Department of Geography, University of South Carolina 4th Quarter 2014

Carolinas Climate Connection

Carolinas Integrated Sciences & Assessments

Integrating Climate Science and Resource Management in the Carolinas

Happy Holidays

The CISA team would like to wish each of you a joyful holiday season and best wishes for a happy and healthy New Year!

Newsletter Contents

Getting to Know Your RISA

Featured Researcher: Greg Carbone

Dr. Greg Carbone is a climatologist and Professor of Geography at the University of South Carolina (USC). He holds a Ph.D. from the University of Wisconsin and has been teaching weather and climate courses at USC since 1989. His research and publications center on climate variability and change and impacts on agriculture and water resources. His work with CISA undergraduate research assistant, Chandler Green, to develop a series of videos about climate influences on water resources and management throughout South Carolina and efforts to support the inclusion of climate change information in the Coastal SC Low Impact Development Manual are featured in this edition of the Carolinas Climate Connection.

Dr. Carbone is traveling to Bologna, Italy this spring to work on drought-related projects at the Institute of Atmospheric Sciences and Climate (ISAC) of the Italian National Research Council (CNR). The work will involve collaborators with similar interests in hydroclimatology, homogenous data records, and climate variability.

When asked what he values most about his work with CISA, Dr. Carbone notes that collaborating with colleagues and students to find the most effective ways to bring climate science to decision making is some of his most rewarding work.

Upcoming Events

Interagency Conference on Research in the Watersheds
Charleston, SC
March, 2-6, 2015

SC Environmental Conference
Myrtle Beach, SC
March 15-17, 2015

NC Water Resources Research Institute Annual Conference
Raleigh, NC
March 18-19, 2015

Coastal GeoTools
North Charleston, SC
March 30 - April 2, 2015

National Adaptation Forum
St. Louis, MO
May 12-14, 205

Carolinas Climate Listserv

Subscribe to the Carolinas Climate Listserv to learn about the latest climate research and information, upcoming events, funding opportunities, and other relevant news for the Carolinas.

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UNIVERSITY OF SOUTH CAROLINA

Using Climate Change Projections to Support Decision Making

Efforts to improve understanding of the climate system and replicate it in global and regional models is a top priority as scientists seek to provide support in addressing future climate change at international, regional and local scales. Downscaling global climate models to a regional level supports these efforts at a decision-relevant scale*. Collaboration between climate model developers and decision makers is a key component in this process.

"Managing climate change scenarios for societal impact studies" (Carbone, 2014) provides insight into the ability of climate change scenarios to support decision making and climate-resilient planning. This article, published in *Physical Geography*, provides a review of data and tools used to develop climate change projections, limitations in their development, and methods used to address these limitations. The final section of the article compares a "climate-modeling-first" strategy, which supports improving model output at increasingly higher resolutions to inform decision making, to a "bottom-up" approach which first determines vulnerabilities to changing climate conditions then estimates the likelihood that those conditions would occur. Carbone notes that "studies measuring adaptive capacity spend less time fretting over perfecting climate change scenarios and downscaling, and focus on sensitivity to past climate variability or change." He also argues that this approach helps to determine what additional information (improved climate models or better understanding of vulnerabilities in a system) are most needed to support decision making.

A recently released USGS publication entitled "Downscaled Climate Projections for the Southeast United States: Evaluation and Use for Ecological Applications" (Wootten et al., 2014) provides findings from the evaluation of six downscaled datasets that cover the Southeast U.S. and guidance to scientists and natural resource managers with specific interests in ecological modeling and conservation planning related to climate change in the Southeast. The authors use the synthesis of literature and their evaluation findings to make recommendations about the use of the data and future work needed to make the datasets more useful for ecological modeling and decision making.

A section of the report entitled "The Climate Sensitivities of Southeast U.S. Species and Ecosystems", discusses the availability and utility of very high resolution downscaled climate projections to support decision making for natural resource managers, citing recommendations for <4 km resolutions by Franklin et al. (2013)**. The authors note several limitations to producing datasets at such fine resolutions including computing power needed for dynamic downscaling and the availability of observed climate data at very fine scales in order to either produce statistically downscaled datasets or to evaluate the resulting dataset with the observed record.

