IWAS
Brazil
ÁGUA-DF

TECHNISCHE UNIVERSITÄT DRESDEN

Modelling land use effects on water resources

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1 Introduction

- **Land use affects water resources:**
  - **Water quantity** (e.g. agricultural water demand, silting)
  - **Water quality** (e.g. nutrient/sediment pollution)
  - and, thus, **water supply** (potentials, costs)

- **Appropriate evaluation / quantification of land use effects requires modelling approaches accounting for:**
  - **Processes** (biophysical)
  - **Scale** (landscape/river basins)
  - **Uncertainties** (input data, parameter, model structure)

2 Methods

Soil & Water Assessment Tool | SWAT

The SWAT model *(Arnold et al. 1998)*

- **Integration** of relevant **processes** on the scale of **river basins**
- Long-term continuum **simulations to predict** the daily…
  - **streamflow** (at the watershed or subbasin outlets)
  - **loads of N, P, sediments, pesticides** in streamflow
  - **production of biomass**
  - **…**
- **Open source** *(http://swat.tamu.edu/software/swat-model/)*
- **Widely used** across the globe, increasingly in the tropics

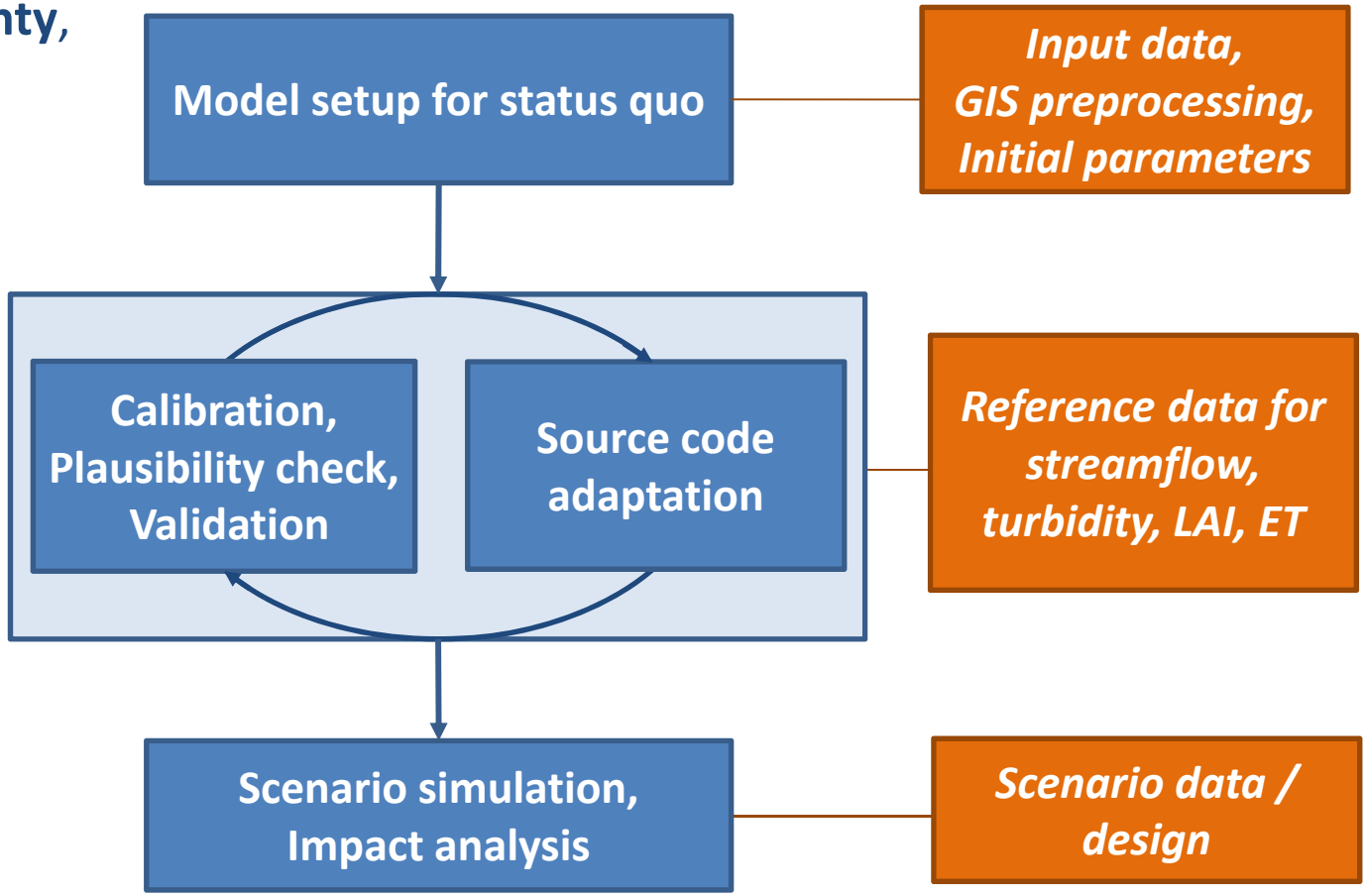
2 Methods

Modelling workflow

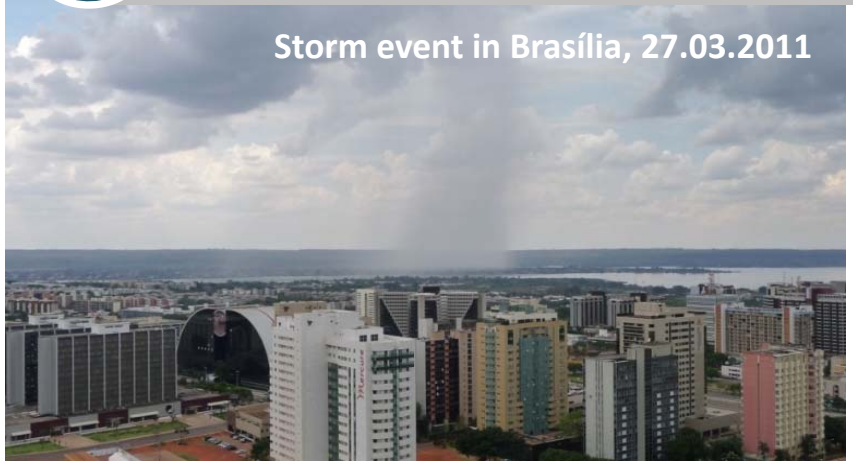
Precipitation uncertainty, Pipiripau
Strauch et al. (2012), J. Hydrol.

