Long-term surface water simulations with GERDA-STEPS

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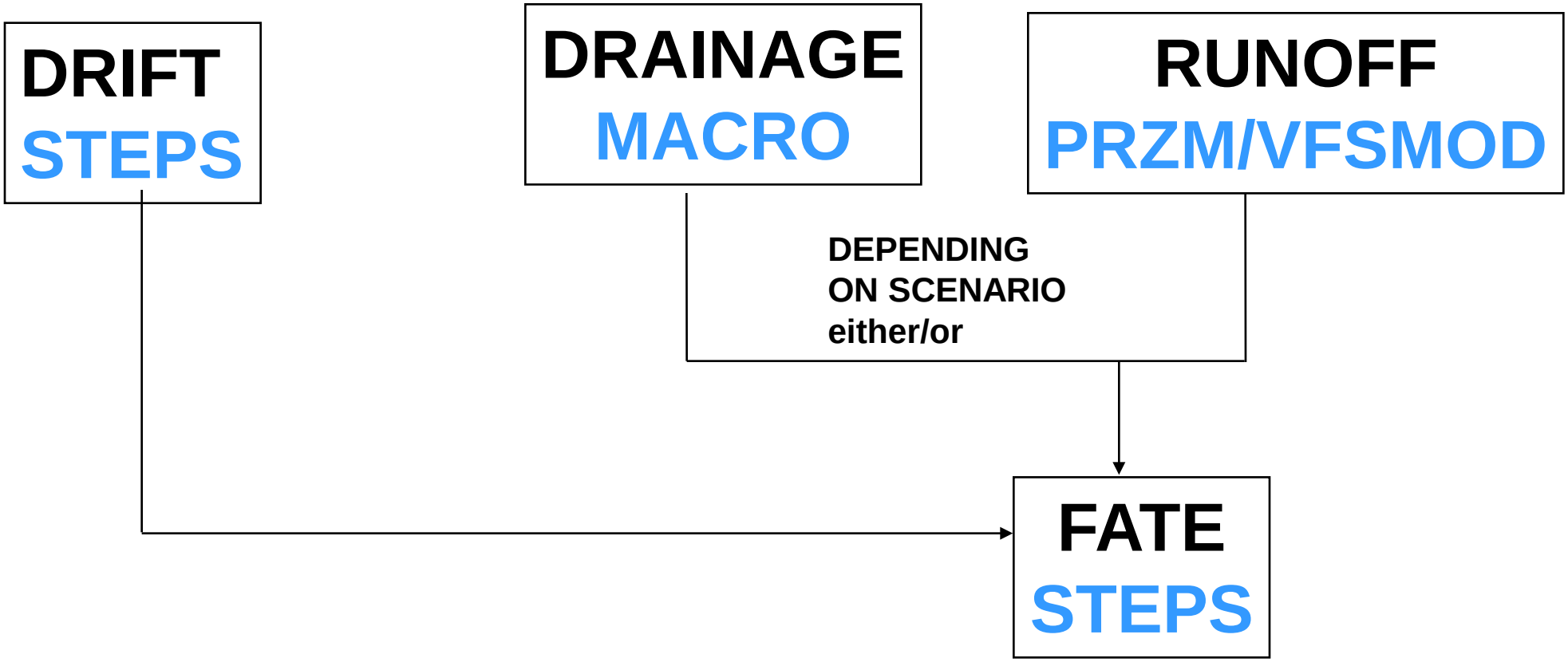
funded by
the German Federal Environmental Agenc/Umweltbundesamt

Long-term surface water simulations with GERDA-STEPS

- Background
- GERDA STEPS Methodology
- Working with GERDA STEPS
- Results of GERDA STEPS
- Conclusions

- Evaluation of the representativeness of the EU FOCUS SW scenarios for Germany
- Develop German FOCUS-type SW scenarios
- Repair the deficiencies of the FOCUS methodology
- Stay in general as close as possible to the FOCUS models and definitions for surface water bodies and catchments (harmonisation)

