Aquatic risk assessment at catchment scale

Case study on insecticide exposure concentrations and effects on macroinvertebrates

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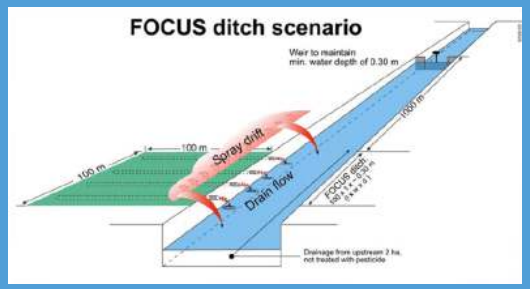
Wageningen Environmental Research, knoell Germany GmbH, Tier3 Solutions, Justus Liebig University Giessen, Bayer AG

Current environmental risk assessment is generic and at field scale

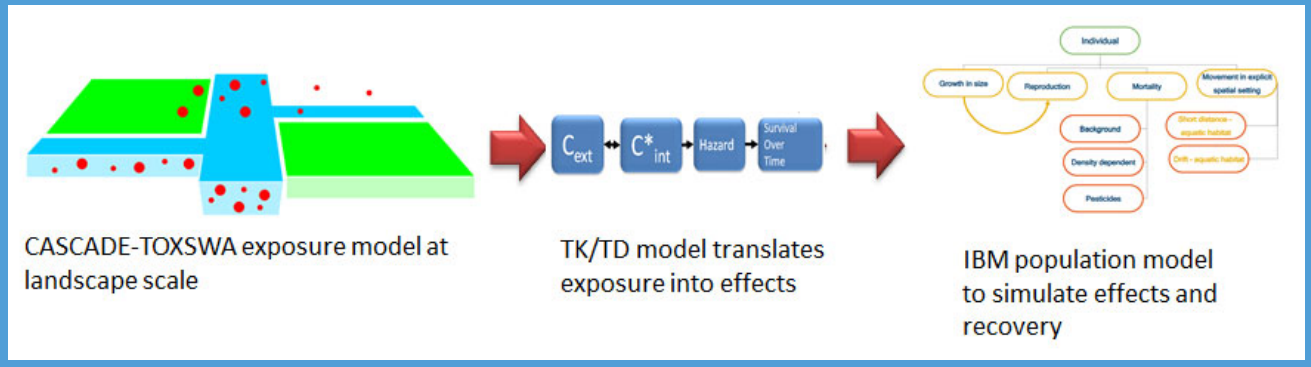
- Exposure estimates are simulated for standard scenarios that represent fields
- Effect threshold values derived from laboratory or semi-field trials



Current environmental risk assessment is generic and at field scale

However:

- Agricultural landscapes consist of many fields, considering the entire landscape including treated and untreated fields may improve the realism of the risk assessment
- Effect models become available and enable integrated modelling of dynamics of exposure and effects



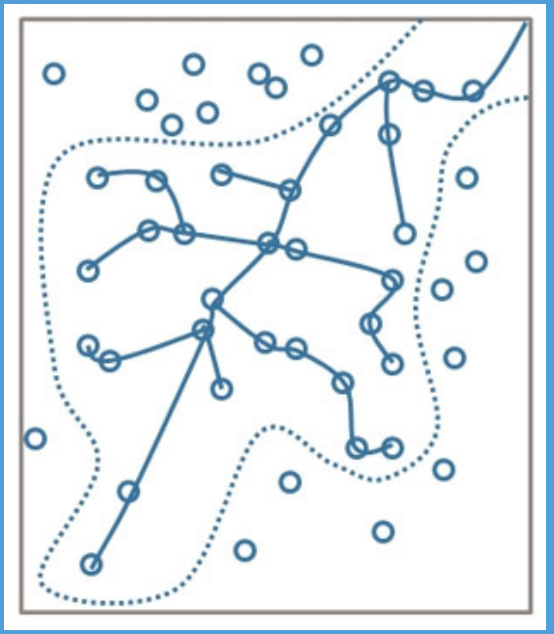
CASCADE-TOXSWA exposure model at landscape scale

TK/TD model translates exposure into effects

IBM population model to simulate effects and recovery

Research questions and objectives

- Include more realism by assessing risk at landscape level
- Need for framework on linking protection goals to landscape scale assessment endpoints (see poster 4. XXX Wipfler et al.)
- Case studies needed to develop such a framework
- Aim in this study -> Calculation of exposure and effects of a plant protection product in surface water at the catchment scale



