Developing a Drought Early Warning Information System for Coastal Ecosystems in the Carolinas

NIDIS Carolinas DEWS Pilot Projects

1: Development of a new coastal drought index based on USGS real-time salinity data

2: Increasing drought impacts reporting through citizen science and CoCoRaHS

3: Identification of ecological indicators of drought in coastal ecosystems in the Carolinas

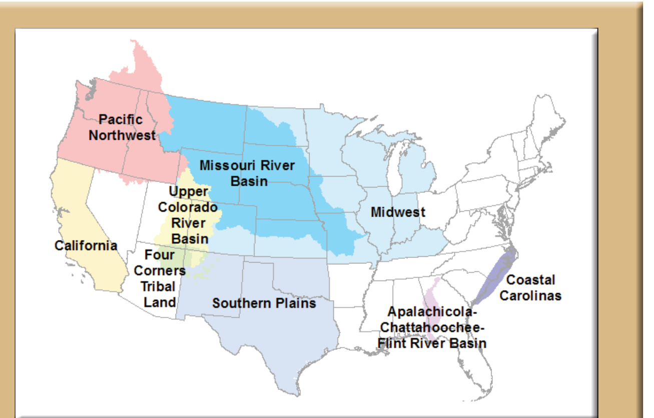
4: Assessment of drought indicators for coastal zone fire risk

5: Forecasting the South Carolina blue crab fishery using real-time freshwater flow data

6: Development of an "Atlas of Hydroclimate Extremes" for the Carolinas

Introduction

The National Integrated Drought Information System (NIDIS) and the Carolinas Integrated Sciences & Assessments (CISA) are collaborating to develop a Drought Early Warning System (DEWS) pilot program. Projects focus on the unique coastal ecosystems in North and South Carolina.



NIDIS DEWS pilot program areas throughout the U.S.

Approach

The project team has engaged with stakeholders through activities such as scoping workshops and interviews to explore the following questions:

- What should a drought early warning information system for the coastal Carolinas look like?
- What information is needed to cope with drought in coastal ecosystems?
- What can we learn about drought in coastal ecosystems?

Stakeholders recommended that the Coastal Carolinas DEWS pilot program address drought impact reporting, evaluation of drought indices, drought forecasting, and impacts of low-flows on water quality and aquatic species. Their guidance was used to develop the pilot activities described here.

Key Concerns

While many drought indices and indicators exist (focusing on, for example, agriculture or reservoir management), little attention has been given to impacts, monitoring, and early warning for coastal ecological resources. Key concerns related to drought and coastal ecosystems focus on impacts to water quality and quantity, habitats, species, and estuarine processes.

- Drought affects coastal species and habitats directly by reducing available freshwater for aquifers and surface water bodies, increasing salinity intrusion and salinity changes in estuaries and marsh systems, and changing fire regimes and risks in maritime forests.
- Ecosystem impact concerns center on habitat loss or conversion and consequent effects on recruitment, distribution, and migration patterns, as well as on primary and secondary production.
- Drought leads to tangible impacts to business costs and operations as well as concerns related to drought interactions with existing stressors such as land use change, development, and broader economic and market conditions.

For More Information

NIDIS Drought Early Warning System Pilot Program: www.drought.gov

Carolinas Integrated Sciences & Assessments: www.cisa.sc.edu, cisa@sc.edu

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References

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PRISM Climate Group, Oregon State University, http://prism.oregonstate.edu, created Jan 2015.

1 — *Development of a new coastal drought index (CDI) based on USGS real-time salinity data:*

The location of the freshwater-saltwater interface in surface-water bodies along the coast is an important factor in ecological and socio-economic dynamics. Salinity is a critical coastal response variable that integrates hydrological and coastal dynamics including streamflow, precipitation, sea level, tidal cycles, winds, and tropical storms.

Project goal: To develop an index that is suitable for characterizing drought conditions in coastal areas.

Integration with drought decision making: The CDI will bring more timely and detailed information about drought in coastal ecosystems using localized salinity data. Knowledge gained through the development of this index is anticipated to be transferable to other coastal locations.