Main Exposure Routes in GERDA Steps



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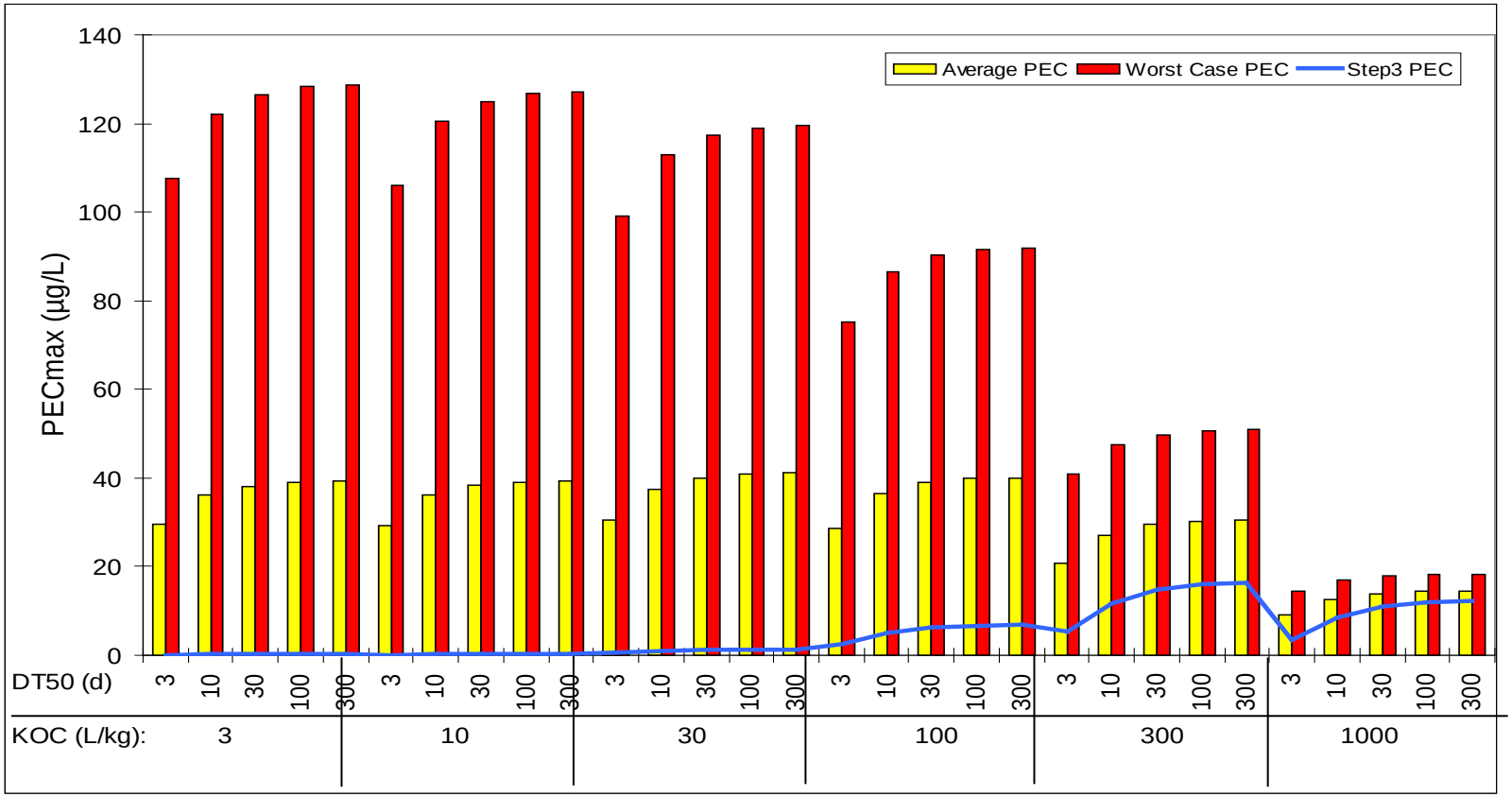
- Situation
  PRZM always runs over 20 years, while only 12 months are used for TOXSWA. MACRO runs over 7 1/3 years, with 16 months being used for TOXSWA
- Problem
  Pesticide concentrations in surface water are much more event driven than respective ground water simulations
- Consequence
  Similar pesticide applications in different years can lead to totally different entries into surface water even when applied in the same season
- Solution
  GERDA STEPS always runs over 30 years with annual applications. The output is based on an adequate spatial and temporal percentile