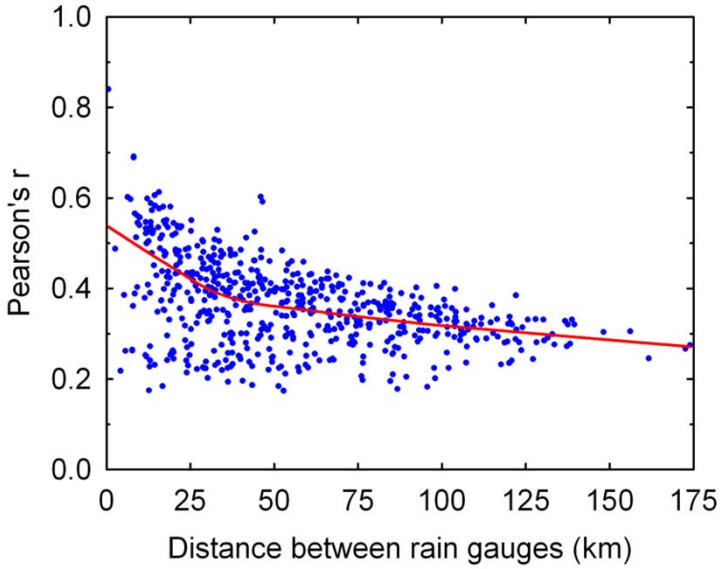
Plant growth, Santa Maria
Strauch & Volk (subm.), Environ. Modell. Softw.

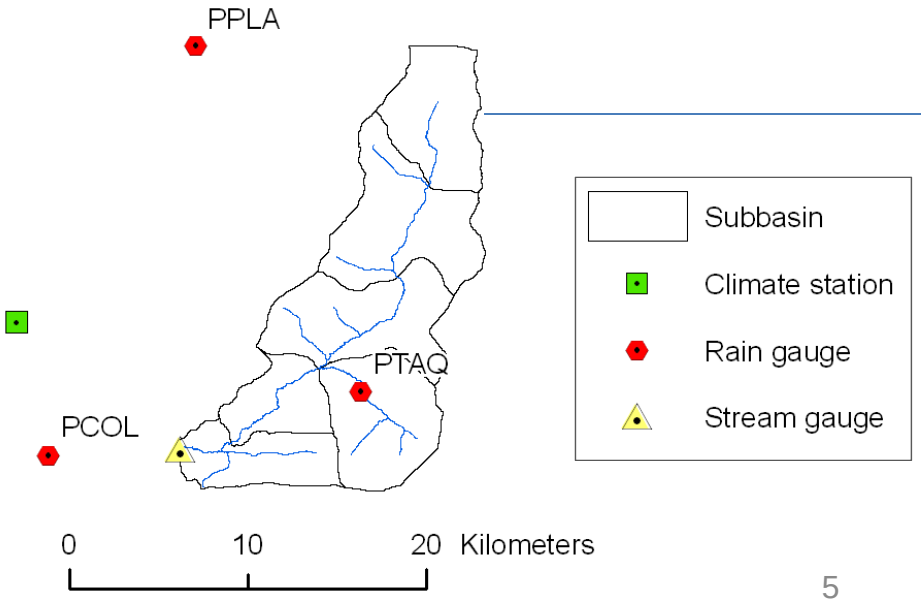
BMP scenarios, Pipiripau
Strauch et al. (2013), J. Environ. Manage.

