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

Paulien Adriaanse, Alterra, NL

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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, τ = 50 d
  - Ditch: 100 x 1 m, 0.3 m deep, τ = 5 d
  - Stream: 1000 x 2 m, >0.3 m deep, τ = 0.1 d

- Sediment: bd=800 $kg.m^{-3}$, por=60 %, oc=5 %
- No macrophytes
- Monthly averaged, scenario-specific temperature

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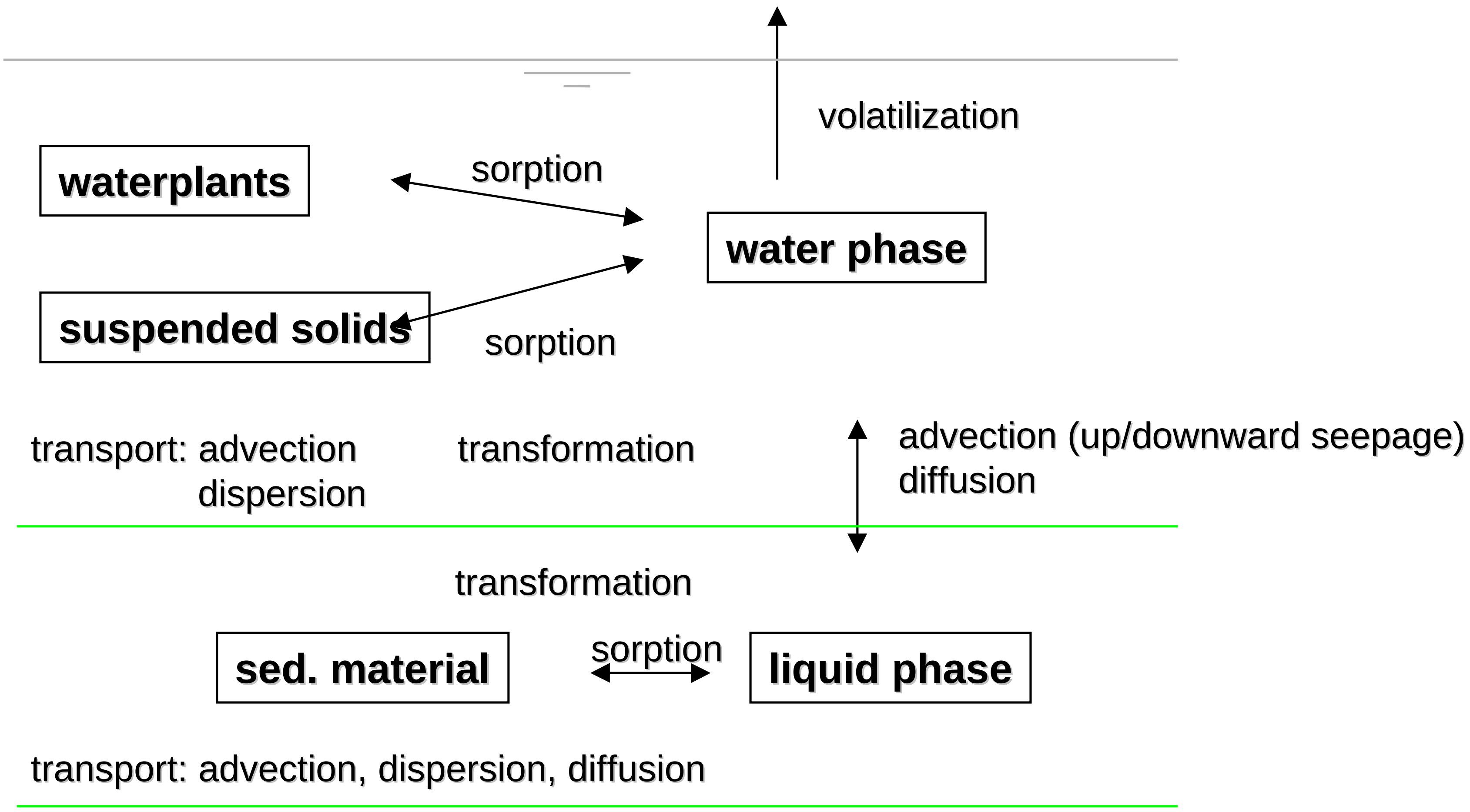
TOXSWA model

- 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
- $\partial A/\partial t = (\partial Q/\partial x) + q_{neighb.field} - E.O_x + N.O_x - S.b$

- $Q = fu(x, t)$, $h = fu(t)$
- Solved with finite diff. method (central explicit): $Q^j_{i+½} = Q^j_{i-½} - \Delta x_i ((A_i^{j+1} - A_i^j)/\Delta t) + \Delta x (q_{neighb.field} - \ldots.)$
- So, all terms known, except h(t) → A(t)

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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)

- $Q_{in} = Q_{base} + rodr.A_{wc}$
- $Q_{out} = Q_{base} + rodr.A_{wc} + q_{neighb.field}$

