SWAT+ model setup verification tool: **SWATdoctR**

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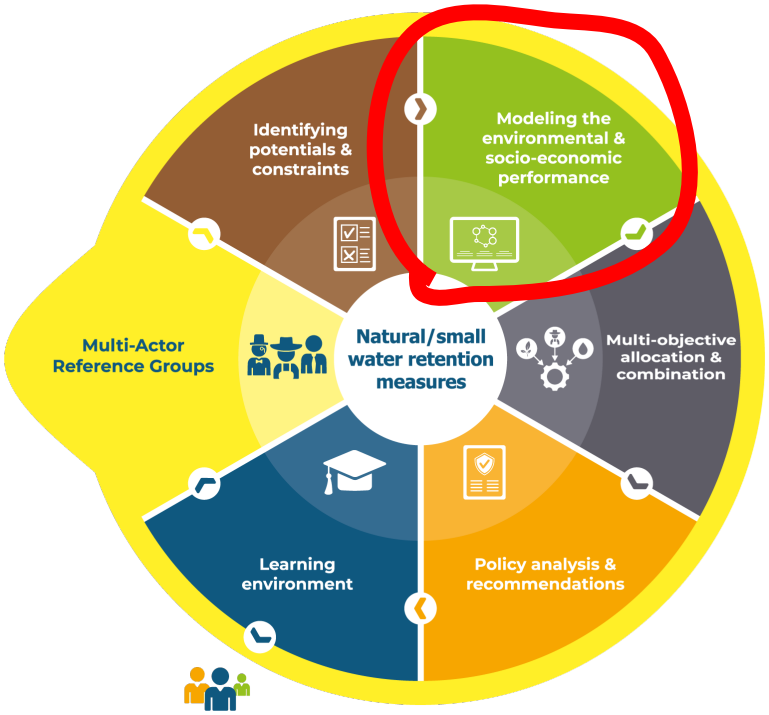

Identifying potentials & constraints
Modeling the environmental & socio-economic performance
Multi-Actor Reference Groups
Natural/small water retention measures
Multi-objective allocation & combination
Learning environment
Policy analysis & recommendations


Biogeographical regions
Boreal
Continental
Pannonian
Other
Case Studies
Hobøl
Sävjaån
Dvietes
Dotnuvėlės
Upper Zgłowiączka
Schwarzer Schöps
Wimbe
Čechtický
Petite Glâne
Pesnica
Tetves-patak
Kobilji potok
Kebele-patak
Csorsza
Cherio
Felső-Válicka

