OPTAIN Optimal Strategies to Retain Water and Nutrients

Assessing the impact of water and nutrient retention measures using a contiguous object connectivity approach

Insights from the German OPTAIN case study

2023 Aarhus SWAT Conference

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UFZ HELMHOLTZ Centre for Environmental Research

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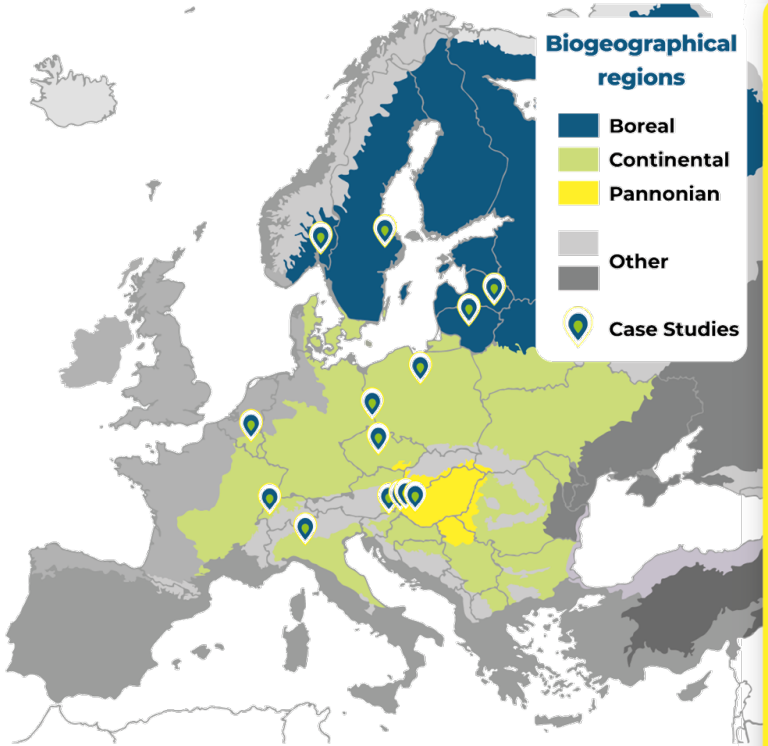
Optimal Strategies to Retain Water and Nutrients

PROJECT INFO



21 partners from 15 countries across Europe

14 partners will contribute with their own case study

7 million Euro budget

5 years duration 2020-2025

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Coordinator
Prof. Dr. Martin Volk
Helmholtz Centre for Environmental Research – UFZ

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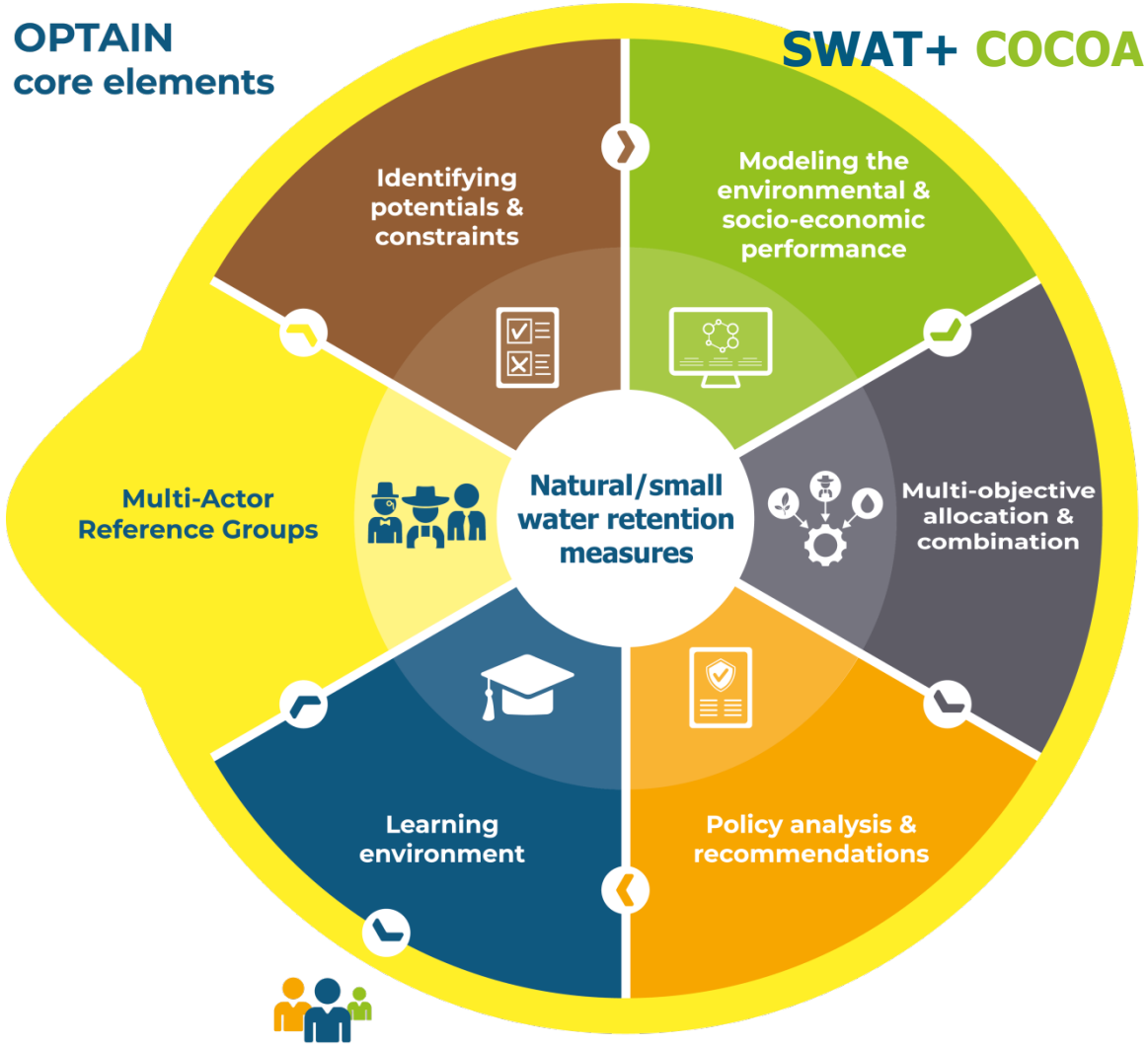
OPTAIN core elements

SWAT+ COCOA



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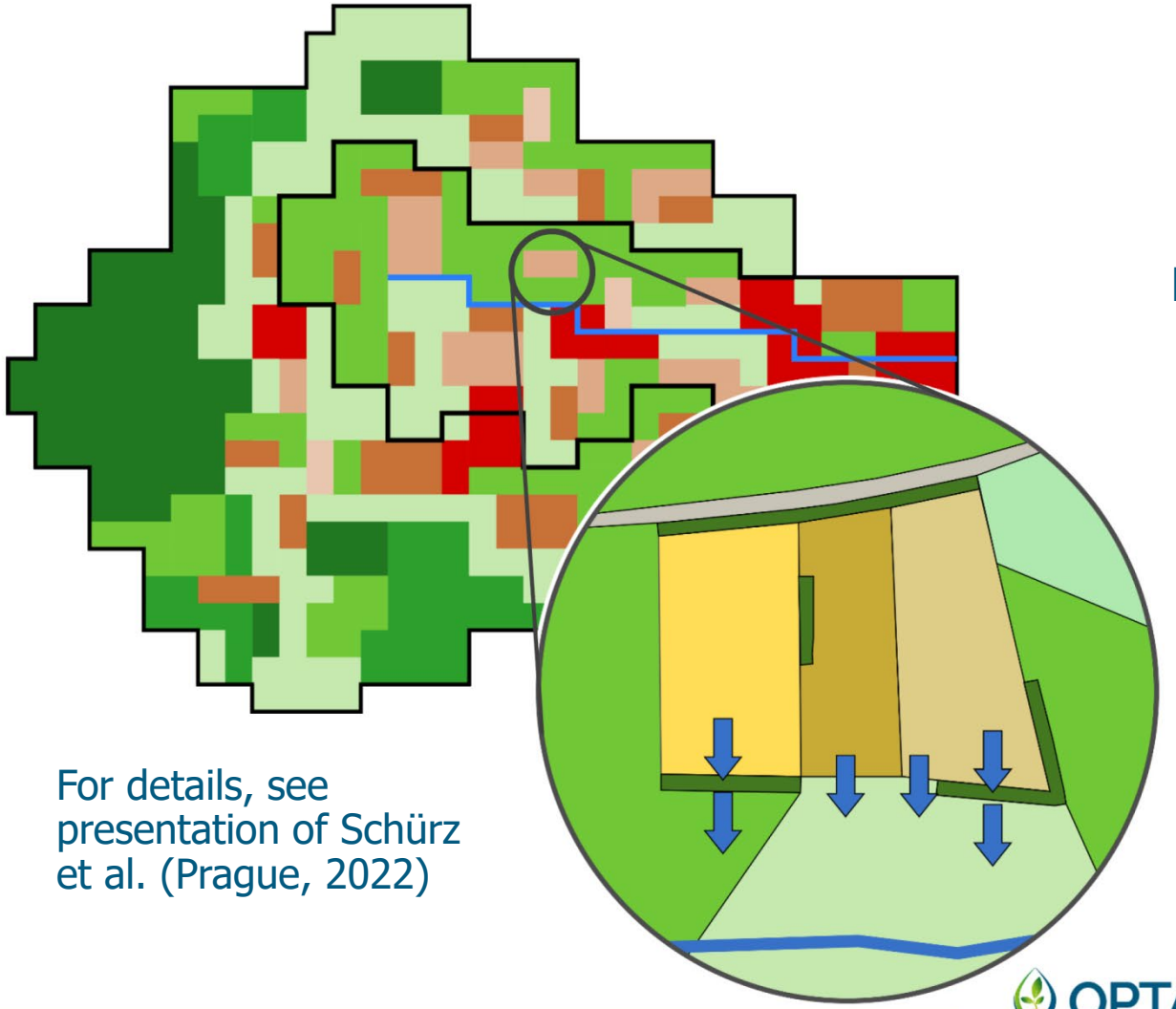
GA 862756

COCOA – Contiguous objects connectivity approach

Connectivity between all objects according to flow accumulation

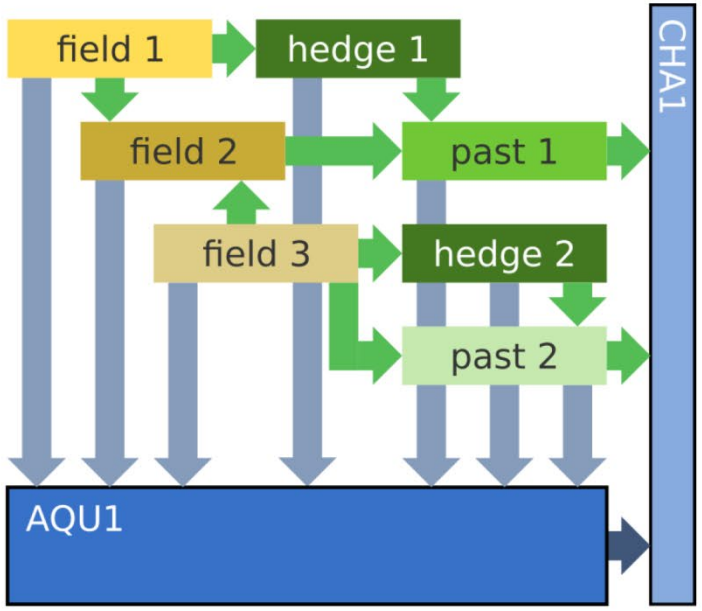


For details, see presentation of Schürz et al. (Prague, 2022)

Contiguous object:

- Self-contained spatial unit
- Defined border with neighbor objects

R package SWATbuildR to setup SWAT+ COCOA models



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Schwarzer Schöps River Basin

Test catchment
(~18 km²)

Full catchment
(~137 km²)

- barren, sparse vegetation
- cropland
- meadows
- forest
- orchards
- grass, semi-natural
- shrubs, semi-natural
- urban, low density
- urban, moderate density
- urban, transport
- water
- wetlands

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Measures to be modelled...

