Comparison of the WIN-PST and SWAT Models for Pesticide Losses in Surface Runoff of the Le Sueur River Watershed

Submitted to: Minnesota Department of Agriculture

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February, 2007

Introduction

Pesticide simulation models can provide an opportunity to evaluate the response of soil and water resources to different farming practices, climatic conditions, soil, and topographic properties in an efficient and cost effective manner. Despite all the important aspects of pesticide simulation models, the reliability of these models depends on how well each process is represented and on the accuracy of the model parameters used. Thus, evaluation of the models before applying them to areas where they have never been tested is a very important issue.

The WIN-PST is recommended by US EPA for qualitative ratings to classify the relative likelihood of pesticide loss through runoff and leaching. The model is based on simple rule-based algorithms developed by USDA to determine pesticide loss risks. The WIN-PST model has been approved for use as a first tier level risk detection tool.

This study evaluates the WIN-PST model under Minnesota conditions for its ability to estimate surface runoff loss risks of selected pesticides. Performance assessment of the model was made in different agroecoregions of the Le Sueur watershed with a variety of soil, crop, management practices, hydrologic, and climatic conditions.

Model Evaluation Methods

The WIN-PST model input parameters were organized to simulate surface runoff losses of six pesticides for all of Minnesota. WIN-PST surface runoff loss risk results were then

evaluated for atrazine in the Le Sueur watershed, in comparison with results from the latest version of the Soil Water Assessment Tool (SWAT) model, AVSWATX. This model is more detailed than WIN-PST and explicitly considers soil properties, slope steepness, daily climatic patterns and typical agricultural management practices. Prediction results from the SWAT model are assumed to be more accurate than results from WIN-PST, therefore WIN-PST results are judged based on how well they match SWAT results.

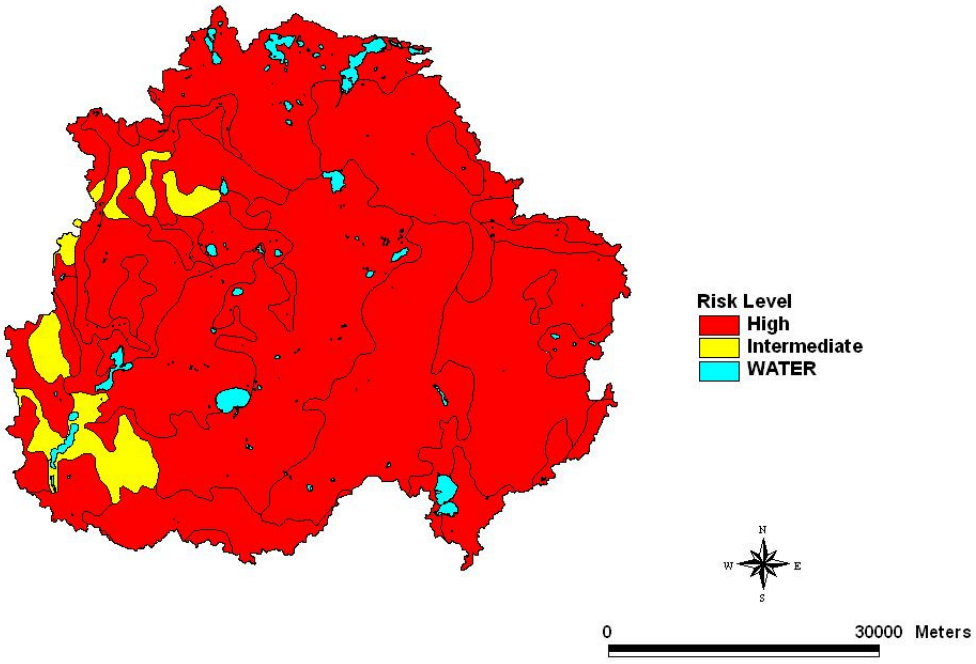
It should be noted that SWAT was run in an uncalibrated mode. SWAT predicted flow discharges from the Le Sueur watershed overestimated measured monthly discharges by roughly two-fold. Although flow was overestimated by SWAT, temporal trends in peak flow predicted by SWAT agreed closely with the temporal trends in measured peak flow. This gives good confidence that the relative pesticide runoff risks predicted by SWAT across the Le Sueur watershed are reasonably accurate, although the magnitudes of loss may be over-estimated by two-fold.

