

Regional Engagement Workshop Summary Report: Southeast Region

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Introduction

The Fourth National Climate Assessment (NCA4), currently in development, will assess the science of climate change and its impacts across the United States. It will document climate change-related impacts and responses for various sectors and regions, with the goal of better informing public and private decision-making at all levels.

To ensure that the assessment is informed by and useful to stakeholders, engagement workshops were planned for each of the 10 NCA4 regions. These workshops provided stakeholders an opportunity to provide input to and exchange ideas with the chapter author team on key message formulation, share relevant resources, and give feedback on issues of importance to their region.

Workshop Structure

In an effort to maximize participation while easing travel burden, organizers employed a ‘Hub and Satellite’ model for NCA4 Regional Engagement Workshops. A hub—or primary location—hosted stakeholders, the chapter author team, and NCA4 staff from the U.S. Global Change Research Program (USGCRP). Satellite locations throughout the region established remote connections to the hub for plenary presentations and discussion. Satellites were encouraged to hold break-out sessions on regional concerns and proposed topics for NCA4, reporting their discussions to the hub at a pre-determined time.

The Southeast Regional Engagement Workshop

On March 16, 2017, the NCA4 Southeast chapter team held its Regional Engagement Workshop. The objectives of the workshop were to gather input from a diverse array of stakeholders throughout the Southeast to help inform the writing and development of NCA4, and to raise awareness of the process and timeline for NCA4.

North Carolina State University and the Southeast Climate Science Center in Raleigh, NC, served as the hub location with approximately 60 attendees. Broward County, FL; Lafayette, LA; Washington, DC; Charleston, SC; Biloxi, MS; Atlanta, GA; and Darien, GA, served as satellites, and a number of stakeholders participated virtually (Figure 1). The event attracted participants from the entire region and across a wide range of professions including students, scientists, NGO staff, and local and state government staff.

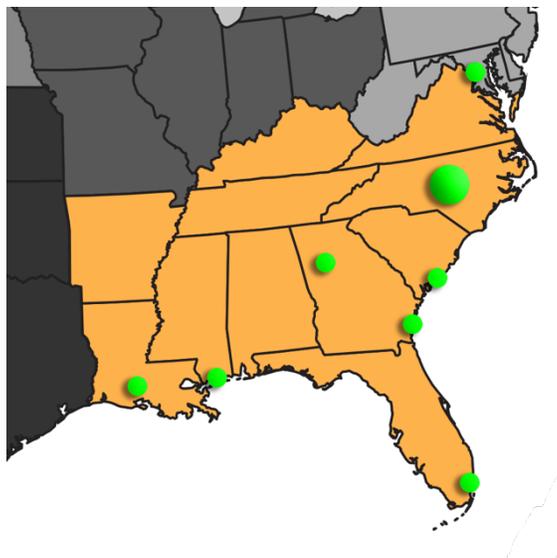


Figure 1. Map of the REW hub & satellite locations.

Authors, Locations, and Staff

Authors who Attended

- Adam Terando (USGS) – Coordinating Lead Author
- Lynne Carter (LSU/SCIPP) – Chapter Lead
- Colin Polsky (Florida Atlantic University)
- Kevin Hiers (Tall Timbers)
- Paul Schramm (CDC)
- Doug Marcy (NOAA)
- Vincent Brown on behalf of Barry Keim (Louisiana State University)
- Mike Oslund (USGS)

Satellite & Hub Hosts

- North Carolina State University (Hub - Raleigh, NC)
- Broward County Government Center (Broward County, FL)
- USGS Wetland Center (Lafayette, LA)
- USGCRP (Washington, DC)
- Hollings Marine Lab (Charleston, SC)
- Coastal Research and Extension Center (Biloxi, MS)
- Emory University (Atlanta, GA)

USGCRP Staff

- Chris Avery
- Tess Carter
- Katherine Weingartner

Overview and Topics of Discussion

Lynne Carter, the Southeast Chapter Lead, and Adam Terando, the Southeast Coordinating Lead Author, opened the workshop with a welcome to all participants and an explanation of the workshop goals. Chris Avery, the NCA Senior Manager, went on to give an overview of the NCA, providing context and explaining ways to get and stay involved.

Carter then went into detail on the Southeast chapter itself. Information on the Southeast Chapter from NCA3 (2014) was presented, with specific detail provided on each of the key messages from that report. From there, the chapter authors presented on the proposed Focal Areas for the Southeast chapter of NCA4:

- Extremes
- Coastal/recurrent flooding and coastal wetlands
- Health issues
- Wildfire
- Adaptation efforts

Participants shared specific questions, issues, ideas, resources, and case studies for each of the aforementioned focal areas. For each of the five focal areas, stakeholders were asked a series of questions around which to structure their responses:

1. How is or how has climate change affected this topic (i.e. observed change)?
 - a. Are there specific case studies you would suggest to illustrate that observed change?
2. How is climate change projected to affect this topic in the next 20-30 years and at the end of the century (i.e. projected change)?
 - a. Are there specific case studies you would suggest to illustrate that projected change?
3. What challenges, opportunities, and success stories for addressing risk can be highlighted?
 - a. Are there specific case studies you would suggest to illustrate those challenges, opportunities, and success stories?
4. What are the emerging issues and/or research gaps on this topic?

- a. Are there specific case studies you would suggest to illustrate those emerging challenges or research gaps?

In Raleigh, participants rotated through break-out discussions on the aforementioned Focal Areas, with each participant given the opportunity to attend break-outs for three of the five topics. Stakeholders were also given the opportunity to share thoughts on areas that were not covered by the previously-identified Focal Areas. An additional break-out group was facilitated for those stakeholders that joined remotely. Each satellite ran its own set of break-outs covering many of the above topics. Each satellite and each break-out group in Raleigh then reported out to the full audience during an afternoon plenary session.

Key Takeaways

Stakeholders identified areas of opportunity and concern, case studies, and relevant regional information associated with each of the focal areas. This feedback was later distilled into key thematic takeaways for the chapter author team. These takeaways are summarized below.

What we value

- Unique and treasured natural spaces that span boundaries between tropical and temperate ecosystems
- Rural communities and economies (food, agriculture, timber, etc.)
- Coastal areas
- Fast growing urban areas

Fire and Climate Interactions, which include a need to consider:

- The buffering capacity of fires
- The fact that increasing temperatures reduce the possibility of prescribed burns
- Human health tradeoffs with acute and chronic smoke exposure, taking urban and rural communities into consideration
- Effects on ecosystem services, hunting, etc.
- The impact that hotter days will have on ozone and volatile organic compounds
- The ways in which drought will affect systems in the Southeast
- Rural health impacts of chronic exposure (to smoke and other wildfire emissions??) around Fort Bragg
- Case studies, including those that highlight:
 - Tradeoffs and impacts of climate change, such as health impacts of prescribed burns versus ecological and management needs
 - The tribal seed collection project
 - Collaboration between tribes and forest service
- Ways to share traditional ecological knowledge with researchers

Coastal flooding and ecosystems, which include the need to consider:

- System changes on agriculture
- Recurrent flooding, inland flooding, and saltwater intrusion
- Increased hurricane intensity, increased precipitation rates, and high tides
- Different scenarios of future planning
- Burmese python as invasive species
- Jet stream changes
- Risks to coastal ecosystems that provide goods and services
- Macroclimatic drivers (unique to region)
- Tradeoffs between two highly-valued ecosystems (mangroves vs. salt marshes)

- Case study: Hurricane Matthew (coastal storm surge and record flooding in North Carolina)
- Potential Figure: Heavy inland flooding map, which could include events with billion dollar costs in damages
- The Seminole Tribe is designing new flood control systems- increasing pump size and altering the way water is moved, collecting LiDAR elevation data, not planning to specific future condition but overdesigning to provide some capacity for the future

Extremes, which include the need to consider:

- Cross-cutting themes such as interconnectedness and cascading effects
- Case Study: Baton Rouge flood event in the context of recurrence and historical floods
 - Sources: World Weather Attribution and BAMS Explaining Extreme Events
- Ecological impacts of freeze events and warm nights
 - Agriculture, health, etc.
- The state of evacuation routes since Katrina and their implications for emergency response and vulnerable coastal areas
- The impact of hurricanes
 - Possible case study: Environmental Systems Research Institute (ESRI) Story Map from South Carolina State Climate Office on Hurricane Matthew impacts
- Defining terms such as “Extreme” and “1 percent”