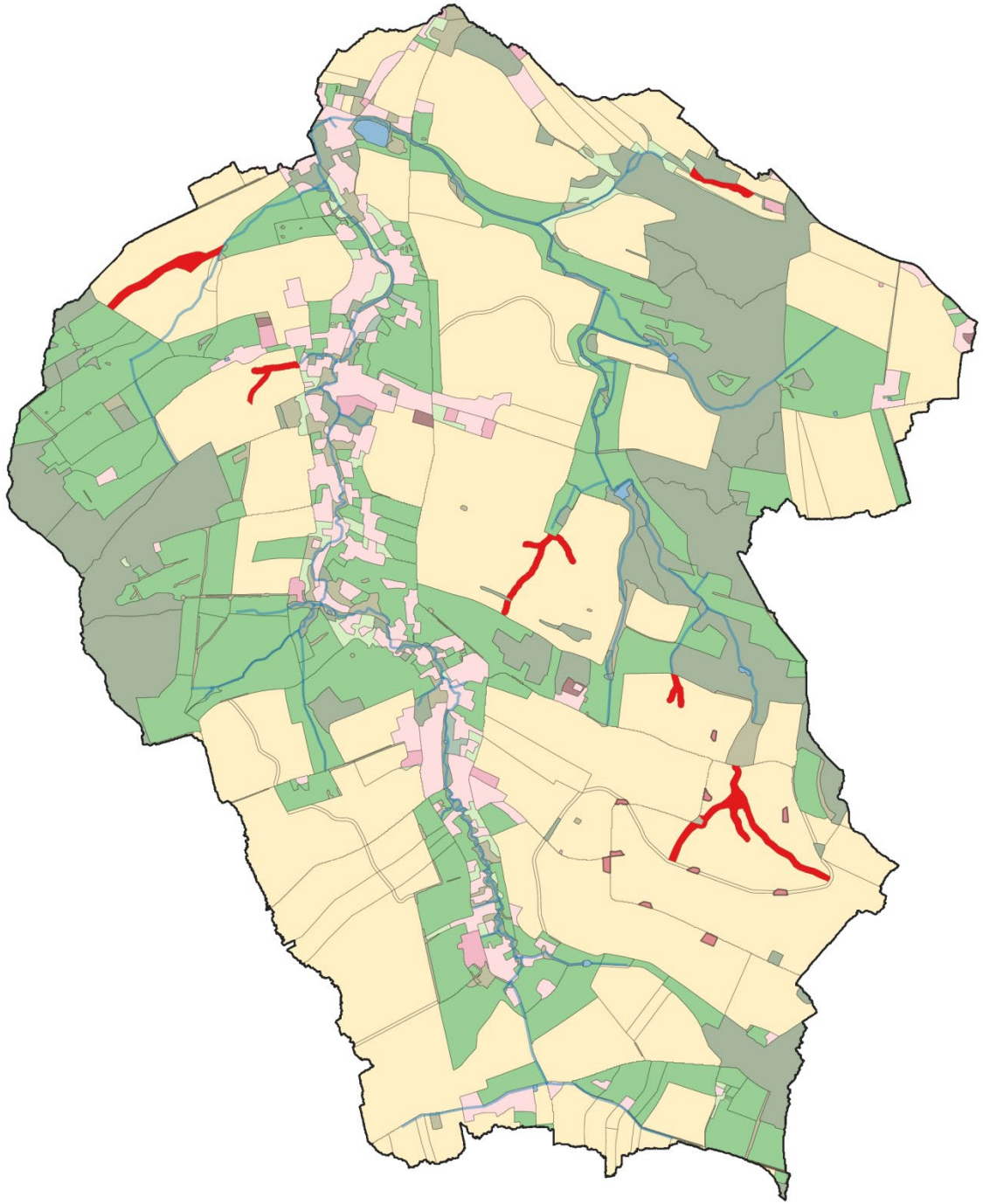
(1) Grassed waterways

Model setting for affected hrus:

landuse.lum

⇒ mgt: rnge
⇒ cn2: pasth
⇒ ov_mann: densegrass

(vs. status quo setting for cropland)



Measures to be modelled...

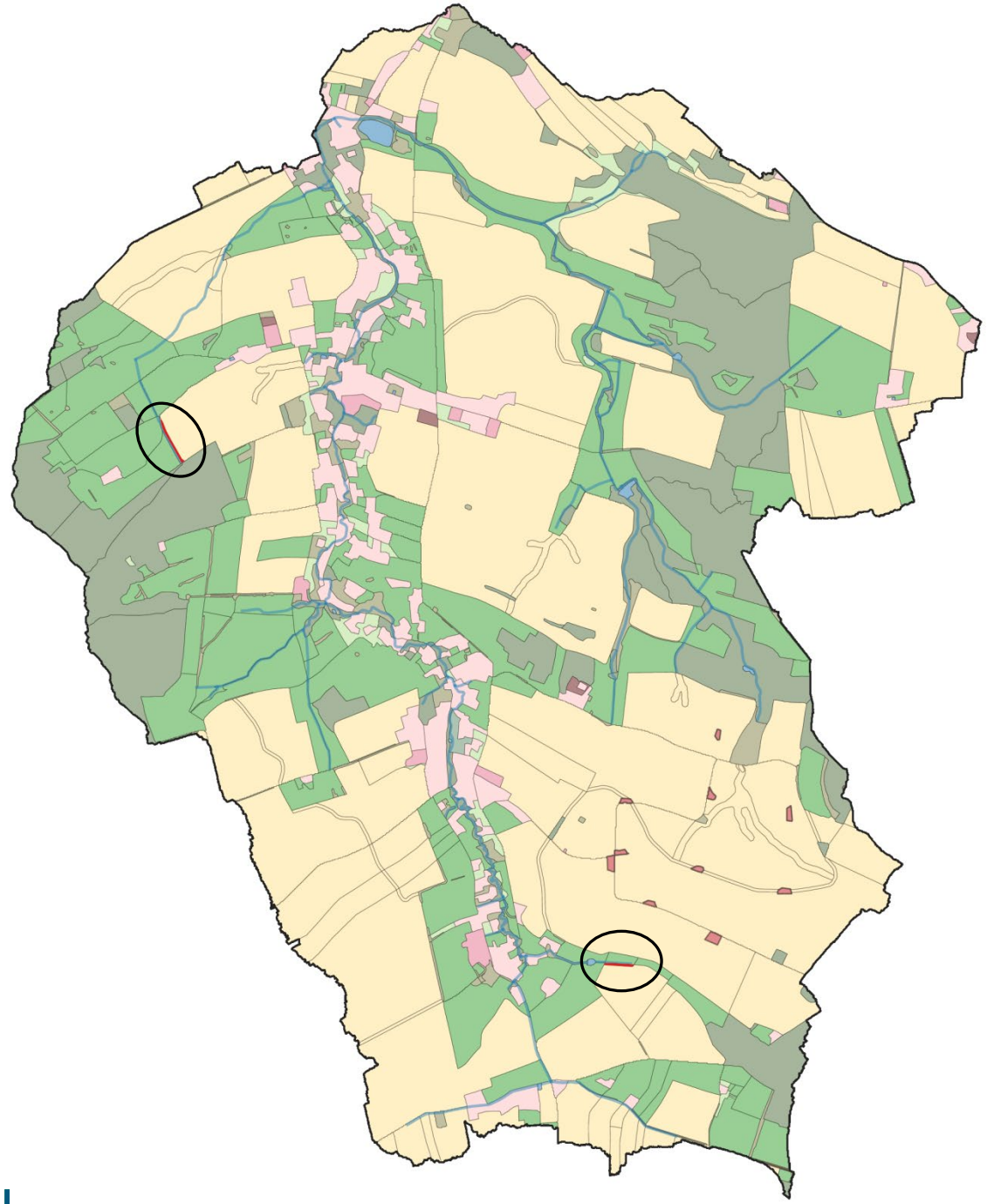
(2) Riparian buffer

Model setting for affected hrus:

landuse.lum

⇒ mgt: rnge
⇒ cn2: pasth
⇒ ov_mann: densegrass

(vs. status quo setting for cropland)



Measures to be modelled...

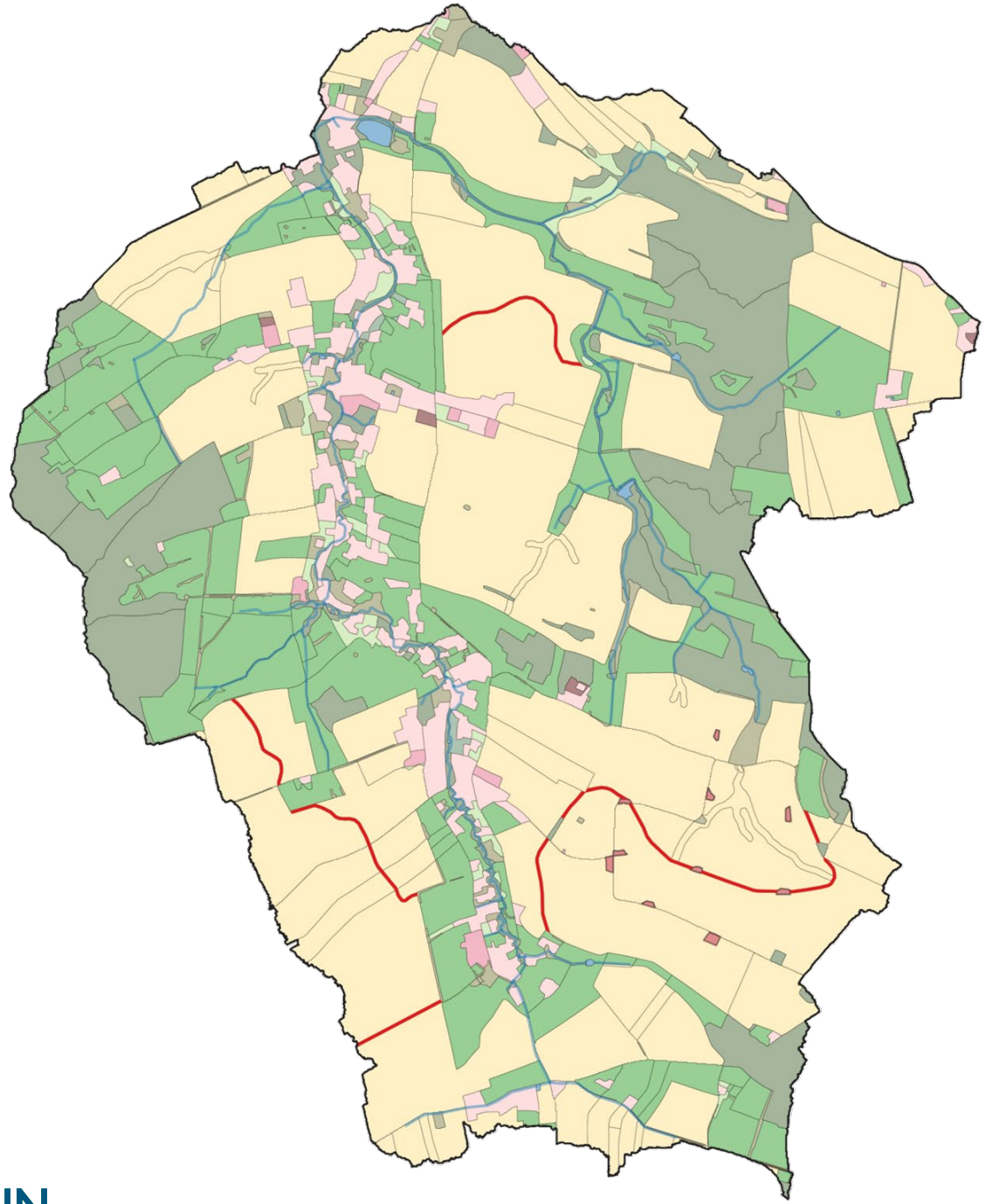
(3) Hedges

Model setting for affected hrus:

landuse.lum

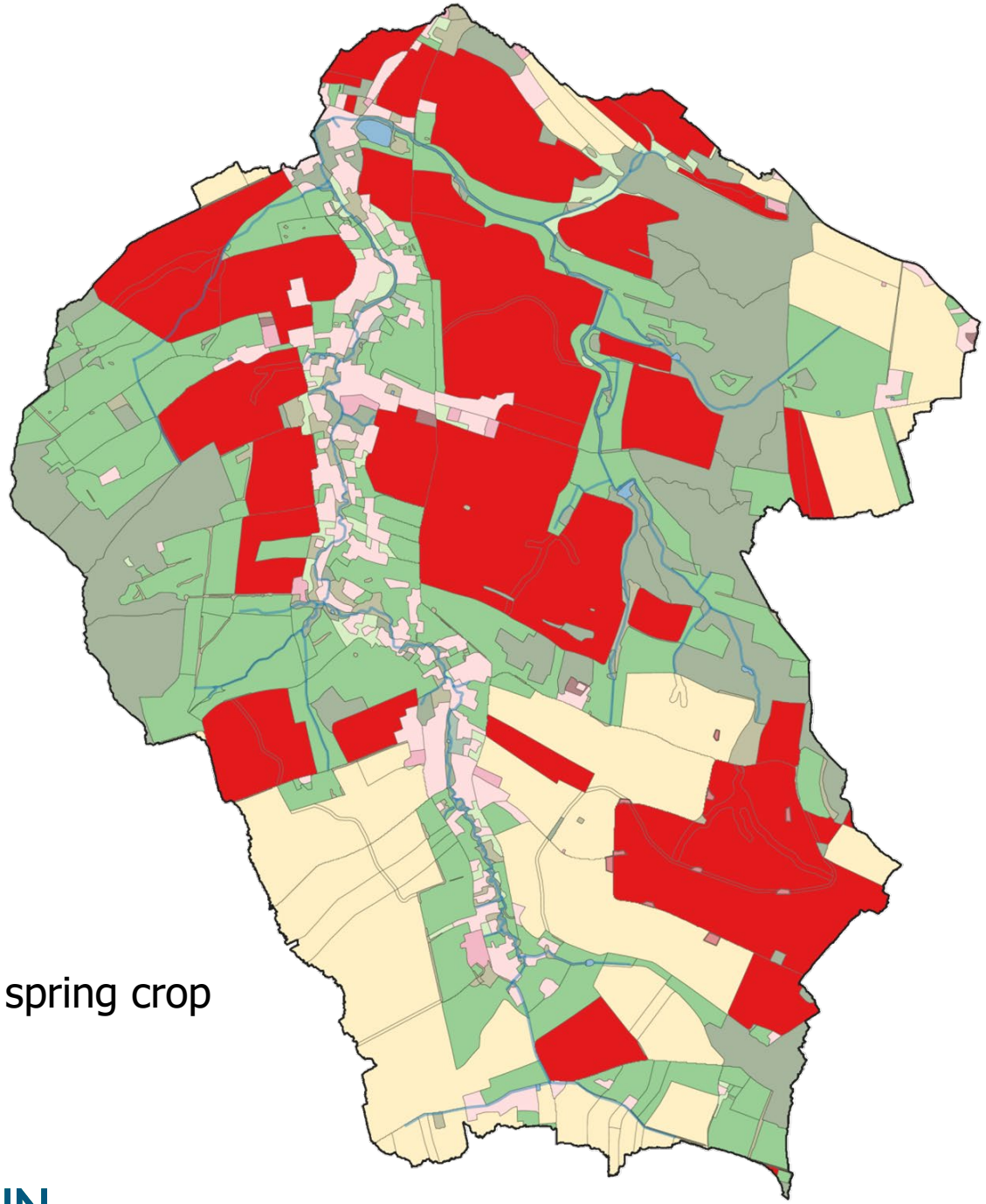
⇒ mgt: frsd
⇒ cn2: wood_g
⇒ ov_mann: forest_light

(vs. status quo setting for cropland)



Measures to be modelled...

(4) Low till & cover crops



Model setting for affected hrus:

landuse.lum

⇒ cn2: rota5
⇒ cons_prac: rota5
⇒ ov_mann: rota5

management.sch

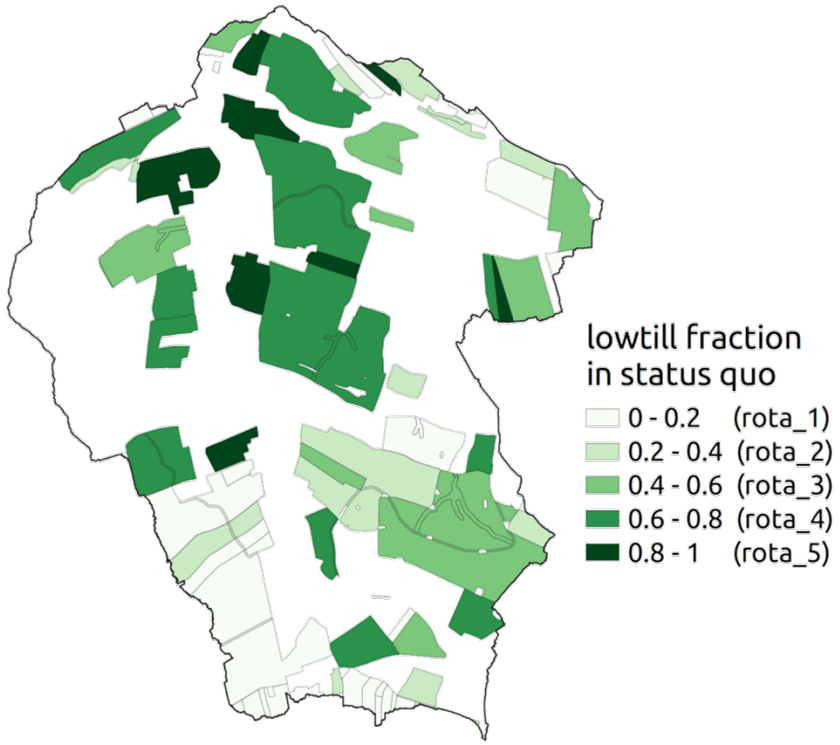
⇒ change till type (100% lowtill)
⇒ include cover crop before each spring crop

(vs. status quo setting with different fractions of lowtill)

Measures to be modelled...

(4) Low till & cover crops

Lowtill is already considered in status quo (assuming different fractions):



In scenario all fields change to 100% lowtill (rota_5)

We defined parameter values for each fraction class:

ranging between straight_row and contoured_w_residue

cntable.lum: written by SWAT+ editor v2.1.0 on 2023-0

name	cn_a	cn_b	cn_c	cn_d
	Good			
rota_1	64.70000	76.15000	83.65000	87.60000
rota_2	64.10000	75.45000	82.95000	86.80000
rota_3	63.50000	74.75000	82.25000	86.00000
rota_4	62.90000	74.05000	81.55000	85.20000
rota_5	62.30000	73.35000	80.85000	84.40000

ranging between up_and_down_slope and contour_tillage

cons_practice.lum: written by SWAT+ editor v2

name	usle_p	slp_len_max
rota_1	0.95000	121.00000
rota_2	0.85000	121.00000
rota_3	0.75000	121.00000
rota_4	0.65000	121.00000
rota_5	0.55000	121.00000

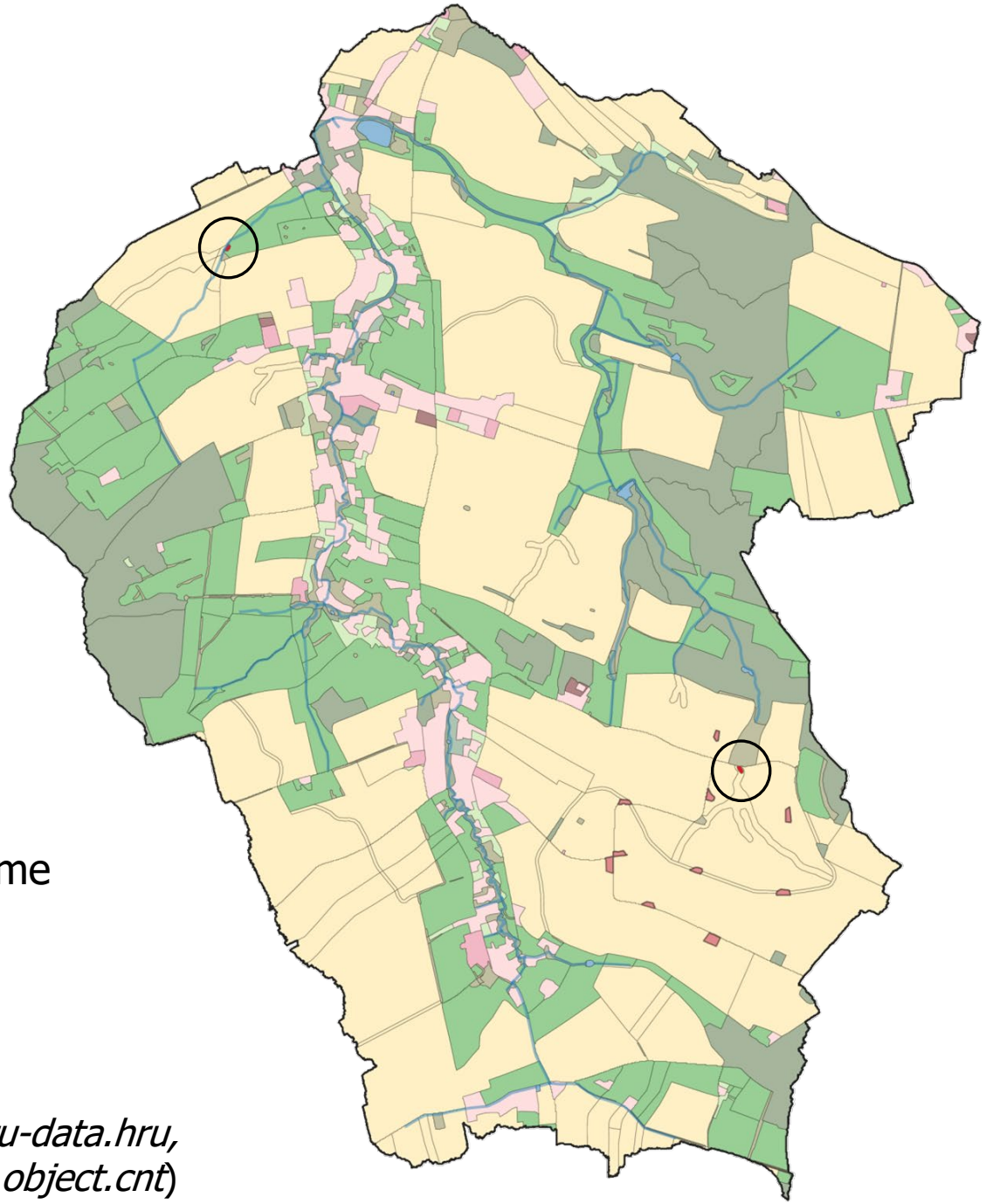
ranging between convtill_nores and fall_disking_residue

ovn_table.lum: written by SWAT+ editor v2.1.0 on 2023-03-29

name	ovn_mean	ovn_min	ovn_max
rota_1	0.12100	0.08400	0.15800
rota_2	0.18300	0.13200	0.23400
rota_3	0.24500	0.18000	0.31000
rota_4	0.30700	0.22800	0.38600
rota_5	0.36900	0.27600	0.46200

Measures to be modelled...

