-your-businesses)

\(^{17}\) [https://www.sba.gov/about-sba/what-we-do/mission](https://www.sba.gov/about-sba/what-we-do/mission)

\(^{18}\) For more information regarding SBA loans offered after a disaster see [https://www.sba.gov/loans-grants/see-what-sba-offers/sba-loan-programs/disaster-loans](https://www.sba.gov/loans-grants/see-what-sba-offers/sba-loan-programs/disaster-loans)
disasters of the same type. These loans will cover uninsured or under-insured losses.

- Economic Injury Disaster Loans: Small businesses, small agricultural cooperatives, small businesses engaged in aquaculture, and most private, nonprofit organizations of all sizes suffering substantial economic injury may be eligible for an Economic Injury Disaster Loan of up to $2 million to meet necessary financial obligations – expenses the business would have paid if the disaster had not occurred. These working capital loans have a deadline nine months post-disaster.

The interest rates on these loan types do not exceed 4 percent if the business does not have credit available elsewhere. Repayment can be made over time periods of up to 30 years, depending on the business’s ability to repay the loan. For businesses and nonprofit organizations with credit available elsewhere, the interest rate may be higher but not exceed 8 percent with the SBA determining if applicant has credit available elsewhere. Once an application is received by the SBA, loan processing time typically averages three weeks between disaster loan application submission and the business being notified.

As of February 23, 2016, 5031 loans totaling over $137 million have been approved for S.C. with the SBA providing 482 of these to businesses for physical damages. In Charleston County, 458 loans for physical damage have been approved totaling $12,623,000. However, the SBA was still receiving applications for physical damage loans at the time of the Symposium. Additionally, four economic injury loans have been approved. The SBA recognizes that most businesses take six months or more to discover and assess their economic impacts before they apply for economic injury loans. However, businesses frequently choose not to pursue SBA loans because of budgetary constraints.

Federal Emergency Management Agency (FEMA) manages the National Flood Insurance Program (NFIP) and a range of programs designed to reduce future losses to homes, businesses, schools, public buildings, and critical facilities from floods, earthquakes, tornadoes, and other natural disasters. The Federal Insurance Mitigation Administration (FIMA) is a component of FEMA comprised of three divisions: Risk Analysis, Risk Reduction and Risk Insurance. The Risk Insurance Division provides the oversight for the Write Your Own Company (WYO) and the NFIP Direct Servicing Agent (NFIP DSA), these NFIP insurers who sell and service NFIP flood insurance policies. The NFIP provides affordable flood insurance to communities and to property owners by encouraging communities to adopt and enforce floodplain management regulations that mitigate the effects of flooding on new and substantially improved structures. The NFIP is designed to provide an insurance alternative to disaster assistance in order to better meet the escalating costs of repairing damage to buildings and their contents caused by floods. In the NFIP, a single family dwelling can be insured up to $250,000, and up to $100,000 for contents; a commercial building such as a retail store or manufacturing structure (General Property Form) can be insured up to $500,000 for the structure and $500,000 for contents. However, FEMA is changing its approach to disasters to focus on resilience. For example, this approach educates citizens about whether their property is located in a high hazard flood zone or not, the risks associated with this location, and making resources available including flood insurance to reduce or spread the cost of risk.

FEMA/FIMA receives daily weather reports that may trigger their disaster preparations once a forecast indicates a hurricane, other coastal storm,

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19 http://www.fema.gov/what-mitigation/federal-insurance-mitigation-administration#0
upstream rains and/or snow melt will cause probable flooding. FEMA begins strategically preparing personnel and equipment for deployment in advance based upon these weather report expectations for off shore storm and weather systems moving across the country. For the flooding event in South Carolina, a FEMA/FIMA Insurance Examiner established and opened the NFIP Flood Response Office in North Charleston on Friday, October 9 after arriving earlier that week and remained until late December 2015, working closely with the South Carolina Director of Insurance in Columbia. FEMA/FIMA anticipated that most of their work would be in the Charleston region because of the large number of policies they hold in Charleston and North Charleston. FEMA/FIMA quickly realized that the Columbia area was among the hardest hit, but had a much lower NFIP policy count. For that area, the spotlight was on FEMA Individual and Family Assistance (IA), with the maximum IA payment totaling approximately $30,000 with the average payment less than $6,000. For dwellings, the maximum limit available is $250,000 with South Carolina average flood insurance claim payment averaging about $23,000. As of February 23, 2016, 5,418 claims had been paid totaling $128 million.

In communities participating in the NFIP everyone is considered to be in a “flood zone” with flood risk exposure varying within the community and carrying higher risk in some zones than others. However, Mr. Waters stated that approximately 20 percent of all NFIP flood claims occur in moderate or low risk zones. While working with the FEMA Joint Field Office, it was noted that three common misconceptions regarding the risk of flooding continually surfaced. First, mortgage companies and other lenders require borrowers to purchase flood insurance in the higher risk zones; however, many building owners do not perceive the need for flood insurance even in those high risk zones. Once the mortgage is paid, many owners discontinue both the mortgage and the flood insurance policy, creating risk exposure. Second, they believe that any damage that occurs during a flooding event will be covered by Federal Disaster Assistance. Finally, an event called a 100 year flood is perceived as happening only once every 100 years; therefore, owners anticipate that after its occurrence such an event will not reoccur for another 100 years. This represents a fundamental miscommunication of the risk, as explained on page 4 of this report.

**Best Practice:**

- South Carolina Emergency Management Division Essential Support Function 24 assigns management and staffing of an Emergency Operations Center (EOC) seat for non-infrastructure based business and industrial enterprise representation during a disaster; this position is staffed at the State and county level EOCs but not the City level.

**Challenges:**

- Many NFIP policyholders did not fully understand that damage caused by wind and localized ponding of rain water is not considered flood damage, which limited the ratio of insurance claims to payout of damages.

- Many business owners and citizens did not understand that damage caused by flooding is not covered by typical homeowner policies except in the case of a few very high limits policies.

- During disasters, schools may close resulting in working parents remaining at home to care for their children. While businesses in the region did not report directly that they were impacted, many businesses adjusted work schedules to accommodate altered school schedules and personal needs of employees.
High psychological stress immediately following an event of this size frequently hinders business owners from fully grasping and utilizing SBA and FEMA/FIMA services.

**Future Needs for Consideration:**

- Adjust business marketing efforts to use coordinated positive social media advertising/marketing across all business sectors that includes the use of digital time stamped media to accurately portray area conditions and counter any negative messaging.

- Anticipate increase in telephone calls and electronic contacts from client bases requesting area status and information by adding personnel or establishing continuity of communications outside of the affected area to ensure messaging is controlled and positive.

- Insurance reviews for small businesses should recommend insurance options for lost revenue coverage which is different than physical damage coverage.

- More effectively communicate that FEMA flood maps are a tool outlining Special Flood Hazard Areas (SFHA); however flooding can occur anywhere. Business owners and citizens have the option that if they are not located in a SFHA, a Preferred Risk Policy can be purchased that will pay, even if no Presidential Disaster Declaration is given for an event unlike other Federal Disaster Assistance products which do.

- Identify the most appropriate and trusted organization or entity in the community to effectively communicate risk and insurance options to small businesses and ascertain what information these businesses most need.

- Investigate the potential to tap various regional business continuity professionals from large corporations to assist small businesses in creating or improving their business continuity plans.

- Train the region’s professional insurance agents, who in many cases are the only contact business owners and citizens have, to effectively discuss the flood risk. Private insurance companies frequently have vast amounts of risk reduction information. For example Zurich Insurance’s Insurance and Risk Management efforts\(^\text{20}\) or the Insurance Institute for Business and Home Safety.\(^\text{21}\) However, individual agents at the local level may not be aware of these programs within their industry. Well informed flood insurance agents can assist their clients in making informed decisions on risk and risk mitigation opportunities.

\(^\text{21}\) [https://disastersafety.org/](https://disastersafety.org/)
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Panel: Critical Infrastructure

Moderator:
Sarah Gambill
U.S. Department of Homeland Security
Office of Infrastructure Protection

Panelists:
Michael Black
SC Department of Transportation
Cedric F. Green
Charleston Electric Operations, SCANA
Kent Scarborough
Charleston Water System

Certain critical infrastructure sectors provide necessary services that support nearly every home or business. If these fundamental services are disrupted, the potential develops to cascade into other services and life threatening situations. For this panel, Charleston Water System, the SC Department of Transportation, and SC Electric and Gas Company were invited to discuss what their organizations did to prepare for and respond to the October rainfall event along with sharing lessons learned and any best practices.

Charleston Water System (CWS) is a public water and wastewater utility that provides clean water services to the greater Charleston community. The Hanahan Water Treatment Plant produces drinking water that’s delivered through 1,800 miles of water mains. Additionally, CWS provides sewer service—not storm water—through 700 miles of collection mains, 187 pump stations, and eight miles of deep tunnels that carry wastewater to the Plum Island Wastewater Treatment Plant that treats an average of 19 million gallons per day and releases clean water into the Charleston Harbor. In 2017, system capacity will increase to nearly double capacity upon completion of major capital improvement projects currently underway. Mr. Scarborough stated that this new capacity will alleviate many of the issues encountered during the October 2015 rainfall event.

CWS began planning for the rainfall flooding event approximately Wednesday afternoon by prepping assets, monitoring conditions and implementing an internal Incident Command System (ICS) based upon past experiences. These actions determined the public health priorities that CWS would focus upon during the first part of the event. CWS pump stations are a mix between SCADA driven systems and manual controls. By monitoring conditions closely, CWS adjusted system levels in advance to accommodate the rainfall amounts received. Once the event started, work tickets were addressed based upon the rainfall amount reported in the area surrounding the associated pump stations. The primary unanticipated problem encountered throughout the event was the presence of ‘flushable’ wipes that have a tendency to remain intact while moving through the system creating clogs and backups in sewer systems at pump stations. Once a public health problem was identified at an asset location, CWS immediately notified DHEC through existing communication pathways and the media through their established Public Relations. CWS implemented site sampling that was then continued at regular intervals until the site’s threat was dissipated; in a few cases this meant monitoring ended over four months later.