Health, which includes the need to consider the impacts of:

- Access to healthcare on rural populations
- Flooding and increased injuries related to storms and flooding
 - Work-related (agriculture and construction, etc.)
 - Temperature - look to Climate Change Impacts and Risk Analysis (CIRA)
- Food security
 - Fisheries connection (coral reef die-offs)
 - Tribes are having a harder time finding typical native food sources and medicinal or wild food
- Algal blooms
- Ticks and mosquitos, including the interactions between ticks and fires
- Zika and emerging diseases
- Mold and indoor air quality
- Mental health related to extreme events
 - Climate and Health Assessment addressed this broadly; may build upon for chapter
- Wildfire-related topics

New topics since NCA3 to consider incorporating:

- Climate change impacts on the Southeast’s built environment
 - Effects on water distribution and storm water capacity
 - Impacts of seal level rise
 - Need for adaptation due to aging infrastructure
 - Issue of saltwater intrusion, including on drinking water and wells
 - Tourism and built environment aspects of Highway 12
 - Issues for transportation and access to health infrastructure
 - Flooding - schools have had to close
- Drought, hydrology, and water quality/management
 - Kentucky state climatologist (Stu Foster) and recent US Forest Service Report on drought could help with this

- Energy production
- Rural communities in Southeast
 - Impacts on rural communities through changes to forests, agriculture, coasts, ecosystems, etc.
 - Tribal concerns, including but not limited to relocation
- Oceans – Southeast region is surrounded by them
 - Seafood is a major industry which is being affected by climate change. There is an increased risk of disease in seafood – there are studies on linkages between climate change and oyster production
 - Dead zones and hypoxia in the Gulf of Mexico
 - Salt water intrusion and related impacts
- Tourism

Additional Topics

- Develop communication and packaging of the chapter for educational purposes
- Focus on the value of the chapter for end users to achieve accessibility and effectiveness
- Examine the scope and examples of adaptation that involve multiple levels of government and public/private partnerships
- Focus on economics for political relevancy, as well as impacts on jobs and opportunities and a call to action
- Consider next steps including identifying gaps, monitoring, surveillance, data needs, and evaluation (development and use of indicators)

Results

The feedback provided during this workshop serves as valuable input to the development of not only the Southeast chapter of NCA4, but of all chapters. This summary report is being shared with all NCA4 authors to inform the development of their chapters. It will also be made publicly available on the NCA4 website (www.globalchange.gov/nca4). Over 100 stakeholders throughout the Southeast region participated in the day-long meeting, providing authors with a great deal of useful feedback – from concerns they face, to resources they use, and specific case studies where communities are working to address the risks they face as a result of climate change. Responses from both authors and participants indicated that the workshop was not only positively received in and of itself, but it served to cultivate new relationships, research ideas and, hopefully, future collaborations across the Southeast.

About the NCA

The National Climate Assessment is the U.S. Government’s premier resource for articulating the risks posed to the Nation by climate change, as well as what is being and can be done to minimize those risks. It is an inter-agency effort, bringing together experts from the 13 Federal agencies of USGCRP, the broader Federal government, as well as hundreds of experts in the academic, non-profit, and private sectors.

Appendix A: Workshop Agenda

Southeast Regional Engagement Workshop Draft Agenda

March 16, 2017 (All times Eastern Daylight Time)

8:30	Registration opens						
9:00-9:10	Welcome, Workshop Goals, and Brief Introductions <i>(Lynne Carter, Adam Terando)</i>						
9:10-9:40	Overview of the National Climate Assessment <ul style="list-style-type: none"> • U.S. Global Change Research Program • Mandate, timeline, and structure of NCA4 • Ways to get involved • Areas of desired input from public comments • Questions and answers <i>(Chris Avery)</i>						
9:40-9:45	Southeast Chapter Outline <i>(Lynne Carter, Adam Terando)</i>						
9:45-10:20	Author Thoughts on Chapter Topics <ul style="list-style-type: none"> • 5-7 minutes per author • Five focal areas/topics <ul style="list-style-type: none"> ○ Extreme Events (Vincent Brown) ○ Coastal Flooding (Doug Marcy, Mike Osland) ○ Health Issues (Paul Schramm – remote) ○ Wildfire (Kevin Hiers) ○ Adaptation Efforts (Colin Polsky, Kristin Dow) 						
10:20-10:35	Q&A and Breakout Group (BOG) Introduction <i>(Adam Terando, Lynne Carter, USGCRP Team)</i> Groups will rotate three times in 20 minute intervals. There are 5 breakout groups and you may choose any three groups to contribute discussion points. Note, we have built in 5 minute breaks between each rotation to allow people to move from BOG to BOG.						
10:35-11:50	BREAKOUT GROUP EXERCISE (Choose <i>THREE</i> to participate in) <ul style="list-style-type: none"> • 10:40 First BOG • 11:05 Second BOG • 11:30 Third BOG <table border="1" style="width: 100%; margin-top: 10px;"> <thead> <tr> <th style="text-align: left;"><u>TOPIC</u></th> <th style="text-align: left;"><u>Leaders plus notetakers</u> (not listed)</th> </tr> </thead> <tbody> <tr> <td>1. Extreme events</td> <td>Vincent Brown</td> </tr> <tr> <td>2. Coastal flooding</td> <td>Doug Marcy</td> </tr> </tbody> </table>	<u>TOPIC</u>	<u>Leaders plus notetakers</u> (not listed)	1. Extreme events	Vincent Brown	2. Coastal flooding	Doug Marcy
<u>TOPIC</u>	<u>Leaders plus notetakers</u> (not listed)						
1. Extreme events	Vincent Brown						
2. Coastal flooding	Doug Marcy						

	3. Health issues	Paul Schramm (remote), Jess Whitehead
	4. Wildfire	Kevin Hiers
	5. Adaptation efforts	Lynne Carter
	6. Other topics	Adam Terando
	REMOTE	Tess Carter
	<p>For Satellite Locations:</p> <ul style="list-style-type: none"> • If there are <i>15 or fewer</i> participants: <ul style="list-style-type: none"> ○ Choose three topics for the group to discuss in order. ○ Refer to the specific topic questions in the BOG handout in the participant packet • If there are <i>more than 15</i> participants: <ul style="list-style-type: none"> ○ Break into groups of 8 or less ○ Rotate among three BOGs of your choice <p>General questions:</p> <ul style="list-style-type: none"> • Introduce yourself (affiliation, area of expertise) • For the given topic: <ul style="list-style-type: none"> ○ How is or has climate change affected this topic (i.e., observed change)? ○ What concerns you about projected climate changes and how they may affect this topic in the next 20-30 years and at the end of the century (i.e., projected change)? ○ What challenges, opportunities and success stories for addressing risk can be highlighted? ○ Are there case studies or specific resources to highlight? ○ What are the emerging issues and/or research gaps on this topic? 	
11:50- 12:00	Break and Return to Assembly	
12:00-12:55	Report out from Breakout Groups (4 minutes per topic/satellite)	
12:55	Concluding remarks and next steps <i>(Lynne Carter, Adam Terando)</i>	
1:00	End of Public Meeting - This is the end of public participation portion of the meeting. The public is welcome to stay for the afternoon sessions involving the NCA author teams and associated subject matter experts. However, no further group or satellite discussions will occur.	