(5) Detention ponds



Model setting for affected hrus:

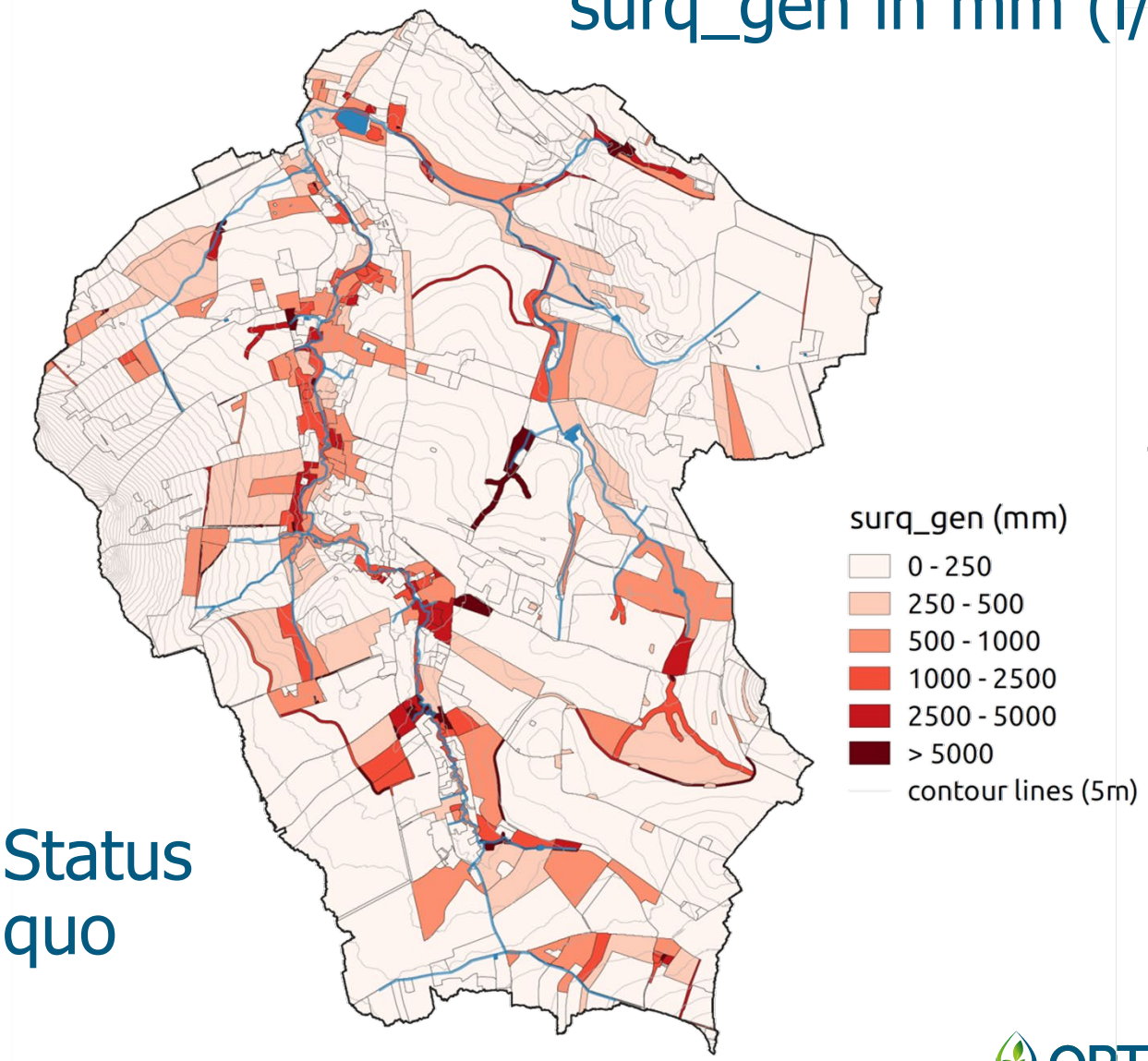
- add pond (res object) with old hru area and default volume
- adopt connectivities of old hru to new res object
- set connectivities of old hru to 0 and its area to 0.00001
- update object count

(files to be changed: *reservoir.res, reservoir.con, hydrology.res, hru-data.hru, hru.con, rout_unit.rtu, rout_unit.con, rout_unit.def, rout_unit.ele, object.cnt*)

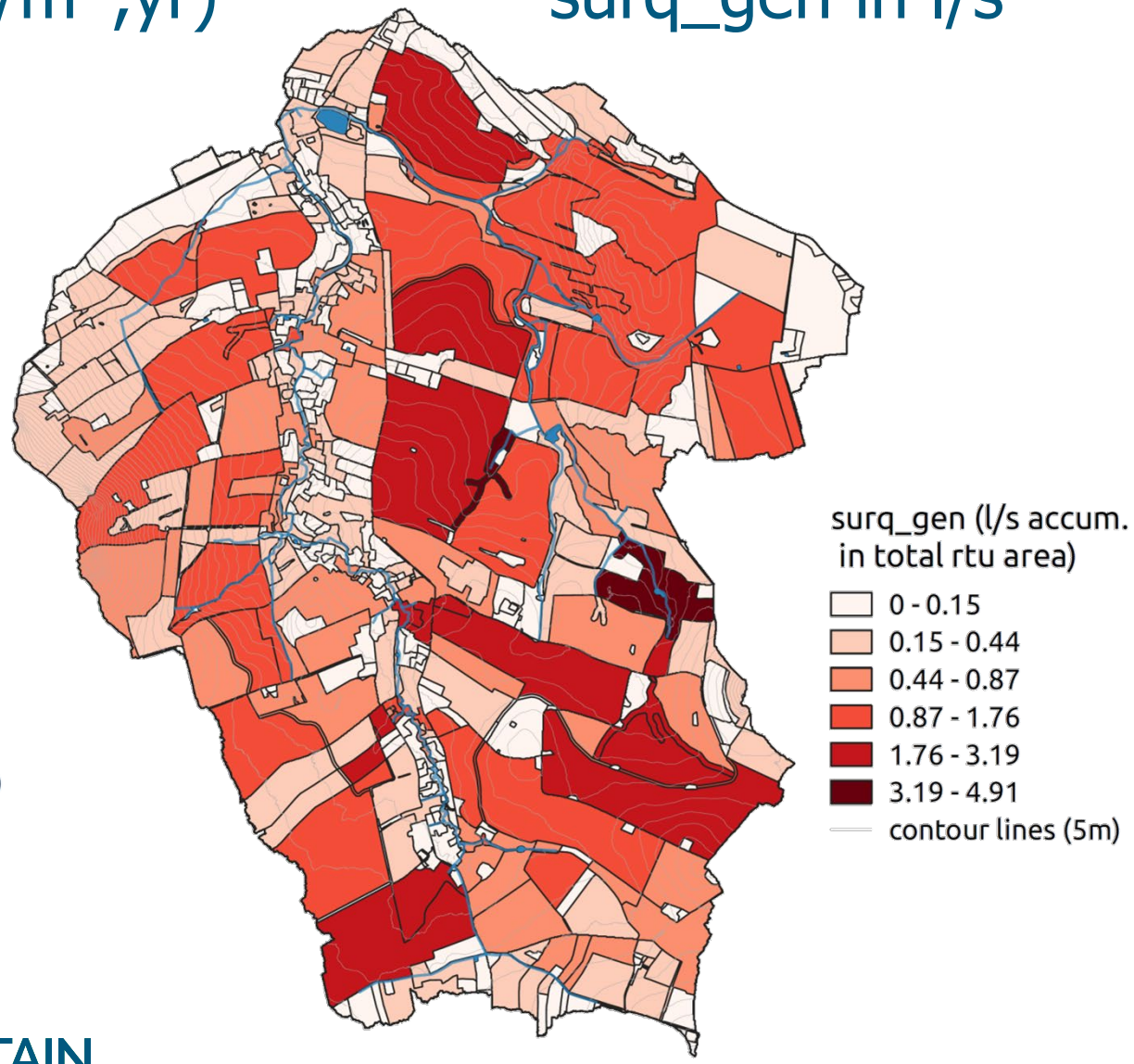
Results

Surface runoff (uncalibrated, much too high!)

surq_gen in mm (l/m²,yr)