Workflow in R

Dr. GuRu

SWATbuildR
An object connectivity based SWAT+ model builder

SWATdoctR
Model diagnostics tool for SWAT+ model setups

SWATprepR
SWAT+ input data preparation

SWATfarmR
Simple rule based management operation scheduling

~~SWATplusR~~

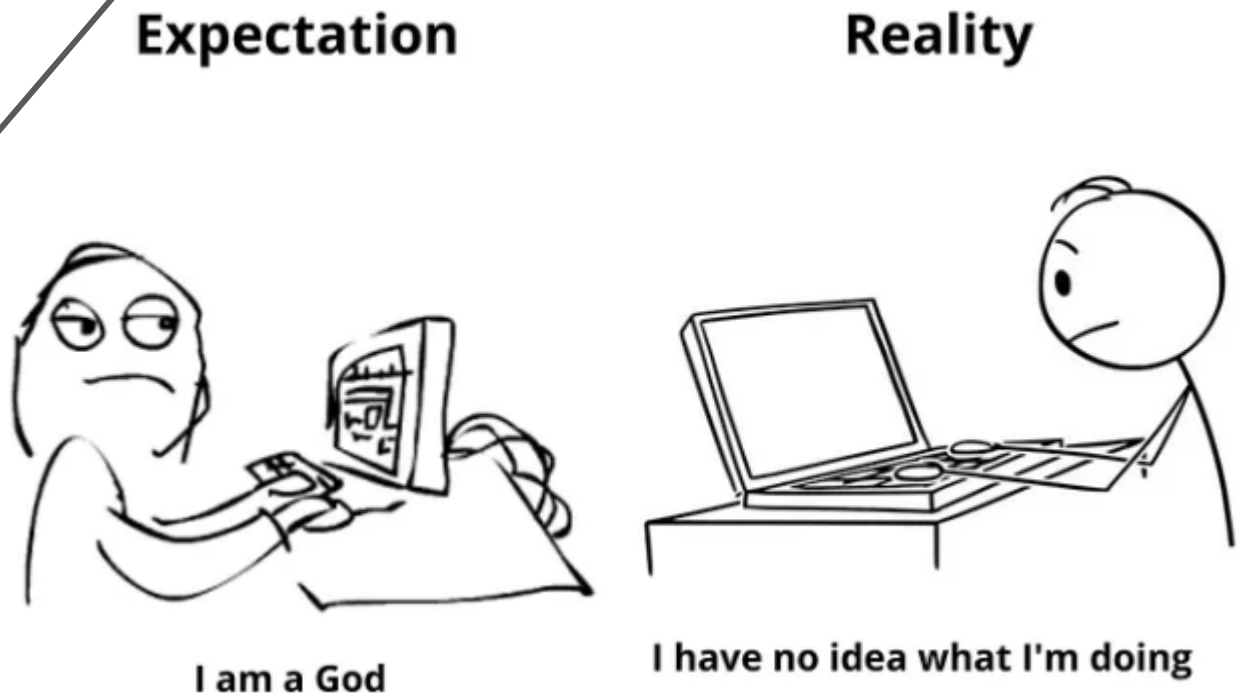
SWATrunR
Running SWAT simulations in R

Vision: SWAT+ modelling process fully scriptable in R

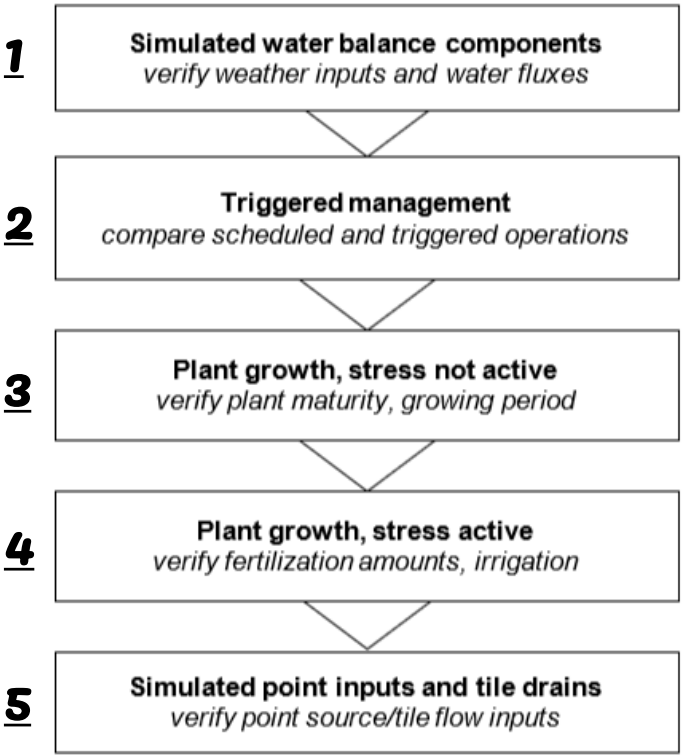
New concept - **model setup verification**

- Input data preparation
- Setup preparation

- Sensitivity assessment
- Calibration
- Validation
- Scenarios
- Reporting



Proposed workflow for SWAT+ model setup verification, 5 steps



SWATdoctR

run_swat_verification()

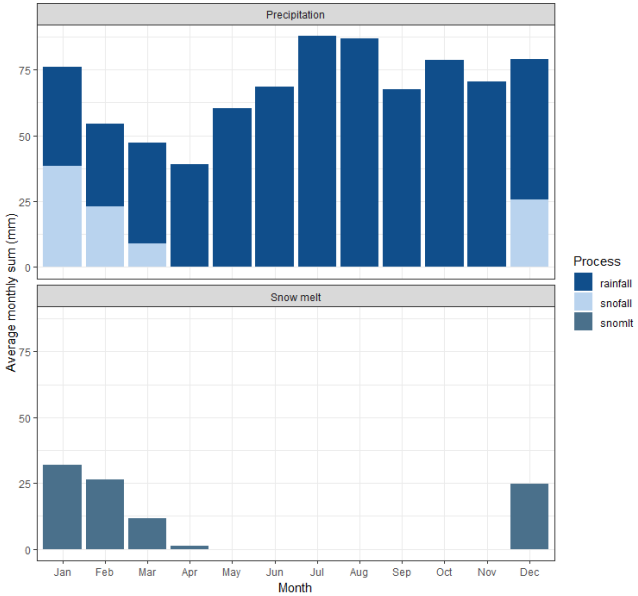
Step 1
plot_climate_annual()
plot_snow_monthly()
plot_waterbalance()
check_hru_waterbalance()