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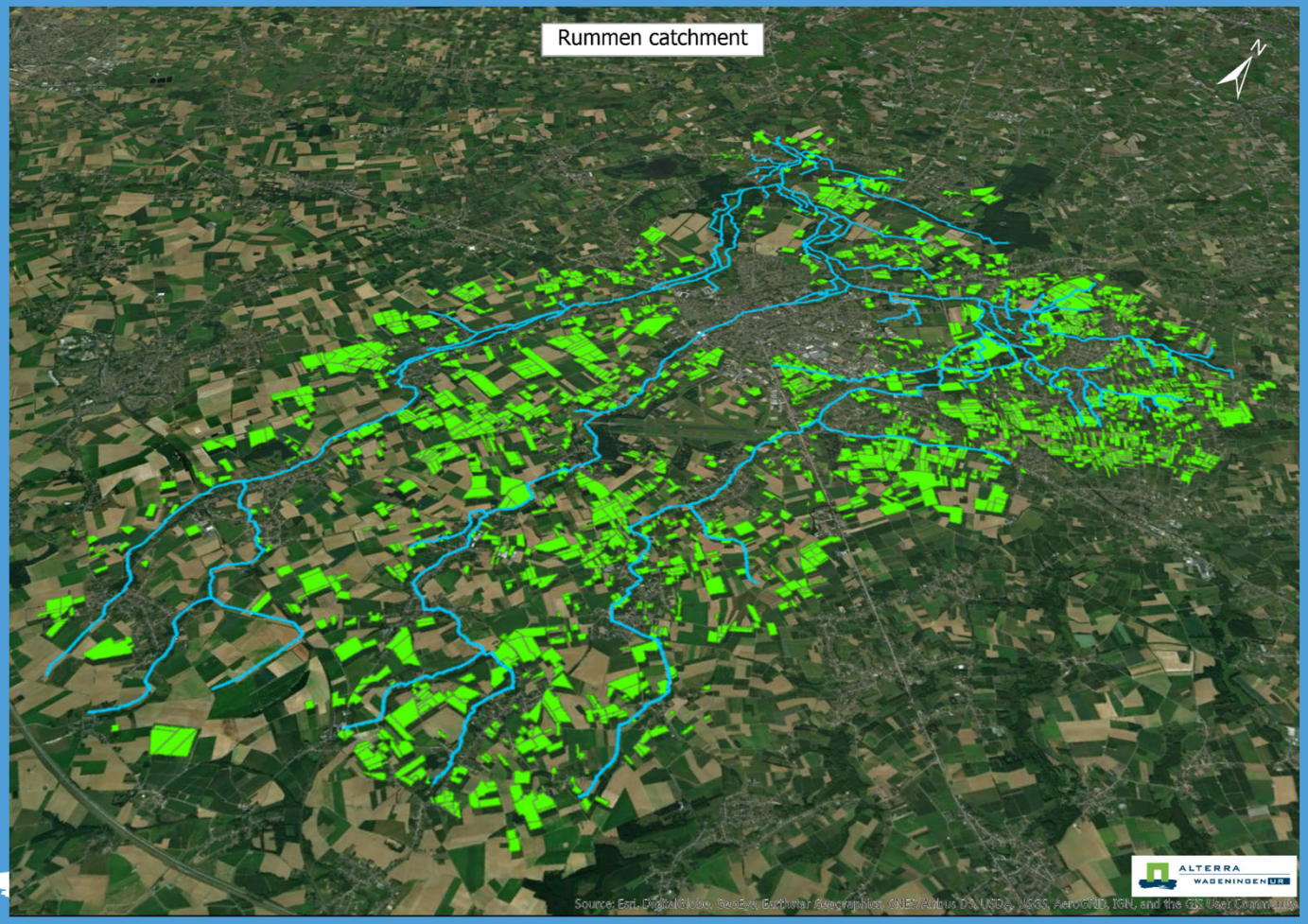
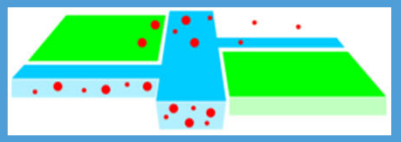
Case study Rummen