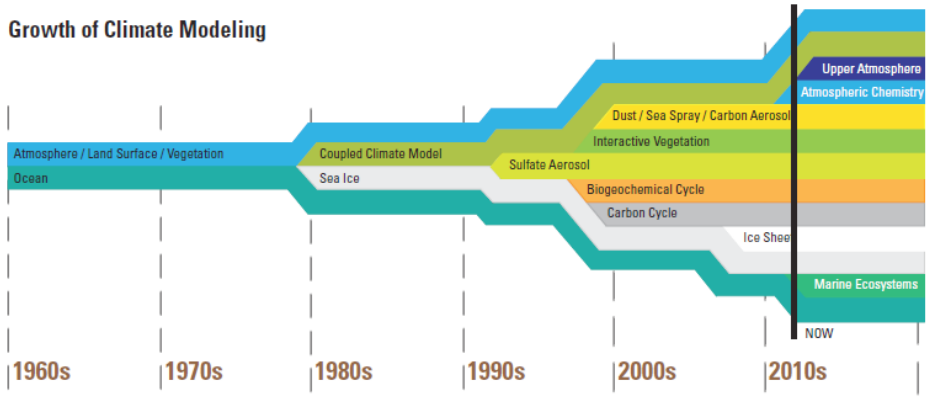
As an alternative approach, the authors suggest that first understanding climate sensitivities of particular species can help to guide the use of lower resolution (10 – 50 km, rather than 4 km) downscaled climate projections which are already available. The downscaled datasets which they evaluate in the report provide insight into projected changes in temperature, precipitation, and extremes (e.g., fire, drought, hurricanes) which are most likely to have the greatest impact on ecosystems in the Southeast. The authors provide an example of a series of studies which analyzed the sensitivity of six native tree species to different climate variables. These studies revealed that all six species are vulnerable to changes in temperature and precipitation regimes. By providing the type of variables to which species of interest are vulnerable, resource managers can help to guide climate information providers as well as the development of climate projections which will best support their decision making needs.

Work to improve the output of climate models will continue to be a priority as we face an uncertain future under changing climate conditions. However, informed decisions can be made with the wealth of information currently available. Continued collaboration between providers of climate information and decision makers will also be an important component in preparing for future change.

CISA serves as a resource for decision support and collaboration in the Carolinas. For more information about the types of climate information CISA researchers can provide, contact us at cisa@sc.edu.

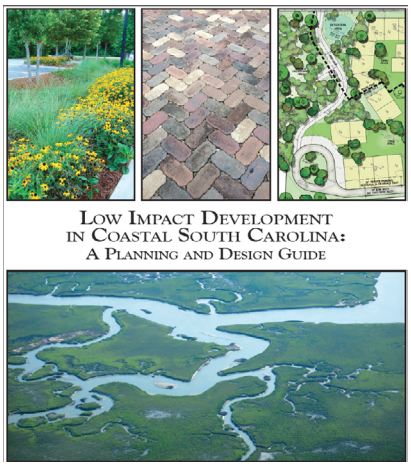
*More information on climate models and downscaling can be found in the 2013 3rd quarter edition of the Carolinas Climate Connection.

**Franklin, J., Davis, F.W., Ikegami, M., Syphard, A.D., Flint, L.E., Flint, A.L., and Hannah, L., 2013, Modeling plant species distributions under future climates—How fine scale do climate projections need to be?: Global Change Biology, v. 19, p. 473–483, DOI: 10.1111/gcb.12051.



