

Carolinas Integrated Sciences and Assessments (CISA)

The Carolinas Integrated Sciences and Assessments (CISA) works with a variety of stakeholders across North Carolina and South Carolina to incorporate climate information into water and coastal management and related decision-making processes. These efforts include the development of the Dynamic Drought Index Tool (DDIT) for improved spatial and temporal resolution of drought levels and comparisons of drought triggers and support of the NIDIS drought early warning system development in the Southeast. We also use hydrologic modeling to integrate regional climate downscaling, sea level rise scenarios, and tidal variability models for salinity intrusion. We conduct needs assessments, develop coastal climate outreach programs, and support adaptation planning in coastal communities. Our efforts give particular attention to clear communication of uncertainty in cartographic representations of model output.

The core team includes researchers from the University of South Carolina and NC and SC Sea Grant. **Greg Carbone** is a climatologist. His work centers on climate variability and change and impacts on water resources. **Kirstin Dow**, an Associate Professor, works on climate impacts, vulnerability, and adaptation. **Dan Tufford** is a Research Associate Professor with the Department of Biological Sciences. His research focuses on watershed ecology and the potential implications of climate and climate change on land use and water resources. **Jessica Whitehead** is Regional Climate Extension Specialist with the NC Sea Grant and SC Sea Grant Consortium. She works with communities to develop tailored information about the impacts of climate variability and long-term climate change on North Carolina and South Carolina coasts. **Kirsten Lackstrom** is a Research Associate focusing on social learning and adaptation in drought management. **Jinyoung Rhee** is a climatologist specializing in drought monitoring. She has extensive geographic information science skills and is a lead developer of the DDIT.

CISA also partners extensively with regional climate service providers including **Chip Konrad**, Director of the Southeast Regional Climate Center; **Ryan Boyles**, Director and State Climatologist, North Carolina State Climate Office; and **Hope Mizzell**, South Carolina State Climatologist and Chair of the SC Department of Natural Resource's Climate Change Technical Working Group. Other federal agency collaborators include staff of EPA Region 4, National Weather Service, USGS, the National Park Service, NOAA Coastal Services Center, and NOAA's Center for Coastal Ocean Science. CISA PIs also serve on advisory committees including the North Carolina Sea Level Rise Science Advisory panel, The Nature Conservancy Alligator River NWR Climate Adaptation project; Science and Technical Advisory Committee of the Albermarle-Pamlico National Estuary Program; and the Sea Grant Climate Network Southeast Regional Group.

Core CISA Activities Planned to October 2011

CISA currently has three general focus areas: drought, watershed modeling, and coastal climate. These topics are closely integrated in several of our projects. We have applied for a continuation and expansion under the CSI-Regions call with an anticipated start date of May 1st, 2011. Depending on the success of that proposal, we will expand our efforts in current areas, begin work on human health, and place greater emphasis on supporting climate adaptation.

Drought. Our drought work seeks to improve monitoring methods, to develop a more comprehensive understanding of regional impacts, and to assess drought planning and early warning needs.

- We are refining the DDIT a web-based mapping tool to compare drought indicators calculated at spatial and temporal scales. Ongoing improvements result from workshops with users,

recommendations of the NIDIS staff, and research on strategies for the improved visualization of mapping uncertainty. As part of the NOAA TRACS program, we are working with the Northeast Regional Climate Center to facilitate the transition of the tool to operations. An expanded DDIT will be driven by the stable, near-real time Applied Climate Information System (ACIS) database. It will be accessed from the Northeast and Southeast Regional Climate Center websites and NOAA's drought portal and cover eighteen states. We will build on DDIT monitoring capacities by testing its use with new precipitation products including gage-calibrated radar precipitation estimates.

- We are collaborating with NIDIS personnel to develop and implement drought early warning system pilots in the Southeast. We expect to engage with a range of stakeholders in multiple basins to determine their decision-support needs and possible opportunities and regional activities through which NIDIS can support those needs. We will work with NIDIS and stakeholders to prioritize and initiate projects and to develop ways to transfer tools and information to stakeholders in other regions. In 2010 we conducted workshops with urban water systems to identify their climate and drought information needs. We also assembled an interdisciplinary group of resource managers concerned over the impacts of drought on coastal ecosystems. Follow-up activities with these groups will be conducted throughout 2011.

Watershed Modeling. Our hydrological modeling project addresses a regional need for a comprehensive analysis of watersheds to understand how climate variability and change affects water supply and quality. We have calibrated HSPF simulation models for the Yadkin Pee-Dee (from the NC mountains to the coast), Waccamaw, and Black Rivers at the 8-digit HUC level so that local variability within each watershed can be adequately addressed. This basin-wide approach to hydrological modeling appeals to a range of stakeholders, including water managers, natural resource managers (e.g. National Wildlife Refuges, state parks), Riverkeepers, citizen-advocates, Native American peoples, and state and national regulatory agency staff. Current and ongoing watershed modeling activities reflect this stakeholder feedback. A few of the specific projects are introduced below.

