Supplementary Material

1 Variable groundwater table

The exponent c of equations (1)-(2) can be estimated from the water retention curves of each soil starting from the assumption of a linear decreasing soil water potential with depth in the unsaturated zone. By normalizing the unsaturated soil depth in equation (1), the exponent c can be estimated from Figure S1 a). Figure S1 b) shows an example of the estimation of the water table from equation (2) for different values of c.

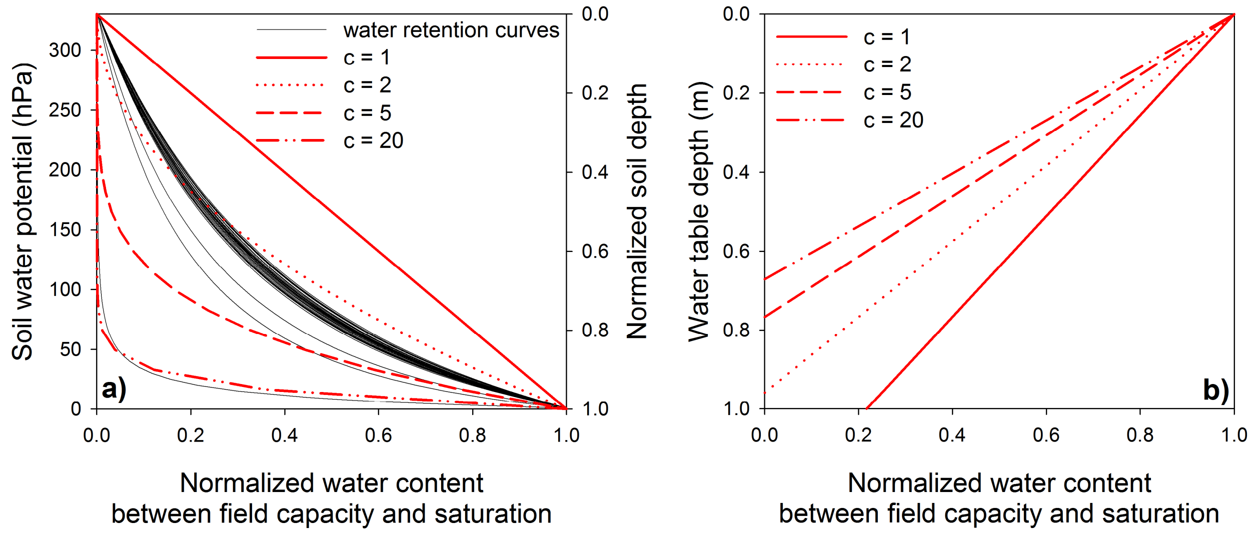

Figure S1: **a)** Water retention curves of all soil in all layers and equation (1) for different values of the exponent c and **b)** example of the impact of the exponent c on the formation and depth of a groundwater table (equation 2).

2 Hydrological parameters

Table S1: Landuse parameter values used in model setup. f_{Macro} is the fraction of laterally connected macropores.

Landuse	I_{max} [2] (mm)	z_{root} (m)	f_{sealed} [1] (-)	C_{crop} [3] (-)	f_{canopy} [5] (-)	n_{Man} (-)	d_{ma} [1] (mm)	n_{Macro} [1] (-)	f_{Macro} [1] (-)
Forest	2.20	1.5[4]	0.00	1.20	0.95	0.400[1]	4.0	200	0.05
Settlement	2.00	0.1[1]	0.50	0.24	0.95	0.100[1]	4.0	0	0.05
Roads	2.00	0.1[1]	0.50	0.12	0.95	0.050[1]	4.0	0	0.05
Quarry, gravel roads	0.00	0.1[1]	0.00	0.84	0.00	0.150[1]	4.0	0	0.05
Intensiv grassland	0.80	0.8[4]	0.00	0.90	0.95	0.200[5]	4.0	200	0.05
Medium intensiv grassland	0.80	0.8[4]	0.00	1.02	0.95	0.200[5]	4.0	200	0.05
Crops	0.74	1.4[4]	0.00	0.96	0.95	0.200[1]	4.0	100	0.05
Maize	0.74	1.2[4]	0.00	0.96	0.95	0.200[1]	4.0	100	0.05
Shrubland	1.10	2.0[1]	0.00	1.20	0.95	0.400[1]	4.0	200	0.05
Extensiv grassland	0.80	0.8[4]	0.00	0.90	0.95	0.200[5]	4.0	200	0.05
Shrubland, Orchard	0.70	3.0[4]	0.00	1.20	0.95	0.300[1]	4.0	200	0.05
Wetland	0.00	0.2[1]	0.00	1.32	0.00	0.100[1]	4.0	200	0.05

[1] estimated, [2] Bremicker (2000), [3] estimated from Allen et al. (1998) and multiplied by a factor of 1.2 for calibration, [4] Breuer et al. (2003), [5] Neitsch et al., (2011)

Table S2: Soil parameter values used in model setup, layer 1.