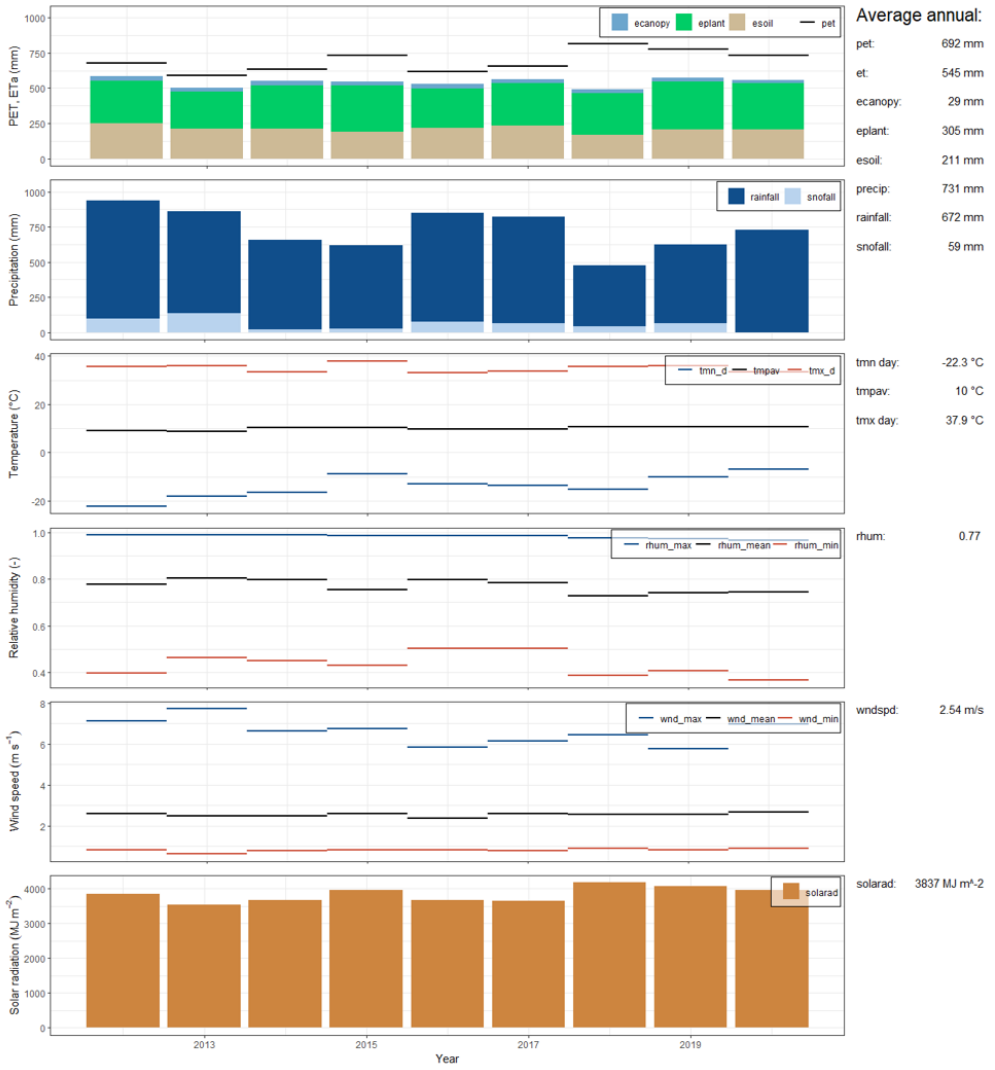
Step 2
report_mgt()
get_hru_id_by_attribute()
print_triggered_mgt()

Step 3&4
plot_variable_at_harvkill()
get_hru_id_by_attribute()
plot_hru_pw()

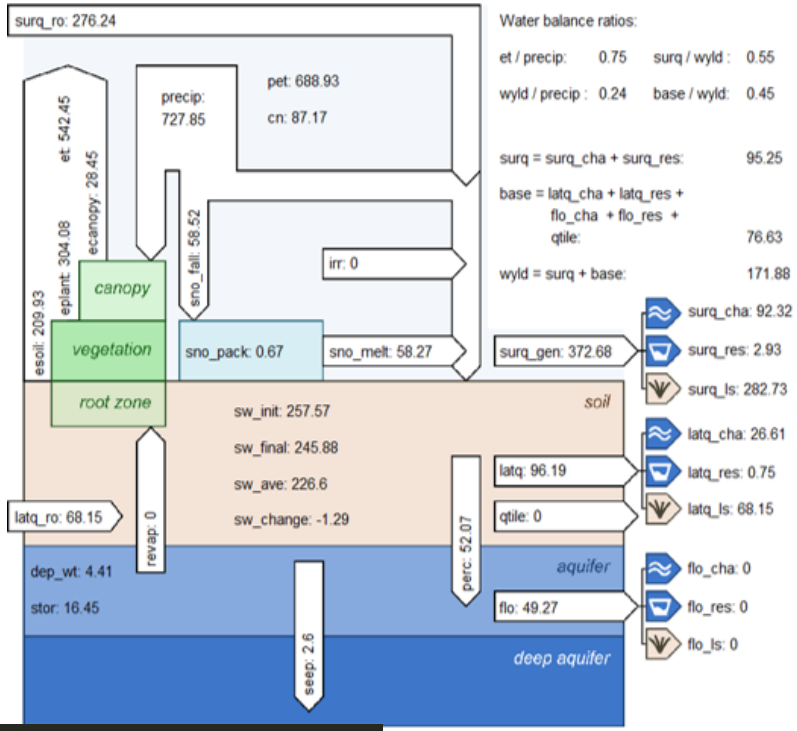
Step 5
print_avannual_qtile()
plot_qtile()
plot_ps()

