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The impact of woody biomass production on the water balance of the North German Lowlands

- A hydrological modelling with SWAT -

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Applied Geography, environmental hydrology and resource management

HNE Eberswalde
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Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz

FNR
Fachagentur Nachwachsende Rohstoffe e.V.

The Problem

Water?

The Problem

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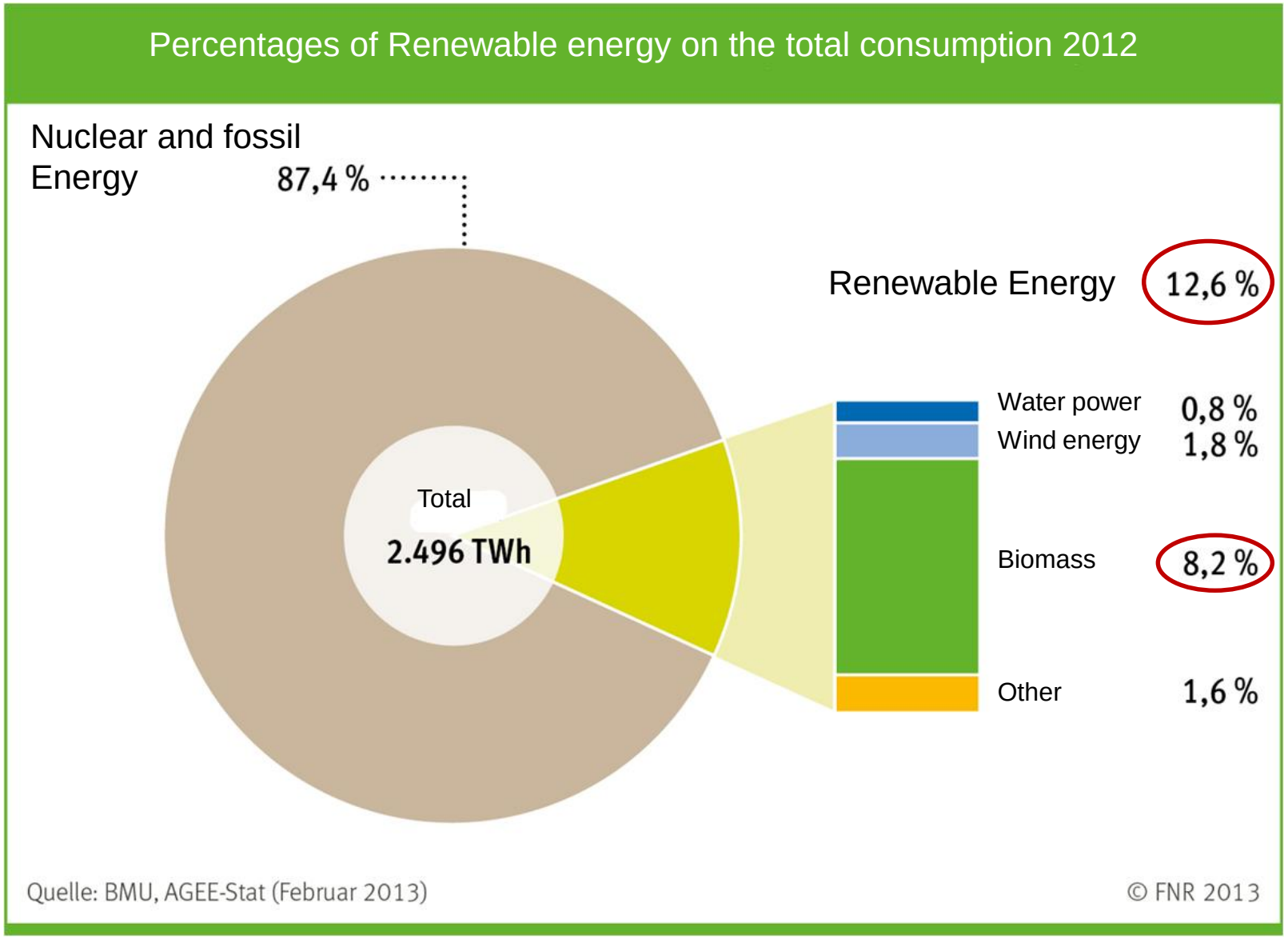