Soil type	K_{Green} (cm/h)	sucthd (cm)	z_{layer} (m)	θ_{sat} (-)	K_f (cm/h)	n_{Gen}	α_{Gen}	L_{Gen}	c	density (g/cm³)	f_{OC} (%)
Cambisol	0.77	14.32	0.21	0.52	1.55	1.466	0.014	0.50	2.2	1.2	2.0
Dystric Cambisol	0.92	8.89	0.25	0.54	1.85	1.498	0.012	0.50	2.2	1.2	1.2
Calcareous Cambisol	0.66	19.40	0.21	0.52	1.31	1.457	0.013	0.50	2.2	1.2	2.3
Regosol	1.20	13.72	0.21	0.53	2.41	1.457	0.015	0.50	2.2	1.2	1.9
Cambisol-Pseudogley	0.61	14.89	0.19	0.53	1.23	1.466	0.012	0.50	2.2	1.2	2.5
Pseudogley	0.60	20.88	0.20	0.52	1.19	1.450	0.011	0.50	2.2	1.2	2.9
Eutric Gleysol	0.59	19.26	0.20	0.50	1.18	1.440	0.015	0.50	2.2	1.2	1.6
Gleysol	0.64	20.95	0.30	0.52	1.28	1.425	0.014	0.50	2.2	1.2	3.7
Wet Gleysol	0.73	23.26	0.29	0.51	1.47	1.409	0.015	0.50	2.2	1.2	5.9
Gleysol with sandy sublayer	0.64	20.95	0.30	0.52	1.28	1.425	0.014	0.50	2.2	1.2	3.7
Forest deep Cambisol	0.77	14.32	0.21	0.52	1.55	1.470	0.010	0.50	2.2	1.2	2.0

Table S3: Soil parameter values used in model setup, layer 2.

Soil type	z_{layer} (m)	θ_{sat} (-)	K_f (cm/h)	n_{Gen}	α_{Gen}	L_{Gen}	c	density (g/cm³)	f_{OC} (%)
Cambisol	0.51	0.47	0.89	1.439	0.016	0.5	2.5	1.4	0.4
Dystric Cambisol	0.77	0.47	0.59	1.439	0.014	0.5	2.0	1.4	0.0
Calcareous Cambisol	0.28	0.47	0.84	1.428	0.016	0.5	2.5	1.4	1.0
Regosol	0.12	0.50	3.54	1.480	0.026	0.5	3.0	1.4	0.1
Cambisol-Pseudogley	0.25	0.50	0.70	1.427	0.013	0.5	2.0	1.4	0.6
Pseudogley	0.18	0.49	0.54	1.411	0.012	0.5	2.0	1.4	0.6
Eutric Gleysol	0.50	0.47	0.54	1.421	0.014	0.5	2.0	1.4	0.3
Gleysol	0.28	0.48	0.52	1.386	0.014	0.5	2.0	1.4	0.5
Wet Gleysol	0.13	0.47	0.58	1.394	0.013	0.5	2.0	1.4	2.6
Gleysol with sandy sublayer	0.28	0.48	0.52	1.386	0.014	0.5	2.0	1.4	0.5
Forest deep Cambisol	0.51	0.47	0.89	1.439	0.016	0.5	3.0	1.4	0.4

Table S4: Soil parameter values used in model setup, layer 3.