Figure 1: Shows the computed coastal drought index for the Waccamaw River (upper plots) and the Little Black River (lower plot). The background colors are the drought declarations (CD0 to CD4) and wet declarations (CW0 to CW4) from pre-determined threshold values for each drought or wetness level. The plots show there are times when there are different drought conditions in the Waccamaw River basin than the Savannah River basin. For a period in October 2007, the CDI was compared to the Drought Monitor map for the week of October 16th. The map shows that the Yadkin-Pee Dee Basin was in greater drought than the Savannah River Basin. The CDI also indicated a similar change in drought along the coast. The background map shows potential USGS real-time gaging locations where the CDI could be applied. Sites were selected based on length of record and concurrence of upland drought.

{Project Lead: Paul Conrads, USGS South Atlantic Water Science Center}

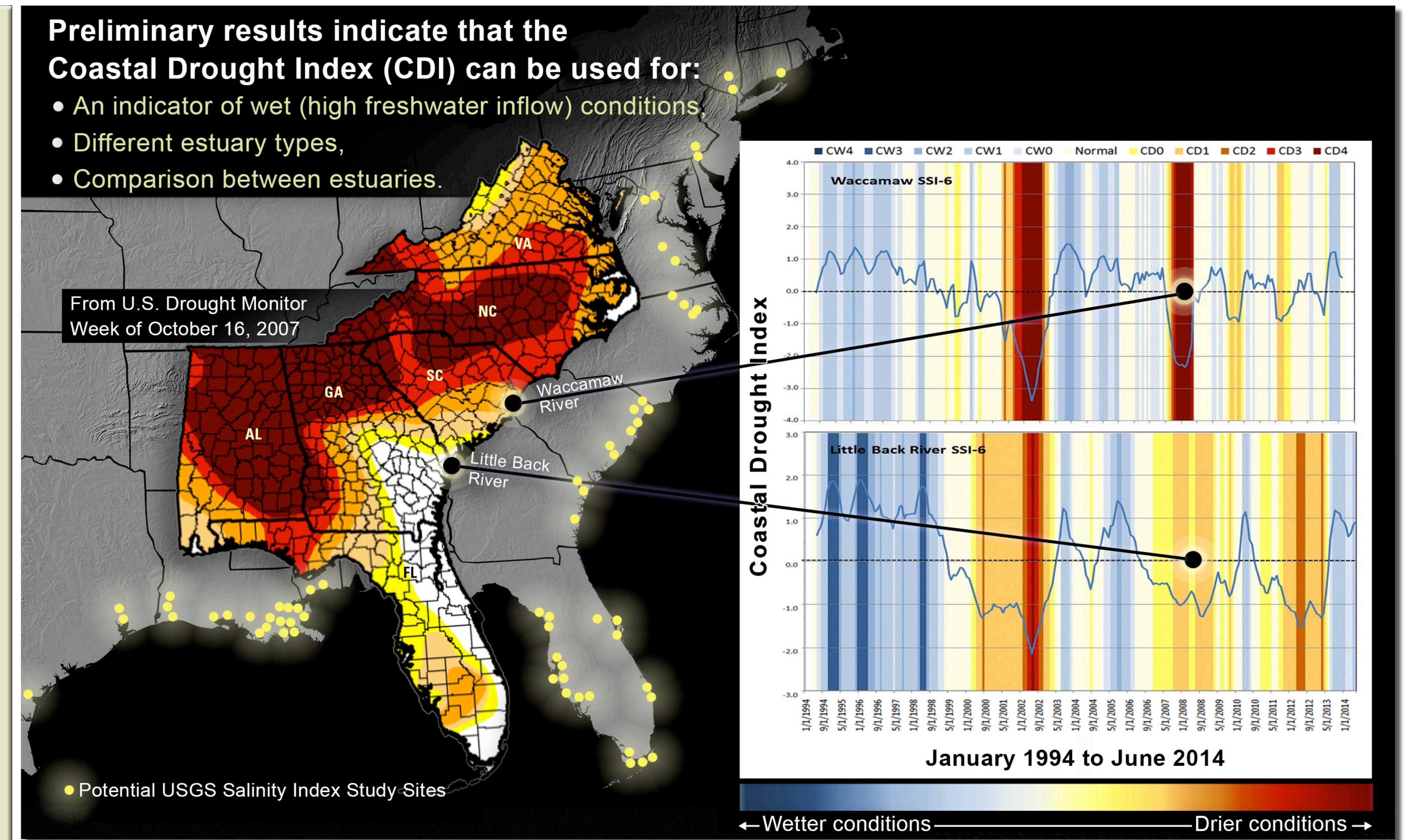

Figure 1: USGS Coastal Drought Index

2 — *Increasing drought impacts reporting through citizen science using the Community Collaborative Rain, Hail and Snow (CoCoRaHS) network:*

CISA is working with CoCoRaHS observers to increase drought impacts monitoring and reporting. Observers provide daily precipitation measurements and weekly reports about local conditions to connect weather and climate with on-the-ground impacts. The weekly reports are intended to create a baseline record of local conditions so that "departures from normal" (i.e. too little or too much rainfall) are more readily identified.

Project goals: To increase drought impacts monitoring and reporting and improve understanding of how drought affects the coastal regions of the Carolinas. The research team is also working to assess the role citizen scientists can plan in drought impacts monitoring through volunteer feedback surveys.

Integration with drought decision making: Interviews with decision makers will be used to evaluate how these reports might be incorporated into drought monitoring and response planning.

Figure 2: Shows the types of drought impacts reported by CoCoRaHS volunteers.