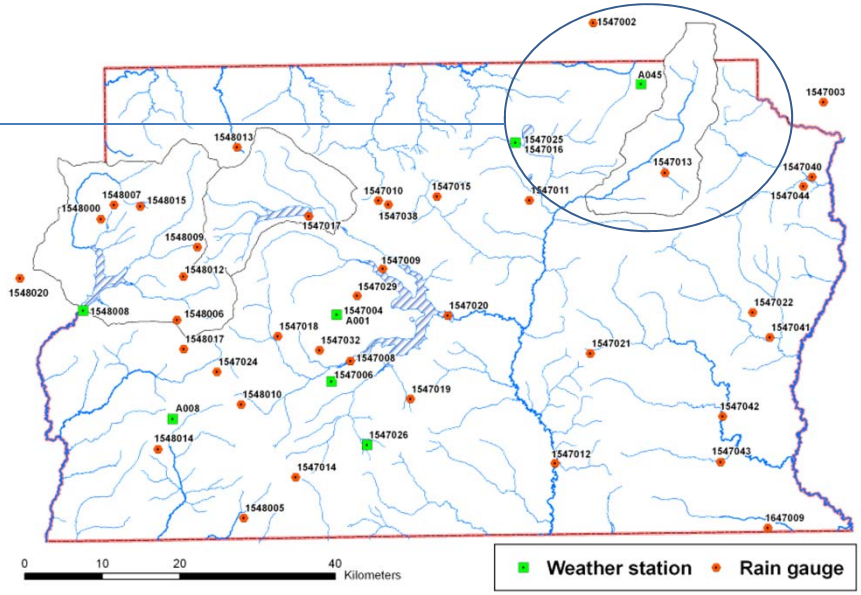


3 Precipitation uncertainty





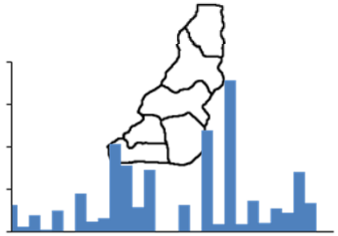




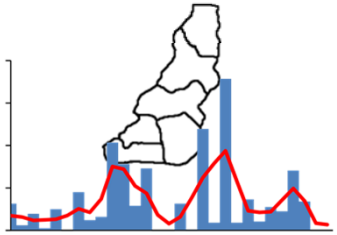
3 Precipitation uncertainty

Ensemble of precipitation input data

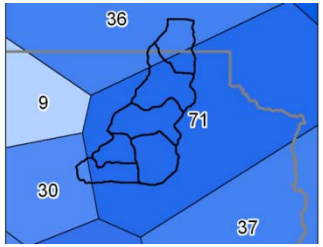
TAQ
Gauge Taquara
uniform



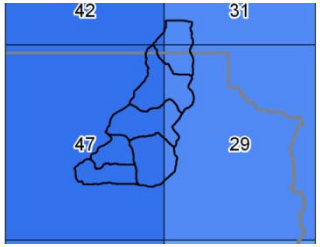
TAQM
Moving average of TAQ
uniform



THIE
Thiessen polygons
spatially distributed



TRMM
Satellite data
spatially distributed

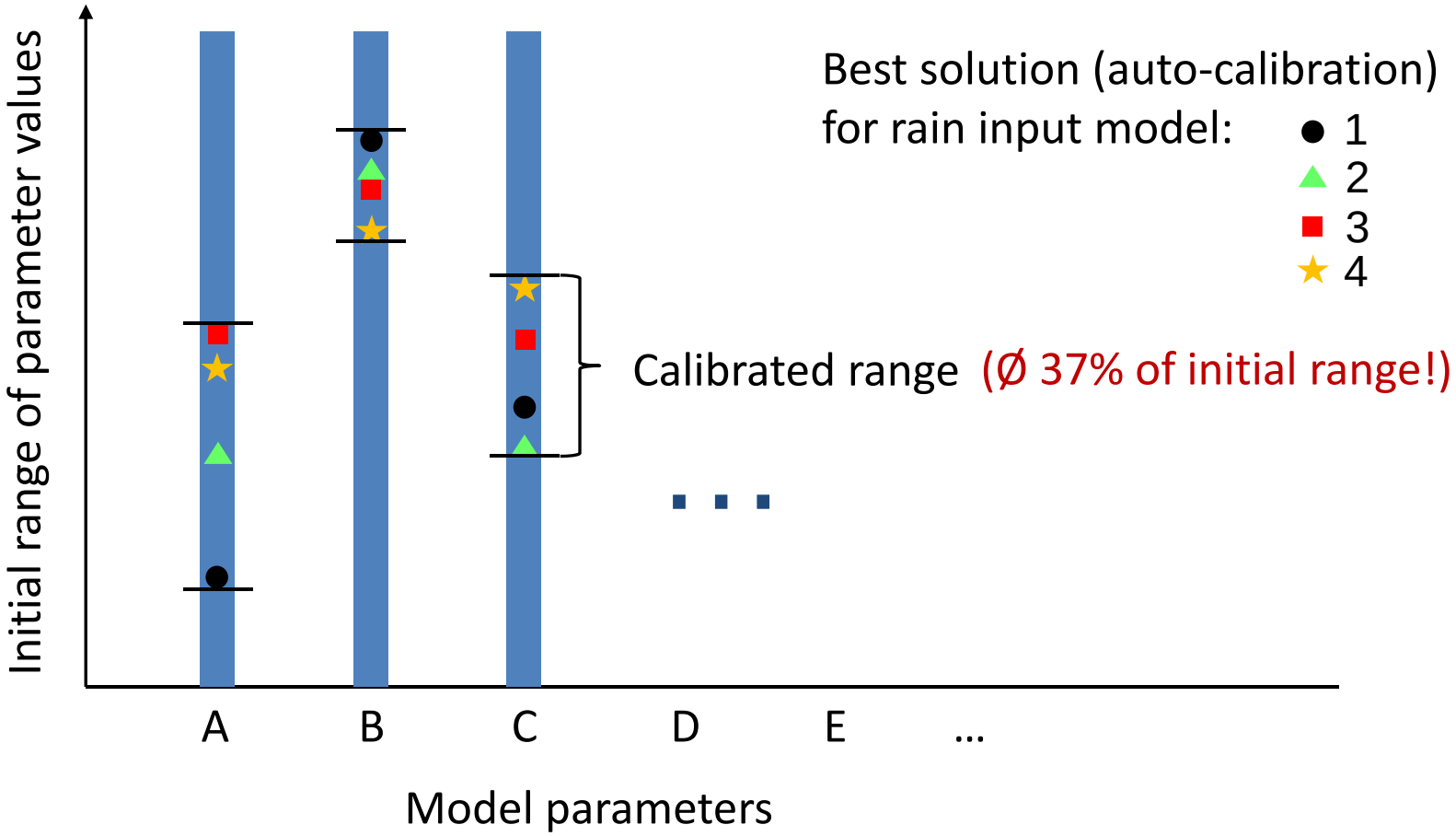


Sensitive Model parameters? (LH-OAT; van Griensven et al., 2006)

Best fit parameters? Streamflow? (SUFI-2; Abbaspour et al., 2004)

