Modeling Switchgrass Yield and Evapotranspiration in Michigan

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Introduction

Switchgrass has been studied as a bioenergy feedstock because of its large aboveground biomass, high resource use efficiency and potentials in growing on marginal land. However, research on switchgrass yield from marginal land and its impact on marginal land is limit.

Objectives

1) To assess the differences in switchgrass yield produced by soils with different capability classes
2) To evaluate switchgrass evapotranspiration (ET) in Michigan.

Methods

We used the SALUS model, which is a process-based crop model and was evolved by CERES (Basso and Ritchie, 2015) for simulating unfertilized and rain-fed switchgrass growing between 1981 and 2010. Switchgrass was validated against observed field data conducted at the Great Lakes Bioenergy Research Center site in Michigan and Wisconsin (unpublished data).

Soil and weather parameters were collected from the Soil Survey Geographic Database and North America Regional Reanalysis dataset, respectively.

Results

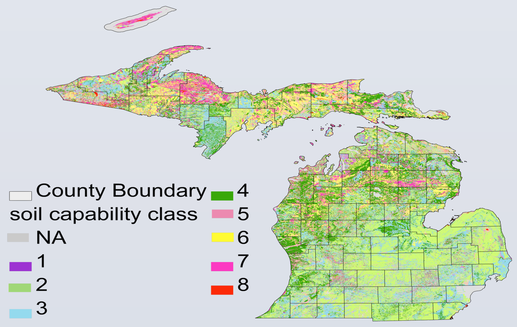

Figure 1. Soil capability class* distribution in Michigan

*Soil capability is classified by the degree to which crop production is constrained. The constraining factors including one or more of the following: 1) rooting depth, 2) water and wind erosion, 3) land slope, 4) stone content, 5) salts, 6) unfavorable climate, 7) moist holding capacity and 8) overflow. (Klingebiel et al. 1961). Capability class 1~4 are considered as agriculture land and 5~8 are considered as marginal land.

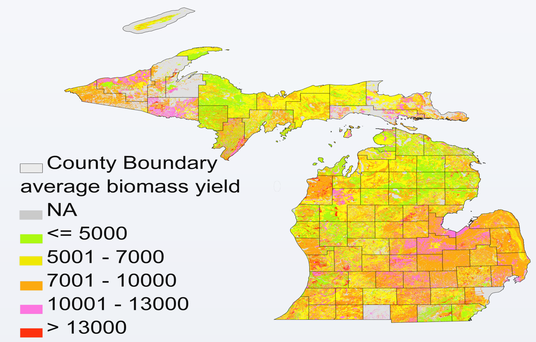

Figure 2. Average simulated switchgrass biomass yield (kg/ha) for 30 years in Michigan

Figure 1 and Figure 2 show the spatial distribution of soil capability class and average simulated switchgrass biomass yield for 30 years in Michigan, respectively. Marginal land with the soil class of 6 and 7 produces low biomass yield consistently. Agriculture land in general produces more switchgrass yield than marginal land except for the class 5 (Figure 3).

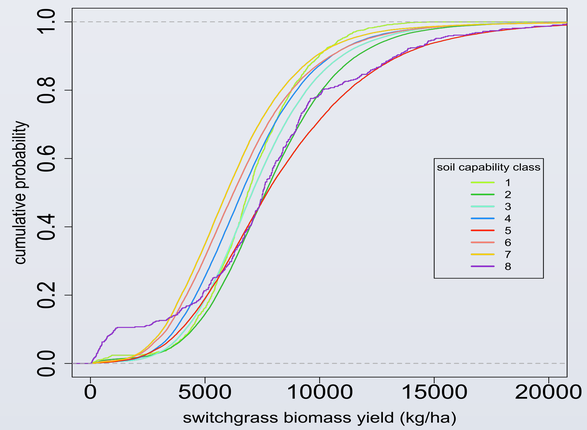

Figure 3. Cumulative probability for the simulated biomass yield from various soil capability classes

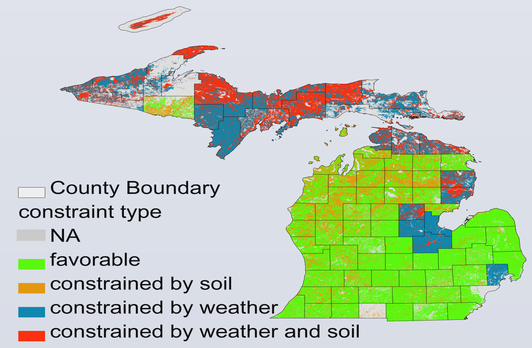

Figure 4. Constraining factors for switchgrass biomass accumulation in Michigan

The differences in switchgrass biomass yield in Michigan is attributed to soil properties and weather conditions (Figure 4).

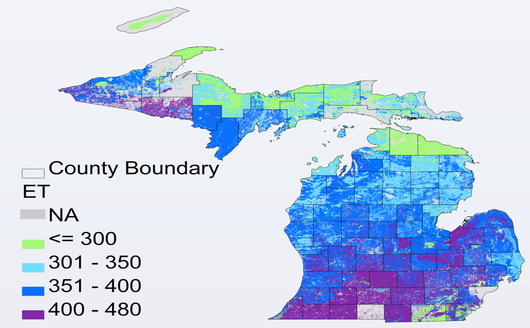

Figure 5. Average switchgrass evapotranspiration (mm) in a growing season across Michigan

Average Switchgrass ET in a growing season ranges from less than 300 mm to less than 480 mm in Michigan (Figure 5). The standard deviations for ET in Michigan are within 40 mm (data not shown)).

Conclusions

1) The study showed that switchgrass cultivation yield differs among the soils with different soil capability. In general, agriculture land produces more switchgrass yield than marginal land, with exception that soil capability 5 are more likely to produce large biomass.

2) ET of 400 mm is not different than ET values of observed for maize, indicating that swithgrass will not pose a threat on water resources.

References

Basso B. and J.T. Ritchie. 2015. Simulating Crop Growth and Biogeochemical Fluxes in Response to Land Management using the SALUS Model . In S. K. Hamilton, J. E. Doll, and G. P. Robertson, editors. The ecology of agricultural landscapes: long-term research on the path to sustainability. Oxford University Press, New York, New York, USA.

Klingebiel, Albert Arnold, and Paul Hooper Montgomery. *Land-capability classification*. No. 210. Washington, DC, USA: Soil Conservation Service, US Department of Agriculture, 1961.