{Project Leads: Amanda Brennan, Kirstin Dow, Kirsten Lackstrom, CISA}

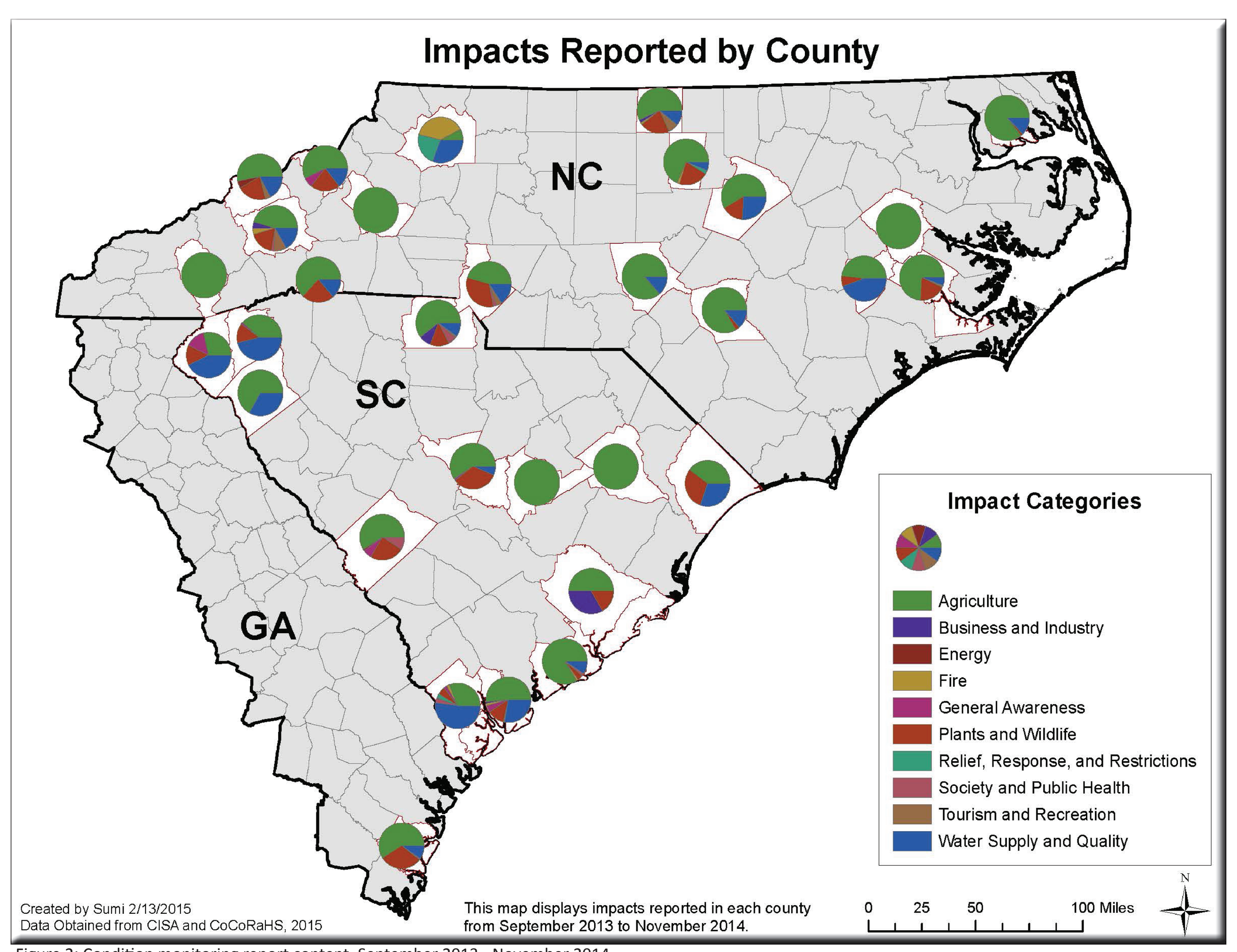

Figure 2: Condition monitoring report content, September 2013 - November 2014

3 — *Identification of ecological indicators of drought in coastal ecosystems of the Carolinas:*

The ability to detect drought onset is important to coastal managers because it enhances preparedness and provides opportunities for mitigation. Existing indicators, however, were designed with agriculture or fire management in mind.

Project goal: To determine if existing indicators are adequate for managing coastal resources under threat of drought and, if not, what information would be most useful.

Integration with drought decision making: A needs assessment with 30 coastal resource managers was conducted to examine the utility of drought indicators for coastal management. Participants agreed on the need for early detection tools and suggested that an index focused on freshwater availability and salinity would provide the greatest insight into potential drought impacts. Findings from the needs assessment will guide the development of scenarios of future drought and salinity dynamics, using the CDI developed by USGS. With resource managers, the team will explore long term strategies for conservation and management and approaches to using drought monitoring tools.

{Project Leads: Dan Tufford, CISA; Dave Chalcraft, East Carolina University}

4 — *Assessment of drought indicators for coastal zone fire risk:*

Fire plays an integral part in terrestrial ecosystem management across the Carolinas. Controlled burns are used to reduce wildfire risk and to manage species diversity in forest systems. Land managers use drought indices to assess wildfire risk, but traditional indices, such as the Keetch-Byram Drought Index (KBDI), do not provide the spatial resolution needed by land managers nor do they capture moisture in soils with high organic content such as those found in the coastal Carolinas.

Project goal: To identify and evaluate an objective index of drought that best represents the local risk of fire in coastal areas with these organic soils.

Integration with drought decision making: Through partnership with the NC Forest Service and The Nature Conservancy, these indicators will be compared to local fire event histories to identify those that best represent fire risk in organic soils. This effort provides for a preliminary investigation into the linkages between objectively defined drought indicators and physical impacts.

{Project Lead: Ryan Boyles, State Climate Office of North Carolina}

5 — *Forecasting the South Carolina blue crab fishery using real-time freshwater flow data:*

Blue crabs are one of the most important commercial fisheries in the Southeast, but landings have declined during recent droughts. To better understand the complex relationship between crab abundance and freshwater flow, a spatially-explicit, individual-based population model was constructed and parameterized using field observations collected in the ACE Basin National Estuarine Research Reserve.