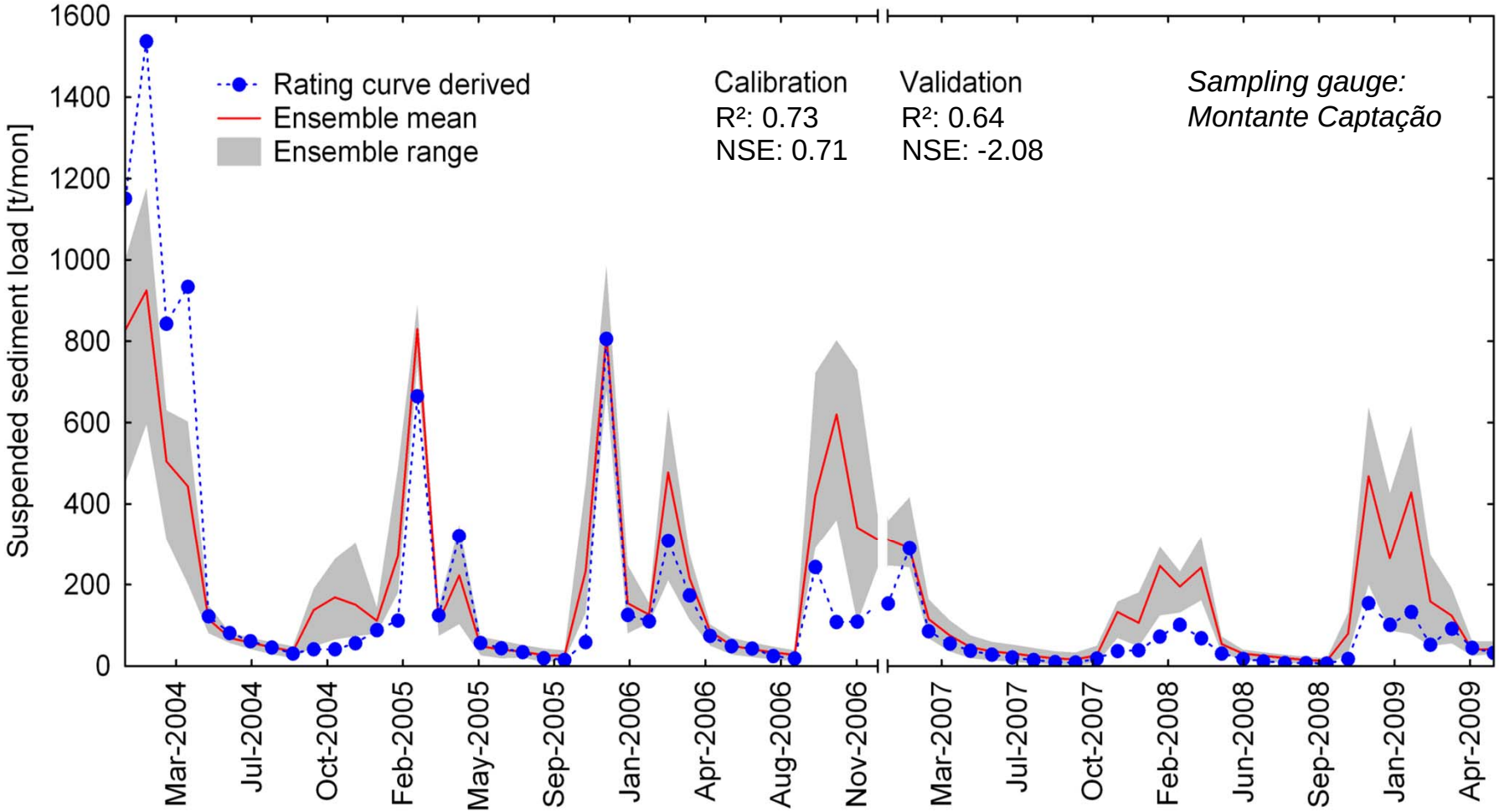
3 Precipitation uncertainty

…and its influence on parameter uncertainty



3 Precipitation uncertainty

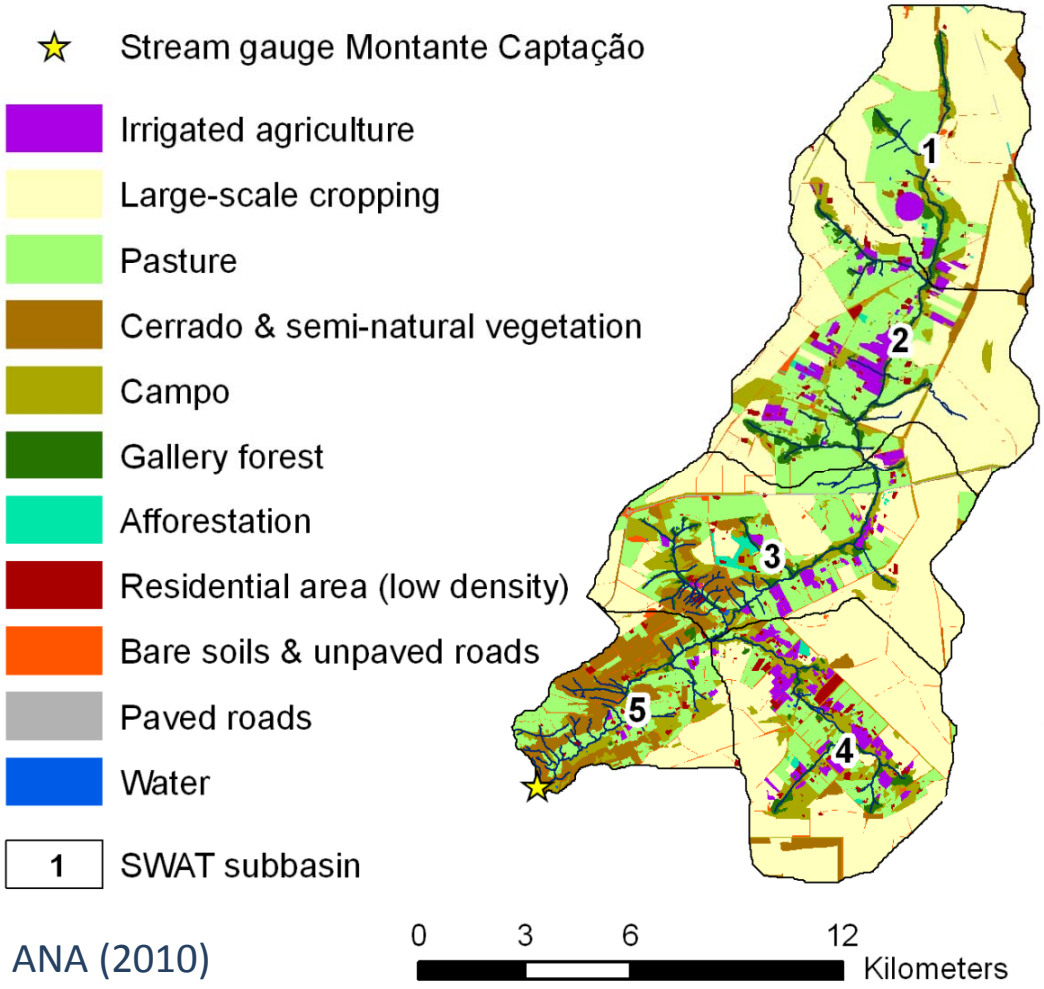
…and its influence on model outputs



4 BMP scenarios

… for the Pipiripau River Basin

Land use (status quo):



Produtor de Água:

Pilot program supporting Best Management Practices (BMP) by „Payments for Environmental Services“

Source: ANA (2010)

4 BMP scenarios

… for the Pipiripau River Basin

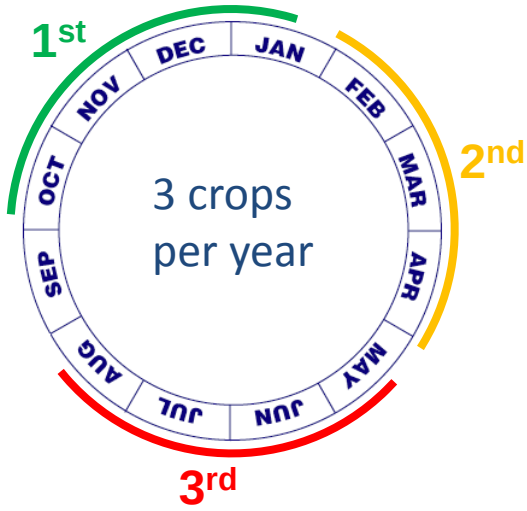
Terraces (TER)

- on pasture and cropland
- USLE P-Factor: 0.5 => 0.12
- Curve Number: calibrated value -5

Barraginhas (BAR)

- simulated as ponds
- pond parameters derived by GIS and expert knowledge
- SWAT code modification: only surface runoff is routed through ponds

Multi-diverse crop rotation (ROT)



- crops change each year:

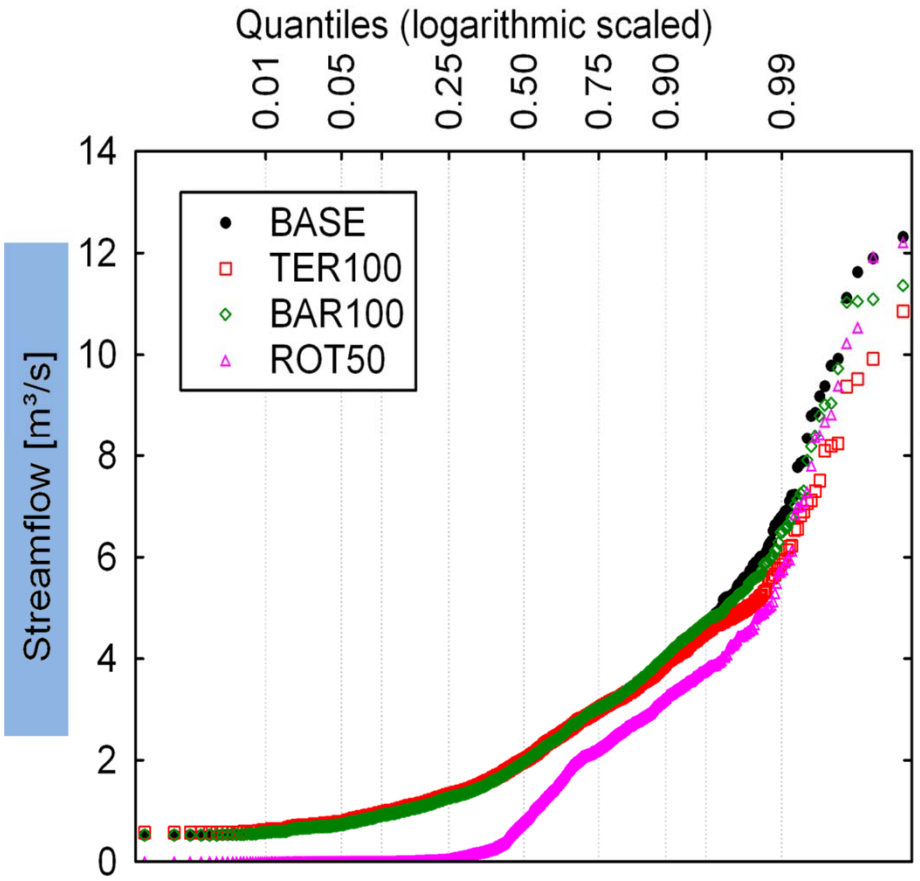
soybean/corn/cotton
corn/beans/sorghum/ /sunflower/canola
beans/wheat/bell pepper/ sweet corn/potato

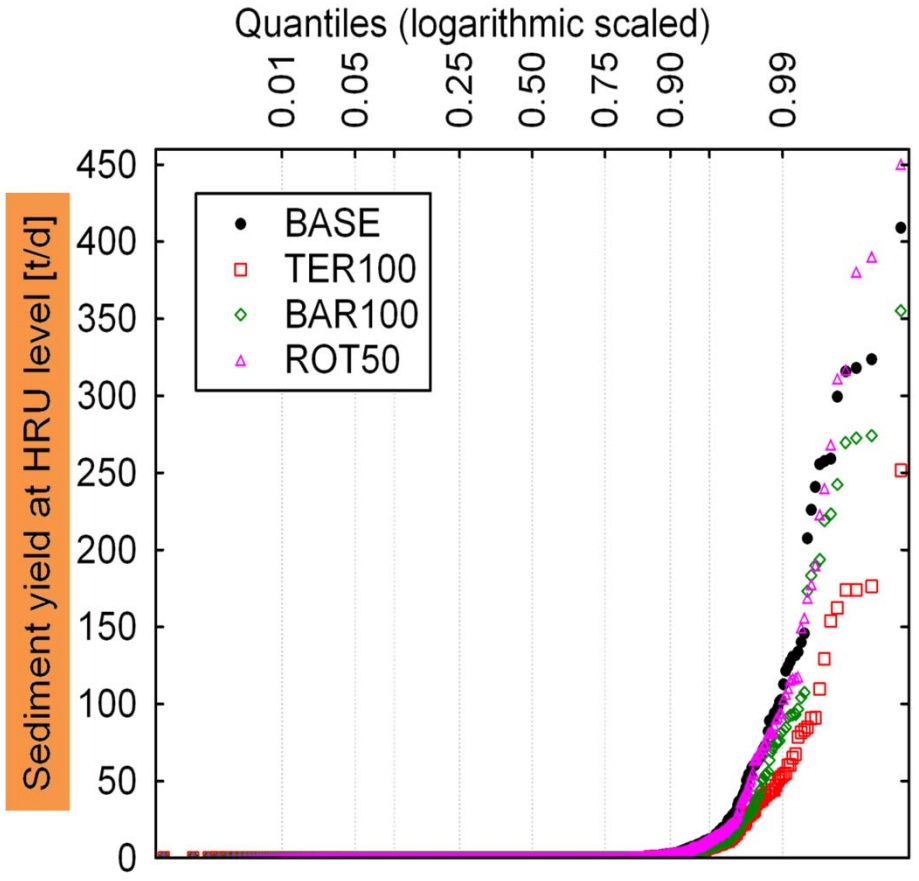
⇒ all scenarios were run in different quantities of implementation