Appendix B: List of Southeast Regional Chapter Authors

Coordinating Lead Author: Adam Terando, US Geological Survey

Chapter Lead: Lynne Carter, Louisiana State University/SCIPP

Authors:

- Kirstin Dow (University of South Carolina)
- Colin Polsky (Florida Atlantic University)
- Kevin Hiers (Tall Timbers)
- Paul Schramm (CDC)
- Doug Marcy (NOAA)
- Barry Keim (Louisiana State University)
- Mike Oslund (USGS)

USGCRP staff:

- Tess Carter, NCA Program Coordinator
- Katherine Weingartner, NCA Program Assistant
- Matt Dzaugis, Knauss Fellow

Appendix C: Expanded Notes

Extreme Events

1. How is climate change projected to affect extreme events in the next 20-30 years and by end of century?
 - a. Question: Notes that natural variability important on the shorter-term of this
 - b. May want to say “climate variability and change”
2. Any specific research or case studies to highlight
 - a. Dr. Lackman - study on Joaquin interaction with frontal precipitation
 - b. Agricultural damages from Oct 2015 Charleston rain
 - c. Issues with warm winters followed by cold snaps
 - i. Is there current research for Southeast area, or region-specific crops

Resources/Case Studies/Opportunities

- Recent US Forest Service Report on drought
- ESRI Story Map from South Carolina State Climate Office (Journal / case study)
 - Hurricane Matthew impacts
- Early Warning System for Drought - Citizen Science via Community Collaborative Rain, Hail & Snow Networks (CoCoRAHs)
 - Kirstin Dow at Carolinas Integrated Sciences & Assessments (University of South Carolina) and Rebecca Ward (North Carolina State Climate Office) - system using CoCorahs “citizen science”
- Any case studies on regional flash flood events (a lot of events throughout the region)?
 - Ever increasing value for shorter term forecasts and adaptations
 - Success stories or opportunities for improved early warning, e.g. flash flood awareness and response?

Questions

- Hurricanes – Is Southeast going to discuss hurricanes?
 - Dr. David Lackman - case study on Hurricane Joaquin interacting with frontal system, leading to precipitation
 - It has been over 11 years without major hurricane
 - Is climate change influencing hurricane (tracks)?
 - Do hurricanes have a role as drought busters? How do their patterns or changes in frequency influence drought?
- Tornadoes?
 - Any trends relevant to Southeast?
- Tipping points
 - Any relevant Southeast tipping points related to extremes?
- Communication
 - For short-term projections, communicating distinction between climate variability and climate change is very important.
 - Extremes events are a way to reach and engage more individuals because people experience them.
 - Attributions
 - Is there value in talking about regionally specific attributions? Mostly case study type events. (What can we attribute directly or indirectly to climate change?)
 - Sources: World Weather Attribution and Bulletin of the American

Meteorological Society Explaining Extreme Events, including a study on Baton Rouge flood event—case study and attribution.

- Interconnected/Cascading extreme events
 - Extreme events affecting specific location (say Baton Rouge) that are interconnected, in turn affect location (Knoxville, or outside Southeast) that is not directly hit by event.
- Timing of precipitation throughout the year
 - Impacts on salinity, seagrass, etc.
 - Can influence drought (falling in fewer events, but heavy precipitation can be a drought buster)
- Urban vs. Rural (differences in susceptibility, especially related to infrastructure)
 - Heavy Precipitation: Rural/Forest Service roads -- culverts handling extreme precipitation
 - Extreme Heat: Vulnerability (and exposure) in Southeast is higher in rural areas vs. urban. Capability to cope with extreme events, differences in rural vs urban.
- Updated Scenario products for extremes - list of variables (thresholds for extremes), newer products that are downscaled (6 km grid size)
 - Will be on scenarios.globalchange.gov
 - What is the right threshold (varies from region to region)
 - Risk perspective (what's the average, but what's range of risk locally)
- CO₂ and crop resilience and links to drought, precipitation changes, etc. (Potential improved crop resilience to drought).
- It might be useful to shed more light on positives
- Useful to do / create maps that demonstrate temperature changes (shifting plant resilience)
- Are their differences in societal adaptations across geographic regions or other variables (building safe rooms, stockpiling resources, changing the way they build)?

Topics that were not specifically extremes-related

- Reinforce strong conclusions already made in NCA3 where possible
 - I.e. how to balance treatment of foundational climate science and findings from Third National Climate Assessment Southeast chapter--can't assume full familiarity but need to focus on what's new.
- Change in rate of convection, what is gradient between inland and coastal regions in terms of atmospheric moisture content? If gradient changing, dynamics are changing.
- Solar Flares - impacting power grid? Climate change leads to changes in the atmosphere, which may lead to changes in how the atmosphere deals with solar flares.

Health BREAKOUT GROUPS (BOG) EXERCISE

Health Issues

What are the observed effects of climate change on health in the Southeast?

- Need to emphasize rural population vulnerability—in the south there are plenty of populations that are vulnerable for other reasons
 - Heat related illness—urban heat islands are a big issue, but not as much as rural heat exposures that are happening. Very place based—still emerging part of the conversation of heat-related illness and not as center stage as it needs to be. Rural vulnerability is not

- as much on the radar. Rural communities can be 8-10 times more vulnerable.
- The Carolinas Integrated Sciences and Assessments (CISA) worked with others to develop model and literature on this (North Carolina Disease Event Tracking and Epidemiologic Collection Tool – NC DETECT)
 - 10 peer reviewed articles for North Carolina and Alabama
 - Rural issues — there are certainly lots of disparities in urban areas, but there are government services there, as opposed to in rural areas, where access to services can be minimal
 - Very little government infrastructure around dealing with heat and wildfire
 - Important to distinguish between those impacts that are climate-specific and what composes vulnerability overall (farmworkers who work outside)
 - Hospital access
 - Poor air quality, wildfire, and heat have synergistic effect
- Is the primary concern we have for health impacts in rural areas heat? Or what else?
 - Currently working on wildfire smoke issues—seeing disparities between rural and urban counties.
 - Chris Nolte is leading the air quality chapter—need to draw on regional chapters—to what extent has air quality come up as a topic for Southeast regional chapter.
 - Timber and land management in Hoke County presents other related issues
- Indoor air quality and flood recovery
- Pollen count—peak used to be in April, but it’s starting earlier
 - Leafout data supports that
- Kidney stones and heat related illness in North Carolina as things get warmer (dehydration)
- Vectorborne disease—cities respond with pesticide and chemicals. Tradeoff of public reaction to vector vs chemical.
- Construction, agriculture, forestry, etc.—health of people who work outdoors
- How do we work with the super smoke/fog smoldering fires, and where do we deal with that? Wildfire or health? Cross sectoral problems--Transportation issues, recreation, tourism
- Children, older folks, pregnant women—balance of recreation and water/air quality/smoke/heat
 - As it gets hotter, more people recreate in water—water fowl shifts, fecal coliform, harmful algal blooms, etc.

How is climate change expected to affect the region’s health in the next 20-30 years and by the end of the century?

- Heat impacts
- Vector borne diseases—lots of literature on how some mosquito/tick diseases impacted by climate change —haven’t seen anything about La Crosse encephalitis (Georgia, Tennessee, North Carolina)
- Mosquito diversity/movement north of these illnesses might see a shift in reduction of exposure to tick exposures
- Food security in relation to extreme climate events—exacerbation of rural food deserts aftermath of Katrina
 - Food security—local agriculture nexus—impacts on farmers
- Increase health care system capability to identify diseases and illnesses to respond to changes

- Rise in population—impact the amount of natural space and impacts on mental health

Are there resources (reports, papers) or case studies we should be aware of? Which case studies should we highlight?

- Extreme events and food security impacts—paper forthcoming
- Robert Wood Johnson metrics—rural areas
- Socioeconomic status (SES) determinants of vulnerability between populations that are particularly vulnerable
- Medical associations report—highlighting mental health aspects of climate change, including the research gaps there
- USDA / US Global Change Research Program report on food security
- Scenarios products—changing population and developed land use can impact exposure to climate driven impacts—alternate scenarios at the county scale out to the end of the century
- Case studies on air quality or aeroallergens from Environmental Protection Agency?
- Open space adaptation and preservation case studies
- Comparison of local/county health departments as a trusted health case study
- Case study on mental health and Katrina.
 - Hurricane Matthew and folks not able to get into their house and separating families

What challenges, opportunities and success stories for addressing risk can be highlighted?

- Rural coastal communities and their ability to adapt. People in urban settings can find the funding, but rural settings often face bigger hurdles and more challenges.
- Case studies/success stories of community gardens—program in Virginia
- “Resilient agriculture”
- Opportunities around health infrastructure - post Hurricane Sandy, resilient infrastructure (John Balbus)—nursing homes, pharmacies, ob-gyn—disruptions to those increase cost for communities

What are the emerging issues and/or research gaps on this topic?