- Upstream catchment, A_{wc} and neighbouring field deliver water (and pesticides) into watercourse

- Behaviour in catchment equals
  behaviour at individual field

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TOXSWA 2.0 model, current status

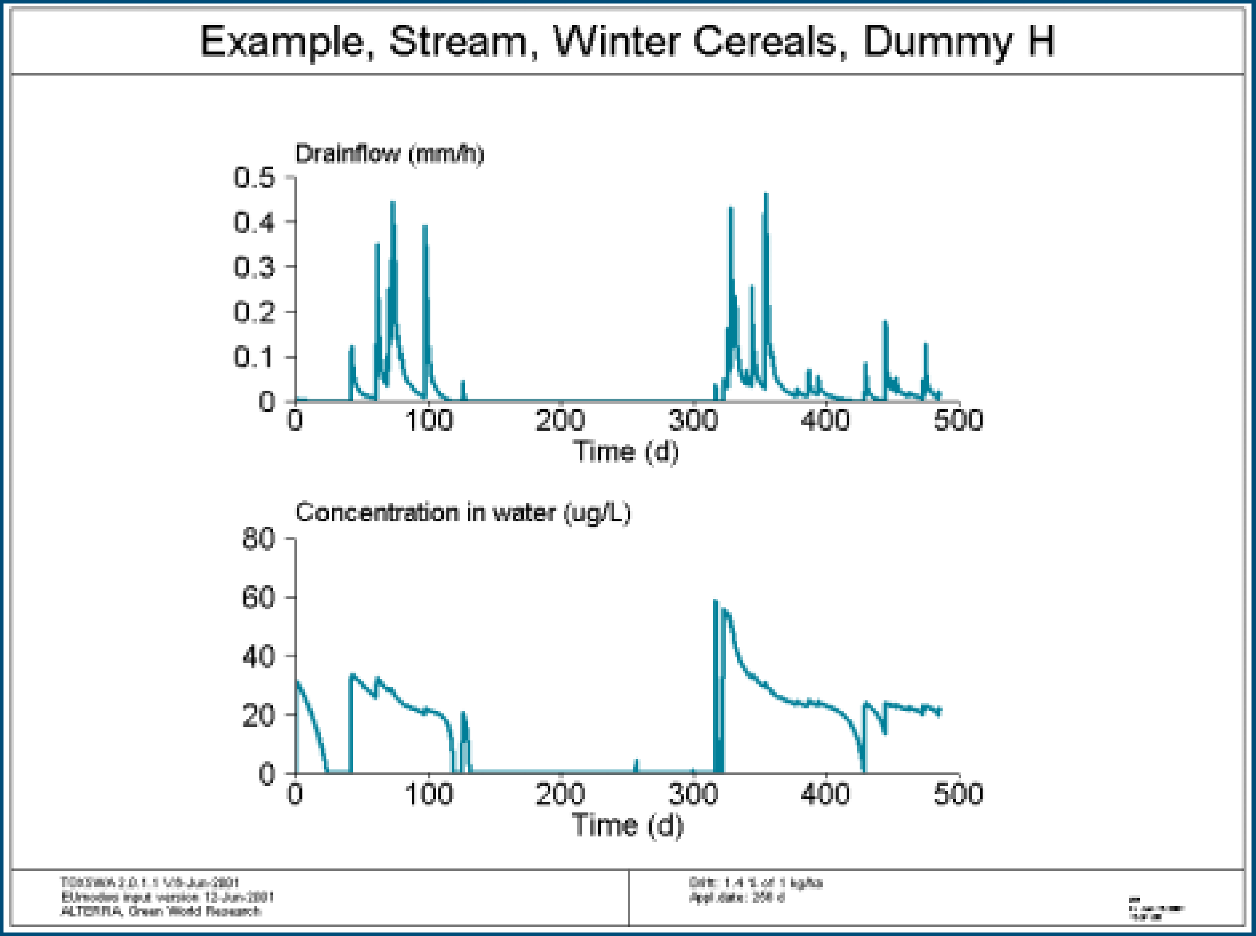
- MS-DOS version, tested to a limited extent
- source 90% finished (run time,output, polishing)
- run time (Pentium III, 666 MHz)
  - pond: 30 s, ditch: 3-6 min, 100 m stream: 1-18 h

- 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



FOCUS sw scenario development

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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)

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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)

