APEX Model Simulation of Runoff and Non-Point Source Pollutants From Watershed Managed With No-Till Management

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Introduction

- Non-point source pollution (NPSP) from agricultural watersheds are the major water quality problems of the watersheds located within the Midwestern USA.
- The NPSP can be reduced through the application of best management practices (BMPs).
- However, quantifying the impacts of management on water quality and runoff is difficult due to large variability in climate and soil types.
- Hydrologic models can be used to assess the long-term impacts of BMPs on runoff and water quality.

Objective

- To simulate the runoff and water quality from the watershed managed with long term no-till (NT) system, and assess the long-term no-till management impacts on runoff.

Materials and Methods

- The present study is conducted on a small watershed located in North Appalachian Experimental Watersheds (NAEW) near Coshocton, Ohio (Fig. 1).
- Long-term managed small NT watershed (WS 118, ~0.79 ha) located at NAEW site was selected for this study (Fig. 1).
- The Agricultural Policy/Environmental Extender (APEX) Version 806 (*Williams et al*., 2000) was used to evaluate different management impacts on water quality and runoff.
- The storm event monitoring data, weather, soil and the management data from the experimental watershed is used for the study.

Model inputs:

- **Soils**: No-till watershed has two map units: CoC2 (Coshocton silt loam, 6 to15 % slopes, eroded) and CoD (Coshocton silt loam, 15-25 % slopes) based on SSURGO soils information.
- **Management:** The NT watershed for year 2000-2005 and 2006-2011 include NT system under (i) corn (*Zea mays* L.), soybean (*Glycine max* L.) with rye (*Secale cereale* L.) cover crop, and (ii) corn-corn cropping system, respectively.
- **Climate:** Average annual temperature and average annual precipitation is 10°C and 1020 mm, respectively.

Modeling Approach:

- APEX model was established for the two periods (2000-2005 and 2006-2011) of the crop rotations.
- Separate model was built for simulating same field to address the long-term management scenarios.
- Model was calibrated and validated for runoff using the observed runoff data for both cropping rotations.
- Long-term (30 years) scenarios of APEX model include: impacts of corn-corn and corn-soybean rotation on runoff.
- The Nash-Sutcliffe Efficiency and R^2 were used for testing the model performance.

Model	Calibration period	Validation period
Corn-Soybean rotation	2000-2003	2004-2005
Corn-Corn	2006-2009	2010-2011

