NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

COASTAL CAROLINAS

DROUGHT EARLY WARNING SYSTEM

A RELATIVELY NEW CONCEPT: COASTAL DROUGHT

Using Salinity Data to Develop a Coastal Salinity Index

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Coastal droughts have a different dynamic from upland droughts, which are typically characterized by agricultural, hydrologic, meteorological, and (or) socioeconomic impacts. The location of the freshwater-saltwater interface in surface-water bodies is an important factor in the ecological and socioeconomic dynamics of coastal communities. Because of the uniqueness of drought impacts on coastal ecosystems, a Coastal Salinity Index (CSI) was developed using an approach similar to the Standardized Precipitation Index (SPI). Instead of using precipitation data, as the SPI does, the CSI utilizes salinity data. The CSI is a standardized probability index with zero indicating historical median salinity amount, and positive and negative values representing increasingly fresh and saline conditions, respectively. The CSI characterizing 1-, 6-, 12-month and monthly salinity values for the Waccamaw River at Hagley Landing are shown in figure 1. Thresholds similar to the SPI values were used to set incremental coastal salinity classifications (fig. 2, table 1).

Evaluation of the CSI indicates that the index can be used for different estuary types (for example, brackish, olioghaline, or mesohaline estuaries), for regional comparison between estuaries, and as an index for wet conditions (high freshwater inflow) in addition to drought conditions. The development of the various drought characteristic intervals (1-, 3-, 6-, 9-, and12-month) allow for the CSI to be correlated with environmental response variables that occur on different time intervals. Figure 3 shows the computed CSI for the Waccamaw River (upper plot) and the Little Back River (lower plot). The background colors are the drought declarations (CD0 to CD4) and wet declarations (CW0 to CW4). The plots show there are times when there are different drought conditions in the Waccamaw River basin than the Savannah River basin. For example, a period in October 2007, the CSI 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 CSI also indicated a similar change in drought along the coast. The background map shows potential USGS real-time gaging locations where the CSI could be applied.

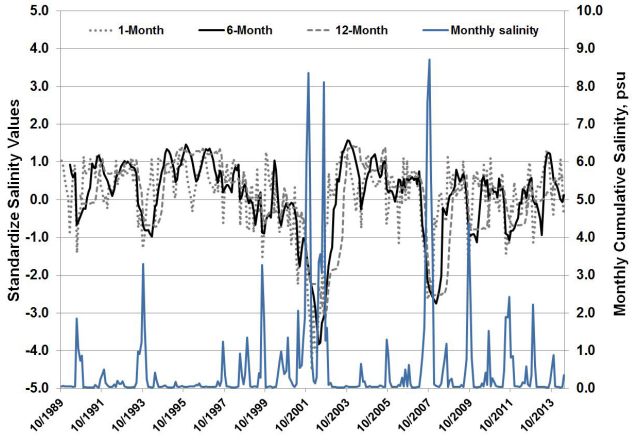

Fig. 1. The 1-, 6-, and 12-month coastal salinity index values for the Waccamaw River at Hagley Landing, South Carolina.

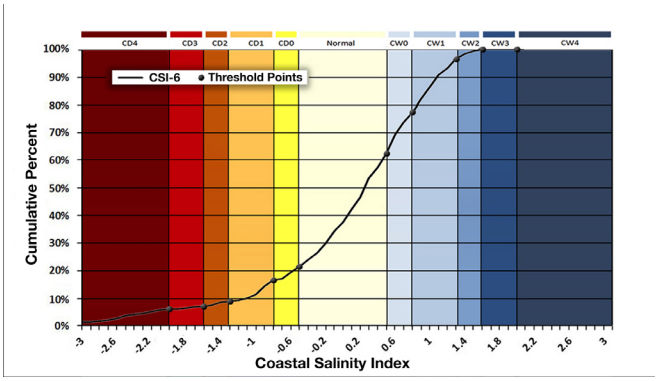

Fig. 2. The cumulative frequency curve for the 6-month coastal salinity index (CSI-6) for the Waccamaw River at Hagley Landing, South Carolina. The background color ramp represents the coastal salinity classifications (table 1).