4 BMP scenarios

Results

Cumulative distribution of daily model predictions for period 2004-2009…



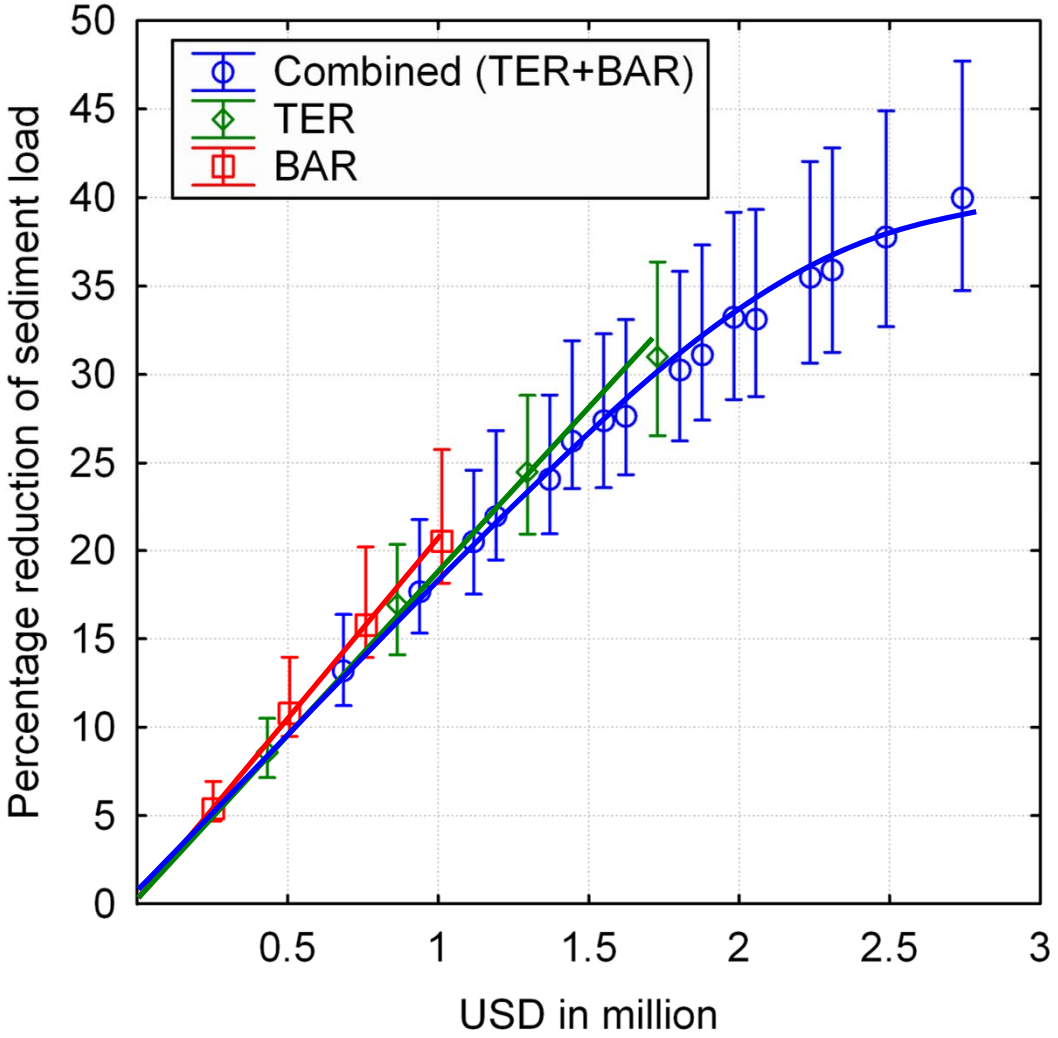


4 BMP scenarios

Cost-Benefit (modeled!)

Implementation costs (ANA, 2010) :

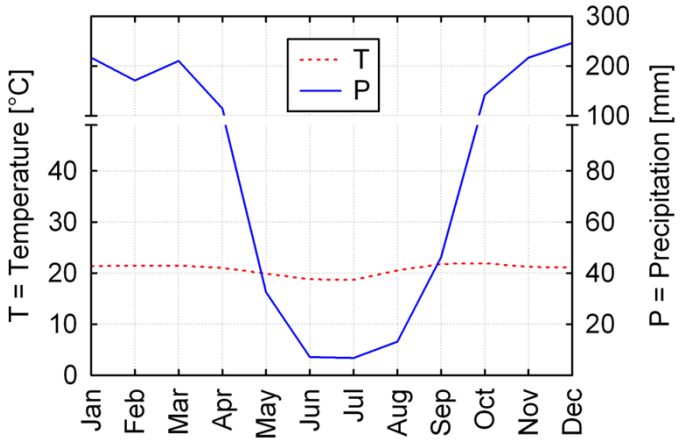
Terraces:
USD 150/ha (implementation)
USD 100/ha (re-establishement)
Barraginhas:
USD 120/unit

