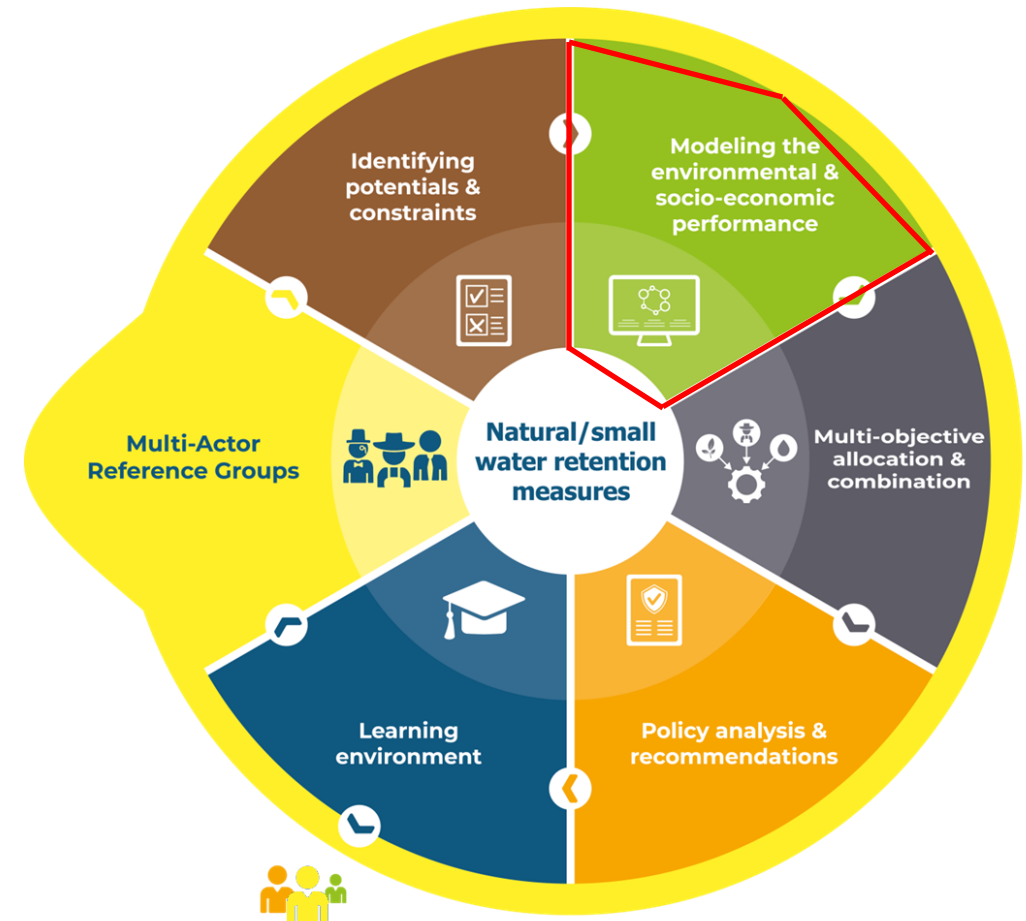# Introduction into modeling in OPTAIN

Why do we need models?
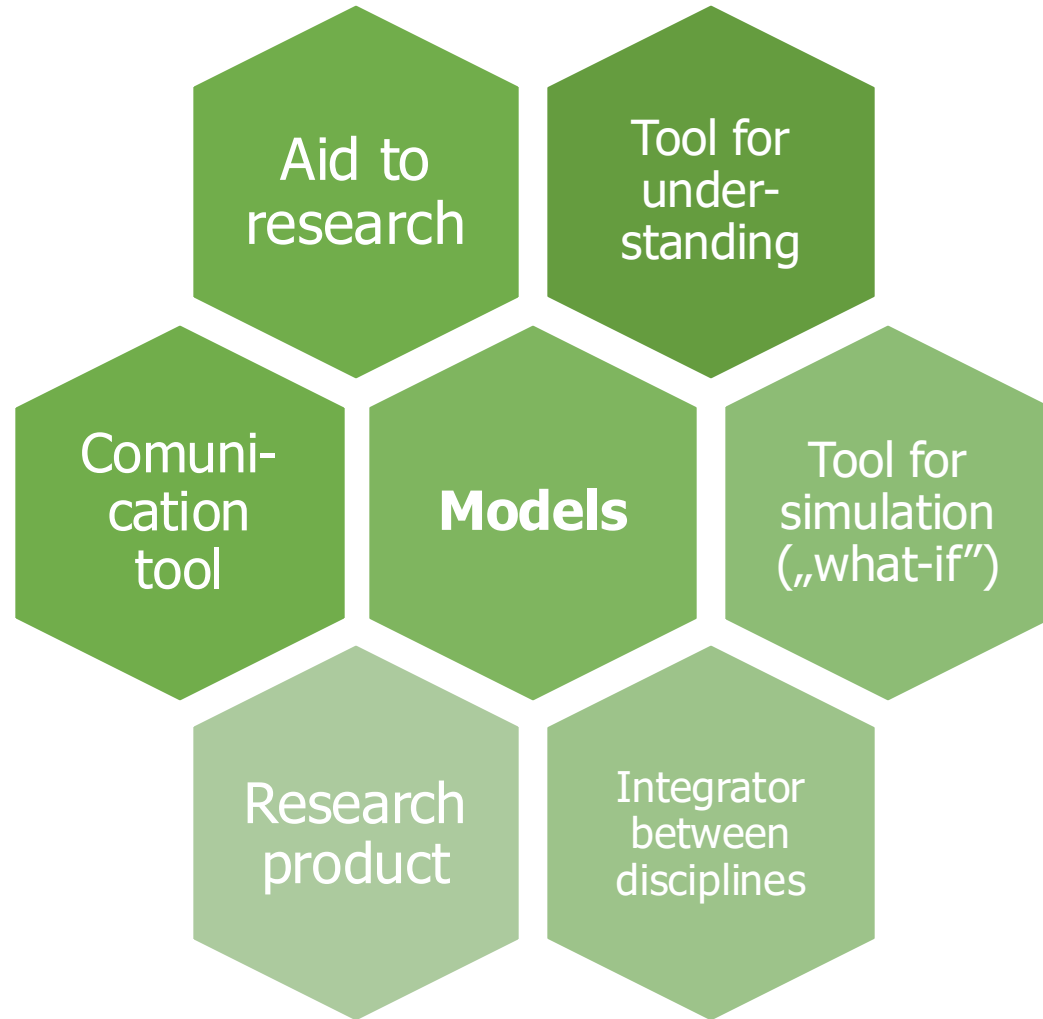
SWAT+ basics

Overview of the OPTAIN modeling workflow

Dr. Mikołaj Piniewski, Warsaw University of Life Sciences, Poland

OPTAIN

Why do we need models?

- Aid to research
- Tool for under-standing
- Comuni-cation tool
- **Models**
- Tool for simulation („what-if")
- Research product
- Integrator between disciplines

Verification, Validation, and Confirmation of Numerical Models in the Earth Sciences

Naomi Oreskes,* Kristin Shrader-Frechette, Kenneth Belitz

„Fundamentally, the reason for modeling is a lack of full access, either in time or space, to the phenomena of interest."