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.

USGS science for a changing world

FOR MORE INFORMATION :
http://sc.water.usgs.gov/drought/coastal-drought

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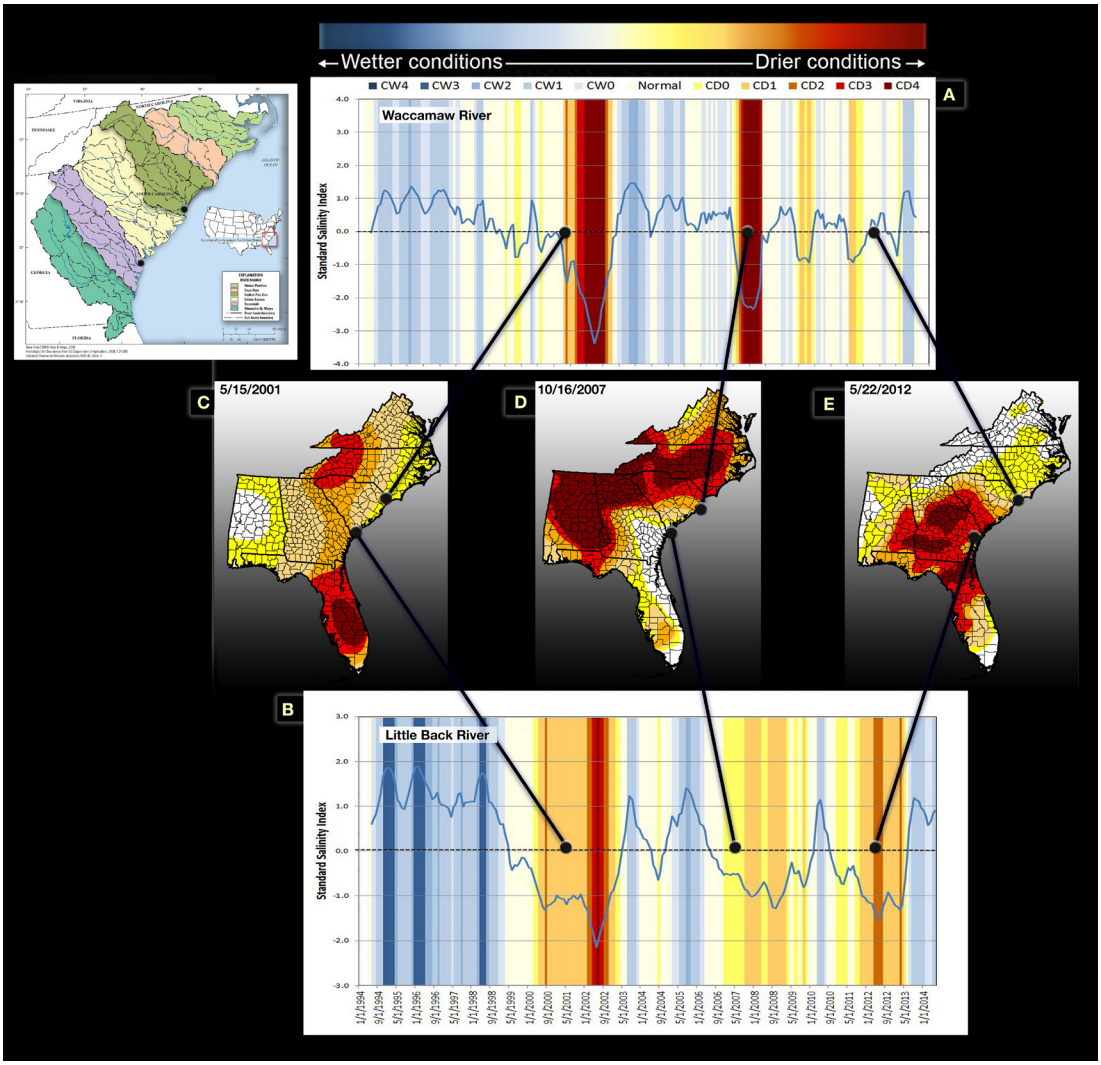

What is a Drought Early Warning System (DEWS)?