Soil type	z_{layer} (m)	θ_{sat} (-)	K_f (cm/h)	n_{Gen}	α_{Gen}	L_{Gen}	c	density (g/cm³)	f_{OC} (%)
Cambisol	0.42	0.45	0.65	1.438	0.016	0.5	2.5	1.6	0.02
Dystric Cambisol	0.12	0.46	0.40	1.486	0.010	0.5	2.5	1.6	0.00
Calcareous Cambisol	0.35	0.44	0.62	1.416	0.017	0.5	2.5	1.6	0.00
Regosol	0.09	0.41	1.98	1.482	0.039	0.5	4.0	1.6	0.00
Cambisol-Pseudogley	0.61	0.46	0.36	1.379	0.013	0.5	2.0	1.6	0.00
Pseudogley	0.72	0.45	0.29	1.371	0.013	0.5	2.0	1.6	0.00
Eutric Gleysol	0.37	0.41	0.30	1.356	0.015	0.5	2.0	1.6	1.69
Gleysol	0.65	0.42	0.30	1.350	0.015	0.5	2.0	1.6	0.00
Wet Gleysol	0.34	0.42	0.26	1.404	0.012	0.5	2.0	1.6	0.00
Gleysol with sandy sublayer	0.95	0.42	4.84	1.680	0.019	0.5	20.0	1.6	0.00
Forest deep Cambisol	1.28	0.45	0.65	1.438	0.016	0.5	2.5	1.6	0.02

3 Influence of kinetic sorption parameters

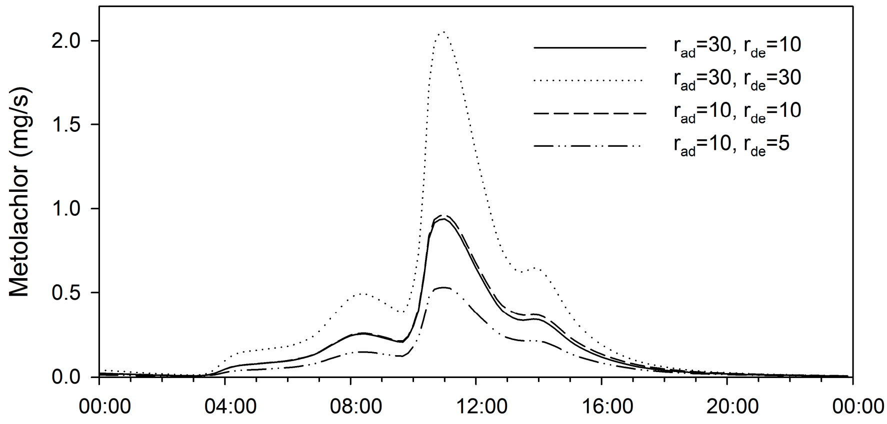

Figure S2: Influence of kinetic sorption parameters for adsorption (r_{ad}) and desorption (r_{de}) on mass fluxes at the 31.05.2000.