Step 1. Analysis of simulated climate variables and water balance component





Step 1. Analysis of simulated climate variables and water balance component



A tibble: 1,426 × 10

	id	lu_mgt	precip_check	et_check	eplant_check	surq_wyld_check	perc_wyld_check	surq_check	sw_check	cn_check
	<int>	<chr>	<fct>	<fct>	<fct>	<fct>	<fct>	<fct>	<fct>	<fct>
1	2	field_392_1_lum	NA	NA	eplant < esoil	NA	perc/wyld < 22%	NA	NA	NA
2	4	rngb_lum	NA	NA	NA	surq/wyld < 31%	perc/wyld < 22%	NA	NA	NA
3	5	rngb_lum	NA	NA	NA	surq/wyld > 78%	perc/wyld < 22%	surq > 150% exp. surq	NA	cn > 95
4	6	field_394_lum	NA	NA	eplant < esoil	surq/wyld > 78%	perc/wyld < 22%	surq > 150% exp. surq	NA	cn > 95
5	7	field_396_lum	NA	NA	eplant < esoil	surq/wyld > 78%	perc/wyld < 22%	surq > 150% exp. surq	NA	cn > 95
6	8	field_167_1_lum	NA	NA	NA	surq/wyld > 78%	NA	NA	NA	NA
7	9	field_167_2_lum	NA	NA	NA	surq/wyld > 78%	perc/wyld < 22%	surq > 150% exp. surq	NA	NA
8	10	frst_lum	NA	NA	NA	NA	perc/wyld < 22%	NA	NA	NA
9	11	frst_lum	NA	NA	NA	NA	perc/wyld < 22%	NA	NA	NA
10	12	frst_lum	NA	NA	NA	NA	perc/wyld < 22%	NA	NA	NA

… with 1,416 more rows
i Use `print(n = ...)` to see more rows

Step 2. Simulation of management operations

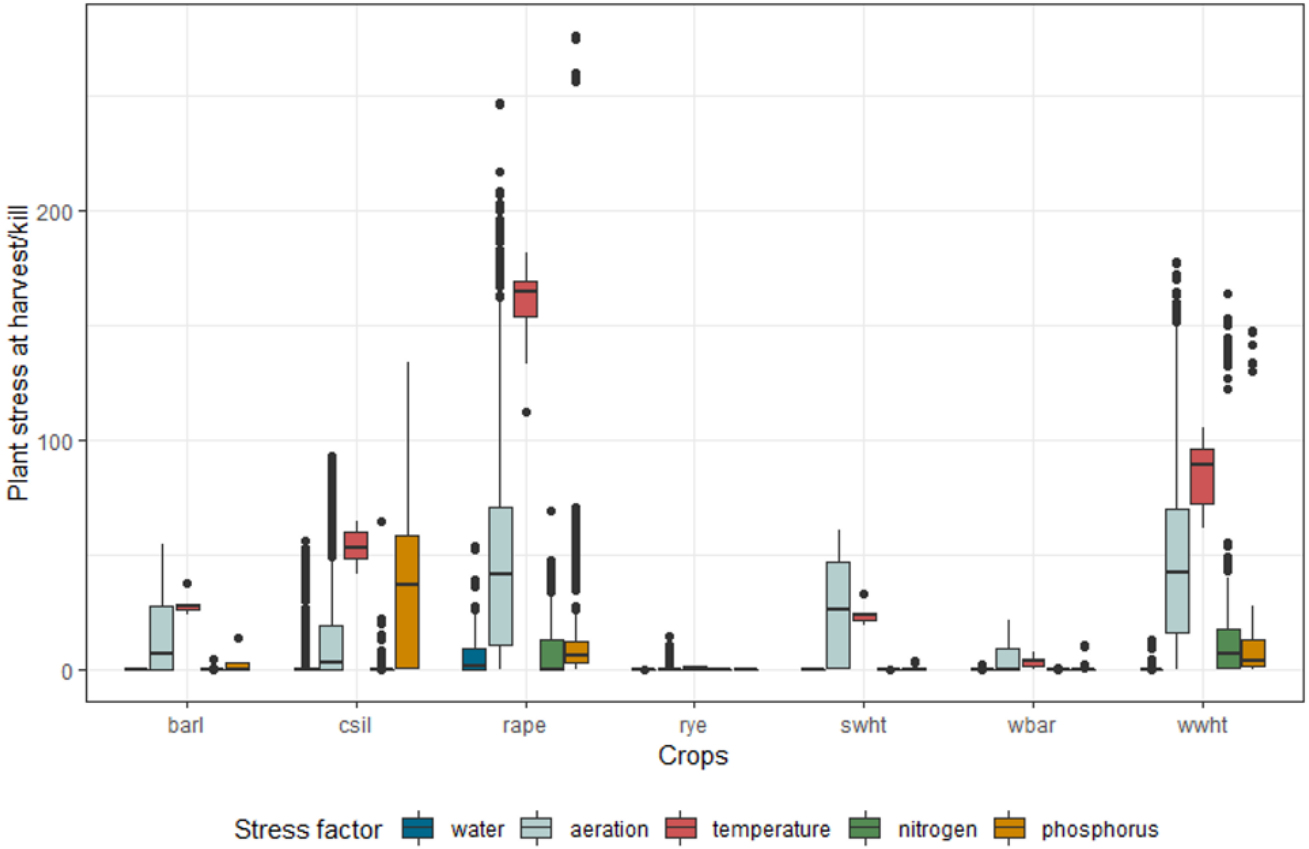
- Identification of issues with management operations
- Comparison between model input and output (*management.sch* and *mgt_out.txt*)