A NIDIS DEWS utilizes new and existing partner networks to optimize the expertise of a wide range of federal, tribal, state, local and academic partners in order to make climate and drought science readily available, easily understandable and usable for decision makers; and to improve the capacity of stakeholders to better monitor, forecast, plan for and cope with the impacts of drought.

What is 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 regions of the Carolinas. Out of the meeting came the Coastal Carolinas Drought Early Warning System, a collaborative federal, state, and local interagency effort to improve early warning capacity and resilience to drought. CC DEWS activities focus on improving the understanding of drought's effects on coastal environmental resources and developing information to enhance drought monitoring and planning processes.

Fig. 3. The 6-month Coastal Salinity Index (CSI) for A) Waccamaw River at Hagley Landing (Yadkin-Pee Dee River basin) and B) Little Back River at Luchnow Canal (Savannah River basin) and the U.S. Drought Monitor maps for C) May 15, 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.

COASTAL ECOLOGICAL RESPONSE

It is essential that a CSI be correlated to a coastal drought response variables to show the importance of a unique coastal drought index. Coastal drought is a relatively new concept and existing datasets may not have been collected or understood as "drought response" datasets. Krauss et al. (2009) studied the response of baldcypress (Taxodium distichum) in tidal swamps to various levels of salinity exposure. Two of the baldcypress study sites were on the Waccamaw and Savannah Rivers, near the salinity sites used to compute the CSIs (fig. 4). Tree-ring chronologies of baldcypress tree from the study sites (Thomas et al., 2015) shows periods of growth suppression (values less than 1) and growth release (values greater than 1).

To evaluate whether the CSI can be used as an explanatory factor on baldcypress growth response, a correlation analysis was done to determine the optimum CSI interval (1- to 24-months) and response time-lag. For the baldcypress tree in the Savannah River, there is an immediate impact of salinity and fresh conditions (fig. 4). The highest correlation (r = 0.81) was with the 6-month CSI and no time lag.

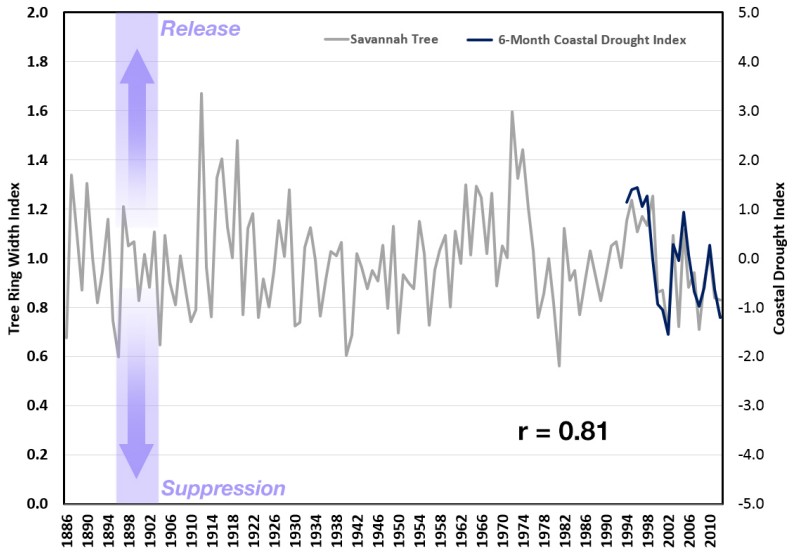

Fig. 4. Plot shows Savannah River tree ring chronology and 6-month CDI.

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References

Krauss, K.W., Duberstein, J.A., Doyle, T.W., Conner, W.H., Day, R.H., and Inabinette, L.W. 2009, Site condition, structure, and growth of baldcypress along tidal/non-tidal salinity gradients. *Wetlands* 29 (2): 505-519.

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.