Project goal: To examine how the rate of declining flow and the degree of inter-annual variability might interact to influence crab abundance, commercial landings, and disease prevalence.

Integration with drought decision making: The model will incorporate freshwater flow forecasts from climate envelope hydrological models and be used to forecast future crab landings given a range of future hydrologic and climate scenarios.

{Project Lead: Michael Childress, Clemson University}

6 — *Development of an "Atlas of Hydroclimate Extremes" for the Carolinas*

Project goals: To meet decision maker needs for an improved baseline understanding and information about drought and normal precipitation in the Carolinas.

Integration with drought decision making: This tool will provide information such as the average frequency of drought events, conditions necessary to support drought recovery, and rates of groundwater and aquifer recharge following a drought. Figures 3, 4 and 5 are examples of the types of products that will be included in the atlas. Annual precipitation values in these figures were derived from the monthly PRISM dataset (Daly et al., 1994). {Project Lead: Chip Konrad, Southeast Regional Climate Center}

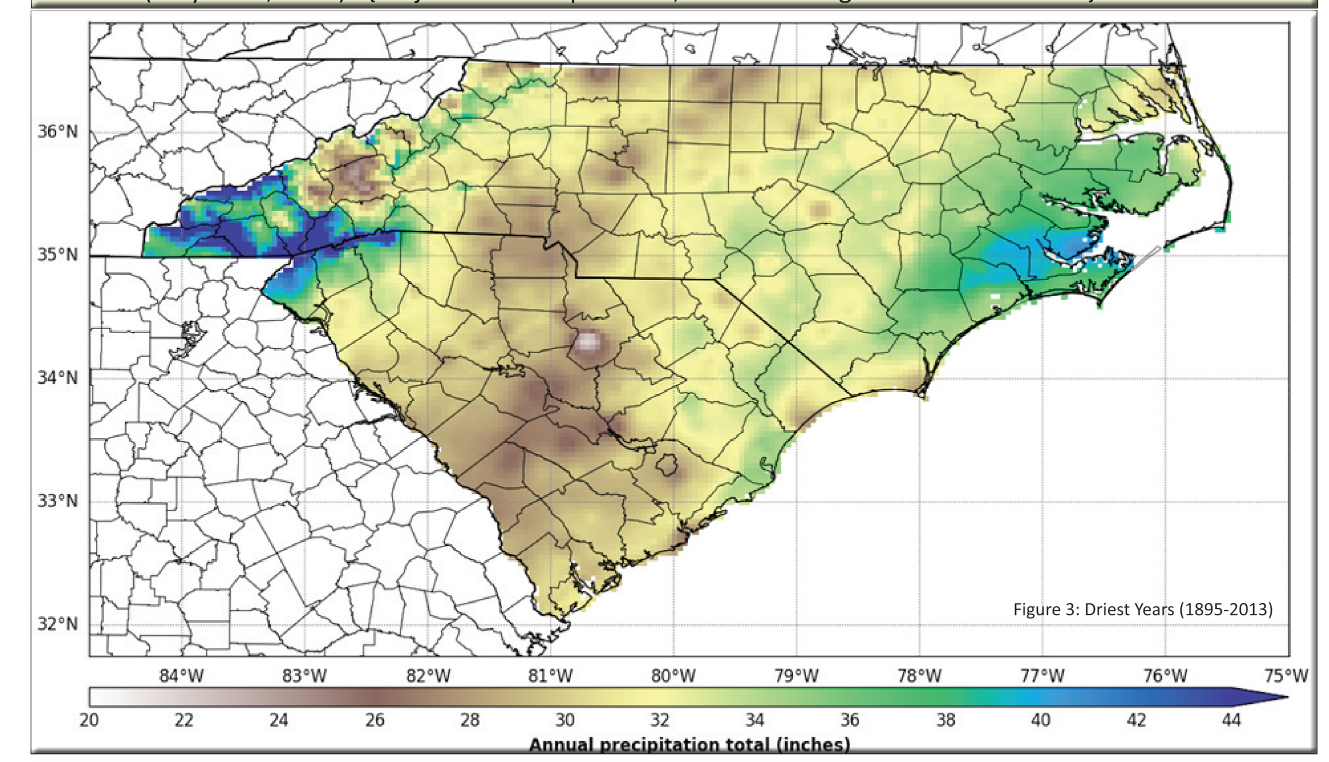

Figure 3: Driest Years (1895-2013)