- Relationships between substandard housing and impacts —creates air quality issues because people don’t have the power or money to fix maintenance issues that exacerbate indoor issues
- Think more ecologically on these impacts
 - Great connectivity to look at health and agriculture changes (acorn crops)
- Animals are sentinels of human health issues
 - Heat associated illness and canines, livestock
 - Availability of hay for horses
 - How changes in soil microbiology lead to higher counts of E. coli, etc.
 - Profound effect of sand temperature and impact on gender of sea turtles
- Gastrointestinal viral illness—pulling out seasonality of illness. Strong precipitation flushing events occurring after periods of dryness and seeing impacts on water quality
- Water borne disease (vibrio) and illness for those working on or near water
- Kidney stones and heat related illness in North Carolina as things get warmer (dehydration)
- Medical associations report—highlighting mental health aspects of climate change, including

the research gaps there

- Mold Issues after Hurricane Irene, and then in Hurricane Katrina
- Hospital emergency preparedness related to climate change
- Water system recovery after floods—vulnerability of coal ash and potential contaminants
- Need to emphasize rural versus urban vulnerability (heat, access to government services, and emergency department visits, etc.)
- Impacts on outdoor workers from fire and smoke
- Changes of impacts of diseases—La Crosse encephalitis and spotted fever, and reduced exposure to ticks (shift of tick exposure north?)
- Ability to use animal health as sentinels as human health (2006 drought and equine forage)

Breakout Group Exercise - Broward County Extreme Events

Extreme Events—BOG Sessions Summary:

A. Observed changes

B. Case Studies/Success Stories

- Cold Snap: Fish population in Florida Bay still being affected by climate impacts, since 2010 – bad season
- Late spring freezing impact on important crops
 - 2017 earlier bloom – concerned about impact in agriculture in general
- Communities that are depending more on surface water for water supply are seeing more and more impacts
- More investments in water storage alternatives, including aquifer storage and recovery and reservoirs.
 - C-51 Reservoir in Florida is one example of how investments are being allocated in projects to increase water security given extreme events
- More investments also being allocated to stormwater master plans in the region – considering sea level rise and extreme events – e.g., West Palm Beach, Fort Lauderdale
- Miami Beach case study – raising streets and improving stormwater system
- Investments in reducing sanitary sewer overflow (SSO) events – infiltration and inflow reduction
- Everglades Headwaters –efforts to build new design patterns
- Give away trees – more native and tolerant species to promote water conservation and reduce peak demands during drier periods
- Increased need for beach nourishment projects in the region

C. Challenges/Opportunities

- Tourism industry affected by extreme events – including cultural resources impacts – e.g. lighthouse historic sites
- Take advantage of the robust structure in place around emergency response planning to invest in adaptation and increase resilience – consider regional opportunities
- Need to understand different characterization of “heavy rain” and intensity in different environments
- Downscaling data – need to understand better / decrease uncertainty changes in rainfall patterns for different planning purposes
- Exacerbated impacts in vulnerable populations and communities – less wealthy to invest in increasing resilience

General Comments from the Extreme Events BOG Sessions:

Things to bring to the chapter

- To be added:
 - Early emergence and late spring freezings - Implications for the economy and vegetation
 - Warmer February and freezing temperatures still happening in March – start to bloom earlier but then with the freezing plants and crops die – e.g., no blueberries
 - 2010 cold snap still affected fisheries in Florida Bay – population still has not bounced back, so the impacts become a multiyear event
 - Ask for specific numbers to be included, e.g., flooding events – recurring tidal flooding – pull out examples for communities specifically affected
 - Precipitation events being less frequent but more water – spring data on number of events
 - They have pretty good examples from the gages map
 - What do people consider heavy rain – 1 inch/day or 4 inch/day
 - Sea level rise could be integrated in this section
 - Risks in the future – extreme heatwaves as problems in the community? How to address tropical storm damages?
 - Series of various warmer nights – implications for the economy
 - Urban flooding and precipitation
 - Traffic safety and insurance cost – more car accidents
 - Lightning important, too – human health concerns – more recurrent

Changes that are projected that haven't been in the past?

- New England worries about hurricanes – Florida has expectations of hurricanes
- Further north – heatwaves... can be dangerous because there is no air conditioning
- Surface water supply for West Palm – now is having more drought periods – communities depending on surface water
- C51 reservoir – engineers like surface reservoir because we can take advantage of rainfall
- What kind of planning is needed for the future e.g., new crop – citrus – need to understand water/rain in the next 20 years
- Stormwater system impacts

Good stories to tell – related to extreme events

- Story of excavating reservoirs – no one would imagine digging reservoirs to store water in south Florida – important to cope
- Telling the stories about impacts – e.g., fish population decreases

Reports

- Stormwater master plan – 30 year horizon – West Palm Beach + capital improvement projects including sea level rise projection
- 2010 – cold snap 2010 work by Florida International University (FIU) – fish population decrease – case study
- Jupiter – high vulnerability area of Fort Lauderdale – Adaptation Action and Stormwater Master Plan
- Miami Dade Water and Sewage Department (WASD) investment in avoiding sanitary sewer overflow (SSO) events – infiltration and inflow reduction
- CIRCLE – Fort Lauderdale – understanding better how all sectors are interdependent
- Urban areas get lots of attention – find adaptation measures for rural communities and efforts to build new design around the Everglades headwaters – increase flow out of Okeechobee
- Water storage alternatives

Round 2.

Climate indicators

- More frequent storm events
- Days of nuisance flooding—sea level over a threshold value
- Less weak hurricanes and more stronger hurricanes are projected
- Miami Beach— concerns on agricultural land – Town of Davie Agricultural Committee – How to avoid threats from sea level rise and climate change (especially concerned about sugar crop)
- Largest agricultural producer in Florida – what to do about crop failures...
- Should have been seeing more cold snaps – fishery industry – 2010 bad cold snap season – all over Gulf of Mexico
- Warmer temperatures – initiation of spring and fall are expanding – migration patterns for some of the animals are changing
- Historical sites, such as lighthouses and other properties, are being impacted
- Funding is not enough to adapt to these resources
- Sea level rise increase has negative impact on flood infrastructure
- Precipitation is still uncertain, making it difficult to forecast a water resources plan
- Warmer temperatures and changes in rainfall make water and ecosystem management challenging for Florida Bay fishermen

Resources/Case Studies

- Tornadoes shifting more towards the southeast – tornado zone moving eastward, the timing of the season seems to be shifting as well
- Aquifer storage and recovery (ASR) and injection wells make a good case study

Opportunities

- Emergency response planning and accident response is pretty robust – systems are in place that are supported by the Federal Emergency Management Agency
- Opportunities for the community to engage in planning process to invest in resilience and adaptation
- Build more resilience through resilience improvement programs such as the Property Assessed Clean Energy (PACE) program
- Cities have been very successful in serving all residents in terms of providing basic services, but investments in infrastructure are needed. Using previous projects to enhance resilience in the communities can bolster community economic development.
- Even though Broward County is progressive in terms of climate, it cannot move forward by itself or ignore political ramifications.

Gaps

- More downscaled precipitation information is needed.
- Long term forecast models could be improved.
- Need more information on the Everglades – the ecosystem is unique and important for water supply, wildlife, etc.
- Need more information about preserving open space areas to buffer natural systems through open spaced planning
- Need more information on how to increase resilience through mitigation strategies

Broward County Break-out for the conversation on Health & Climate Change

Observed Effects

- Coral reef die-offs
- Vulnerable populations (Aging, youth, poor) experience greater impacts. For example, prolonged flooding in poor neighborhoods has a greater impact on its residents who

are dependent on walking and public transportation. Flooded streets are dangerous to navigate on foot because of bacteria, loose materials and road debris, canals, etc.