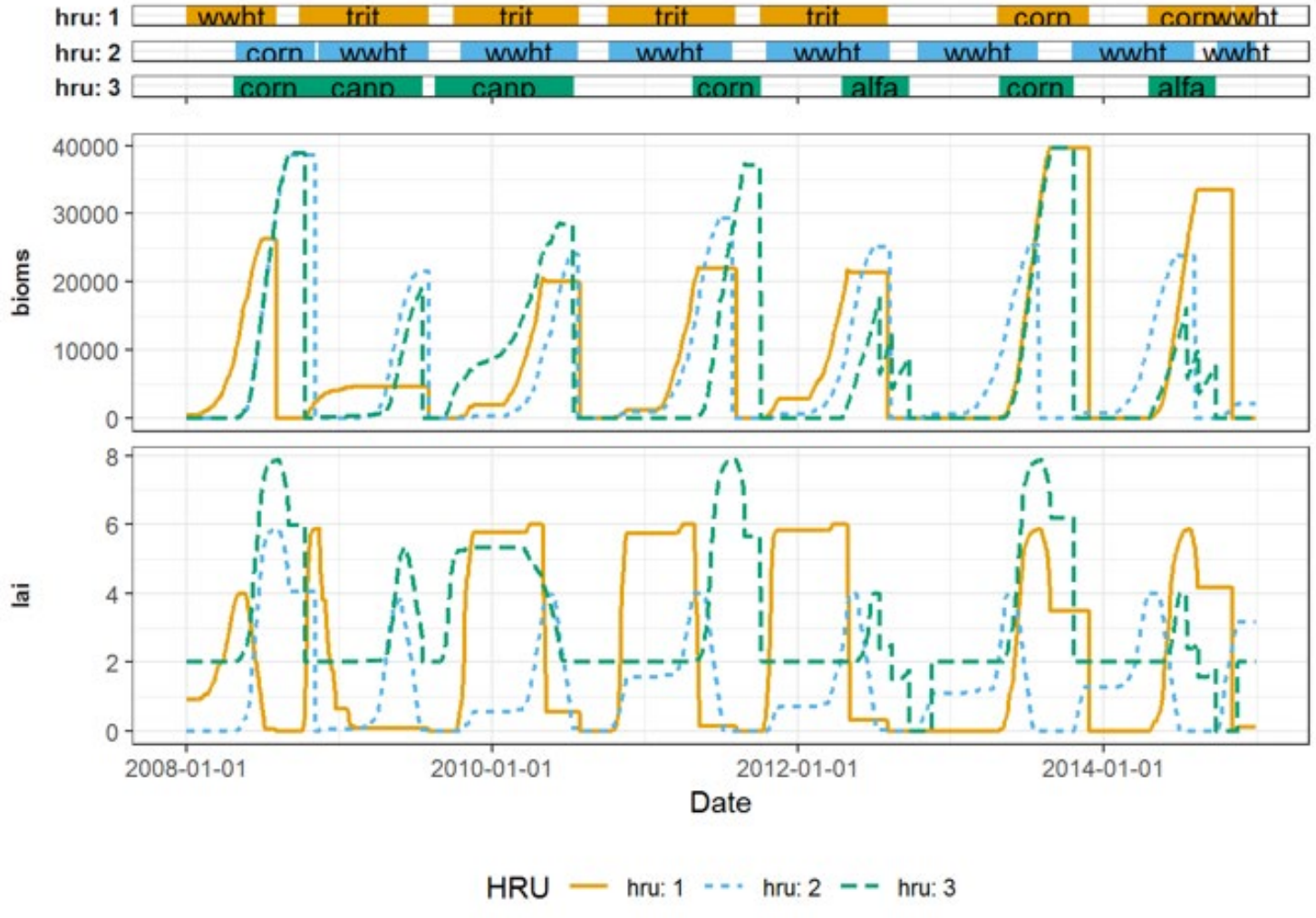
```
mgt_report <- report_mgt(sim_nostress)

mgt_report

#> # A tibble: 3 × 3
#>   schedule    op_issue schedule_report
#>   <chr>          <int> <list>
#> 1 agrr_rape          1 <tibble [1 × 8]>
#> 2 agrr_wbar          1 <tibble [1 × 8]>
#> 3 agrr_wwht          1 <tibble [1 × 8]>
```

```
mgt_report$schedule_report[3]

#> [[1]]
#> # A tibble: 1 × 8
#>    year   mon   day op_typ op_data1_trig op_data1 op_data2 op_data3
#>   <dbl> <dbl> <dbl> <chr>  <chr>         <chr>    <chr>       <dbl>
#> 1     1     8     1 harv   NA            rape     grain           0
```