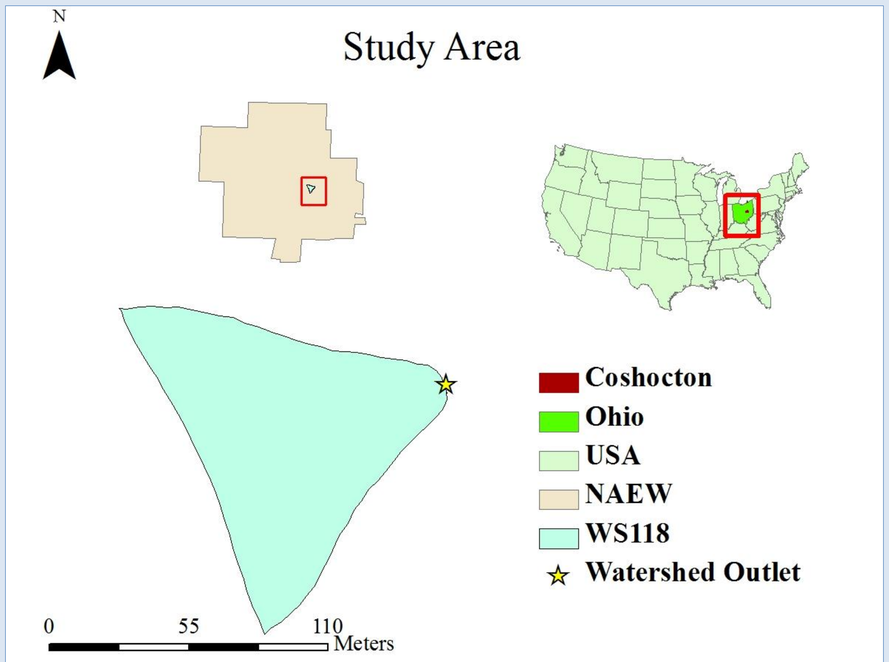

Fig. 1. The North Appalachian Experimental Watersheds, Coshocton, Ohio

Results

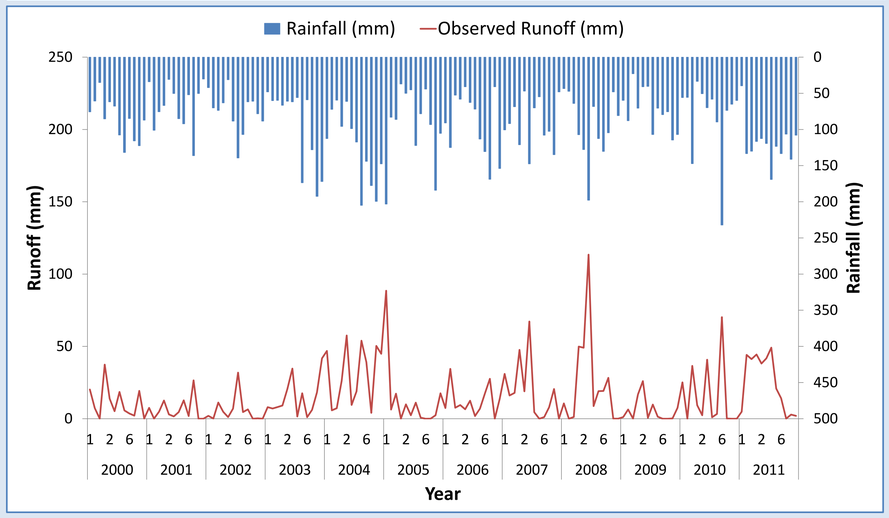

Fig. 2. Measured runoff and rainfall during modeling period (2000-2011).

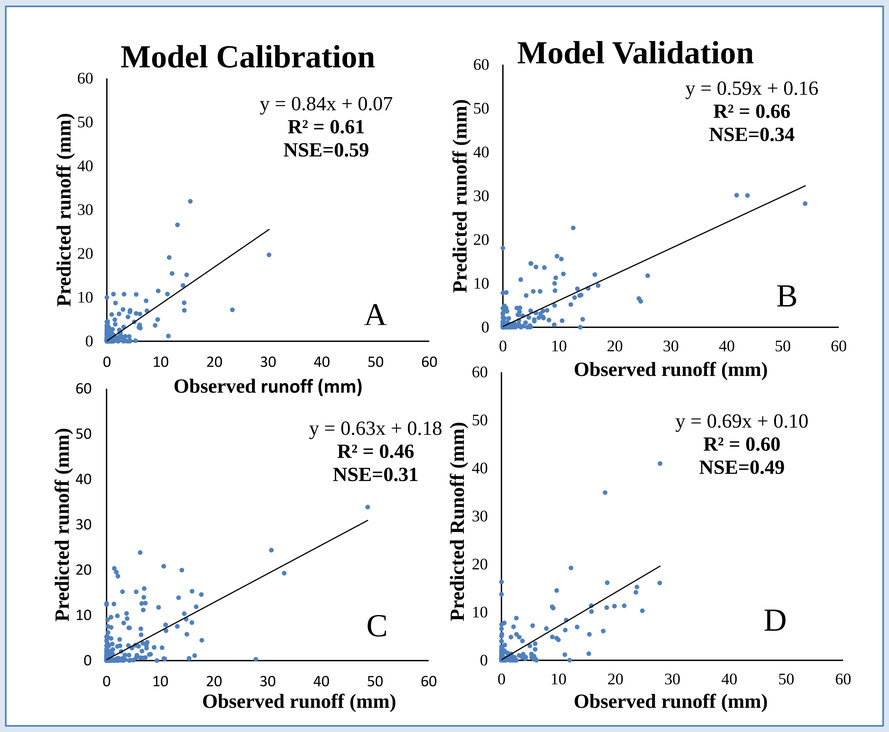

Fig. 3. Simulated versus measured runoff for calibration (2000 to 2003, A) and validation (2004-2005, B) of no-till corn-soybean rotation; and simulated versus measured runoff for calibration (2006-2009, C) and validation (2010 to 2011, D) of no-till corn-corn rotation.