The South Carolina Department of Transportation (SCDOT) operates as a centralized government agency that systematically plans, constructs,

22 http://www.charlestonwater.com/

23 SCADA is supervisory control and data acquisition system for remote monitoring and control that operates with coded signals over communication channels.
24 http://www.dot.state.sc.us/
maintains, and operates the state highway system along with the development of a statewide mass transit system. The SCDOT is organized in three divisions: Engineering, Intermodal Planning, and Finance and Procurement with these functions operating from the central headquarters, in Columbia. The SCDOT field offices are divided into seven districts headed by a District Engineering Administrator with the responsibility for the maintenance, construction, traffic, and equipment (mechanical) operations within its boundaries. District 6 covers Charleston, Berkeley, Dorchester, Colleton, Beaufort, and Jasper Counties.

The week before the rainfall event, District 6 managed a response to an EF-2 tornado that struck Johns Island and West Ashley sections of Charleston on September 25 using their existing hurricane response model. Alert crews already were focused on the primary SCDOT goal of returning the transportation system to normal as quickly as possible. As this rainfall event unfolded, four out of the six District 6 counties were affected. Being a part of a centralized agency, the District relied on SCDOT HQ to work with the Emergency Management Division’s State Emergency Operations Center to coordinate information concerning road conditions, and closings, etc. with other state agencies. Overall, SCDOT had over 130 crews respond to this event with work performed on 900 sites throughout the State highway system. At the peak of the event, there were over 541 road and bridge closings across the State representing $137 million total damages. U.S. Highway 17 from Bees Ferry Road to Ponderosa Road and from Sewee Road to Doar Road was shut to traffic and the James Island Connector going into downtown Charleston was closed as was Main Road from U.S. 17 to River Road. U.S. 17 is considered a lifeline route for this region and had never been closed before. However, the District reopened U.S. 17 in a timely manner with the inclusion of a creative solution detouring traffic through a private business parking lot with the owner’s permission.

During recovery, District 6 was able to draw crews from the two District counties that were not affected to address damage in the Charleston region. SCDOT used a combination of in-house resources and contracting mechanisms to address recovery projects to return the transportation system to normal as soon as possible. These efforts began with the District working closely with SCDOT HQ and FEMA to complete assessments focusing on high priority and volume routes with immediately available resources to make repairs. Time requirements and resources also limited the opportunities for SCDOT to plan for or implement forward thinking mitigation steps into the projects. Mr. Black noted that in a few cases mitigation plans existed for a site prior to the rainfall event but the majority of the transportation system repairs were made based upon past design for expediency reasons. SCDOT made every effort to contain costs and maximize return while returning the transportation system to normal as quickly as possible. SCDOT utilized three types of contracts – prepositioned, emergency procurement, and three-bid contracts – when outside resources were required.

South Carolina Electric and Gas Company (SCE&G)\(^\text{25}\), a subsidiary of SCANA and a regulated public utility, is the primary provider of electricity and natural gas service to the Charleston region. The SCE&G’s planning efforts for emergency response are grounded in Hurricane Hugo experiences that have led to prevention actions being carried out on a daily basis across transmission and distribution. SCE&G recognizes the tremendous growth occurring in the metro-Charleston area and places strong emphasis on maintaining the electric and gas infrastructure that

\(^{25}\) [https://www.sceg.com/home](https://www.sceg.com/home)
will support that growth. Company efforts revolve around hardening the distribution system, a daily circuit line inspection program to ensure that it is salt-water capable, and an assertive tree-trimming program. For instance, the tree trimming program meets weekly to manage the three to five year maintenance schedule. In the month prior to the October rainfall event, SCE&G was implementing the lessons learned from a rainfall event on August 31, 2015 where six inches of rain fell within two hours resulting in power impacts to the Boeing and Tanger areas of Charleston.

During Wednesday afternoon September 30, SCE&G implemented the company-wide storm plan that led to mutual aid discussions with other energy companies in the South Carolina region to discuss support and resources that could be mobilized as the event unfolded. The company increased staffing, especially linemen but also supervisors and subject matter experts. Deployment of staff began during the afternoon of Friday, October 2 and utilized state-of-the-art SCADA systems to pinpoint trouble quickly. Increased staffing continued through Sunday that included bringing in mutual aid partners for staging in areas anticipated to experience the most trouble. SCE&G credited the strong relationships their employees maintain with the municipalities and public safety personnel as aiding their efforts to respond and recover as efficiently as possible.

The Charleston peninsula had minimal issues because SCE&G operates an underground system that ensures the handling of diverse environmental conditions daily. One of the challenges encountered during this event was ground saturation where heavy trees toppled. By the morning of Sunday October 4, a fairly accurate picture of electric outage needs had emerged that included more than 11,500 customers without power, with Charleston County and Dorchester County having the largest number of outages including critical customers and sites in those areas with priority restoration requirements. Mr. Green noted that weather conditions continued to impact restoration efforts across the SCE&G service territory with many roads still impassable making it difficult for crews to get to affected areas until at least Wednesday, October 7, 2015. Additionally, flooding impacted the SCE&G equipment in places, and crews were not able to restore power until the water receded.

**Best Practices:**

- Existing mutual aid agreements with out-of-area utilities provided a seamless increase in resources during peak needs that led to quicker return of service throughout the region.
- Existing positive relationships between utility and DOT crews and EOCs, police, fire and EMS departments led to quicker responses to utility service needs.
- Utilization of monthly utility bills and other regular customer communications to disseminate risk information led to a more informed and cooperative public.
- DOT and utility PIOs used traditional and social media effectively throughout the event to convey updates and situational awareness.
- Agile thinking of personnel was attributed to prior planning and exercises drove ability to adapt and respond as the event quickly changed. Found plans, procedures and prior exercises greatly influenced success with minor issues while handling this event.
- Proactive maintenance in the months and years prior to the event led to SCE&G’s ability to effectively mitigate storm damage and outages to restore electricity.
**Challenges:**

- SCE&G experienced issues with underground infrastructure due to rising flood water.
- Flood conditions hindered response of utility crews.
- Lack of capacity in surrounding storm water management system influenced the water utility system’s pump station operation; the City of Charleston has ongoing capital improvement projects that will address this need eventually.
- Volume of water from the rainfall event challenged localized response and recovery.
- Public ignored road closure information and signs; frequently stating that the detours added significant time to commutes that were found inconvenient.

**Future Needs for Consideration:**

- Work on diverting storm water away from water/wastewater utility system.
- Examine rainfall engineering models in addition to existing hurricane and coastal flooding to improve utility systems by creating redundancies.
- Improve public utility and DOT EOC representation.
- Develop a method to assess public health issues earlier and re-evaluate utility priorities more quickly throughout an event of this size.
- Engineer pump stations for resiliency while working with municipality and storm water management departments to better protect those pump stations from inundation.
- More accurate mapping of expected norms of flooding in the current built environment with an ability to model flooding based upon change in climate, sea level rise, and alterations in the built environment. Utilize existing mapping efforts and products to better inform utilities during mitigation, response, and recovery efforts.
A Look at Future Flooding Events

Doug Marcy, a Coastal Hazards Specialist at the NOAA Office for Coastal Management, presented information to participants on realistic expectations for changes in the region related to climate change and sea level rise (SLR)\textsuperscript{26}. Mr. Marcy’s work focuses on enhancing coastal flooding forecast products and GIS capability, storm surge assessments, and coastal hazards assessment projects (including SLR) contributing to more disaster resilient communities.

Mr. Marcy explained that changes in climate occur when certain naturally occurring gases, such as carbon dioxide (CO\textsubscript{2}) and water vapor (H\textsubscript{2}O), trap heat in the atmosphere causing a greenhouse effect. As the atmosphere warms so do the oceans of the Earth which increase the ocean volume and change ocean circulation patterns. These global changes in combination with local land movement and tidal processes cause sea levels to rise or fall at different rates around the world. This process has happened for millennia but based upon scientific studies has leveled off in the last 6,000 years. During this time, human civilization has developed to highly advanced societies (mainly along vulnerable coastal regions) that burn fossil fuels, like oil, coal, and natural gas thereby adding additional CO\textsubscript{2} to the atmosphere. Science has noted that CO\textsubscript{2} levels have risen faster in the last decade than in the last 400 years.

According to the 3\textsuperscript{rd} National Climate Assessment\textsuperscript{27}, global sea level is projected to rise anywhere from 0.8 to 6.6 feet by 2100, with a more likely range between 1 to 4 feet. Based on input from a consensus report published by NOAA in 2012,\textsuperscript{28} four Sea Level Rise (SLR) scenarios are provided in increasing order based upon extrapolation, ocean warming, moderate ice melt and major ice melt. The range is wide because of the uncertainty of the amount of ice melt contribution in this time frame. Based upon the uncertainties of these multiple outcomes, planning for SLR should focus on the multi-scenario approach and a community’s risk tolerance.

In Charleston, the tidal gauge at the U.S. Custom House has been measuring sea level since the 1920s. In the approximately 100 years since, sea level in Charleston has risen approximately one (1) ft. NOAA tide gauges can be used to monitor sea level change and local land movement. Tools provided by NOAA and the U.S. Army Corps of Engineers enable users to calculate local SLR rates and project the above mentioned relative scenarios. The City of Charleston has used these tools to decide on sea level projections based on levels of risk tolerance using a rolling 50 year projection. Considerations for future risk to the area need to consider what is being built, the expected life span of the structure, and what the intended use will be. The Charleston SLR Strategy\textsuperscript{29} recommends using freeboard of 1.5 ft. for short-term, less vulnerable investment, such as a parking lot and 2.5 ft. for more critical longer term investments, such as emergency routes and public buildings.

Currently, critical thresholds are being reached more often. Higher frequency, low impact coastal flooding from astronomical high tides or “King

\textsuperscript{26} The full presentation is available from the Charleston Resilience Network on the website at www.charlestonresilience.net
\textsuperscript{27} http://nca2014.globalchange.gov/
\textsuperscript{28} http://cpo.noaa.gov/Home/Home/AllNews/TabId/315/ArtID/668/ArticleID/80/Global-Sea-Level-Rise-Scenarios-for-the-United-States-National-Climate-Assessment.aspx
\textsuperscript{29} http://www.charleston-sc.gov/index.aspx?NID=1432
Tides” is happening more often, challenging the capacity of the region’s infrastructure such as the storm water system, and parts of the transportation network. NOAA NWS uses local thresholds to warn for coastal flooding events, typically 7.0 ft MLLW in Charleston Harbor. The addition of rainfall to normal tidal flooding exacerbates flooding due to overwhelmed storm water systems. NOAA Center for Operational Oceanographic Products and Services (CO-OPS) has been tracking how many times local nuisance flood thresholds have been exceeded in the past and how many times they may be in the future. Recent NOAA reports list Charleston in the top 10 cities experiencing nuisance flooding with the expectation of 30 days a year of nuisance flooding becoming the norm by 2020.