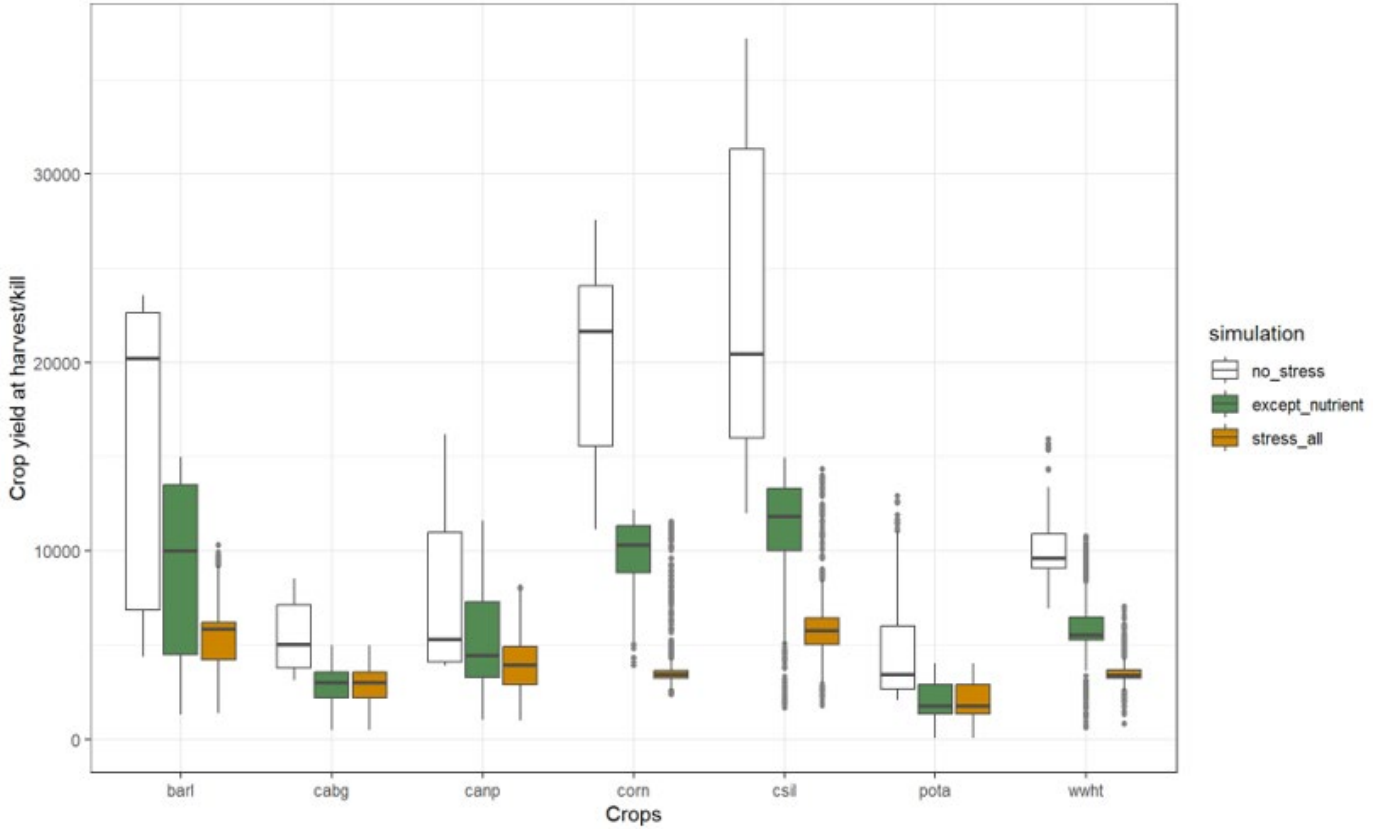
Step 3. Analysis of unconstrained plant growth

- 5 plant stress factors
- What is plant growth in ideal conditions?

