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Simulating the Effects of Alternative Management Practices on Suspended Sediment and Phosphorus Loads to Green Bay using the Soil and Water Assessment Tool (SWAT) and SNAP-Plus

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This study was conducted to assist in the development of load allocations within the 1580 km^2 Lower Fox River sub-basin. Major sources of phosphorus (P) and suspended sediment export to lower Green Bay were quantified through watershed model simulations with a modified version of the USDA-ARS Soil and Water Assessment Tool model (SWAT). Simulations were conducted for a 1977 to 2000 climatic period under (1) 1992 baseline conditions; (2) 2000 conditions; and (3) 11 categories of alternative management scenarios. The calibrated model was able to produce reasonable predictions of water yield and loads of sediment and P during validation periods. Constituent loads and sources were determined at sub-watershed, watershed and sub-basin scales. The highest simulated yields of sediment (0.56 ton/ha) and P (1.34 kg/ha) were from the largely agricultural Plum Creek watershed (213 km^2). A large range in sediment and P reductions was simulated for the alternative scenarios that involved agricultural practices. Phosphorus export from the Plum Creek watershed was predicted to decrease 14% when nutrient management to stabilize soil P at current levels was adopted throughout the watershed, but dropped by 37% when soil P was stabilized to levels observed in the early 1970's. Widespread adoption of mulch tillage on conventional tilled lands was predicted to decrease the P load by 13%, but a total reduction of 22% was achieved when all applied manure was also incorporated (current incorporation rate is 50%). The largest P and sediment reductions were obtained through widespread implementation of intensive rotational grazing (up to 59% and 69%, respectively). However, some of the simulated BMP adoption rates were intended to be upper-bound limits, and not likely to be practical. If intensive rotational grazing was adopted on 40% of all dairy farm land, loads of P and sediment at the Plum Creek outlet were predicted to decrease by 19% and 21%, respectively. If all applied manure was incorporated, and the level of conservation tillage was increased to reflect 30% no-till, 60% mulch-till and 10% conventional tillage, then P and sediment loads were predicted to decrease by 34% and 25%, respectively. Lower P and sediment reductions were predicted when agricultural conservation practices were implemented at other watersheds in the sub-basin due to the greater influence of urban land use.

Ultimately, load allocations made at the watershed scale will require changes at the farm scale. Therefore, the SNAP-Plus farm management model developed by the University of Wisconsin was applied to farm fields in a portion of the intensively monitored Apple Creek watershed to predict the effect of different management scenarios on P and sediment export to streams, and to verify the validity of the model at the watershed scale. Relationships between SNAP-Plus predictions and observed water quality are being developed. Preliminary results show a significant relationship ($p<0.05$) between water quality observations and SNAP-Plus soluble P-Index ratings in adjacent sub-watersheds. Comparisons between observed water quality and SWAT and SNAP-Plus simulations at the sub-watershed scale will be presented.