The ability of models to replicate more complex processes in the Earth's climate system continues to improve. However, because scientists do not have perfect knowledge of the climate system, there are still processes, such as the development of hurricanes or more localized events such as convective thunderstorms, which models are not able to fully replicate. Additionally, downscaled climate models do not decrease the uncertainty inherent in global climate models, such as poor simulation of the impact of El Niño on precipitation trends in the Southeast. Source: IPCC 2001

Considering Future Climate Changes in Low Impact Design



The ACE Basin and North Inlet-Winyah Bay National Estuarine Research Reserves (NERRs), the Center for Watershed Projection, and the SC Sea Grant Consortium, with funding through a NERR Science Collaborative Grant, have published *Low Impact Development in Coastal South Carolina: A Planning and Design Guide*. From a stormwater perspective, low impact development (LID) practices have been promoted as an effective way to reduce runoff from urbanized landscapes and reduce water quality contamination. In more recent years, LID practices have also been suggested as an adaptive management strategy for dealing with the uncertain and variable impacts of climate change on local rainfall patterns.

This project is one of the first instances where a group is specifically concerned about ensuring that LID practices can withstand potential climate changes over the expected 30 to 50 year lifetime of LID site design. CISA team members met with the project development team and other coastal stakeholders in September 2013 to discuss climate change projections, sea level rise, and their potential impacts on LID best management practices (BMPs). CISA provided additional technical support and guidance to the project team to aid in understanding of the variability, trends, and potential future changes in precipitation as they worked to incorporate these potential impacts into the guidance.

Guidance for considering potential climate change impacts was provided as part of an appendix as well as in call out boxes and case studies throughout the manual. Katie Ellis, North Inlet-Winyah Bay NERR Coastal Training Program Assistant, notes that providing the information in an appendix, rather than giving specific technical guidance, allows for flexibility by manual users which includes engineers, planners and local municipalities. Engineers will use the manual for technical specifications to certify development plans.

There is still a good deal of uncertainty around future precipitation projections for the Southeast (Ingram et al., 2013)* making it difficult to provide specific technical guidance for site design. The information in the appendix provides a range of possible future conditions (e.g., increased recurrence of drought conditions, heavier storm events) and suggestions for considering this variability in site design (see table below).

The manual is also designed to support stormwater management planning in local municipalities. Broader strategies were considered in providing guidance for the municipal scale. For example, wetlands conservation is one suggested strategy that not only supports stormwater infiltration and improved water quality, but also provides protection against coastal storms and hurricanes.

Ellis notes that the manual is a "living, breathing document" and, just as it recommends that LID projects should be routinely maintained to ensure lasting efficiency, so too will the manual be updated to provide the best guidance for users tailored to changing conditions in the coastal communities of South Carolina.

Ingram, K., K. Dow, L. Carter, J. Anderson, eds. 2013. Climate of the Southeast United States: Variability, change, impacts, and vulnerability. Washington DC: Island Press.

Elements of low-cost solutions and adaptations over time in support of climate resilient low impact development

LID Design Recommendations	Climate Change Variables Addressed
Implement LID practices at the site scale	• Changing rainfall patterns • Design storm intensity • Sea level rise • Increasing temperatures
Modify practices to prevent bypass during intense storm events (i.e., creating redundancy in the "treatment train")	• Changing rainfall patterns • Design storm intensity
Periodically revisit design storms and mapped floodplains to create "new generation" best management practices (BMPs) suitable for changing conditions	• Changing rainfall patterns • Design storm intensity • Sea level rise
Create adaptable planting plans to use native species which thrive in the region	• Drought • Increasing temperatures
Use stormwater as a resource to reduce water demand for irrigation	• Drought • Increasing temperatures

CISA Video Series Highlights Climate Influences on Water Resources in South Carolina

CISA PI Dr. Greg Carbone and research assistant Chandler Green have produced a series of short video interviews highlighting the variety of ways in which climate influences water resources in South Carolina. Interviewees range from natural resource managers to private business owners and municipal water system directors. Information shared by interviewees includes how historic droughts of record in the past decade have influenced water resource planning and management in the state, how changes in the climate of South Carolina may impact water resources and the ecology of lakes and rivers, and creative ways business owners are conserving water resources and improving their financial bottom line.

View more of the 2-3 minute videos through the CISA website or on our YouTube channel.


