Modeling non-point source pollutants in soil: Applications to the leaching and accumulation of pesticides and cadmium
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Maps of independent spatially distributed parameters in the PESTRAS model.

Average maximum concentration of pesticide in the 1-2 m soil layer, using a standard dose of 1 kg ha\(^{-1}\).

Maps of the cadmium content in the topsoil, based on the observations.

Maps of the cadmium content in the topsoil, simulated with the SOACAS model.

Maps of basic soil properties for the 0-20 cm soil layer, derived from the 1:50,000 soil map of the Netherlands (De Vries, 1994a).

Maps showing the contribution of the basic soil properties (a), parameters related to cadmium uptake (b), and the sorption PTF (c) to the total uncertainty.

Results from the uncertainty analysis with the SOACAS model. (a) Simulated Cd contents, (b) Standard deviations obtained with FOUA, (c) Accuracy of the predictions, and (d) Model Capability Index.

95% Confidence intervals of simulated Cd contents and the contribution of different sources to the total uncertainty.
Color plate 1
Maps of independent spatially-distributed parameters in the PESTRAS model

Organic matter content of the upper meter of the soil profile. (g g⁻¹)
- 0.000 - 0.011
- 0.011 - 0.015
- 0.015 - 0.020
- 0.020 - 0.040
- 0.040 - 0.130
- 0.130 - 1.000

Soil texture classes according to the Winand Staring Soil Series.
- loam-poor sand
- loamy sand
- licht sandy clay
- heavy sandy clay
- clay
- loam
- peat
- boulder-clay

Groundwater-depth-class, based on the 1966 classification.
- very shallow
- fairly shallow
- moderately deep
- fairly deep
- deep
- very deep

- < 764
- 764-794
- 794-819
- > 819
Average maximum concentration of pesticide in the 1-2 m soil layer, using a standard dose of 1 kg ha\(^{-1}\).
Color plate 3
Maps of the cadmium content in the topsoil, based on the observations. a) Map of observation sites; b) Map based on the Generalized Additive Model; c) Approximate standard error; and d) 95% confidence interval of the cadmium content as a fraction of the mean.

a) Cadmium content in the topsoil, measured at 2544 point locations. (mg kg⁻¹)
- <0.2
- 0.2-0.3
- 0.3-0.4
- 0.4-0.5
- >0.5

b) Cadmium in the topsoil, obtained by Generalized Additive Modelling. (mg kg⁻¹)
- 0 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- > 0.5
- not relevant

c) Standard error of the mean cadmium content (mg kg⁻¹)
- 0 - 0.025
- 0.025 - 0.050
- 0.050 - 0.100
- 0.100 - 0.150
- > 0.150

d) 95% Confidence intervals as a fraction of the mean. (−)
- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- > 0.4
Color plate 4
Maps of the cadmium content in the topsoil, simulated with the SOACAS model (left), and the model capability index (right hand side; see chapter 3.2; Eqn. 14).

a) Cadmium content before calibration; b) Model capability index before calibration

c) Cadmium content after calibration; d) Model capability index after calibration.

The model is rejected if $ICI > 2$. 

- **a)** Cadmium content in the topsoil simulated with SOACAS before calibration.
- **b)** Model capability index before calibration

- **c)** Cadmium content in the topsoil simulated with SOACAS after calibration.
- **d)** Model capability index after calibration

The model is rejected if $ICI > 2$. 

<table>
<thead>
<tr>
<th>mg kg$^{-1}$</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.2</td>
<td>Green</td>
</tr>
<tr>
<td>0.2 - 0.3</td>
<td>Green</td>
</tr>
<tr>
<td>0.3 - 0.4</td>
<td>Light Green</td>
</tr>
<tr>
<td>0.4 - 0.5</td>
<td>Yellow</td>
</tr>
<tr>
<td>&gt; 0.5</td>
<td>Red</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Index</th>
<th>Color</th>
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<tbody>
<tr>
<td>C &lt; -2</td>
<td>Green</td>
</tr>
<tr>
<td>C &lt; -1</td>
<td>Green</td>
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<tr>
<td>C = 1</td>
<td>White</td>
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<tr>
<td>C &gt; +1</td>
<td>Red</td>
</tr>
<tr>
<td>C &gt; +2</td>
<td>Red</td>
</tr>
</tbody>
</table>
Color plate 5
Maps of basic soil properties for the 0-20 cm soil layer, derived from the 1:50,000 soil map of The Netherlands (De Vries, 1994a). Mapped properties are averages for 500x500 m$^2$ grid cells.

a) Organic matter content
(g $100g^{-1}$)
- 0 - 2.5
- 2.5 - 5.0
- 5.0 - 10.0
- 10.0 - 20.0
- > 20.0

b) Clay content
(g $100g^{-1}$)
- 0 - 2.5
- 2.5 - 5.0
- 5.0 - 10.0
- 10.0 - 20.0
- 20.0 - 30.0
- > 30.0

c) pH$_{KCl}$
(-)
- 0 - 4.0
- 4.0 - 4.5
- 4.5 - 5.0
- 5.0 - 5.5
- 5.5 - 6.0
- > 6.0
Maps showing the contribution of the basic soil properties (a), parameters related to cadmium uptake (b), and the sorption pedo-transfer function (c) to the total uncertainty.

a) Contribution of the basic soil properties to the total uncertainty

b) Contribution of the cadmium uptake parameters to the total uncertainty

c) Contribution of the sorption PTF to the total uncertainty
Color plate 7
Results from the uncertainty analysis with the SOACAS model.
(a) Simulated cadmium content; (b) Standard deviations obtained with First-Order
Uncertainty Analysis; (c) Accuracy of the simulation (i.e. difference between the interpolated
observations and the simulations); and (d) Model capability index (cf. Chapter 4.2; Eqn. 16).

a) Cadmium content in the topsoil
simulated with the SOACAS model.

(b) Standard deviation of the simulated Cd
content obtained by FOUA.

(c) Accuracy of the simulation (difference
between the simulation and observations).

(d) Model capability index, considering the
uncertainty in the model and the observations.
Color plate 8
95% Confidence intervals of simulated cadmium contents and the contribution of different sources to the total uncertainty obtained by Monte Carlo Simulation (MCS; left hand side) and First-Order Uncertainty Analysis (FOUA; right hand side).

**Monte Carlo Simulation**
95% Confidence interval of Cd content (mg kg\(^{-1}\))

**First Order Uncertainty Analysis**
95% Confidence interval of Cd content (mg kg\(^{-1}\))

<table>
<thead>
<tr>
<th>Contribution to total variance (%)</th>
<th>Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>log(K_f)</td>
<td>1</td>
</tr>
<tr>
<td>(f_{bc})</td>
<td>2</td>
</tr>
<tr>
<td>(r_g)</td>
<td>3</td>
</tr>
<tr>
<td>(f_{oc})</td>
<td>4</td>
</tr>
<tr>
<td>Other parameters (dominated by pH)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>7</td>
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