Oreskes et al. (1994), Science
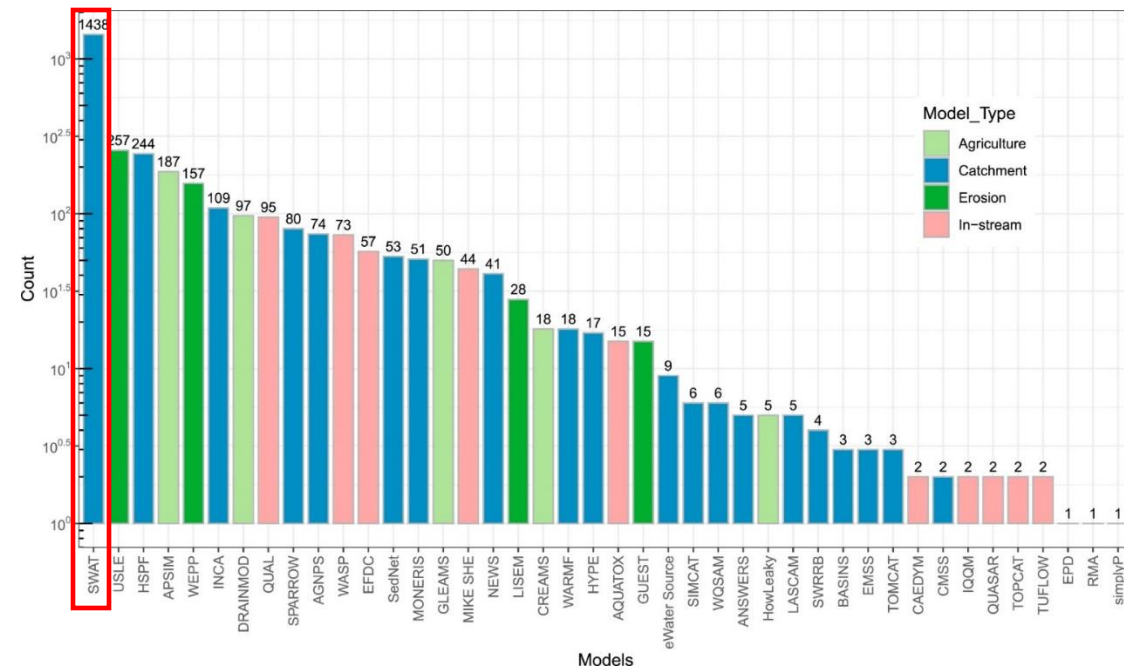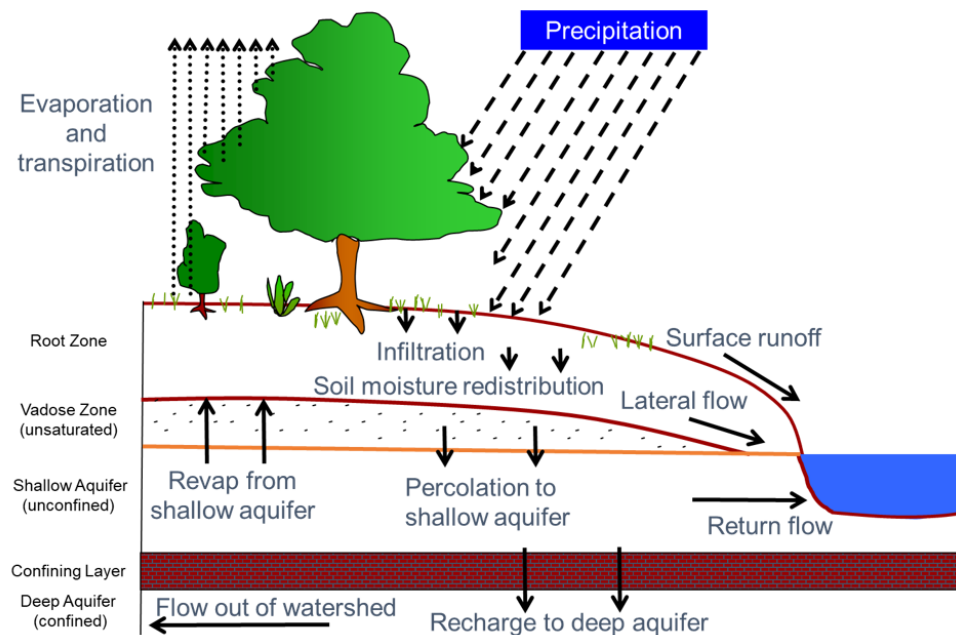
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Soil & Water Assessment Tool (SWAT)

Product of over **45 years** of U.S. Department of Agriculture and Texas A&M University model development

Small watershed to river basin-scale model to simulate the **quality and quantity** of surface and ground water and predict the environmental impact of land use, land management practices, and climate change

Comprehensive simulation of **land phase** processes and **in-stream** routing with a daily time step

New, restructured version **SWAT+**, with new features (e.g. connectivity, decision tables) available since 2017

Currently transitioning into a true **community model** (Github repo)

Fu et al. (2018)

SWAT+ modeling goals in OPTAIN

WHAT?