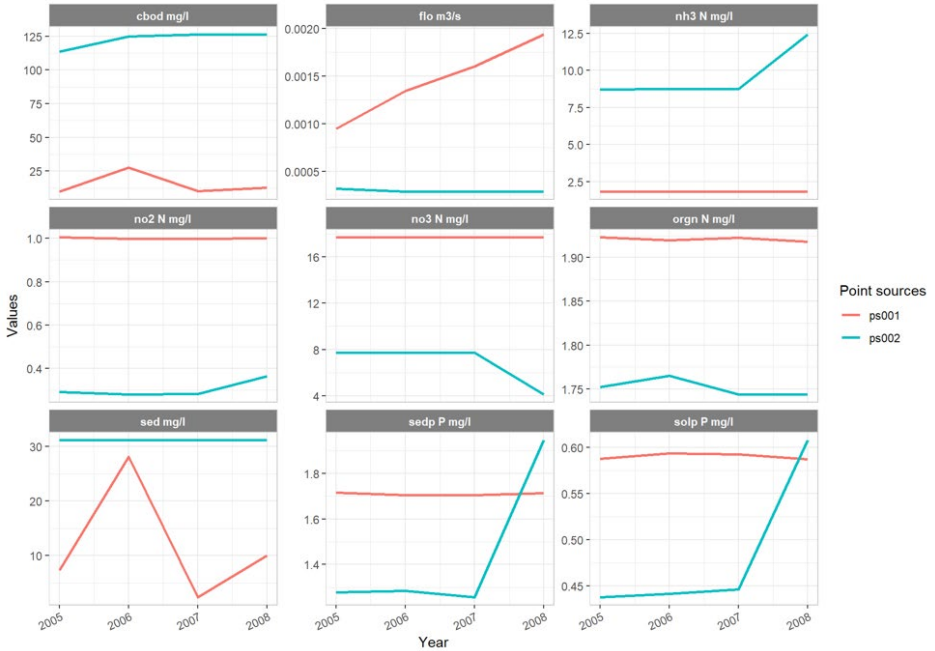



hru: 1
wwht
trit
trit
trit
trit
corn
cornwwht
hru: 2
corn
wwht
wwht
wwht
wwht
wwht
wwht
wwht
hru: 3
corn
canp
canp
corn
alfa
corn
alfa
bioms
40000
30000
20000
10000
0
lai
8
6
4
2
0
2008-01-01
2010-01-01
2012-01-01
2014-01-01
Date
HRU
hru: 1
hru: 2
hru: 3