- Use of insecticide in apples. Catchment selected with large area of fruit: Rummen in Belgium



Landscape modelling components



Hydrology CMF

Agriculture

Drift Xdrift

Timing of application

Future: IBM population model

Water depth and discharge per reach

Spray drift amount per reach

Water and sediment concentrations per reach

Effect per reach

Fate Cascade_TOXSWA

Effect TKTD

Catchment Modelling Framework (see also poster XXX Krebs)

Based on Rautmann trials considering variable wind conditions (see also Schad et al., 2013; Bub et al., subm)

Main processes in water and in sediment: transport, sorption and transformation

Internal concentration and effects on survival (TKTD), margins of safety (LP50)

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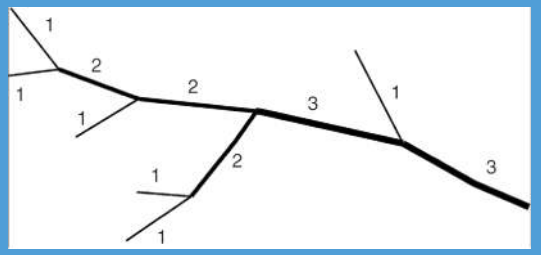
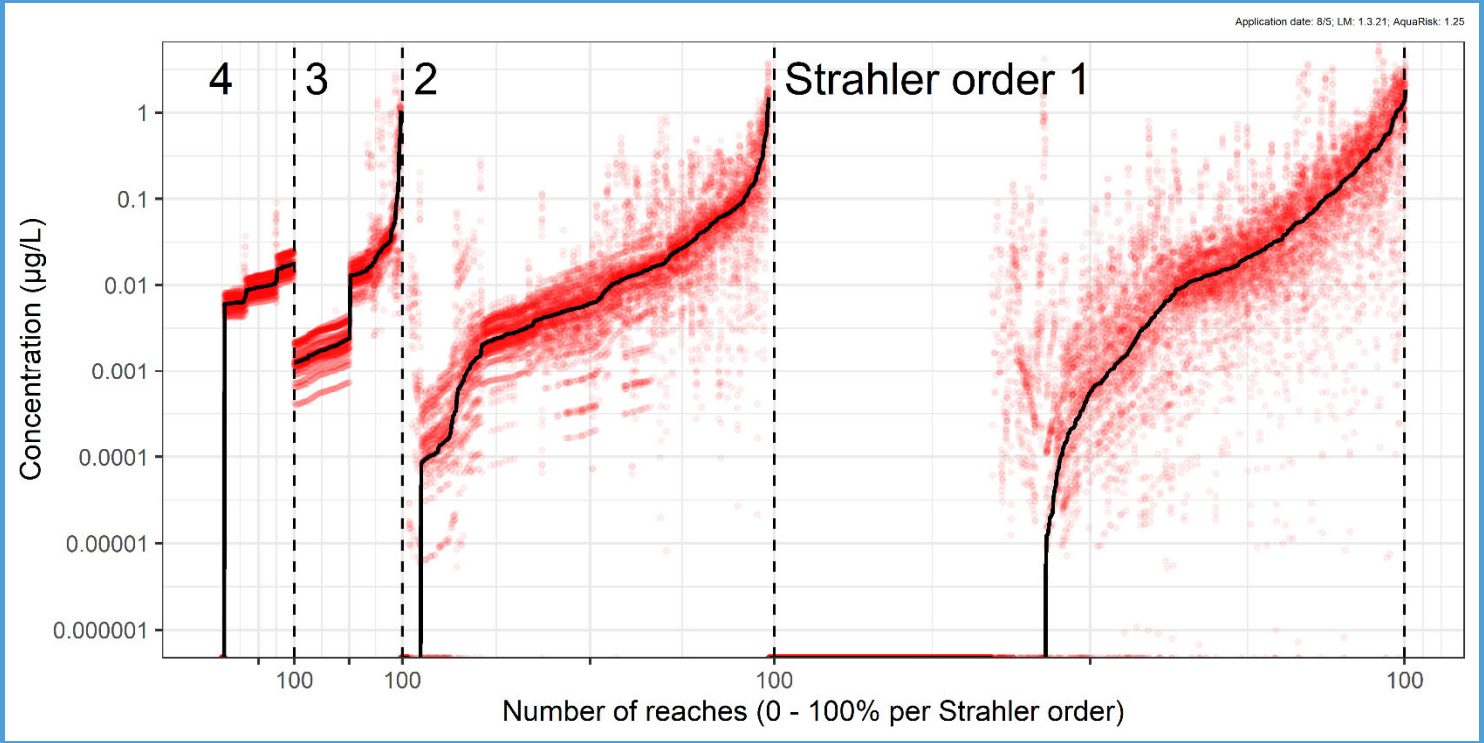
Simulation 23 years single application of an insecticide in apples