- Tribes are having a harder time finding typical native food sources and medicinal or wild food
- Urban and rural farmers are dealing with planting zone changes due to temperature changes, and crop failure due to irregular rain
- Saltwater intrusion is affecting clean drinking water supplies.
- Trihalomethanes (THMs) are increasing because of temperature increases, and water filtration and treatment will only increase in price in the future.
- Because night time temperatures are higher, people are opening their windows less, which causes greater indoor air quality problems due to lack of circulation and more mold problems.
- Similarly, we no longer have typical afternoon showers every day in the summer season. The result is that there is cooling off of temperatures to allow for outdoor activity which impacts mental and physical fitness. Also, pollution builds up and isn't cleaned by daily rain.
- We are seeing more vector-borne diseases like Zika and ticks.
- There is increased mental stress for populations already under social and financial stresses due to social and physical factors like migration, change, heat, etc.
- Shorter winters mean a longer mosquito season.
- Urban heat island effect is stronger.
- Humidity makes temperature increases twice as impactful.
- There are more exotic plants and animals with less natural controls (like cold snaps), so there is a greater need for more active management.
- Light pollution is not a climate impact but is an energy impact. Consider weaving energy and health stories together for greater public understanding of impacts and actions they can take.

Expected Impacts

- Breathing problems due to wildfires, pollen, and pollution
- Introductions of new vector borne diseases
- Water quality issues because of prolonged surface water flooding
- Warmer surface water temperatures leading to increases in microbes
- Increased costs of water treatment (more facilities, or more layers of filtration)
- Greater migration of people, plant zones, tropical diseases, and microbes
- Harder to balance water supply between competing users (agriculture, power plants, ecosystems, and people)

Resources/Case Studies

- Dr. Joanne McCoy is doing work on seed banking at North Carolina Arboretum with the Cherokee Indian Nation
- National Academy of Science "Hidden Cost of Energy" and Carbon Tracker & Environmental Protection Agency's Health Costs of Climate Change. The latter states cost in dollars and lives in respect to different energy choices. This can connect to the results in Health Impact Studies and close the loop from one sector's externalities to another's inputs so that the user can see a full-scale accounting of mitigation and renewable energy investment, with impacts and risk assessment/adaptation investment.
- Lessons learned from others on extreme heat events (both as an incident and as future planning) – like big cities, other subtropical environments, European cities, pilgrimage to Mecca, etc.

Opportunities

- Green infrastructure and natural systems benefits can help us with cooling, storm surge, stress reductions, water filtration, etc.
- Building code can be updated to mandate energy efficiency, solar water heaters, electric vehicle ready infrastructure, etc.
- New technologies make citizen engagement possible for air quality monitoring and communication
- Increasing investment in permaculture (the development of agricultural ecosystems intended to be sustainable and self-sufficient) and local food production
- Public attention on Zika and health impacts gives us an opportunity to connect to other impacts and expand the conversation by using health as a link to what people care about
- Improve customs checkpoints and standards for exotic species

Gaps

- State and federal support and funding for mosquito control, emissions standards, etc.
- Continuous education and support for problems like Zika
- Education on the combined impact of humidity and heat for residents, health care providers, planners, builders, and engineers

Options & Highlights

- Keep top issues as focus, even if covered before as these issues are still important and will continue to be. It is important to focus more on the connections among issues to make the message more impactful.
- Highlight lots of interagency collaboration
- To balance lots of statistics and generalizations, focus on local costs or impacts on a smaller and more personal scale. What are the impacts to X community or hospital, or even a person in X region. Break it down to make it relatable to the reader.
- Focus on vulnerable populations and basic needs (air, water, food, shelter)
- Focus on people, what they are going to face, and what they can do.
- Focus on natural systems and solutions, like biocontrol of vectors
- Use lessons from Tribal Planning and longer term approaches and focus on natural resource management.

Coastal Flooding

How has climate change affected coastal flooding? How is climate change projected to affect this topic?

- Sea level rise is most important, caused in part by glacier melt. Unusual geology affecting water resources, as well as melting in the Everglades and salt water intrusion, are also issues. Pumps are one solution but a finite solution.
- Flooding in Miami Beach is one of its biggest issues. \$100's of millions in new pumps are not solving the problem. There's a point where it can't be contained, which is already happening in the Everglades.
- Through beach nourishment, resilient coastlines can be created out of suitable sand, armored coastlines, and by dredging historical areas
- As the beach erodes, resources migrate landward. Limited sand and resources continue to be protected. However, there are hundreds of miles of canals and seawalls. There is a challenge in raising canals and sea wall elevations along with streets without flooding and gaining the financial ability to do that. The result is that houses are either raised or demolished
- Potential retreat is an issue
- There is a large-scale hardening of the shoreline with changes in habitat. We need materials

to protect the shore, but it is important to consider where we get the sediments as they can affect rivers, as well as the kinds of subsidence structures that are needed. Another issue is what will happen with runoff and discharge patterns for the system, which will bring more problems that will be further exacerbated by sea level rise impacts.

- Not sure of an alternative aside from leaving coastal areas
- City infrastructure, such as those for drainage and water quality, will affect the way we distribute freshwater to residents. We must be prepared for issues like saltwater intrusion to pose future challenges.
- Seminole tribes' natural systems and Everglades face more significant challenges from water flow being inhibited by saltwater levels. Six reservations are inland. This is of interest to the US Geological Survey
- As the sea rises, the water levels in the conservation area will also be affected. In the last three years, there has been a decrease in wading birds
- The Army Corps of Engineers was able to open the first one mile stretch of Tamiami trail, but, for the first time, there were no birds in January. Counties have good data on saltwater wedge moving that includes both frequency of flooding and economic impact.
- More extremes in precipitation patterns create a risk of more energy intensive water pumping with the question of from where this energy would come

Next 20-30 years

- The Paris Agreement outlines goals to reduce global carbon dioxide emissions, but there is a tipping point after 3 feet of sea level rise. What can be done if the rise is six feet?
- How will we communicate the projections of sea level rise and make clear that IPCC representative concentration pathways are business as usual and not worst case?
- Do you plan for what is most likely, and what do you do about the unlikely extreme limits? People tend to focus on the worst case, but how do you plan knowing that? An adaptive management approach may be helpful
- Regulations can mandate prescribed elevations and types of mitigation to achieve no net loss, but with anticipated sea level rise, rainfall and water levels, none thus far are sufficient. The vast majority of regulations are developed to mitigate in a type of habitat that will not be the same in the future. Threatened and endangered species will also be different, and this is a system that cannot adapt. The Everglades will be open water, and coastal habitats will not be the ones we need.
- Some Gulf Coast states are thinking about sea level rise and the migration of species at the state planning level. However, the rates of change are too fast and mangroves can't migrate fast enough to cope. There is more rapid sea level rise than we anticipated three years ago. Some maps of natural areas, such as Lake Worth Lagoon, try to predict new habitats, such as for sea grass. Marsh tidal wetlands are being created, and the hope is that planning takes sea level rise into account.
- In respect to hardening the eastern coastline, there are many questions, such as how much has been built, what's been built, and do we have a place for habitats to migrate?
- There also needs to be considerations for discharge events, which involves the moving out of sea water. This could result in wastewater outflow putting material into a sensitive area because of change in discharge patterns, larval transport, nutrients, etc.
- We're adding to the challenges because of inadequate growth management laws that don't take into account sea level rise. Irreversible damage is happening now with rampant development. Despite buildings along the coast and garages often flooding, people are still in denial.
- In worst case scenarios, there are limits to what adaptation can do. Mitigation is a policy that

is national and international in scope.

Success stories

- Miami Beach Levee is an example of a pilot project adjusting to two feet of sea level rise. We can't build for five feet before we deal with two feet.
- In general, shorelines are being depleted of sand, resulting in a net deficit. Jupiter Island has met this challenge and is a good example of mitigating historical losses of sand. Perhaps this is a potential case study.
- Southeast Florida Regional Climate Compact has meaningful adaptation and mitigation plans

Challenge

- Louisiana/New Orleans and New York City have built barrier islands, but Florida cannot do the same as it must protect its reefs and the species that live there

Research gaps

- For years, we've been talking about threats, and now we're talking about solutions. We need a risk assessment: For which threats do we need to design solutions?
- There is a need to define storm surge as they are different for oceans versus canals. US Army Corps of Engineers is working with Ft. Lauderdale to raise their walls. At some point, quality of life and property values will be severely affected in South Florida. There is a need to calculate probability timing and severity. In eight years, there hasn't been an assessment. With drinking water scarcity, low level areas flooding, beach fronts flood, we can't afford to replenish sand.
- Are there other data sources?