Annual PECmax (µg/L) for 30 hypothetical compound using FOCUS PRZM run-off entries over 20 years when 1 kg/ha was applied close to crop emergence (R1 pond scenario, winter cereals, spray drift switched off)

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- Situation
  Worst case situations depend on the combination of environmental conditions (weather, soil), pesticide properties and application pattern

- Problem
  Fixed soil-climate scenarios with short evaluation periods can hardly account for all these combinations

- Solution
  Adequate worst case scenarios should be selected based on the actual weather situation dependent on pesticide properties and application pattern

- Methodology
  Deriving cumulative distribution functions (CDFs) for all combinations of soil, weather, crop, application, entry route and pesticide properties based on the results of many preliminary GERDA-STEPS simulations (Ranking based on 80th percentile of 30 annual values)

- Environmental conditions:

  102 soil-climate-scenarios
  (based on BÜK and FOOTPRINT Soil Type system)
  12 climate scenarios (based on German DWD)

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  973 soil/climate combinations (used for run-off and erosion)
  311 soil/climate combinations (used for drainage modelling)

- Crop: 2 variations: "1 winter crop, 1 spring crop

- Application pattern: 12 different application dates (one per calendar month)

- Pesticide half life: DegT50soil (3 d, 30 d, 300 d)

- Pesticide sorption: drainage: 4 variations (KOC: 10, 100, 1000, 10000)
  run-off: 5 variations (KOC: 10, 100, 1000, 10000, 100000)

- Endpoint: 2 variations (PECmax, AUC)

Total number of combinations: drainage: 89 568, run-off: 350 280

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- General vulnerability: given according to the specified spatial percentile
- Entry routes: run-off and drainage (spraydrift, volatilisation similar as in FOCUS)
- Pesticide properties: smallest Euclidean distance in the logarithmised Koc-DT50 space
- Application month: The CDF is selected considering the first event of the actual application month
- Crop: The CDF is selected dependent on the crop type (winter or spring crop)
- Endpoints: Scenarios are given based on the cdf for PECmax and AUC
- Surface water bodies: Simulations are performed for ditches and streams

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Total number of simulations:

2 surface water bodies * 2 PEC descriptors * 2 entry routes = 8 combinations
(ditch and stream) (Max and AUC) (run-off and drainage)

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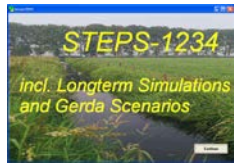
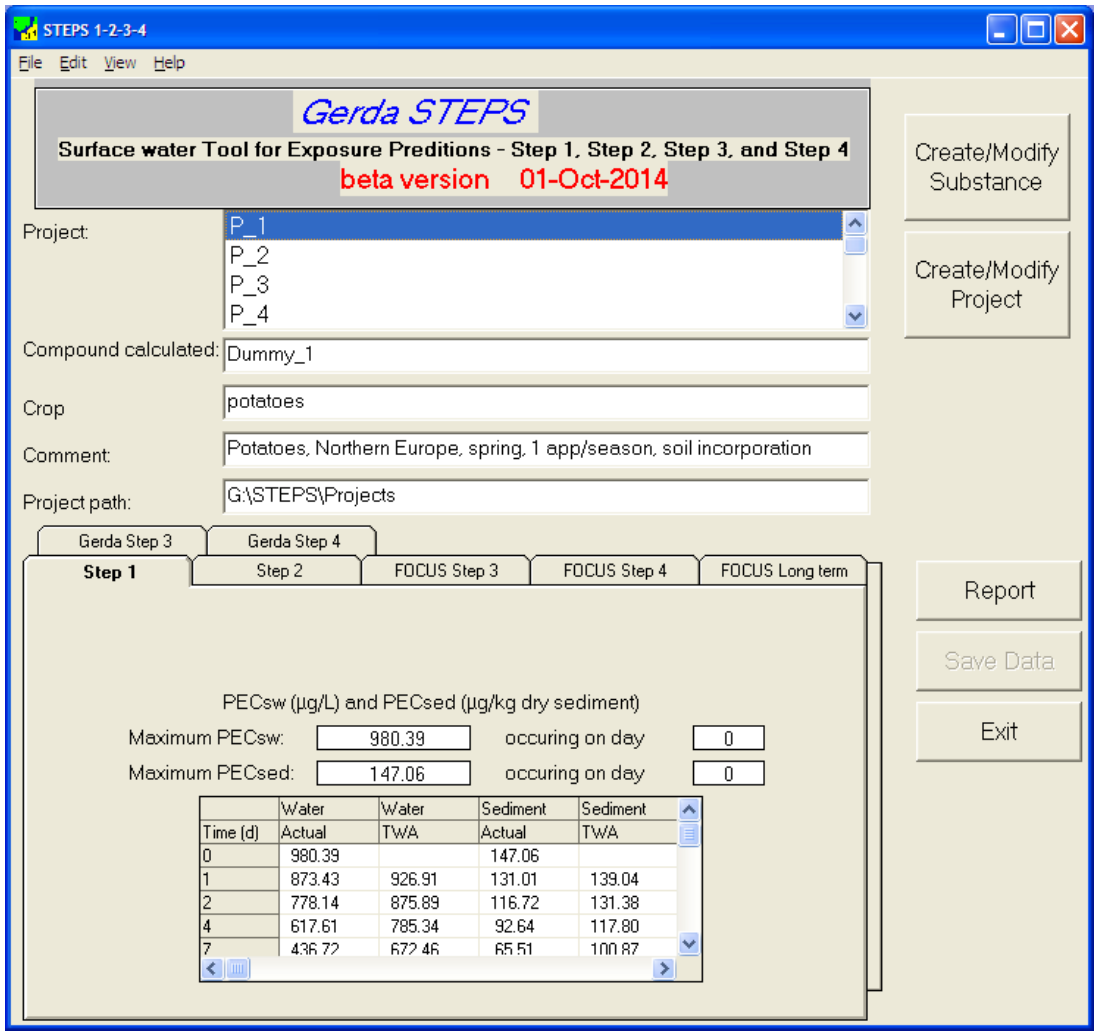