New tools and findings and recommendations to address future coastal flooding are now available such as: NOAA’s Sea Level Rise Viewer; the 2015 Technical Mapping Advisory Council future conditions risk assessment and modeling report that provides recommendations to FEMA on how to include climate change in mapping; The Federal Floodplain Management Standard which requires federal agencies to consider current and future risk when taxpayer dollars are used to build or rebuild in floodplains. However, participants were asked to consider that new FEMA coastal digital flood insurance rate maps (DFIRMs) will be issued within the next year. However, the DFIRMs do not consider sea level rise and are based on a 1 percent chance exceedance probability event which limits their applicability to address more frequent events. The new DFIRMs are also based on historical rainfall data and do not take into account potential changes in rainfall patterns resulting from climate change and thus alter the 1 percent chance of an exceedance probability event. Additionally, S.C. DHEC’s social app My Coast: South Carolina is available to the public for download to assist in documenting tidal flooding events and Climate Central’s Unnatural Coastal Floods offers visualization of the SLR issues.

The scientific community and public need to learn more in order to develop guidance that goes beyond current land planning regulations to build smarter and better in the future. Data layers addressing various flooding magnitudes and frequency can provide for data analysis and risk assessment that will inform local jurisdictions of the impacts to expect in the short and long term future. These maps can become part of a climate resilience toolkit that lead to steps for building resilience with robustness, planned and sustainable possibilities.

30 Nuisance flooding is flooding that causes such public inconveniences as frequent road closures, overwhelmed storm drains and compromised infrastructure.
32 The Annual Exceedance Probability is the chance or probability of a natural hazard event (usually a rainfall or flooding event) occurring annually and is usually expressed as a percentage. Bigger rainfall events occur (are exceeded) less often and will therefore have a lesser annual probability
33 http://mycoast.org/sc
Panel: Moving Forward

Moderator:
Dr. Gerry Galloway,
University of Maryland/NAS Resilient America Roundtable

Panelists:
Michael Seekings
Charleston City Council, District 8
Rhonda Jerome
Council District 2, City of North Charleston
Steve Batson
SC Emergency Management Division
Laura Cabiness
City of Charleston
Butch Barfield
City of North Charleston

Charleston35, as the principal and largest city in the Metropolitan area, and North Charleston36, as the second largest city along with the South Carolina Emergency Management Division37 were invited to discuss the challenges of dealing with an event of this magnitude, the short-term governmental agendas that are developing, and the long-term leadership decision-making needed to address future events.

City of Charleston Councilman Seekings stated that the October event was a dramatic occurrence for the City of Charleston. City Council’s immediate future actions are to reach out to the Charleston constituents to ascertain where the community is in understanding this specific event and to educate residents and visitors of the science and engineering of how these events will increasingly effect the region. He stated that the primary challenge is convincing his constituents that the increased risk is an identifiable and quantifiable problem that needs addressed now. For now, City and Council leadership are searching for the right set of tools to assist in educating the public; the residents of the City and the approximate 5 million visitors to the region. Councilman Seekings noted that the challenge was not in communicating specifics to the public but creating the strategy and messaging to convey that this topic is among the top of the top ten issues that need to be addressed by the community in order to gain consensus. As a first step, the City presented its Sea Level Rise Strategy in December 2015 which details almost 80 initiatives that the City reports are necessary to ensure Charleston’s ability to withstand the rising sea level.38 Because the Charleston Historic District is well established, solutions for that area will need to focus on adaptation as much as relocation and the consideration of increasingly larger populations in this area. In order to address adaptation, the City will place emphasis on the importance of more accurate mapping, drainage studies, and engaging more dialogue on local and regional land planning. To this end, Charleston recently voted for a property tax increase to put money aside to deal with effects of climate change.39 Since 1989, the City of Charleston has invested significantly in storm water management improvements and is projected to spend more than $235 million through ongoing efforts. Along these lines, the City of Charleston has plans to buy out approximately 40 houses as part of post-disaster mitigation efforts but this requires between $4 and $6 million to complete. Unfortunately, some of these owners were retired

35 http://www.charleston-sc.gov/
36 http://www.northcharleston.org/
37 http://scemd.org/
38 The Sea Level Rise Strategy was adopted by Charleston City Council on April 26, 2016
39 http://www.postandcourier.com/article/20151207/PC16/151209532/1009/city-residents-face-tax-increase-for-drainage-improvements
individuals that have experienced some type of flooding event and related damage four or five times since 2008 but did not carry flood insurance. To mitigate some of these issues in the future, the Charleston Department of Public Service is looking into establishing specific design standards based on the specific individual drainage basin characteristics. The City will be completing drainage studies in areas that are slated to grow in the near future and develop pertinent development standards to prevent negative impacts from climate change, rising tides and storm water runoff.

City of North Charleston Councilwoman Jerome stated that the worst hit area in North Charleston was an older neighborhood populated by a more elderly group that City services managed to evacuate without difficulty. The City also took steps to pre-stage public safety services into those areas before, during, after the event to assist citizens as much as possible. North Charleston Council’s immediate future steps are to encourage citizens to obtain flood insurance. The City will communicate through existing channels that include monthly neighborhood meetings and email communication. For the City, the Council plans to continue their sound budgeting practices to maintain a healthy General Fund in anticipation that this can and will happen again. One the biggest problems experienced in North Charleston was that many constituents did not have flood insurance. North Charleston is investigating the development of a communications strategy to communicate flood risks and convince constituents of the need for flood insurance. One of the challenges faced is that the properties that flooded were not in mapped flood zones which precluded residents’ consideration for flood insurance prior to this event. The Council is looking at how to strengthen their relationship with neighborhood associations and their resources in order for these associations to better serve their immediate community. Looking at future actions, North Charleston plans to look at a mix of population relocation and encouraging residents to purchase flood insurance. However, City officials recognize that flood insurance can be cost prohibitive for many homeowners.

The South Carolina Emergency Management Division’s (SCEMD) Chief of Staff, Steven Batson, began by stating that SC had not seen an event of this magnitude since Hurricane Hugo in 1989. Since the October event, the SCEMD is working to address gaps in policy, information, studies, projects, and education in order to assist recovery efforts. For instance, $86 million has been awarded to South Carolinians with over 100,000 households seeking FEMA Individual Assistance monies. Due to FEMA limitations, roughly 32,000 of those applications have received funds thus far. In the FEMA Public Assistance grant funds, the Division is looking at over 1,000 projects totaling up to $270 million and there are cost share requirements within that program.

The State will qualify for FEMA’s Hazard Mitigation Grant Program (HMGP) funding potentially reaching $40 to $50 million. Overall this appears small but allows for local and regional coalitions, similar to CRN, to influence how those monies are spent. The spend plan, proposed by the state Interagency Coordinating Committee, outlines the state’s priorities for hazard mitigation funding. Community suggestions are essential to refining these priorities for potential project applicants. SCEMD is receiving input via email at mitigationteam@emd.sc.gov. It was noted that these funds cannot be spent on repairing the various dam failures in the state. Rather, state-regulated dams may increase capacity or conveyance, or otherwise increase their ability to prevent flooding. The SCEMD anticipates at least one quarter of these monies may be used to fund mitigation of houses in flood prone areas. Projects may include the acquisition and demolition or elevation of severely or repetitively damaged or
otherwise flood-prone properties. Municipalities are tasked with determining the local mitigation needs, pre-registering their intent with the State, and submitting in the pre-application process to apply for portions of this $50 million by May 5, 2016. All other projects that measurably reduce risk associated with future disasters will comprise almost half of the funding. These projects may include, but are not limited to, generators, structural retrofits, nonstructural flood control, projects involving engineered beaches, and all other projects that are eligible in accordance with the 2015 Unified Hazard Mitigation Assistance Guidance. These projects will be ranked by Benefit-Cost Ratio (BCR), with priority given to the most cost beneficial projects.

SCEMD intends to continue long standing practices of comprehensive planning and exercises that heavily influenced the successful actions during this event. Mr. Batson stated that disasters begin and end locally and that resiliency does also. The SCEMD sees CRN activities as laying the ground work for resiliency in this region with a strong ability to affect change in the community.

**Best Practice:**

- Substantial efforts occurring in the region to address sea level rise. The CRN effort was noted as vital to help spearhead community involvement and foster collaboration of future funding opportunities.

**Challenges:**

- Affected businesses and citizens experienced limited monetary payouts from disaster damage claims to FEMA. SCEMD had encouraged everyone to apply; resources now are encouraging anyone that received a refusal letter to dispute the determination.

**Future Needs for Consideration:**

- Conduct a study that addresses flood area mapping but also acknowledges future, i.e. 30+ years or more, to ensure municipal leadership makes informed decision regarding what is right and fair to the citizens.
- Diligently keep citizens aware of risk and encourage them to have proper and adequate insurance coverage.
- Change policies at federal level to address parameters on infrastructure improvements in disaster prone areas.
- Develop flood insurance programs that are understandable and affordable.
- Complete and maintain sound mitigation planning at the regional level.
- Request a federal regional study of sea level rise.
- Work on a disaster case management plan that will help non-profits assist applicants with future disaster application processes.
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Symposium Summary and Wrap-Up

The purpose of this Symposium was to explore the Charleston region’s resilience through the lens of the major flooding event in October 2015. The Symposium fostered information sharing and lessons learned across key critical infrastructure sectors where practices, partnerships, and opportunities for increased resilience to future flooding events were discussed. The message throughout the day was resiliency - “The ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events,” (NAS 2012).

Resilience planning is not new to the Charleston region; Hurricane Hugo focused the area’s jurisdictional agendas towards thinking about resiliency. In the decades following Hurricane Hugo landfall (1989), many efforts and improvements have been made to plan for and mitigate against disasters throughout the region. Chronic hazards continue to challenge the region’s infrastructure, economy, and safety. Without adequate future planning and with incremental interventions, the Charleston region’s ability to remain resilient to catastrophic and chronic events will be diminished. Effective long-term regional preparedness and resilience planning requires a concerted and coordinated effort among governmental entities, private industries and owner/operators of critical infrastructure.

The Charleston region has benefitted from the work of many institutions and organizations on resiliency issues in the past; it needs to continue to take advantage of the multitude of resources available. This effort should include utilizing science, especially climate and flooding topics, and information such as state-of-the-art design standards to inform decision-making. However, information should be refined within the scope of the region’s needs, appropriately timed, and to the right spatial scales to meet the needs of the region. The Charleston region needs to continue thinking further into the future – where climate change and sea level rise are inevitable - when making decisions and apply more caution than in the past.

