Aquatic exposure assessment and linking exposure to effects in the risk assessment

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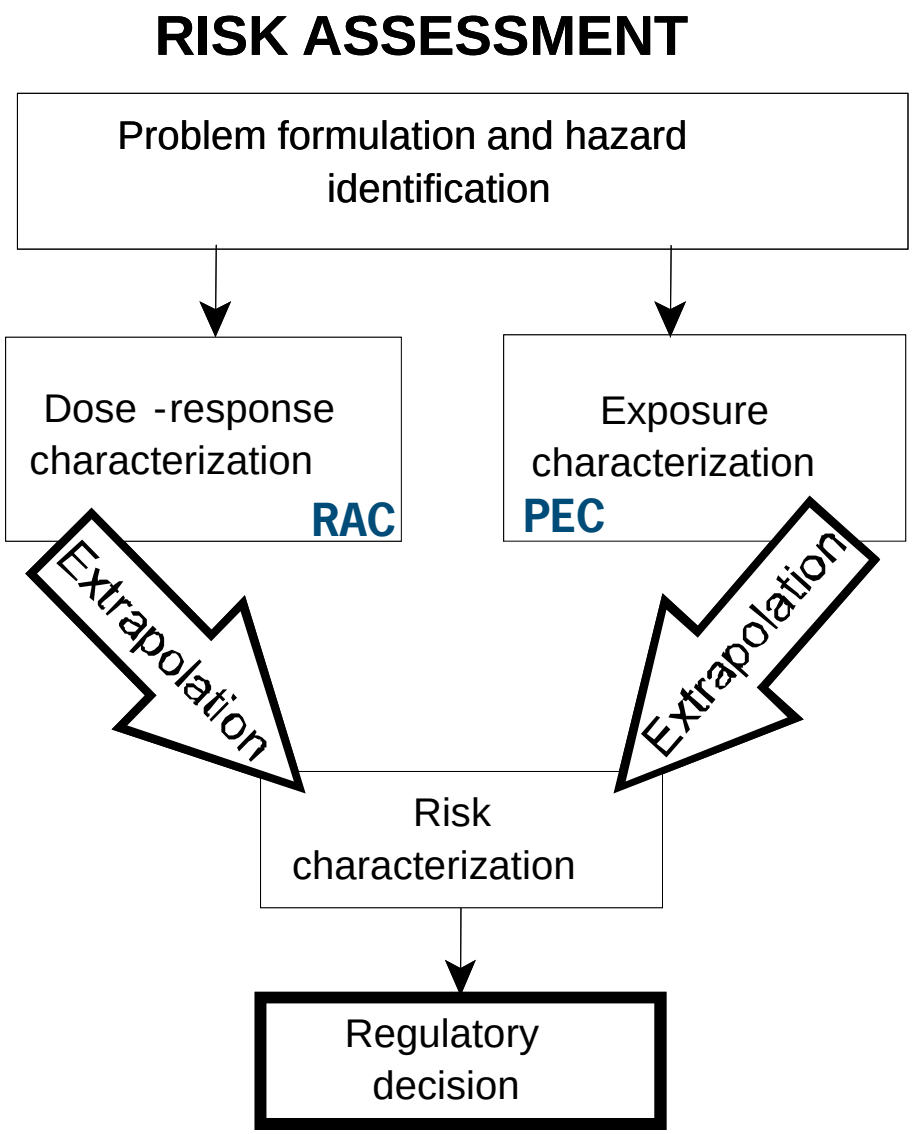
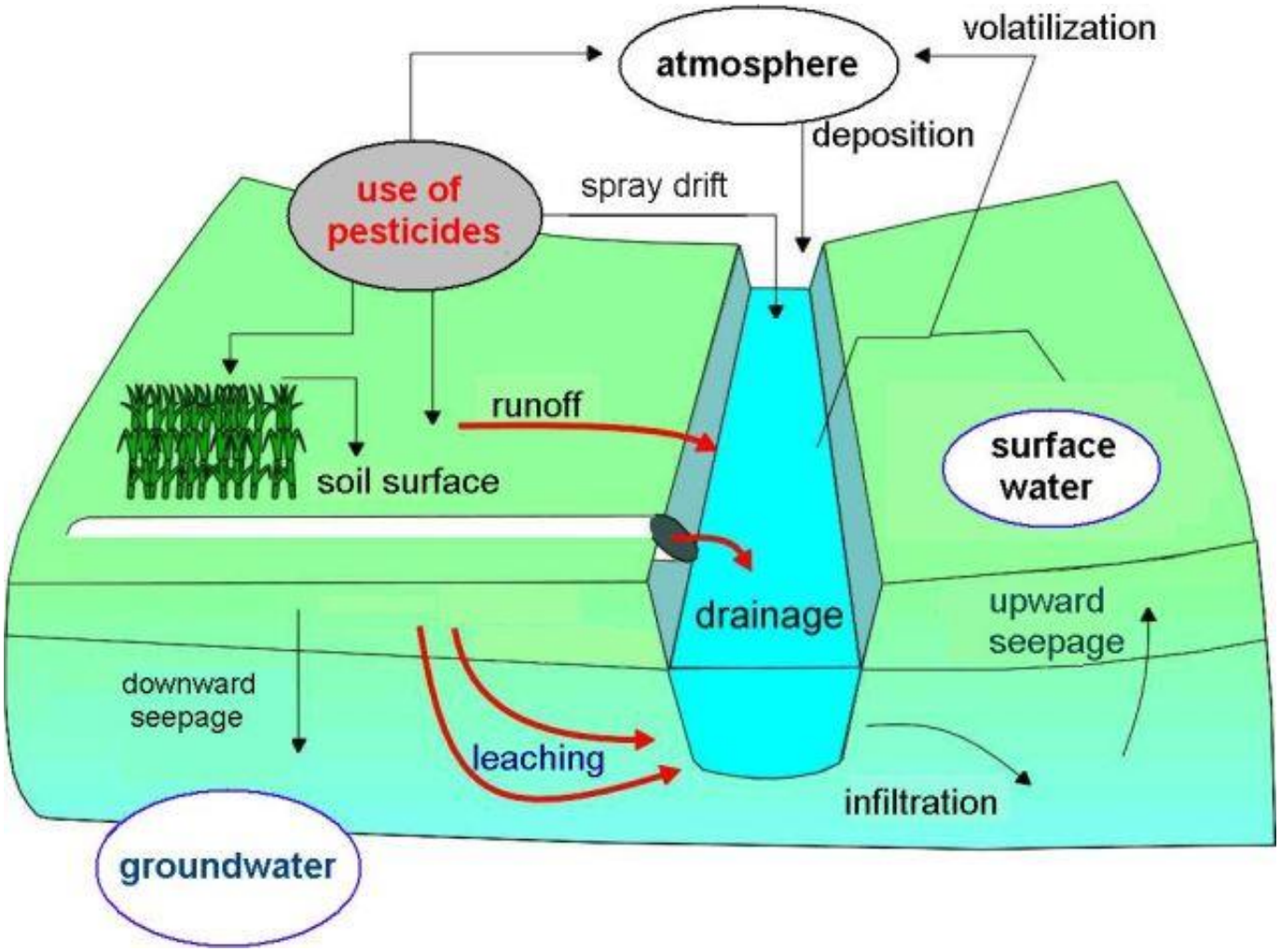
Linking exposure to effects is key in risk assessment



- **RAC** = Regulatory Acceptable Concentration on basis of ecotoxicological tests
- **PEC** = Predicted Environmental Concentration

