THE COASTAL SALINITY INDEX:

A TOOL FOR MONITORING DROUGHT IN COASTAL AREAS

What is the Coastal Salinity Index (CSI)?

The Coastal Salinity Index (CSI) utilizes real-time and historical salinity datasets to characterize saline (drought) and freshwater (wet) conditions in coastal areas over multiple intervals from 1- to 24-months.

Why was the CSI developed?

The CSI was developed as a way to characterize coastal drought. Commonly-used drought indices characterize hydrological, agricultural, and meteorological conditions; however they do not depict the uniqueness of coastal drought. Nor do these indices incorporate salinity, the primary stressor associated with coastal drought, or the multiple factors that contribute to high salinity conditions, such as precipitation, streamflow, sea level, tides, and wind.

What are the potential benefits of the CSI?

The CSI provides a tool to monitor the freshwater-saltwater interface and changing salinities in surface water bodies. This tool can help researchers to better understand the effects of changing conditions on freshwater and saltwater ecosystems, fish habitat, and freshwater availability for municipal and industrial water intakes. The CSI can also be used to assess the adverse effects of coastal drought such as those associated with fish kills, marsh dieback, harmful algal blooms, hypoxia, beach closures, and higher concentrations of *Vibrio* bacteria.

How is the CSI computed?

The CSI uses an approach similar to the Standardized Precipitation Index (SPI), substituting total monthly precipitation with monthly salinity data. The CSI is based on the probability of recording a given amount of salinity. A value of zero indicates historical median salinity amount, and positive and negative values represent increasingly fresh and saline conditions, respectively (see Figure 1, Table 1). The CSI can be calculated at short or long-term intervals (1-, 3-, 6-, 9-, 12- and 24-month), which allows for the CSI to be used to evaluate short- and long-term drought (saline) and wet (freshwater) conditions (Conrads and Darby, 2016).

How has the CSI been used so far?

To date, the CSI has been calculated for locations in South Carolina and Georgia and at fifteen sites in South Florida, where it was used to examine regional differences in drought intensity (see Figure 2). The CSI has also been compared with other climate indices, including the SPI (meteorological index) and the Palmer Hydrologic Drought Index (PHDI, hydrologic index), indicating that the CSI does provide unique coastal salinity and drought information not captured by other indices (Conrads and Darby, 2016).

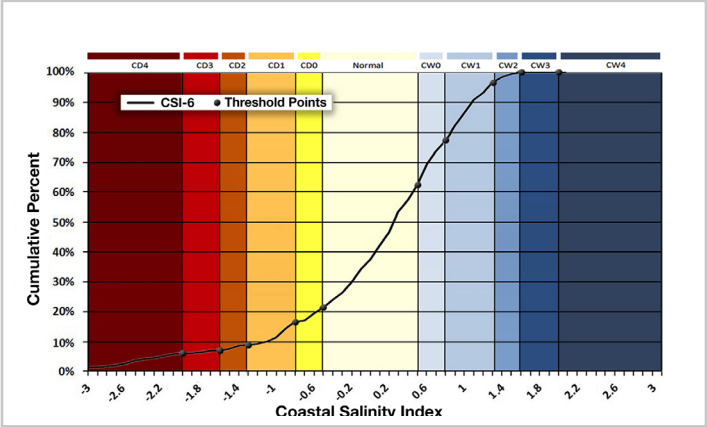

Fig. 1. The cumulative frequency curve for the 6-month coastal salinity index (CSI-6) for the Waccamaw River at Hagley Landing, SC. The background color ramp represents the coastal salinity classifications.

Coastal salinity classification	Description	Threshold values
CW4	Exceptional Freshwater Conditions	2
CW3	Extreme Freshwater Conditions	1.6
CW2	Severe Freshwater Conditions	1.3
CW1	Moderate Freshwater Conditions	0.8
CW0	Abnormal Freshwater Conditions	0.5
N0	Normal Salinity Conditions	0
CD0	Abnormal Salinity Conditions	-0.5
CD1	Moderate Salinity Conditions	-0.8
CD2	Severe Salinity Conditions	-1.3
CD3	Extreme Salinity Conditions	-1.6
CD4	Exceptional Salinity Conditions	-2

Table 1. Classification labels, descriptions, and threshold values used for the Coastal Salinity Index.

FOR MORE INFORMATION :

http://sc.water.usgs.gov/drought/coastal-drought

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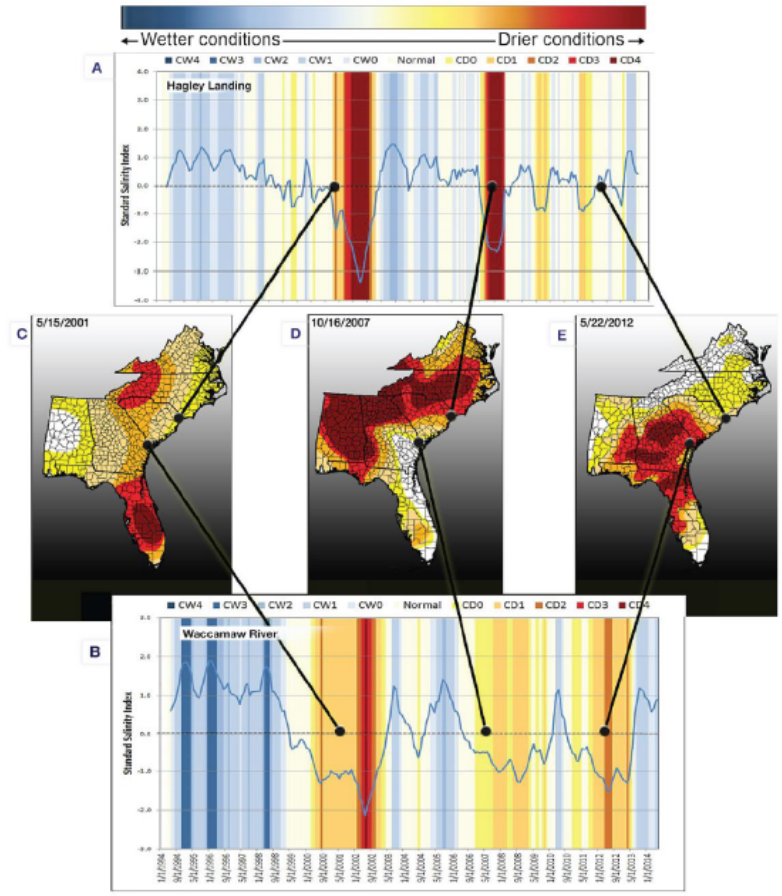