4 High resolution modelling results

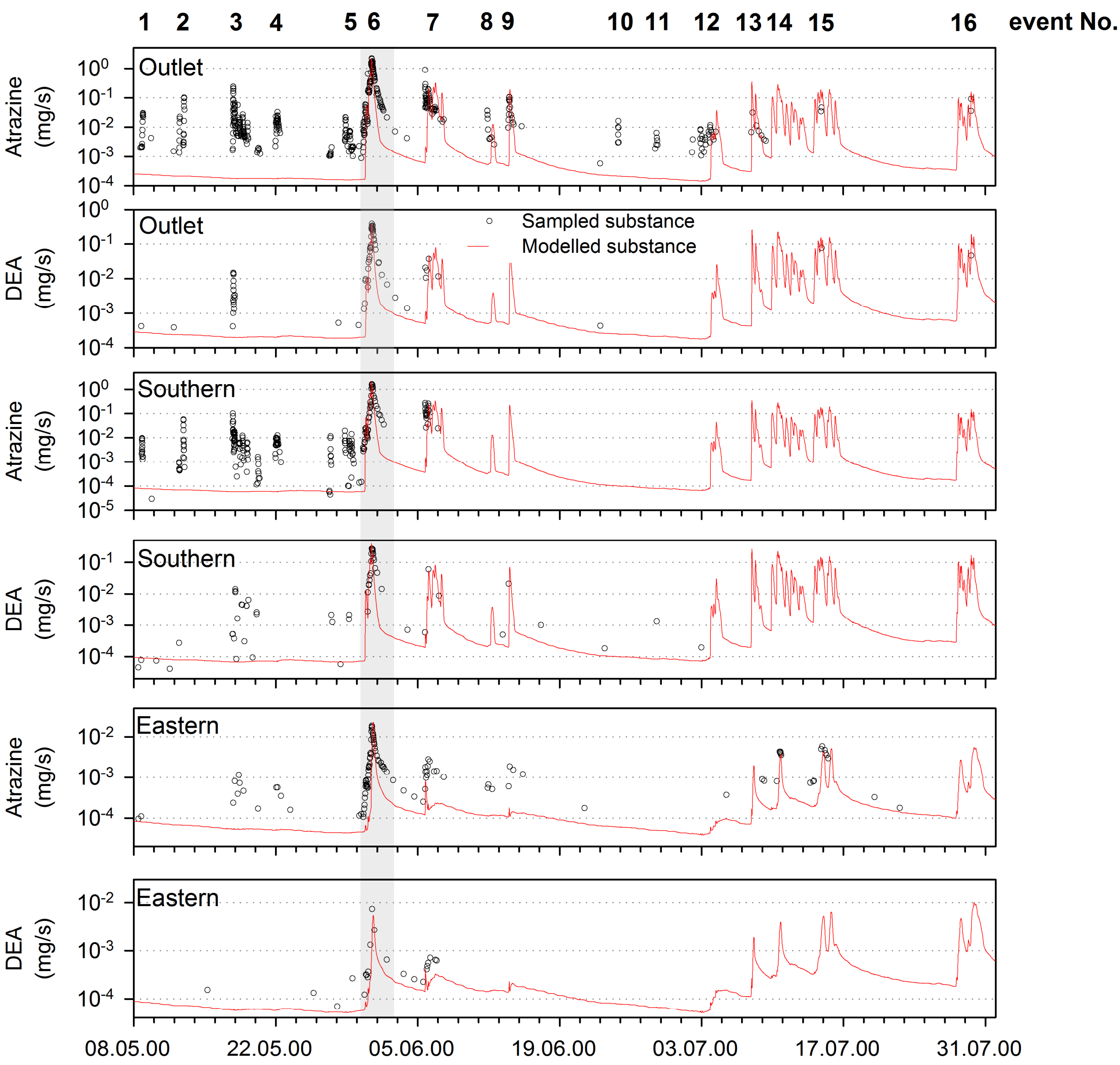

Figure S3: Modelled and observed Atrazine and DEA fluxes at the Ror catchment outlet, the southern subbasin and the eastern subbasin. The main loss event (No. 6) is shaded.