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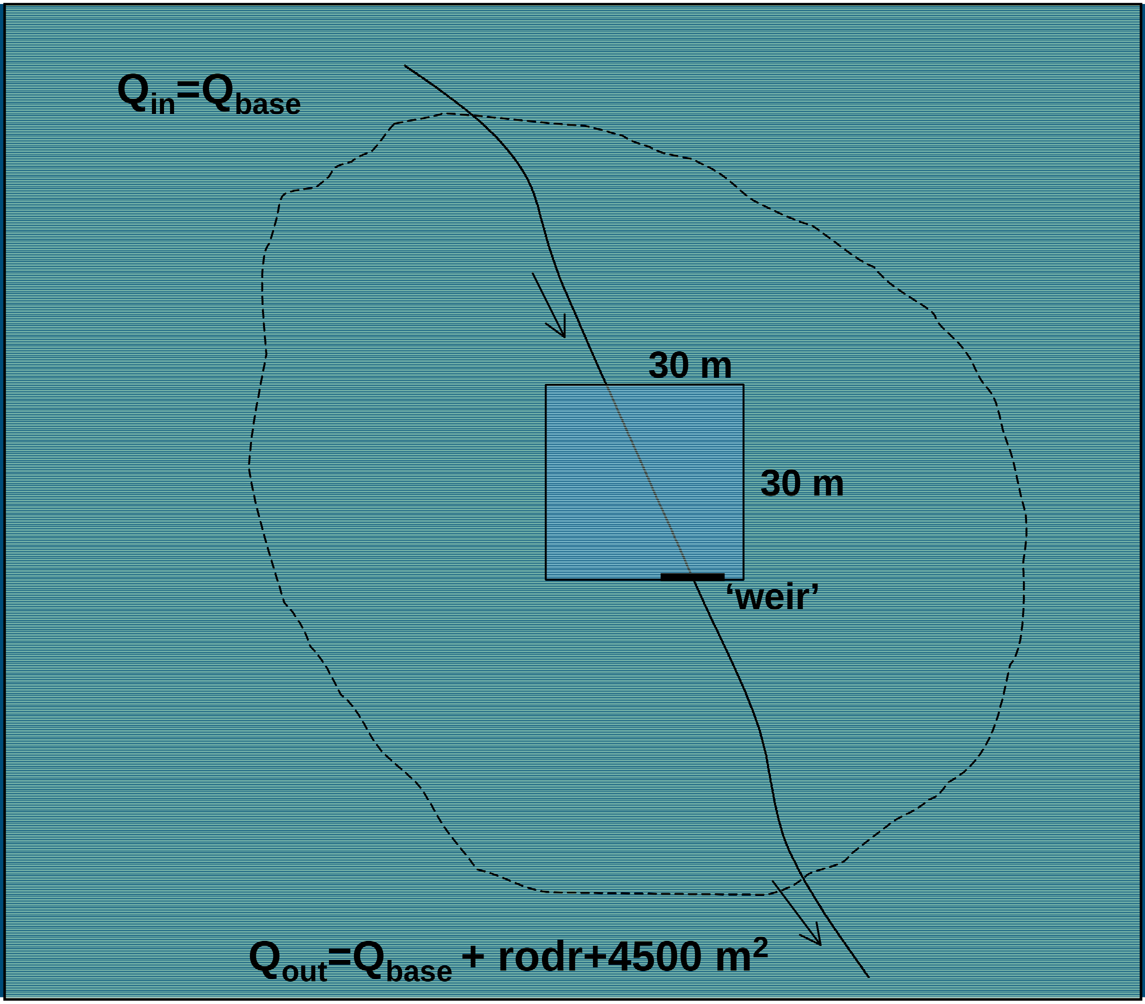
Pond



± 1 m deep

Ideally mixed reservoir (1 segment)

Pond (2)

- Exposure depends on:
  - assumed water depth (1->2 m: PEC_{ac} *½)
  - 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

