The Rathbun Lake project: An evaluation of the water quality implications of switchgrass production for biomass using SWAT modeling and ArcView GIS

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Background

Rathbun Lake is a 4,455-hectare multi-purpose reservoir on the Chariton River in south-central Iowa. Its watershed is approximately 1,480 square kilometers. The watershed of Rathbun Lake is predominately rural with land use distribution 60% row crop and Conservation Reserve Program land, 25% pasture and hay, and 9% forest. Construction of Rathbun Dam was completed in 1969. Currently, Rathbun Lake is filling with sediment three times faster than anticipated. Nutrient and pesticide runoff is also a concern.

Switchgrass (Panicum virgatum L.) production for biomass is being evaluated as an alternative crop for the region as a source of renewable energy, potentially improve water quality of Rathbun Lake by reducing the delivery of sediment, nutrients and pesticides; diversify present cropping systems; and stabilize farm income for participating farmers.

Objective

The objective of this study was to evaluate effects of switchgrass production for biomass on sediment yield, nutrients (nitrogen and phosphorus), and pesticide (atrazine) loading in Rathbun Lake watershed.

Approach

?? The Soil and Water Assessment Tool (SWAT)-ArcView Interface version 99.2 was selected for this project because it uses available digital geographic information systems (GIS) databases. SWAT is a biophysical, semi-distributed model designed to simulate water yield, sediment delivery and nutrient and pesticide loading from large, ungaged watersheds. It was imperative that a GIS be used to manage the volume of data necessary for a project of this size.

?? Soil, land use and digital elevation model (DEM) GIS coverages were prepared.

?? Weather data from four local stations was used in the model.

?? Management and cultural practices for each of the major land uses were generalized by interviewing local land use experts.

?? Annual SWAT model water yield was compared to the observed data from the Chariton River mainstem and its tributaries. The predictive capability of the SWAT model for water yield was assessed using standard statistical methods of model reliability. Model efficiency parameters were calculated.

?? Alternative land use targeting strategies were explored to elucidate their impacts on hydrology and water quality relative to the baseline (current) conditions. One scenario was to grow switchgrass for biomass production on selected highly erosive soils within the watershed.

Conclusions

The 61 subbasins (14-digit hydrologic unit classification) in Rathbun Lake Watershed were categorized based upon their probability of producing excess sediment. The SWAT demonstrated the relative impact of changing management and cultural practices by comparing current land use to an alternative land use scenario growing switchgrass for biomass production. Ongoing research will evaluate the relative changes of nitrogen, phosphorus and atrazine loading between the current and the alternative land use scenario.