

# Improving Climate Information in Hydropower Dam Relicensing

Kirstin Dow<sup>1</sup>, Greg Carbone<sup>1</sup>, Hope Mizzell<sup>2</sup>,  
Dan Tufford<sup>1</sup>, Kirsten Lackstrom<sup>1</sup>, and Jinyoung Rhee<sup>1</sup>

**Carolinas Integrated Sciences and Assessments**

<sup>1</sup>University of South Carolina, <sup>2</sup>SC State Climatologist  
Supported by NOAA's RISA Program



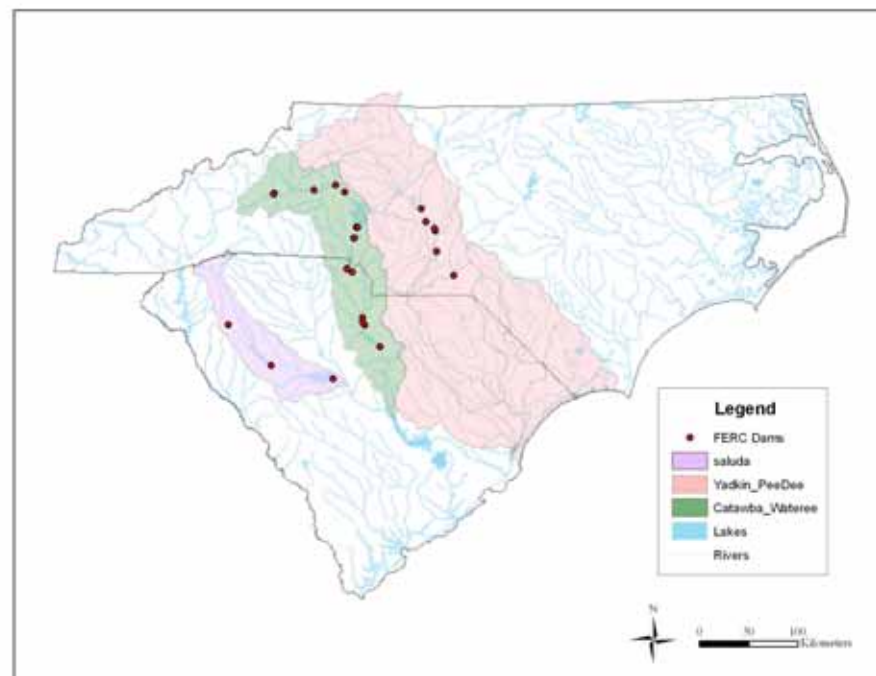
# Significance of Relicensing Agreements

## Federal Energy Regulatory Commission (FERC) licenses

- more than 1,000 private and non-federal, public dams used for hydroelectric power generation
- Dams are located in 44 states and Puerto Rico
- 25% of licenses are up for renewal before 2020
- 30-50 year licenses terms that set management standards, e.g.
  - Minimum flows for downstream water usage needs
  - Low inflow protocols
  - Emergency condition protocols
  - Normal operating ranges for lake levels
  - In-stream flows for wildlife habitats and water quality
  - Public information systems
  - Hydro Station operations
  - Various management plans for cultural resources, public recreation, species protection, shoreline management, etc.
- Many existing licenses were granted before the major environmental laws of the 1970s came into full force and implementation e.g.,
  - National Environmental Policy Act (1970); Endangered Species Act (1973); Clean Water Act (1977)

