Mechanistic models to predict pesticide stress on *Daphnia magna* populations – an intermediate tier tool for ecological risk assessment

Karel Vlaeminck[1,2], Karel P. J. Viaene[1], Patrick Van Sprang[1], and Karel A. C. De Schamphelaere[2]

1 ARCHE Consulting, Liefkensstraat 35D, B-9032 Ghent (Wondelgem), Belgium;
2 Laboratory of Environmental Toxicology and Aquatic Ecology, Ghent University, Ghent, Belgium
Contact: karel.vlaeminck@arche-consulting.be

Introduction

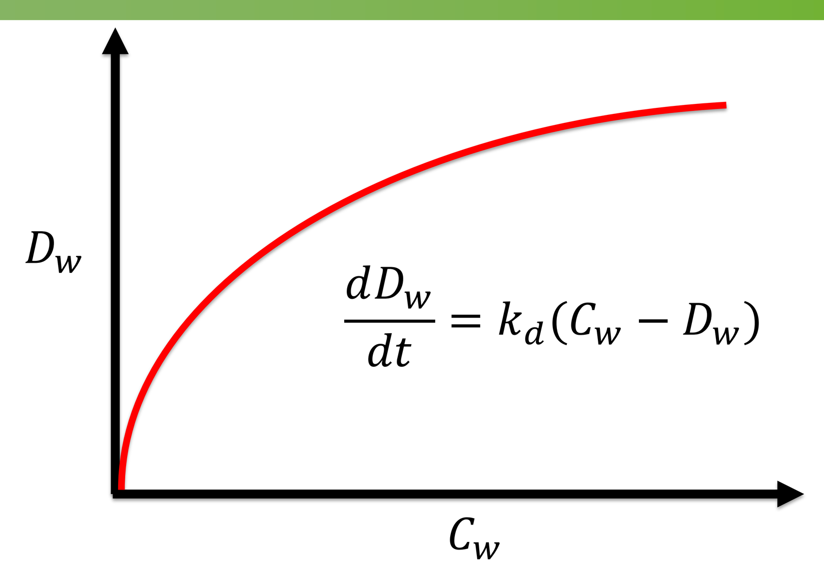
Pesticide risk assessment: complex and costly higher tier tests
Mechanistic models: an alternative intermediate tier tool

- Toxicokinetic-toxicodynamic (**TKTD**) models: predict the time-dependent build-up of effects
- Dynamic energy budget (**DEB**) models: describe the energy flows within the organism
- Individual-based models (**IBM**): individuals in the population are simulated as single entities

Goals and objectives:

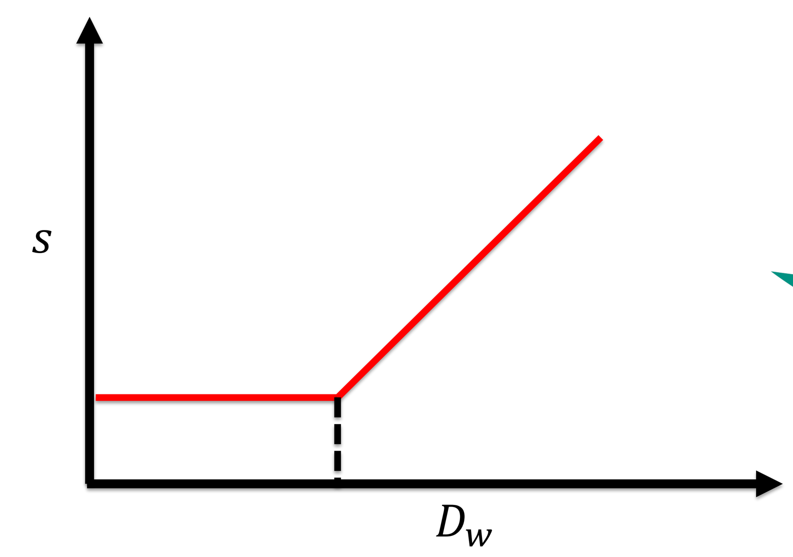
- Incorporate **effects into DEB-IBM**
- Simulate **FOCUS** scenario to assess effect of **time-variable** exposure
- Assess effects at the **population** level