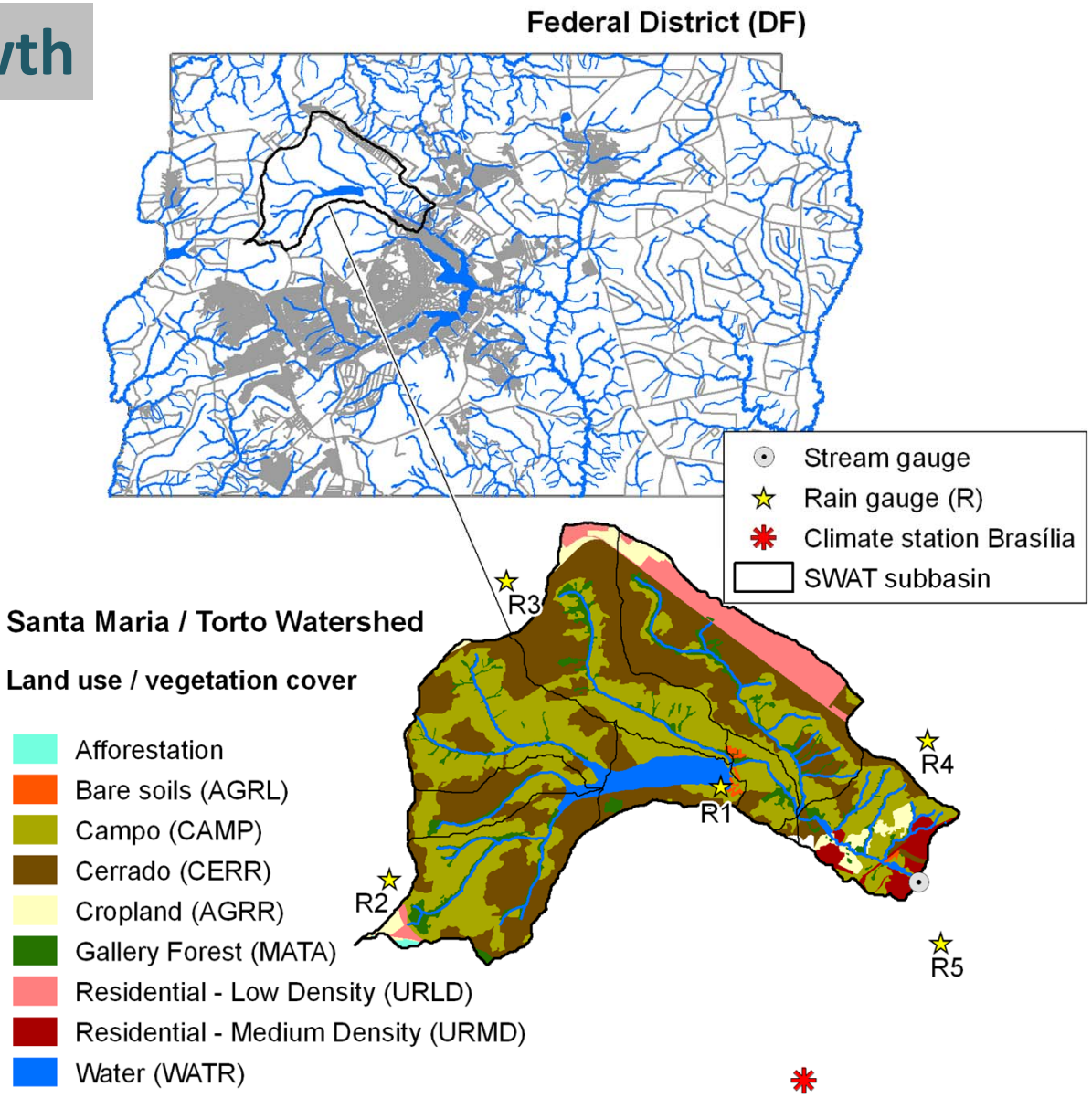


5 Plant growth

Savanna/forest

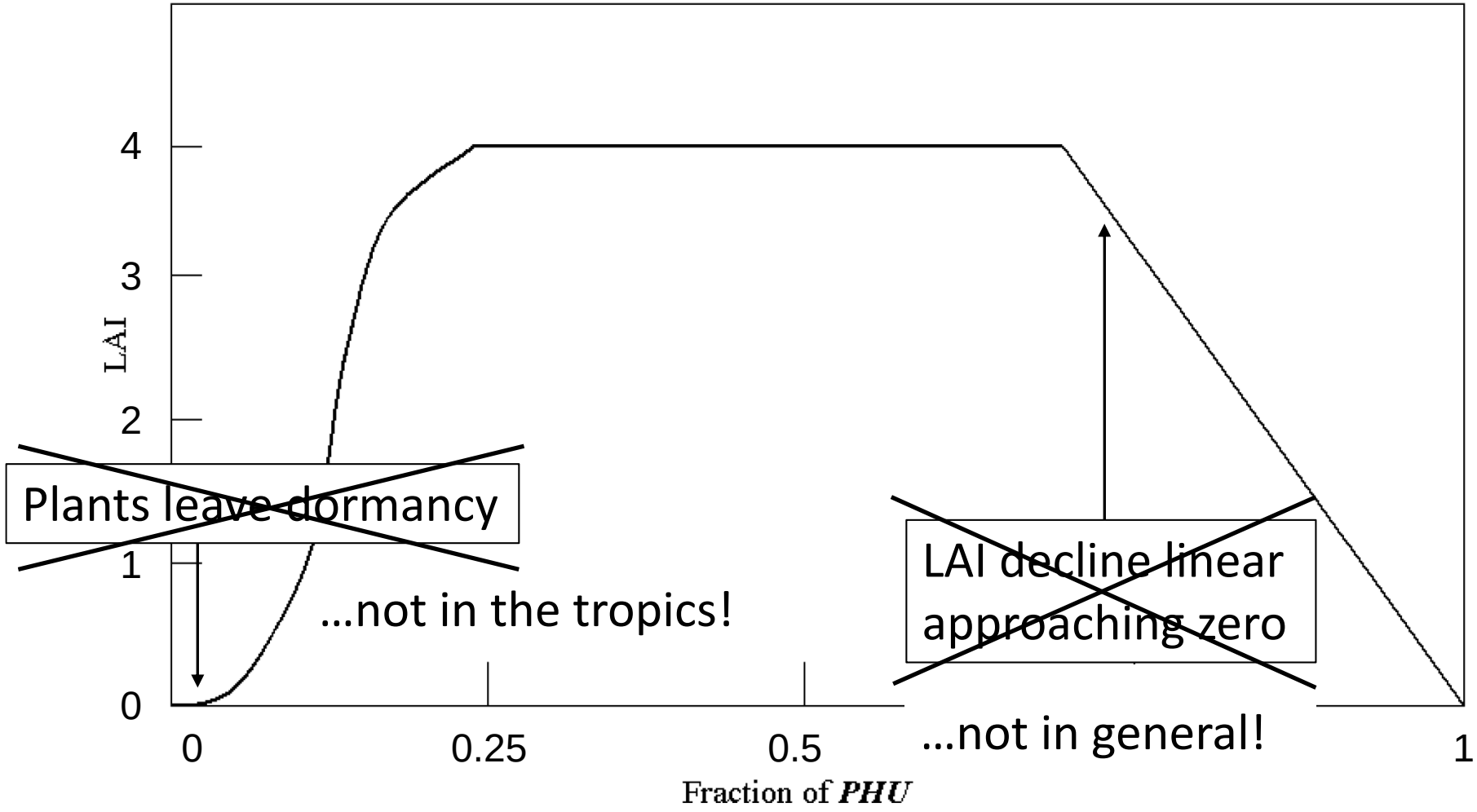
Phenology driven by precipitation pattern





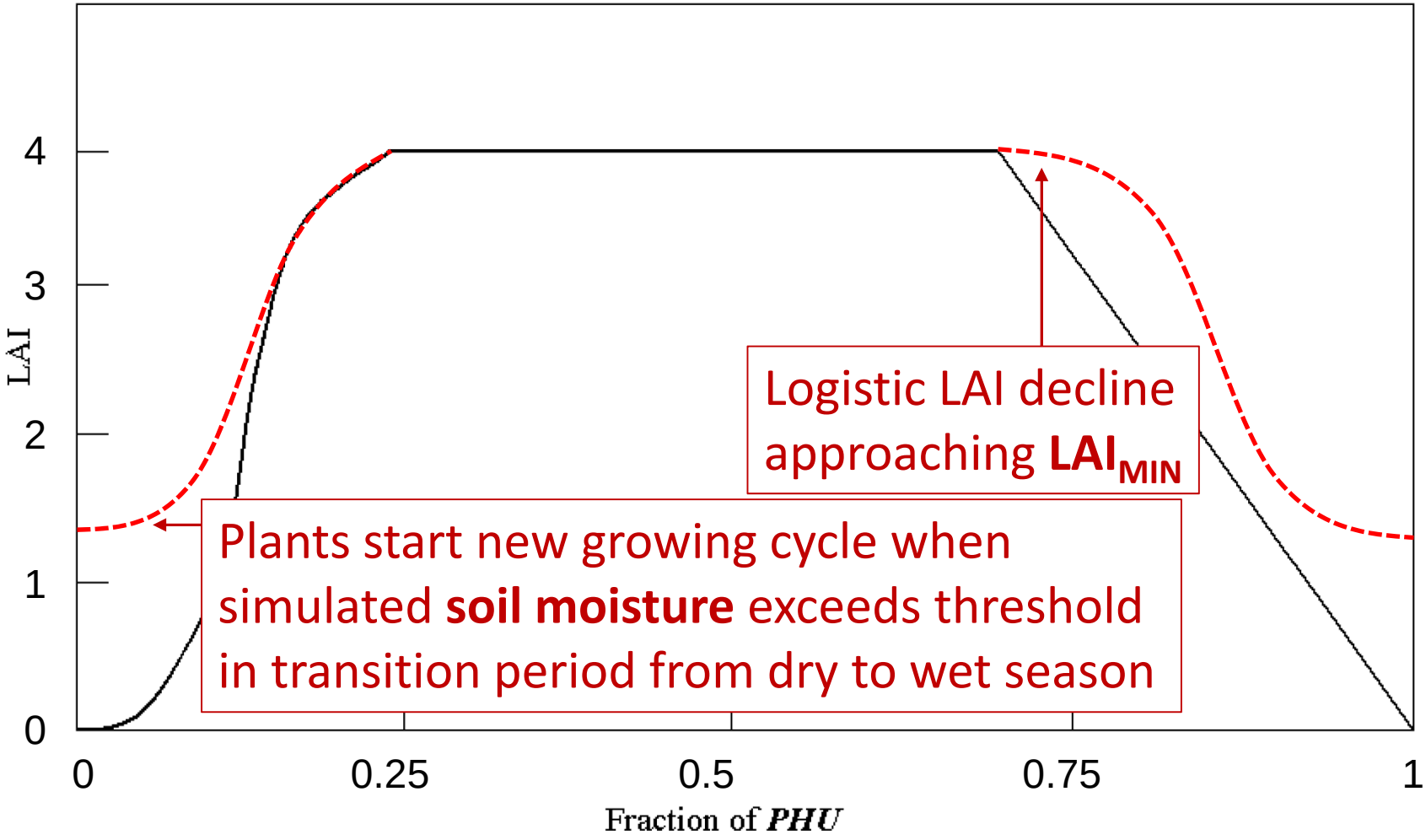
5 Plant growth (savanna, forest)