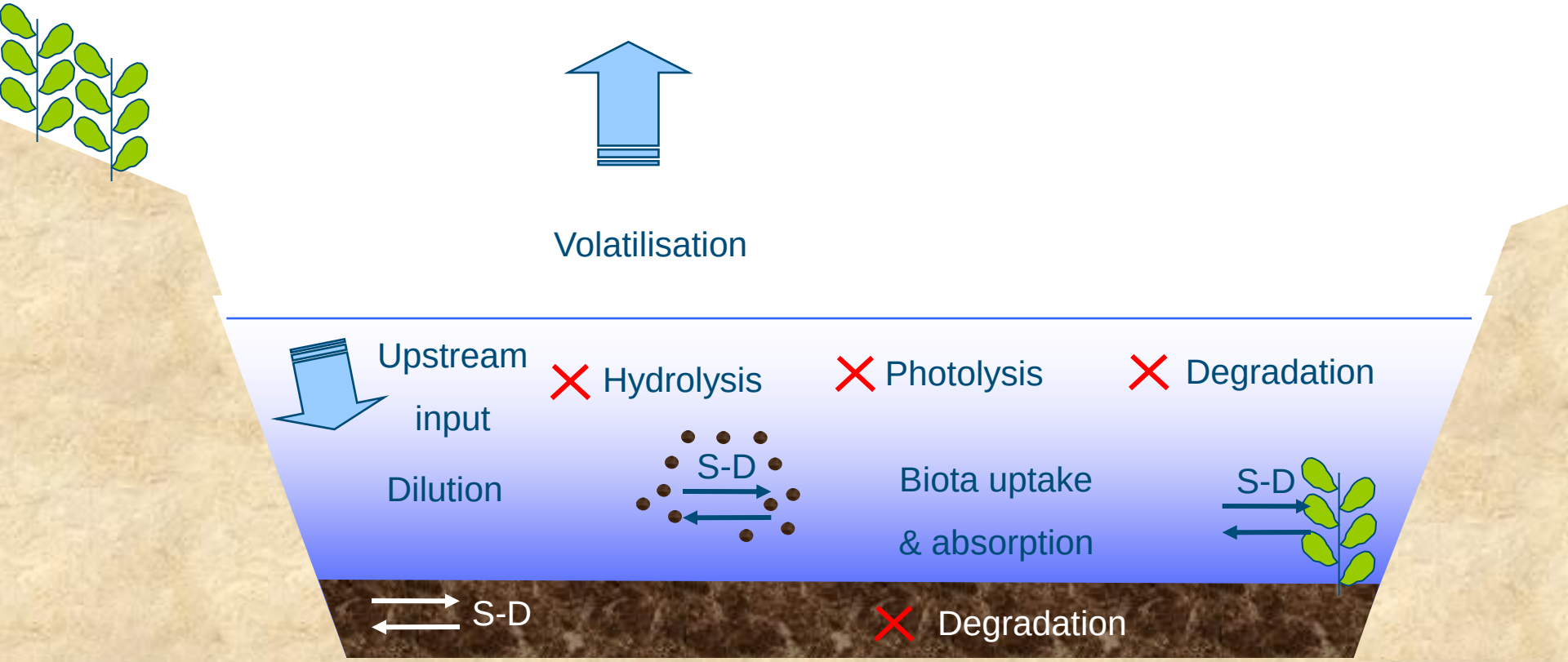
Aquatic exposure assessment and exposure



Spray drift, atmospheric deposition, surface runoff, drainage and leaching may be important emission routes

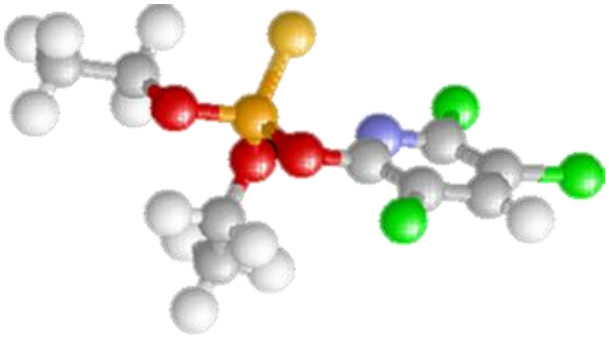
Processes that determine the fate of pollutants in surface waters

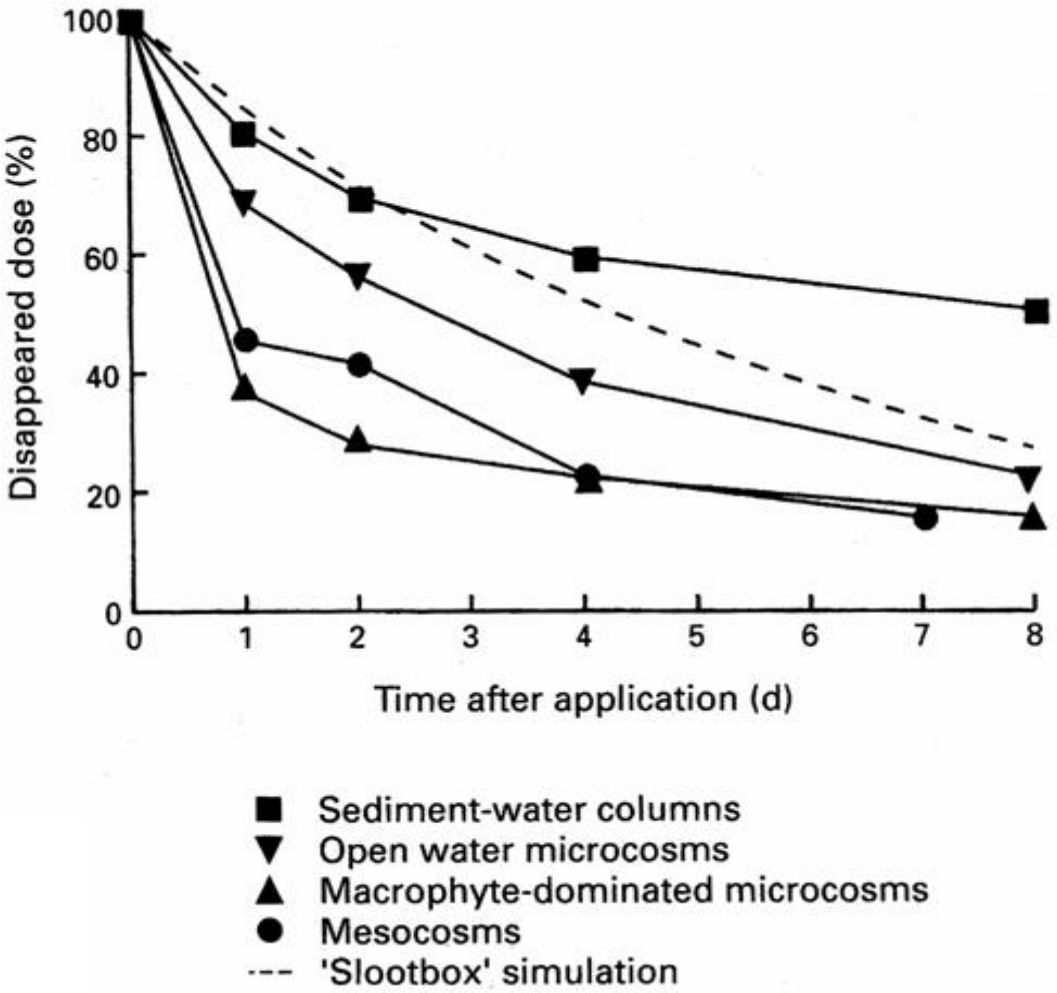
(degradation, hydrolysis, photolysis, sorption/desorption, dilution, volatilisation



Environmental fate and exposure

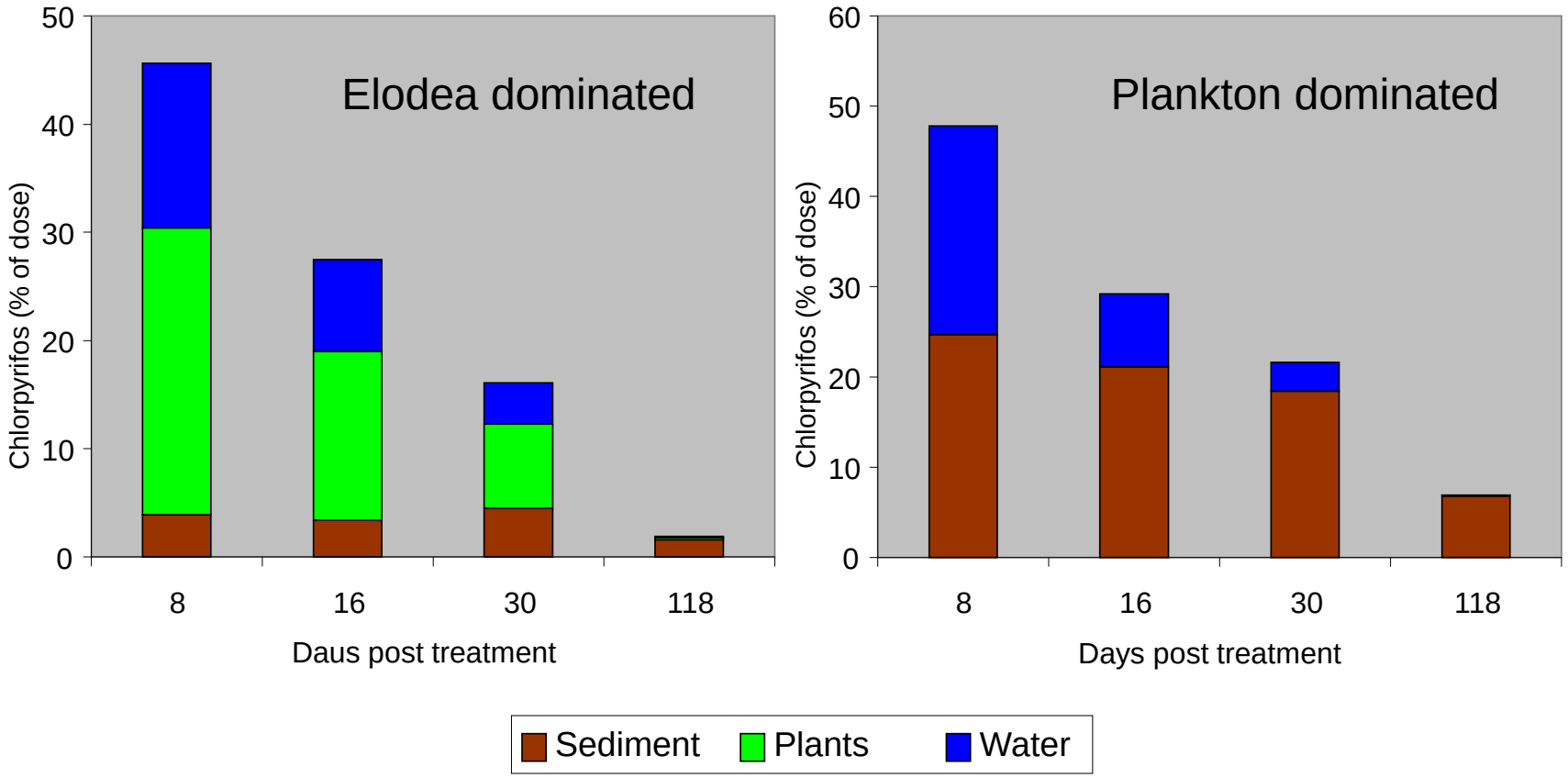
System-dependent dissipation from water (example chlorpyrifos)