Simulate the local effect of NSWRMs on the **field scale**

Simulate the „global" effect of the **combinations of measures** based on aggregated catchment scale outputs

Assess the measure performance under **climate change** conditions

HOW?

Harmonize representation of landscape features and its parametrisation across all case studies
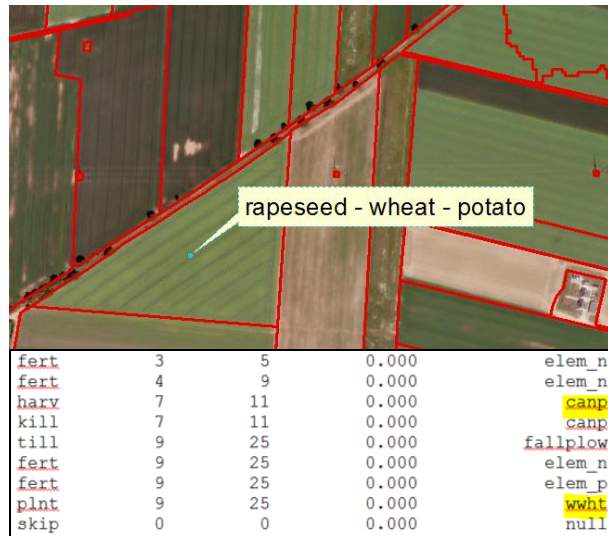
Develop new tools to ensure sufficient **spatial detail** and complexity of agricultural management in the model setups

Use **scripted workflows** to ensure transparency and facilitate cross-comparisons
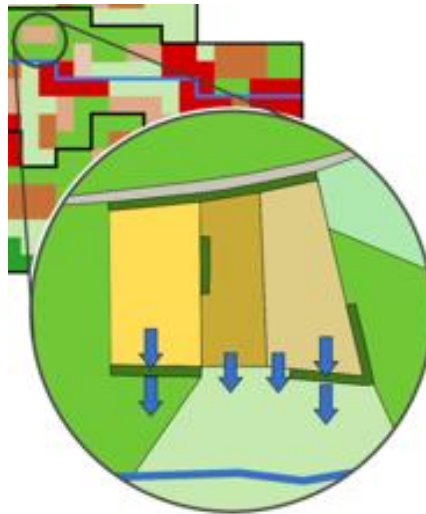
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Key requirements for SWAT+ model setups in OPTAIN

1. Individual fields as HRUs with their crop rotations and associated management
2. Allow contiguous routing between all land and water objects
3. Allow for spatially-explicit representation of selected structural NSWRMs at HRU level

1

rapeseed - wheat - potato

fert	3	5	0.000	elem_n
fert	4	9	0.000	elem_n
harv	7	11	0.000	canp
kill	7	11	0.000	canp
till	9	25	0.000	fallplow
fert	9	25	0.000	elem_n
fert	9	25	0.000	elem_p
plnt	9	25	0.000	wwht
skip	0	0	0.000	null

2

3

Potential NSWRM locations
- Grassed waterway
- Hedge row
- Riparian buffer
- Retention pond

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Workflow - overview

INPUT DATA PREPARATION
Prepare all required .csv, .shp, and .tif files.

MODEL SETUP
Setup a ready-to-run model with initial parameter values

HARD CALIBRATION
Based on numerous model simulations (parameter variations) fit simulated time series for streamflow, sediments, and nutrients to observed time series.

SOFT CALIBRATION
Based on a few model simulations (parameter variations) adjust plant growth and the overall water balance to realistic magnitudes.

MODEL SETUP VERIFICATION
Verify that most important model inputs (climate, agricultural management) are read-in correctly. Check model behavior and correct the setup if necessary.