Leaf Area Index (LAI in m^2/m^2) calculation (default)



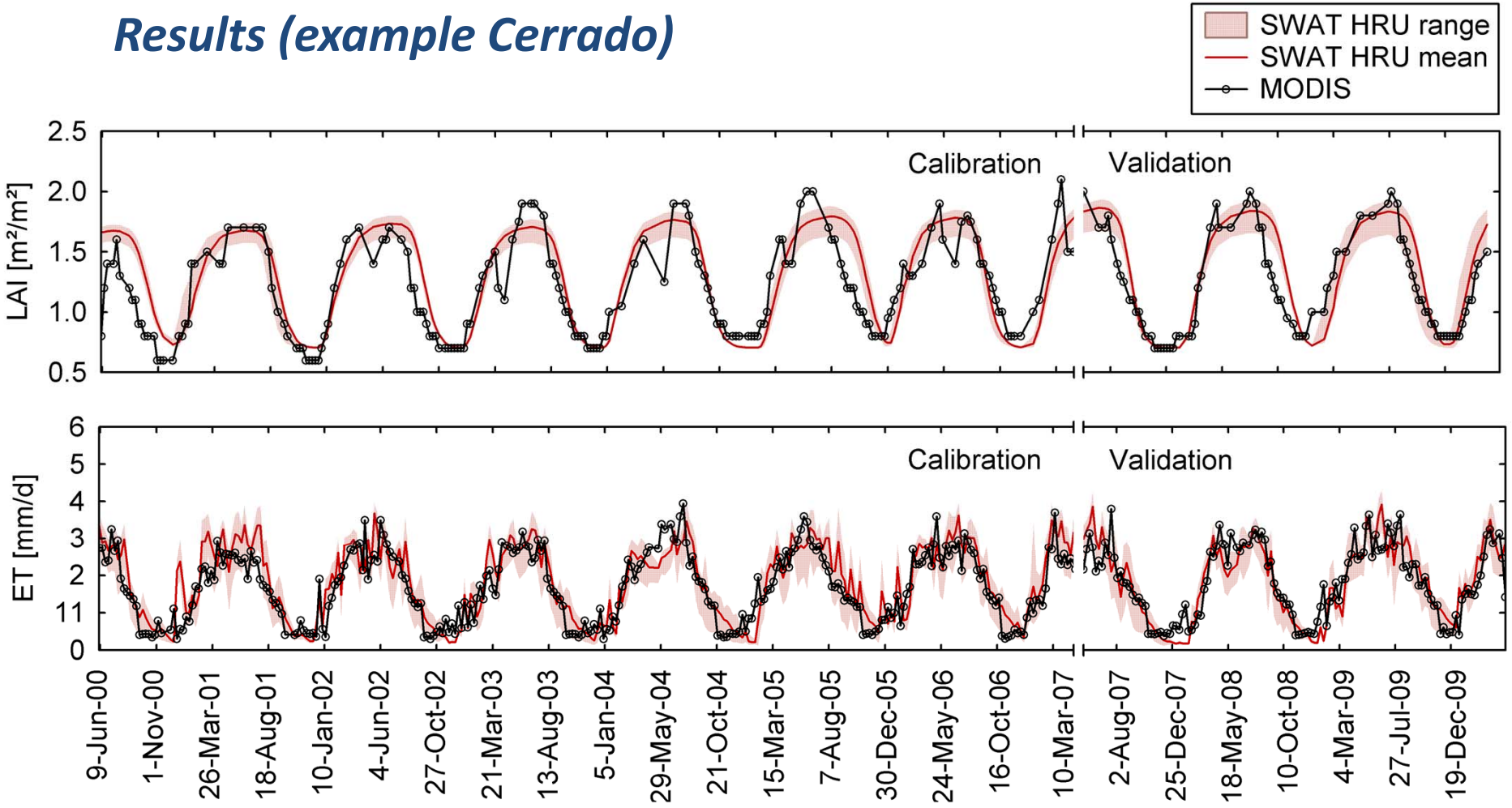
5 Plant growth (savanna, forest)

LAI calculation (modified)



5 Plant growth (savanna, forest)

Results (example Cerrado)



6 Conclusions

- SWAT successfully applied for two watersheds in the DF
  ⇒ **Source code adaptation (SWAT not designed for the tropics)**

- Precipitation input data must be considered as highly uncertain
  ⇒ **Ensemble input data as useful approach**

- Terraces and Barraginhas are promising BMPs
  ⇒ **Up to 40% less sediment load while maintaining streamflow**

- Irrigated dry season crops no option
  ⇒ **Risk of extreme low flow conditions**

- SWAT ready for take off to further DF scenario applications
  ⇒ **E.g. scenarios on climate change / urban sprawl**
  ⇒ **Monitoring most crucial for further modeling / model integration**
  ⇒ **Increasing SWAT community (IWAS-ÁguaDF with huge contribution)**

Muito obrigado!!

Thanks to BMBF and all partners involved.