ICECREAM improves the water quality simulation of the Finland-wide VEMALA modeling system

Aim

More data on the amount and sources of phosphorus (P) loading into rivers and lakes is needed for the planning of water protection measures. As water quality measurements are expensive and time-consuming, the required information is not possible to achieve by measurements only. The diffuse P loading from agriculture is especially difficult to measure. Modeling together with available observations is cost-effective and can be used for estimating P loads in various conditions, if the models used are accurate enough. The aim of this work was to improve the simulation of P loading from agriculture in the Finland-wide VEMALA water quality model. For this purpose, the field scale phosphorus loading model ICECREAM was modified and coupled with VEMALA.

Methods

The VEMALA model (Huttunen et al., submitted) simulates nutrient transport and leaching from terrestrial ecosystems, including agricultural fields and forested areas, as well as the transport and processes of nutrients within rivers and lakes. In the earlier version of VEMALA (version V1) the simulation of P loading from land area is based on a concentration-runoff relationship and an estimate of the uncertainty related to the simulation. There are still many challenges in Finland-wide simulation of agricultural P loading. One of the main difficulties is the poor availability of accurate input data. Also the field research is much concentrated on the clayey soils in the southern part of Finland, and the information on other soil types (e.g. organic soils and coarse mineral soils) is scarce. In large catchment areas, the performance of both model versions is usually quite satisfying (Figure 2). However, in small catchment areas, or when water quality observations are scarce, the V1 version may produce unrealistic concentration patterns (Figures 2b and 2d). Version V2 has not been performing well in the Ostrobotnian area, where a considerable proportion of the P loading originates from organic soils. About half of the organic soils in this area are peat soils. The P loading dynamics of peat soils differs from that of mineral soils, so that relatively higher fraction of the loading is formed during the low flow periods. However, a new version of ICECREAM has been developed for peat soil simulation. The preliminary results of this new version are promising, although the model cannot reach the high concentration peaks in the spring time (Figure 2e). One explanation might be, that part of the fields in the Kupiole catchment area are covered by floodwater in the spring, and the additional leaching caused by the flooding is not considered in the simulation. The locations of the simulation points are shown in Figure 3.

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Conclusions

Field scale modeling of agricultural phosphorus loading with the modified ICECREAM model improves the VEMALA simulation in small catchment areas and areas with scarce or no water quality observations, as the process based model is less dependent on calibration. Comparing the results of the different model versions also gives an estimate of the uncertainty related to the simulation. There are still many challenges in Finland-wide simulations of agricultural P loading. One of the main difficulties is the poor availability of accurate input data. Also the field research is much concentrated on the clayey soils in the southern part of Finland, and the information on other types (e.g. organic soils and coarse mineral soils) is scarce. However, by using the VEMALA model, useful information of the phosphorus loading in Finland can already be produced.

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References


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References


