
Influence of scenario assumptions on exposure in FOCUS water bodies, as calculated with TOXSWA

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Overview

- Water body types in FOCUS sw scenarios
- TOXSWA 2.0: What is new ?
- Calculation of exposure concentrations
- Scenario assumptions and exposure

Ten FOCUS sw scenarios - step 3

- six Drainage scenarios
 - D1 - D6: 4 ditches, 3 ponds and 4 streams
- four Runoff scenarios
 - R1 - R4: 1 pond and 4 streams
- three possible entry routes of pesticides
 - spray drift deposition
 - drainage
 - surface runoff and erosion

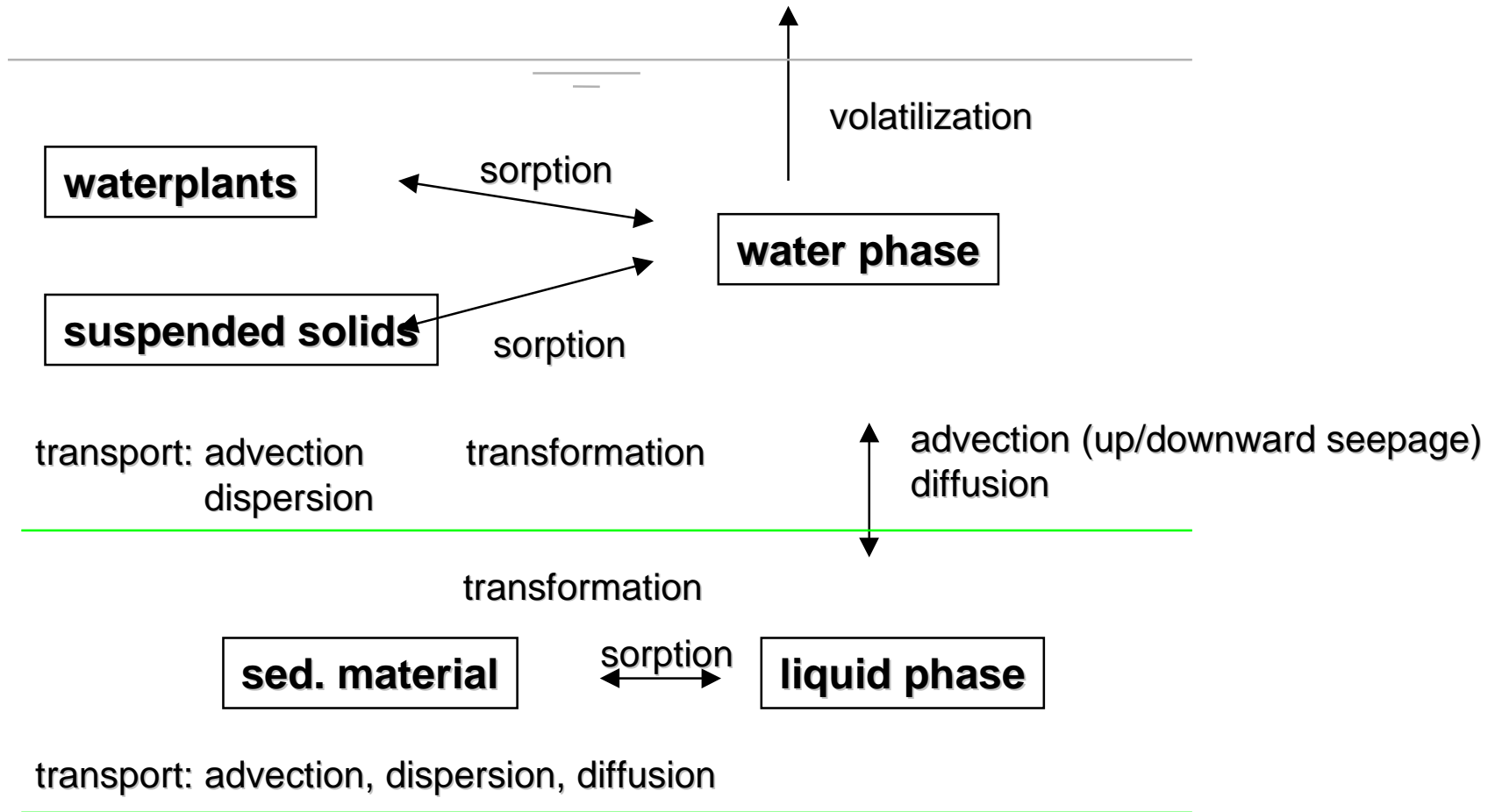
Characteristics of water bodies

- Water bodies, aimed residence time
 - Pond: 30 x 30 m, 1 m deep, $\tau = 50$ d
 - Ditch: 100 x 1 m, 0.3 m deep, $\tau = 5$ d
 - Stream: 1000 x 2 m, >0.3 m deep, $\tau = 0.1$ d
- Sediment: $bd=800$ kg.m⁻³, $por=60$ %, $oc=5$ %
- No macrophytes
- Monthly averaged, scenario-specific temperature

TOXSWA model

- Behaviour of pesticides in small water bodies at edge-of-field scale
- Version 1.2:
 - constant flow and water depth
 - spray drift entry route
 - processes described: sorption, transport, volatilisation and transformation

Processes in water and sediment



TOXSWA model

- Version 2.0:
 - pesticide entries by surface runoff or drainage (so, accompanied by considerable water fluxes)
 - transient hydrology (Q and h function of time - d, h basis)
- Field-scale system forms downstream part of small catchment basin
- Simple water balance for dynamics in water depth and flow

Water balance

- Elemental volume of water layer
- Accumulation = inflow - outflow + lateral inflow - evaporation + precipitation - seepage
- $\partial A / \partial t = (\partial Q / \partial x) + q_{\text{neighb.field}} - E \cdot O_x + N \cdot O_x - S \cdot b$
- $Q = fu(x, t), \quad h = fu(t)$
- Solved with finite diff. method (central explicit):
 $Q_{i+1/2}^j = Q_{i-1/2}^j - \Delta x_i ((A_i^{j+1} - A_i^j) / \Delta t) + \Delta x (q_{\text{neighb.field}} - \dots)$
- So, all terms known, except $h(t) \rightarrow A(t)$

Calculation of water depth, $h(t)$

- $h(t)$, but constant with distance
- Watercourse
 - Representative channel with $Q = Q_{in}$ of FOCUS watercourse
 - either uniform flow depth
 - or depth somewhere in backwatercurve in front of weir
- Pond
 - $Q(h)$ -relation for outflow across a dam/weir