Environmental fate and exposure

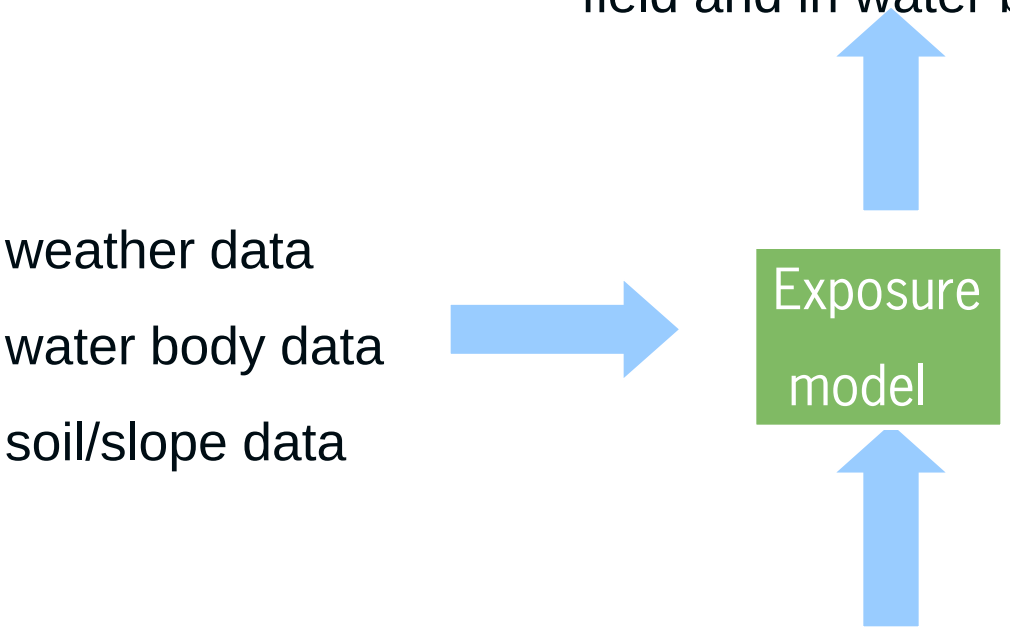
System-dependent partitioning (example chlorpyrifos)



Prospective exposure assessment

chemical behaviour at

field and in water body



laboratory chemical behaviour

-- solubility - half-life

-- vapour pressure -sorption

For prospective exposure assessment exposure scenarios and models are used

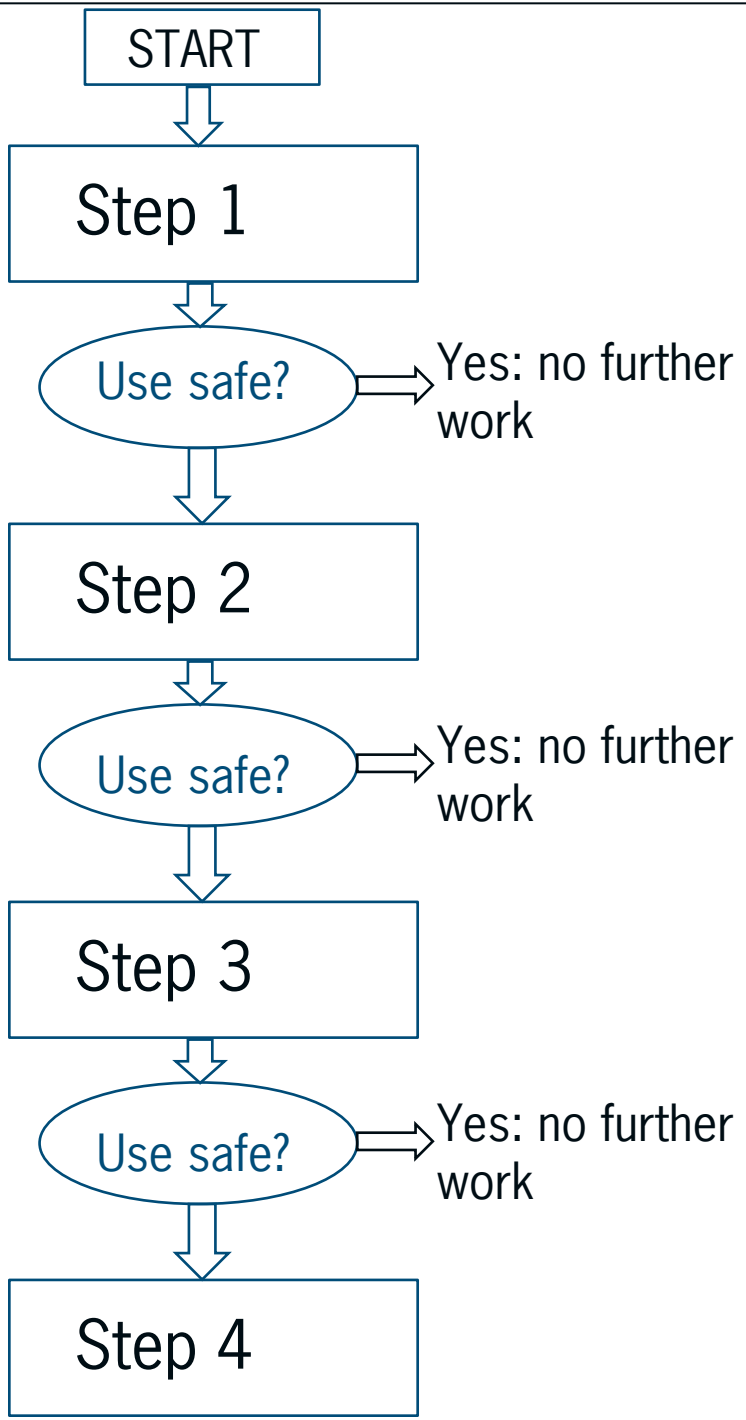
Exposure assessment

No specific climate, cropping, topography or soils scenario. Worst case loading

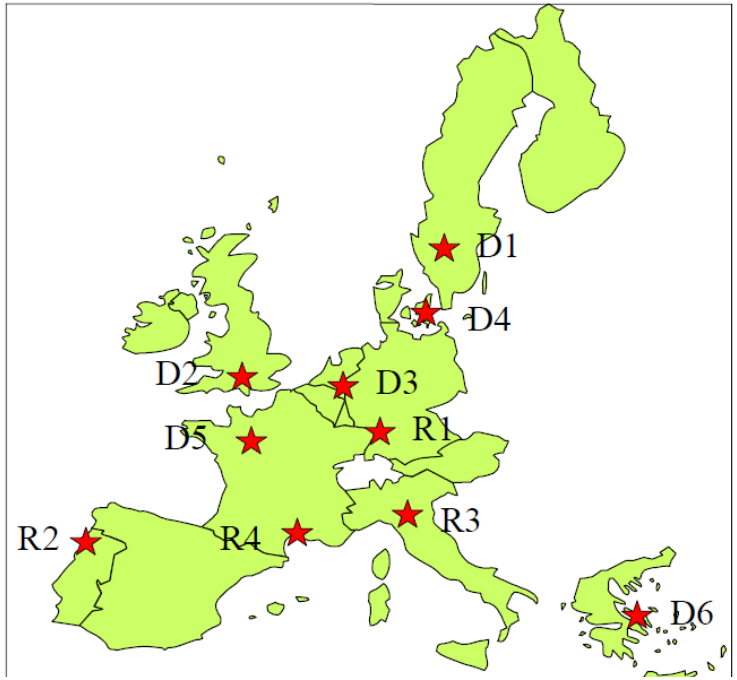
No specific climate, cropping, topography or soils scenario. Loading based on sequential application

10 realistic worst case scenarios (FOCUS). Loading based on sequential application pattern

Loading as in step 3, site specific calculations including mitigation measures



FOCUS Surface Water Scenarios for exposure assessment



Scenario	Ditch	Stream	Pond
D1	X	X	
D2	X	X	
D3	X		
D4		X	X
D5		X	X
D6	X		
R1		X	X
R2		X	
R3		X	
R4		X	

