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Distributed Hydrological Modeling of Runoff Generated and Total Dissolved Phosphorus Transport

Two physically-based, fully-distributed, GIS-integrated models were developed to simulate the hydrological behavior of small rural 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 165-ha farm watershed in Delaware County, NY, on the headwaters of the Cannonsville reservoir, over a 9-year period. The model uses easily derived distributed parameters from data readily available in national databases or in the literature. In addition transport of TDP with baseflow and surface runoff from both manure-covered and non-manure-covered areas was modeled Simulated hydrographs compared reasonably with flows measured at the watershed outlet over the whole period, and peak timing and intensities were well reproduced. The agreement was slightly better in summer than in winter. The models usually slightly underestimated summer low flows. We attribute occasional discrepancies between observed and simulated flows to the fact that most weather input data was recorded about 18 km from the study site. Simulated soil moisture distribution patterns agreed well with observed hydrological features. Simulated saturation degrees followed the same spatial trend as soils samples taken on four pre-selected transects. Predicted TDP loads agreed well with loads observed at the watershed outlet. Difficulty in predicting snowmelt might explain the lack of fit in the spring season. As a final step, we analyzed the effectiveness of Best Management Practices to reduce the TDP losses. As expected, the models predicted that prohibiting manure spreading in near-stream areas would reduce TDP losses. These results agree well with the implementation of nutrient management plans on farms in the basin, which recommend avoiding manure application on hydrologically active areas and the concurrent observed decrease in P concentrations in water entering the Cannonsville Reservoir.

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