Calculation of discharge, $Q(x,t)$

- $Q_{in} = Q_{base} + rod_r.A_{wc}$
- $Q_{out} = Q_{base} + rod_r.A_{wc} + q_{neighb.field}$
- Upstream catchment, A_{wc} and neighbouring field deliver water (and pesticides) into watercourse
- Behaviour in catchment equals behaviour at individual field

TOXSWA 2.0 model, current status

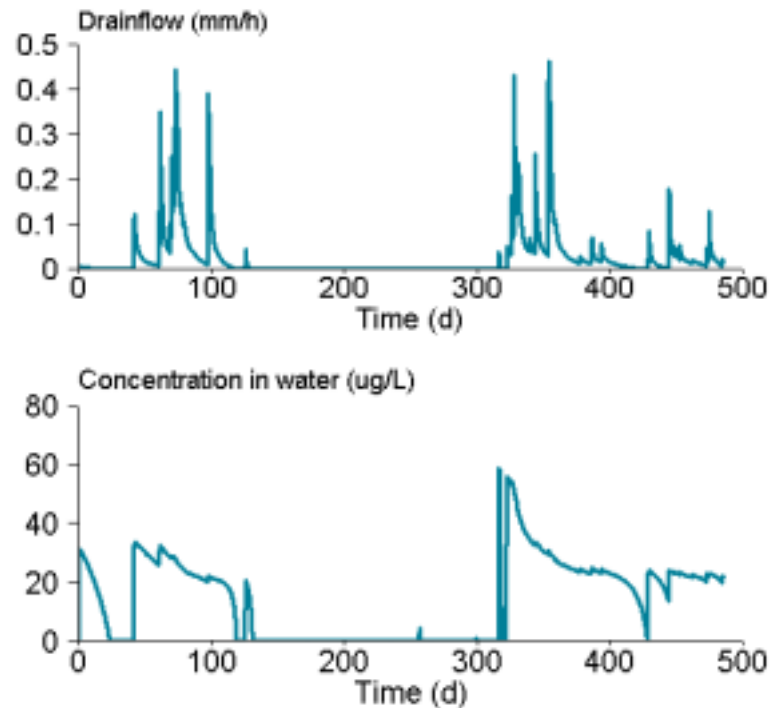
- MS-DOS version, tested to a limited extent
- source 90% finished (run time,output, polishing)
- run time (Pentium III, 666 MHz)
 - pond: 30 s, ditch: 3-6 min, 100 m stream: 1-18 h
- GUI and user manual: to be updated
- Description of hydrology, other new concepts: to be done

Exposure concentration

- At downstream end of stretch receiving loadings
- PEC: acute and (semi-) chronic (21 d)
- Result of two entry routes !

Exposure concentration

Example, Stream, Winter Cereals, Dummy H

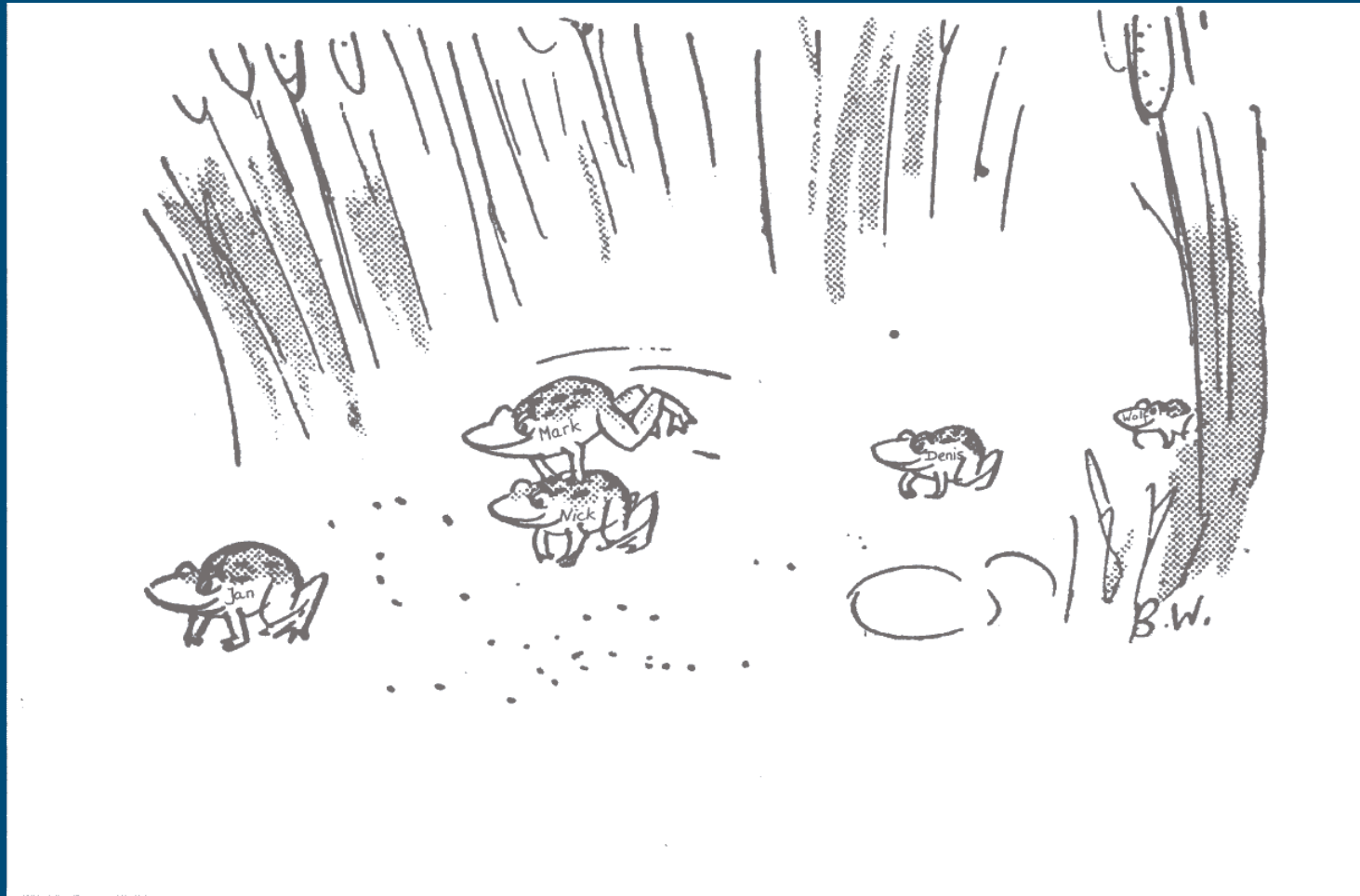


TOXSWIN 3.0.1.1 V09-Jun-2001
Elusioles input version 12-Jun-2001
ALTEERRA, Green World Research