Key points underlying the Symposium’s discussion:

- Partnerships and relationships are critically important. Where they do not currently exist, they need to be built and developed; where they exist they need to be nurtured, expanded and strengthened. No one person, committee, or jurisdiction should plan this effort in a vacuum. Develop coalitions and connections at the grass-roots level to discuss and align common goals, themes, and messaging.

- Public and private sector leaders and managers must:
  
a. Leverage resources, information, tools, technologies, and people from all aspects of the area and in conjunction with State and Federal partners to maximize future decision making. Analyze these resources to identify information and capability gaps that need to be addressed. Cultivate these resources to fill in the gaps and to accomplish priority needs as they are uncovered.

b. Build a cooperative environment where everyone learns from the available research, others’ experience, and related training.

c. Develop effective communication and messaging of technical information, the associated risk, the potential ramifications, and efforts needed to prevent, mitigate, and respond.
d. Create awareness within every community by addressing the multiple audiences involved, understanding of the pathways to reach those audiences, and the most effective communication methods to reach them.

e. Deliver the resilience message proactively, consistently, and continuously to the community so that the public better understands vulnerabilities and how to prepare and respond.

f. Anticipate future events by planning through regional partnerships and preparation, proactive decision making and implementation efforts that coordinate across the region for the maximum benefit of all. This includes preparing for multiple projected scenario types and the potential for multiple outcomes related to each.

g. Instill that responsibility for the future success of the area starts with all taking ownership to be a part of the resiliency planning and implementation.

The Charleston Resilience Network works to foster a unified strategy and provide a forum to share information, educate stakeholders and enhance long-term planning decisions that result in the implementation of effective pre-hazard mitigation strategies and post-hazard recovery efforts. As an initial step, the S.C. Sea Grant Consortium, on behalf of the CRN, received a Regional Coastal Resilience Grant from the National Oceanic and Atmospheric Administration (NOAA) to help community leaders plan for and adapt to the area’s increasing flood challenges through the development of more robust and localized flooding models that can be used to plan infrastructure improvements in the Charleston, S.C. region. CRN invites everyone, public and private sector stakeholder organizations, that participated today and those that read this report to join this conversation at www.charlestonresilience.net
Appendices

Appendix A – Symposium Agenda

Understanding the 2015 Charleston Floods
A Symposium Hosted by the Charleston Resilience Network
in Partnership with the National Academy of Sciences
February 23, 2016
8:30 AM – 4:30 PM

Location: Gaillard Center
City’s Public Meeting Room, 1st Floor
2 George Street

OBJECTIVE

To assess the Charleston region’s resilience through the lens of the major flooding in October 2015; allow for information sharing and lessons learned across sectors; and discuss practices, partnerships, and opportunities for increased resilience to future flooding events

8:00 – 8:30 am Welcome and Registration
8:30 – 8:45 am Opening Remarks
   Speakers:
   • Lauren Alexander Augustine, Resilient America Roundtable, National Academy of Sciences
   • Dan Burger, S.C. Department of Health and Environmental Control/Chair, CRN
8:45 – 9:15 am Overview of October Flooding Events
   Speakers:
   • Rick DeVoe, South Carolina Sea Grant Consortium/CRN
   • Ron Morales, National Weather Service
9:15 – 10:30 am Panel 1 - Public Safety and Health
   Moderator:
   • Ellis Stanley, Ellis Stanley Partners/Resilient America Roundtable
   Panelists:
   • Deputy Chief Tony Elder, Charleston Police Department
   • Chief Karen Brack, Charleston Fire Department
   • Louise Welch Williams, American Red Cross Lowcountry Region
   • Carl Benton, Charleston County EMS
10:30 – 10:45 am Break
10:45am – 12:15pm  **Panel 2 - Business and Economic Impacts**  
*Moderator:* 
- Gerald McSwiggan, U.S. Chamber of Commerce Foundation/Resilient America Roundtable  
*Panelists:* 
- Perrin Lawson, Charleston Convention and Visitor’s Bureau  
- Ray Harbour, Small Business Administration  
- Frank Knapp, SC Small Business Chamber of Commerce  
- Donald Waters, FEMA Region IV National Flood Insurance Program

12:15 – 1:15 pm  **Lunch (provided)**  
*Speaker:* 
- Norm Levine Ph.D., College of Charleston Santee Cooper GIS Laboratory and Lowcountry Hazards Center

1:15 – 2:30 pm  **Panel 3 - Critical Infrastructure/Lifelines**  
*Moderator:* 
*Panelists:* 
- Michael Black, S.C. Department of Transportation  
- Kent Scarborough, Charleston Water System  
- Cedric F. Green, Charleston Electric Operations, SCANA

2:30 – 2:45 pm  **Break**

2:45 – 3:15 pm  **Primer on Future Flooding**  
*Speaker:* 
- Doug Marcy, NOAA Office for Coastal Management

3:15 – 4:15 pm  **Panel 4 - Moving Forward**  
*Moderator:* 
- Dr. Gerry Galloway, University of Maryland/Resilient America Roundtable  
*Panelists:* 
- Michael Seekings, Charleston City Council, District 8  
- Rhonda Jerome, Council District 2, City of North Charleston  
- Steve Batson, SC Emergency Management Division  
- Laura Cabiness, City of Charleston  
- Butch Barfield, City of North Charleston

4:15 – 4:30 pm  **Meeting Summary and Final Wrap-up**  
*Speaker:* 
- Rick DeVoe, South Carolina Sea Grant Consortium/CRN
Appendix B – Best Practices, Challenges, and Future Considerations

**Best Practices:**

- Ability to seamlessly shift monitoring, analysis and reporting activities to another location during the event.
- Incorporation of Incident Command System (ICS) by all response partners during normal daily response operations led to successful management and outcomes during this event.
- Emphasis on pre-existing relationships and daily collaboration between all response partners led to successful outcomes despite challenges encountered.
- Existing mutual aid agreements functioned seamlessly during the event.
- South Carolina Emergency Management Division Essential Support Function 24 assigns management and staffing of an Emergency Operations Center (EOC) seat for non-infrastructure based business and industrial enterprise representation during a disaster; this position is staffed at the State and county level EOCs but not the City level.
- Existing mutual aid agreements with out-of-area utilities provided a seamless increase in resources during peak needs that led to quicker return of service throughout the region.
- Existing positive relationships between utility and DOT crews and EOCs, policy, fire and EMS departments led to quicker responses to utility service needs.
- Utilization of monthly utility bills and other regular customer communications to disseminate risk information led to a more informed and cooperative public.
- DOT and public utility PIOs used traditional and social media effectively throughout the event to convey updates and situational awareness.
- Agile thinking of personnel was attributed to prior planning and exercises drove ability to adapt and respond as the event quickly changed. Found plans, procedures and prior exercises greatly influenced success with minor issues while handling this event.
- Proactive maintenance in the months and years prior to the event led to SCE&G’s ability to effectively mitigate storm damage and outages to restore electricity.
- Substantial efforts occurring in the region to address sea level rise. The CRN effort was noted as vital to help spearhead community involvement and foster collaboration of future funding opportunities.
Challenges:

- Citizens did not heed evacuation warnings.
- Drivers continued to drive through flood waters.
- Shortfalls in alternate resource requirements necessary for rescue and shelter of citizens with disabilities, pets, etc.
- For a short period of time the ARC experienced difficulty in delivering blood to local hospitals in a timely manner.
- Rapidly changing water level conditions impeded responder access at times.
- Loss of facility communications during the event.
- Many NFIP policyholders did not fully understand that damage caused by wind and localized ponding of rain water is not considered flood damage which limited the ratio of insurance claims to payout of damages.
- Many business owners and citizens did not understand that damage caused by flooding is not covered by typical homeowner policies except in the case of a few very high limits policies.
- During disasters, schools may close resulting in working parents remaining at home to care for their children. While businesses in the region did not report directly that they were impacted, many businesses adjusted work schedules to accommodate altered school schedules and personal needs of employees.
- High psychological stress immediately following an event of this size frequently hinders business owners from fully grasping and utilizing SBA and FEMA/FIMA services.
- SCE&G experienced issues with underground infrastructure due to rising flood water.
- Flood conditions hindered response of utility crews.
- Lack of capacity in surrounding storm water management system, influenced water utility system’s pump station operation; the City of Charleston has ongoing capital improvement projects that will address this need eventually.
- Volume of water from the rainfall event challenged localized response and recovery.
- Public ignored road closure information and signs; frequently stating that the detours added significant time to commutes that were found inconvenient.
- Affected businesses and citizens experienced limited monetary payouts from disaster damage claims to FEMA. SCEMD had encouraged everyone to apply; resources now are encouraging anyone that received a refusal letter to dispute the determination.
**Future Needs for Consideration:**

- Improvements in mapping and modeling to more accurately depict rainfall patterns and flood prone areas throughout the region.
- Modify dispatching protocols and establish their implementation early or in anticipation of an event of this size to improve responses.
- Utilize unique regional resources and formalize relationships with their owners; for example, utilize harbor pilots and assets to ferry hospital personnel during disasters.
- Continue to map flood prone areas throughout the region and delineate between tidal coastal flooding and rainfall flooding, where possible.
- Through their ongoing initiatives propose the Charleston Sea Level Rise Task Force take identified flooding projections and overlay to regional mapping to drive future discussions and regional planning.
- Cross train between police, fire and emergency medical service departments on swift water rescue.
- Track and apply for more grant opportunities especially for funding of disaster and related specialized training needs that are frequently minimized or cut from normal operating budgets. Efforts may require assignment of a grants coordinator position.
- Application of these best practices, challenges and needs to better inform the region’s all-hazards planning especially against an earthquake scenario.
- Adjust business marketing efforts to use coordinated positive social media advertising/marketing across all business sectors that includes the use of digital time stamped media to accurately portray area conditions and counter any negative messaging.
- Anticipate increase in telephone calls and electronic contacts from client bases requesting area status and information by adding personnel or establishing continuity of communications outside of the affected area to ensure messaging is controlled and positive.
- Insurance reviews for small businesses should recommend insurance options for lost revenue coverage which is different than physical damage coverage.
- Communicate better that FEMA flood maps are a tool outlining Special Flood Hazard Area (SFHA), however flooding can occur anywhere. Business owners and citizens have the option that if they are not located in a SFHA, a Preferred Risk Policy can be purchased that will pay, even if no Presidential Disaster Declaration is given for an event unlike other Federal Disaster Assistance products which do.
- Identify the most appropriate and trusted organization or entity in the community to effectively communicate risk and insurance options to small businesses and ascertain what information these businesses most need.
- Investigate the potential to tap various regional business continuity professionals from large corporation to assist small businesses in creating or improving their business continuity plans.
- Train the region’s professional insurance agents, who in many cases are the only contact business owners and citizens have, to effectively discuss the flood risk. Private insurance companies frequently have vast amounts of risk reduction information. For
example Zurich Insurance’s Insurance and Risk Management efforts\textsuperscript{40} or the Insurance Institute for Business and Home Safety.\textsuperscript{41} However, individual agents at the local level may not be aware of these programs within their industry. Well informed flood insurance agents can assist their clients in making informed decisions on risk and risk mitigation opportunities. Work on diverting storm water away from water/wastewater utility system.

