Handling Support Problems In Accuracy Assessment Of An Environmental Process Model

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Abstract

Agricultural activities in the Netherlands cause high nitrogen and phosphorus emissions from soil to ground- and surface water. To study and predict ground- and surface water pollution under different agricultural scenarios, a model chain (STONE) has been developed (Overbeek et al. 2001). STONE has three main components. These are the emission model CLEAN, the atmospheric transport and deposition model OPS and the soil model ANIMO. There are also links to additional models, such as to the hydrological model SWAP and the crop growth model QUADMOD. These models operate at different spatial scales (i.e., supports), mainly because they describe different processes. Simple aggregation and disaggregation procedures have been developed to adapt the input supports to the model support and to bring the STONE output to a desired block support of 500 × 500 m. STONE predictions are then made on a regular grid covering relevant parts of the Netherlands. Apart from support problems, another problem is that input and model uncertainties are introduced and propagated to the STONE output. Validation procedures may be used to assess the overall accuracy of the model output. First validations have been done by comparing cumulative frequency distributions of STONE output for the whole of the Netherlands with those of independently collected observations of the target variables (Overbeek et al. 2001). However, the procedure used did not take spatial variation in model outputs and

observations and differences in spatial support into account.

The goal of this paper is to redo the validation, this time taking spatial variation in observed and predicted variables and differences in support into account. Building upon work by Heuvelink and Pebesma (1999), Leopold et al. (2002) found that there are two possible routes to validate the STONE model: (1) use block-kriging to interpolate and aggregate the validation data to yield block support predictions on the regular grid, and compare the aggregated validation data with the STONE output at all grid cells; (2) obtain STONE output on point support at the sampling locations, subtract these from the observations, and aggregate the resulting validation outcomes to the desired block support. Route (1) has been investigated in Leopold et al. (2002). The problem with this route is that the STONE output is not compared with error-free observations but with 'observations' that contain interpolation errors. In this case it turned out that the interpolation error was quite large. This made it difficult to decide whether observed differences between model output and interpolated and aggregated validation data were caused by model inaccuracy or by interpolation error. Another important problem with route (1) is that it may well be that STONE prediction errors and interpolation errors are correlated, which further undermines the validity of the results of the validation exercise (Heuvelink and Pebesma 1999).

To avoid the problems associated with route (1), this study investigates the usefulness of the alternative route (2). In route (2), STONE output is compared directly with the point support observations. The differences are computed and interpolated and aggregated to the desired block support. For this we used universal block kriging. The selection of trend variables used by universal kriging was done using stepwise linear regression. The variables selected were soil type, soil texture and land use. The validation data were obtained from a Dutch national sampling campaign (Finke et al. 2001). The campaign employed a stratified random sampling design to derive bulk samples from ~$10m^2$ at 1,392 sample locations for various depths. In this study, the chosen variable is oxalate-extractable Phosphorous for a soil depth of 0 - 30 cm. In addition to the above, the differences between STONE predictions and validation point data were also aggregated to the county scale, the size of which allowed the use of a design-based approach (Brus and De Gruijter 1997).

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