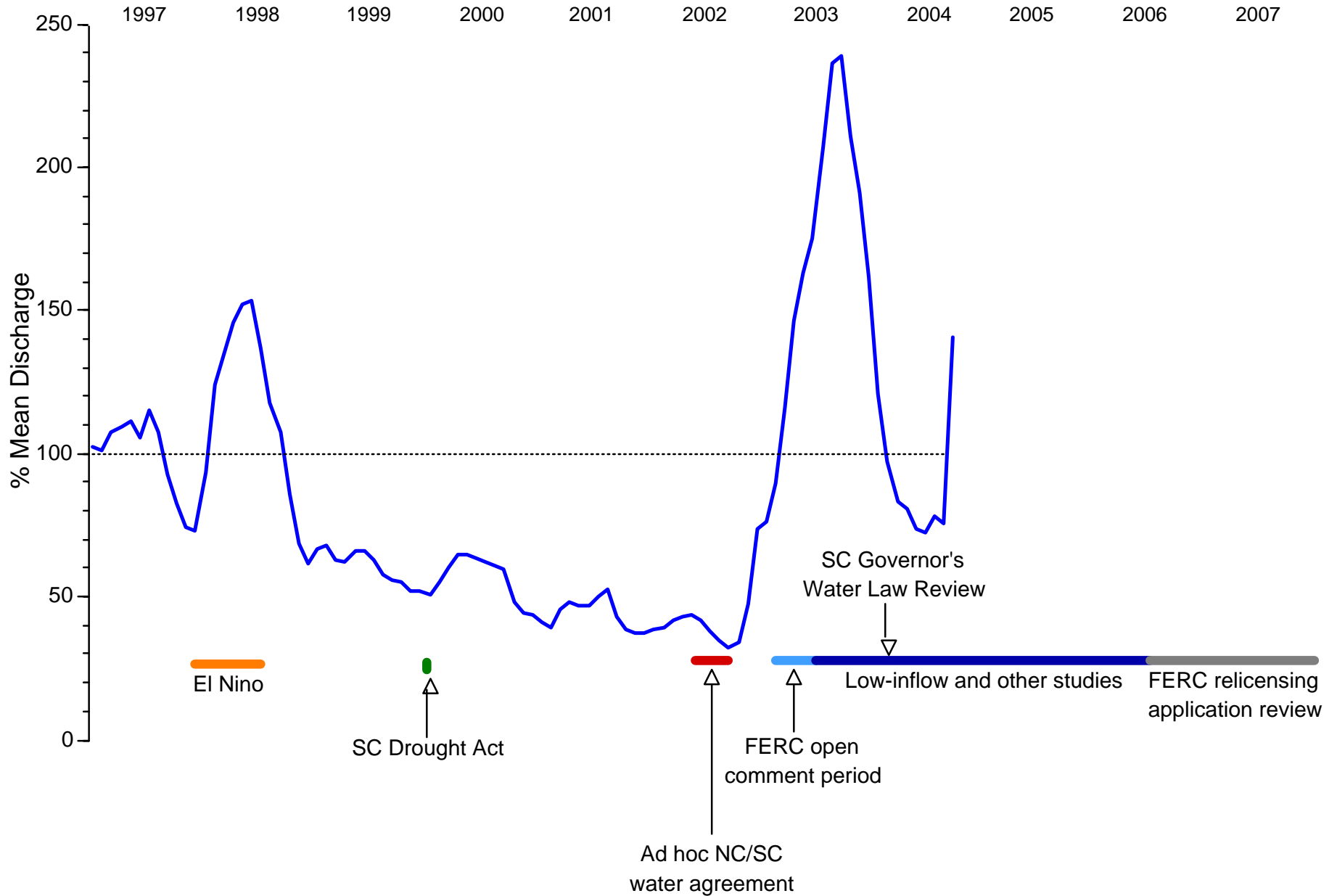
# In the Carolinas

- FERC dams control major river basins
- Economic and population growth are expected to place further pressures on water resource supplies and allocation
- A recent 4-year drought has heightened sensitivity to drought impacts
- Interstate water agreements do not yet exist, but policy makers are aware of the need