The Problem

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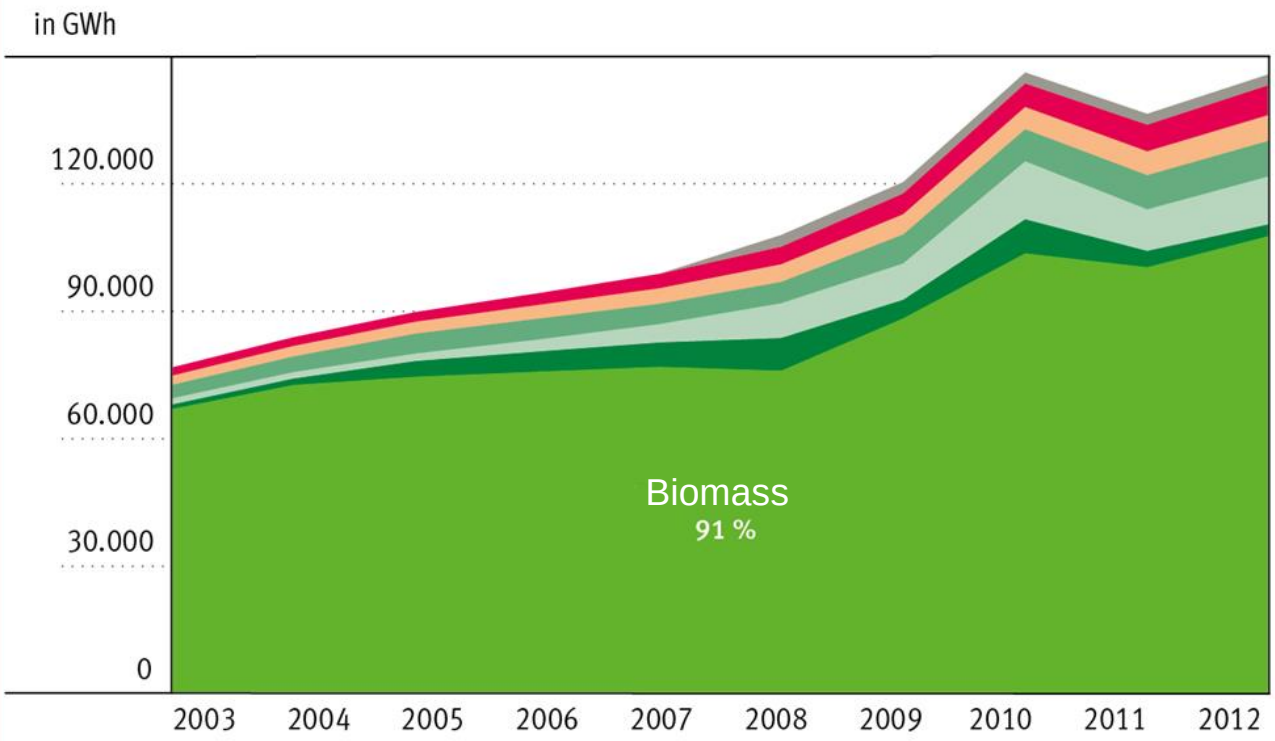
Heat production out of renewable energy sources