6 Drainage scenarios (D1-D6)

4 Run-off scenario (R1-R4)

All scenarios: spray drift

Drainage scenarios: no run-off

Run-off scenarios: no drainage

Each scenario has one or more types of water body linked to it:

realistic combinations

Characterization of FOCUS Surface Scenario R2

R2

***Climate*:** Warm temperate with very high precipitation.

***Representative Site*:** Porto, Portugal.

***Soil type*:** Free draining light loam with relatively high organic matter content.

***Surface water bodies*:** First order streams.

***Landscape*:** Steeply sloping, terraced hills.

***Crops*:** Grass, potatoes, field beans, vegetables, legumes, maize, vines, pome/stone fruit.

Characterization of FOCUS Surface Scenario D3

D3

***Climate*:** Temperate with moderate precipitation.

***Representative Site*:** Vredepeel, Netherlands.

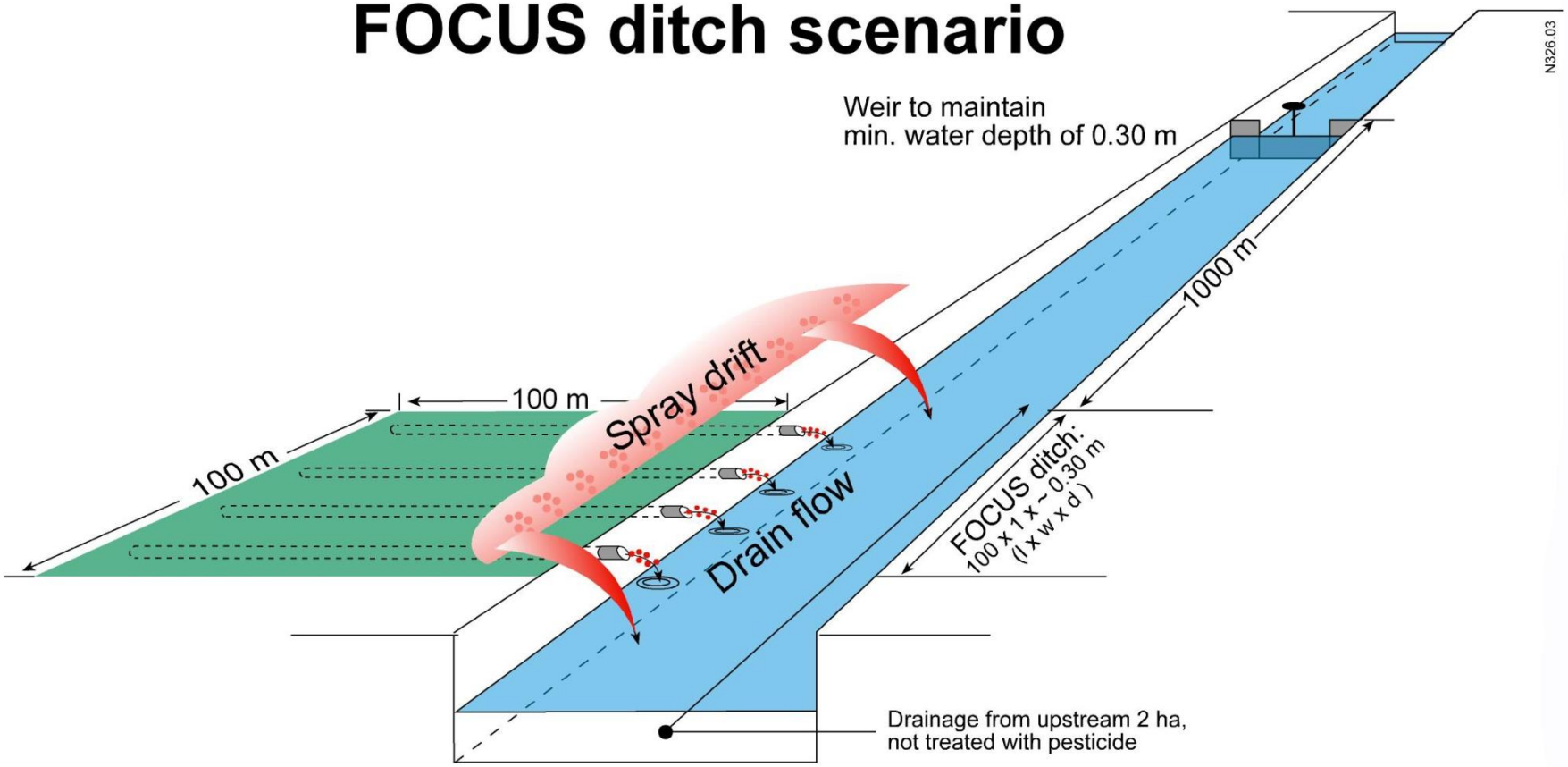
***Soil type*:** Sands with small organic carbon content and field drains. Subsoil waterlogged by groundwater.

***Surface water bodies*:** Field ditches.

***Landscape*:** Level land

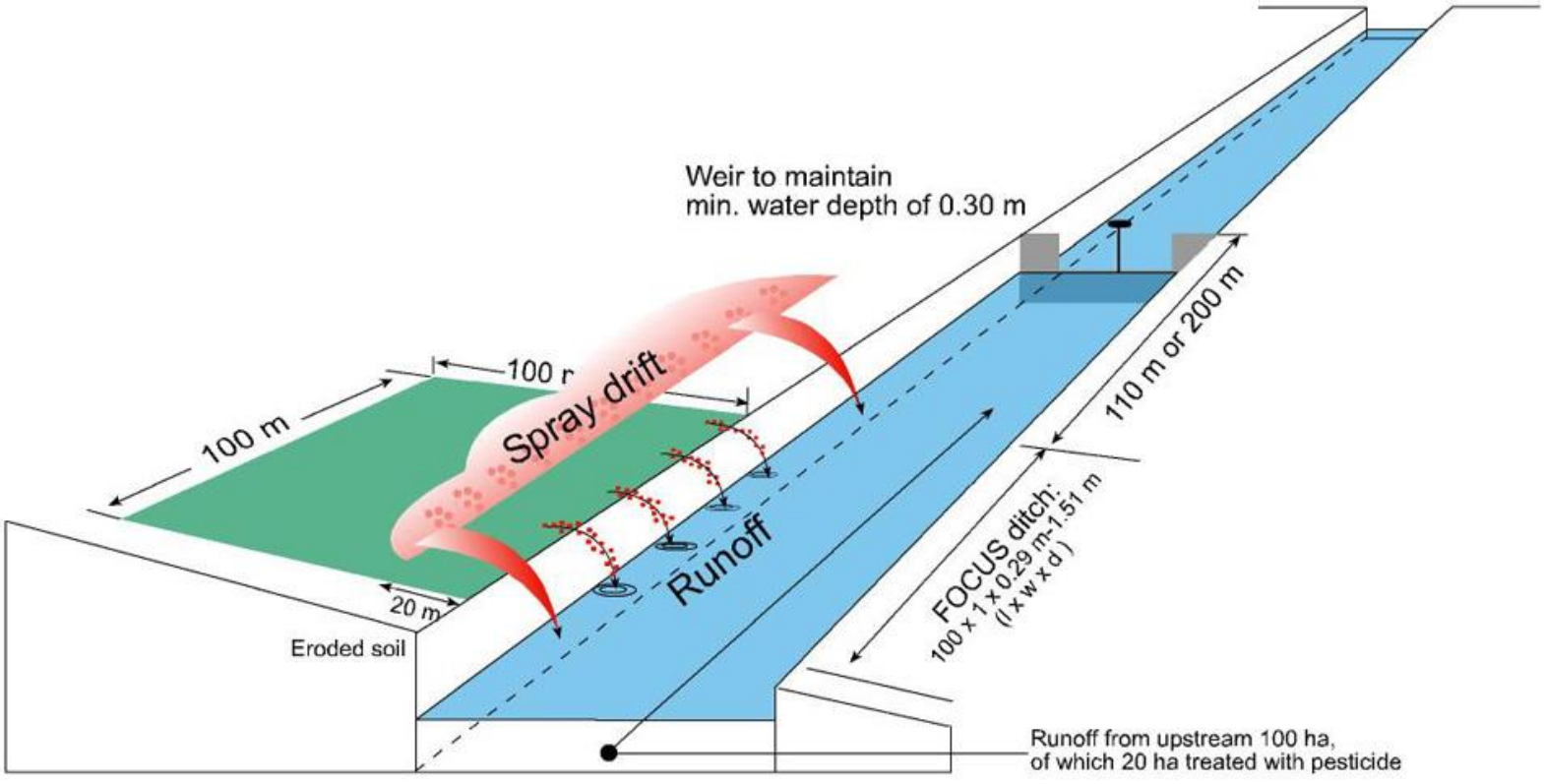
***Crops*:** Grass, winter & spring cereals, winter and spring oilseed rape, potatoes, sugar beet, field beans, vegetables, legumes, maize, pome/stone fruit.