Dams and basins managed under FERC licenses

# Catawba-Wateree Basin



# Agencies and Interests in the FERC Relicensing Process

## Federal Agencies



The Licensee



Non-Agency  
Stakeholders

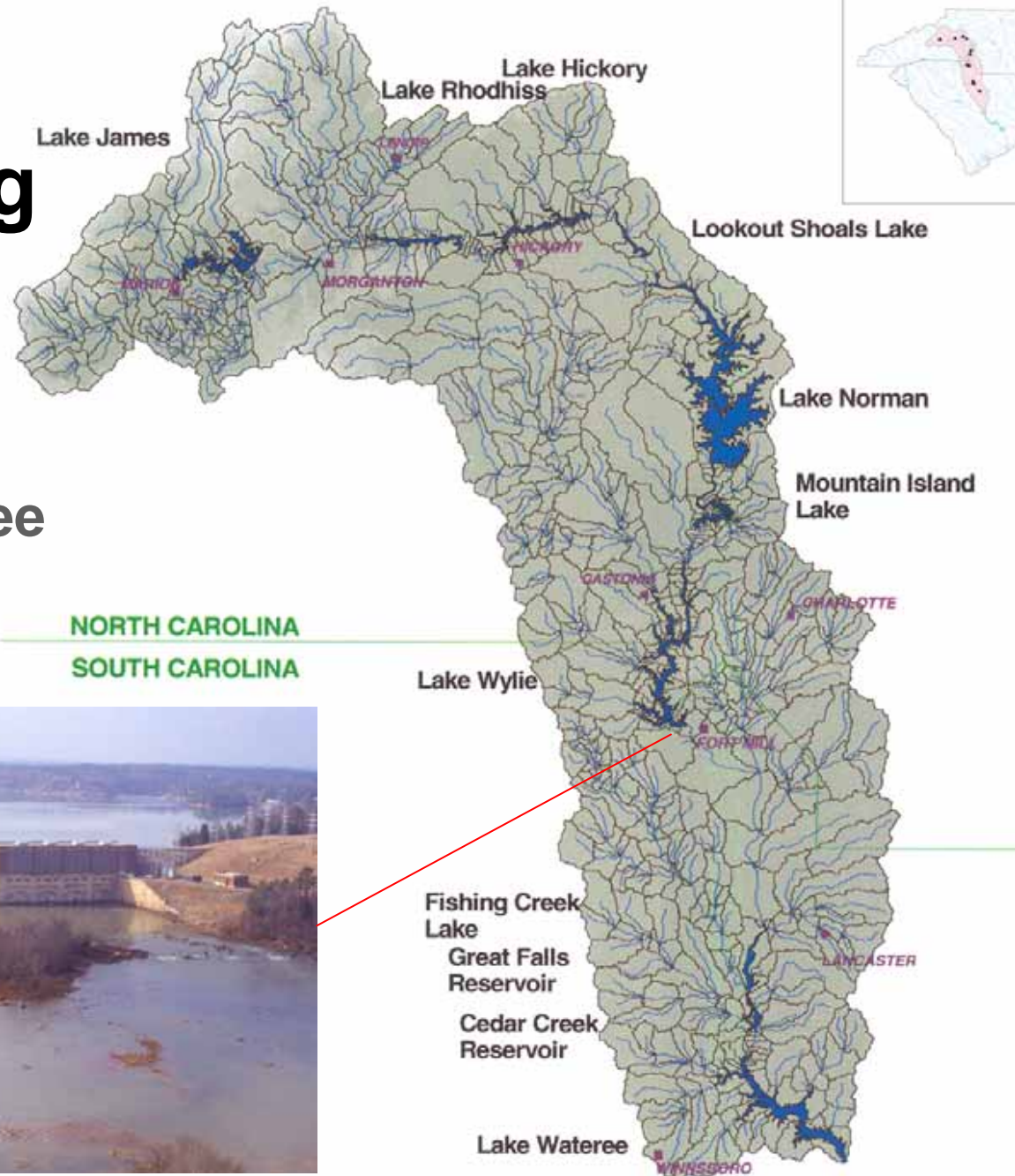


## State Agencies



# FERC Relicensing

## Duke Power and the Catawba/Wataeree River



# Motivating Climate Adaptation through FERC Relicensing

## Water resources stakeholders

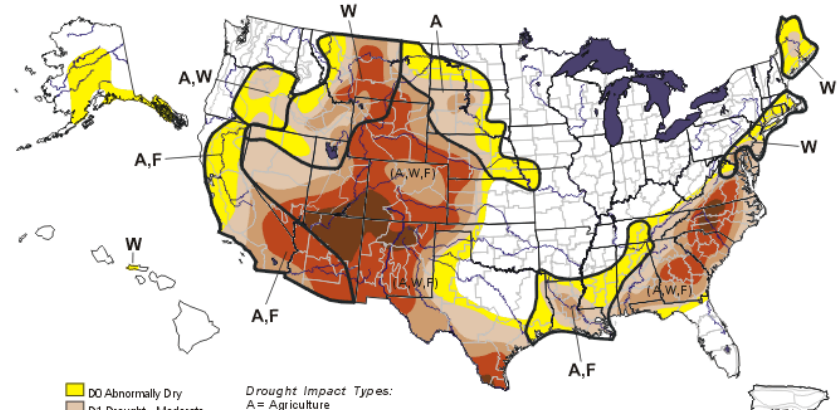
- Are very sensitive to drought impacts and committed to addressing management shortcomings
- Want better information on variability to anticipate and manage drought and low inflow periods
- Asked CISA and NC/SC State Climatologists to develop a climate-based low inflow management tool

# Existing Low Inflow Protocol Tools

- On the Catawba-Wateree, Duke Power uses set management triggers based on streamflow levels
- Streamflow measured at 4 gages with unregulated flow

*Some relicensing working group participants are aware of the U.S. Drought Monitor from other regulatory processes*

**U.S. Drought Monitor** June 25, 2002  
Valid 8 a.m. EDT



**Drought Impact Types:**  
A = Agriculture  
W = Water (Hydrological)  
F = Fire danger (Wildfires)  
— Delineates dominant impacts  
(No type = All 3 impacts)

The Drought Monitor focuses on broad-scale condition. Local conditions may vary. See accompanying text summary for forecast statements.

<http://drought.unl.edu/dm>



Released Thursday, June 27, 2002

Author: David Miskus, JAWFCPC/NOAA



# Creating the Next Generation Low Inflow Protocol Tools

## Stakeholder interests

- Better understanding of the range of variability and associated probabilities
- Increasing the spatial resolution of the drought monitor
- Providing the ability for stakeholders to investigate the way different drought indices represent the sensitivity of their systems – by management unit

# Dynamic Drought Indices Webpage

- Available for review at [drought.dnr.sc.gov](http://drought.dnr.sc.gov)
- During development, CISA team has presented regular updates to the FERC working group
- Addresses stakeholder interests
- Regulatory use of this tool is still under discussion in the relicensing process