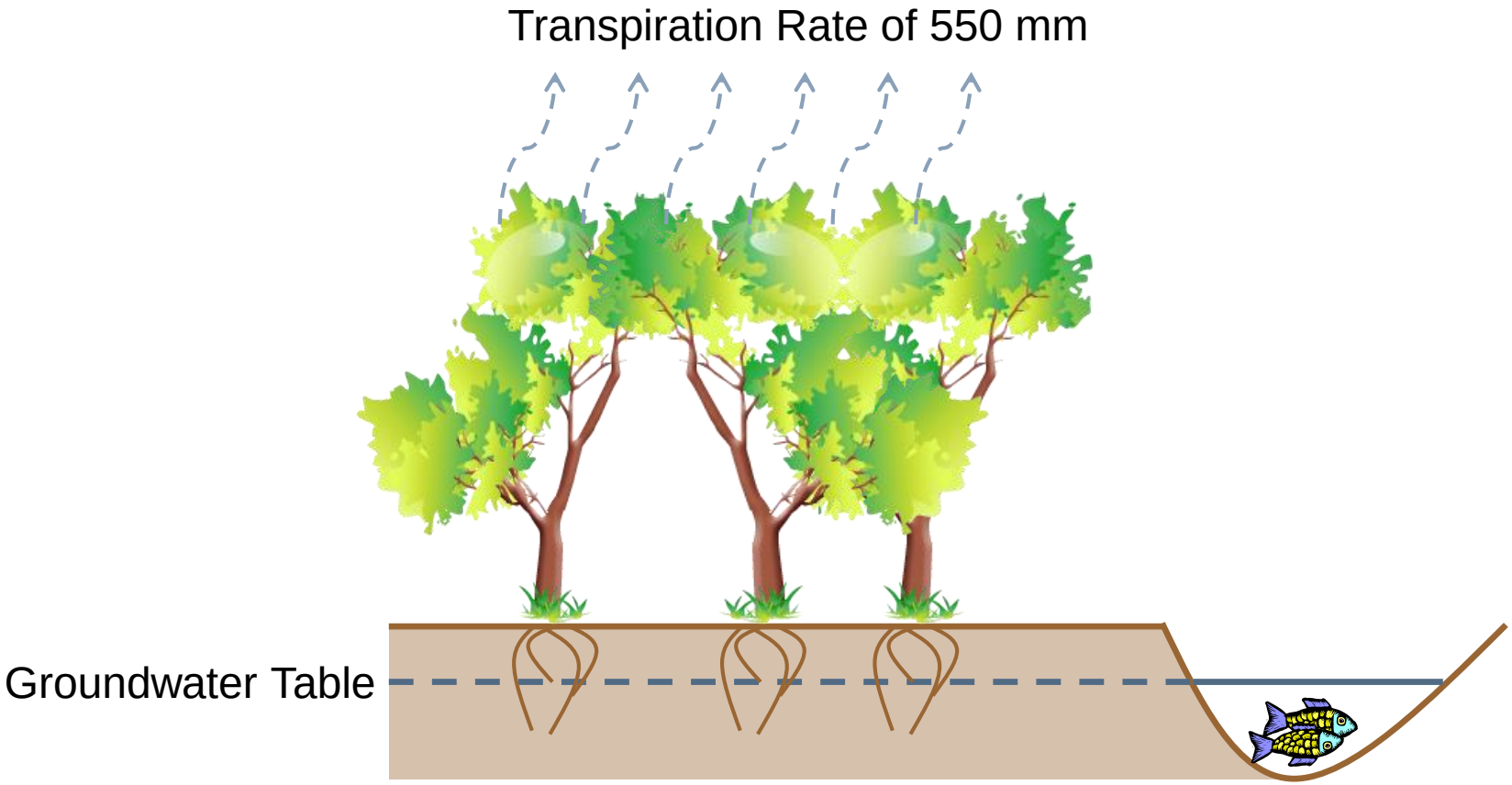


Quelle: AGEE-Stat (Februar 2013)