- 1735 Reaches in catchment allocated to four Strahler orders
- Spray drift from application of 12.4 g/ha insecticide, on 8 May in fields grown with apples
- Fate substance properties: K_{oc} 124 000 L/kg, DegT50 water 0.7 d, sediment 76 d
- Effects: TKTD-IT parameters for effects on survival of Asellus aquaticus, Cloeon dipterum, and Gammarus pulex
- Fate also simulated with six generic FOCUS stream scenario

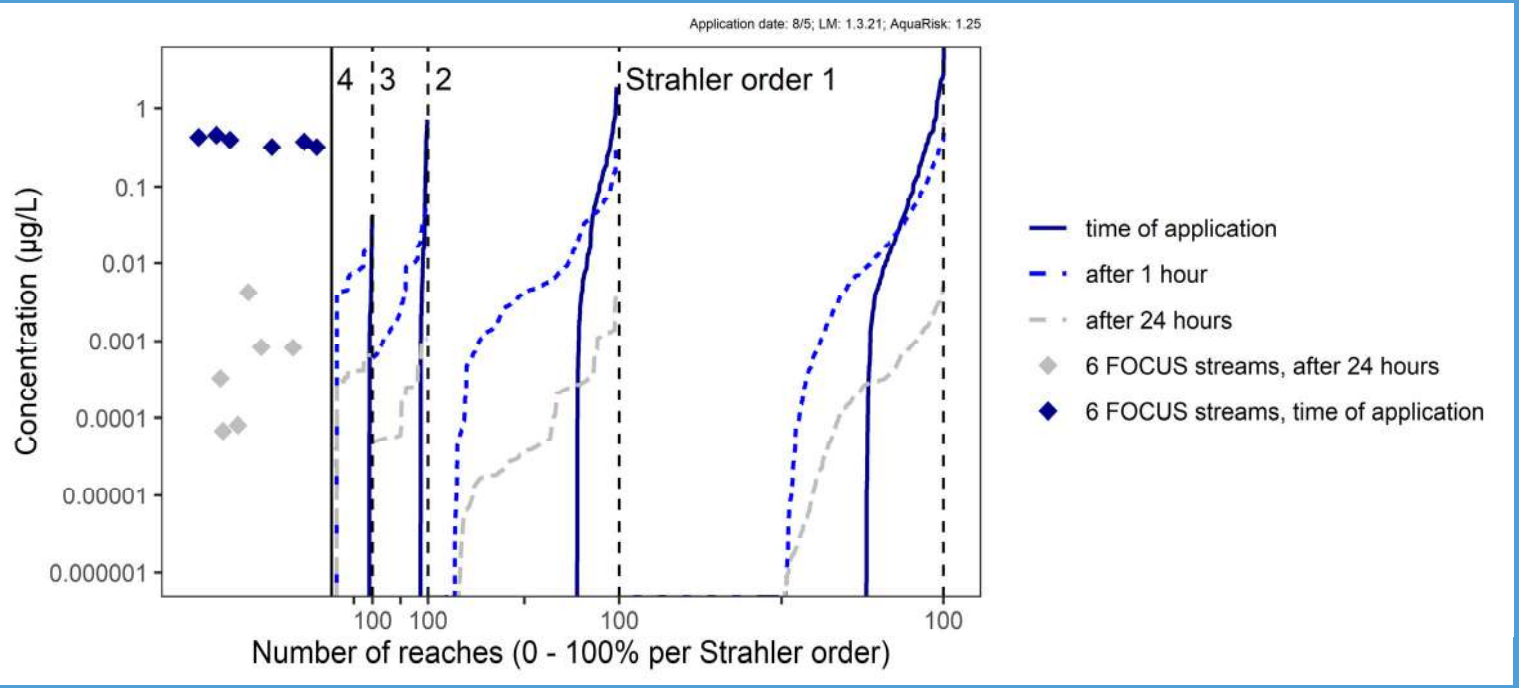
PEC-maximum concentration 1992-2015



PEC-maximum for 1735 reaches in 23 years (red circles), given per Strahler order with number of reaches 0 -100 %, sorted to the median value of 23 years (black curve).