# Allows Comparison of Drought Indices, Blends, and Streamflow

## Drought indices

- Palmer
  - PDSI
  - PHDI
  - Z index

## At several time scales

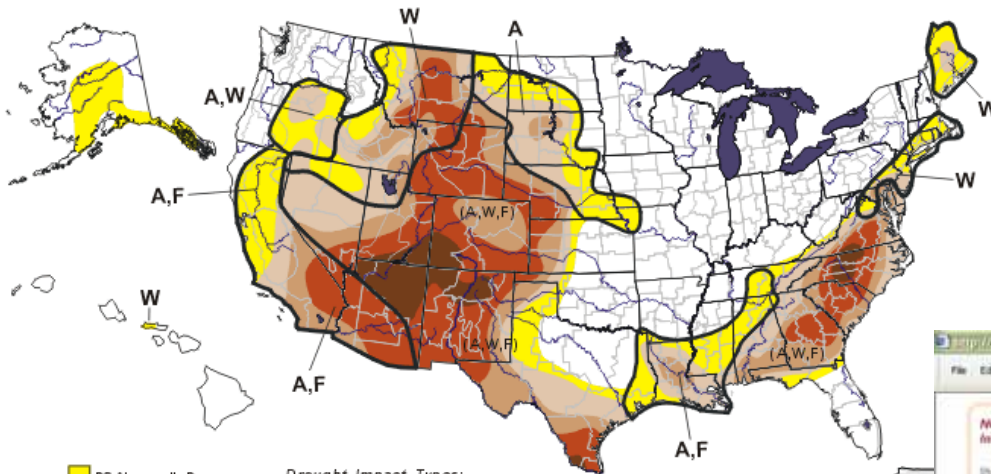
- SPI
- Precipitation
- Streamflow

The screenshot shows a web browser window with the URL <http://drought.dnr.sc.gov/user.php>. The page title is "DYNAMIC DROUGHT INDEX FOR BASINS IN NORTH AND SOUTH CAROLINA". The browser's address bar shows several tabs: Novell WebAccess, Novell WebAccess, USC Directory, Apple, Amazon, Yahoo!, News, RCPL, Mac, and eBay. The page content includes a navigation menu with links for HOME, USER INPUT, MAP, GRAPH/TABLE, and HELP. A notice states: "NOTICE: Adobe SVG Viewer plugin is needed to see maps/graphs. Click the banner to install it. This web page is optimized for Internet Explorer 6.0." Below the notice, there is a section for creating a blend, with instructions: "Create your blend here. For displaying raw index values, select 'Raw value' and choose one of the drought indices. For displaying blended index, choose 'Percentiles' and enter weights (%) for each drought measure (must sum to 100):". A table allows users to select display options (Raw value or Percentiles) and assign weights to various drought indices and streamflow measures. The table has two columns: "Raw value" and "Percentiles". The "Raw value" column has radio buttons, and the "Percentiles" column has input boxes. The "Palmer Drought Severity Index (PDSI)" is selected in the "Raw value" column, and its weight is set to 100. Other indices and streamflow measures have their "Raw value" radio buttons selected and their "Percentiles" input boxes set to 0. At the bottom of the table, there are "Test sum" and "Clear" buttons. Below the table, there is a section for selecting the display type: "Select display type:  Map  Graph  Table".

	Raw value	Percentiles
Palmer Drought Severity Index (PDSI)	<input checked="" type="radio"/>	100
Palmer Hydrological Drought Index (PHDI)	<input type="radio"/>	0
Palmer Z Index	<input type="radio"/>	0
1-month Standardized Precipitation Index	<input type="radio"/>	0
3-month Standardized Precipitation Index	<input type="radio"/>	0
6-month Standardized Precipitation Index	<input type="radio"/>	0
9-month Standardized Precipitation Index	<input type="radio"/>	0
12-month Standardized Precipitation Index	<input type="radio"/>	0
24-month Standardized Precipitation Index	<input type="radio"/>	0
1-month Precipitation	<input type="radio"/>	0
3-month Precipitation	<input type="radio"/>	0
6-month Precipitation	<input type="radio"/>	0
12-month Precipitation	<input type="radio"/>	0
24-month Precipitation	<input type="radio"/>	0
60-month Precipitation	<input type="radio"/>	0
7-day Streamflow	<input type="radio"/>	0
14-day Streamflow	<input type="radio"/>	0
1-month Streamflow	<input type="radio"/>	0
3-month Streamflow	<input type="radio"/>	0
6-month Streamflow	<input type="radio"/>	0
12-month Streamflow	<input type="radio"/>	0
24-month Streamflow	<input type="radio"/>	0

# Offers Increased Spatial Resolution

**U.S. Drought Monitor** June 25, 2002  
Valid 8 a.m. EDT



■ D0 Abnormally Dry  
■ D1 Drought—Moderate  
■ D2 Drought—Severe  
■ D3 Drought—Extreme  
■ D4 Drought—Exceptional