SRC management

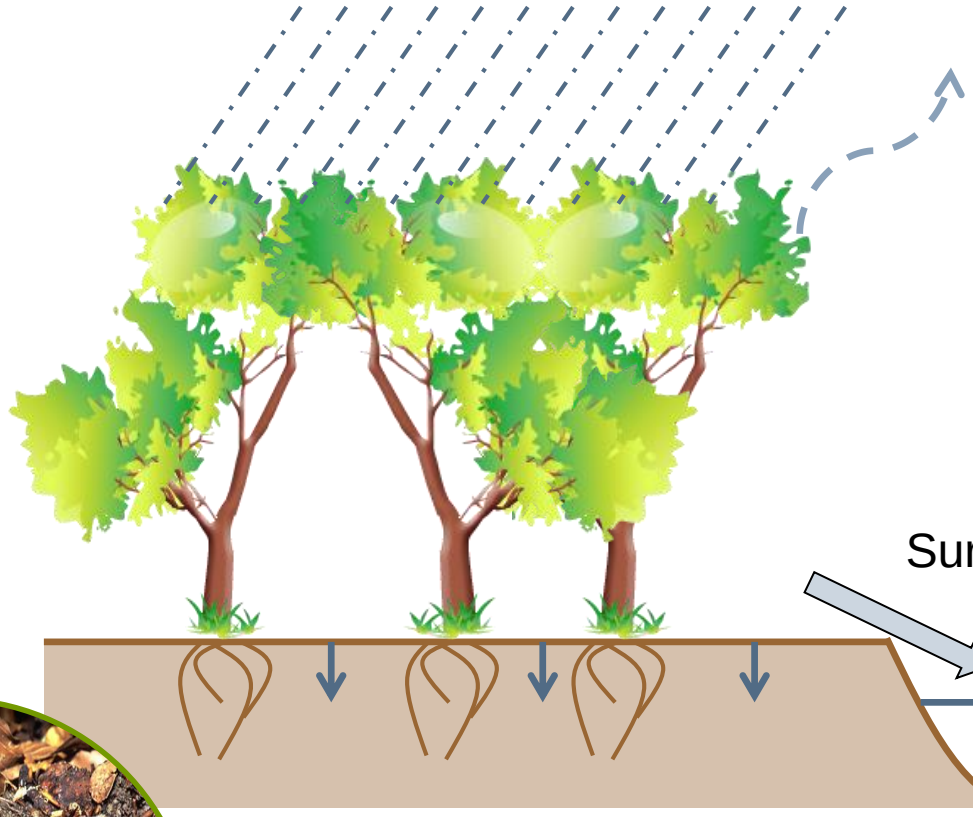
Trees 3-6 years after establishment

Impacts on Hydrology



Impacts on Hydrology

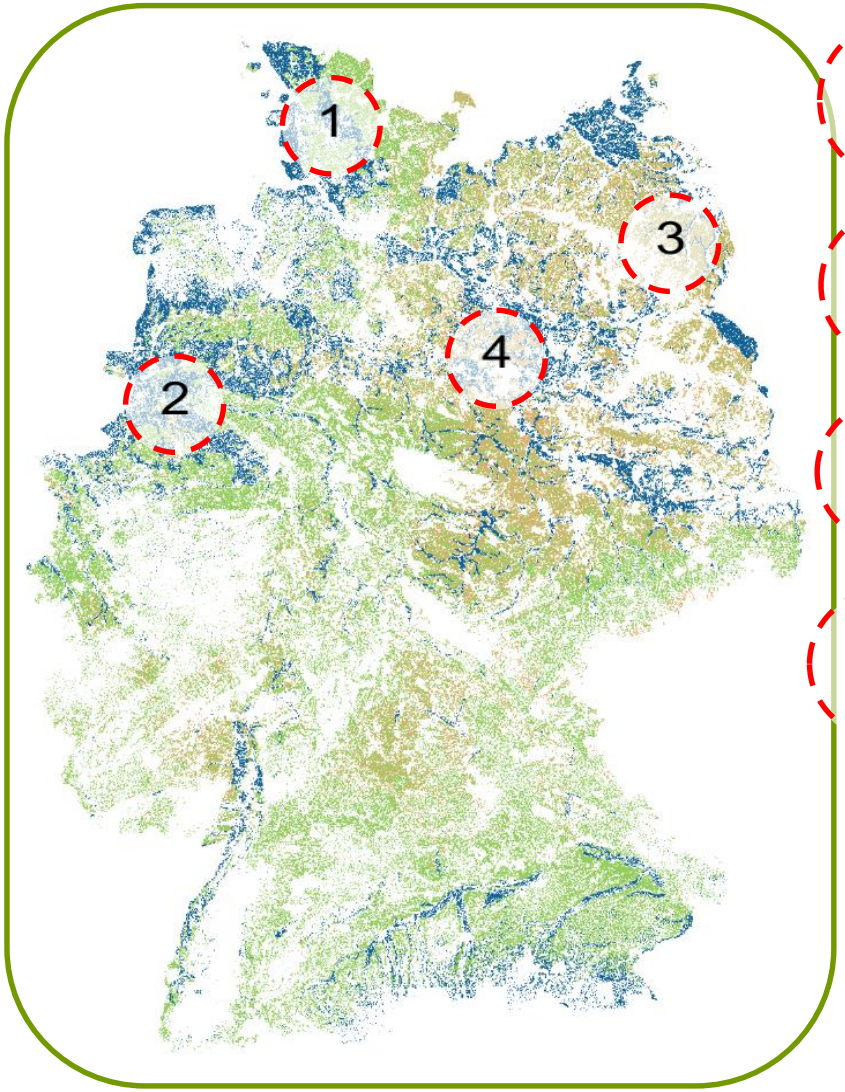
Interception



Surface Runoff

Infiltration

Basins
– selected by suitability for SRC



1
- **Treene** – 477 km²

2
- **Ems** – 9.093 km²

3
- **Ücker, Randow and Welse** – 3.290 km²