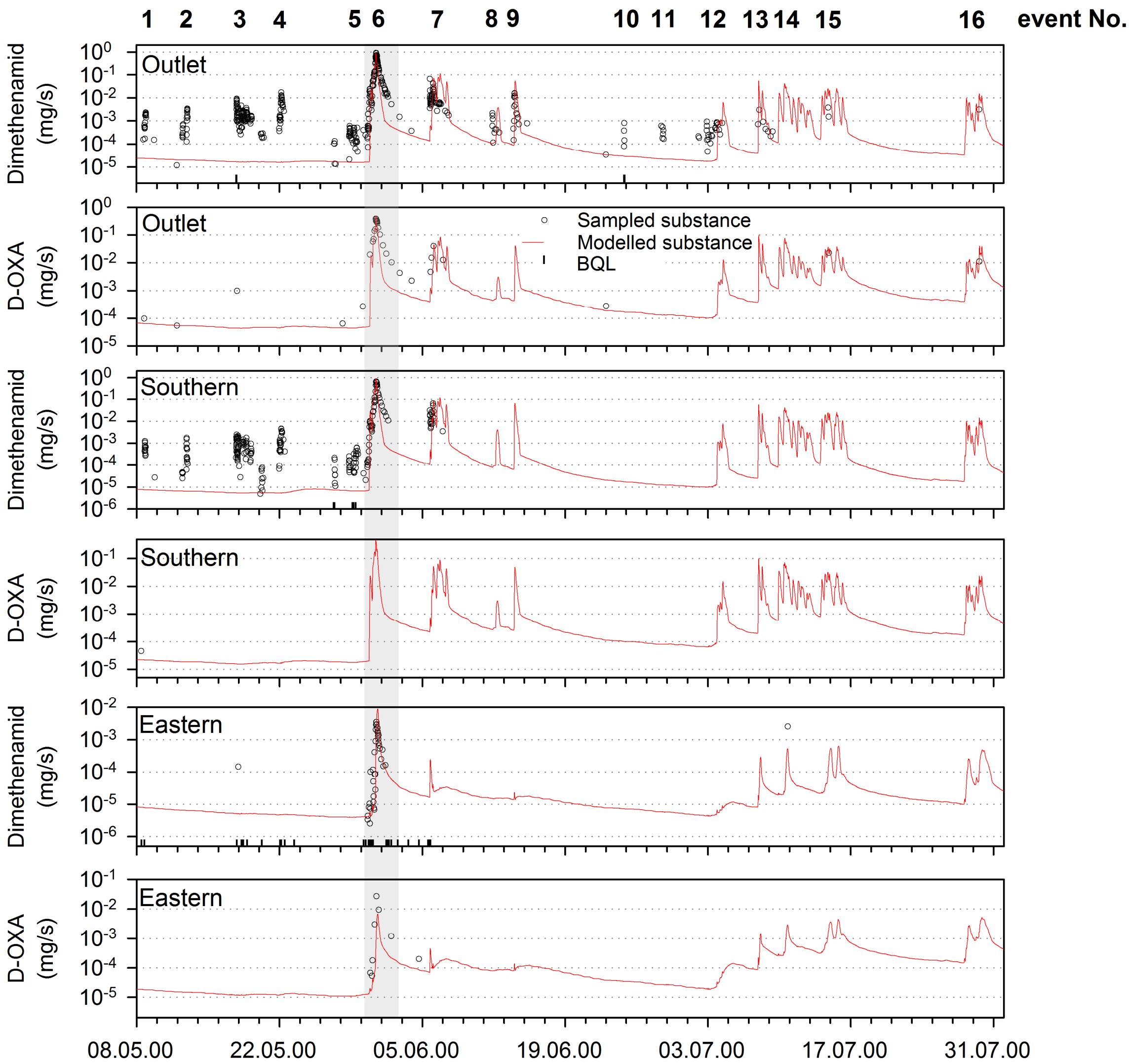

Figure S4: Modelled and observed Dimethenamid and D-OXA fluxes at the Ror catchment outlet, the southern subbasin and the eastern subbasin. The main loss event (No. 6) is shaded.

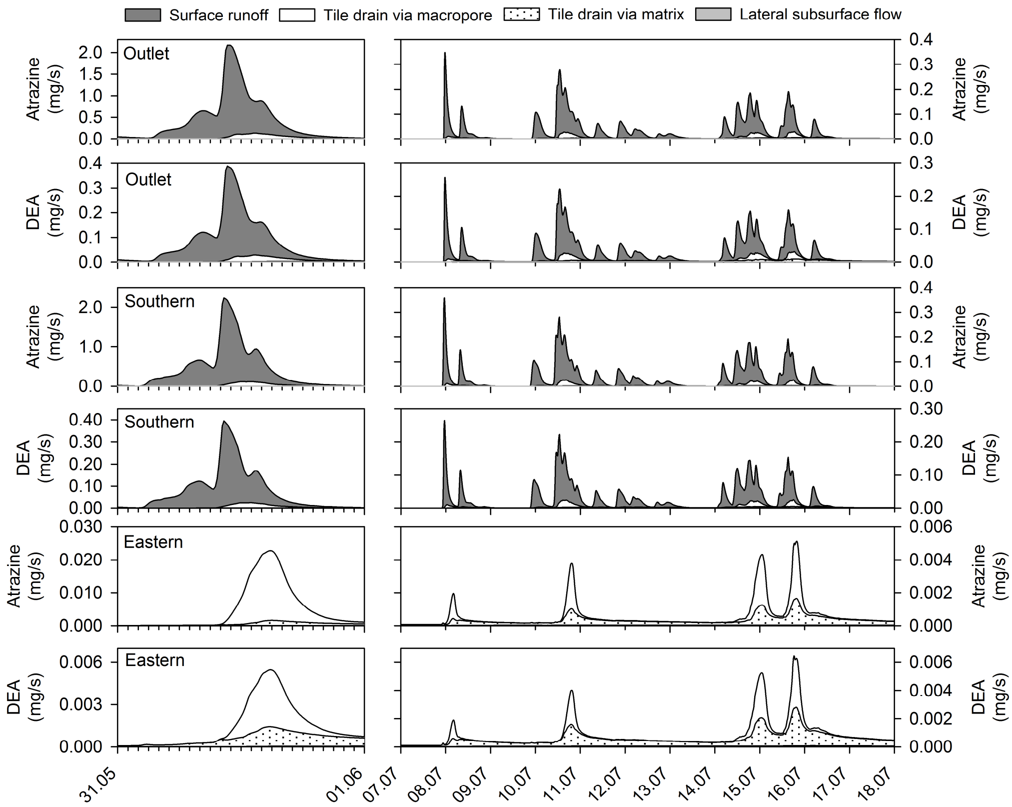

Figure S5: Modelled pathways of Atrazine and DEA fluxes reaching the outlet of the eastern subbasin during the main export event (23 days after application) and 60-71 days after application.