- Examine rainfall engineering models in addition to existing hurricane and coastal flooding to improve utility systems by creating redundancies.
- Improve public utility and DOT EOC representation.
- Develop a method to assess public health issues earlier and re-evaluate utility priorities more quickly throughout an event of this size.
- Engineer pump stations for resiliency while working with municipality and storm water management departments to better protect those pump stations from inundation.
- More accurate mapping of expected norms of flooding in the current built environment with an ability to model flooding based upon change in climate, sea level rise, and alterations in the built environment. Utilize existing mapping efforts and products to better inform utilities during mitigation, response, and recovery efforts.
- Conduct a study that addresses flood area mapping but also acknowledges future, i.e. 30+ years or more, to ensure municipal leadership makes informed decision regarding what is right and fair to the citizens.

- Diligently keep citizens aware of risk and encourage them to have proper and adequate insurance coverage.
- Change policies at the federal level to address parameters on infrastructure improvements in disaster prone areas.
- Develop flood insurance programs that are understandable and affordable.
- Complete and maintain sound mitigation planning at the regional level.
- Request the Army Corps to conduct a regional study of sea level rise.
- Work on a disaster case management plan that will help non-profits assist applicants with future disaster application processes.

\textsuperscript{40} \url{http://www.zurichna.com/}
\textsuperscript{41} \url{https://disastersafety.org/}
Appendix C – Hurricane Hugo Overview

Hurricane Hugo\(^2\) originated as a tropical wave which moved off the west coast of Africa on September 9, 1989 that was soon classified as Tropical Depression Eleven southeast of the Cape Verde Islands. Tropical Depression Eleven steadily intensified to become Tropical Storm Hugo on September 11 and two days later reached hurricane strength 1265 miles (2035 km) east of the Leeward Islands that gradually turned to the west-northwest due to a low-pressure area to the south while the storm strengthened to a category 2 hurricane on the Saffir–Simpson Hurricane Scale. Hugo began to rapidly deepen and accelerate to the northwest soon after exiting eastern Puerto Rico. On September 18, the hurricane was located a couple of hundred miles east of Florida when it tracked more northward in response to a steering flow associated with an upper-level low pressure area that was moving across the southeastern United States. Hugo strengthened to a Category 4 hurricane and made landfall on September 21 at Isle of Palms, South Carolina. The storm continued inland, weakening to a Category 1 hurricane as the eye passed over Charlotte, North Carolina, to a tropical storm later on the same day over central North Carolina, and continued inland and northward until it reached a remnant low on September 23.

As a Category 4 hurricane, the storm primarily caused damage from strong winds. In downtown Charleston, sustained winds of 87 mph (140 km/h) were reported with gusts of 108 mph (174 km/h). The local National Weather Service office at Charleston International Airport recorded sustained winds of 78 mph (126 km/h) and gusts up to 97 mph (156 km/h). The strongest wind gust of 120 mph (190 km/h) was recorded by the Snow Goose, which was anchored along the Sampit River near Georgetown. Extensive property damage was reported in several counties, especially in the South Carolina Lowcountry and the Grand Strand. More than 227,800 residences experienced power outages.

Storm surge and rough tides also caused extensive damage, especially in Charleston County. The highest storm surge observed was 20.2 feet (6.2 m) at Seewee Bay near McClellanville. Storm related waves re-sculpted beaches with sand carried and piled dozens of yards away from normal locations. A portion of the Ben Sawyer Bridge that connects Mount Pleasant to Sullivan's Island collapsed due to strong winds and storm surge. On Sullivan's Island, water destroyed two or three rows of beach houses in some areas. On Isle of Palms, boats harbored at the marina were washed ashore and piled into a large heap culminating in nearly $270 million in losses.

No widespread flooding was reported, though a combination of rain and strong winds resulted in significant agriculture losses. The Red Cross estimated that 3,307 single family homes were destroyed, 18,171 suffered major damage, and 56,580 sustained minor impact. Additionally, more than 12,600 mobile homes and 18,000 multi-family houses were either damaged or destroyed. Damage from Hurricane Hugo in South Carolina was estimated at $5.9 billion.

Appendix D – Lowcountry Hazards Center

Dr. Norman Levine, a geology professor at the College of Charleston and Director of the Lowcountry Hazards Center (LHC), was invited to discuss the LHC work as it pertains to and supports long term resiliency planning in the region.

Lowcountry Hazards Center Overview

The Lowcountry Hazards Center (LHC) integrates and communicates natural and social sciences research and knowledge through the development and implementation of hazard assessments information and strategies to assist regional policy makers and emergency management professionals increase the Lowcountry community’s resilience. The Lowcountry is vulnerable to a number of natural hazards, including devastating hurricanes and earthquakes. The College of Charleston established the Lowcountry Hazards Center with two overarching goals:

- To foster research, education and communication among College of Charleston faculty, hazard professionals, community leaders, and policy makers about natural hazards, and
- To increase the resiliency of the region to future geological and meteorological disasters [i.e., increased robustness of systems and processes (pre-disaster) and faster recovery (post-disaster)].

The Center’s work informs county and municipal governments on a wide range of hazards – hurricanes, sea level rise, tidal and periodic flooding, earthquakes, coastal erosion and channel maintenance, salt water intrusion marshland degradation, infrastructure degradation, and land subsidence – through mapping visualization and modeling.43 LHC efforts draw from the wider academic community for inspiration and direction particularly Dr. Susan Cutter’s work at the University of South Carolina and the Hazards and Vulnerability Research Institute. As her work points out, resilience is more than specific hazard focus. Socio-economic issues such as at-risk populations, population growth, business stability, and economic sources like tourism and the port highly influence this region’s resiliency. LHC developed a set of priorities based upon the region’s needs and resiliency influences. Their research supports: the region’s integrated management structure to develop a common operating picture; coastal development strategies towards common regulations and enforcement; and, hazard mitigation prioritization. LHC is investigating developing a common operating platform to disseminate information out to emergency managers and responders during an event. The Center’s coastal development strategies work focuses on how to protect and better integrate human living environments along the water. For hazard mitigation prioritization, the LHC assists municipalities in making informed decisions regarding where projects and funding will be most effective by providing quantifiable research and mapping. This rainfall and flooding event afforded the LHC an opportunity to combine real world information with tidal flow knowledge to validate and derive more fine-tuned visualization mapping models of the region.

The October 2015 Event

Beginning Wednesday, September 29, the State and county EOCs began standing up in support of what was anticipated to be heavy rainfalls based upon the NWS Charleston predictions. As previously stated by Mr. Morales, this weather event was

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43 Dr. Levine took a moment to thank the following students most involved in the LHC mapping, research, and visualization: Alex Braud, Corey Callahan, Kelsey McClellen, Andrea Sassard, and David Treadway.
anticipated to be historic, i.e. 1,000 year event, based upon standard charts available that are statistically built based upon prior rainfalls and our understanding of their recurrences. However as pointed out in earlier presentations, the public misunderstands what a 1,000 year rainfall event truly means. To start, a three day 1,000 year event for this region was predicted to be 17.1 inches of rainfall and a four day 1,000 year rainfall event predicted to be 17.5 inches of rainfall. In reality, Boone Hall Plantation, just north of Mount Pleasant, Charleston County reported more than 24 inches of rain for the four day event ending on Sunday morning.

Dr. Levine noted that the difference between 17 inches and 24 inches of rainfall is significant enough of an event at a normal high tide to have substantially flooded the area; this event actually occurred at a perigean king tide morning creating even greater flooding issues. The rainfall totals for this event dramatically change our perceptions of prior predictive models.

Dr. Levine noted that the public frequently forgets that the number of extra flood days a year are increasing significantly over time but the concerns are not just extra flooding from tides and weather systems. The planet is experiencing extremes in weather precipitation overall where either there is too much precipitation or not enough.

The chart above shows a significant averaged rise in precipitation events and illustrates the more variability and extremes in both directions – colder colds with warmer warms and more rain. In reality, the October event represents some of the top five wettest days on record in South Carolina and comparably measures to the wettest five days recorded in other parts of the country. It is a reminder that this level of rainfall happens elsewhere however it is usually connected to tropical storms. It is possible that a future hurricane could produce the same amount of rainfall in the region but researchers now understand that the clouds can just align to produce these amounts.

When viewing pictures of downtown City of Charleston during the event, it was obvious that the
peninsula was experiencing major flooding problems. High precipitation coupled with high tides are guaranteed to cause flooding in that area.

For instance, the picture of the truck in the above slide shows the Battery just off of Wentworth proving that these flooding problems were across the peninsula. The area had freshwater and salt water flooding into crawl spaces and first floors throughout the peninsula. Additionally, the region’s rainfall and flooding issues extended to roads and bridges washing out but not to the same degree that Columbia, S.C. experienced.

Dr. Levine explained that the earthquake zone in Summerville is of particular concern during a significant rainfall event. Extremely saturated soils from a similar rainfall event type occurring just before an earthquake could worsen damages significantly. Two days prior to the 1886 earthquake, Charleston experienced a tropical storm. While earthquakes and storms are not associated or considered cascading events, they can occur at the same time. Concern heightens in the emergency management realm over potential for major hazards happening concurrently.

Flooding in the West Ashley area was expected for the amount of rainfall received; however as illustrated in the following picture, flooding events can quickly become an environmental event also.

Resilience is not only applicable to the population but also the

built environment and infrastructure that facilitate the population living and working in the region.

Regular tidal movement affects the transport of stormwater sometimes dramatically. When tides are low, storm drains function as optimally designed sometime causing hazards to pedestrians or cyclists; sometimes enough to pull the bicycle over. When water flows well it also pull garbage and trash from the surrounding area that eventually clogs the storm water drain gate.