Variation PEC maximum in 23 years due to variation in spray drift (wind) and reach hydrology; water depth and discharge

Concentrations in reaches in 1993 and for FOCUS stream scenarios

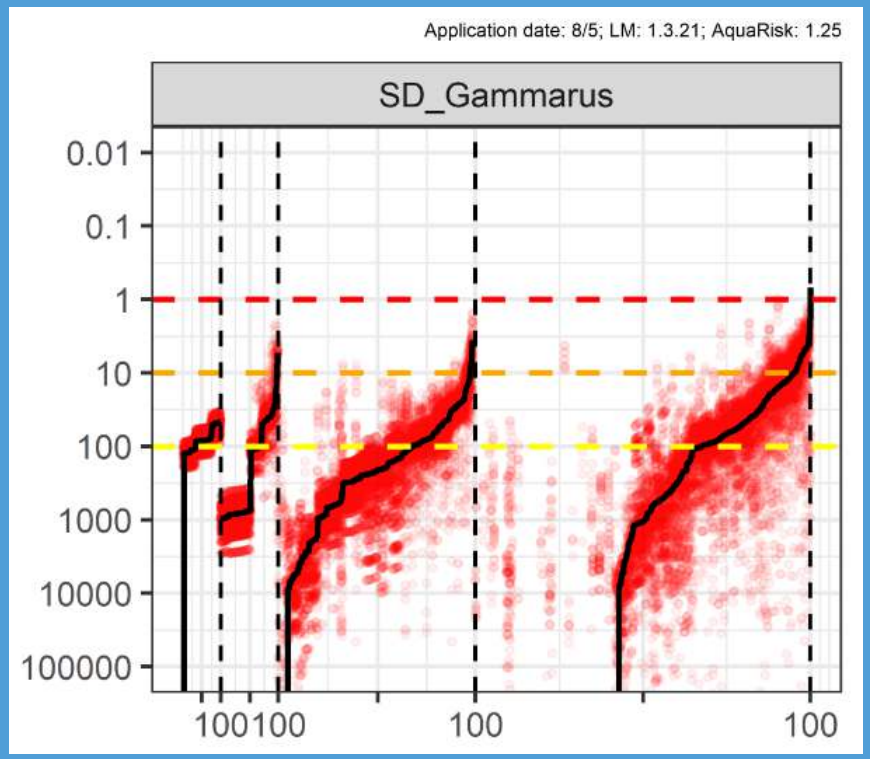


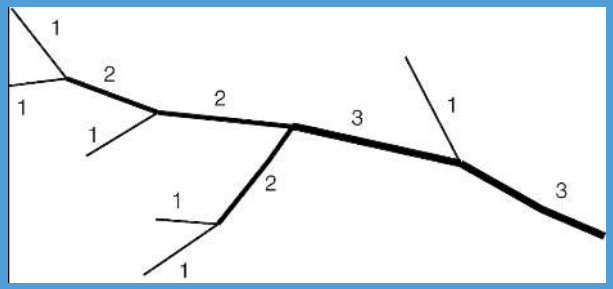
Concentrations in 1735 reaches per Strahler order (sorted with increasing concentration) at time of application, and after 1 and 24 hours (spray drift on 363 reaches)

Maximum PEC in reaches (0.00001 – 6.5 ug/L) higher than in FOCUS streams (0.32-0.46 ug/L) in 3.1 % of reaches, up to a factor 14

LP50 using GUTS model in catchment 1992-2015

Example for Gammarus





LP50 = the multiplication factor for the concentration corresponding to a decrease in survival of 50%

LP50 > 100 means no risk, so from horizontal yellow line down to x-axis

LP50 values for 1735 reaches in 23 years (red circles given per Strahler order with number of reaches 0 -100 %, sorted to the median value of 23 years (black curve). Horizontal dashed lines; LP50 100 (yellow), 10 (amber), 1 (red)