Dir: 1.4 % of 1 kg/ha
Appl.date: 200 d

11/11/2001
10:00

FOCUS sw scenario development



Scenario description

- For a defined pesticide, application pattern and given ro/dr input
- Dummy H:
 - $DT_{50,wat}=100$ d, $DT_{50,sed}=300$ d
(overall $DT_{50} = 136$ d)
 - $DT_{50,soil}=300$ d
 - $K_{oc}=100$ L.kg⁻¹
- Application: 1 kg.ha⁻¹, 1x autumn, every year
(Pond: 5x autumn, 10 d interval)

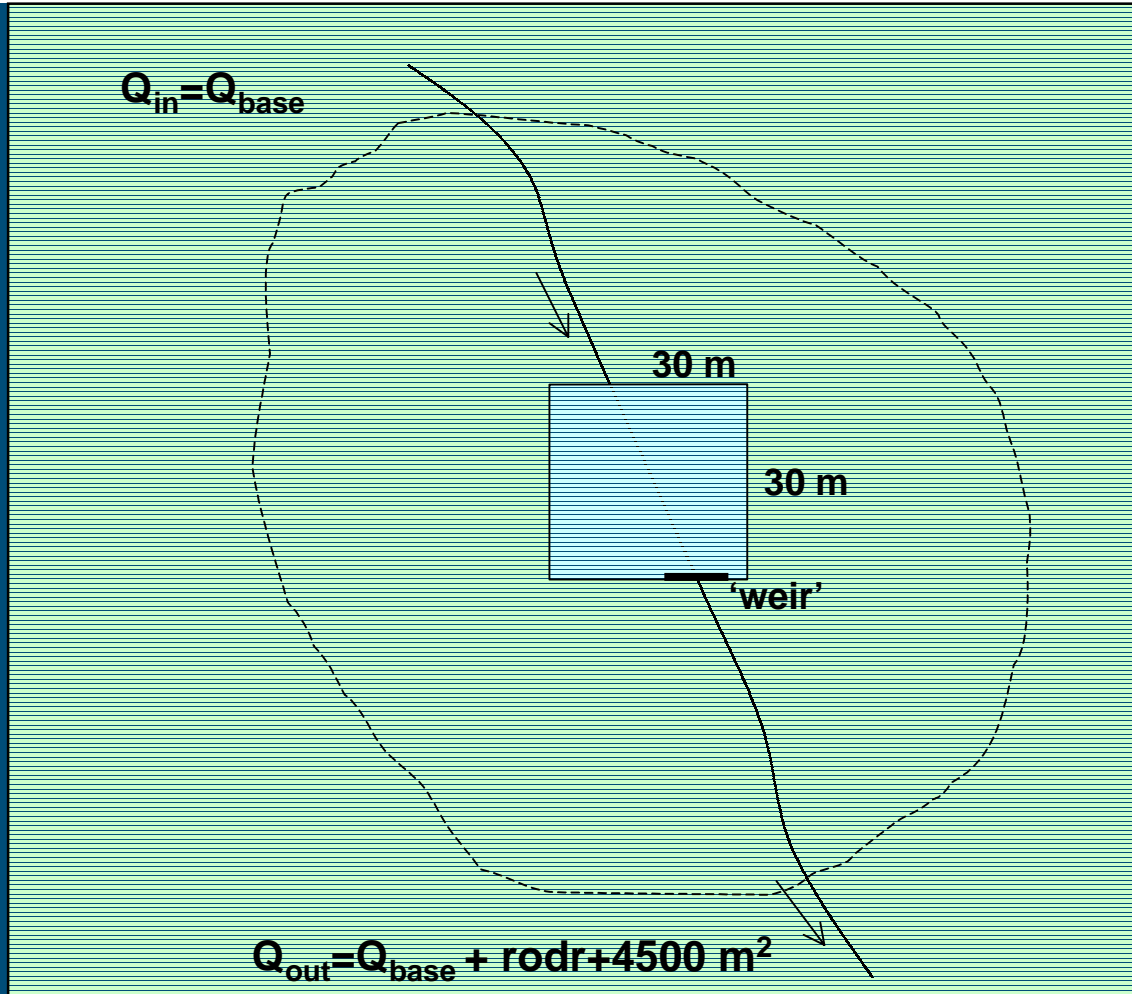
Scenario description (2)

- D6 pond
 - East.Med., heavy loam, warm, mod.prec., gently sloped
 - Drained at 1 m depth, 13.5 m spacing, macropore flow
- D1 ditch
 - Scand., clay, cold, mod.prec., gently sloped
 - Drained at 1 m depth, 8 m spacing, macropore flow

Assumptions - pesticide loadings

- Drainage/runoff+erosion ->MACRO/PRZM (soil type, drainage system, slope, prec.)
- Spray drift deposition:
 - source of data (Ganzelmeier, BBA, NL, Agdrift, nozzle)
 - probability of occurrence
 - distance last row crop - edge water surface
e.g. 2.76 % at 1 m, 0.74 % at 4 m
 - width water surface (integrated log.dep. profile)
e.g. 0.72 % (3.5-4.5 m), 0.22 % (3.5-33.5 m)

Pond



$\pm 1 \text{ m}$ deep

Ideally mixed reservoir
(1 segment)

Pond (2)