Step 4. Model simulations with plant stress active



Step 5. Simulation of point inputs and tile drains



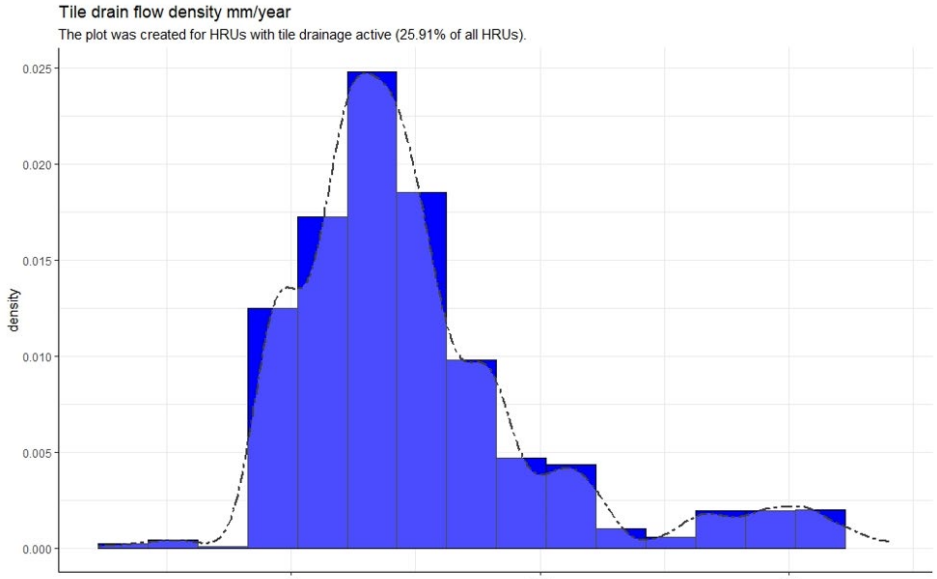
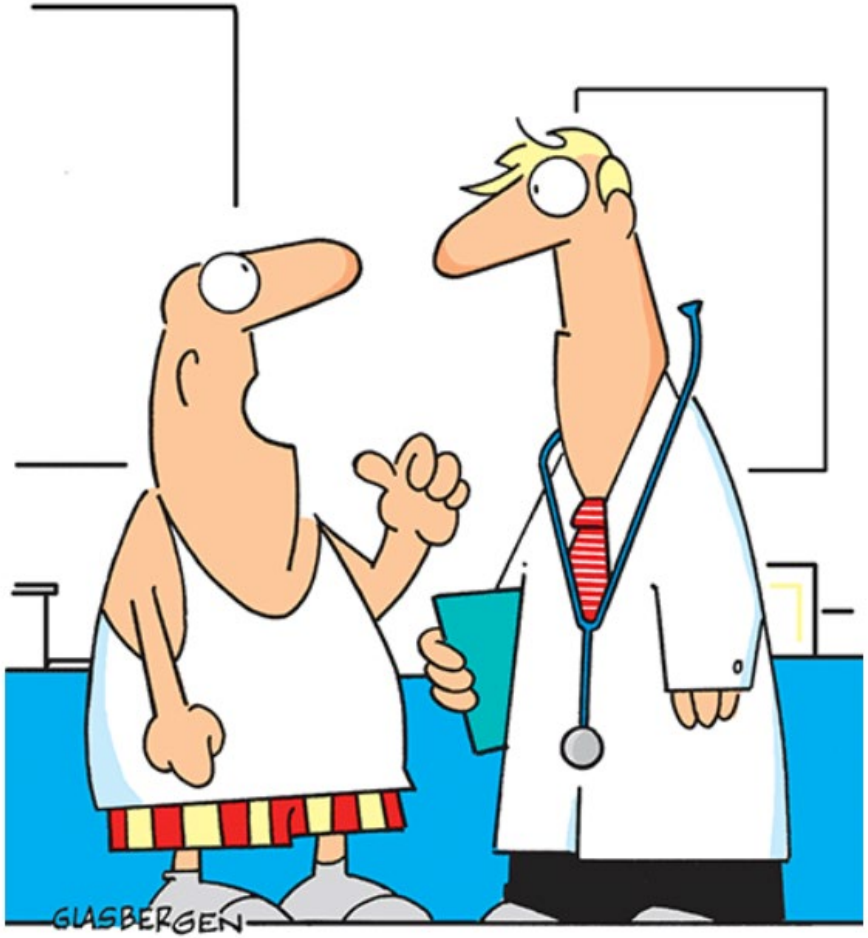


Table 1. Characteristics of SWAT+ model setups used in case comparison.

	Case I	Case II	Case III	Case IV
Catchment size (km^2)	417	386	150	2926
Land use (%): **-forest** **-pastures** **-arable land** **-urban and water**	 22 45 30 3	 16 8 67 (39[2]) 7 (3+4)	 5.5 2 89 3.5	 1 4 83 (77[3]) 12 (7+5)
HRU number	1197	5391	10240	7437
Routing units	9	93	10240	68
Channels	9	93	128	522
Reservoirs	3	0	27	67
Aquifers	10	94	1	34
Point sources	6	93	2	34
Management	HU-based	HU-based	Date-based	Date-based
HRUs with tile drains (%)	83	26	59	83
Calibration status	Calibrated flows and water quality	In process	Not started	Finished soft calibration[4]

- Wrong units
- Not credible ET or PET values
- Wrong parametrization of wetlands
- Wrong PHU at harvest
- Management issues
- Bad quality of ps input data, no data provided or wrong units
- Too high tile drain flow



"I could be a healthy person if you'd stop finding things wrong with me!"

Summary

- Model setup verification procedure helps to identify and eliminate input or structural errors in early stages
- Saving time and efforts in later stages (calibration, validation, scenario runs)
- Important for building confidence, especially for stakeholders
- Easy to integrate into templates (as markdown) and provide automatized reports
- Helps to investigate issues, find problems with model

More information

- SWAT+ modelling protocol
  10.5281/zenodo.7462415

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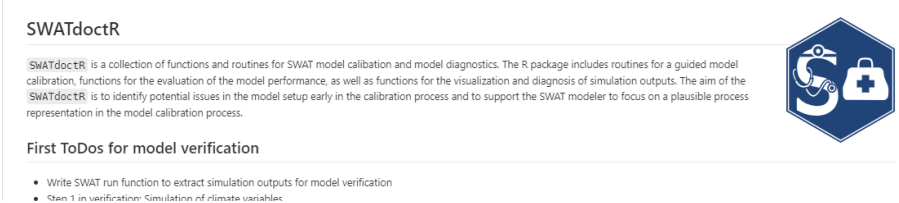
SWAT+ modeling protocol for the assessment of water and nutrient retention measures in small agricultural catchments

- Tool is accessible
  https://git.ufz.de/schuerz/swatdoctr



- Article under review in EMS

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