surq_gen in l/s



Status quo

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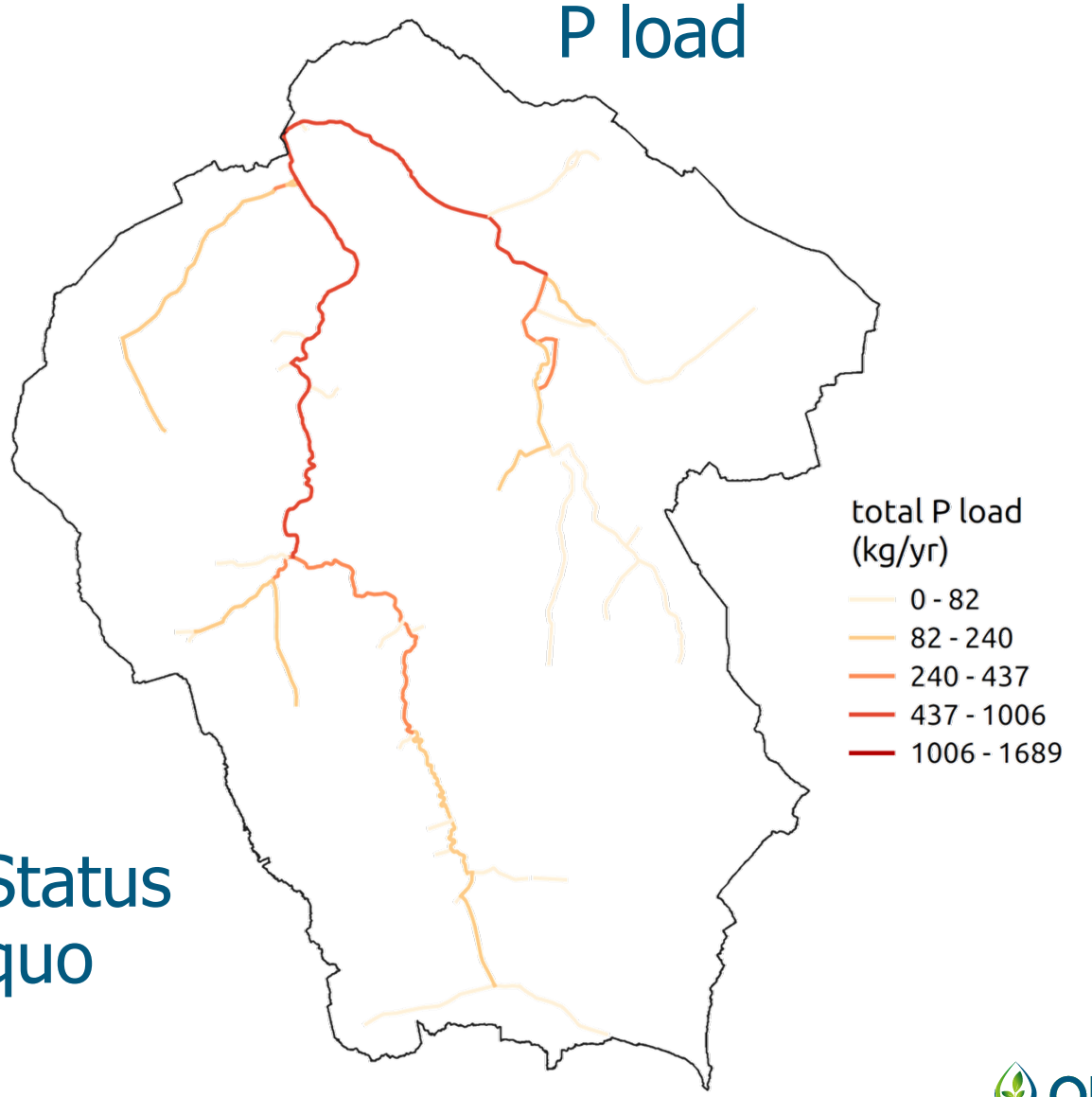
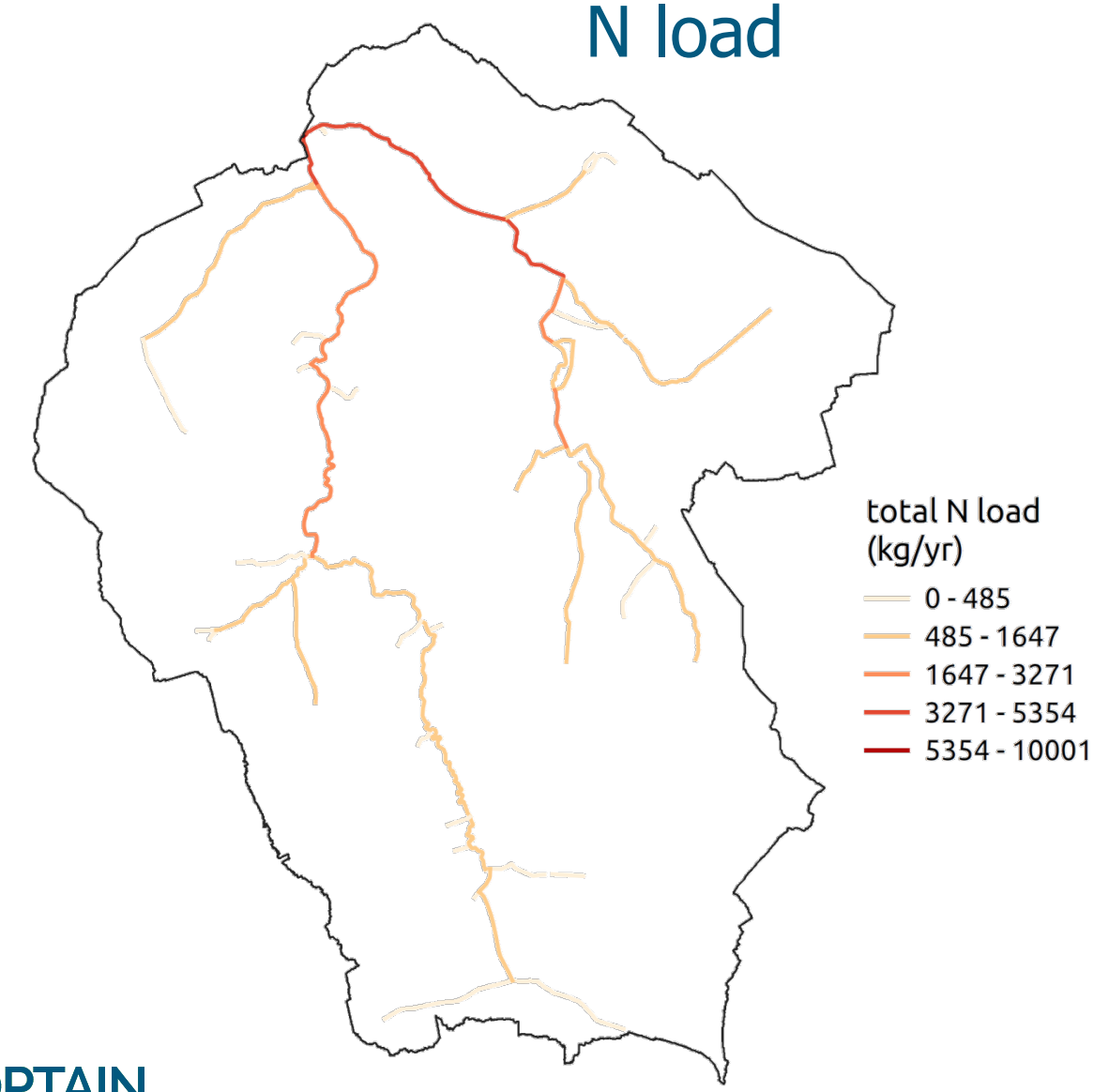
Results

Nutrient loads (uncalibrated, probably too high!)

P load



N load



Status quo

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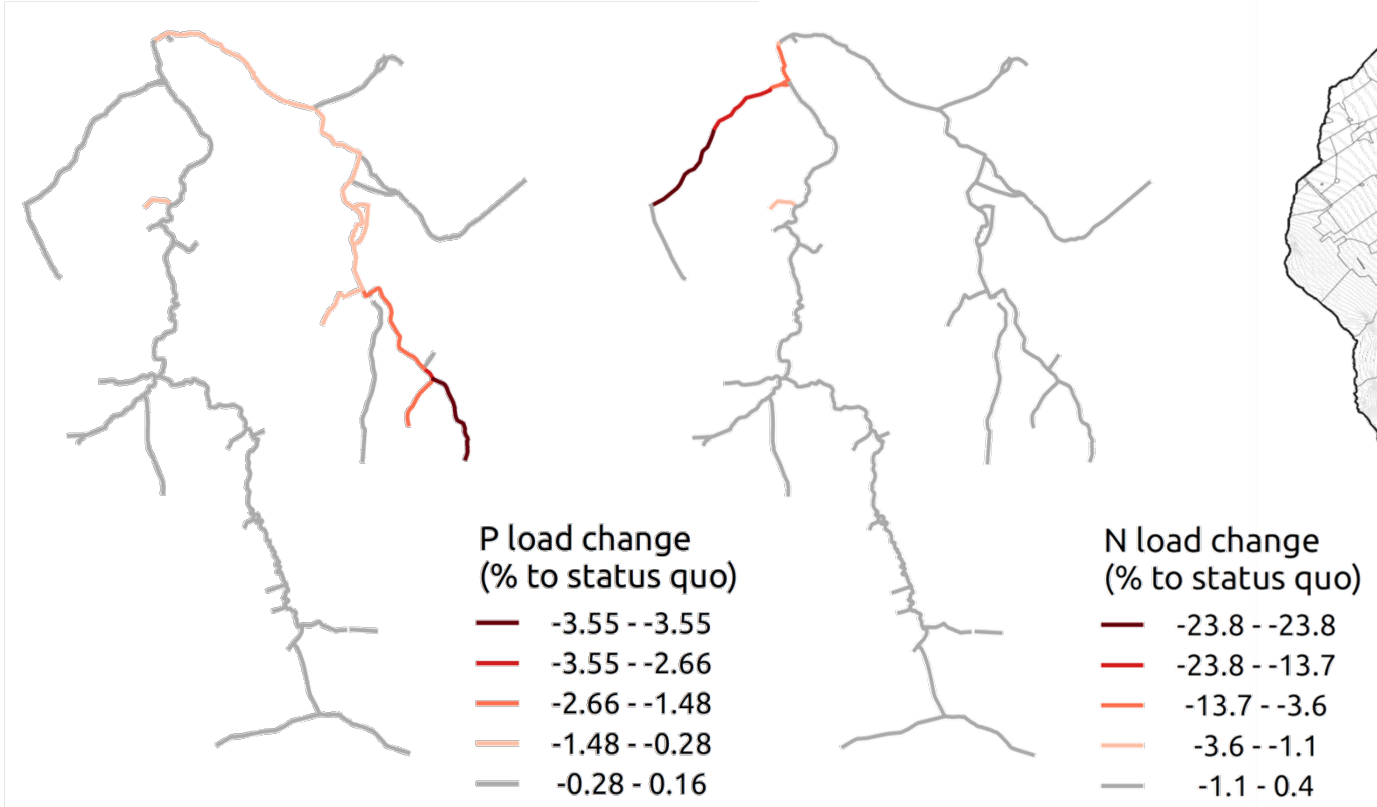
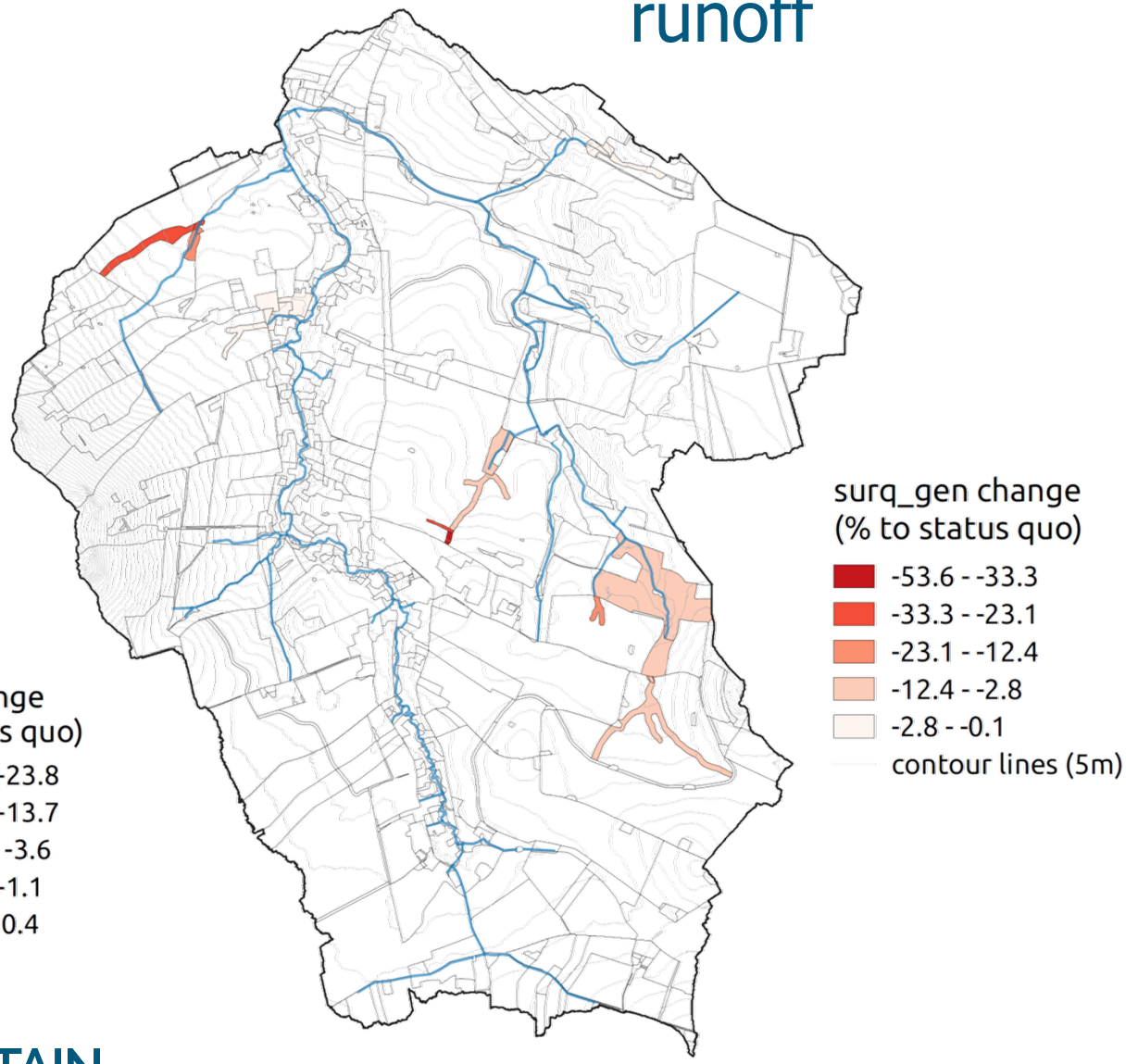
Results

