

Using science to promote sustainable biofuels production in the southeastern United States

Abstracts:

Environmental and socioeconomic sustainability analysis of switchgrass-to-ethanol production in Eastern Tennessee, Esther Parish, Scientist, Landscape Ecology and Regional Analysis Group, Environmental Sciences Division, Oak Ridge National Laboratory (ORNL)

An interdisciplinary team of researchers from ORNL, the University of Tennessee's Institute of Agriculture, and Genera Energy Inc. recently conducted a holistic sustainability assessment of switchgrass production to supply a demonstration-scale cellulosic biorefinery located in Vonore, Tennessee. This was the first case study application of a suite of 35 environmental and socioeconomic sustainability indicators developed by ORNL for use by the United States Department of Energy Bioenergy Technologies Office (BETO) to compare the sustainability of bioenergy production systems across different feedstock types and locations. Through synthesis of empirical data, literature review and expert opinion, the team was able to develop qualitative ratings for 28 of the 35 recommended sustainability indicators across all 12 environmental and socioeconomic indicator categories. Distributing the ratings within a hierarchical multi-attribute decision support system framework enabled the team to evaluate the overall sustainability of producing 5000 acres of no-till switchgrass relative to two alternative business-as-usual scenarios of unmanaged pasture and tilled corn production. The team found that within this East Tennessee context, switchgrass production is an attractive option for improving environmental and social sustainability trajectories. Although external trade does not yet exist for this switchgrass commodity, the team's economic modeling indicates that switchgrass production can still be beneficial to the counties surrounding the biorefinery in terms of dollars earned and jobs created. The opportunity to use inactive equipment and laborers is a potential benefit captured indirectly by the sustainability evaluation framework.

Examining the effects of woody biomass production for bioenergy on water quality and hydrology in the southeastern United States, Natalie Griffiths, Scientist, Researcher in the Ecosystem Observations and Experiments, Oak Ridge National Laboratory (ORNL)

Our project is examining the effects of growing and managing loblolly pine for bioenergy on water resources using watershed-scale experimental and modeling approaches. In 2010, we instrumented three watersheds in the Upper Coastal Plain of South Carolina (watersheds R: 45 ha; B: 169 ha; C: 117 ha). After 2 years of baseline hydrologic and water quality monitoring (2010-2012), approximately 40% of the 2 treatment watersheds (B, C) were harvested (2012), planted with loblolly pine seedlings (spring 2013), and received herbicide and fertilizer treatments (2013-2015). The third watershed (R) served as an unmanipulated control. All silvicultural activities followed Best Management Practices (BMPs) for South Carolina, and thus our project will also evaluate the efficacy of BMPs for this woody bioenergy crop. Our baseline hydrologic results suggest that these low-relief watersheds are groundwater dominated, thus excess fertilizers or herbicides applied in planted areas will likely first enter groundwater and then stream water after a several year lag. This hypothesis is supported by the post-treatment water quality data as stream water nutrient concentrations have not increased in the treatment watersheds (B, C) relative to the control (R) watershed, but groundwater nitrate concentrations in the treatment watersheds are increasing. Groundwater nitrate concentrations (<2 mg N/L) are below regulatory standards (of 10 mg N/L). This project will continue to collect hydrologic and water quality measurements until canopy closure (2018).

Future bioenergy production in two southern tributary basins of the Mississippi River Basin is projected to improve water quality, Henriette Jager, Senior Scientist, Environmental Sciences Division, Oak Ridge National Laboratory (ORNL)

US bioenergy production is projected to increase through the next several decades. Concerns have been raised that converting lands to produce bioenergy feedstocks in lands draining the Mississippi River Basin (MRB) will hamper efforts to reduce the size of the Gulf of Mexico “dead zone”. In collaboration with Argonne, ORNL research has quantified nutrient, sediment, and freshwater inputs to the Gulf. Our research has identified opportunities for producing 2nd generation cellulosic feedstocks that are economically sustainable and that can improve water quality in two large southern tributary basins feeding into the MRB, i.e., the Arkansas-White-Red (AWR) river basin and the Tennessee River Basin (TRB). We quantified water quality and quantity from a baseline scenario using the Soil and Water Assessment Tool (SWAT). These results were compared with results from a future bioenergy landscape generated by an economic model, POLYSYS. Our results over the AWR and TRB indicated decreases in median nutrient and sediment loadings. Responses differed both between the basins and spatially within basins. Improvements to water quality were projected in areas where growing perennial crops are projected to be economically feasible. The largest change observed in the AWR was a decrease in water yield, but no change was observed in the TRB. Our results for the AWR and the TRB will be combined with similar analyses done for the other tributaries to the MRB. Our research is also supporting DOE’s ‘Billion Ton 2016 Sustainability’ effort by using spatial optimization to identify where conservation practices are most-beneficial and how bioenergy crops can be arranged on a regional scale to protect biodiversity. Our ultimate goal is to assess whether sustainable production of bioenergy crops and residues can help to reduce the size of the Dead zone (hypoxic waters) in the Gulf of Mexico.