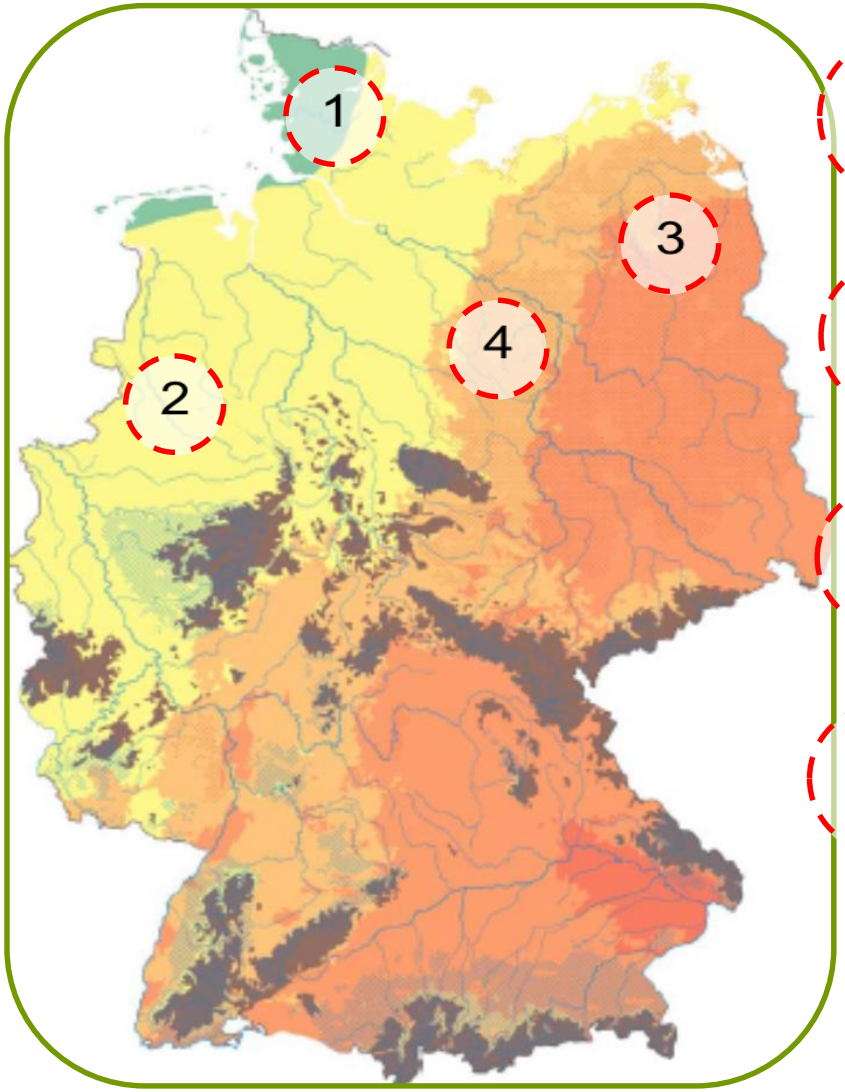
4
- **Aland** – 1.907 km²

- Total Area: 14.767 km²
  → 1047 Subbasins

Calculated by DEM with a resolution of 25m and a 1000 ha Threshold

highly suitable suitable not suitable

Climate Background



1
- **Treene**

Atlantic

2
- **Ems**

Marine

3
- **Ücker, Randow and Welse**

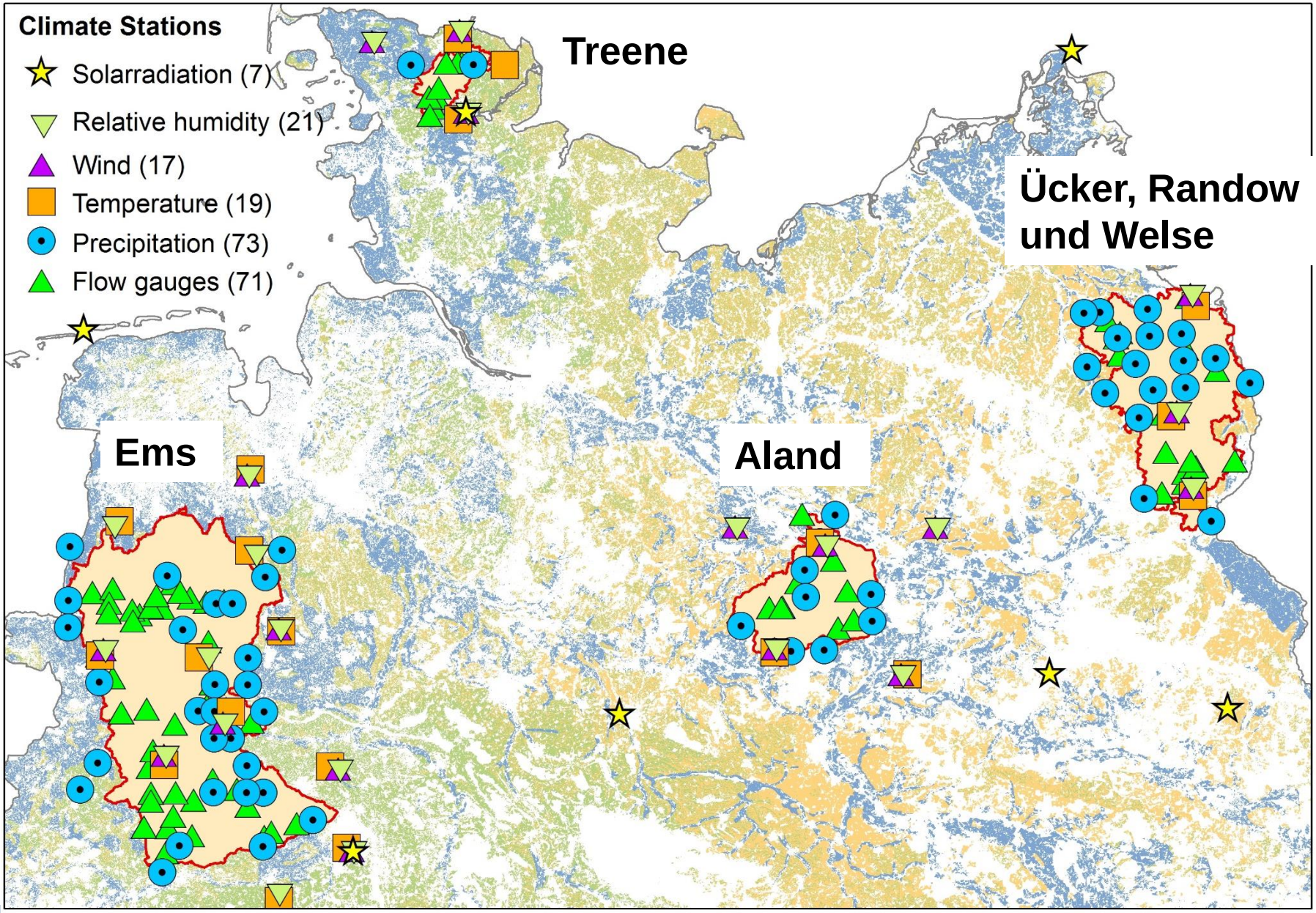