Grassed waterways

Nutrient loads



Surface runoff



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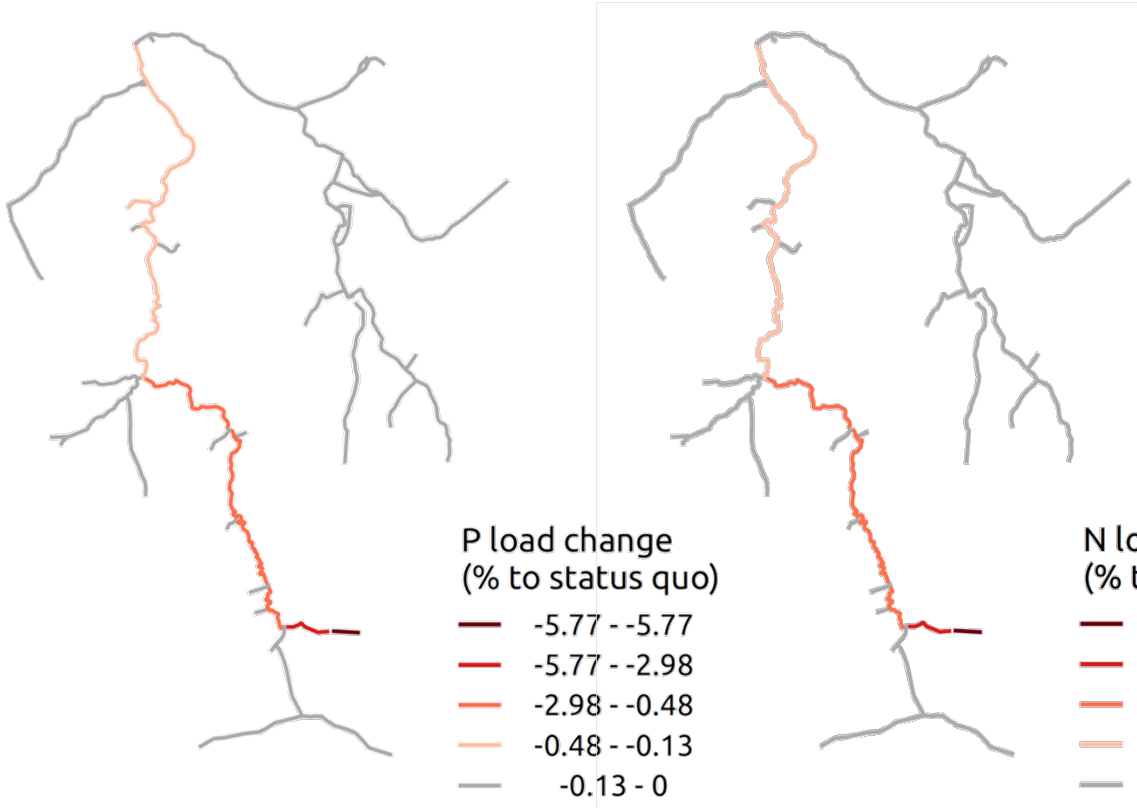
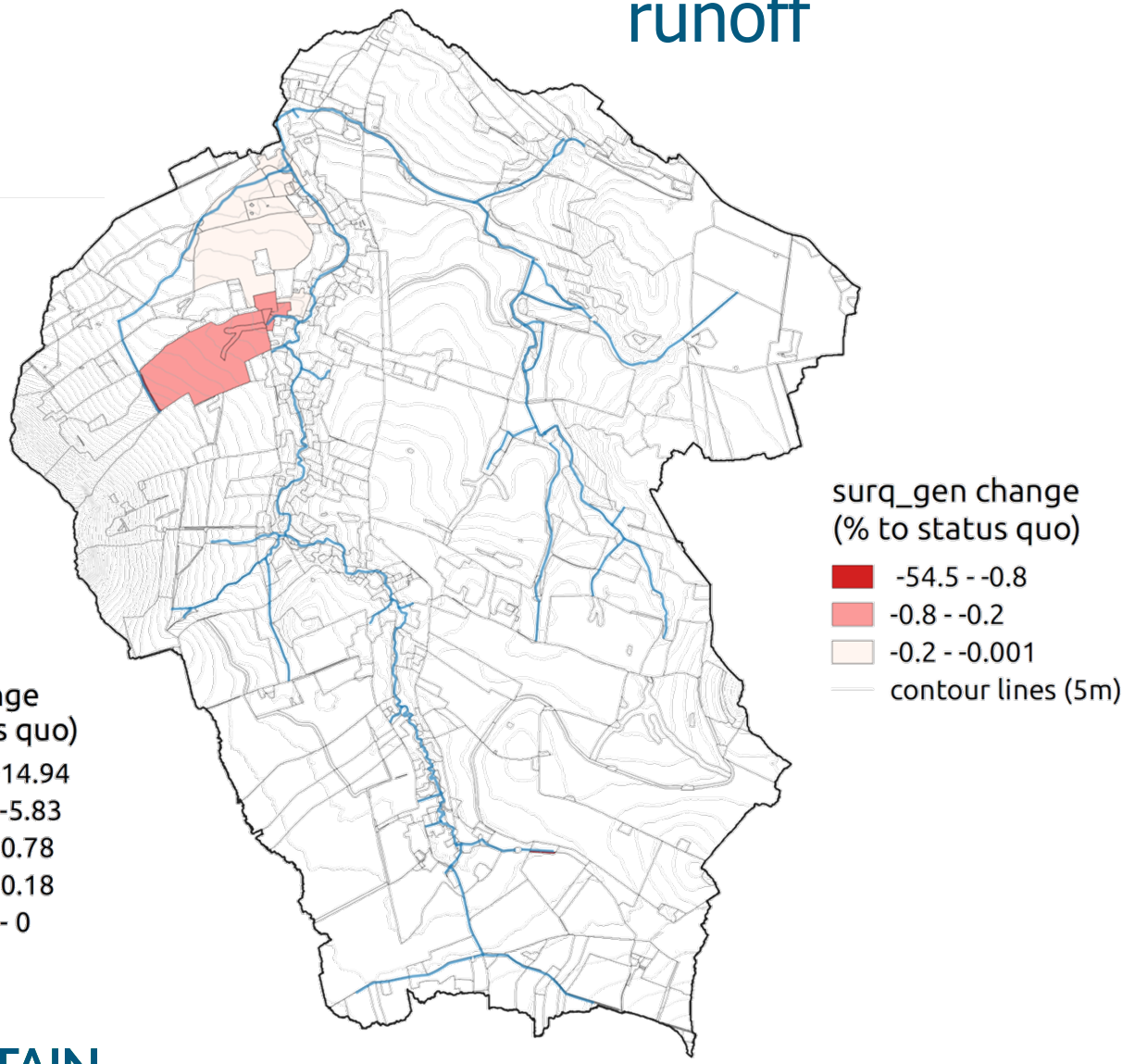
Results

