Exposure assessment for pesticide inputs into surface waters via surface runoff, erosion and drainage in Germany (GERDA)

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Outlook

- Motivation
- National exposure assessment approach
- GERDA assessment tool (brief outline)
- Percentiles of resulting PECsw

Disclaimer: the talk does not necessarily reflect exactly the position of the German Federal Environment-Agency to all particulars

Project launched by the German Federal Environment Agency (Umweltbundesamt, UBA, Project no 371163427), Environmental Research Plan, sponsored by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety).

Background

FOCUS surface water approach

Authorisation of active substances in the EU ➔ Annex I listing under Directive 91/414/EEC and approval under Regulation 1107/2009

FOCUSsw NOT intended for registration of compounds (national level)

Nevertheless: In 22[#] out of 27 EU* Member States
regulatory decision based on ≥ 1 FOCUSsw **R** and **D** scenario(s)

DK, NL[§], SL: Runoff and drainage: not considered
UK: Runoff: not considered; drainage: national approach
DE: Model Exposit

*) incl. Norway #) Regulatory experience DR. KNOELL CONSULT GmbH (stated 2013)

§) Conc. drainage ref. to Tiktak et al., 2012. Scenarios for exposure of aquatic organisms to plant protection products in the Netherlands: Part 1: Field crops and downward spraying. RIVM Report 607407002/2012

Motivation

Some weaknesses of FOCUS sw approach

- **EFSA Scientific Opinion:**

  "However, due to the lack of comprehensive database that characterize most of these agro-environmental parameters at the European level, when [FOCUSsw] scenarios were defined (1997-2003), they were not selected in a rigorous, statistically based manner". (EFSA 2013, p. 64)

EFSA, 2013. Guidance on tiered risk assessment for plant protection products for aquatic organisms in edge-of-field surface waters. EFSA Journal 2013, 11(7):3290.

Motivation

- **EFSA Scientific Opinion:**

  "(…) the FOCUS scenarios therefore may not address all the needs of groundwater assessments at the *national* level. For national assessments (…) the entire potential use area must be considered. The use of FOCUS scenarios for national registration purposes would require a thorough investigation of specific parameters (…) in order to assess whether the protection goals are met." (EFSA, 2013b, p. 7)

  Replace *groundwater* by *surface water* and the evaluation is true for FOCUSsw as well.

EFSA, 2013. Scientific opinion on the report of the FOCUS groundwater working group (FOCUS, 2009). EFSA Journal 2013, 11(2):3114

Starting point

- **Generally**

  Target variable PEC = f{soil; weather; substance properties; application practice}

  „Worst caseness" of exposure scenario and resulting PEC can not derived *a priori* from *CDF*[soil], *CDF*[weather], a.i. properties, and application data

CDF: Cumulative Distribution Function

National exposure assessment approach

Requirement for authorisation with statistically defined protectivity:

„overall“ *CDF*[PEC], covering

- all site conditions (here: soil and climate) for the territory
- all weather conditions

for a new substance with given properties and application data.

Problem: Computing time ➔ „overall“ CDF routinely not availabe

Alternative

i) Calculate overall CDFs for *given* DT50-Koc-crop-appl. month („substances“)

ii) Registration process: select one soil-climate scenario, whose properties of pre-calculated „substance“ similar to *new* substance

Criterion for selection: percentile of resulting PEC (i.e. protectivity)

iii) Use selected soil-climate scenario for exposure assessment of *new* substance

National exposure assessment approach

Identifikation of soil-climate scenarios for Germany

1) Soil classification

German Soil Map 1:1 Mio (BUEK 1000) soil units converted to **FOOTPRINT Soil Types (FST)***

➔ **102 FSTs for arable land** (132.000 km²)

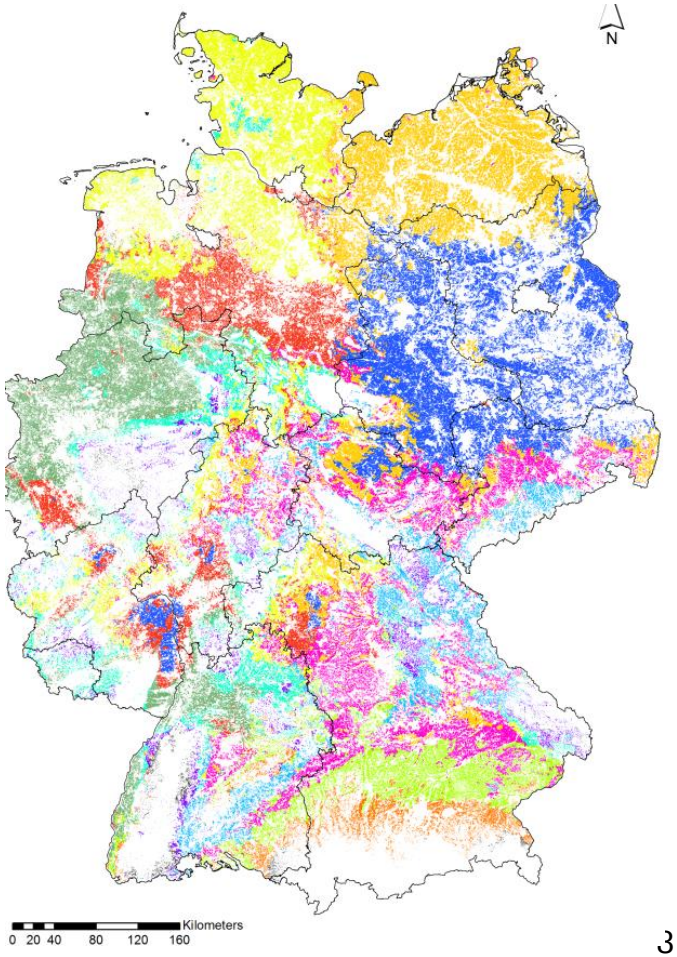
2) Clustering climate (100 m x 100 m grid)