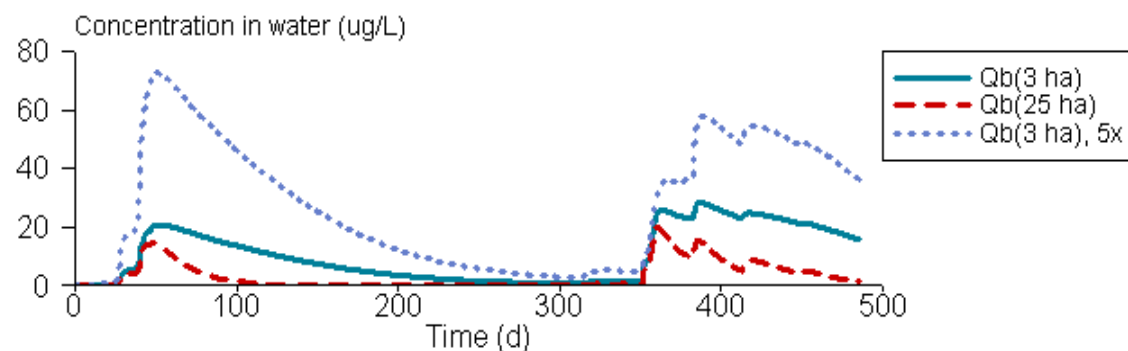
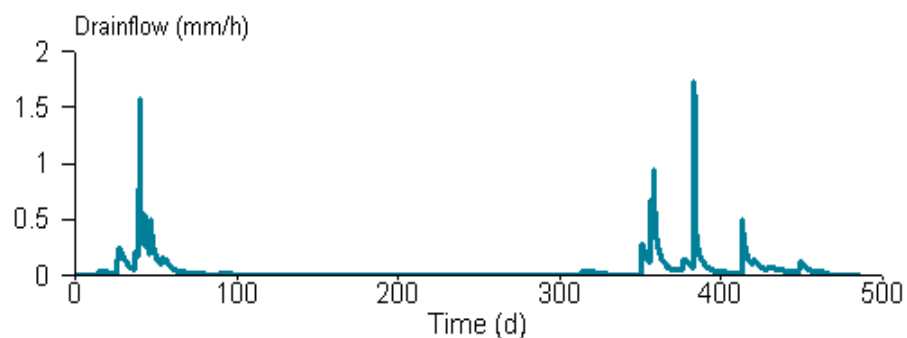
- Exposure depends on:
 - assumed water depth (1->2 m: $PEC_{ac}^{*1/2}$)
 - assumed width water surface (30->10 m: PEC_{ac}^{*3} , spr.drift only !)
 - assumed ratio land:water (5:1-> 10:1: PEC_{ac}^{*2} , drainage loading only !)
 - assumed size baseflow -> monthly, average residence time (d) in pond

Pond: hydrology (4)

	h (m)	Q_{in} (L/s)	τ_{mo} (d)	V_{mo} (m/d)
Q_{base} (3 ha)	1.00 - 1.02	.064 - 2.21	31 - 162	0.2 - 1.0
Q_{base} (25 ha)	1.01 - 1.02	.54 - 2.69	13 - 20	1.5 - 2.3

Pond: 30 m * 30 m (3)

D6, Pond, Winter Cereals, Dummy H



TOXSWA 2.0.1.1 V 6-Jun-2001
Eilmodis Input version 12-Jun-2001
ALTERRA, Green World Research

Drift: 0.22 and 0.19 % of 1 kg/ha
Appl date: 336 d

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Appl date: 336 d

Pond (5)

- Assumptions: Exposure ($\mu\text{g.L}^{-1}$) :
 - $\tau_{\min} = 31$ d
($A_{\text{basefl}} = 3$ ha) - $\text{PEC}_{\text{ac}} = 28$
 $\text{PEC}_{21 \text{ d}} = 27$
 - $\tau_{\min} = 13$ d
($A_{\text{basefl}} = 25$ ha) - $\text{PEC}_{\text{ac}} = 20$
 $\text{PEC}_{21 \text{ d}} = 15$
 - $\tau_{\min} = 31$ d, 5x
($A_{\text{basefl}} = 3$ ha) - $\text{PEC}_{\text{ac}} = 73$
 $\text{PEC}_{21 \text{ d}} = 70$
- $\text{PEC}_{\text{ac}} = 0.14 \mu\text{g.L}^{-1}$ (spray drift only)

Pond: conclusions (6)

- Exposure dominated by drainage entry route (drift dep. negligible)
- PEC_{ac} slightly influenced by (constant) inflow
- PEC_{21d} influenced by size of inflow
- Multiple appl.: piling up of conc. (20->75 $\mu\text{g.L}^{-1}$)

Ditch

– Water:

$$Q_{in} = Q_{base} + A_{wc} * r_{odr}$$

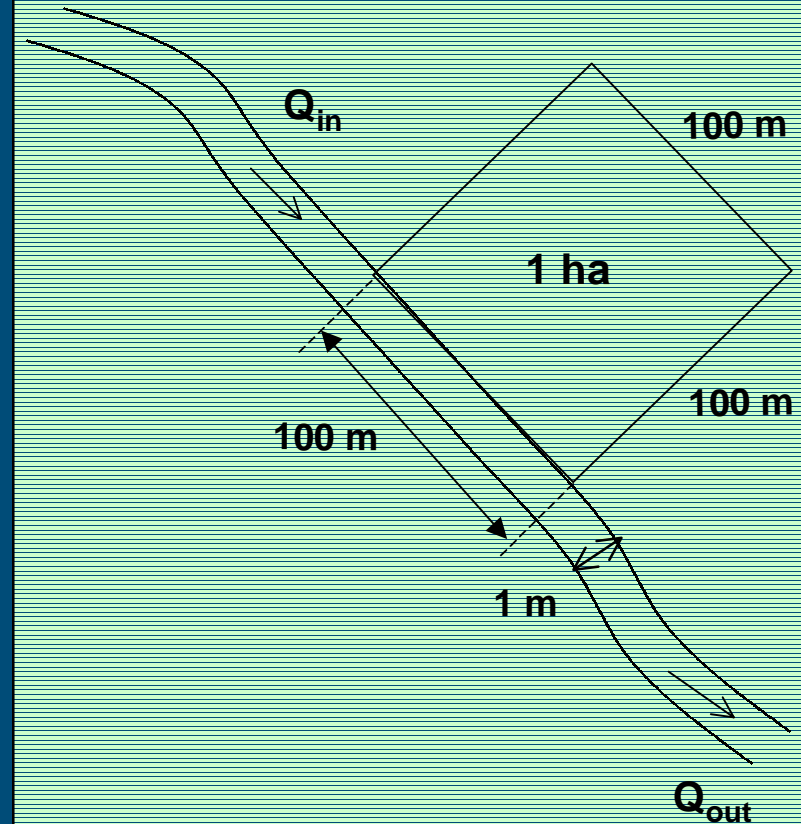
$$Q_{out} = Q_{base} + A_{wc} * r_{odr} + q_{neighb.field}$$