Riparian buffer

Nutrient loads



Surface runoff



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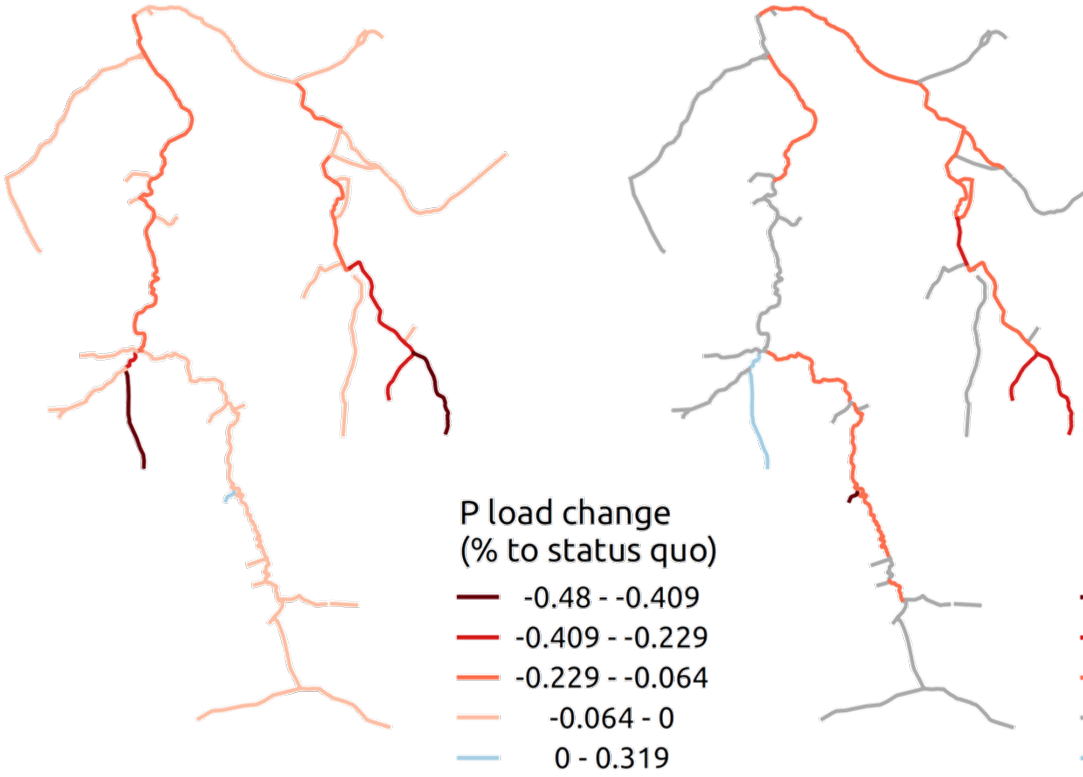
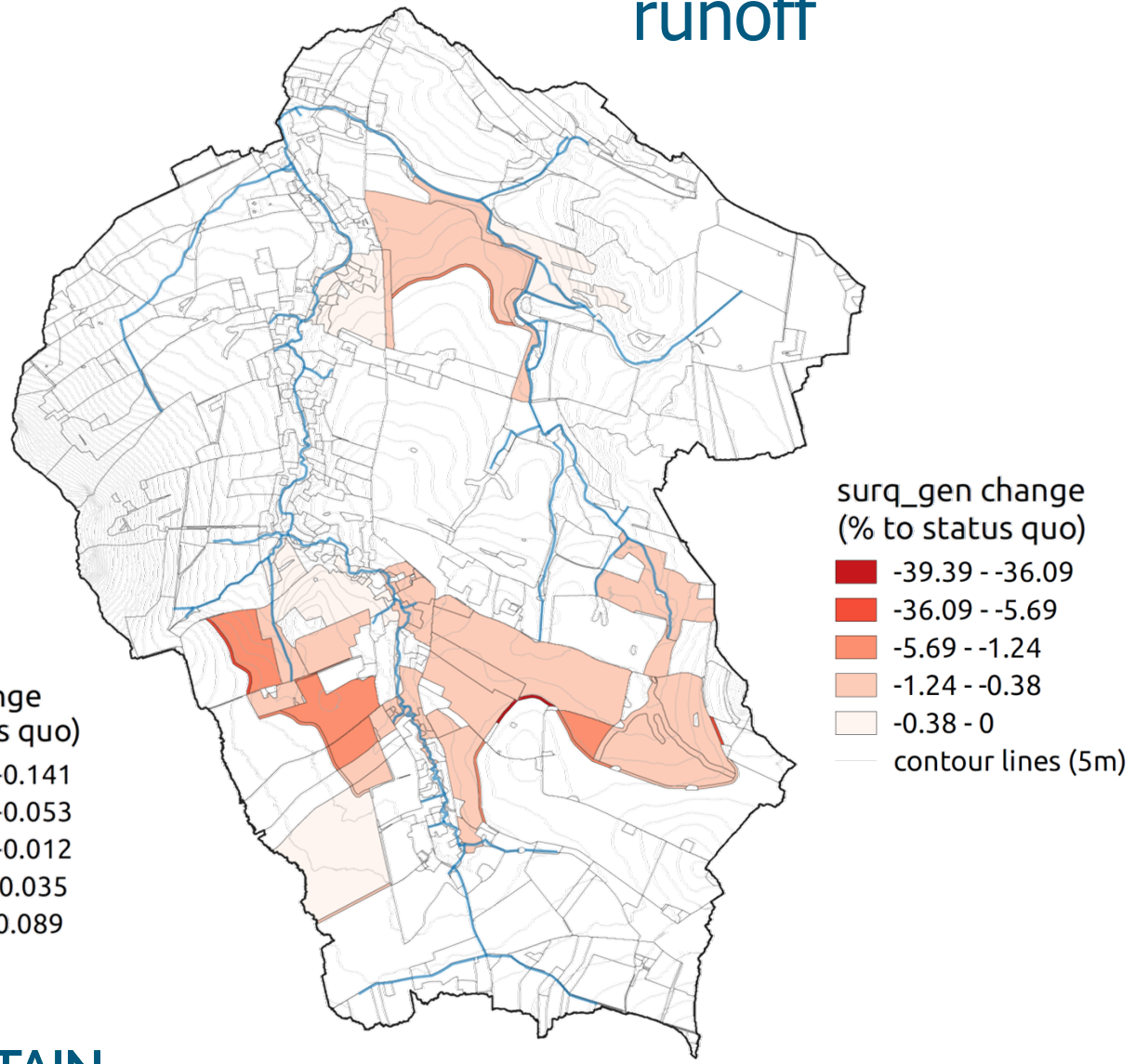
Results

Hedges

Nutrient loads



Surface runoff



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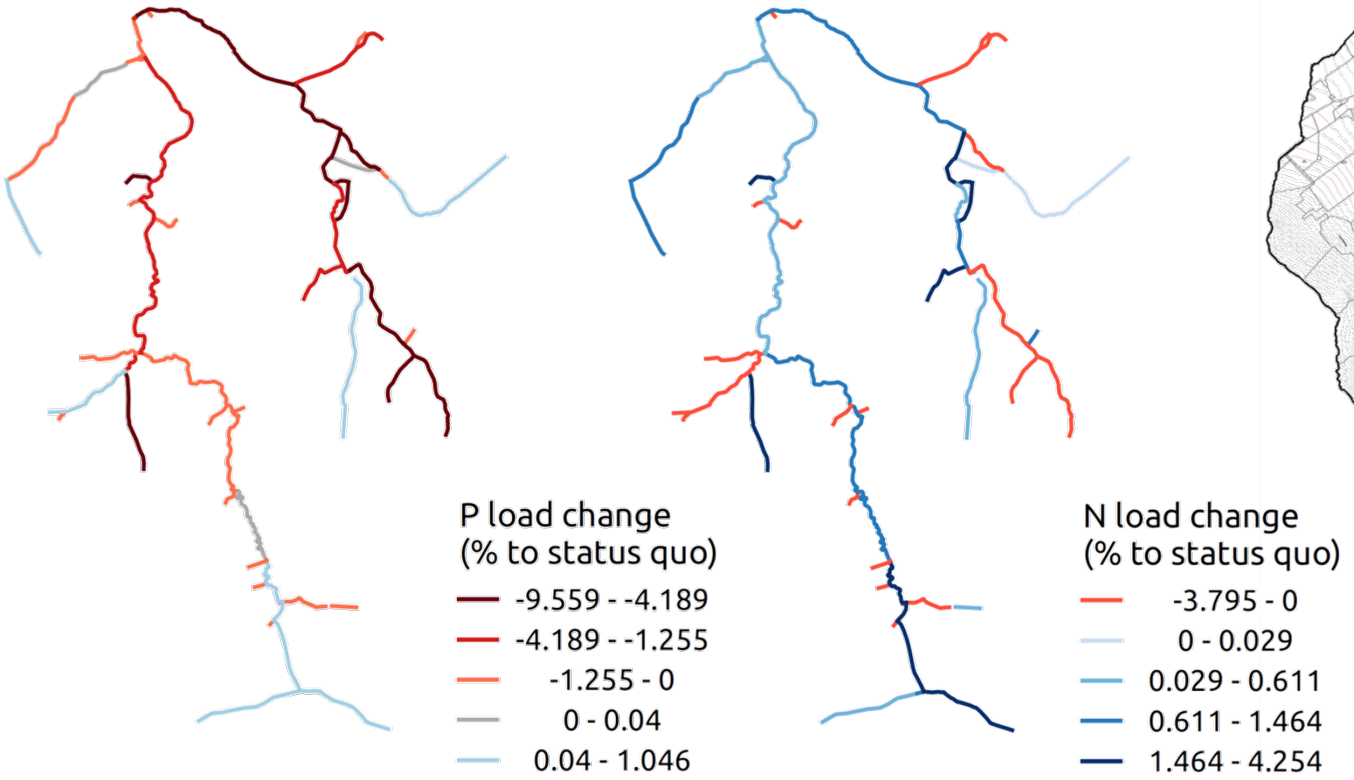
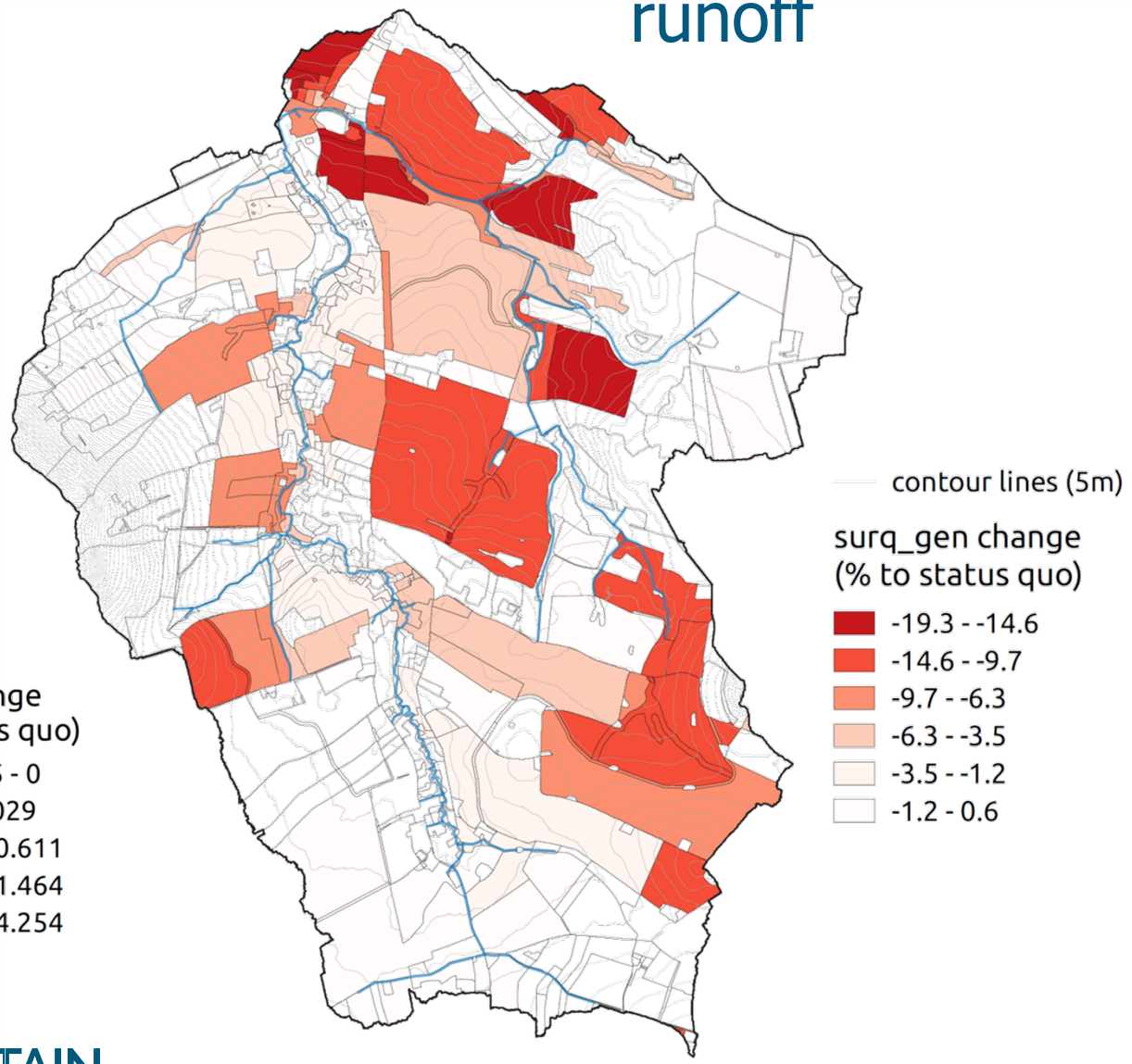
Results