Opportunities

- We have the opportunity to look outside federally or otherwise officially designated flood mitigation areas to try to mitigate losses, for example, around Lake Okeechobee.
- There are prime opportunities to implement new standards for infrastructure in storm water and waste water, but they need to be replaced in a sustainable fashion. Sea walls may not be as effective with the limestone.
- There is an opportunity to look at public and private construction standards and the finances available to make important changes

Adaptation Efforts

Adaptations underway

- Sea oats are planted on dunes for stabilization
 - The challenge is gaining support from property owners to install dunes and change views
- Miami Beach is raising its road elevation
- South Carolina tribes have a Pre-disaster Hazard Mitigation Plan to address flooding and stormwater culvert sizing
- There is a disconnect between sea level rise and surge driven flooding. Raising seawalls to address tidal flooding does not necessarily increase protection from surge flooding
- Alligator River, North Carolina and Cape Romaine, South Carolina, have sea level rise and subsidence issues. They are developing plans for adaptation and considering issues such as where they might expand development to compensate for losing property, fiduciary responsibilities, and property ownership
- Broward County is raising infrastructure to comply with Federal Emergency Management Agency base flood elevations
- Seminole Tribe is designing new flood control systems which includes increasing pump size, altering the way water is moved, and collecting LiDAR elevation data. They are not planning to specific future conditions but are overdesigning to provide some capacity for the future

- Wind mitigation and adaptation is required when more than 50% of a structure is replaced.
- A1A Hwy in Fort Lauderdale was damaged during Superstorm Sandy and was repaired resiliently including a 42' buried steel sheet pile wall behind dune, knee wall, and tilted road to provide additional surge and erosion protection
- It may be useful to look at Southeast Florida Regional Climate Change Compact's [Climate Indicators](#)
- Jupiter Island is undergoing beach nourishment and construction of an advanced nourishment section of the beach to provide more storm protection. It is a privately implemented project
- Fort Lauderdale has installed tide valves on stormwater outfalls
- The US Army Corps of Engineers Flood Risk Study in Broward models hydrodynamics and determines seawall top elevations by implementation phase
- There have been tree canopy efforts including hiring urban foresters and green infrastructure specialists in cities to mitigate heat island effects and complete street projects
- There is hiring of Chief Resiliency Officers at county and city levels

Long term adaptation strategies

- Green building techniques to improve energy efficiency incorporate the use of grey water and solar
- New construction of public and private infrastructure is held to new standards when existing infrastructure reaches end of life
- There is a plan for a 500-year storm to build a factor of safety for extreme events occurring back to back or occurring more frequently
- A strategy could include cost effectiveness analysis
- Broward County is developing a future condition map series including flood depths and groundwater table elevations to serve as a design standard for new construction
- There is a need to identify new funding sources
- There is a finance initiative to launch more projects with return on investment focused on 30-year investments and social buy-in
- There is a need to consider trade-offs with natural areas. Lake Okeechobee will have higher levels to manage stormwater, causing loss of littoral habitat, and will need to consider mitigation for this adaptation. This includes adding reservoirs for water storage conflicts with current Everglades restoration and management strategies trying to match water levels to historic natural conditions
- C-51 reservoir is a regional water storage that captures excess fresh water sent to tide through Lake Worth Lagoon and reduces harmful discharges, recharges surficial aquifer, and serves as an alternative water supply for future drinking water needs
- An idea is to return to stilt structures like in the Florida Keys
- Ordinances and land use updates and development regulations should recognize future conditions and drive resilience. There should be a graceful transition away from low-lying vulnerable areas and efforts to prevent densification in vulnerable areas
- Avoid basing decisions solely on the market
- There is a need to maintain neutral agencies such as the Environmental Protection Agency to avoid collusion between developers and cities and avoid building in vulnerable areas
- There is a need to mandate resiliency standards instead of leaving them up to the influence of social consciousness
- An option is to collect coral spawn and transplant corals to enhance the reef as it dies

Resources

- South Florida Water Management District, [Southeast Florida Regional Climate Change Compact](#) and individual cities and counties have benefitted from global technical exchange programs focused on adaptation
- Beach nourishment and dune restoration in New Jersey and New Orleans benefit from more frequent nourishment and the use of sand fences
- US Geological Survey [modeling](#) in Broward County could be useful
- A possible case study is the seawall ordinances in South Florida
- A pilot project in Monroe County is elevating homes and mother in law suites
- Urban Land Use Institute reports for Fort Lauderdale highlight need to identify where to direct growth

Risk mitigation

- There is a need for innovative funding strategies to address the issue of aging infrastructure
- The National Oceanic and Atmospheric Administration is partnering locally to develop technical tools for local adaptation planning by sharing satellite and vulnerability data
- National Oceanic and Atmospheric Administration has a real-time surge prediction tool

Emerging issues/ research gaps

- Is there a resistance to stilts or implementation of coastal construction standards?
- Design criteria and prioritization of hazards and risk assessment
- Is surge risk greater at the beach or intracoastal?
- Hydrodynamic modeling is needed to identify risk at Hollywood reservation
- Tracking if mortgages are being denied is difficult as flood insurance is not available
- Future precipitation patterns at a higher resolution are needed for South Florida
- There is a lack of metrics for resilience which would allow specific goals to be set and achieved
- Vulnerability assessments on sea level rise, extremes for all applications are lacking
- Communication gaps on rate of gulfstream slowing, and we cannot easily look up recent changes in speed and their correlation to local impacts
- There are more local tide gauges, waves, temperature monitoring
- Climate impacts on fisheries in southeast Florida is an emerging issue
- A coral reef sustainability plan is needed

Broward County Satellite Meeting - Plantation, FL

Topic: Wildfire & Other Topics (Natural Systems), Facilitator: Albert Lee, Broward County

Observed changes in and risk posed by wildfires and other impacts

- Drought is creating more fuel for wildfires
- Changes in temperature and the flowrate of streams are causing impacts on wildlife and fisheries as well as excess runoff from and erosion in wildfire affected areas, which has consequences for local/tribal economy and culture
 - Damaged infrastructure from flooding and extreme events has negative spillover impacts to streams

Longer-term climate change impacts on natural systems

- There is increasing impacts from invasive pests
- The migration of native plants and trees (e.g. higher elevation spruce fir) has cultural significance to tribes. For example, tribes use them for medicinal uses, which will be lost

Resources and case studies

- Sharing of traditional ecological knowledge with researchers is an important resource, which is enhanced by collaboration between tribes and the US National Forest Service

Challenges, opportunities, and success stories

- There is a lack of planning, resources, and funding for prescribed burn programs on tribal lands

- Outdated plans and lack of integrated plans create a hazard for mitigation and emergency management plans
- Negative public perceptions of prescribed burns erode public support
- There is a need for mechanical restoration and wildfire fuel reduction
- There is a lack of program administration as well as current and long-term hazard mitigation plans and projects

Emerging issues and research gaps

- There is a need to create a vision for the future landscape
- There is a lack of studies on the causes and effects of plant decline and migration as well as the associated social effects, such as cultural values, economic, health, etc.
 - Research is needed on native plant and animal species, biodiversity, and habitat effects
- There is a lack of baseline data to identify causes of observed change and to give a better understanding of what future impacts may be
 - Data is from photos and oral histories

Charleston Satellite Meeting – Charleston, SC

Topic: Flooding

How has climate change affected this topic?

- Flooding is not just coastal. We need a definition of flooding that incorporates sea level rise, rain, and tides

Concerns about projected climate change 20-30 years in the future:

- With the projected increase in development, there will be an increase in the affected population and run-off
- Huge investments in infrastructure have been made without regard for climate change, sea level rise, flooding, or drainage. Information regarding these may not be up to date or available/accessible, especially regarding stormwater infrastructure
 - There is a worry that developers will not end up being responsible and pass responsibility on to municipalities
- Regulations and permitting are not keeping up with the changing climate which poses particular challenges as pollutant and toxin input enter the ecosystem and stormwater threatens to act as a disease vector. There is not a requirement that developments take climate change into account when planning, and jurisdictional rules vary greatly across local scales.