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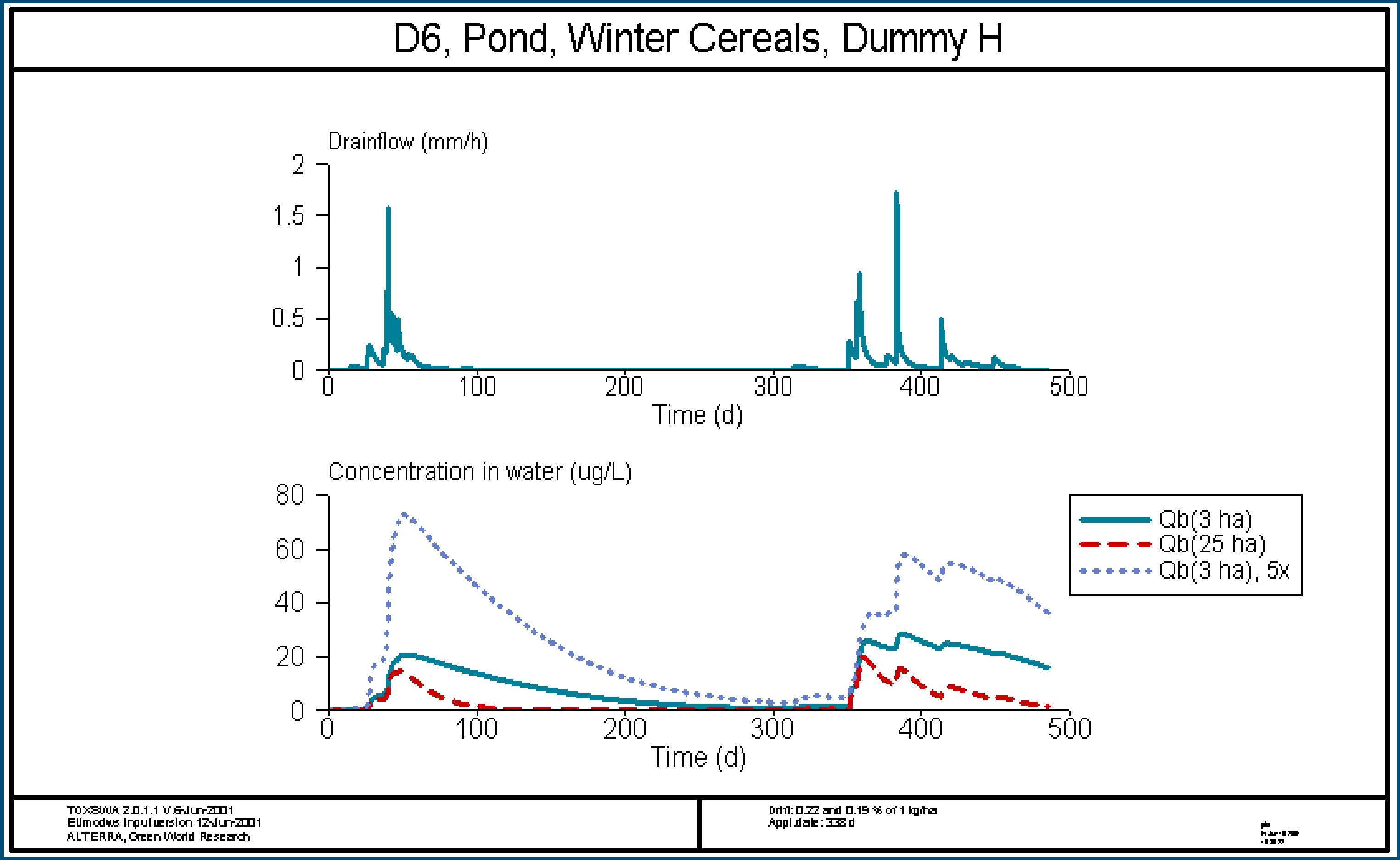
Pond: 30 m * 30 m (3)



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Pond (5)

- Assumptions:
  - τ_{min} = 31 d (A_{basefl} = 3 ha)
  - τ_{min} = 13 d (A_{basefl} = 25 ha)
  - τ_{min} = 31 d, 5x (A_{basefl} = 3 ha)

  Exposure (ug.L^{-1}) :
  - PEC_{ac} = 28, $PEC_{21\,d}$ = 27
  - PEC_{ac} = 20, $PEC_{21\,d}$ = 15
  - PEC_{ac} = 73, $PEC_{21\,d}$ = 70

- PEC_{ac} = 0.14 ug.L^{-1} (spray drift only)

Pond: conclusions (6)

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

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Ditch

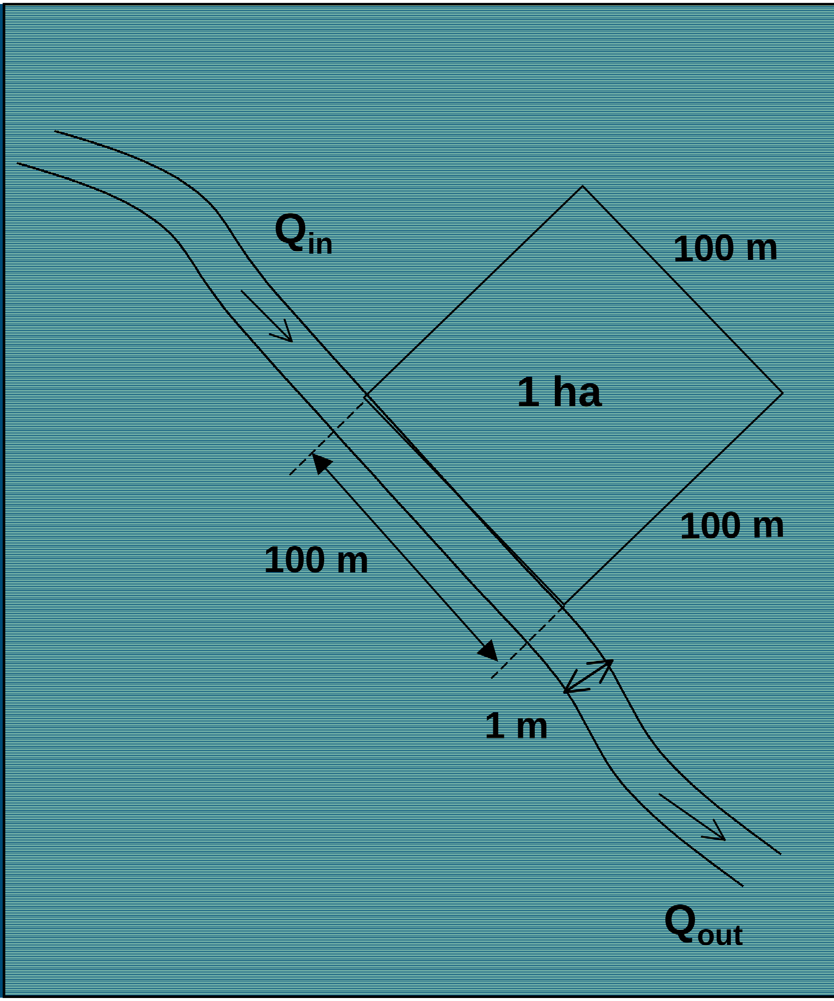
– Water:

$Q_{in} = Q_{base} + A_{wc} * rodr$

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

– Pesticide:

* from 1 ha neighbouring field
* from upstream catchment, A_{wc} ?



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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

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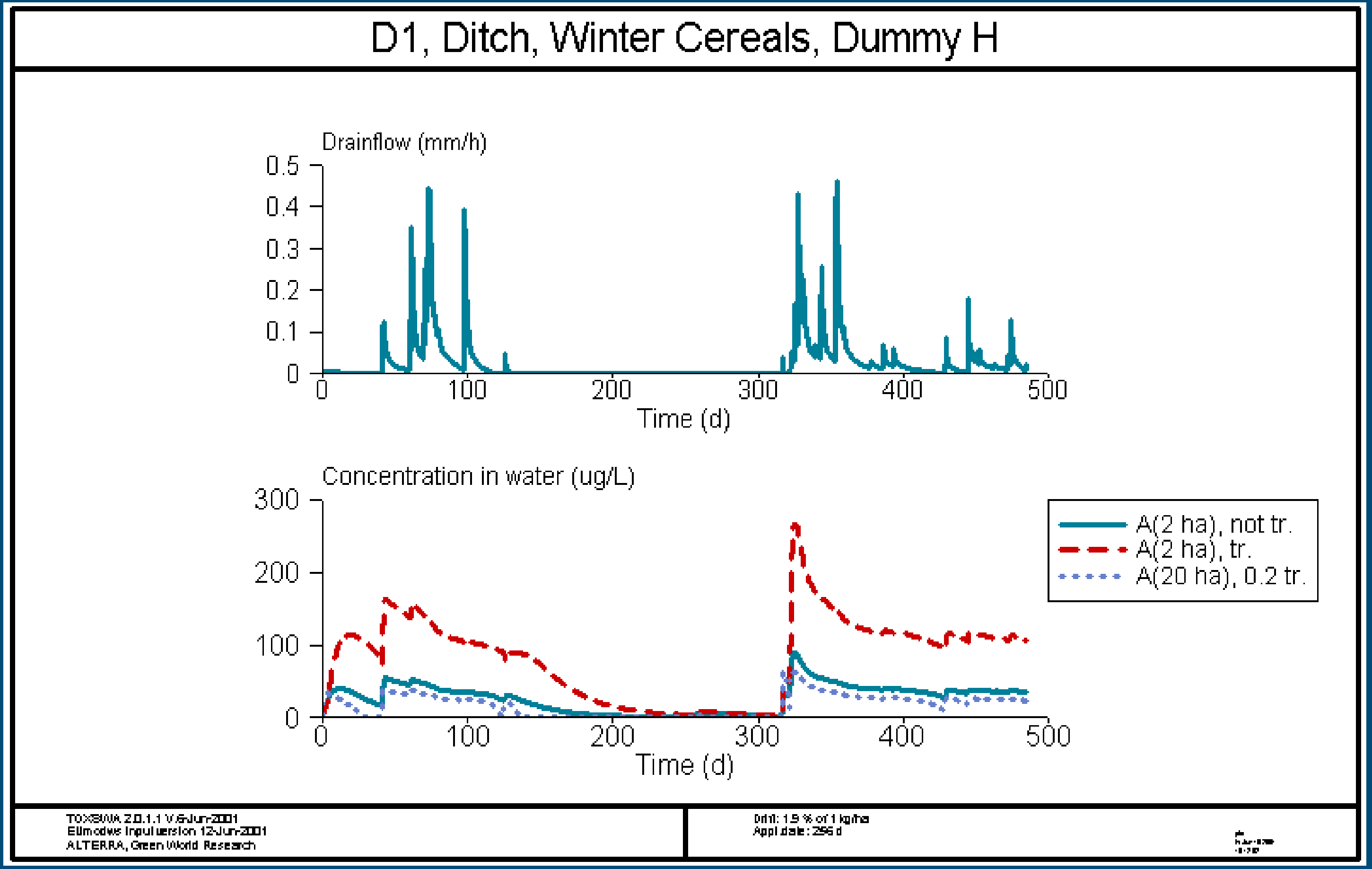
Ditch: 100 m * 1 m (2)



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Ditch (4)

