Understanding prediction robustness of the Root Zone Water Quality Model (RZWQM)

Lei Gu1, Robert Anex1, Michael Fienen2, Matthew Helmers3

1Department of Biological Systems Engineering, University of Wisconsin – Madison
2United States Geological Survey, Wisconsin Water Science Center
3Department of Agricultural and Biosystems Engineering, Iowa State University

Introduction

The RZWQM model is often used to make predictions of environmental behaviors such as hydrologic and chemical response, translating research to other locations and climates. Typically, a well calibrated model is believed to be able to produce reasonably good predictions under other conditions. Unfortunately, this assumption is false, as we have shown for prediction of nitrate loss from a tile-drained, corn-soybean experiment in Northern Iowa. Using experimental data over 12 years, we investigated the robustness of RZWQM predictions of crop yield, subsurface drainage flow, and nitrate-N loss for multiple model calibrations using the PEST parameter estimation software. Post-processing analyses provided insights into parameter-observation relationships. We found that prediction robustness of RZWQM model was related to the range of soil moisture conditions represented in the calibration data. We also tested the use of the Palmer Drought Severity Index (PDSI) as an indicator of the information content of calibration data related to soil moisture. We show that data representing a particular range of PDSI allow a calibration able to predict performance in years exhibiting a similar range of PDSI. For example, we show that adding to a five year calibration set a single year identified by examining the PDSI, improves the Nash-Sutcliffe model efficiency coefficient (NSE) from -0.18 to 0.7, and achieves nearly all of the improvement possible when all available observation are included in calibration. Our work shows how field observations under more variable soil moisture conditions constrain the RZWQM parameters and suggests one way of evaluating the predictive power of a calibration.

Preliminary Results

RZWQM Modeling

![Graphs showing simulated and measured crop yield, tile flow, and nitrate-N loss](Image)

Soil moisture measure: PDSI

![Monthly PDSI values of the 12 observation years](Image)

Identifiability of RZWQM parameters

![Pie charts showing identifiability of RZWQM parameters](Image)

Conclusions

- This work demonstrates the use of Palmer Drought Severity Index (PDSI) as an indicator of the soil moisture related information contained in calibration and its use in evaluating the suitability of calibration data for making predictions about other climate conditions.
- Prediction robustness of a calibration is related to the range of soil moisture condition contained in the calibration data. Predictive uncertainty is only reduced when the information content of the calibration dataset is able to constrain the model parameters relevant to the processes controlling the desired prediction.
- This work provides insights into parameter-observation relationships and suggests one way of evaluating the predictive power of a calibration.

This research is part of a regional collaborative project supported by the USDA-NIFA, Award No. 2011-68002-30190 “Cropping Systems Coordinated Agricultural Project (CAP): Climate Change, Mitigation, and Adaptation in Corn-based Cropping Systems” sustainablecorn.org

[Image 75x27 to 577x195]

[Image 714x1059 to 1380x1277]

[Image 1400x1383 to 1974x1810]