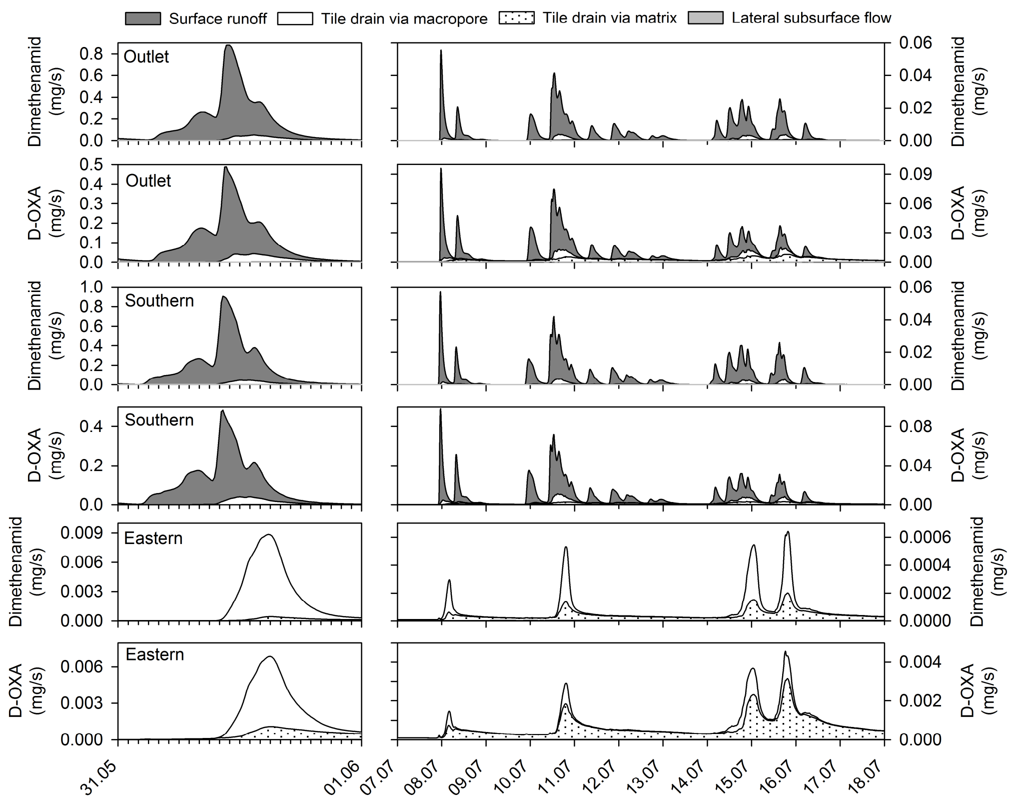

Figure S6: Modelled pathways of Dimethenamid and D-OXA fluxes reaching the outlet of the eastern subbasin during the main export event (23 days after application) and 60-71 days after application.

5 References

Allen, R.G., Pereira, L.S., Raes, D., Smith, M., 1998. Crop Evapotranspiration - Guidelines for computing crop water requirements. FAO, Water Resources, Development and Management Service, Rome, Italy.

Bremicker, M., 2000. Das Wasserhaushaltsmodell LARSIM - Modellgrundlagen und Anwendungsbeispiele. Freiburger Schriften zur Hydrologie 11. Institut für Hydrologie, Freiburg i. Br.

Breuer, L., Eckhardt, K., Frede, H.-G., 2003. Plant parameter values for models in temperate climates. Ecol. Modell. 169 (2-3), 237–293.

Neitsch, S., Arnold, J., Kiniry, J., Williams, J.R., 2011. SWAT2009 Theoretical Documentation. Texas Water Ressources Institute Technical Report No. 406.