- We are using the watershed model to assess the potential consequences on flood frequency, magnitude, and duration of various build-out scenarios in high growth areas of the Winyah Bay watershed. Our watershed model allows us to simulate differences, such as density, percentage of impervious surface, and water conservation measures among development methods. County and regional planning agencies will assist us in refining these projections further.
- We will extend our considerable modeling experience and engagement with stakeholders in the Catawba-Wateree watershed through new project to evaluate climate impacts on floodplain habitat in the Congaree National Park.
- Stakeholders have expressed interest in the development of a useful suite of climate scenarios for future water planning. To this end, CISA has conducted a downscaling project – using output from NARCCAP, the North American Regional Climate Change Assessment Program – to assess the regional impacts of climate variability and change. We are exploring the effects climate-related changes may have on water quality, particularly on dissolved oxygen.

Coastal Climate. CISA partners with North Carolina and South Carolina Sea Grant Extension to assist coastal communities and stakeholders in evaluating and addressing ways to cope with the

potential impacts of ongoing and future climatic changes and variability. Our long-term goal is for stakeholders in the coastal Carolinas to mainstream climate information into decision-making processes. We have received additional funding to expand our capacity to work with coastal decision-makers:

- “Assessing the Impact of Salt-Water Intrusion in the Carolinas under Future Climatic and Sea-Level Conditions.” This project uses the watershed modeling project described above to develop a web-based decision support system for salinity intrusion scenario analysis. The process entails working with community water systems, coastal industries, and marine biologists to develop scenarios of salinity intrusion threats to surface water resources in coastal areas and inform the evaluation of adaptation options.
- “Informing Coastal Management Adaptation Planning and Decision Making for Climate Change Using an Interactive Risk-based Vulnerability Assessment Tool.” With our partner the Social and Environmental Research Institute (SERI) of Massachusetts, we have conducted a pilot project in Sullivan’s Island, SC. We are developing software tool and mediated modeling process that assists decision-makers in integrating local and scientific knowledge to diagram the consequences of impacts associated with sea level rise and climate change. In the coming year we plan to transition the coastal adaptation planning tool from the development to operational stage. End users include coastal communities and extension agents.
- We are involved in several efforts to support climate adaptation planning in coastal areas. Ongoing projects include reproducing the Kitchen Table Climate Study Group of McClellanville, SC (a local climate study group concept) in other communities, facilitating climate resilience and adaptation planning in McClellanville, SC, and Plymouth, NC, and partnering with Charleston, SC, to identify infrastructure vulnerabilities and adaptation options for current flooding events and future increased tidal flooding frequency under sea level rise.

National Assessment Activities for FY10

Collaboration with Key Climate Service Providers. We are partnering with the Southeast Regional Climate Center (SERCC), the Southeast Climate Consortium (SECC), and the state climatologists of Alabama, Florida, Georgia, North Carolina, Puerto Rico, South Carolina and Virginia to systematically document and consistently evaluate climate information requests made of the SCOs and SERCC. SCOs do not all track and record climate information needs and generally, they have not inquired about the specific decisions at hand or the capacity to process information. A systematic effort across the region will help us identify shared concerns and needs. We will use that information to coordinate climate service development efforts.

We will collect data regarding the types of information requested; the range of individuals, sectors, or groups currently requesting information; the types of decisions and inquiries being made; differences in the specificity of information needs and the issues clients address; user requirements for additional data/information processing; initiatives taking place throughout state government to integrate climate information into decision making; and the role of these climate service providers in supporting major statewide and regional climate-change studies and action plans. The NC SCO is developing a web-based reporting tool that is expected to become operational in October. CISA will coordinate survey development, data coding, and producing summaries.

Engaging Climate-Sensitive Sectors, Decisions, and Peoples. CISA is conducting an array of studies to identify key climate sensitive decisions, improve our understanding of decision-support needs, and assess the multiple dimensions of adaptive capacity in the region. We intend to focus on regionally significant sectors and planning processes, including recreation and tourism, forestry, wildlife and habitat conservation planning, water- and wastewater systems, urban sustainability initiatives, and needs of southeast indigenous peoples.

- The first component of this project is to analyze existing stakeholders' engagement with and thinking about climate knowledge needs in the Carolinas. We will minimize demands on stakeholders by using existing documents to build a comprehensive database of stakeholder characteristics and regional needs. We will collaborate with the GL RISA and WWA in the design and implementation of this review and evaluation framework.
- The second component of our research plan focuses on engaging key decision-makers and opinion leaders in the major climate sensitive sectors in the Carolinas. We will conduct coupled interviews-questionnaires to understand the capacities and networks that exist to support decision making about climate change issues. Interviews will elicit information about the decisions and adaptations occurring within the various sectors, how those decisions and adaptations interact with other plans and initiatives, and the major limitations in the capacity of their sector to adapt. Questionnaires will be used to collect data regarding the information and communication networks that exist to support decision-making, e.g. the key resources that deliver and help decision-makers to analyze information; science needs to assess the costs and benefits of alternative adaptation and mitigation options; the best methods for engaging colleagues in identifying decision-support needs; and, other opinion leaders in the region.