– Pesticide:

* from 1 ha neighbouring field

* from upstream catchment,

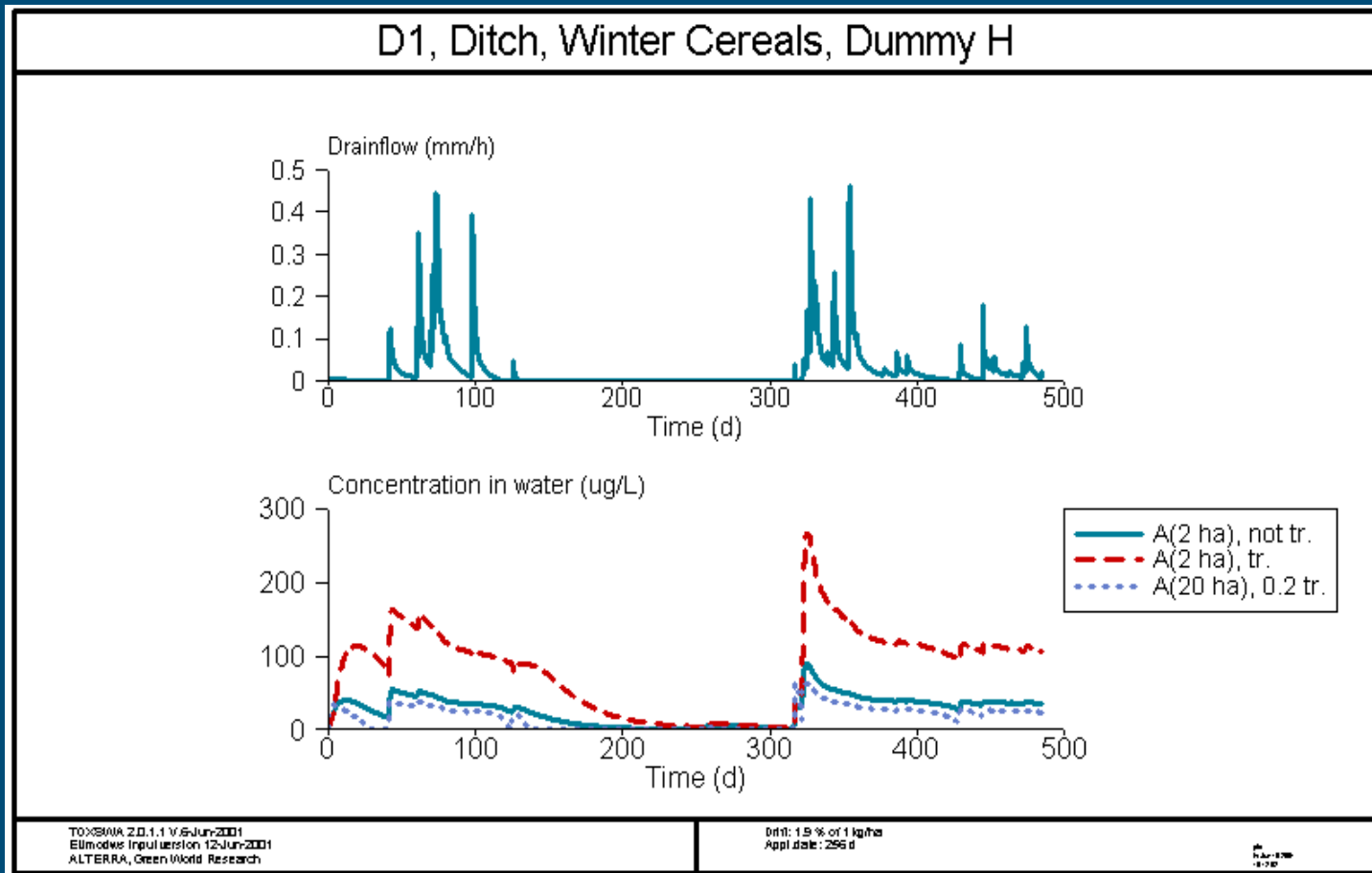
A_{wc} ?



Ditch: hydrology (3)

	h (m)	Q_{in} (L/s)	τ_{mo} (d)	V_{mo} (m/d)
A_{wc} (2 ha)	0.30 - 0.32	.008 - 2.6	.47 - 46	2.2 - 252
A_{wc} (20 ha)	0.30 - 0.45	.008 - 25.8	.064 - 4.6	22 - 1600

Ditch: 100 m * 1 m (2)



Ditch (4)

- Assumptions:
 - $A_{wc} = 2$ ha, not treated
 - $A_{wc} = 2$ ha, treated
 - $A_{wc} = 20$ ha, 20% treated
- Exposure ($\mu\text{g.L}^{-1}$):
 - $\text{PEC}_{ac} = 89$
 $\text{PEC}_{21d} = 69$
 - $\text{PEC}_{ac} = 266$
 $\text{PEC}_{21d} = 207$
 - $\text{PEC}_{ac} = 66$
 $\text{PEC}_{21d} = 52$
- $\text{PEC}_{ac} = 6 \mu\text{g.L}^{-1}$ (spray drift only)

Ditch: conclusions (5)

- Exposure dominated by drainage entry route
- Assumptions on treatment in catchment determine exposure:
 - A_{WC} of 2 ha treated: $PEC_{ac, 2 \text{ ha not tr.}} * 3$
 - A_{WC} of 20 ha, 20 % treated: $PEC_{ac, 2 \text{ ha not tr.}} * 0.7$
- Dynamics in water depth and flow hardly influence PEC

Stream

– Water:

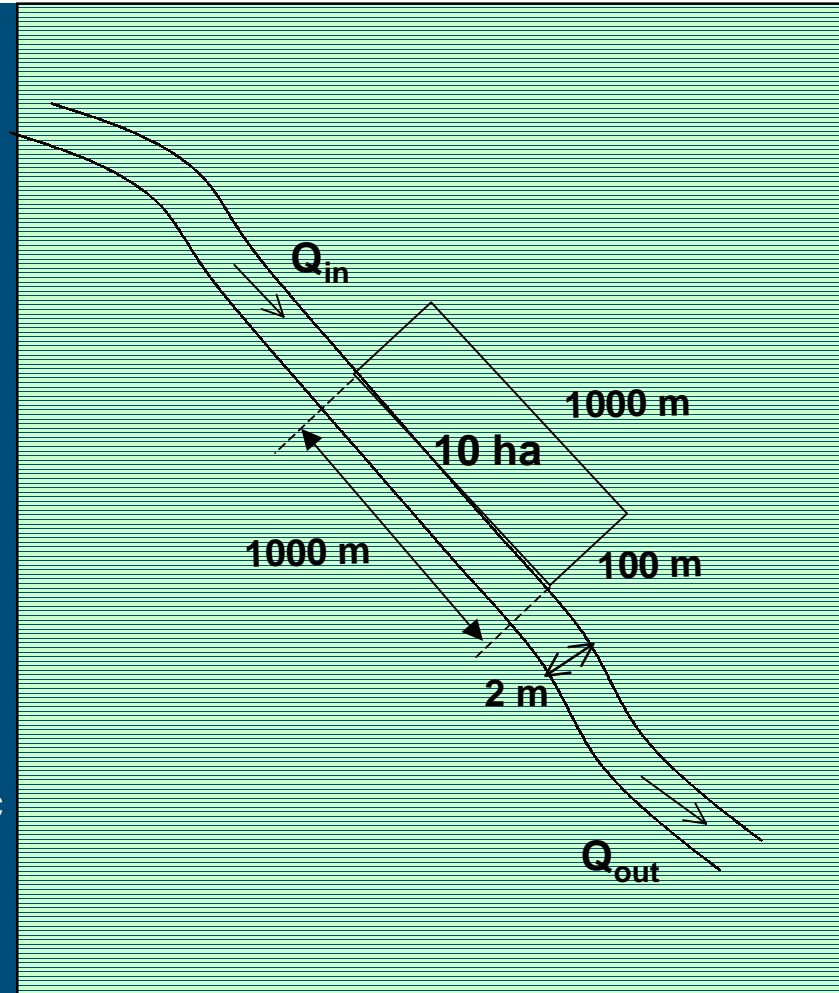
$$Q_{in} = Q_{base} + A_{wc} * r_{odr}$$

$$Q_{out} = Q_{base} + A_{wc} * r_{odr} + q_{neighb.field}$$

– Pesticide:

* from 10 ha neighbouring field

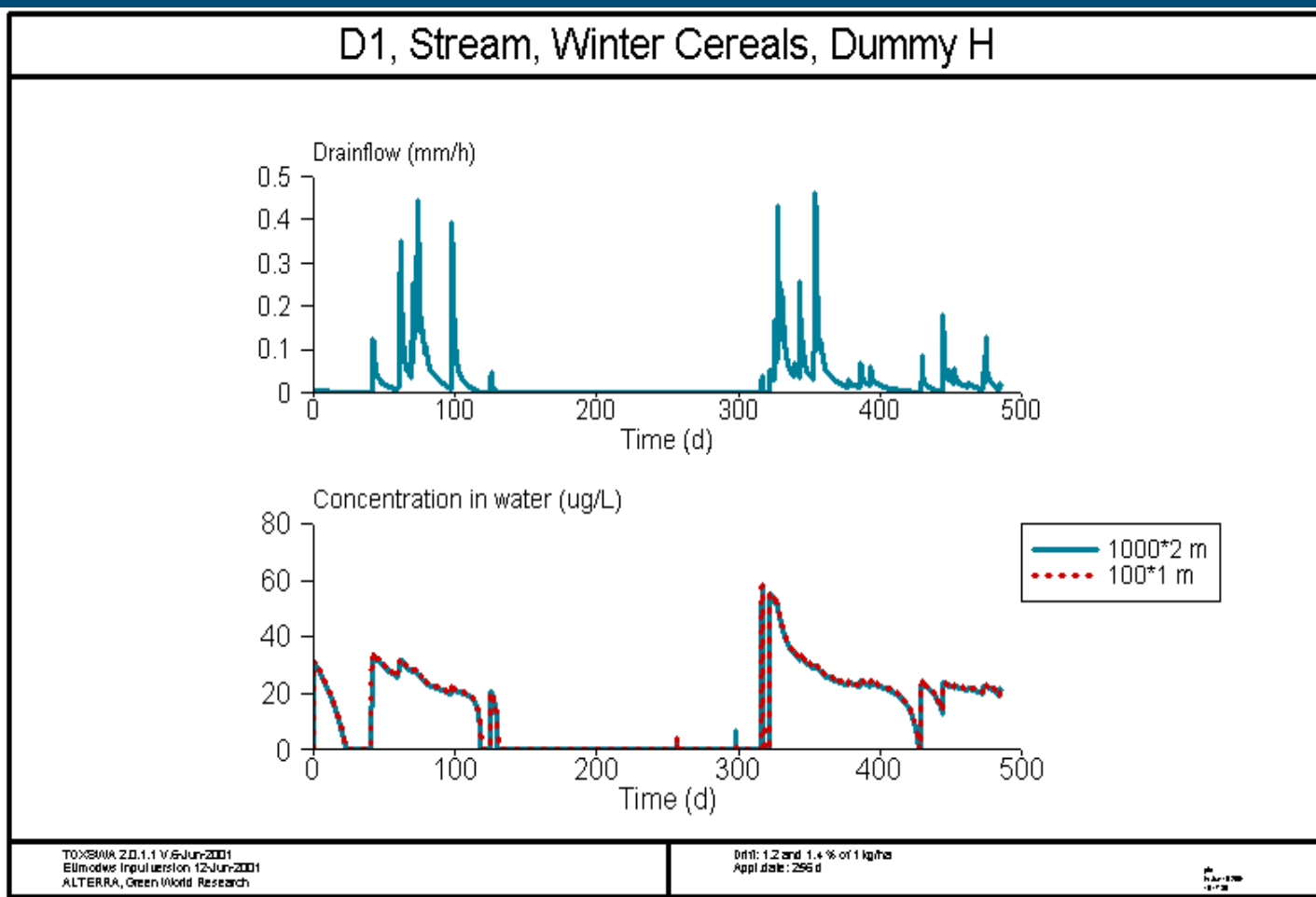
* from upstream catchment, A_{wc}



Stream: hydrology (3)

	h (m)	Q_{in} (L/s)	τ_{mo} (d)	V_{mo} (m/d)
A_{wc} 5000 ha	.35 - 3.56	19.1 - 646	.0024 - .042	2390 - 41400
A_{wc} 100 ha	.31 - .82	.38 - 130	.017 - .93	108 - 5800

