

ABSTRACT

Mao, Dazhi. Ph.D., Purdue University, December, 2008. Development and application of a coupled erosion and hydrology modeling system. Major Professor: Keith A. Cherkauer.

Soil erosion at regional-scales where management decision are made, such as counties, states, and river basins, is not well represented by current field-scale models due to limitations imposed on such models during their development. In addition, cold season processes are not adequately represented in many of those erosion models. To address this problem, a coupled modeling scheme was developed to integrate a process-based hillslope scale erosion model (the Water Erosion Prediction Project – Hillslope Erosion (WEPP-HE)) with a large-scale hydrology model (the Variable Infiltration Capacity (VIC) model) to estimate soil erosion at the scales of the hydrology model. Simulation results from the coupled modeling system were compared with those from a stand-alone hillslope erosion model and hydrologic observations. The coupled model results were comparable with annual average soil loss rates calculated using the full WEPP model. Performance of the soil frost algorithm was evaluated and analyzed for the coupled modeling system to determine the effects of soil frost on erosion predictions. Snow depth and soil temperatures were in good agreement with observed data, and ice content in the top soil layer corresponded to soil frost development. Soil losses were mainly driven by precipitation and runoff, and rill erodibility adjustment and critical shear stress were important in at least one evaluation watershed. The model was then applied to the Great Lakes region to study the impacts of historical land-use change on hydrologic responses and soil erosion. Simulated changes resulting from land-use modifications varied spatially and seasonally, but were strongly correlated to the type of vegetation conversion and geographic locations. Soil erosion increased in the agriculturally dominated regions.

Erosion was not only related to vegetation cover, but also impacted by precipitation intensity, which was in turn affected by the presence of vegetation canopy and steepness of slopes.