Running simulations at different levels



- Gerda Steps is based on STEPS-1234
- All FOCUS SW tiers are implemented
- Gerda scenarios were added, (PEC calculation for FOCUS stream and ditch)
- Central databases for Gerda and FOCUS projects and pesticide properties

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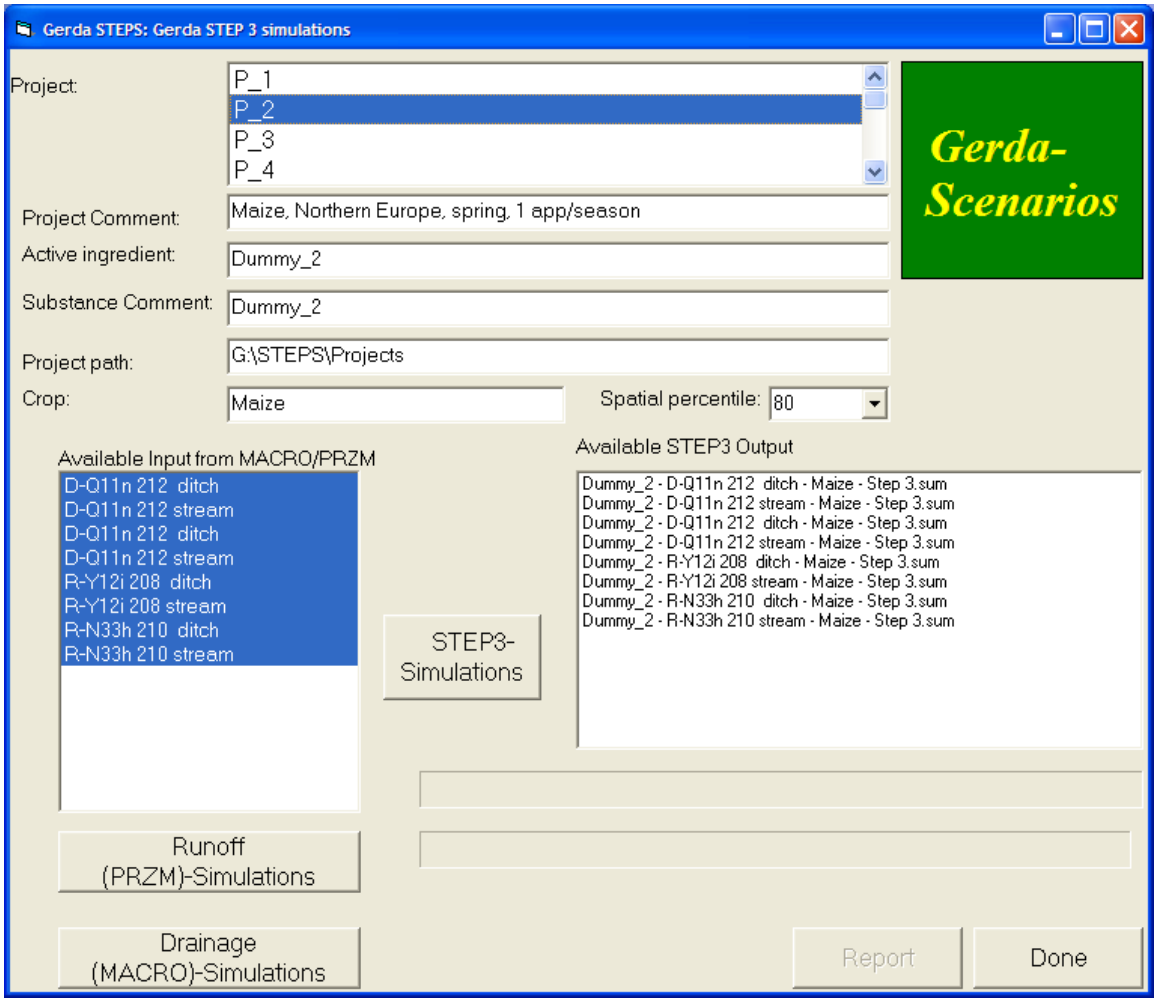
GERDA Steps 3 simulations