CLIMATE SCENARIOS
Run climate scenarios for 3 RCPs and 6 RCMs assuming status quo land use.

NSWRM SCENARIOS
Run maximum implementation scenarios for all relevant NSWRMs under observed climate.

COMBINED SCENARIOS
Run maximum implementation scenarios for all relevant NSWRMs under different climate scenarios.

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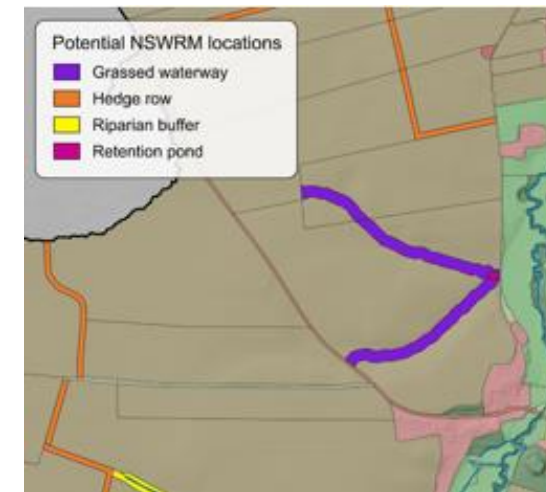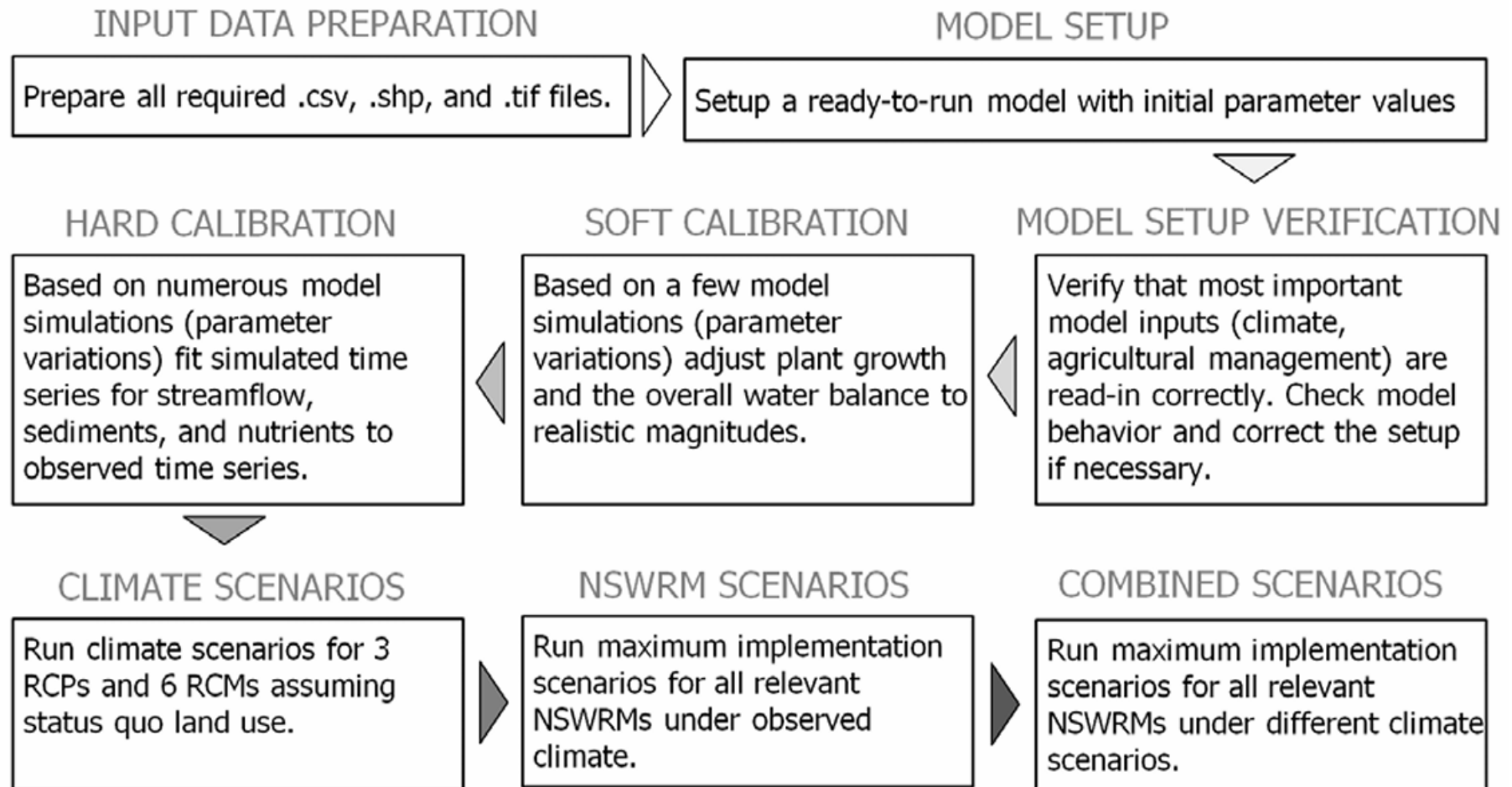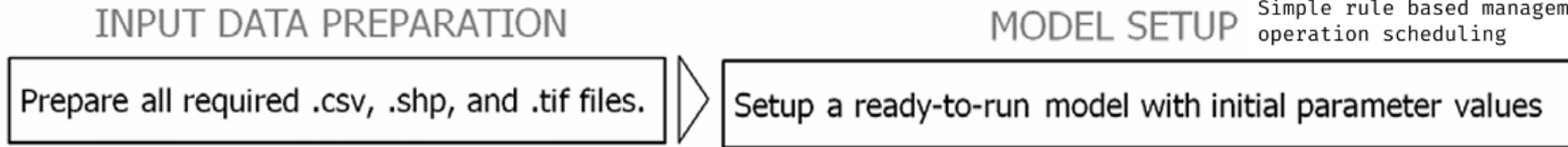
Workflow + tools - overview
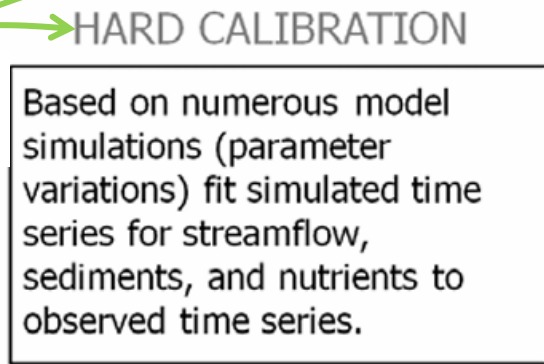

