Hydrologic Record Extension of Salinity Data to Evaluate Long–Term Coastal Drought Conditions

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Changes in the salinity of coastal waters during extreme meteorological conditions (droughts and floods) can result in substantial environmental response. The location of the freshwater–saltwater interface is an important factor in the ecological and socio–economic dynamics of coastal communities: It influences composition of freshwater and saltwater ecosystems, determines fisheries spawning habitat, and controls freshwater availability for municipal and industrial water intakes. Salinity is a critical response variable that integrates hydrologic and coastal dynamics including streamflow, precipitation, sea level, tidal cycles, winds, and tropical storms. Unlike other hydrologic variables, such as precipitation or streamflow, there are a limited number of long–term (> 50 year) salinity data sets. To recreate a > 90-year salinity history of the Waccamaw River for evaluating interannual– to–decadal variability of estuarine habitat, an empirical model was developed to extend (hindcast) monthly salinity values back to 1929. The model uses inputs of 1) 28 years of daily salinity data, 2) long–term daily streamflow data, and 3) daily tide records. The 90–year salinity record was used to compute a Coastal Salinity Index (CSI) for the site. The CSI is computationally similar to the Standardized Precipitation Index (SPI) and can be used for different estuary types (for example, brackish, oligohaline, or mesohaline estuaries), for regional comparison between estuaries, and as an index for wet conditions (high freshwater inflow).

A correlation analysis was done with bald cypress (Taxodium distichum) tree–ring data from a tidal swamp along the Waccamaw River to evaluate whether the 90–year salinity record and the corresponding CSI could be used as an explanatory factor for tree–growth response to various levels of salinity exposure. There are many factors affecting bald cypress tree growth including precipitation, cloudiness, temperature (heat stress), and pore–water quality. Preliminary results indicate that the highest correlation (Pearson coefficient [r] = 0.38) was with the 24–month CSI and a 2–year time lag on the tree–ring growth rate index. Although the correlation is not strong, it is an accounting of one factor affecting tree growth. The CSI time interval and time lag indicates that bald cypress trees on the Waccamaw River may be affected by extended saline or “fresh” conditions of approximately 2 years. The presentation will describe the technique used for extending salinity records, comparison of the CSI with other climate indices (the SPI and Palmer Hydrologic Drought Index), and implications of anthropogenic basin alterations to hydrologic record extension.