**Drought Impact Types:**  
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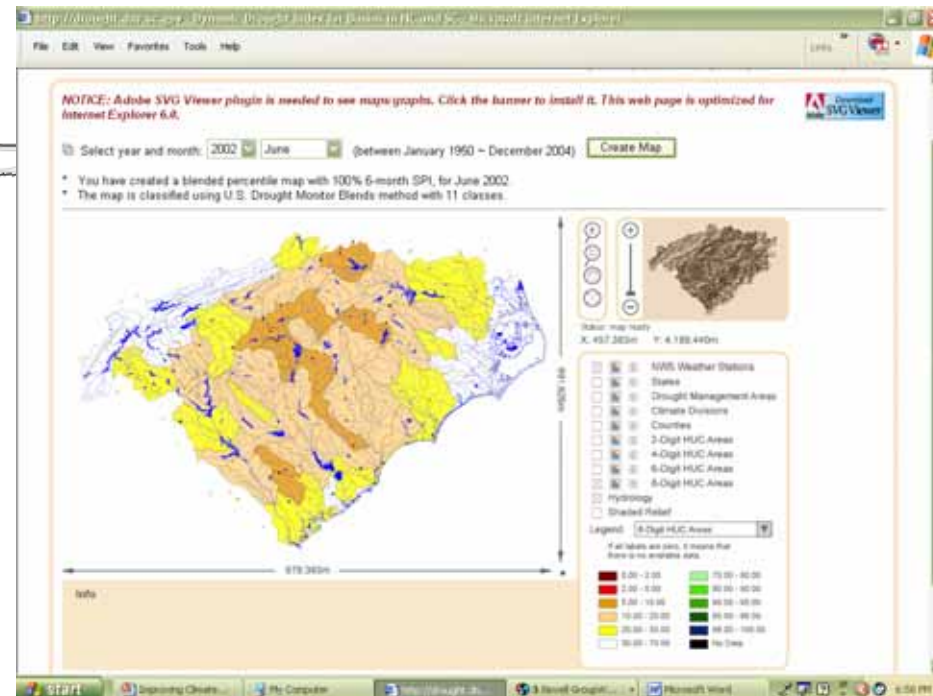


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Based on Climate Divisions

*Both figures represent June 2002, the height of the recent drought*

Based on 8 digit Hydrologic Unit Codes



# Uses a Denser Monitoring Network

http://drought.dnr.sc.gov - Dynamic Drought Index for Basins in NC and SC - Microsoft Internet Explorer

File Edit View Favorites Tools Help

NOTICE: Adobe SVG Viewer plugin is needed to see maps/graphs. Click the banner to install it. This web page is optimized for Internet Explorer 6.0.

Select year and month: 2002 June (between January 1950 ~ December 2004) Create Map

\* You have created a blended percentile map with 100% 6-month SPI, for June 2002.  
\* The map is classified using U.S. Drought Monitor Blends method with 11 classes.

Info

- Stream flow gages
- NWS stations

*The 4<sup>th</sup> streamflow gage is slightly south of the basin*

Legend: 8-Digit HUC Areas

If all labels are zero, it means that there is no available data.

0.00 - 2.00	70.00 - 80.00
2.00 - 5.00	80.00 - 90.00
5.00 - 10.00	90.00 - 95.00
10.00 - 20.00	95.00 - 98.00
20.00 - 30.00	98.00 - 100.00
30.00 - 70.00	No Data

start Improving Climate... My Computer http://drought.dn... 3 Novell-GroupW... Microsoft Word 7:00 PM

# Climate Awareness and Adaptation with Dynamic Drought Indices Tool

- Allows stakeholders to compare drought indices and blends
- Increased spatial resolution for multiple management units
- Based on a more robust monitoring network – improved spatial and temporal record to support streamflow gages

# **Additional Options For Better Climate Integration and Adaptation**

- More holistic view of the hydrologic cycle
- Relies on a continuously updated database in calculations
- Stakeholders all use the same climate record for management decision making
- Potential for percentile-based rather than fixed low inflow protocol triggers
- Depending on the index or blend, can provide an earlier warning signal

# Next Steps

- Catawba-Wateree stakeholders consider how to use tool
  - Experimentation, evaluation, identification of uncertainties
  - Debate and determine -- Which drought index blend?
  - Consider -- Percentile-based versus fixed trigger points for management stages?
- Hydropower management protocols that anticipate climate variability and potential impacts
  - Influence major river basins and downstream uses
  - Integrated with major federal environmental regulations over 30-50 year license period
- Foundation for learning, adaptation, and adaptive management that integrates climate information
- Investigate potential uses in other sectors and other basins