Low till & cover crops

Nutrient loads



Surface runoff



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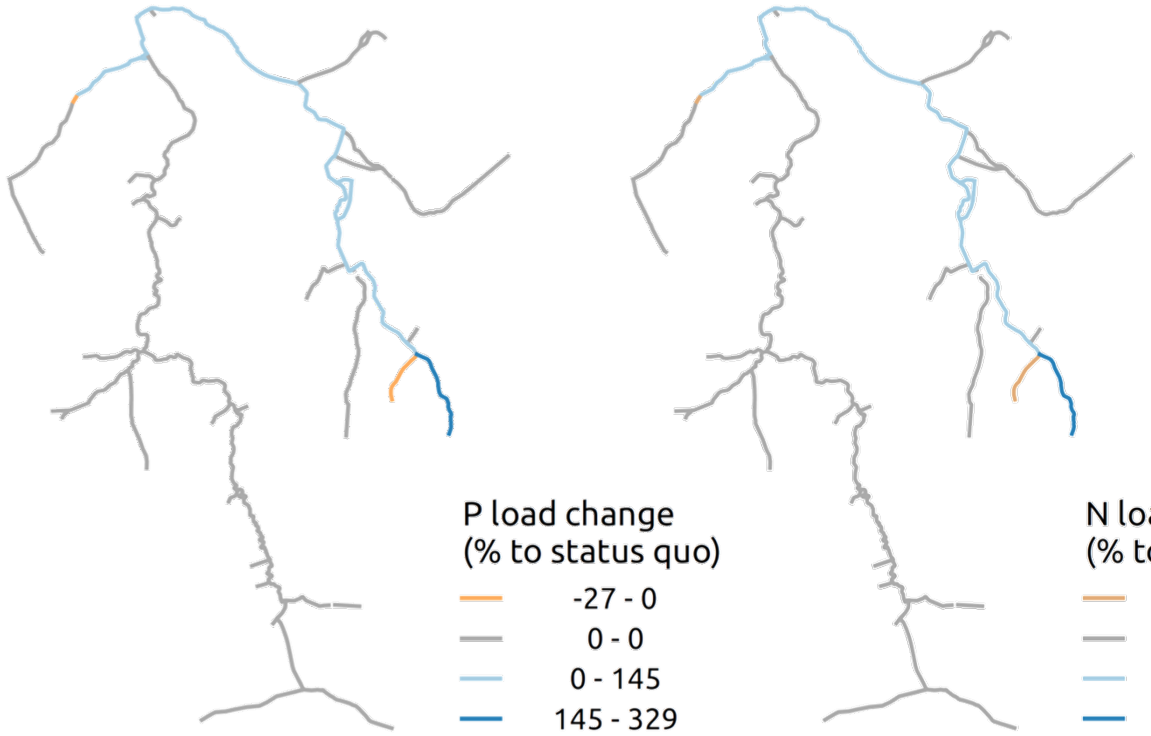
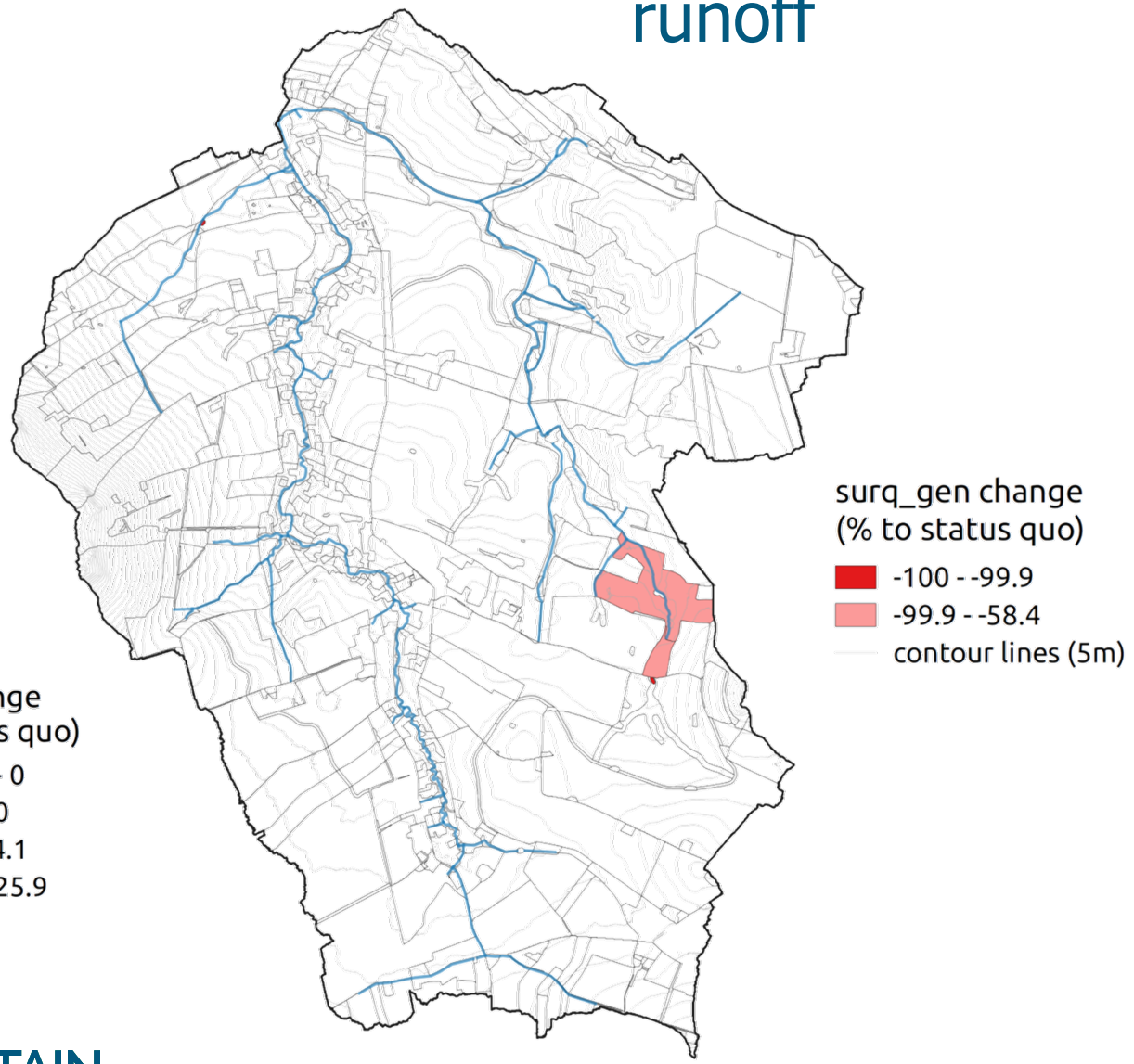
Results

Detention ponds

Nutrient loads



Surface runoff



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Results

Basin-wide effects (changes to status quo in %)

	grassed waterways	riparian buffer	hedges	lowtill + cover crops	detention ponds
Water balance					
surq_gen	-1.03	-0.01	-0.3	-4.71	-4.44
latq	0.15	0	0.18	3.69	-1.66
perco	0.18	-0.01	0.17	1.92	-0.1
wyld	-0.78	-0.01	-0.19	-2.75	-3.75
et	0.09	0	-0.02	0.3	-0.01
sw_ave	0.02	0	0.03	0.61	-0.07
Sediment/nutrient loss (land-phase)					
sedyld	-3.46	-0.19	-1.54	-13	-1.79
tn_loss	-2.05	-0.1	-0.64	-0.15	-0.29
tp_loss	-1.77	-0.09	-1.54	-5.49	-0.58
Export out of basin (outlet)					
q_mean	-1.04	-0.01	-0.14	-3	1.39
q_min	-29.38	-0.04	0.03	2.86	4.19
q_max	-0.47	0	0.31	-5.39	-4.27
sed_out	-1.47	-0.04	-0.33	-8.58	-4.09
tn_out	-1.69	-0.08	-0.01	0.65	1.68
tp_out	-0.13	-0.07	-0.08	-2.79	3.98

Summary & take home messages

- Novel routing approach for SWAT+ models (COCOA – connectivity of contiguous objects) developed and applied in EU project OPTAIN
- First results on the effectiveness of measures from German test case are promising:
  - mostly plausible but hard to judge and impossible to verify
  - where to allocate which measure matters!
- It needs now a critical reflection of:
  - parameter values representing land cover types and measures
  - connectivities among the objects (especially for those implemented as measures)
- Outlook:
  - final adjustment and calibration of full Schoeps River Basin model
  - scenario runs for single measures (also considering climate change)
  - multi-objective optimization of measure allocation and combination

Thank you

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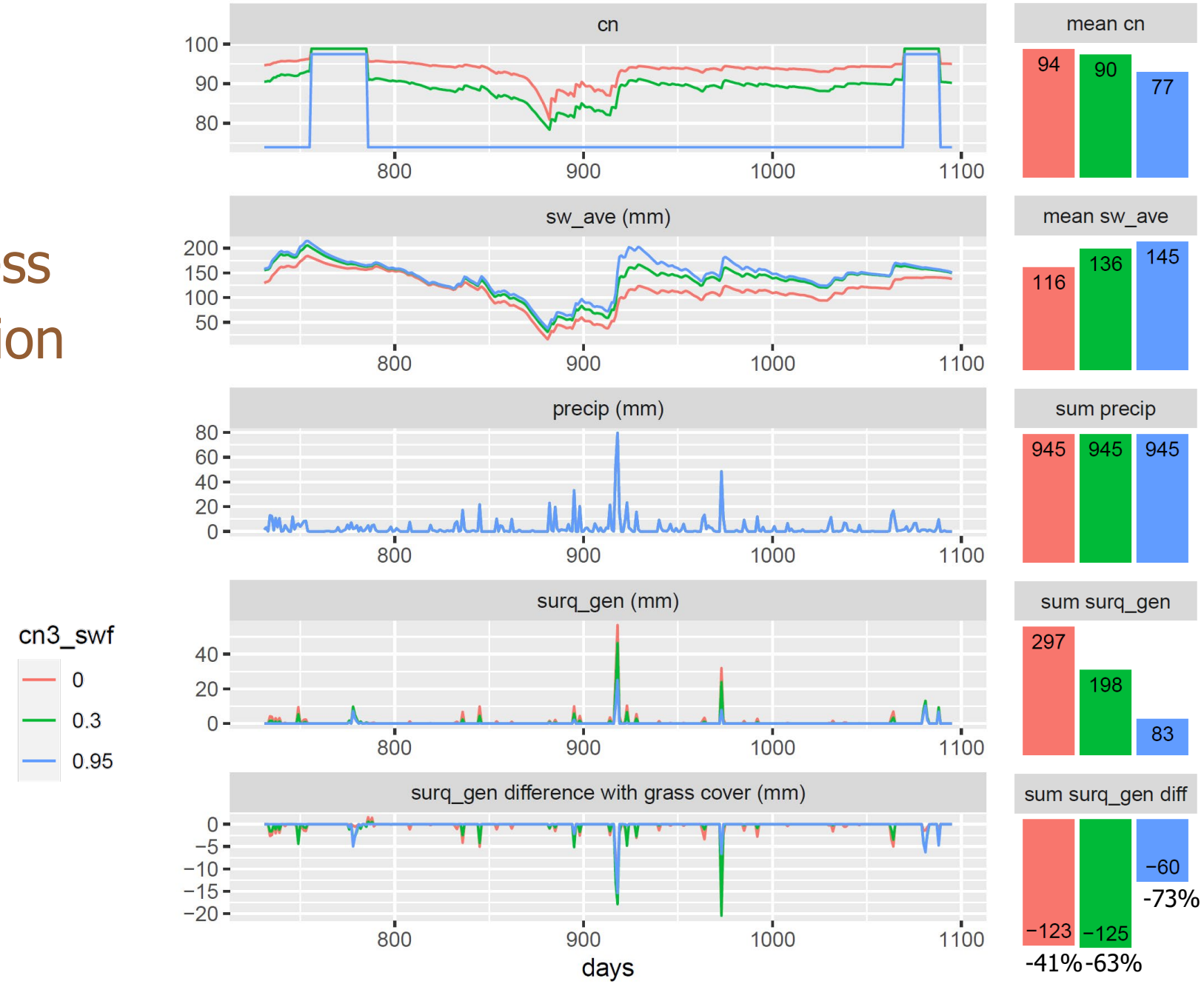
Measure effectiveness depends on calibration parameters!

Example *cn3_swf*…



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