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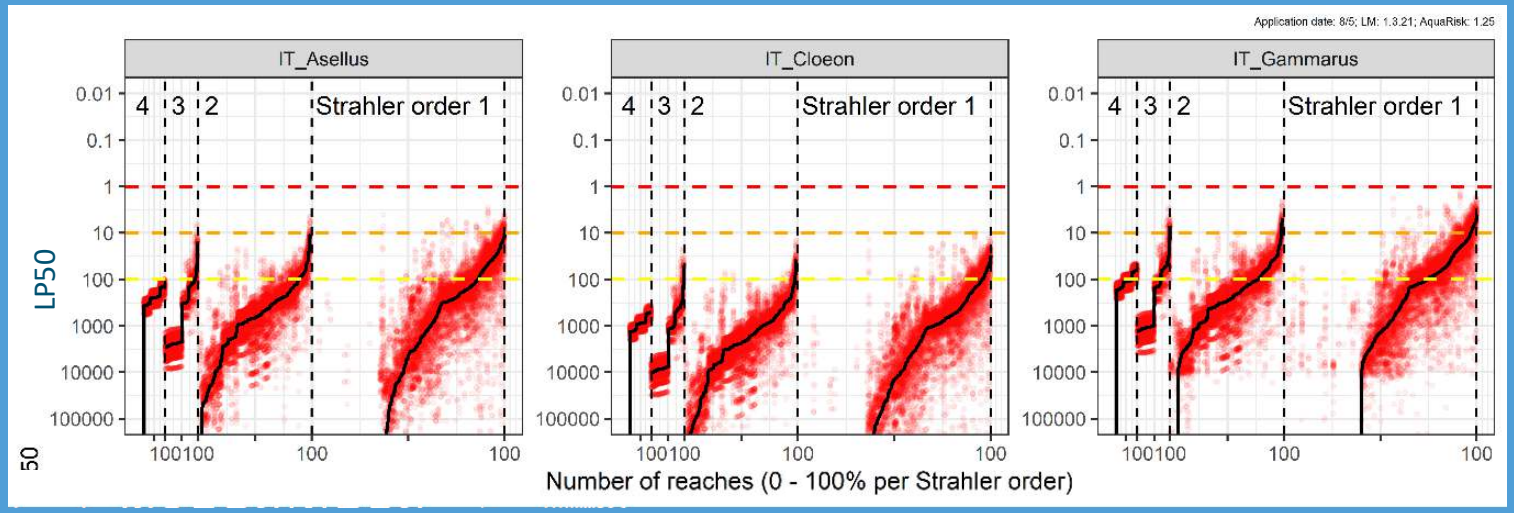
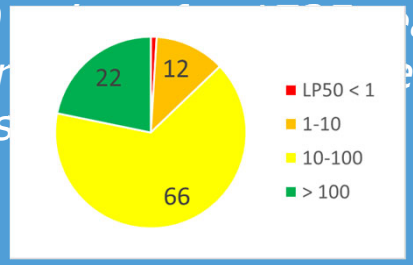
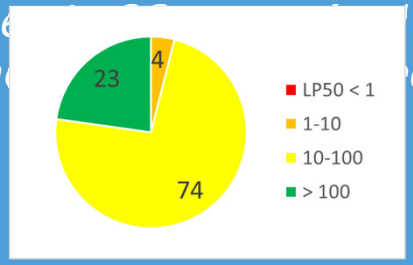
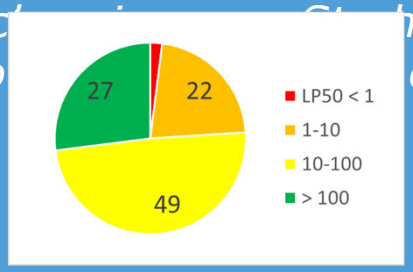
LP50 using GUTS model for Asellus, Cloen and Gammarus in catchment 1992-2015



LP50 [illegible] circ[illegible]hler order [illegible]d to [illegible] of 23 years







