Parameterisation of FOCUS drainage scenarios using PEARL

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Introduction

For the assessment of drainage of plant protection products towards surface waters at the EU-level, the MACRO model is currently the only model available. In this model, the macropores are considered to be continuous down to the bottom of the soil and vertical penetration of water in the macropores is mainly based on the ratio between the rates of downward flow and lateral diffusive water exchange between macropores and soil matrix.

In the new version of FOCUSPEARL (FOCUSPEARL 4.4.4), an option has been implemented to take macropore flow into account based on the geometry of the macropores with a distribution of macropores ending at various depths.

Objective

The new version of PEARL is applied to the existing FOCUS drainage scenarios. The aim is to test whether PEARL can be used to simulate the drainage of pesticides to surface water in these scenarios.

Material and methods

The Lanna and Brimstone scenarios were selected first, because the soils for these scenarios are heavy clay soils. The Lanna soil is a clay soil with groundwater at a shallow depth and the Brimstone soil is a clay soil over a impermeable clay subsoil. The crop selected was winter cereals and the FOCUS example substance A was taken for the comparison of the concentration of substance in drain water. This example substance has a Kom of 5.8 L/kg and it has a half-life of 3 days in the soil.

The procedure of the parameterisation consisted of two steps. First the hydrological model SWAP was parameterised and run. Then the SWAP output on the water balance and the discharge rates of water via the drains was compared with the output of the MACRO model kernel (part of FOCUS MACRO 5.5.3 and MACRO 5.2). Relevant parameters were calibrated against the MACRO output on water balance terms. The second step consisted of parameterisation of the fate parameters of PEARL. The course with time of the concentration in the drain water was compared with that calculated with MACRO. As the SWAP and PEARL output is on a daily basis, the hourly data of MACRO were averaged over daily periods.

The crop and soil input data for winter cereals in these scenarios were taken from the parameterisation of FOCUSMACRO. As the input section for macropore flow in SWAP differs from that in MACRO, estimates were made for several SWAP input parameters that would approach as good as possible the MACRO parameterisation.

Characteristics of the soils and drainage systems are given in Table 1.

Table 1. Characteristics of the soils and drainage systems

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Drain depth (m)</th>
<th>Drain spacing (m)</th>
<th>Organic matter content in topsoil (kg/kg)</th>
<th>Clay content in top soil (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lanna</td>
<td>1.0</td>
<td>13.5</td>
<td>0.0344</td>
<td>47</td>
</tr>
<tr>
<td>Brimstone</td>
<td>0.55</td>
<td>2.0</td>
<td>0.0568</td>
<td>54</td>
</tr>
</tbody>
</table>

Results

The results of the water balance for the last year computed with SWAP for the Lanna and Brimstone scenarios are given in Table 2. Both the evapotranspiration and the drainage amounts calculated with SWAP after calibration on these terms are in good agreement with the amounts calculated with MACRO.

Table 2. Water balance for the last year of the simulation period for the Lanna and Brimstone scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Rain (mm)</th>
<th>Evaporation (mm)</th>
<th>Drains (mm)</th>
<th>Percolation (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lanna</td>
<td>SWAP</td>
<td>MACRO</td>
<td>SWAP</td>
<td>MACRO</td>
</tr>
<tr>
<td>Brimstone</td>
<td>535</td>
<td>534</td>
<td>348</td>
<td>348</td>
</tr>
<tr>
<td></td>
<td>623</td>
<td>623</td>
<td>324</td>
<td>337</td>
</tr>
</tbody>
</table>

There is overall good agreement between the temporal patterns of the drainage flux computed with both models (Figure 1). The peaks computed with MACRO are somewhat higher than those computed with SWAP.

The timing of peak events calculated with PEARL corresponded to those computed with MACRO (Figure 2). The order of magnitude of the daily peak concentrations are also in agreement. For further improvement concentrations in drain water may be needed to improve calibration of flow related macropore parameters (Tiktak et al., 2012).

Conclusions

• The new PEARL model with the option for macropore flow is appropriate to assess the fate of plant protection products in soils with preferential flow.
• The first results of testing the new PEARL model on the fate of plant protection products in heavy clay soils are similar to those obtained by MACRO. More testing is needed.

References