- The user selects the project
- The tool shows the respective 8 scenarios for the selected combination (PPP and GAP)
- The user has to run PRZM and MACRO first
- GERDA STEPS does not use the PRZM and MACRO model shells.
- Afterwards PECsw can be simulated (over 30 years)

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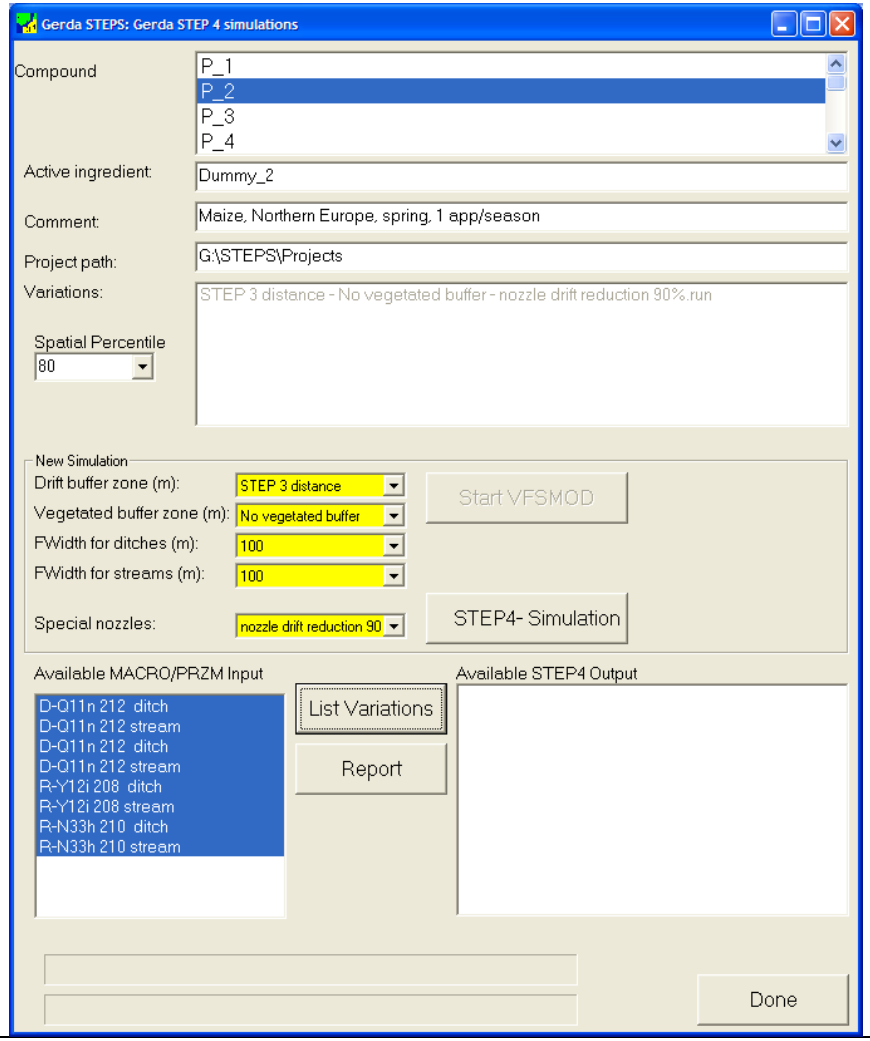
GERDA Steps 4 simulations