- Assumptions:
  - A_{wc}= 2 ha, not treated
  - A_{wc}= 2 ha, treated
  - A_{wc}= 20 ha, 20% treated

Exposure ($ug.L^{-1}$):
- PEC_{ac} = 89
  $PEC_{21\,d}$ = 69
- PEC_{ac} = 266
  $PEC_{21\,d}$ = 207
- PEC_{ac} = 66
  $PEC_{21\,d}$ = 52

- PEC_{ac} = 6 $ug.L^{-1}$ (spray drift only)

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Ditch: conclusions (5)

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

Stream

– Water:

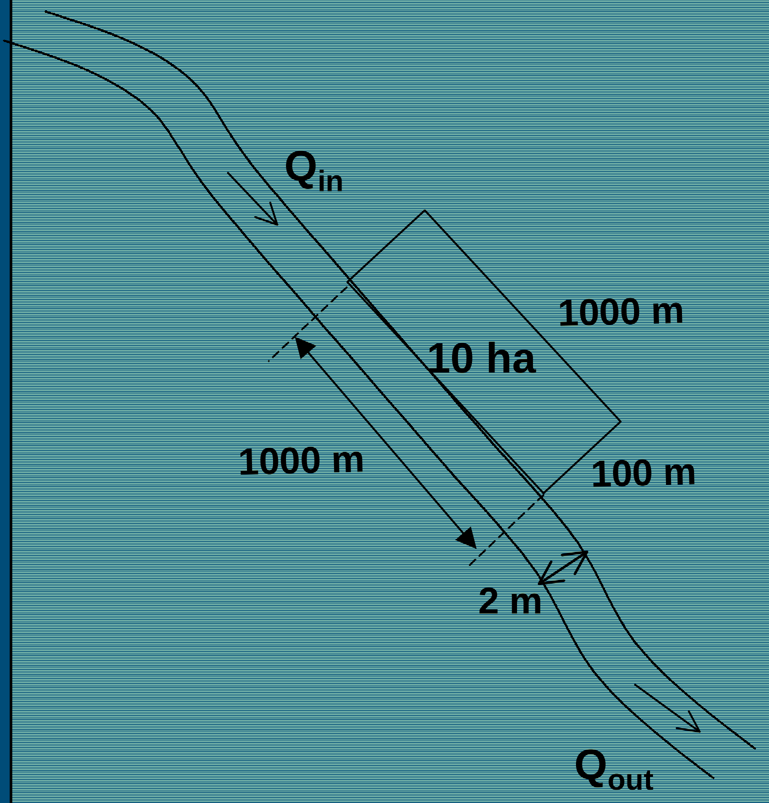
$Q_{in} = Q_{base} + A_{wc} * rodr$

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

– Pesticide:

* from 10 ha neighbouring field

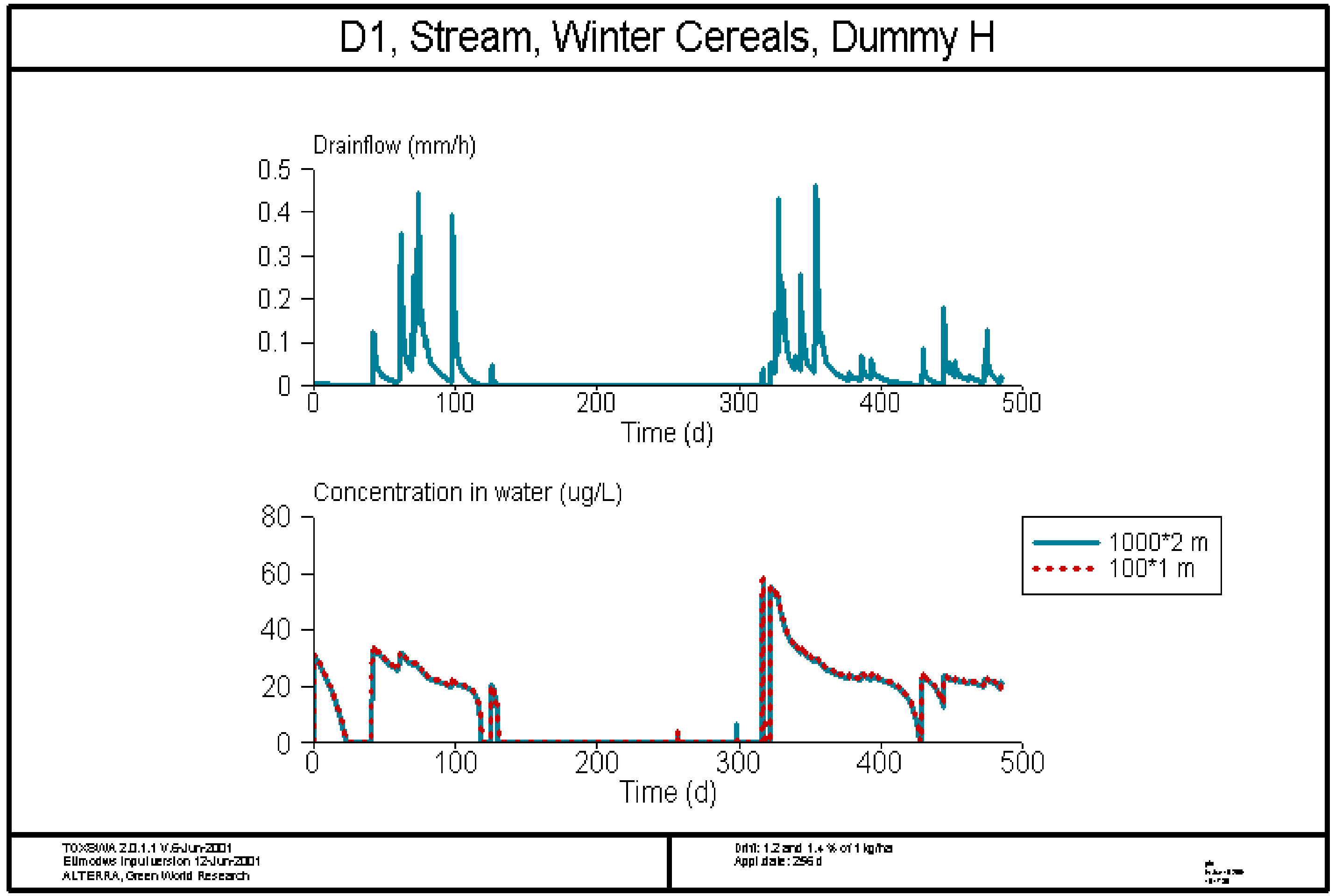
* from upstream catchment, A_{wc}



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 (ug.L^{-1}):

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

- PEC_{ac} = 4 ug.L^{-1} (spray drift only)

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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

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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 (fu(prop., rain), not flow dyn.)

- Pond: PEC_{ac} hardly influenced by Q_{in}, $PEC_{21\ d}$ is
- Ditch and stream: PEC hardly or not influenced by dynamics in Q and h

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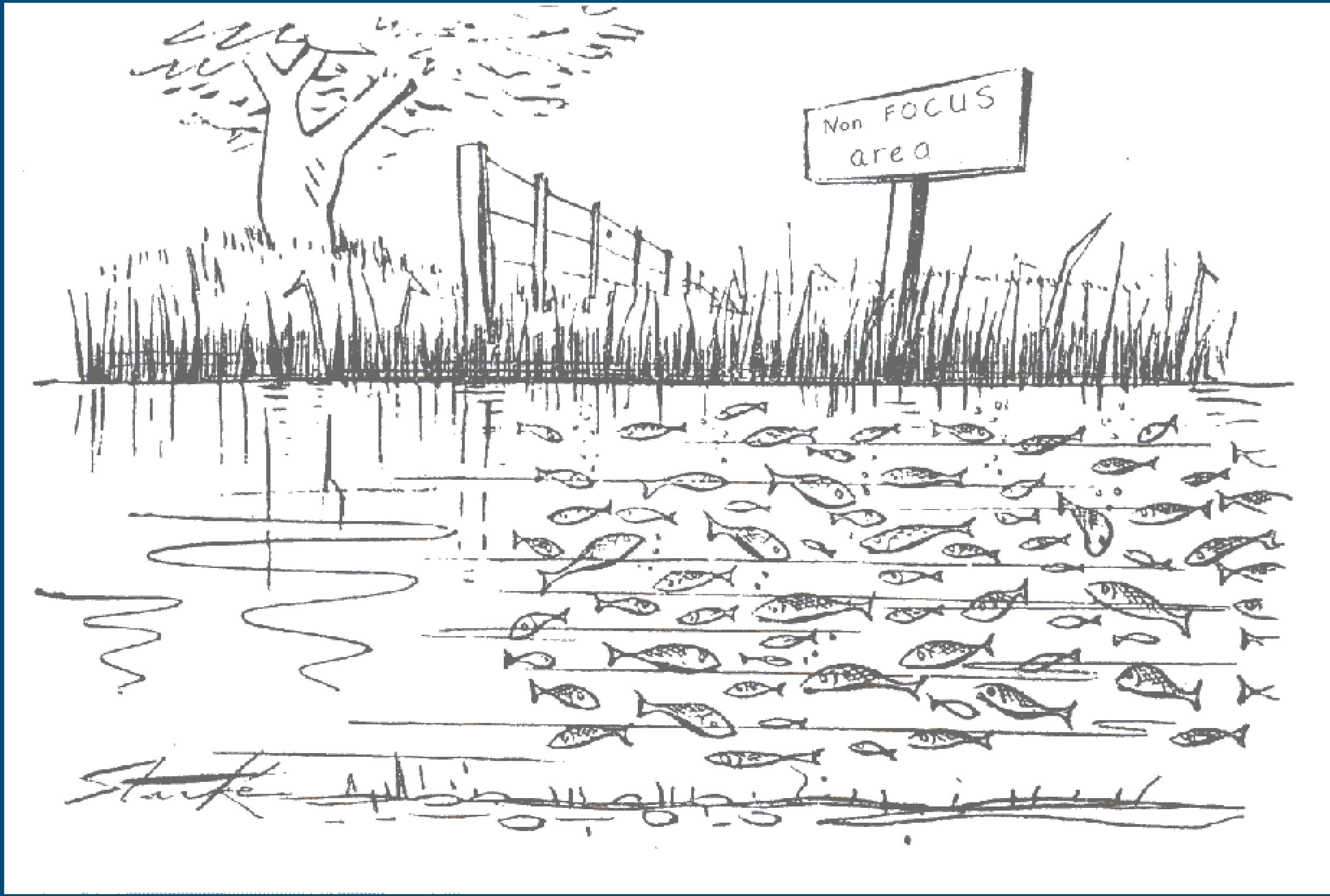
Science <-> group judgement