Challenges, opportunities, case studies, or success stories:

- Adaptation and planning work done by the Georgia Sea Grant at Tybee Island and Georgia barrier island could be a good case study
- The Beaufort County, South Carolina sea level rise report is a good success story. Liz Fly from South Carolina Sea Grant would be the point of contact for this.
- Small, rural area, vulnerable populations such as retirees are of keen interest to residents and the government, particularly when considering the population growth risk factor.
- Defense infrastructure is also at risk, such as Marine Corps sites on Paris Island
- A volume-sensitive stormwater study completed by the South Carolina Department of Natural Resources, National Oceanic and Atmospheric Administration, South Carolina Sea Grant and others is a good resource
- An excellent example of data-driven changes to stormwater regulations that increase climate change preparedness can be seen through collaborative research with South Carolina Department of Natural Resources, University of South Carolina, Beaufort County, and National Oceanic and

Atmospheric Administration on stormwater pond flow into receiving waters and valuable work in Bluffton

- Urban Land Institute (ULI) is a prioritization scheme responding to the value of infrastructure and aspects of environmental justice.

Emerging issues/research gaps:

- Environmental justice will become a greater issue over time

Extreme Events

How has climate change affected this topic?

- Are hurricanes, tropical storms, and tornadoes being accounted for? Where do these factor into the National Climate Assessment? The Southeast is frequently affected by such events, along with rain and wind events
- There is almost a need for a “super extreme” category
- How do we define what constitutes an extreme event?

Concerns about projected climate change 20-30 years in the future:

- Rising minimum temperature will increase insect species and numbers
- There is a changing definition of extreme events, and less extreme events are now more impactful than historically, thus creating a new baseline

Challenges, opportunities, case studies, or success stories:

- A comparison between 2015 and 2016 rain and flood events would be useful as affected places differed due to differences in rain patterns

Emerging issues/research gaps:

- What is the level of increasing frequency? What are the projections? How might they change in the future? How has development influenced the historical baseline?

Health

Concerns about projected climate change 20-30 years in the future:

- There will be a decrease in mental health and food security
- Mold is a concern, especially for vulnerable populations
- An increase or change in insects can cause issues

Challenges, opportunities, case studies, or success stories:

- Challenges include providing access to emergency services in floods, dealing with filled marshland, and losing pilings

Emerging issues/research gaps:

- Considering the location of emergency services with climate change in mind will be a challenge
- A decrease in mental health is an emerging issue

Lafayette Satellite Meeting – Lafayette, LA

Tribal Issues

- The Houma tribe was awarded a US Department of Housing and Urban Development grant to relocate but have not yet received it because the funding is being held by the state. Another tribe has already been forced to leave their land and the Houma tribe is their neighbor.
- If there is a major storm, the Houma tribe could be flooded as in Hurricane Katrina.
- Some don't want to leave because they have been there for centuries.
- Tribe members have relied on fishing for generations. This way of life and cultural identity is threatened by climate change

- The tribe was told their area would be gone in 50 years but at the current rate, they believe it will be faster

Health

- The Louisiana State University Psychology Department is doing a study looking at how the stress of constantly relocating due to extreme events and flooding are impacting human health.
 - Specifically looking at people who left their homes to move north because of Katrina but have since needed to relocate several times because of flooding in other areas.
- People don't know how to deal with mold in their homes after flooding.
- People doing home restorations after flooding and extreme events have led to an increased demand for Tetanus vaccines. This brings up the issue of what do you do if you do not have enough shots for everyone in a situation like this
- Water stood for weeks after flooding, killing everything below the water. This resulted in a big sod moth problem, and these moths killed everything else.
- Contaminated water is left standing for weeks, which contain all kinds of harmful substances such as pesticides from lawns, etc. This water soaks into the ground so nothing grows in some people's lawns and they can't eat fruit from trees in their own backyard because of health concerns.
 - University students are coming to people's homes and testing soil quality for free
- There is an increasing concern regarding incidents of West Nile and Zika in the area

Built Infrastructure

- Levees and barriers were put up to protect against water coming from the south, but some water came from the north from extreme events and barriers actually trapped the water in areas that otherwise would not have flooded. Roads are blocked during emergencies.
- There is a question of where people can relocate, especially as there is not enough housing. This is especially a problem because many people who have moved before refuse to move again, creating safety issues.
- For Interstate 10 between Orange, Texas and Lake Charles, flooding models were not adequate.
 - Said the interstate was built to withstand a major flooding event but it was not sufficient for the recent flooding. National oil reserves are there in Texas which poses additional risks
- Has anyone looked at how often highways are shut down in Louisiana due to flood events? This would be a very interesting thing to include in the chapter given the economic and safety impacts.
- Because there is so much rain on such a scale, water is unable to drain as quickly as it needs to because the system was not built to withstand such things. Infrastructure and poor planning are part of the problem
- After Hurricane Katrina, nothing really changed. We still have the same number of bridges, and roads are not widened to let people evacuate in the event of an emergency
- There are regulations to build on the coast, but according to Louisiana law, owners of property in inland Louisiana can build however they want on their land. A trend has been seen for opting to build new instead of repairing the old. New houses and roads are being built in areas vulnerable to flooding. The reason roads were built where they were in the first place was because they were in the highest elevated areas.
- People are commuting from New Orleans to Lafayette and other areas, despite the risks, because they can at least find housing in New Orleans. Infrastructure availability issues abound
- Most major infrastructure plans take 20 years to complete, and some need five years just to get a permit. This is not fast enough to deal with the changes communities are experiencing

Agriculture

- In the spring, Louisiana had a 1,000 year flood event. Then there was another 1,000 year flood event in August. The resulting standing water stayed there for weeks - longer than it should have - killing everything under the water. This created agricultural losses on land impacted by this kind of flooding.

Tourism

- After the recent flooding, people were told not to go to New Orleans; although, the flooding did not take place in New Orleans. Extreme events have consequences for the state as a whole, regardless of where the events actually take place

Oceans

- The Southeast Region has so far not talked much about oceans, and yet the region is surrounded by oceans.
- Seafood is a major industry which is being affected by climate change. There is an increased risk of disease in seafood, and there are studies on linkages between climate change and oyster production
- Extremes of salinity and freshwater damage oysters which need a mix of both kinds of water
- Contaminated water is going into the river or the Gulf of Mexico. The oyster industry is suffering. This year was also the first time they ever closed early during blue crab season.
- Oceans have absorbed much of the warming. One impact is the increase in brain eating amoebas. This happened last year in coastal waters and takes place when there is warm, stagnant water
- Dead zones and hypoxia are major issues in the Gulf, which are growing due to contaminated water flowing to the area
- Salt-water intrusion is affecting groundwater
- The Gulf was really warm this year, and we are looking at a possible La Nina this year, which points to an above average hurricane season. Information on moisture fluxes from tropical to mid-Atlantic would be helpful.

Ecosystems

- The BP oil spill exacerbated problems, such as by killing marsh and wetlands. These kinds of events cannot be predicted but magnify climate change impacts in a way that we cannot account for
- Changes of invasive species cause issues. Some say that pythons will be coming up to Louisiana from Florida

Brunswick Satellite Meeting – Brunswick, Georgia

Adaptation Efforts

Observed Change

- Raising heating, ventilation, and air conditioning infrastructure to prevent damage from sea level rise is a priority
- There is a greater willingness to adapt than retreat
- There is more awareness of the need to adapt due to flood insurance, i.e. the Community Rating System (CRS)
- There are more tools available for the public
- Local and state governments are incorporating climate change into plans
- Some infrastructure retrofits are happening

Projected Change

- More adaptation is expected
- Costs are likely to increase. There is a need to minimize long term costs
- Economies may change because of climate change impacts on major industries, such as seafood and tourism

Case Studies & Specific Resources

- The National Oceanic and Atmospheric Administration's Sea Level Affecting Marshes Model is a good resource

Challenges, Opportunities, Successes

- There are sediment delivery issues associated with reservoirs
- There are issues with invasive species, which can act as a compounding stressor
- Work done in the Altamaha Corridor for habitat migration has been successful
- Challenges include working with vulnerable communities to retreat /adapt and finding successful adaptation examples to share

Emerging Issues or Research Gaps

- There are gaps in economic research, cost benefit analysis for mitigation, adaptation, and retreat options, as well as networking across the state, geography and sectors
- There is a need for funding and to prioritize actions based on needs
- There are challenges in the capacity to adapt and any resulting unintended consequences