Results of WIN-PST Model Evaluation

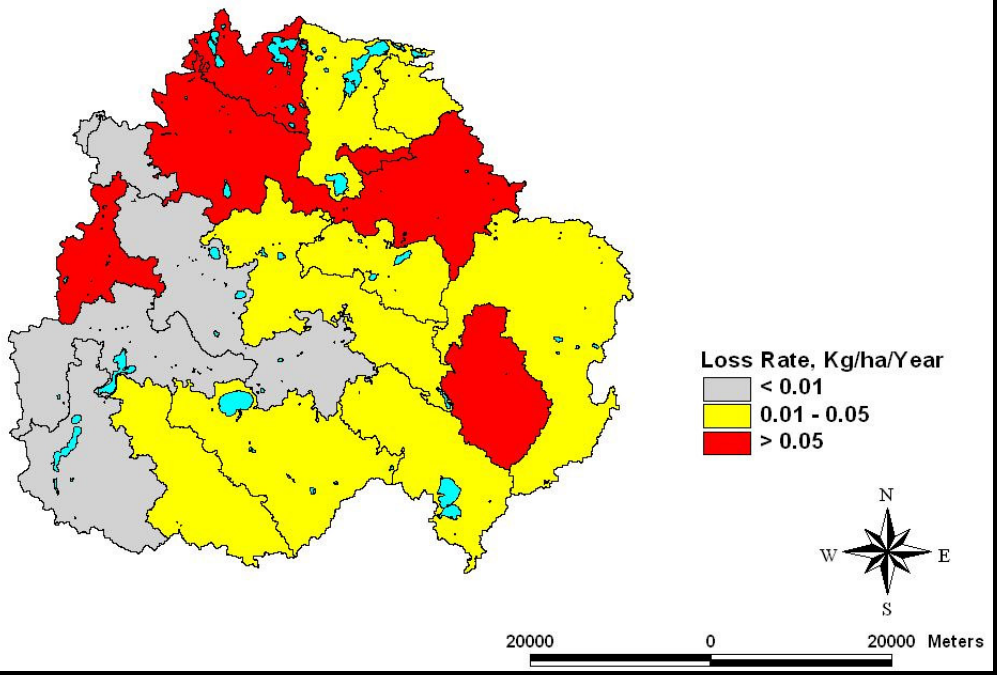
WIN-PST predicts high risks of surface runoff risk for atrazine across the entire Le Sueur watershed. Based on field experience and knowledge about variations in soil type and slope steepness across the study area, this result does not seem reasonable. Therefore, the WIN-PST results were compared against surface runoff loss risks for atrazine in the Le Sueur watershed using SWAT.

The SWAT model predicts three levels of atrazine runoff risk across the Le Sueur watershed. SWAT predicts that 24% of the watershed has low risk (<0.1 kg/ha/year), 51% has an intermediate risk (0.1 to 0.5 kg/ha/year) and 25% has a high risk (> 0.5 kg/ha/year) of atrazine loss in surface runoff. As mentioned earlier, these risks are likely overestimated, since SWAT was not calibrated and it overestimated measured river discharges by roughly two-fold. The spatial distribution of runoff risks for atrazine from WIN-PST and SWAT are shown in the following two maps. These spatial distributions are very different, with WIN-PST nearly the entire watershed is at high risk of atrazine losses to surface waters. This is not realistic, given the wide range of soil types and landscape characteristics in the watershed. The SWAT results are more reasonable, since they are closely related to spatial distributions in soil type and slope.

WIN-PST Model Predicted Atrazine Surface Runoff Loss Risk



Atrazine Surface Runoff Loss Predicted Using SWAT Model



Major Weaknesses of WIN-PST Model

- The algorithms of the WIN-PST model for surface runoff losses are not as accurate as the algorithms for its leaching component. The factors which correlate to surface losses are much greater than those to leaching losses. However, the stepwise regression procedure showed little difference in the weighting of the first five to seven parameters.
- The type of crops grown, rates of pesticide application and site specific meteorological components are not considered by WIN-PST and are beyond the scope of this screening procedure.
- The predicted surface loss potential is most dependent on pesticide properties and soil hydrologic group. The potential role of organic soils to mitigate pesticide loss from surface runoff is less important. Pesticides with a Koc over 300 ml/g can strongly adsorb to organic matter (OM).This aspect is very important for Minnesota where we have extensive areas of soil with high OM.
- The depth to ground water used by WIN-PST is largely based on the perched water table. Shallow water tables that are not representative of the actual ground water levels in an aquifer lead WIN-PST to over-estimate surface runoff losses of pesticides.
- WIN-PST does not consider the influence of tile drainage on pesticide losses to Minnesota surface waters. Thus, the greater losses predicted by WIN-PST are also due to the extremely high soil solution runoff potential simulated by the model.

Conclusions

Based on the comparisons between WIN-PST and SWAT, and on some of the weaknesses of WIN-PST discussed in this report, it is not advisable to adopt the WIN-PST model to estimate risks of pesticide losses in surface runoff for the conditions in Minnesota. Further work is needed to calibrate the SWAT model for the Le Sueur watershed in order to refine its estimates of river discharge and pesticide runoff loss risks.