➔ **12 Reference weather stations (DWD)**

30-year weather time series (1982–2011)

3) Intersection soil map ∩ climate cluster

- Runoff & erosion: **973 Soil-climate-comb.**
- Drainage: **311 Soil-climate-comb.**



*) J. Hollis (UK), Details ref. to FOOTPRINT Final Report, Dubus et al. (2009)

National exposure assessment approach

Definition of substance properties-crop-application month-combinations

	PRZM	MACRO
- Crop	**2** (Winter crop, Spring crop)	
- Application month	**12** (1. Jan, …, 1. Dec)	
- DT50	**3** (3, 30, 300 d)	
- Koc (L/kg)	**5** (10, 100, …, 100‘000)	**4** (10, 100, …, 10‘000)
Total number of combinations	**360**	**288**

CDF[PEC] for soil-climate-substance-crop-application-combinations

Simulation runs with PRZM 4.51 and MACRO 5.2 for 30 weather years

Combinations	PRZM	MACRO
Soil-climate	**973**	**311**
combined with	×	×
DT50-Koc-crop-appl. month	**360**	**288**
Combinations in total	350280	89658

STEPS-3 calculation of PECsw and PECsed

Output: 360 (runoff & erosion) and 288 (drainage) CDFs[PEC]

➔ Pre-processing for GERDA tool

GERDA exposure assessment (brief outline)

GERDA – GErman [or: GEobased] Runoff, erosion and Drainage risk Assessment

i) Selection of 2 **CDFs** with Koc & DT50 „nearest“* to the substance to be modelled

ii) From this CDFs: Selection of the **soil-climate-scenario**, correspondig to 80th spatial centile

iii) Simulating **edge-of-field losses** with **PRZM 4.51** (runoff & erosion) and **MACRO 5.2** (drainage) for 30 weather years (1982 – 2011).

Output: two 30-year time series of
- pesticide loss in water
- pesticide loss in sediment
- surface runoff volume
- sediment yield

*) „nearest“: Euclidean distance in the logarithmized Koc-DT50 axis

GERDA exposure assessment (brief outline)

iv) **STEPS-3:** From inputs via runoff, erosion, drainage and additionally spray drift and deposition: calculation of 30 year PECsw and PECsed time series for surface water scenarios *stream* and *ditch*

v) Read out 80th centile of 30 year time series (i.e. 6th highest conc. annual max) = **exposure endpoints**:

- annualPECmax,sw
- annualPECmax,sed

x 2 Inputs

- runoff & erosion
- drainage

x 2 Surface water scenarios

- ditch
- stream

(additionally: TWACs)

vi) **Authorisation decision**

GERDA – Percentiles of exposure endpoints

Distribution of percentiles of exposure endpoints PECmax,sw for **360** (PRZM) and **288** (MACRO) substances-crop-appl. month combinations
(PECmax for the combination 80th spatial / 80th temporal percentile for the scenarios)

Input via (model)	**Distribution of „level of protection“, i.e. percentile of exposure endpoint annual PECmax,sw**		
	Minimum	**MEDIAN**	Maximum
Runoff & erosion (PRZM)	83,2	**90,1**	93,2
Drainage (MACRO)	80,0	**82,6**	89,1

Summary

- GERDA: statistically based protectivity of exposure assessment
- Identification of 973 soil-climate combinations for runoff & erosion and 311 for drainage, covering spatial variability in Germany
- Definition of 360 (runoff & erosion) and 288 (drainage) combinations of Koc, DT50, crop, and appl. month.
- PRZM/MACRO/STEPS simulations: spatial CDF[PECsw,max] for 360 / 288 combinations of Koc, DT50, crop, and appl. month in Germany available
- Exposure endpoints: Combination of 80^{th} spatial / 80^{th} temporal percentile for soil-climate-scenario leads to “overall” (approx.) 90^{th} centile level of protection for PECmax
- For a new substance: GERDA exposure assessment (PRZM, MACRO, STEPS-3) is based on the ‘nearest’ soil-climate-scenario (by log-Koc and log-DT50)
- GERDA tool is ready to use
- Methodology is applicable to all EU member states (with appropriate soil and weather data)