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Distributed Hydrological Modeling of Runoff Generation and Total Dissolved Phosphorous Transport to Improve BMP Evaluation in a New York City Source (CEAP) Watershed

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Abstract:

Two physically-based, fully-distributed, GIS-integrated models were developed to simulate the distributed hydrological behavior of watersheds with shallow soils and steep to moderate slopes. The models rely on the hypotheses that gravity is the only driving force of water movement and that only saturation excess processes generate overland flow. We applied the models to a 1.65 km2 farm watershed in Delaware County, NY, in the headwaters of the Cannonsville Reservoir, and to the 37 km2 Town Brook sub-watershed over a 9-year period. The models use easily derived distributed parameters from data readily available in national databases or in the literature.

Simulated hydrographs from both watersheds compared reasonably with flows measured at the watershed outlet over the whole period, and peak timing and intensities were well reproduced. Simulated saturation degrees followed the same spatial trend as soils samples taken on four pre-selected transects in the farm watershed. Modeled water table levels, and thus presumably saturation dynamics, compared well with measured levels in the Town Brook basin.

In addition, routines were developed and tested in the farm watershed to model the transport of Total Dissolved Phosphorus (TDP) with baseflow and surface runoff from both manured and non-manured areas. For non-manured soils, we assigned a temperature-dependent estimated TDP release coefficient based on soil sampling, simulated rainfall application and land use. For manure-covered areas, we computed estimated TDP concentrations from predicted cumulative flow, available water-extractable P, and time since manure application, using field-specific manure spreading data. Predicted loads agreed well with loads observed at the watershed outlet.

Impact Statement:

The effectiveness of Best Management Practices (BMP) implemented to reduce TDP loss was analyzed. The model predicted that prohibiting manure spreading in frequently saturated or near-stream areas would reduce TDP losses. These results are generally corroborated by the observed reductions in P concentrations in water entering the Cannonsville Reservoir, presumably resulting from BMP implementation in the basin.

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