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Watershed-scale Effects of Longleaf Pine Restoration on Water Yield and Carbon: A Paired Watershed and Modeling Approach

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Abstract: Restoration of longleaf pine (LLP) ecosystems is an important land management objective throughout the southeastern U.S. While there have been numerous studies on LLP restoration, very little information is available on its restoration effects on the forest water and carbon (C) balance. The linkage between watershed-scale LLP restoration and hydro-biogeochemical processes is important as regional issues on water resources and C sequestration increase. In contrast to commercial loblolly pine stands, LLP stands have a higher water-use efficiency and much lower stocking, potentially influencing on soil moisture, evapotranspiration (ET) and the C balance.

We have designed a field experiment employing paired watersheds in conjunction with hydrologic modeling to test the principal hypothesis guiding this study that the LLP restoration treatment will result in an increase in water yield due to reduced ET. The experiment is being conducted on the USDA Forest Service Santee Experimental Forest located in the lower coastal plain of South Carolina. Data from 2011-2018 that includes the extreme rainfall events used as the pre-treatment calibration yielded a significant monthly relationship (WS77Flow = 0.98WS80Flow + 7.23; R^2 = 0.95). We will also present the pre-treatment water budget using the continuously measured hydro-meteorologic variables that will be continued through post-treatment period (2020 and thereafter) that will include prescribed fire, harvesting, thinning, and stand development. The above relationship will be used to detect a shift in water yield during the conversion to establish LLP and after a full restoration of the LLP forest community. We also expect that the 8-year pre-treatment average annual runoff coefficient of 0.24 on WS-77, which is 30% more than 0.18 on the control (WS-80), will increase in the post-treatment periods, as a result of decreased ET and increased soil moisture.

Initial pre-treatment calibration results of the physically based, watershed-scale MIKE SHE-Forest DNDC linked model will be presented for water and C balance for the WS77 watershed. The linked model will later be validated with the post-treatment WS77 data for long-term simulation assessment of LLP restoration effects on water yield and C.