FOCUS ditch scenario



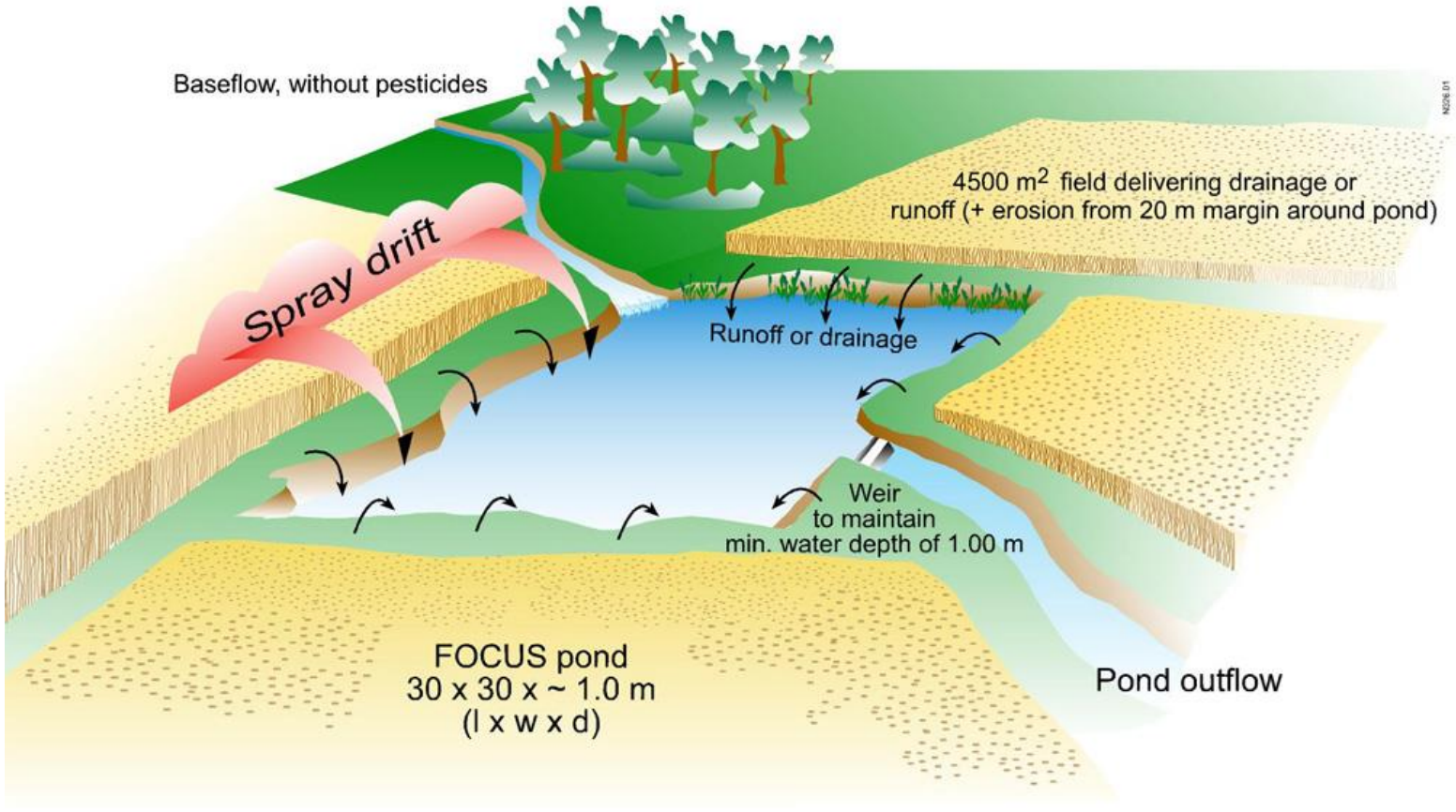
Type of water body	Width (m)	Total length (m)	Average water depth (m)	Target average residence time (days)
Ditch	1	100	0.3	5

FOCUS stream scenario



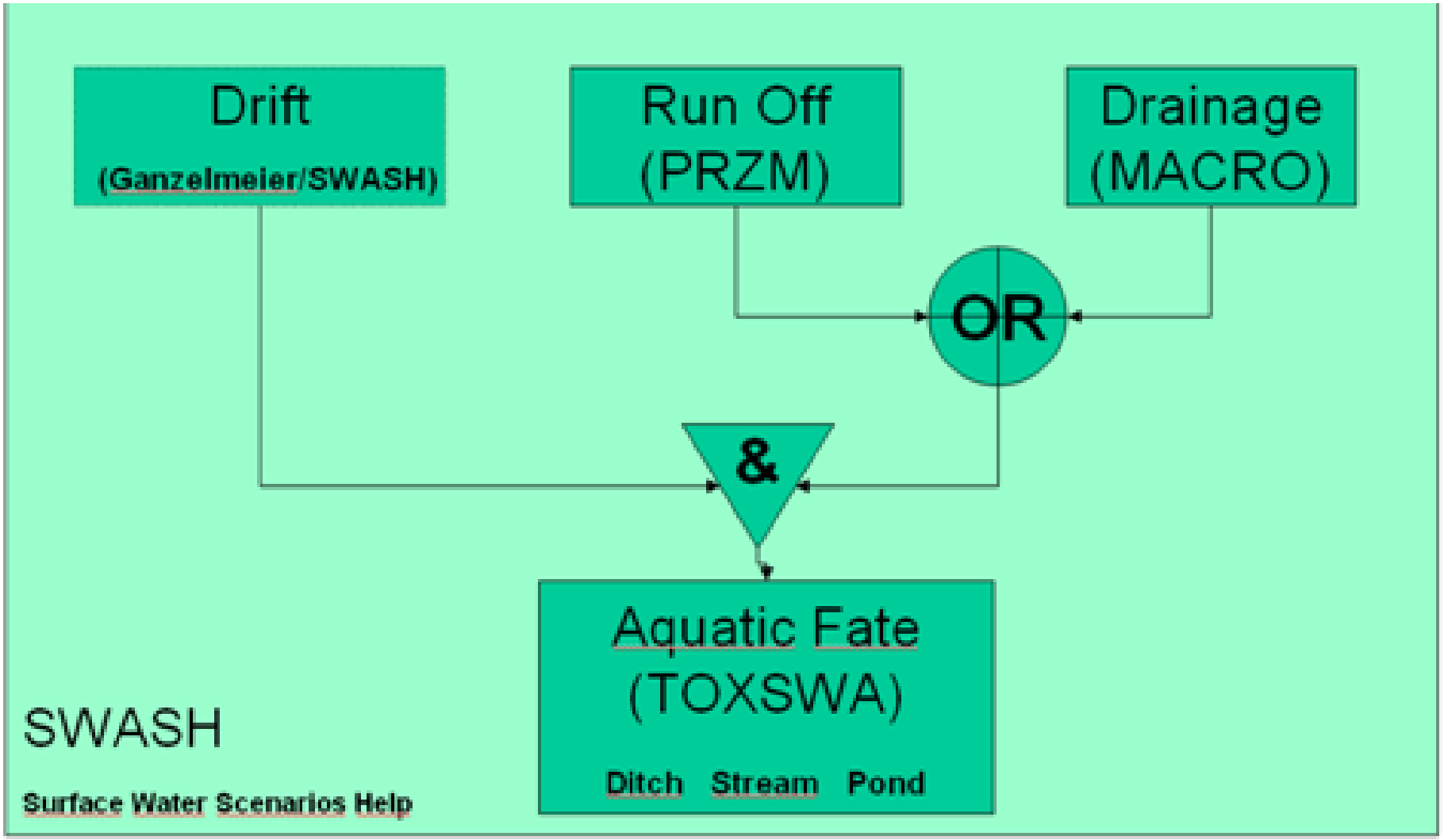
Type of water body	Width (m)	Total length (m)	Average water depth (m)	Target average residence time (days)
Stream	1	100	0.3 to 0.5	0.1

FOCUS pond scenario



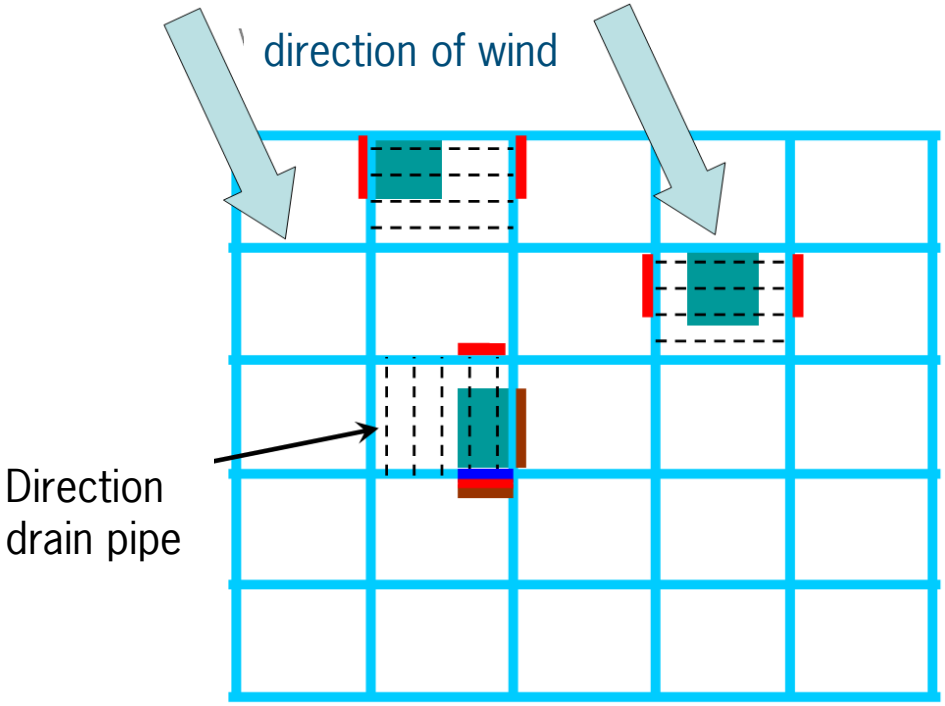
Type of water body	Width (m)	Total length (m)	Average water depth (m)	Target average residence time (days)
Pond	30	30	1.0	50