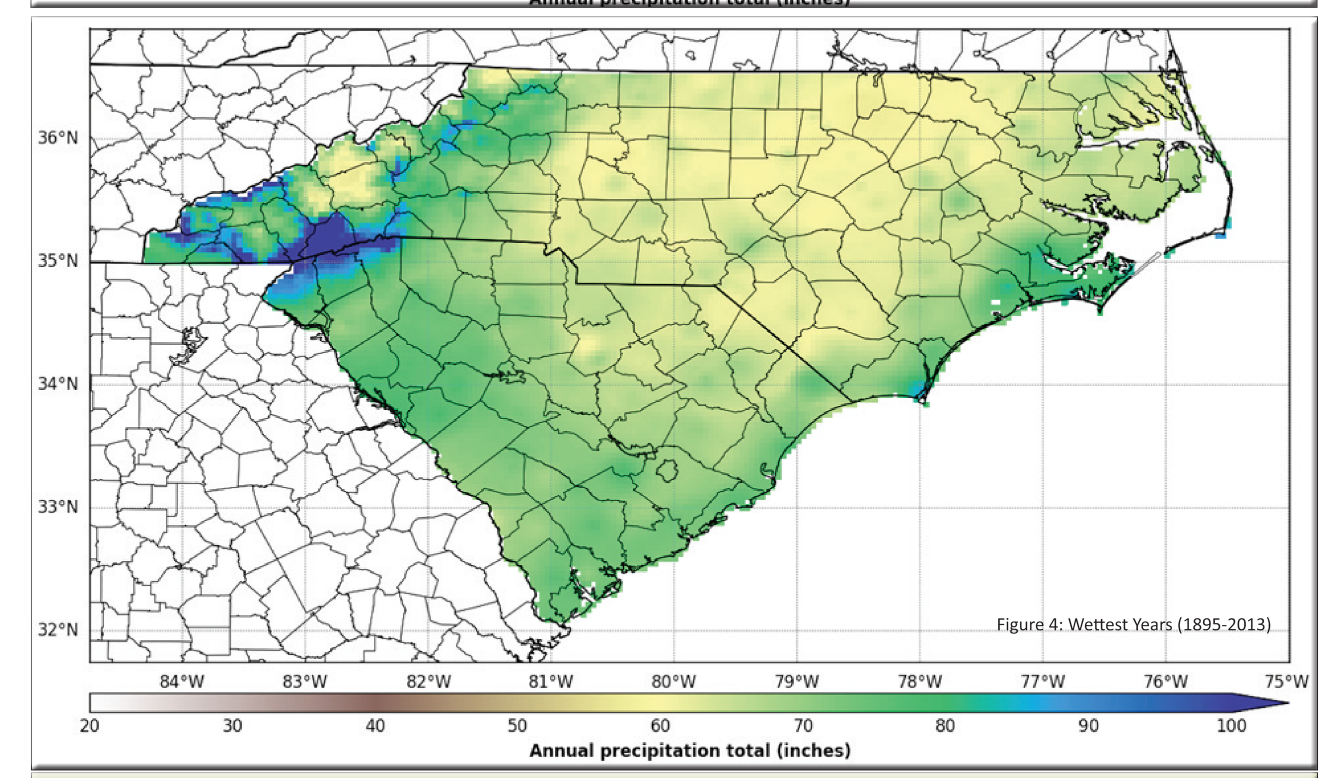

Figure 4: Wettest Years (1895-2013)

Figures 3 and 4: Annual precipitation totals during the driest (top) and wettest (bottom) year on record (1895 - 2013) for each 4x4 km pixel. During the driest years on record, the most elevated terrain within the western Carolinas and portions of the NC coastal plain remain relatively wet, while the Carolinas Piedmont and portions of southern SC are exceptionally dry. During the wettest years on record, central SC receives a considerably greater amount of precipitation than central NC. The French Broad River valley centered on Asheville, NC, is consistently drier than surrounding areas during the driest and wettest years on record.

