Catchment modeling in two agricultural catchments – does local information improve the results, an how do the model reflect P dynamic and spatial processes?

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Introduction and aims

Two agricultural catchments in the Swedish county of Östergötland (Skenaån: 160 km^2 and E23: 8 km^2) were intensively monitored in space and time (with focus on flow events) and investigated with respect to especially phosphorus (P) but also nitrogen (N) losses from the catchment.

The aims were to investigate

- The dynamics of nutrient concentrations in the catchment, during and after snowmelt or heavy precipitation
- How well does the HYPE* catchment model reflect the monitoring results?
- Does the use of local information improve the model compared to the use of national/regional databases?

The local data included water discharge, crop type, precipitation (only in E23), sewage from rural households, soil type, fertilization, and nutrient pools in the soil. The regional data were based on information used by the national setup of the HYPE model (S-HYPE), available at http://vattenweb.smhi.se/.

* Lindström et al, 2010: *Development and testing of the HYPE (Hydrological Predictions for the Environment) water quality model for different spatial scales*, Hydrological Science Journal.

Materials and methods

Measurements of water discharge and nutrients were performed at the two catchments during 2009-2011. Grab samples were collected during occasions that represented various water flow regimes. During snowmelt and some other flow events, automatic water samplers were placed at strategic locations in the catchment, taking samples every third or sixth hour in order to capture the movements of P during high flow.

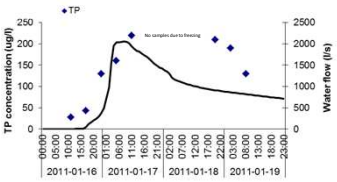
Water samples were analyzed for total P (TP) and N (TN), inorganic P (PO_4) and N (IN), organic P and N, suspended material (SUSP) and silica (Si).

Two locally calibrated HYPE models was setup with local information to generate water flow and concentration data. Results were compared to the monitored data in order to evaluate if the detailed model setup provide a better estimate of nutrient concentration dynamics compared to the national S-HYPE model**.

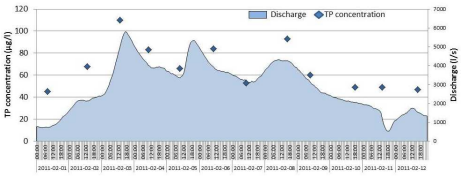
**Strömqvist et al, 2012. *Water and nutrient predictions in ungauged basins: set-up and evaluation of a model at the national scale*. Hydrological Sciences Journal

Results

Monitoring results

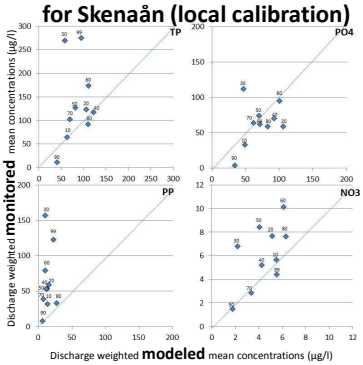


Rapid changes in e.g. TP concentration occurred during the snowmelt period (from 28 µg l^{-1} to 220 µg l^{-1} in 24 hours).

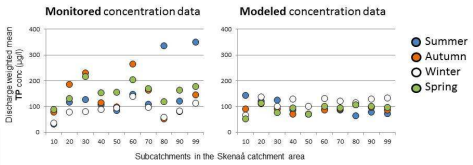


There was no general relationship between discharge (daily means) and TP concentrations. However, TP concentration co-varied with *hourly* discharge data.

Example of monitored vs. modeling data for Skenaån (local calibration)



Model results were sensitive to input data and calibration which makes it difficult to draw general conclusions of the dynamics of monitored vs measured concentrations.



When comparing seasonal variability for modeled and monitoring data, respectively, the model results were less dynamic than the monitored (e.g. TP concentrations).

Modeling results

Skenaån

- Modeled discharge was improved by use of local information and local calibration of discharge in sense of dynamics (NSE and R) but not in sense of volume (percent mean error).
- TP- dynamics was not improved of local information nor local calibration but TP-transport was.
- Modeled TN was not clearly improved (dynamics and transport) by local calibration nor local data.

E23

- Use of a local precipitation station improved discharge modeling significantly. For P concentrations, a main improvement was achieved by local calibration. Local information on wastewater emissions gave some added value, as well as the use of a local precipitation station.

Conclusions

- Local calibration and use of local precipitation were the most important factors to improve the model
- The model did often not catch the fast fluxes of nutrients during intense discharge, neither the seasonal variability, which indicates that the use of more local information not is the main key to improvements of results.

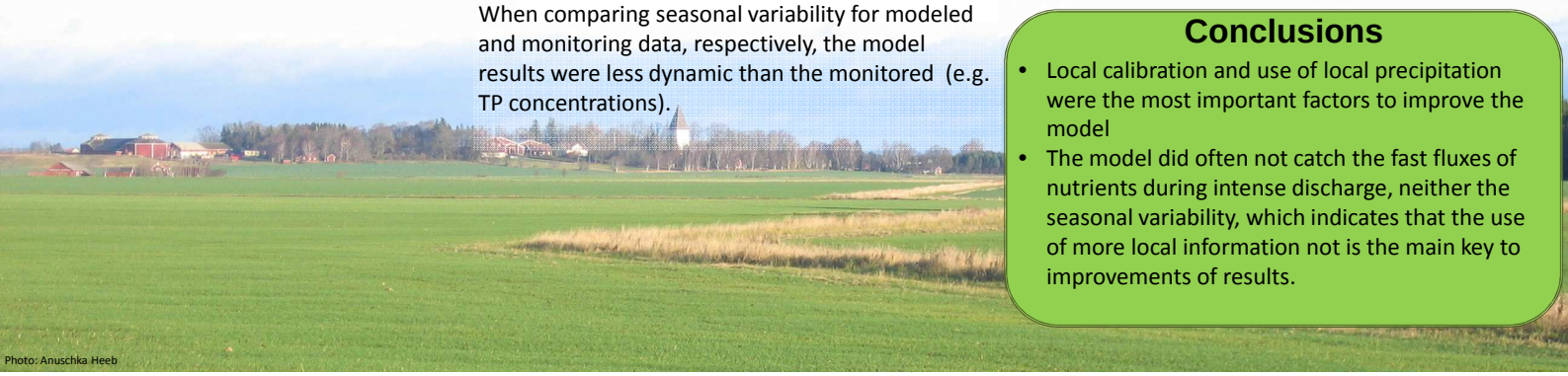


Photo: Anuschka Heeb