Coastal Flooding

Observed Change

- Instances of 'Nuisance Flooding' are increasing
- Property & infrastructure damage including road washouts is increasing
- There is more intense flooding from rain and riverine overflow
- There are climate change effects on commerce and traveling on Highway 80
- Saltwater intrusion, vegetation alteration, and salt impacts to landscape are issues
- Standing water and mosquito issues present challenges

Projected Change

- There will be more economic impacts, land loss, erosion issues, and water quality impacts, which include salt and severe runoff
- More infrastructure retrofits will be needed
- There will be a loss of floodplain where there is not an ability to migrate, as well as habitat loss for fish and wildlife

Case Studies & Specific Resources

- Useful resources include the Sea Level Affecting Marshes Model 6.2, St. Mary's and City of Tybee's research, research on Sapelo Island National Estuarine Research Reserve habitat loss, and University of Georgia sea level rise habitat loss research
- Dean Hardy's vulnerability assessments at the University of Maryland could be useful
- Flood watch from the University of Georgia Marine Extension is a good resource

Challenges, Opportunities, Successes

- Living shorelines, including those in Sapelo, Little St. Simons Island, Cannons Point Reserve, and Burton Center on Tybee, have been successful
- There are funding challenges, especially in the near future
- There is an opportunity to incorporate more in the local planning process and coastal management.
- The urgency of the issue of climate change and seeing its impacts now provides both opportunities and challenges

Emerging Issues or Research Gaps

- There is a need for more local case studies, broader public engagement, improved political education, increased communication, and a broader network of sector involvement
- Understanding the economic impact, especially with economic services, is a gap

Health Issues

Observed Change

- There has been a change in mosquitos, tick borne diseases, and water quality and quantity for coastal and drinking water
- Vulnerable communities have been more exposed to impacts of sea level rise and heat
- Stress and hardship has increased
- Instances of cardiovascular issues and heat stroke have increased
- Shellfish quality has changed and harvest area closures have been longer

Projected Change

- Spread of Zika and West Nile as well as water borne diseases is projected
- A decrease in food availability because of pollution and water issues is expected
- Mold issues may increase

Case Studies & Specific Resources

- Oyster aquaculture education regarding water quality would be a good case study

Challenges, Opportunities, Successes

- There is an opportunity to educate the health field and benefit from personally experienced impacts
- The health department has been successfully involved in a community of practice

Emerging Issues or Research Gaps

- The ways in which population increases will exacerbate health issues are an emerging challenge
- More information is needed on the impacts of population density on health as well as new diseases

Extreme Events

Observed Change

- Precipitation has negatively impacted fisheries/crabs
- There have been negative impacts on drinking water supplies, groundwater availability, sedimentation
- Saltwater intrusion, habitat impacts and loss, as well as marsh dieback has increased in drought
- There is greater erosion from storms and precipitation
- Algal blooms have increased
- Mosquito & pine beetle outbreaks have taken place as the result of decreases in freezes
- Invasive species such as water hyacinth and pythons are encroaching, which can act as a compounding stressor to ecosystems already under stress by a changing climate
- Displaced population and damaged infrastructure from hurricanes are issues

Projected Change

- Greater economic impacts, increased wildfires, forestry issues, challenges with food costs and availability, more intense storms, changes in fish assemblages, and alternate drinking water issues are projected to increase

Case Studies & Specific Resources

- Jason Christensen's work at the University of Georgia could be useful

- Marsh dieback reports by Dr. Franklin could be helpful
- Rachael Guy has conducted research on shrimp and droughts
- A good resource is also harmful algal bloom research by coastal regional health departments
- Drought plan by the Department of Natural Resources in Georgia could provide insights

Challenges, Opportunities, Successes

- Local action in the form of disaster recovery redevelopment plans has been successful
- Challenges include costs and creative ways to conserve water

Emerging Issues or Research Gaps

- Emerging issues include aging water infrastructure and aquifer storage recovery methods
- Funding to address these issues is a gap
- How climate change impacts tourism & socially vulnerable communities is an issue

Emory University Satellite Meeting – Atlanta, Georgia

Future research needs

- Who is using the Evaluation of National Climate Assessment and at what education levels (K-12) and for which communities?
- There is a need to be aware of the audience when communicating about climate change impacts and develop communication tools for those audiences
 - Using videos for storytelling is a good idea. Perhaps a collaboration with Climate Central of George Mason on this would be possible
 - Communication should be easily accessible and online
 - Personal stories for a specific audience is helpful. Packaging information outreach to younger populations is also important. The Piper cartoon on adaptation is an example
- There should be more information on Positive Feedbacks Hydrology
- How is uncertainty measured and taken into account? How can this be made useful to policy makers?
- Better economic analysis is important
- There is a need to better understand the economic, health, energy, and infrastructure impacts of oil and hydraulic fracturing operations
- A greater understanding of the links between social sciences and infrastructure/engineering is needed. Important organizations to this end include:
 - American Society of Civil Engineers (ASCE)
 - American society of agriculture and biological engineers (ASABE)
- Shorter vs longer term weather time series
- There is an interest in better understanding shifts in precipitation patterns
- Shifts in agriculture and drought impacts, such as in Flint River, Georgia presents a future research need

Health

- The health impacts of prescribed fires should be considered
- The impact of heat on migrant and outdoor workers as well as the resulting need for emergency response is an important health consideration
- There is a need to consider the types of Infrastructure for biomonitoring indicators and their use of surveillance
- Focusing on weather information, health adaptation, information sharing, and communication on the impacts on vulnerable populations is important
- Injury and trauma needs in the face of storms and tornadoes needs to be emphasized

Adaptations

- Specific to national/state/local

- How do we characterize adaptive capacity?
 - Matrix of intersections of scale by sector “how we are doing” (rate) in adaptation terms – something to consider in Adaptation Chapter
 - Possibly emphasize systematic efforts
- Public/private partnerships - Florida example: Payne recharge - Workforce/jobs created
- Tybee Island as adaptation example to sea level rise (New York Times)
 - Federal response at local level (Centers for Disease Control and Prevention, Department of Transportation, etc.)

Rural/Urban

- Social science research around Infrastructure, Trees/canopy
 - Climate effects, co-benefits

Key Items to Report Back

- Communication and packaging of the chapter for education purposes should focus on end users to achieve accessibility and effectiveness
- The scope of adaptation involves multiple levels of government and public/private partnerships
- Adaptation examples exist across multiple levels. There should be a focus on economics for political relevancy, as well as the opportunity for jobs. A call to action is also important.
- Next steps include filling gaps, addressing monitoring, surveillance, and data needs, and improving evaluation, in part through the development and use of indicators

Discussion from Remote Participants

A few people in Norfolk discussed coastal flooding and adaptation

- Is extremes covering drought?
- The case study for Portsmouth is interesting one
- Virginia Beach incorporates National Oceanic and Atmospheric Administration’s coastal flooding work using science curves to connect science to planning, policy, and engineering, with a greater focus on engineering. The city is also a National Oceanic and Atmospheric Administration coastal resilience grant recipient. The city has rural areas like Northeast North Carolina and includes both urban and rural planning in one locale. The city also has an agriculture department which looks at impacts of water intrusion and how increasing salt and water tables affect agriculture
- Norfolk is doing innovative work which includes being a part of the Rockefeller 100 Resilient Cities program and producing its vision 2100 plan last summer
- Hampton has an urban water plan similar to New Orleans; although, they are earlier in the process. Thus, this may not be at a stage to be a case study yet.
- The Louisiana Sea Grant is doing interesting work which includes observing how drought in Texas and elsewhere affects them in Louisiana
- Kentucky state climatologists are looking at drought. In particular, Kentucky State Climatologist Stu Foster has inland examples and perhaps a case study on drought
- In the Hampton Roads region, they are reinjecting wastewater into groundwater to help with subsidence as a way of engineering the water cycle
- The chapter needs a section on freshwater supply and management to cover drought as well as southeast water management and movement to other regions
- Going back to the upstream storm surge flooding such as occurred in North Carolina, how can we handle breaching of large hog farm and rural septic systems in light of upstream storm surge flooding, such as what occurred in North Carolina?
- There are more and more impacts from “nuisance flooding” on agriculture
- There are research needs in forecasting around extreme events