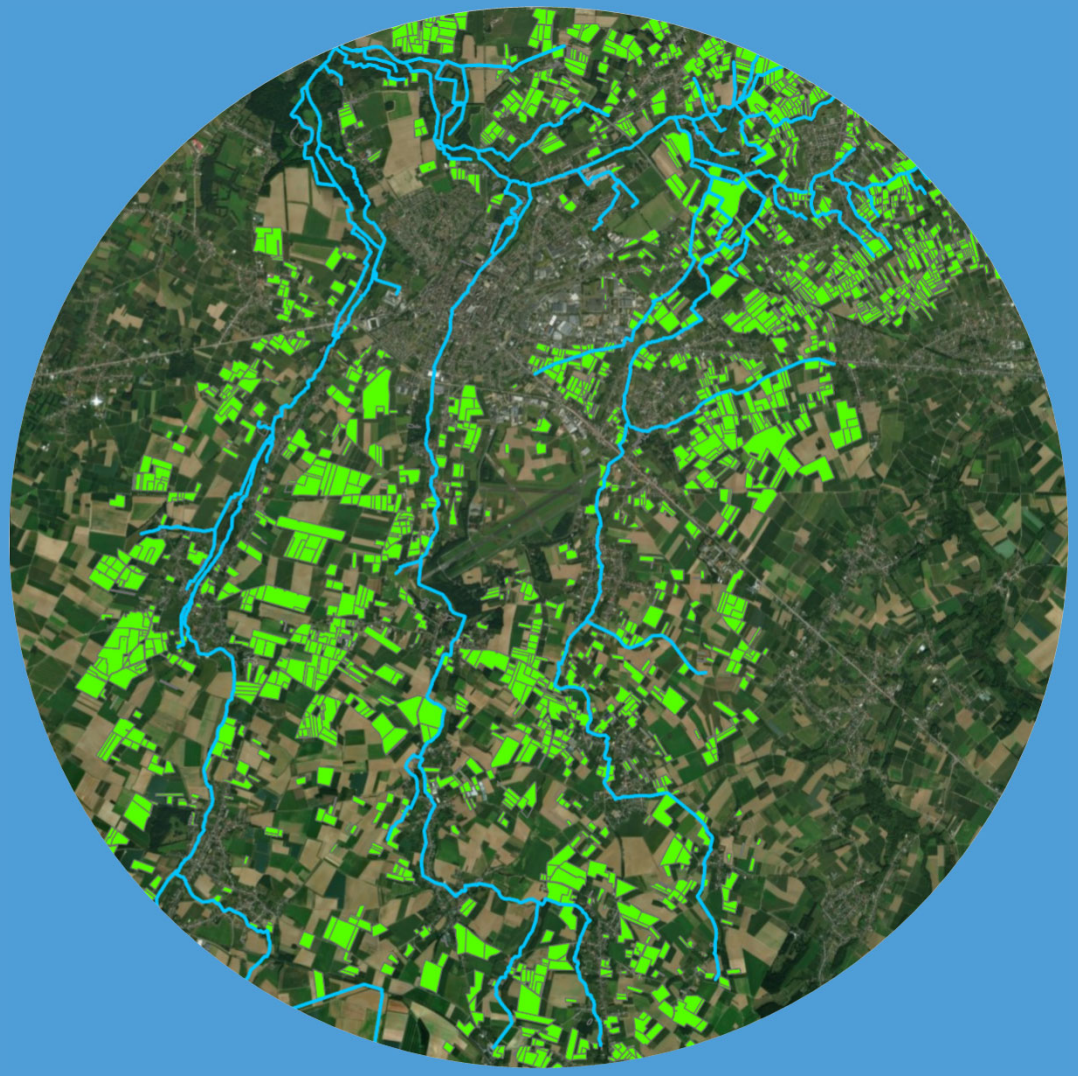
LP50 categories per species

#Gammarus highest risk in categories LP50 < 1 (2%) and LP50 1-10 (22%)

Conclusions and outlook

- Exposure: For a case study with strongly sorbing substance / spray drift
  - Compared to FOCUS streams, (1) PEC maximum concentrations caused by spray drift in this catchment is by a factor up higher to 10, because water depths in a catchment can be very low, (2) after 24 hours concentrations are similar
- Effects:
  - GUTS evaluations can be done for full time series for all 1735 reaches.
  - Differences between Strahler orders are less pronounced for LP50 than for PEC max -> GUTS evaluates full exposure time series, not only the maximum
- Risk assessment:
  - Regulatory interpretation of these results open

Thank you for your attention



This presentation links to posters by Louise Wipfler (4.07P.15) and by Florian Krebs (3.10P.13)

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