Model development



Toxicant will be taken up by the organism: this will increase **damage**

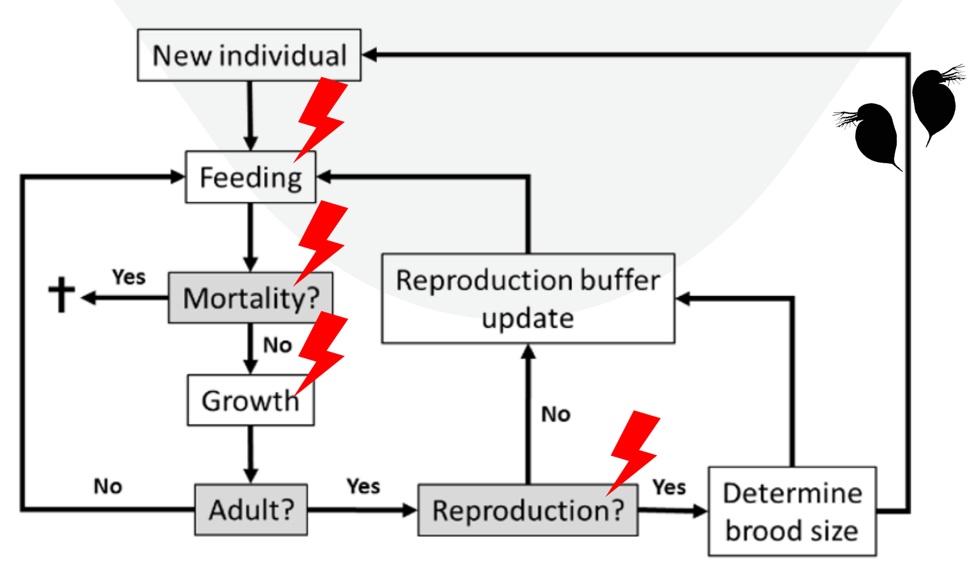
Symbols: dominant rate (k_d), damage level (D_w), water concentration (C_w), stress level (s), no effect concentration (NEC), tolerance parameter (c_T), hazard rate (h_z), background hazard rate (h_b), threshold for lethal effects (h_z), killing rate (b_w)



Damage above a certain threshold will cause **effects**

Lethal:	$h_z = b_w * \max(0, D_w - z_w) + h_b$
Sub-lethal:	$s = \frac{1}{c_T} * \max(0, D_w - NEC)$

DEB-IBM framework



DEB-IBM model for *Daphnia magna* populations

TKTD-DEB-IBM framework incorporates lethal and sub-lethal effects of the modelled compound and predicts population-level effects of time-variable exposure

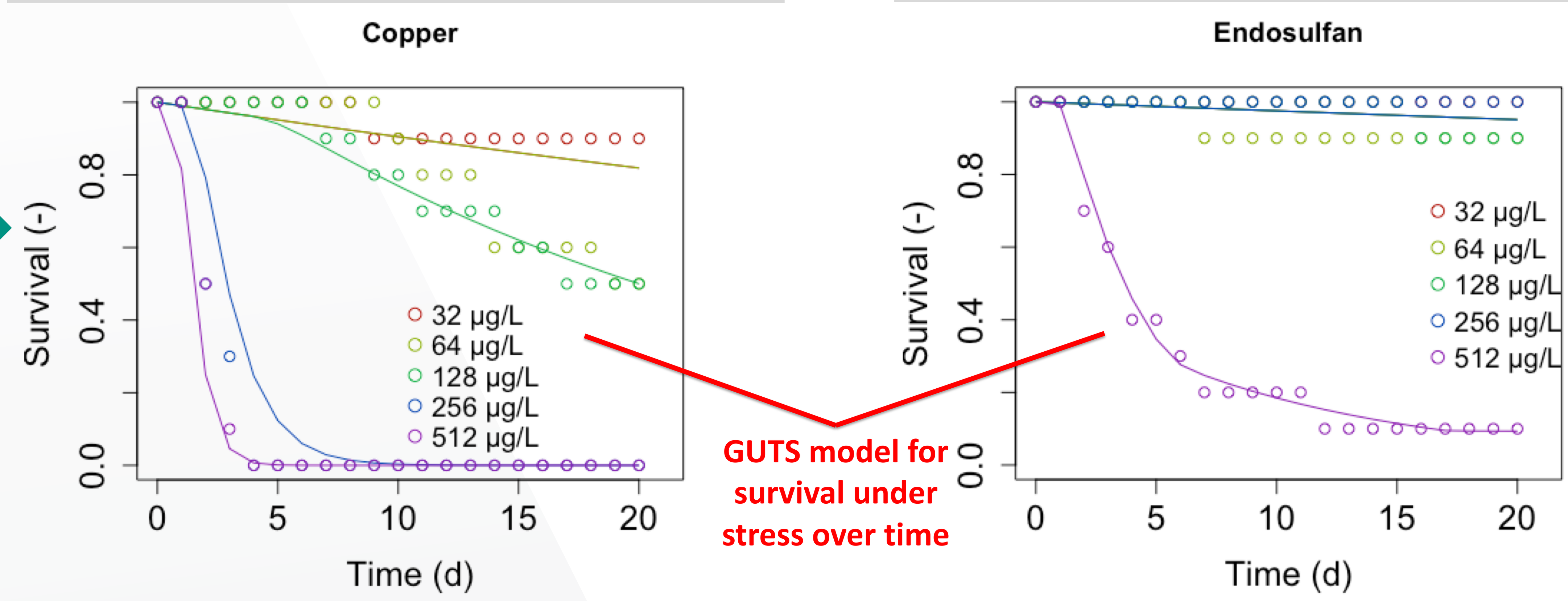
Model calibration

Standard toxicity test (21d) with *D. magna*

Survival:
Growth:
Reproduction:

Two model compounds: **Copper** (Cu) and **endosulfan**

GUTS approach for lethal effects
DEBtox approach for sub-lethal effects

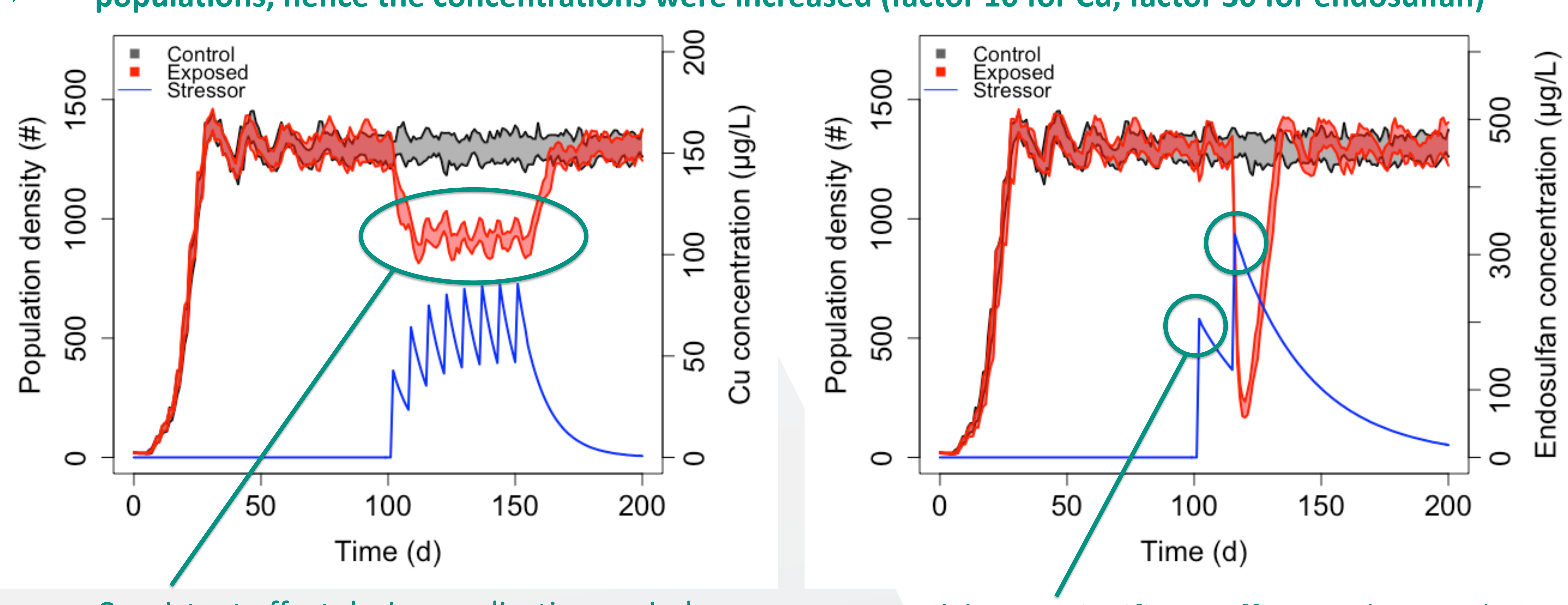


Scenario analysis

FOCUS scenarios for pesticide exposure and effect assessment

	Copper	*Endosulfan*
Application rate:	850 g/ha	840 g/ha
Nr. applications	8	2
Interval	7 d	14 d
Crop type	Fruity vegetables	Leafy vegetables
Location?	Northern EU	Southern EU
When?	May – June	March – May

*Predicted concentrations from the FOCUS scenario did not show significant effects on *D. magna* populations, hence the concentrations were increased (factor 10 for Cu, factor 30 for endosulfan)



Consistent effect during application period: a **decrease of 20%** in mean population density is predicted

First peak has **no significant effect** on the population
The second peak significantly reduces population density, but there is **fast recovery**

Discussion & conclusion

GUTS + DEBtox + IBM framework was constructed to extrapolate individual-level effects to the population level

DEB-IBM calibrated with standard toxicity data can assess time-variable effects at the population level for relevant exposure scenarios and predict ECx values at the population level

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