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Application of SWAT-HS, a lumped hillslope model to simulate hydrology in the Cannonsville Reservoir watershed, New York

Linh Hoang (1,2), Elliot Schneiderman (2), Rajith Mukundan (2), Karen Moore (2), Emmet Owens (2), and Tammo Steenhuis (3)

(1) Hunter College, City University of New York, 695 Park Avenue, New York, NY 10065, USA , (2) New York City Department of Environmental Protection, 71 Smith Avenue, Kingston, NY 12401, USA, (3) Department of Biological and Environmental Engineering, Cornell University, Ithaca, NY 14853, USA

Surface runoff is the primary mechanism transporting substances such as sediments, agricultural chemicals, and pathogens to receiving waters. In order to predict runoff and pollutant fluxes, and to evaluate management practices, it is essential to accurately predict the areas generating surface runoff, which depend on the type of runoff: infiltration-excess runoff and saturation-excess runoff. The watershed of Cannonsville reservoir is part of the New York City water supply system that provides high quality drinking water to nine million people in New York City (NYC) and nearby communities. Previous research identified saturation-excess runoff as the dominant runoff mechanism in this region. The Soil and Water Assessment Tool (SWAT) is a promising tool to simulate the NYC watershed given its broad application and good performance in many watersheds with different scales worldwide, for its ability to model water quality responses, and to evaluate the effect of management practices on water quality at the watershed scale. However, SWAT predicts runoff based mainly on soil and land use characteristics, and implicitly considers only infiltration-excess runoff. Therefore, we developed a modified version of SWAT, referred to as SWAT-Hillslope (SWAT-HS), which explicitly simulates saturation-excess runoff by redefining Hydrological Response Units (HRUs) based on wetness classes with varying soil water storage capacities, and by introducing a surface aquifer with the ability to route interflow from “drier” to “wetter” wetness classes. SWAT-HS was first tested at Town Brook, a 37 km2 headwater watershed draining to the Cannonsville reservoir using a single sub-basin for the whole watershed. SWAT-HS performed well, and predicted streamflow yielded Nash-Sutcliffe Efficiencies of 0.68 and 0.87 at the daily and monthly time steps, respectively. More importantly, it predicted the spatial distribution of saturated areas accurately. Based on the good performance in the Town Brook watershed, we scale-up the application of SWAT-HS to the 1160 km2 Cannonsville watershed utilizing a setup of multiple sub-basins, and evaluate the model performance on flow simulation at different gauged locations in the watershed. Results from flow predictions will be used as a basis for evaluating the ability of SWAT-HS to make sediment and nutrient loading estimates.