Edge-of-field exposure modelling



Exposure modelling & risk management decisions

- **Edge-of-field exposure assessment goal**: Overall management aim is to obtain 90th percentile “worst case” exposure concentration of a selected population of edge-of-field surface waters



For example ditches that are located downwind of treated fields AND that have drain pipes from treated fields

- Worst case
- Best case
- drift
- drain-pipe

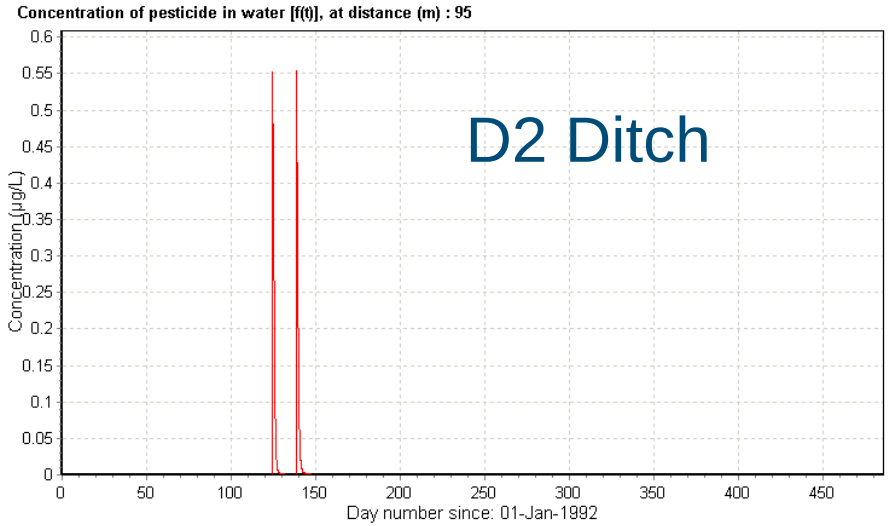
$FOCUS_{sw}$ modelling steps

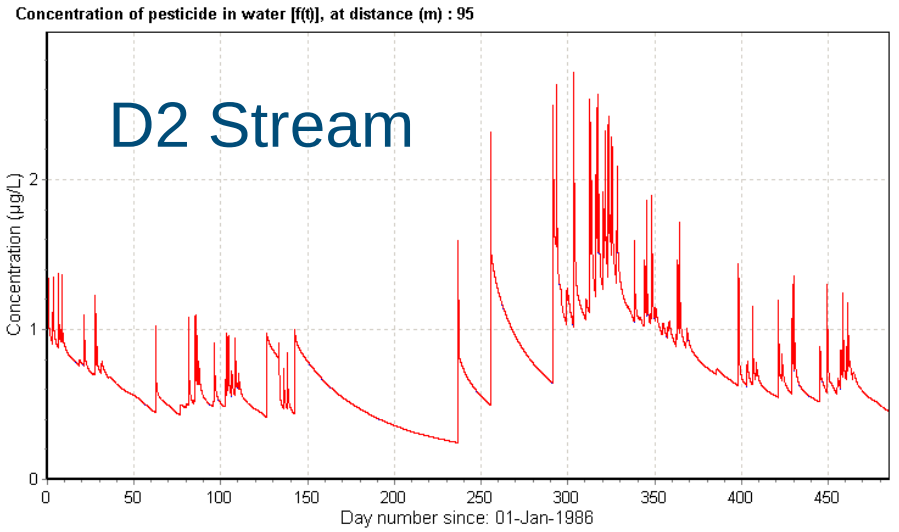
The calculation steps provide:

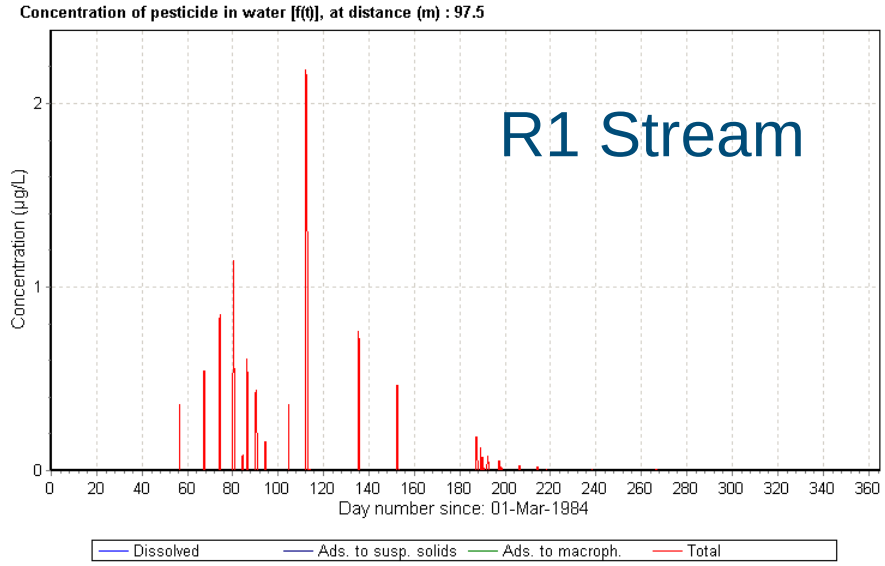
- actual concentration time series in water column and sediment.

- time-weighted average concentrations in water column and in sediment.

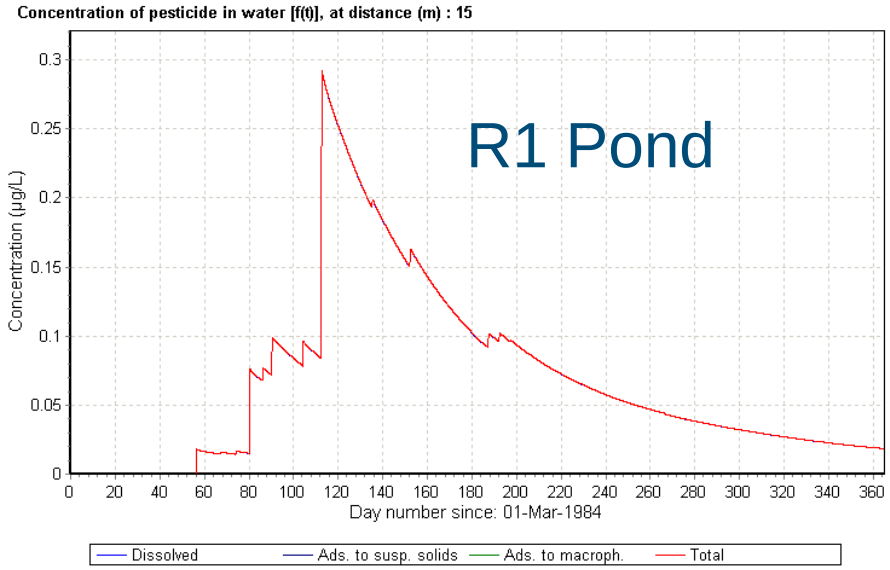
Some examples of FOCUSsw exposure profiles







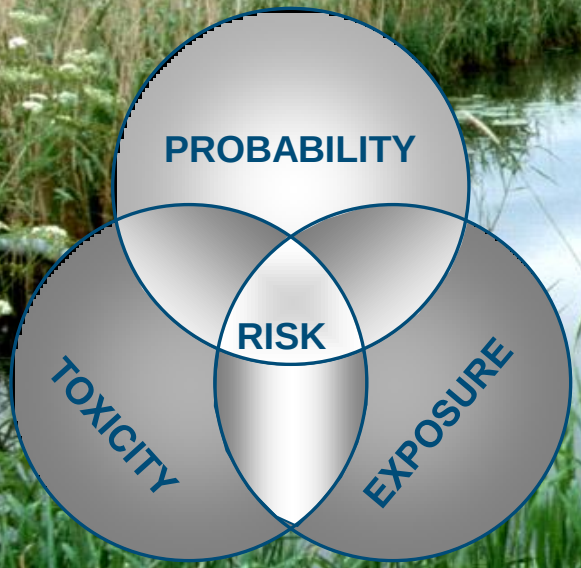
Project : Elinkstrobin_WC
RunID : 00128s_pa
Substance : ELINK "Strobilurin"
Location : R1 (Meteo station: Weiherbach)
Water body : Stream
Crop : Cereals, winter



