Climate Change and Bioenergy Crop Production Impacts on Watershed Sustainability

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Environmental sustainability analyses of futuristic plausible land use and climate change scenarios are critical in making watershed-scale decisions for simultaneous improvement of food, energy and water management. Bioenergy production targets for the US are anticipated to impact farming practices through the introduction of fast growing and high yielding perennial grasses/trees, and use of crop residues as bioenergy feedstocks. These land use/land management changes raise concerns over potential environmental impacts of bioenergy crop production scenarios, both in terms of water availability and water quality; impacts that may be exacerbated by climate variability and change. The goal of the study was to assess environmental sustainability of plausible bioenergy scenarios for two watersheds in the Midwest US under changing climate scenarios. 21 bioenergy production scenarios were developed with switchgrass, *Miscanthus* and corn stover as candidate biofeedstocks and marginal lands, best management practice (BMP) areas and prime agriculture areas as potential growing areas. The study considered fourteen sustainability indicators under nine climate change scenarios from World Climate Research Programme's (WCRP's) Coupled Model Intercomparison Project phase 3 (CMIP3). The distributed hydrological model SWAT (Soil and Water Assessment Tool) was used to simulate bioenergy crop production scenarios and their impacts on hydrology and water quality. The watershed-scale environmental sustainability analysis was done with measured and projected climate data for the St. Joseph River watershed located in Indiana, Michigan, and Ohio; and the Wildcat Creek watershed, located in Indiana. The results indicate streamflow reduction at the watershed outlets with increased evapotranspiration demands for perennial grasses. Corn stover removal increased sediment loading and adsorbed nutrient loadings in streams, while a reduced nitrate loading to streams was evident for the no-stover removal baseline scenario. The perennial bioenergy crops in general improved in-stream water quality compared to conventional cropping systems (maize-soybeans). Water quality benefits due to land use change were generally greater than the effects of climate change variability.

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