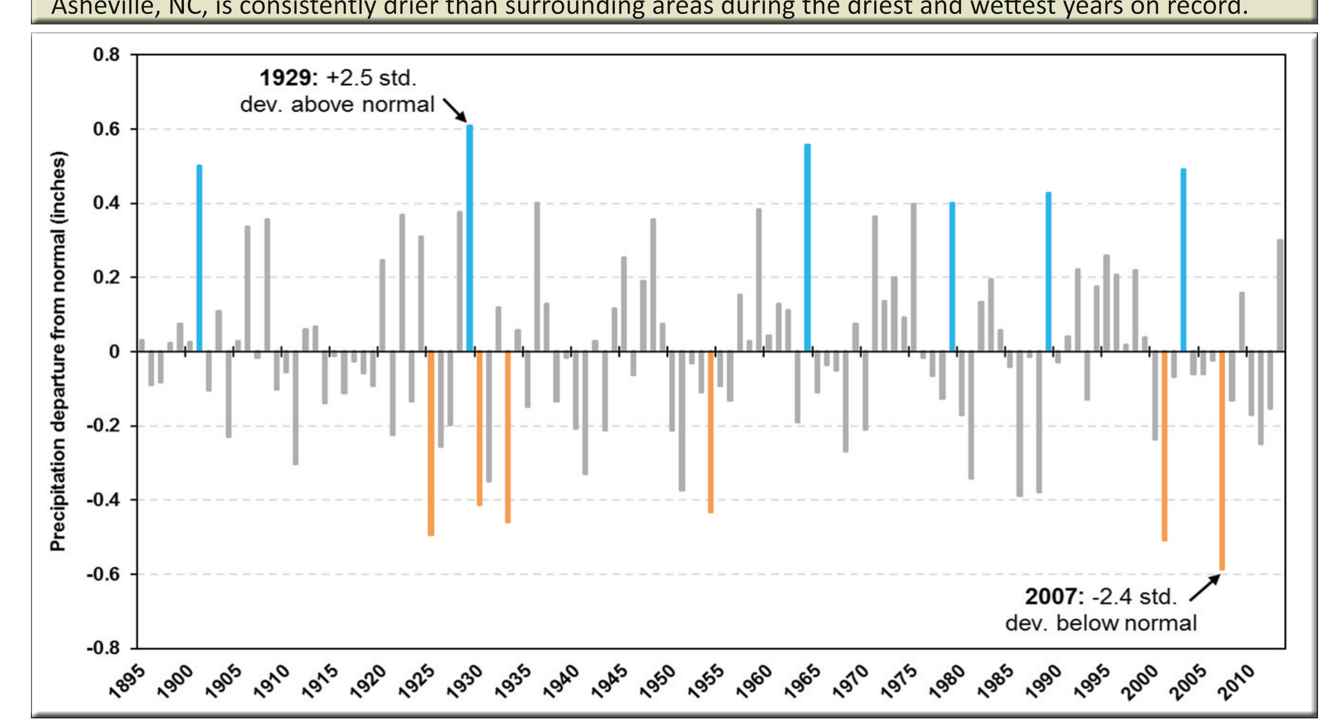

Figure 5: Departure from normal (1895-2013)

Figure 5: Departure from normal of the average annual precipitation across the Carolinas region during 1895-2013. The top and bottom 5th percentile of the distribution were selected to highlight exceptionally dry (orange bars) and wet (blue bars) years. Average annual precipitation shows considerable interannual variability but no long-term trend during 1895–2013. Three of the top six driest years occurred during a 10-year interval from 1925–1935.