Stream: 1000*2 m and 100*1 m (2)



Stream (4)

- Assumptions:

- $A_{wc} = 5000$ ha, 20% treated
1000 m * 2 m
- $A_{wc} = 100$ ha, 20% treated
100 m * 1 m

- Exposure ($\mu\text{g.L}^{-1}$):

- $PEC_{ac} = 58$
 $PEC_{21d} = 44$
- $PEC_{ac} = 59$
 $PEC_{21d} = 43$

- $PEC_{ac} = 4 \mu\text{g.L}^{-1}$ (spray drift only)

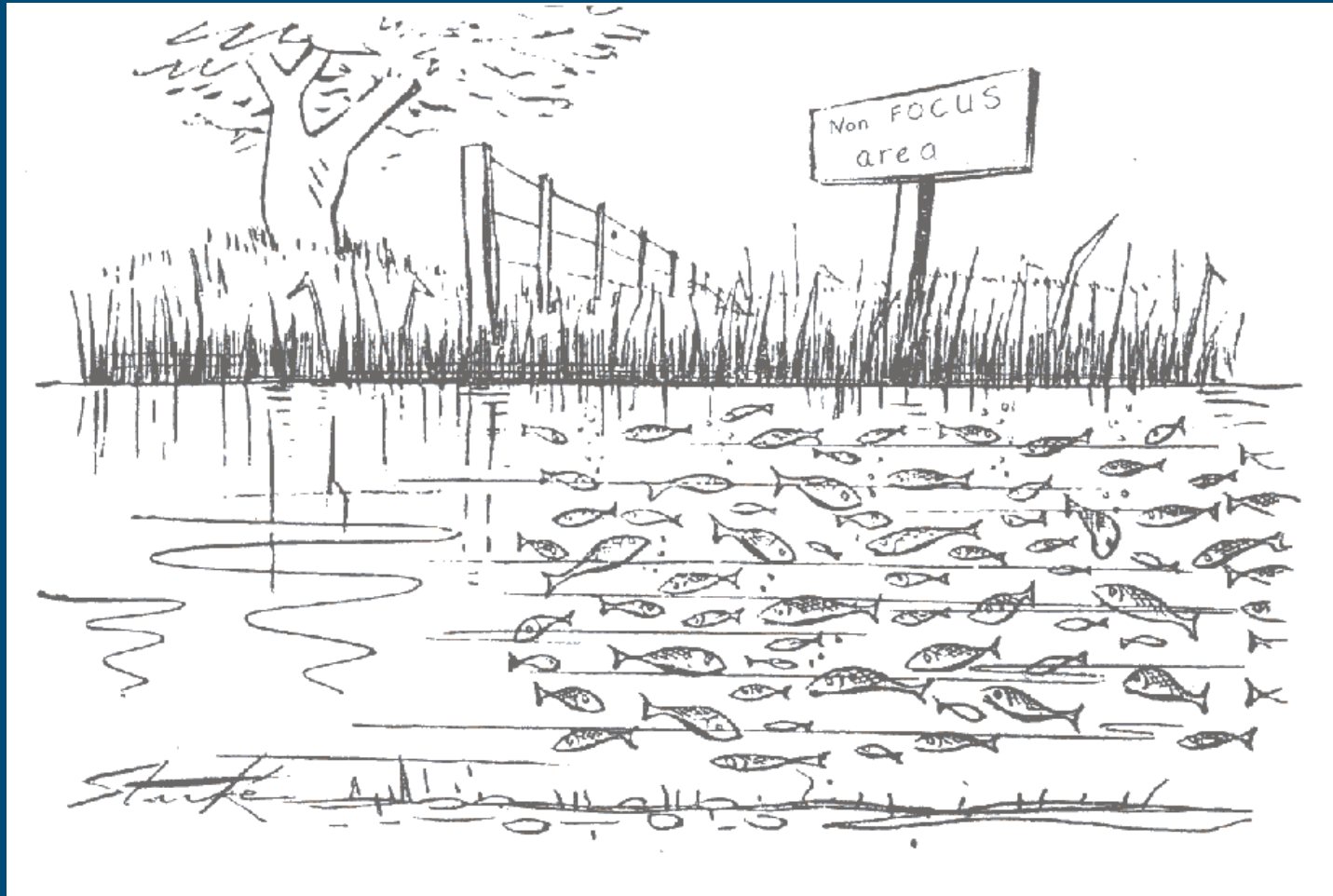
Stream: conclusions (5)

- Exposure dominated by drainage entry route
- Assumptions on treatment in catchment determine exposure:
- Dynamics in water depth and flow do not influence PEC

Overall conclusions (Dummy H)