Part of the region’s draw for people moving to the area is the natural environment. Outside of downtown Charleston, the regional beach and
coastal areas were affected. If the dune structure completely erodes, the beach no longer exists.

The LHC culled pictures of places known to have flooding to compare to prior generated visualization maps. Those maps were a product of an earlier project that began 5 to 6 years ago to map downtown Charleston to gain an understanding of how the area may flood based upon the rising sea level predictions.

Charleston has been experiencing sea level rise, as pointed out earlier today, more quickly than many other places along the Eastern sea coast and thanks to Dan Burger, Director of Coastal Services Division at DHEC Ocean and Coastal Resource Management, the area better understands King Tides. The population is paying more attention but that is directly attributable to messaging and branding by the many groups providing the flood message. It is important to understand that the public takes interest when they understand the problem and the message being delivered. For example, all the work messaging about king tide allows citizens to understand that they may experience flooding problems at specific times throughout the year. The following picture shows what flooding happens with just a regular king tide along where Lockwood meets Broad Street. A regular King Tide on a sunny day with no rainfall will flood areas. This type of nuisance flooding will happen more and more frequently as sea level rises.

As LHC has discovered, Charleston is a land of hidden streams. Historically, the Charleston area built out land as needed by filling in marshland. Charleston had been utilizing this land use method since early colonization when cobble and ballast stones arrived in the port but by British rule it was unlawful to dispose of them on land. This set the precedent for rubble disposal after the 1886 earthquake. The next slide below shows an 1800s Charleston map overlaid on Charleston’s footprint today. The peninsula was a much smaller footprint before and note that much of the flooding experienced today
follows some of these old and buried streams. The real take away is that the Charleston area has a problem because the land was originally marsh. The common misconception is that Charleston has a population growth problem. In reality filled marshland, population growth, and various hazards intersect to form the problem. Risk elevates when these impact people. Building and construction is not only occurring east of the Cooper River where it is most obvious visually. West Ashley is considered the fastest growing area. As far as new growth and building, a suburban, urbanized corridor is emerging along the Ashley River up into Dorchester County. This growth follows a stream whether intentionally or not.

The first series of models LHC created tried to use the tidal height along with the information about how tides affect storm water during rain storms. This multi-layer depth map presents one of the stages modeled to show heights, distances, density to round out our understanding of water movement.

The corner of Morris and Jasper just pictured provides an example of the LHC mapping capability. Notice the fountain nearly at the center of the model in the upper left and in the lower right picture. The model was fairly accurate in its prediction. Another example is the corner of Bennett and Gadsden. The picture in the upper left shows a dry section of the parking lot, a wet section of parking lot, and the dry road beyond which closely corresponds with the model in the lower right of the slide. LHC feels confident that these models are accurate enough in their predictions at this point.

Yet another example is the gas station on Huger and King. When looking at the picture on the left, you
notice that just before the bushes the water level is low enough to see the grass through the water. The LHC models predicted little to no water on that side of the street. The model on the right shows the water all moves down toward the gas station. Gas stations notoriously have multiple environmental hazards – tire particles, spilled drops of gasoline, brake fluid leakage, antifreeze – that are now flushed into the neighborhood. These are issues not typically thought of during high water and flooding.

The last example is 8.2 feet of water at the Battery shown below. This flooding event confirmed the model showing the water on the street side of the retention wall.

The LHC research efforts are part of the region’s actions to be proactive in understanding what communities can expect during these events. The LHC mapping allows emergency managers to anticipate problems in different areas and prioritize resources accordingly instead of sending out a patrol to check and make determinations about area conditions and needs.

In practical application, the LHC created models using HAZUS44 and flood modeling programs to determine 500 and 1000 year storm events for all of the major waterways in Dorchester County and model the effect on the transportation system to create an application for the emergency manager. During the October event the EM was proactively closing roads and intersections throughout Dorchester County based upon this application on his telephone. In the application, the EM could zoom into a specific area and see what transportation assets are affected. The EM could turn on and off the various asset layers to gain a more accurate understanding of the situation. If the predictive model indicated 6 to 10 inches of rainfall, the EM knew to call for road closures since this water depth strongly affects vehicles driving capability. This is an

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44 HAZUS is a nationally applicable standardized methodology that contains models for estimating potential losses from earthquakes, floods and hurricanes using Geographic Information Systems (GIS) technology to estimate physical, economic and social impacts of disasters. https://www.fema.gov/hazus/
ongoing LHC effort in support of the community and region to make the area more resilient.

The LHC created a site during the rainfall event to show current condition mapping that was posted for students to use. The site had live feeds from NOAA, live information on the gauging stations, and the traffic alerts from police. LHC researchers could zoom into an area and know how it was being affected. Looking outward from this event, the communication piece is key to what needs to be done for any type of community in the future.

The next planned step for LHC efforts is to develop full three dimensional models for the downtown Charleston area. Student project related to LHC are creating 3-D models as well how to push Information forward

that entails enormous amounts of data. For example, it took the students approximately 2 to 2.5 weeks of solid work to produce the above graphic but took them exponentially longer to prep the data, collect the information and format it appropriately to feed this 3-D model. However, they find that it is taking less and less time to do this because data are being packaged in formats more easily usable for these applications. This is a fully functioning 3-D model where layers can turn on and off to show water levels at different heights and see when water impinges or touches buildings. Impingement on buildings is important because of its structural material – cinder block, cement, wood – will degrade when repeatedly wet and dried. By creating 3-D visualizations and 3-D models, infrastructure degradation risk can be better communicated to the local community.

In discussion with the audience, Dr. Levine noted that downtown Charleston mapping worked at a fairly sophisticated level that we now want to apply to the other counties. LHC has a portal for geospatial data and maps that can be accessed from the CRN website to share information with the city and the counties. The various mapping projects utilize a mix of modeling that begin with a bathtub model but a few incorporate the bathtub model coupled with tide stage and precipitation volumes. The researchers are also starting to incorporate the hydraulics of head grass modeling and HAZUS which is the Army Corp of Engineers standard. The researchers actually are working on a 1 foot resolution LIDAR model for the entire county right now. This model already exists for Dorchester and most of Berkeley Counties that is a fairly detailed flood mapping however the Charleston map is more complicated due to the area’s hydrology. When asked about the hydrology difference, Dr. Levine explained that the Charleston water sheds are often interconnected especially in the marsh and low lying areas allowing for meandering, cross cut and cut through water flow so channelized that we are draining from one watershed into another watershed in many places. This added complexity translates to an inability to apply a standard digital elevation model and build a hydrologic model out of it. A researcher must take into account not only storm water and channeling but also roads. More is being caught in these models but still more needs to be considered and incorporated. For instance, the regular tidal cycle complicates modeling. If water flow comes down river while tide is out, water moves out easily. If water flows down river while tide is in, the water cannot push out and
backs up. This constant ebb and flow of water in Charleston is not just a simple hydraulic problem.

Based on pictures taken at the height of the rainfall and flooding, knowing the approximate time the picture was taken, the LHC researchers were able to map the storm height at that particular time and the volume of water received for that area as a “back of the envelope” calculation of how much water would have fallen in that area based upon the precipitation and the general area. Dr. Levine suggested several resources for further reading displayed here.

- **Historic Flooding - October 1-5, 2015 NWS**
- **Weather Channel Compilation: South Carolina’s Catastrophic Floods Caused By One of the Most Prolific Rainfall Events in Modern U.S. History**
- **Thousand-year deluge in South Carolina**
- **The meteorology behind South Carolina’s catastrophic, 1,000-year rainfall event**
- **Charleston Resilience Network**
Appendix E – Speaker and Panelist Biographies

Captain Brian Ambrose, Charleston Police Department
Captain Brian Ambrose serves as the Division Commander of the West Patrol Division, which includes the West Ashley Patrol Team, the Traffic Unit, K-9 Unit, School Resource Officers and Harbor Patrol along with collateral commands include the Civil Disturbance Team, Honor Guard, and Underwater Recovery Team. He assists as a secondary Emergency Management officer for the Department along with various ICS staff roles during major incidents and natural disasters. Captain Ambrose began his career as a full time officer in Charleston in 1997, serving over the years as a patrol officer, supervisor in several patrol Teams, a supervisor in Central Detectives, and a Command Duty Officer. Additionally, he served as a law enforcement supervisor for the Charleston County COBRA team and as a Clandestine Lab Technician. He is a Specific Skills Instructor through the SC Criminal Justice Academy, and has delivered courses on a variety of topics such as Defensive Tactics, Ethics, Ebola response, Law Enforcement Response to Weapons of Mass Destruction, Active Shooter, and Incident Response to Terrorist Bombings. He is also a certified Incident Command System Instructor through FEMA’s Emergency Management Institute. Captain Ambrose graduated from the SC Criminal Justice Academy with honors in 1997, the 2009 Carolina Command College sponsored by the FBI, and recently from the Police Executive Research Forum’s 60th session of the Senior Police Management Institute. Captain Ambrose holds a Bachelor’s Degree in Psychology with double minors in Sociology and Government from Erskine College and is a native of the Charleston area where he attended Summerville High School.

Butch Barfield, Emergency Preparedness Coordinator, City of North Charleston
Butch Barfield is the Emergency Preparedness Coordinator for the City of North Charleston; a role he has filled since the City created the position early in 2013. He advises city staff on operational and technical matters related to the City’s emergency management programs along with the development of policies and operating procedures for the implementation of public safety programs and homeland security activities in the City. Prior to this position, Mr. Barfield served as a Deputy Chief of the City of North Charleston Police Department from 2005 until late 2012.

Steve Batson, Chief of Staff, SC Emergency Management Division
Steven Batson currently serves as the Chief of Staff for the South Carolina Emergency Management Division. Duties include supervision of the Division’s preparedness, operations, logistics, administration/finance and recovery/mitigation sections. He has been with the Division since 2001 except for a one-year break in service while he worked for the South Carolina Law Enforcement Division’s Office of Homeland Security in 2011-2012. Steven graduated from the University of South Carolina with a Bachelor Degree in Marine Science and a Master of Arts in Teaching in Biology. He also holds a Leadership South Carolina certificate from Clemson University and a Master Exercise Practitioner certification from FEMA’s Emergency Management Institute.

Carl Benton, Shift Commander, Charleston County Emergency Medical Services
Carl Benton is a Shift Commander with Charleston County Emergency Medical Services and has served in that capacity for the past 15 years. During that time, he has gained considerable experience managing mass casualty
and large scale EMS events. He was directly involved in the CCEMS medical coordination and response planning for the flood events in October, 2015. He holds several EMS instructor certifications, is the unit leader of a CCEMS special response team and has worked for Charleston County as a paramedic since 1983.