- Step 3 results have to be available. The user selects the project
- The tool shows the respective 8 scenarios for the selected combination
- The user selects the mitigation option
- If vegetated buffers are to be considered an additional VFSMOD-simulation has to be performed first
- Afterwards PECsw can be simulated (over 30 years)

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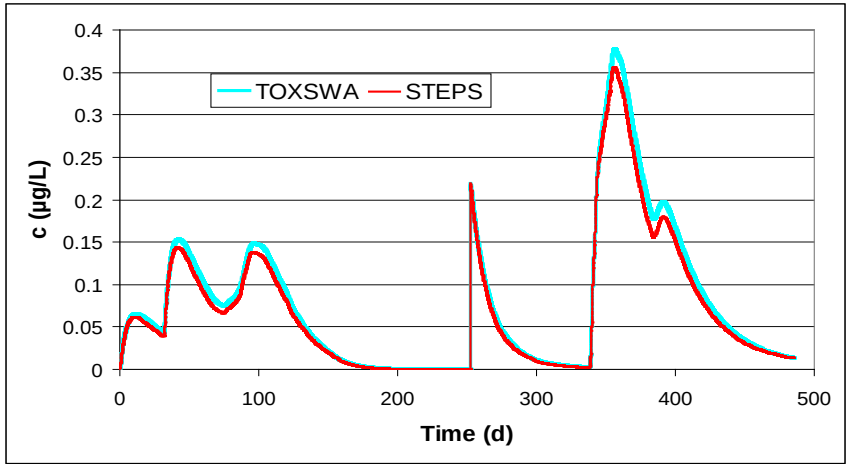
- Results are presented for FOCUS example Compounds 1 to 7

- Application timing as given in the FOCUS SW 2001 report but always "granular applications" to exclude the effect of spray drift

- Results are presented for
- FOCUS STEP 1 and 2
- FOCUS STEP 3 (calculated with STEPS instead of TOXSWA)
- GERDA STEPS 3
- GERDA STEPS 4



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Input parameters for the simulations (all with granular applications)

Substance		**1**	**2**	**3**	**4**	**5**	**6**	**7**
Koc	(cm^3/g)	15	91	1	1024000	860	66	500
Freundlich 1/n	(-)	1	0.88	1	0.93	1	1	1
Soil half-life	(days)	6	43	4	26	250	28	50
DT50(water)	(days)	6	26	1.5	0.7	6	24	2.5
DT50 (sed)	(days)	6	26	1.5	76	118	24	28
DT50(system)	(days)	6	26	1.5	76	118	24	28
Application rate	(kg/ha)	3	1	1	0.0125	0.075	0.4	0.75
Crop		Potatoes	maize	winter wheat	Apples	Vines	Cereals	Vines
Number of App		1	1	1	3	5	1	4
App. month		5	5	3	4	4	3	4

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GERDA: Results of GERDA STEPS for Drainage Scenarios (PECmax [µg/L])