SWATbuildR
An object connectivity
based SWAT+ model builder

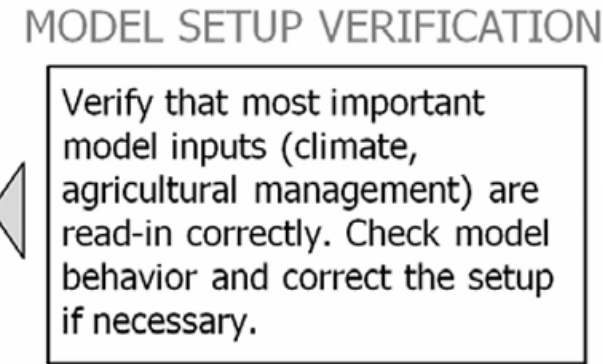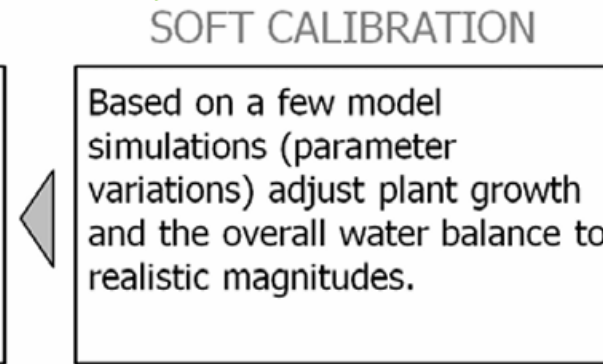SWATfarmR
Simple rule based management
operation scheduling