Project : Elinkstrobin_WC
RunID : 00128p_pa
Substance : ELINK "Strobilurin"
Location : R1 (Meteo station: Weiherbach)
Water body : Pond
Crop : Cereals, winter

Linking exposure (PECs) to effects (RACs)

Chain as weak as weakest link



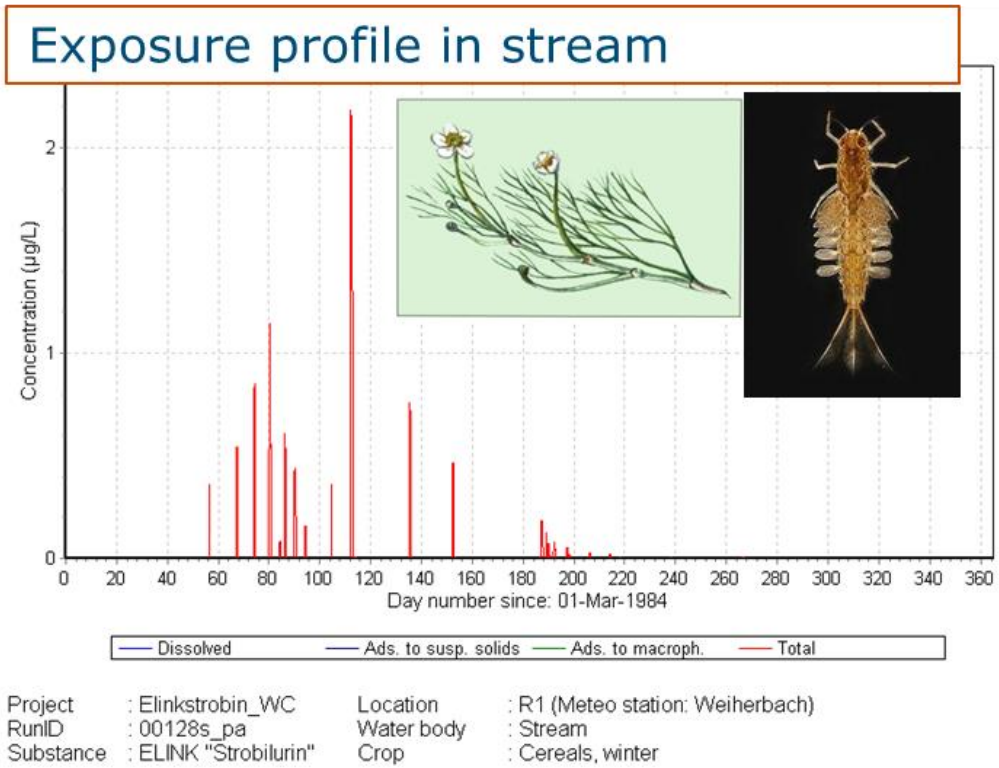
Linking expertise

Linking people

Interface between fate and effects

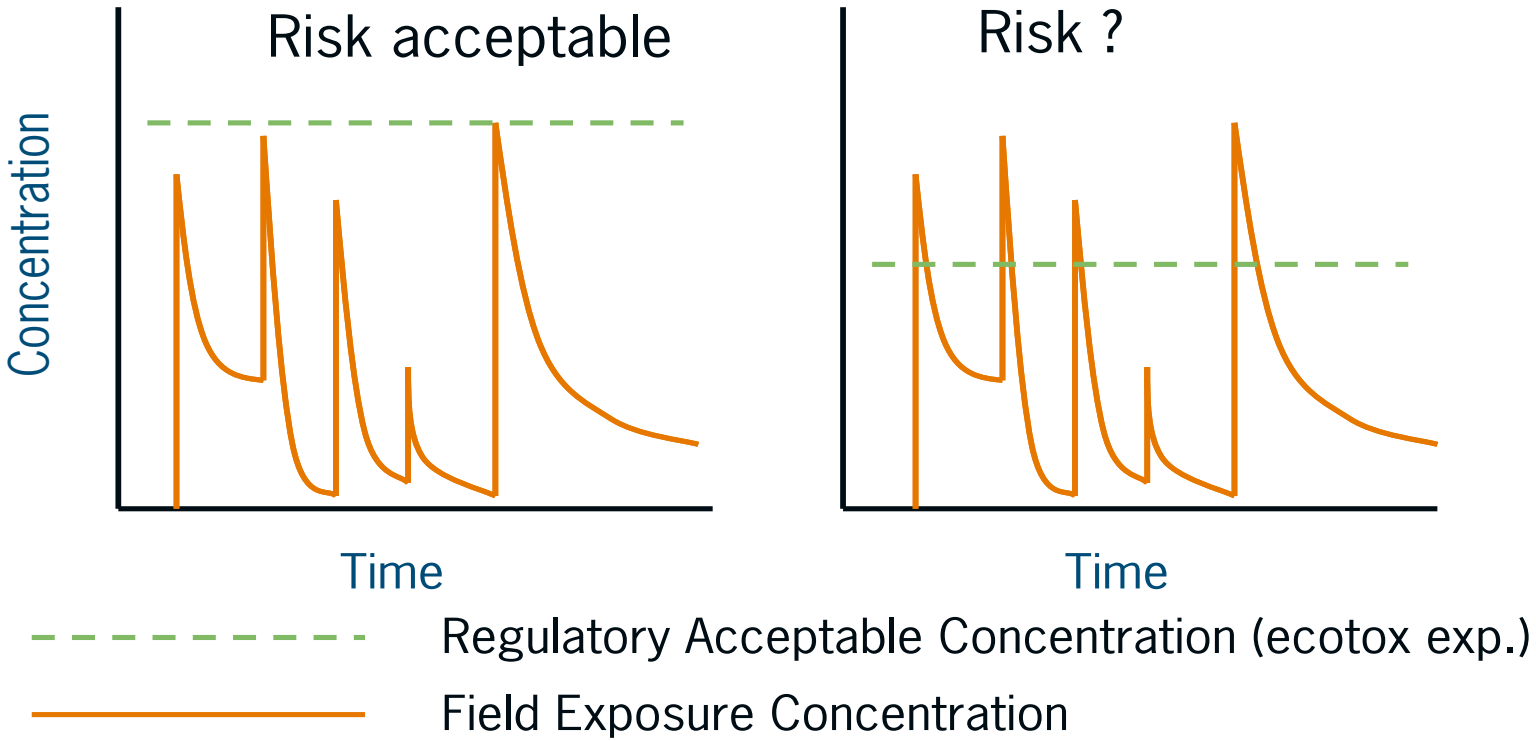
- **Ecotoxicologically Relevant Concentration** (**ERC**) is the **type of concentration** that correlates with the relevant effect
- ERC is measured /predicted for both the ecotoxicological experiments and for the field
  - e.g. for water organisms
    - Peak or Time Weighted Average (TWA) concentration in water of depth integrated water sample (µg chlorpyrifos/L water)
  - e.g. for sediment dwelling organisms
    - Peak or TWA concentration in pore water in top 5 cm of sediment (µg chlorpyrifos/L pore water)
    - Peak or TWA concentration in total sediment in top 5 cm layer (mg chlorpyrifos/kg dry weight sediment)

Problem formulation



- In surface waters time-variable exposure regimes are often the rule rather than the exception
- Implications of time-variable exposure concentrations needs to be appropriately addressed