FOCUS substance	**1**	**2**	**3***	**4**	**5**	**6**	**7**
FOCUS STEP 1	980.39	306.5	342.09	3.66	61.6	126.23	627
FOCUS STEP 2 North	123.52	55.74	33.29	0	6.54	16.65	52.12
D1 ditch (STEPS)	-	-	91.9 (95.5)	-	-	34.06	-
D1 stream, (STEPS)	-	-	60.5 (60.5)	-	-	21.35	-
D2 ditch (STEPS)	-	-	202 (217)	-	-	-	-
D2 stream (STEPS)	-	-	201 (207)	-	-	-	-
D3 ditch (STEPS)	0.0179	0.0285	0.0126	0	-	0.0835	-
D4 pond (STEPS)	0.1209	1.6309	0	0.018	-	0.3662	-
D4 stream (STEPS)	0.4744	1.8281	0.0001	0.146	-	0.3024	-
D5 pond (STEPS)	-	0.9806	0	0	-	0.1176	-
D5 stream (STEPS)	-	0.9482	0	0	-	0.1023	-
D6 ditch (STEPS)	41.4593	0.6539	0.0002	-	7.0	-	5.7743
GERDA D ditch°	0.9735	0	0	0	0	0.002	0
GERDA D stream°	0.6266	0	0	0	0	0.0013	0

(* in brackets: Toxswa results, GERDA PECmax scenario)

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GERDA: Results of GERDA STEPS for Run-off Scenarios (PECmax [µg/L])

FOCUS substance	**1**	**2**	**3***	**4**	**5**	**6**	**7**
FOCUS STEP 1	980.39	306.5	342.09	3.66	61.6	126.23	627
FOCUS STEP 2 North	123.52	55,74	33.29	0	6.54	16.65	52.12
R1 pond (STEPS)	0.27	0.5130	0.20 (0.20)	0	0.0235	-	0.2466
R1 steam (STEPS)	33.14	12.5	9.0 (9.1)	0.0001	1.7931	-	20.214
R2 steam (STEPS)	61.43	20.7	-	0	1.0784	-	14.1874
R3 stream (STEPS)	82.3	43.0	0.48(0.48)	0	0.8511	-	11.8816
R4 stream (STEPS)	-	45.0	0.25 (0.3)	0.0002	2.0369	0.24968	17.2496
GERDA R ditch	121.34	46.02	15.8252	0.0011	1.9345	12.5383	15.6417
GERDA R stream	109.75	41.7084	24.3764	0.0009	1.4563	16.4605	12.1489
GERDA R ditch, 10 m°	22.134	7.6734	10.3325	0	0.107	2.1945	0.5654
GERDA R stream, 10 m°	44.32	10.9195	2.2376	0.0003	0.0228	6.9639	1.7818

(* in brackets: Toxswa results, GERDA PECmax scenario)

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- The new Software GERDA STEPS tool provides tailored step 3 scenarios for German environmental conditions
- With regard to surface water and catchment properties GERDA STEPS considers the original FOCUS definitions
- Soil-climate scenarios are selected by the software dependent on pesticide properties, crop type and application timing
- Major FOCUS deficiencies such as the short simulation period were repaired
- The system allows the calculation of PECsw for user-defined spatial and temporal percentiles
- GERDA STEPS includes mitigation options for drift as recommended by FOCUS landscape and mitigation (drift reduction) and considers the effect of vegetated buffer strips based on VFSMOD simulations.

Summary and Conclusions related to example simulations 1

- In 2 of the 7 example runs FOCUS step 3 show higher results than respective FOCUS step 2 simulations (always caused by drainage entries)

- The so far available GERDA results (80 spatial + 80 temporal percentile) always remained below respective FOCUS STEP 1 and 2 simulations.

- Compared to FOCUS Step 3 the GERDA Step 3 drainage scenarios (80 spatial + 80 temporal percentile) result in lower or similar concentrations.

- In 4 of the 7 example the GERDA Step 3 run-off scenarios (80 spatial + 80 temporal percentile) show higher results than respective FOCUS Step 3 simulations.
  The differences were partly significant (up to a factor 100 in one example).
  Background of these deviations seem to be the short simulation period in FOCUS

- GERDA step 4 simulations performed with VFSMOD show different reduction dependent on the scenario and the compound. The range was between a factor of 2 to 30 for a 10 m vegetated buffer zone

- The combination of an 80th spatial with an 80th temporal percentiles seems to obtain reasonable realistic worst case situations resulting in a overall protection level for exposure of around 90 %.

- The methodology could be principally transferred to other European conditions assumed the necessary information on soil and weather can be made available

Thank you for your attention

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