SWATprepR
SWAT+ input data preparation
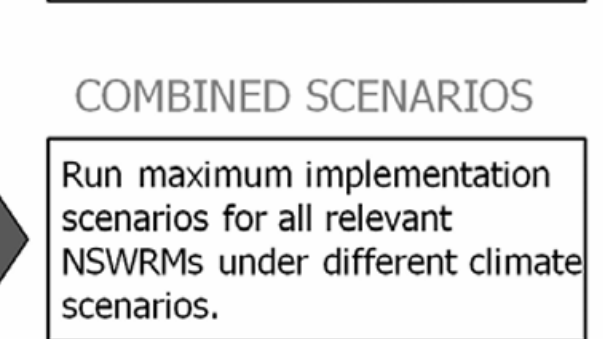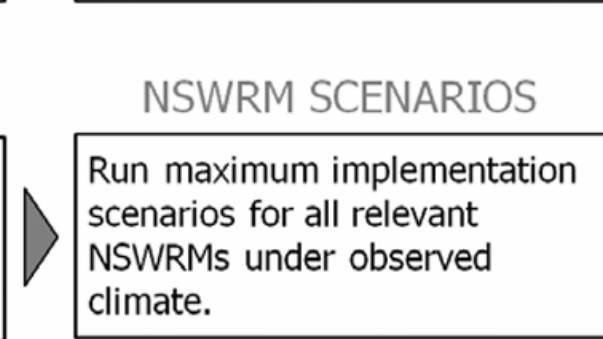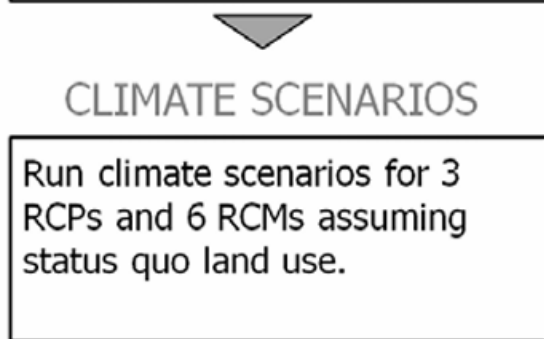
SWATtunR
Tuning SWAT+ model parameters

SWATrunR
Running SWAT simulations in R

SWATdoctR
Model diagnostics tool
for SWAT+ model setups

SWATmeasR
Implementation of NSWRMs in
SWATbuildR model setups

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Scripted workflow

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Technical part - agenda

15:20 - 15:30	**Challenge #1 Be sufficiently spatial with your processes!** Dr. Michael Strauch Helmholtz-Centre for Environmental Research - UFZ, Leipzig, Germany
15:30 - 15:45	**Challenge #2 Prepare inputs and overcome data scarcity!** Dr. Brigitta Szabó, Institute for Soil Sciences, HUN-REN Centre for Agricultural Research, Budapest, Hungary Dr. Svajunas Plunge, Warsaw University of Life Sciences (SGGW), Warsaw, Poland
15:45 - 15:55	**Challenge #3 Be sufficiently detailed with your crop management!** Dr. Michael Strauch Helmholtz-Centre for Environmental Research - UFZ, Leipzig, Germany
15:55 - 16:05	**Q&A**
16:05 - 16:20	**Challenge #4 Ensure reliability in your model's results!** Dr. Svajunas Plunge, Warsaw University of Life Sciences (SGGW), Warsaw, Poland
16:20 - 16:40	**Challenge #5 Be sufficiently spatial with your retention measures!** **&** **Challenge #6 Optimize the allocation of NSWRMs for multiple objectives!** Dr. Michael Strauch, Helmholtz-Centre for Environmental Research - UFZ, Leipzig, Germany
16:40 - 16:50	**Q&A**

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An object connectivity based SWAT+ model builder

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SWAT+ input data preparation

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