**Michael Black, District Maintenance Engineer, S.C. Dept. of Transportation**

Michael Black is a graduate of Clemson University where he received a Bachelor of Science in Civil Engineering. He is a registered professional engineer in South Carolina. He began his career with SCDOT directly from college and spent the first ten years in Construction. In 2000 he transferred to the District Maintenance Office and currently serves as the District Six Maintenance Engineer.

**Chief Karen Brack, Charleston Fire Department**

Karen Brack has 34 years of experience in the fire service. Started as a Firefighter in Fulton County (Atlanta), GA in 1982. Certified as a Hazardous Materials Technician, Paramedic, and Bomb Technician while in Fulton County. Served as the Special Operations Chief in charge of Urban Search and Rescue Team, Hazardous Materials Team and Tactical Medics. Served as a founding member of the Fulton County Fire Department Bomb Squad. In addition to an operational background Brack has served also as a Captain and Chief in the Training Division and as the Division Chief for the Fire Prevention Bureau. Obtained the position of Deputy Chief of Operations in Eugene, OR in 2007. Responsible for the oversight of operations personnel during the merger of two organizations- the City of Eugene Fire Department and the City of Springfield Fire Department. Both are all hazards organizations with EMS transport responsibility. Total of 238 personnel and 16 fire stations. Current position as the Chief of the Charleston Fire Department since August 2012. Charleston has 15 stations and 300 personnel. In addition to fire and basic emergency medical response we also have marine response, urban search and rescue and hazardous materials response.

**Dan Burger, S.C. Department of Health and Environmental Control/Charleston Resilience Network**

Dan Burger is the Director of the Coastal Services Division at the S.C. Department of Health and Environmental Control, Ocean and Coastal Resource Management (DHEC-OCRM). Mr. Burger leads a division of staff responsible for coastal policy analysis, technical assistance to municipal governments, stakeholder engagement and inter-governmental coordination. Mr. Burger currently serves as the Chair of the Charleston Resilience Network. Mr. Burger is a graduate of Western Maryland College and holds a Master of Public of Public Administration degree from the College of Charleston.

**Laura Cabiness, City of Charleston/Charleston Resilience Network**

Laura S. Cabiness, P.E., is the Public Service Director for the City of Charleston, South Carolina (population 120,083). She received a degree in Civil Engineering from Clemson University in 1983 and she is a registered professional engineer in South Carolina. Ms. Cabiness began her career working for the Department of Defense at Southern Division Naval Facilities Engineering Command. In 1987 Ms. Cabiness was employed by Keck and Wood, Inc., in Atlanta, GA and in 1988 Ms. Cabiness joined by Florida Land Design, Inc., in Tampa FL. Ms. Cabiness returned to Southern Division Naval Facilities Engineering Command in 1989. In 1990 she began her 25 year career with the city of Charleston first as the City Engineer and currently as the Director of the Department of Public Service.
Rick DeVoe, South Carolina Sea Grant Consortium/Charleston Resilience Network

Rick DeVoe joined the S.C. Sea Grant Consortium in 1980, and has served as its Executive Director since 1997. He is a member of the Graduate School Advisory Board at the College of Charleston and the Board of Advisors for the Center for Marine and Wetland Studies at Coastal Carolina University. He earned degrees from Fairleigh Dickinson University (B.S., marine biology), CUNY/City College of NY (M.A., biological oceanography), and the University of Rhode Island (M.M.A., marine policy). Mr. DeVoe serves as a member of the Executive Planning Team for the Governor’s South Atlantic (Ocean) Alliance, the Board of Directors of the Southeast Coastal Ocean Observing Regional Association (SECOORA), and the Regulatory Task Force for Coastal Clean Energy (South Carolina Energy Office). His professional interests focus on coastal and marine resource policy, state and regional coastal ocean planning and policy, ocean observing, marine aquaculture policy, science-to-management linkages, and science communication and education.

Dr. Gerry Galloway, [Moderator], University of Maryland / Resilient America Roundtable

Dr. Gerald E. Galloway, Jr. (Member, National Academy of Engineering) is a Glenn L. Martin Institute Professor of Engineering and an affiliate professor of Public Policy at the University of Maryland, College Park. His 38-year career in the military included positions such as commander of the Army Corps of Engineers District in Vicksburg, Mississippi, member of the Mississippi River Commission, and professor and founding head of the Department of Geography and Environmental Engineering and dean of the Academic Board at the U.S. Military Academy. He retired from the Army in 1995 as a Brigadier General. Dr. Galloway earned his M.S.E. at Princeton and his Ph.D. in geography (specializing in water resources) from the University of North Carolina at Chapel Hill. A civil engineer, public administrator, and geographer, Dr. Galloway’s current research focuses on the development of U.S. national water policy and disaster resilience in general and national floodplain management policy in particular. He currently serves as a consultant to several federal and state and non-governmental agencies on water resources policy development and flood risk management including the Louisiana Governor’s Advisory Commission on Coastal Protection, Restoration and Conservation, the Maryland Coast Smart Council, an international panel of experts examining the flooding threats to Florence, and a panel of experts advising on sea-level rise challenges Singapore. Prior to joining Maryland, he was vice president, Geospatial Strategies, for the ES3 Sector of the Titan Corporation. He was a six-year member of the National Research Council’s Water Science and Technology Board and has served as chair or member of 13 National Research Council Committees. He is a member of the National Academy of Engineering and the National Academy of Public Administration.


Sarah Gambill currently serves as Chief of Infrastructure Development and Recovery within the Department of Homeland Security’s Office of Infrastructure Protection, where she is responsible for developing, coordinating, and supporting the implementation of integrated security and resilience solutions, with a focus on informing infrastructure planning, design, construction and maintenance. Ms. Gambill is also responsible for overseeing the execution of the organization’s recovery mission, and was heavily involved in the initial recovery efforts in Columbia, S.C. following the 2015 floods. She has 11 years of experience implementing infrastructure security and resilience programs at the federal, state and local levels and has worked extensively with industry and academia. Ms. Gambill holds a Bachelor of Arts in Geography and International Relations and Diplomacy from
The Ohio State University and a Master of Science in Environmental Planning and Management from the Whiting School of Engineering at Johns Hopkins University. Ms. Gambill is also an active member of Engineers Without Borders, leading water resource development programs in Cameroon and El Salvador, and is an active member of the Women’s Council on Energy and the Environment, the U.S. Green Building Council’s National Capital Region Chapter, the National Capital Area Chapter of the American Planning Association, and Women in International Security.

**Cedric F. Green, General Manager of Charleston Electric Operations, SCANA**

Cedric Green is the General Manager of Charleston Electric Operations at South Carolina Electric and Gas Company, located in the North Charleston area, where he, his wife Rachell, their daughter Madeline and their son Cedric Jr. make their home. Cedric started his career at Wateree Generating Station and has since worked in engineering and operations roles in gas operations in Columbia, Lexington, Aiken, and Charleston. Currently, Cedric is responsible for a customer base of 210,000 in electric operations for the Metro Charleston district. Cedric serves on the Board of Directors for the Charleston Metro Chamber of Commerce. Cedric is serving as Immediate-past Chairman of the Leadership South Carolina Board of Trustees. He is a member of the Liberty Fellowship Class of 2009. Cedric earned his undergraduate degree in Mechanical Engineering from the University of South Carolina (USC) in 1997. In 2002, he earned his MBA degree from USC. In 2008, he earned his Master of Mechanical Engineering degree from USC. In 2015, he earned a Ph.D. in Mechanical Engineering program at USC. Cedric is a licensed Professional Engineer in the State of South Carolina.

**Ray Harbour, U.S. Small Business Administration**

Ray Harbour serves as public affairs specialist for SBA’s Office of Disaster Assistance, Field Operations Center East (FOCE) in Atlanta. She provides SBA disaster program information to the media, the public and government offices so that survivors are aware that assistance is available during declared disasters. FOCE serves the 27 states east of the Mississippi River, Minnesota, the U.S. Virgin Islands, and the Commonwealth of Puerto Rico. Ray is an award-winning writer and editor with a 30-year background in communications. She earned a Bachelor of Arts Degree from Emory University in Atlanta.

**Rhonda Jerome, Council District 2, City of North Charleston**

Rhonda Jerome is the City Council Representative for District 2 in the City of North Charleston, which includes two of worst hit neighborhoods damaged by the 2015 flood. She strives to make North Charleston a better place to live, work and play for ALL citizens of North Charleston. She has been on City Council since 2003. With the help of volunteers in her district she has been able to open many doors and opportunities for the Hispanic/Latino population.

**Frank Knapp, SC Small Business Chamber of Commerce**

Mr. Knapp co-founded the SC Small Business Chamber of Commerce (SCSBCC) in February of 2000. He serves as the president and CEO of the 5000+ member statewide advocacy organization that has taken a leadership role in making South Carolina more small business friendly in areas such as taxation, regulation, worker training, Workers Compensation Insurance, utility costs, health insurance, energy/conservation and economic development. Mr. Knapp serves on the Advisory Board for the South Carolina Small Business Development Center and was recognized by the Small Business Administration as the 2014 South Carolina Small Business
Financing Advocate of the Year. In 2015 SBA Administrator Maria Contreras-Sweet appointed Mr. Knapp to serve on the U.S. Small Business Administration’s Region IV Regulatory Fairness Board. He serves as the Co-Chair of the American Sustainable Business Council Action Fund and has advocated for reforms at the national level in the areas of health insurance, regulations, access to capital, taxation and the environment/energy. He also hosts an hour-long, weekday talk-radio program on WGCV-AM in Columbia, S.C. Mr. Knapp is also the president of The Knapp Agency, a full service advertising/public relations firm he founded in 1991 in Columbia, S.C. For 23 years he has provided marketing services to locally-owned small businesses. Mr. Knapp holds a Master’s Degree in Social Psychology from the University of South Carolina and a Bachelor’s Degree in Psychology from Indiana University of Pennsylvania.

Perrin Lawson, Vice President for Business Development, Charleston Convention and Visitor’s Bureau
Perrin Lawson has been with the Charleston Area Convention and Visitors Bureau since 1992, and has served as its deputy director since 2000. His duties focus on research, key partner relations, strategic planning and business development. Prior to joining the bureau Mr. Lawson worked for 10 years in the hotel industry as marketing director of a boutique hotel management company and as general manager of a four-star, four-diamond inn. He is a graduate of the College of Charleston, the Southeast Tourism Society’s marketing college, and the South Carolina Economic Developers School. He serves on the advisory board of the College of Charleston’s Hospitality & Tourism Management program and the board of directors of the Cooper River Bridge Run. Additionally, he is a member of the Charleston Regional Development Alliance’s Opportunity Next Alignment Board and the Charleston Metro Chamber of Commerce's Economic Outlook Board.