Continental

4
- **Aland**

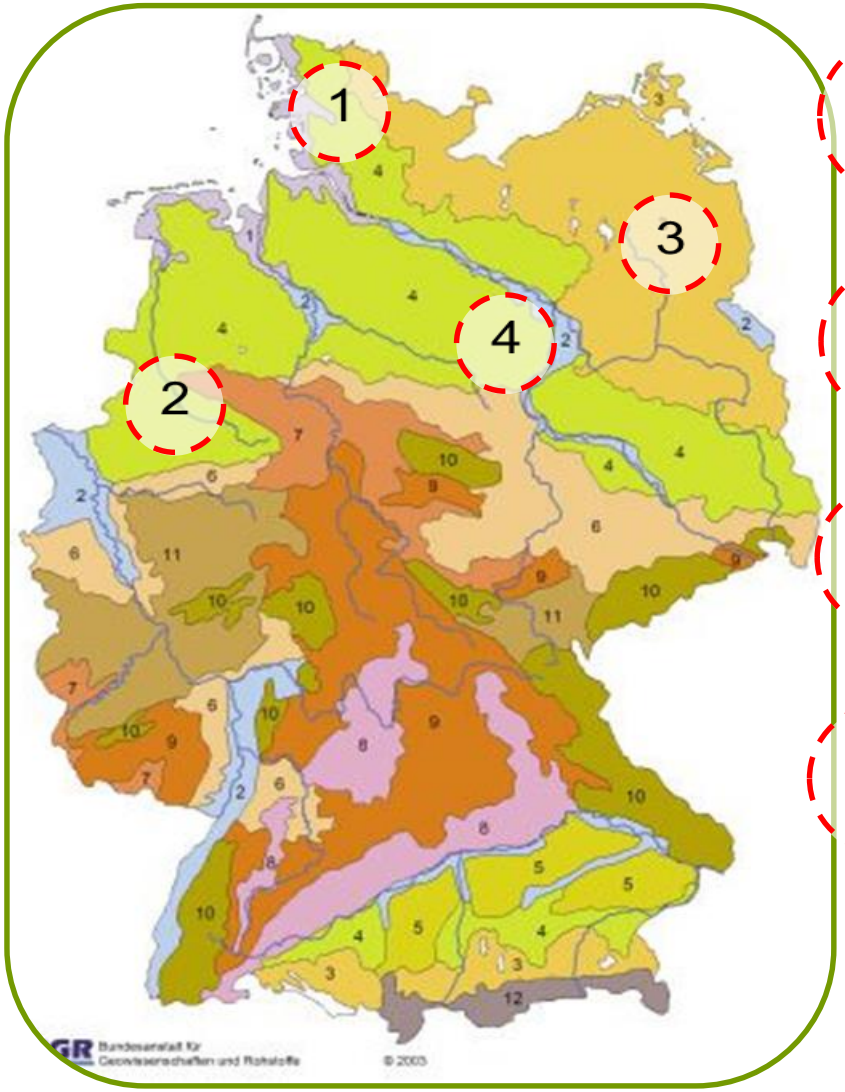
Transition zone Marine-Continental

Endlicher & Hendl, 2009

Climate Stations
with daily observations in the period 1990-2013



Soil- and Morphological Background



Hartwich et al., 1995

1
- **Treene**

  Transition zone young – pre-Weichselian landscapes

2
- **Ems**