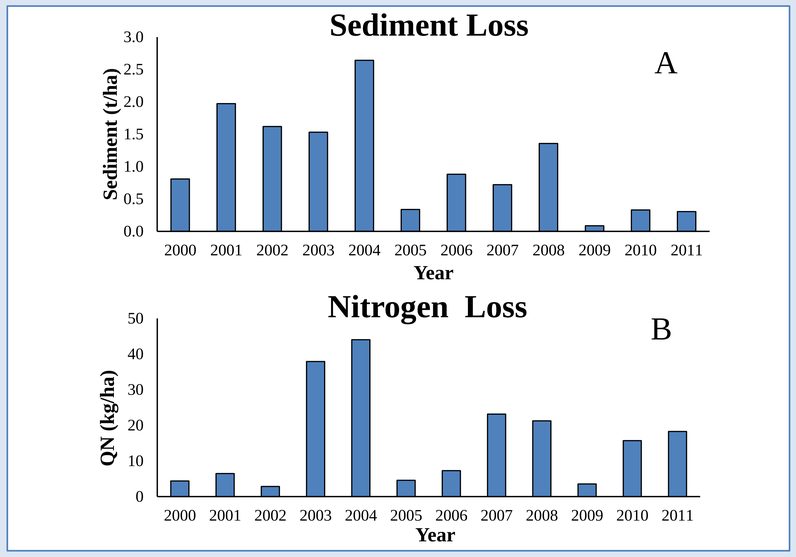

Fig. 4. Measured sediment loss (t ha^{-1}) (A), and nitrogen loss (QN, kg ha^{-1}) (B) in runoff from the no-till watershed during year 2000 to 2011.

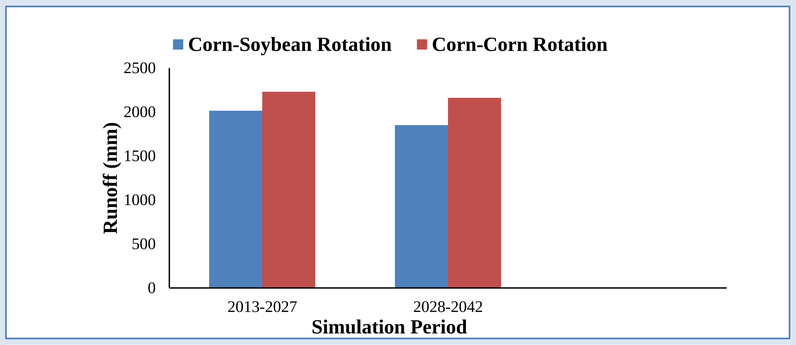

Fig. 5. Long-term (30 yr) corn-soybean and corn-corn rotation impacts on surface runoff.

- Average annual measured runoff (2000-2011) was 184 mm (Fig. 2).
- The R^2 and Nash-Sutcliffe Efficiency (NSE) for daily calibration and validation of runoff ranges from 0.46-0.66, and 0.31 to 0.59 respectively (Fig. 3)
- Average yearly measured nitrogen and sediment loss (2000-2011) was 15.8 kg ha^{-1} and 1.04 t ha^{-1}, respectively (Fig. 4).
- Long-term scenarios analysis of runoff (30 years) showed that NT corn-soybean reduced runoff by **12%** compare to that of NT corn-corn rotation (Fig. 5).

Conclusions

- Hargreaves PET equation coefficient, Exponent SCS curve number index, Hargreaves PET equation exponent and RUSLE C-factor were found to be the most sensitive parameter governing Runoff in APEX model.
- Result showed that the APEX model simulated runoff reasonably well with (R^2 > 0.46) for daily calibration and validation.
- The next step in this modeling will include the calibration of the sediment and water quality, and long-term scenario analysis to assess the impacts of management on water quality.

References and Acknowledgements

- Williams, J.R., Arnold, J.G. and Srinivasan, R., 2000. The APEX Model. . In: NRCS-USDA (Editor). NRCS-USDA, Texas Agricultural Experiment Station, pp. 1-141.
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