Norm Levine, Ph.D., College of Charleston Santee Cooper GIS Laboratory and Lowcountry Hazards Center/Charleston Resilience Network
Dr. Norm Levine is an Associate Professor of Geology and Environmental Geosciences at College of Charleston. He is currently the Director Santee Cooper GIS & Remote Sensing Laboratory, as well as, Director of Lowcountry Hazards Center at the College of Charleston. Dr. Levine also serves as the Director of the South Carolina Earthquake Education Preparedness Program. He is a FEMA HAZUS trainer, and the College of Charleston Citizens emergency response team (CERT) coordinator. He received his doctorate from Purdue University in Earth and Atmospheric Sciences, a Masters in Geology from Indiana State University, and his Bachelor’s degree from The George Washington University in Geology. Dr. Levine has published in a diverse number of fields including: Environmental and Engineering Geology, Hydrology, Geography, Computer Science, Disaster Management, Biology, and Archeology. He has been the primary academic advisor for 45 masters’ students and some 15 undergraduate research projects.

Doug Marcy, NOAA Office for Coastal Management
Doug Marcy is a Coastal Hazards Specialist at the NOAA Coastal Services Center, Charleston, S.C. He has been with the CSC for 11 years working on enhancing coastal flooding forecast products and GIS capability, storm surge assessments, and coastal hazards assessment projects (including sea level rise) contributing to more disaster resilient communities.
**Gerald McSwiggan, [Moderator], US Chamber of Commerce Foundation / Resilient America Roundtable**

Gerald McSwiggan is the Director, Issues Networks and oversees the U.S. Chamber of Commerce Foundation Corporate Citizenship Center Issue Network capabilities. The Center's Issue Networks are business-led coalitions of leading companies that work together to harness their collective power to advance progress against specific issues they care deeply about. He also manages the Center's disaster assistance and recovery capabilities. The disaster portfolio provides best-practice recovery information for businesses and communities, as well as critical on-the-ground support during times of disasters. He organizes the Disaster Corporate Aid Tracker and the popular cross-sector disaster events, leads on-the-ground recovery delegations, and creates information exchanges so lessons learned from previous disasters are remembered. Mr. McSwiggan has managed the Center’s response to disasters including the earthquakes in Haiti and Japan, multiple hurricanes in the Gulf Coast and Atlantic Ocean coastal regions, flooding in Pakistan and parts of the United States, tornadoes and wildfires in the United States, and more. He previously served as Federal Programs Coordinator in the Washington, D.C. Federal Affairs Office of Florida Governor Jeb Bush, and helped lead the transition to current Governor Charlie Crist. Prior to working for the State of Florida, he worked on Capitol Hill as a Legislative Fellow for U.S. Senator James Inhofe of Oklahoma. Mr. McSwiggan holds a B.A. in Psychology from Wake Forest University, and an MBA from Georgetown University.

**Ron Morales, National Weather Service**

Ron is currently the Warning Coordination Meteorologist (WCM) at the Charleston, S.C. National Weather Service (NWS) Office, and has held that position since July 2008. In short, Ron’s job is to make sure the NWS Office in Charleston, S.C. is serving their customers and partners with the highest quality weather related products and services. In addition, Ron is currently leading a team for the Eastern Region of the NWS to explore how to utilize remote controlled aircraft (i.e., drone) data for storm damage surveys. Ron’s National Weather Service career began back in 1992 as an intern at the National Center for Environmental Prediction (NCEP), in the Washington D.C. area. After his internship, Ron moved south to the Tampa Bay-Florida office, where he served for nearly 11 years as a Lead Forecaster, as well as the program leader for both the tropical, and NOAA Weather Radio programs. From Tampa, FL Ron moved over to the other side of the Gulf of Mexico and became the Science and Operations Officer at the Corpus Christi, TX office from 2004-2008. Outside of work, Ron is married with two young daughters. He tries to spend as much time as possible with his family and friends, and enjoys music, traveling and flying remote controlled aircraft.

**Kent Scarborough, Charleston Water System/Charleston Resilience Network**

Kent is the Safety Director of the Charleston Water System, public water and wastewater utility serving the Greater Charleston area.

**Michael Seekings, Charleston City Council, District 8**

Mike Seekings is a magna cum laude graduate of Amherst College and received his law degree from the University of Pittsburgh. Following law school, he clerked for former South Carolina Governor Donald S. Russell on the United States Court of Appeals for the Fourth Circuit and thereafter worked for Latham & Watkins, in its Washington, D.C. office. He is now a partner with the firm of Leath, Bouch & Seekings, LLP representing owners in complex construction defect litigation. He is a member of the South Carolina, New York, and District of Columbia Bar Associations and is admitted to practice before the United States Supreme Court, the Fourth
Circuit Court of Appeals and the District of South Carolina. Mike Seekings is a regular speaker at seminars and community association meetings. Throughout his career, Mike has been active in political, civil, and educational activities and is currently serving a second term as Charleston City Councilman representing District 8. He is Chairman of CARTA, Chairman of the Sustainability Advisory Committee, Chairman of the Traffic and Transportation Committee, on the Board of the Charleston Area Convention and Visitor Bureau, the Gibbes Museum, and the Cooper River Bridge Run. He is a former member of the South Carolina Bar’s House of Delegates and the executive committee of the Charleston Bar. Mr. Seekings is a private pilot and one of Charleston’s most avid runners. He is married to Michele H. Seekings. Michele also has a passion for the outdoors.

Ellis Stanley, [Moderator], Managing Partner of Ellis Stanley Partners / Resilient America Roundtable
Mr. Ellis M. Stanley, Sr. is Managing Partner of Ellis Stanley Partners, LLC. After 32 years as an Emergency Manager that included North Carolina, Atlanta-Fulton County, GA, City of Los Angeles, CA - he worked in the private sector with Dewberry, LLC and HGI. Mr. Stanley currently serves as a member of the NAS/NCR Resilience Roundtable; Chair of the Global Board of Directors of the International Association of Emergency Managers; Advisory Board member of the Coastal Hazards Center of Excellence; Board of Directors National Disaster Resiliency Center; Hope Coalition America Advisory Board. Former Board Member of Atlanta and Los Angeles Red Cross Chapters; Disaster Recovery Institute International; Former Chair Emergency Management Accreditation Program; Mr. Stanley also serves as an adjunct professor at American University, teaching Senior Crisis Management, and at Harvard University, teaching Meta-Leadership.

Donald Waters, Federal Emergency Management Administration
Donald Waters is an Insurance Examiner for the Federal Insurance & Mitigation Administration National Flood Insurance Program. As an insurance examiner, he participates in directing and providing directions to stakeholders and partners including approximately 90 private-sector insurance companies participating in FEMA’s Write Your Own Program (WYO), the NFIP Bureau and Statistical Agent, the NFIP Direct Servicing Agent, and various independent claims adjusting firms and NFIP Certified adjusters. Presents the Federal Insurance & Mitigation Administration’s (FIMA) and Risk Insurance Division’s claim positions at meetings, conferences and State Congressional Inquiries. Additionally, Donald takes the lead for the NFIP Claims Presentations and Webinars for the NFIP Certified adjusters along with the lead person for the NFIP Claim Forms. Previously Donald served as a contractor to Federal Emergency Management Agency (FEMA) working for the National Flood Insurance Program (NFIP). He has more than 30 years of overall claims experience managing casualty, property and flood adjusters. He has a Bachelor of Arts in History from the State University of New York @ Binghamton, in Binghamton, New York.

Mark Wilbert, Director of Emergency Management, City of Charleston, S.C. /Charleston Resilience Network
Mr. Mark Wilbert’s responsibilities include the building and maintaining of a comprehensive Emergency Management Program in a thriving city of approximately one hundred and thirty seven thousand residents and more than five million visitors annually. In addition to his primary duties, Mark is required to create and maintain strong relationships with all City Departments, other local jurisdictions and state and federal partners to better prepare the City of Charleston to respond to “All Hazards” incidents. Prior to assuming his current role, Mark served on active duty in the United States Coast Guard for more than 30 years, retiring as a Captain in
2013. While on active duty, Mark was involved in numerous incidents and events including being Operational Commander for all Coast Guard forces in North Florida and South Georgia on 9/11; Maritime Operations Section Chief – South, G-8 Summit in Sea Island Georgia, where he was responsible for planning and executing all maritime operations for the 2004 National Special Security Event (NSSE) and as the Planning Section Chief, Area Command – Deepwater Horizon Oil Spill Response. In addition, Mark has been involved in the response for numerous weather related disasters up and down the East Coast of the United States.

**Louise Welch Williams, American Red Cross, Lowcountry Region**

South Carolina born and raised. Louise grew up in Kingstree where she worked with her father. She and her husband Bailey live in Mount Pleasant. Her first experience with the American Red Cross was after Hurricane Hugo. Louise became an active Red Cross volunteer again in 1998 after Hurricane Floyd in Myrtle Beach. She served on the Red Cross Advisory Board for the Coastal South Carolina Chapter and served as the South Carolina Liaison for the Red Cross before going to work for the American National Red Cross in 2001 as a field agent. Louise accepted the position of Regional Executive Director for the Carolina Lowcountry Chapter of the American Red Cross on March 12, 2007. In September 2014, Louise was appointed Regional CEO for the state of SC, serving all 46 counties. Louise has served on numerous national disaster assignments as a Government Liaison, Public Affairs Manager or Fund Raising Manager. Louise is a member of the American Red Cross Advance Public Affairs Team. Members of APAT are “dropped in” to handle national media before and immediately after a catastrophic event. She is on call a minimum of 4 weeks each year for national APAT assignments. A few of the larger disaster assignments include Arizona Wildfires 2001, Hurricane Ivan 2004, Hurricanes Katrina & Rita in 2005, Hurricane Irene 2011, Hurricane Sandy 2012, and devastating flooding across the state of South Carolina in 2015. The complete list of disaster assignments is very long. She serves NHQ as board member and development staff trainer. She has served on South Carolina’s Government Relations Committee and the American National Red Cross Development Advisory Committee. Louise is a South Carolina representative on the U.S. Global Leadership Coalition Board.