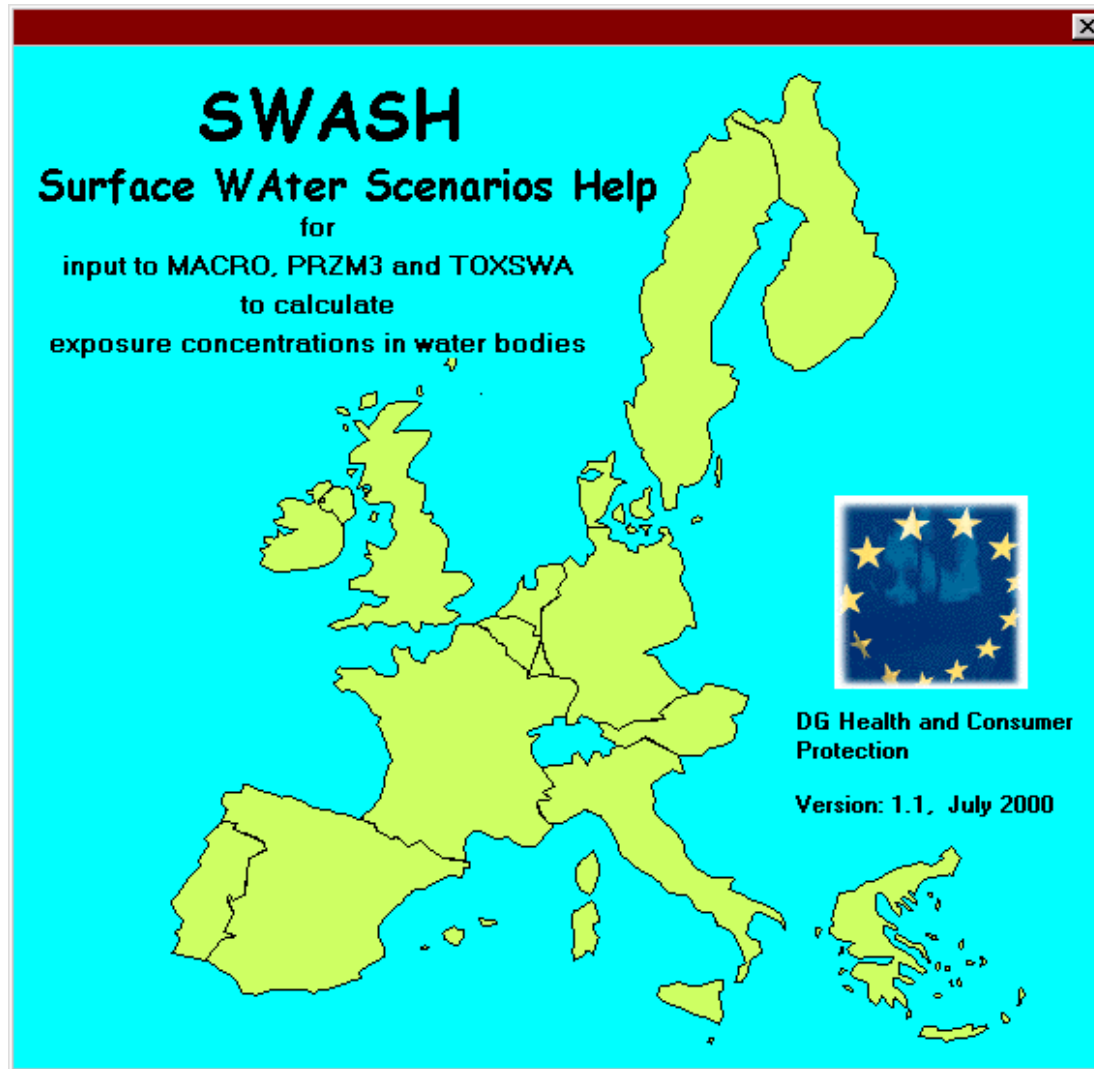
- Exposure dominated by drainage entry route (not drift), so, assumptions on nature catchment and treatment % dominate exposure
- Multiple appl.: tendency to pile up ($f_u(\text{prop.}, \text{rain})$, not flow dyn.)
- Pond: PEC_{ac} hardly influenced by Q_{in} , PEC_{21d} is
- Ditch and stream: PEC hardly or not influenced by dynamics in Q and h

Science <-> group judgement


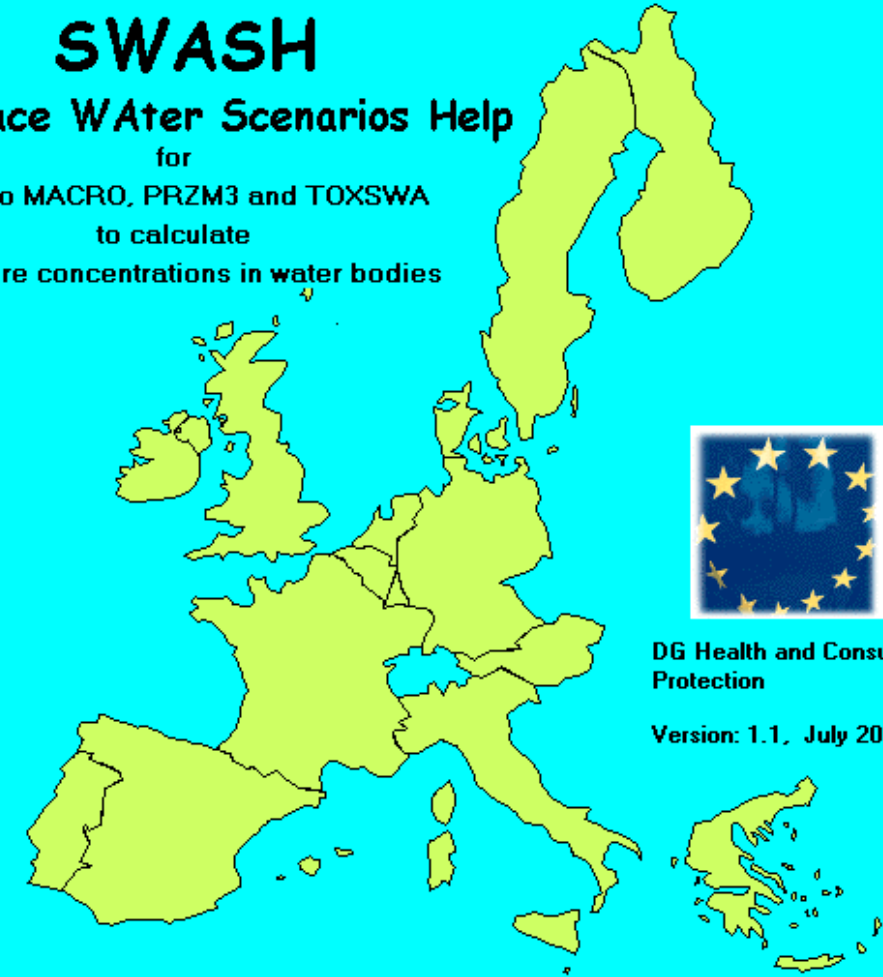


Title

SWASH



SWASH
Surface Water Scenarios Help
for
input to MACRO, PRZM3 and TOXSWA
to calculate
exposure concentrations in water bodies



DG Health and Consumer Protection
Version: 1.1, July 2000

The image shows a software splash screen for SWASH. It features a light blue background with a map of Europe in the center. The text is arranged in a blocky, sans-serif font. The title 'SWASH' is at the top, followed by the subtitle 'Surface Water Scenarios Help'. Below this, it states 'for input to MACRO, PRZM3 and TOXSWA to calculate exposure concentrations in water bodies'. To the right of the map is the European Union flag, and below it, the text 'DG Health and Consumer Protection' and 'Version: 1.1, July 2000'. The entire splash screen is framed by a dark red border with a small 'x' icon in the top right corner.

SWASH - Surface Water Scenarios Help

- Objectives:
 - Help user to define and run correct scenarios (i.e. combinations of crop, EU region, entry routes, waterbody)
 - Maintain a central database with pesticide properties and application pattern
 - Run the drift calculator