

Monitoring Soil Moisture to Manage Climate Impacts in North Carolina

J. L. Heitman¹, M. Brooks², R. P. Boyles², R. Austin¹ and A. Sayed²

¹Department of Soil Science, North Carolina State Univ., Raleigh, NC

²State Climate Office of North Carolina, Raleigh, NC

North Carolina has recently been subject to both regional and statewide droughts. These droughts have required restrictions on water usage for more than half of North Carolina citizens and cost the State millions of dollars in drought-associated losses. While these conditions are the result of large-scale climate patterns, rainfall influences on water supplies are determined by the interaction between climate and local land conditions. Land cover, soil type, and antecedent soil moisture combine to affect partitioning of rainfall between runoff, groundwater recharge, soil moisture storage, and evapotranspiration. Feedback mechanisms between soil-land cover conditions and climate also can provide direct influences on precipitation frequency and storm development. While land cover and soil type are relatively constant on short timescales, antecedent soil moisture is a dynamic hydrologic state variable. Temporally fluctuating soil moisture conditions are important in determining the variable interaction between static land conditions and climate. Soil moisture is the most influential component of the meteorological memory for climate over land. Without adequate understanding of soil moisture conditions, predictions of event-based and seasonal variations in hydrologic response are limited. Further, soil moisture status within the soil profile provides a primary indicator of drought recovery. Knowledge of how soil moisture status varies with time for major soil-land cover areas throughout the State provides improved opportunity to both determine and forecast rainfall-related impacts on water supplies for urban, natural, and agricultural systems.

The State Climate Office of North Carolina currently provides soil moisture data to the public through the NC ECONet system. The NC ECONet consists of a near real-time point-based monitoring network distributed across the State. The network provides soil moisture monitoring data at a single depth from thirty monitoring stations. While this information is potentially useful, the current network was not designed to represent soil moisture conditions in major soil-land cover units. Instead, current network monitoring sites have been chosen to maximize spatial coverage and make use of existing monitoring frameworks irrespective of specific soil-land cover patterns. The connection between soil moisture status at these monitoring locations and regional soil moisture status for the diverse set of soil and land conditions found in North Carolina has not been well defined. Thus, despite availability of soil moisture data, these data are limited for characterizing conditions that contribute to regional land-climate interactions influencing storm response and water availability. Within the existing monitoring framework, significant benefits could be achieved by characterizing soil properties at the monitoring sites as they pertain to soil moisture conditions affecting short-term (event-based) and long-term (seasonal) processes in major surrounding soil-land cover units. Though it is not feasible to install monitoring stations to provide complete data coverage, targeted installation of additional stations to cover under-represented major soil-land cover combinations could also significantly improve network benefits for determining water supply influences. The impetus for our current work is to increase the benefits of the NC ECONet to its client base across the State for use in water resource planning. We are currently beginning characterization of soil conditions/properties at monitoring sites and exploring opportunities to develop water management and drought mitigation tools.

Contact Information: Joshua Heitman, Soil Science Department, North Carolina State University, Campus Box 7619, Raleigh, NC 27695, USA; Phone: 919-513-1593; Fax: 919-515-2167; Email: josh_heitman@ncsu.edu