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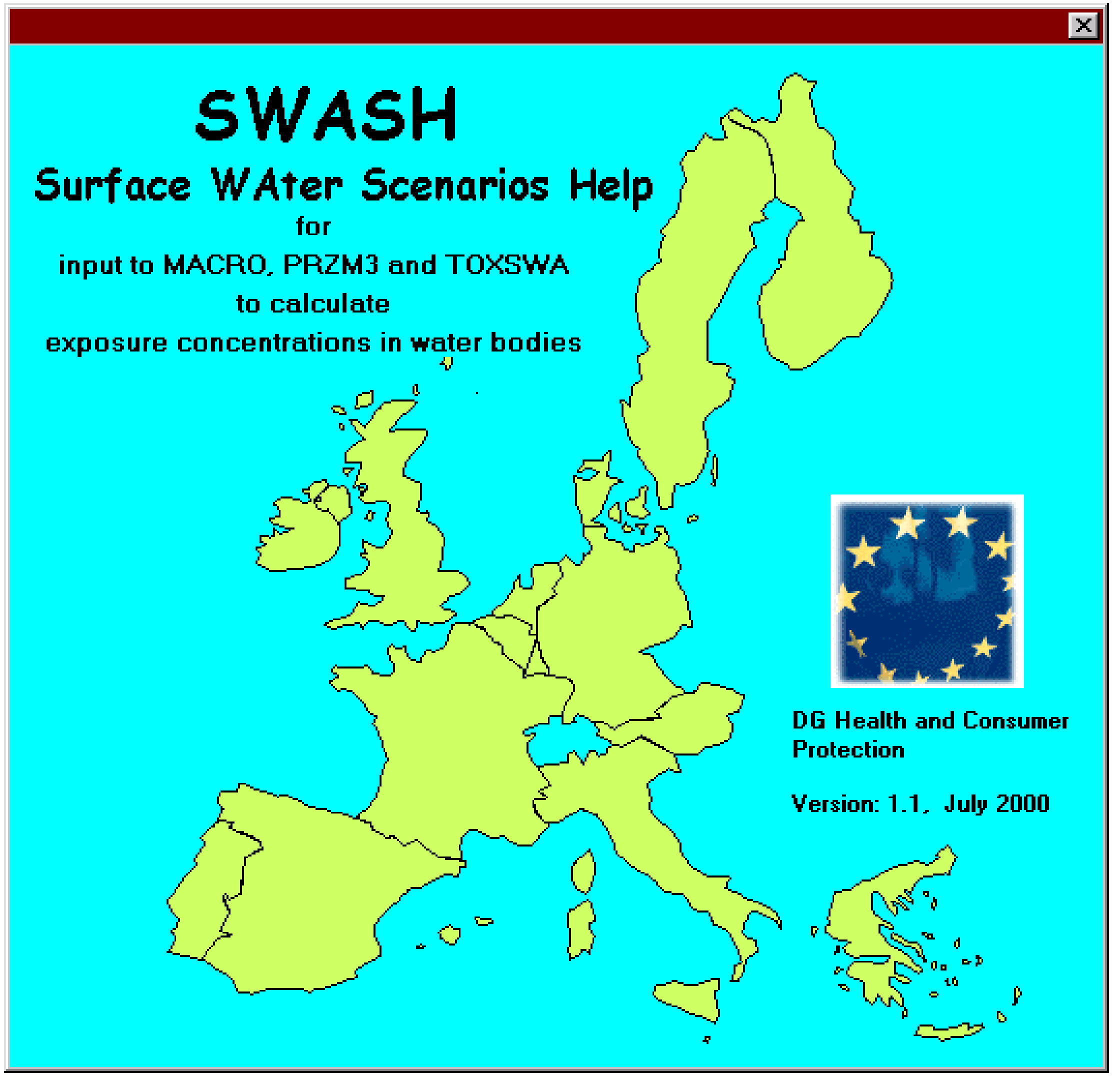
SWASH


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

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