Fig 2. The 6-month Coastal Salinity Index (CSI) for A) Waccamaw River at Hagley Landing (Yadkin-Pee Dee River basin) and B) Little River at Luchnow Canal (Savannah River basin) and the U.S. Drought Monitor maps for C) May 5, 2001, D) October 16, 2007, and E) May 22, 2012. Note that regional differences in drought intensities in the maps are reflected in the CSIs.

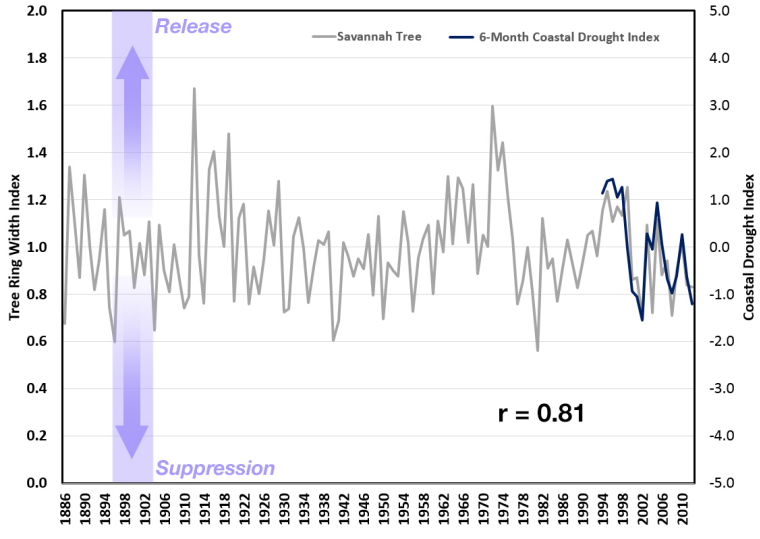

Figure 3. Using tree ring chronologies from the Savannah River (Thomas et al., 2015), the CSI was correlated with baldcypress growth response. The plot shows periods of growth suppression (values less than 1) and growth release (values greater than 1). The highest correlation was with the 6-month CSI.

References

Conrads, P., and L. Darby. 2016. Development of a Coastal Drought Index Using Salinity Data. *Bulletin of the American Meteorological Society*. doi:10.1175/BAMS-D-15-00171.1, in press

Thomas, B.L, T.W. Doyle, and K. W. Krauss. 2015. Annual growth patterns of bald cypress (Taxodium distichum) along salinity gradients. *Wetlands* 35 (4): 831-839.

What are the next steps in the development of the CSI?

Compare the CSI with environmental response variables

Correlating the CSI with environmental response variables will show the importance of a unique coastal drought index. Thus far preliminary work has investigated the linkages between the CSI and blue crab landings, fisheries monitoring data, and bald cypress growth (Figure 3). As coastal drought is a relatively new concept, existing datasets may not have been collected or understood as "drought response" datasets. USGS and CISA are currently compiling existing datasets with which the CSI can be correlated including: fishes, crustaceans, trees, grasses, and other biota found along the coast.

Develop an operational CSI

During the summer of 2017 USGS staff plan to create a CSI package in R, which will be fed with real-time data, to calculate the CSI at locations across the Carolinas and the Southeast United States. More information will be made available through USGS websites once this step has been completed.

Calculate the CSI at additional locations

USGS and CISA are compiling information on existing salinity datasets in the coastal Carolinas so the CSI can be calculated at additional locations. Salinity data is available at various stations supported by the U.S. Geological Survey, the National Estuarine Research Reserve System, and other agencies.

Pilot test the CSI with resource managers

Resource managers will be provided with the opportunity to test the CSI to determine how it can best serve them. Their valuable feedback will allow the CSI to be improved for future users.

The Coastal Carolinas Drought Early Warning System (DEWS)

The Coastal Salinity Index is a project of the Coastal Carolinas DEWS. A diverse group of stakeholders convened in August 2012 in Wilmington, NC, to identify issues of concern about drought in the coastal Carolinas. Out of the meeting came the Coastal Carolinas DEWS, a collaborative federal, state, and local interagency effort to improve early warning capacity and resilience to drought. Activities focus on improving the understanding of drought's effects on coastal environmental resources and developing information to enhance drought monitoring and planning processes.
The CSI project has been designed to specifically address the question raised by stakeholders: "Can a unique index be developed to characterize coastal drought?" The Coastal Carolinas DEWS is supported by the National Integrated Drought Information System (NIDIS), an interagency program tasked with improving the nation's capacity to manage and prepare for drought-related risks and impacts.
For more information: https://www.drought.gov/drought/dews/coastal-carolinas/about-coastal-carolinas