A river tributary flowing through Congaree National Park

Featured Video: Water, Climate Change and Congaree National Park

One of the newest videos in the collection features Congaree National Park education coordinator David Shelley. A very unique ecosystem, Congaree is the largest expanse of old growth bottomland hardwood forest remaining in the southeastern U.S. In the interview Shelley describes the vital role of water in the park and how the frequency, magnitude, timing, duration and rate of flooding are all factors which fundamentally drive the ecosystem there. He also discusses changes to the flooding regime, recurrence and duration of drought, and temporal shifts in plant and animal life cycles as potential impacts of climate change in the park landscape. Through the integration of downscaled climate projections, a watershed model and a floodplain model, CISA researchers are conducting work to improve understanding of the effects of climate change on floodplain hydrology and habitat connectivity in the park.

National Park Service "Climate Friendly Parks" Program

Congaree National Park is part of the National Park Service's "Climate Friendly Parks Program", which is a component of the broader Green Parks Plan to provide an integrated approach to climate change by implementing sustainable practices within park operations. As Shelley mentions in his video, the NPS works to protect and preserve national parks for future generations. He notes that, in the last ten years, he has seen a shift in how climate change is approached and describes the park as a valuable public space where discussions about climate change can take place while creating a sense of empowerment in our ability to address potential impacts.

Other climate friendly parks in the Carolinas include the Carl Sandburg Home National Historic Site and Great Smoky Mountains National Park.


The low boardwalk in Congaree National Park

Stakeholder Workshop: Understanding Rapid Environmental Change at Alligator River National Wildlife Refuge

What will the impacts of climate change look like along the landscape of the Carolina coastline? How will these changes affect wildlife habitat and local communities? What types of adaptation strategies might help protect the shoreline and native species in these changing environments?

Changes taking place at Alligator River National Wildlife Refuge in North Carolina provide insight into these questions. With support from CISA, community members and stakeholders came together on Friday, December 5, 2014 to learn more about the refuge, research that is being conducted to understand changes there, and adaptation strategies being implemented to protect the landscape.

Workshop host and project lead John King shares information about the changing ecology of Alligator River National Wildlife Refuge with local stakeholders. Fewer pine trees are seen in the landscape to the left of the road, as this area transitions from pond pine pocosin to marsh.

When it was established in 1984, much of the 154,000 acre refuge was a pocosin, a Native American word meaning “swamp on a hill” which is characterized by poorly drained soils high in organic material. As sea levels have risen, drainage in the refuge has been impeded, leaving the soil wetter for a longer period of time throughout the year. Changes in soil moisture and salinity levels have led to a transition in the ecosystem. The pond pine pocosin is being replaced by marsh grasses and changes in habitat are leading to changes in species distribution.

Researchers at the NC State University Tree Physiology and Ecosystem Science Laboratory are studying changes at the refuge. As part of a CISA-funded minigrant, graduate student Chase Brown is conducting research to document these ecosystems in transition and determine causative factors, including thresholds of transitions. He is analyzing organic soil content in the areas, which has been building up for thousands of years. He is also studying the effects of roads throughout the refuge. Roads acts as dams, holding back water and limiting soil drainage, and are a contributing factor in ecosystem shifts from pocosin to marsh.


These water control valves allow freshwater to flow downstream but limit saltwater inflow upstream, protecting sensitive plant and animal species in the refuge.

Additionally, some of the shoreline on the refuge is experiencing very rapid erosion rates, upwards of 15 feet per year in locations such as Point Peter Road. The Nature Conservancy is conducting a series of experiments to identify adaptation strategies to reduce erosion rates and limit saltwater flow into the ditches which traverse the refuge. They have constructed offshore oyster reefs to dissipate wave energy in an attempt to control localized erosion and are using water control valves strategically placed in ditches to reduce saltwater flow further inland.

Workshop attendees were able to view these study sites first hand during a morning tour of the refuge. The afternoon was spent in discussion of the changes visitors had seen. The discussion emphasized research and other information needs of local residents whose livelihoods and well-being are directly tied to the health of the refuge. Stay tuned for further details - additional information about workshop results and Chase Brown’s research findings will be posted to the CISA website as it becomes available.