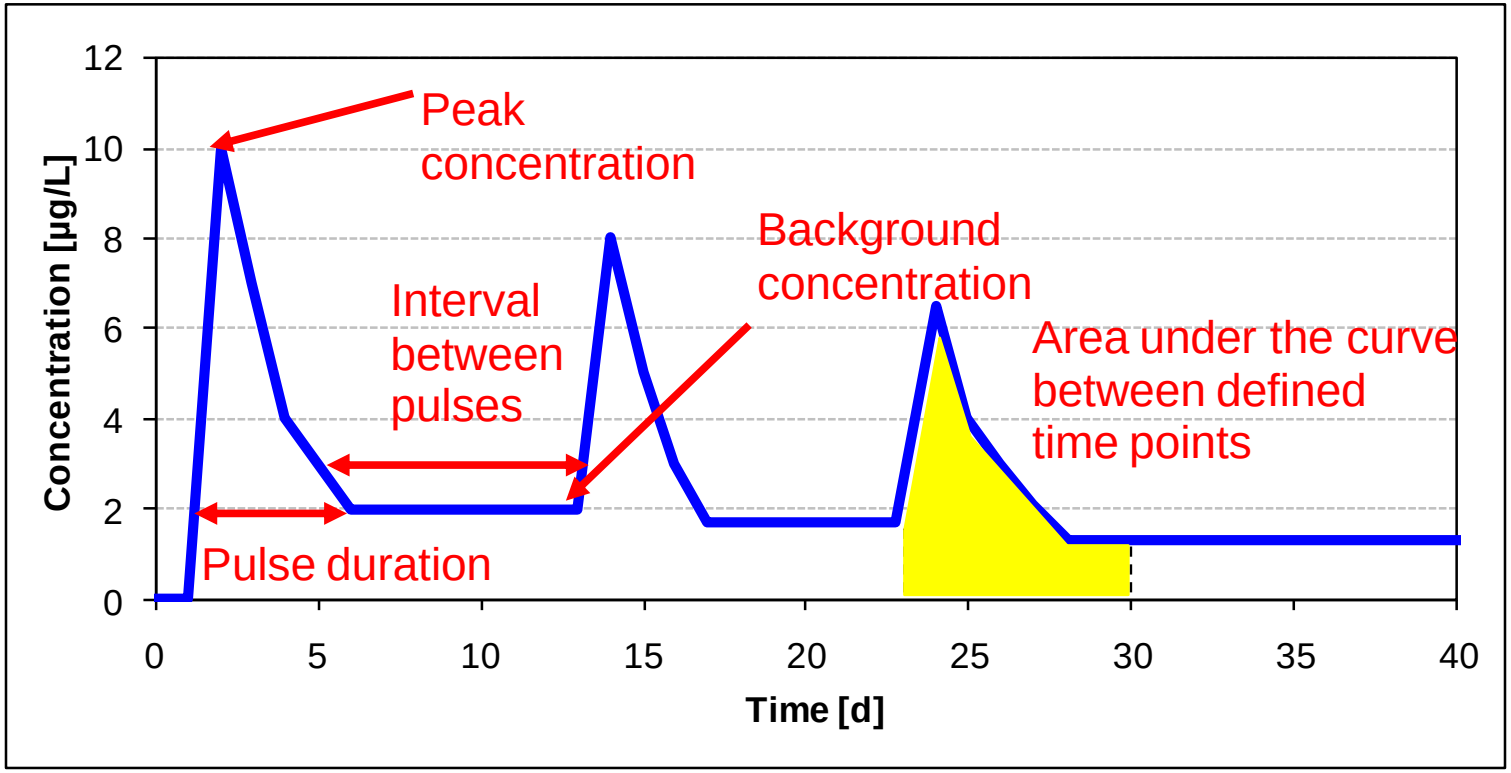
Exposure in ecotox experiments and field



To be used in aquatic ERA the exposure conditions in the ecotox tests used to derive the RAC should be realistic to worst-case when compared with the exposure profile predicted for edge-of-field surface waters

Proposal in the EFSA Aquatic Guidance Document

In aquatic risk assessment in first instance the $PEC_{sw;max}$ is used. Under certain conditions the $PEC_{sw;twa}$ may be used as field exposure estimate

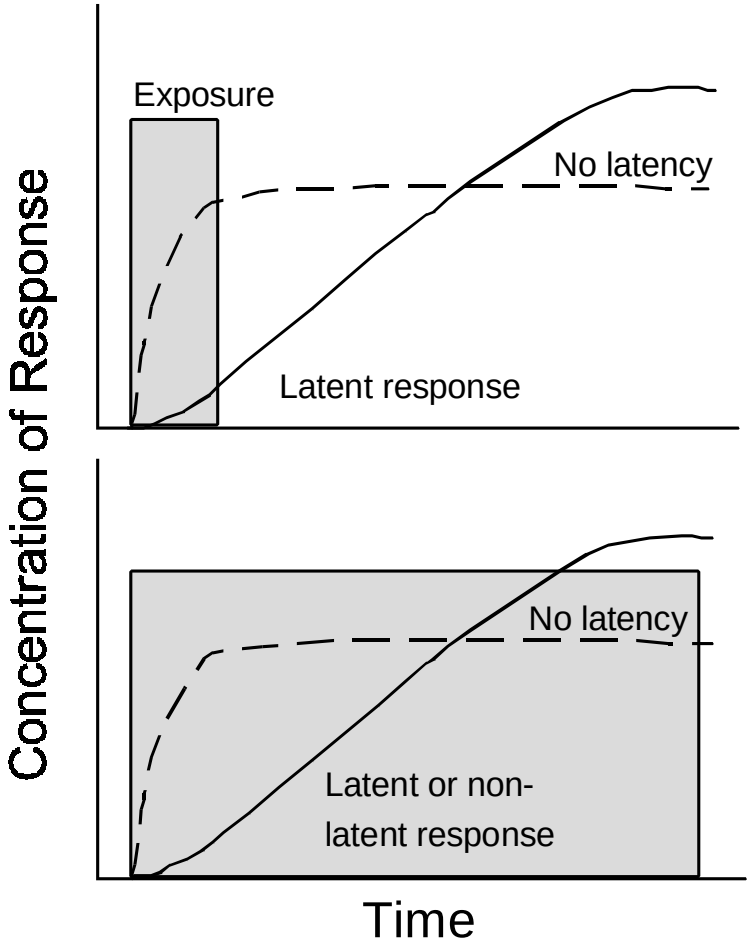


The time-weighted average (TWA) concentration is the area under the curve in a defined period.

Proposal in the EFSA Aquatic Guidance Document

Ecotoxicology must determine if the $PEC_{sw;twa}$ is appropriate to use in chronic risk assessment.

- Use of $PEC_{sw;twa}$ may not be appropriate in chronic risk assessment
  - When linked to RACs based on effect studies where the loss of the substance is fast and toxicity is expressed in terms of initial concentration
  - When effect endpoint in the chronic test is based on a developmental process during a specific life-cycle stage
  - When the (acute EC50/chronic NOEC) ratio is < 10
  - If latency of effects has been demonstrated (or might be expected)

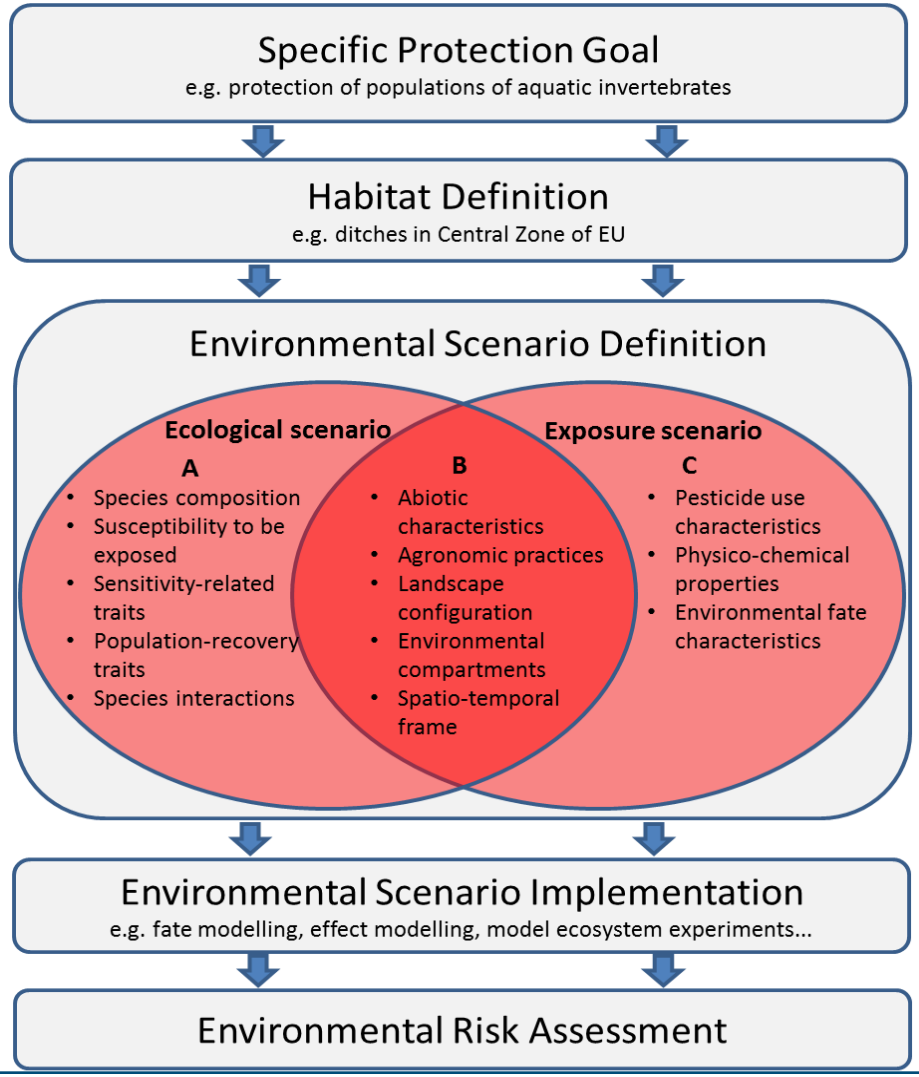


Proposal in the EFSA Aquatic Guidance Document

If the TWA approach is deemed appropriate it is proposed to use a 7-d TWA PEC (= $PEC_{sw;7d\text{-}twa}$) as default for fish and invertebrates (and possibly also macrophytes)

- The default 7-d TWA period may be shortened or lengthened on basis of time-to-onset-of-effect information in the chronic test
- The length of the TWA period should not be longer than the length of the relevant chronic toxicity test (or life stage of highest ecotoxicological concern) that triggered the risk

Environmental scenarios and modelling



- Currently effects assessment is mainly based on experimentation and exposure assessment is mainly based on modelling
- In the near future effect modelling will become more important

Thank you for your attention

Questions?