We will emphasize areas with which we have less experience and anticipate this process will generate potential opportunities to work with new stakeholder groups. For example, we are working with the Southeast Indigenous Peoples' Center (SIPC) to investigate the relationships between drought and domestic water supply and quality. SIPC would like a better understanding of whether their vulnerability to water quality problems is elevated during drought and, if appropriate, support for identifying early warning indicators of drought impacts on water quality. In the water sector, we will focus on the capacity of private sector consultants to support climate decisions. And, given that states are currently revising their wildlife action plans, we will also examine outdoor recreation interests including hunting, fishing, and paddling. We have initiated a new partnership with the Center for Sustainable Tourism at East Carolina University in Greenville, North Carolina to pursue topics related to this major economic sector.

- Laws and regulations are major elements shaping adaptation strategies. We are working with the University of South Carolina School of Law on a conference to explore how the interaction of international, national, state, and local laws create barriers and/or opportunities for improving state and regional adaptive capacity. We will use this conference as a first step to explore regional issues concerning coastal land and wildlife habitat management in plenary and breakout sessions. We expect that many of our stakeholders will participate in these sessions and raise issues that will inform subsequent activities. Among these activities, we will also support an applied legal research seminar (Spring 2011) at the University of South Carolina. This seminar is part of a national effort to examine how existing land conservation easements, and similar agreements, can be adapted to changing climate and habitat conditions and to evaluate strategies to introduce greater flexibility into easement agreements if needed. The group will conduct case studies in the coastal, agricultural, and piedmont areas of South

Carolina and present results to wildlife managers, extension agents, and NGOs from North and South Carolina at the end of the semester.

Drought. We have initiated several projects to advance regional and local capacity to cope with drought and to improve understanding of drought impacts on social and environmental systems currently under-represented in regional drought assessments (e.g. indigenous people, coastal ecosystems). We expect that the extensive assessment interviews on climate sensitive decisions, networks, and capacities will result in a better characterization of drought risks in these sectors.

Long Range Projects

CISA will continue to work with decision makers on improving their adaptation to drought, linking climate variability to watershed/landuse planning, planning coastal adaptation, and characterizing climate vulnerability in the region. We expect to see the major efforts in integrated climate and watershed modeling informs a variety of decisions.

Drought. We seek to monitor drought more thoroughly and accurately and to reduce vulnerability to drought across multiple sectors. We plan to enhance the DDIT to improve spatial resolution and to provide forecasts on the onset and end of droughts, to support the NIDIS drought early warning system pilot in the Southeast, and to evaluate the understudied impacts of drought on indigenous peoples and coastal ecosystems.

Watershed/Basin Management. We will build on our watershed modeling work to address growing interest in the complexities of climate variability and change and land-use change to understand what they mean for water (quantity and quality). We will address these questions using dynamically- and statistically-downscaled scenarios for large watersheds, but with a sub-watershed scale model to support local and regional decision-making.

Coastal Adaptation Planning. Efforts will continue to inform numerous local community planning activities as well as statewide planning processes, such as the South Carolina Shoreline Change Advisory Committee and Blue Ribbon Panel and the North Carolina Sea Level Rise Science Advisory Committee.

Health. We plan to investigate links between climate and human health including water-borne diseases, heat stress, and respiratory response to poor air quality. Our planned work with the NOAA Hollings Marine Lab on human health threats posed by *Vibrio* in shellfish integrates our work on watersheds, coastal adaptation, and drought. The spread of *Vibrio* is believed to be associated with changing temperature and salinity conditions. Models in North and South Carolina will monitor and assess the potential for increased exposure to *Vibrio* bacterial hazards in the southeastern US coastal water under changing salinity trends. Potential human health impacts make this work of value to both North and South Carolina Shellfish programs. We will work with the Southeast Regional Climate Center, National Weather Service Offices, and State Climatology offices to investigate heat stress vulnerability in rural areas by investigating microclimate conditions in agricultural fields and assessing methods to improve existing warning systems.

State Wildlife Action Plans. We will work with the North and South Carolina natural resource agencies to consider climate change impacts in their revision of state wildlife management plans.

We have significant experience and field data from work on the hydrology and habitat characteristics of Coastal Plain streams and geographically isolated wetlands.

Regional Significance

Much of climate adaptation will be comprised of local actions. Our efforts focus on informing local response to regional patterns and on major economic, environmental management, and social issues relevant throughout the region. To this end, we anticipate adding seasonal drought forecast information to the DDIT. Our work on watershed modeling has broad relevance for local land use planning and development decisions, stormwater management, conservation and habitat planning. In coastal areas, understanding the risks and local adaptation decisions related to tourism, landuse planning, salinity intrusion, and the fishing and shellfish industries will have broad applicability across the region and in other coastal economies.