  Pre-Weichselian glacial landscapes

3
- **Ücker, Randow and Welse**

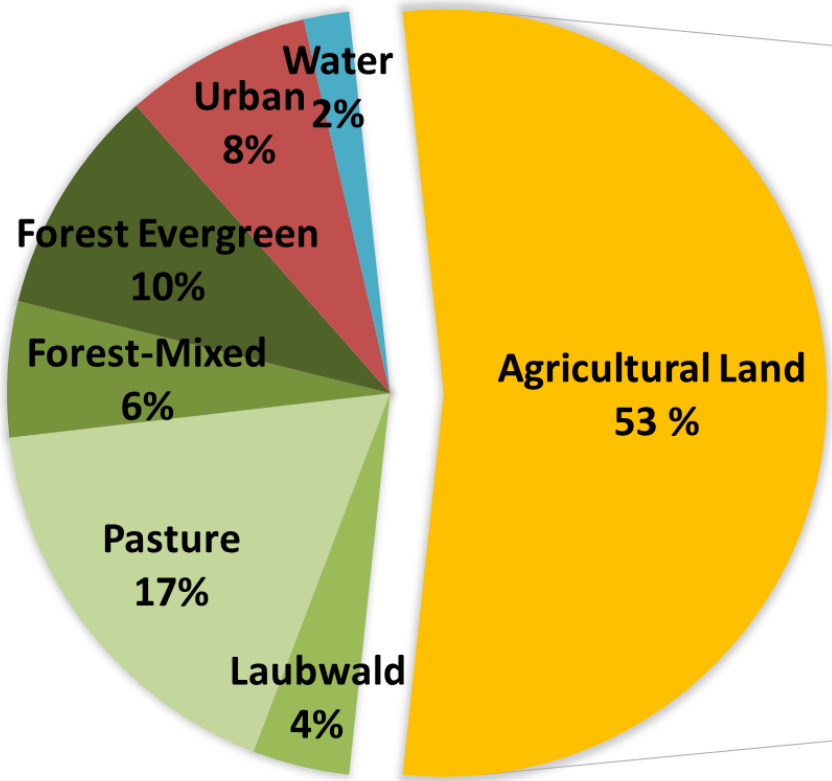
  young Weichselian glacial landscapes

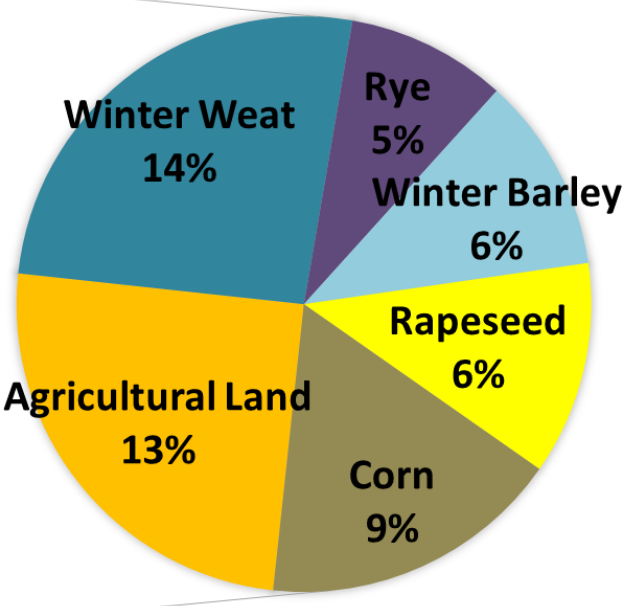
4
- **Aland**

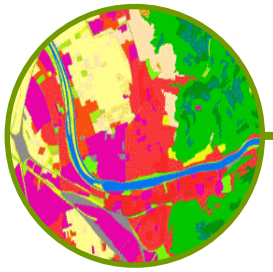
  Pre-Weichselian glacial landscapes

64 soil types were defined by soil maps with a resolution of 1:200,000 and other german soil databases

Land use and HRU Definition







Digital Land Use model (2009)

Statistical agricultural data (period 1995-2013)

12

Land use classes

24,592

HRU‘s

Calibration with daily values

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Parametrisation

SWAT-CUP v. 5.1.6

SUFI 2

Pre-Processing in Windows 7

Literature e.g:
- Schmalz et al. 2010
- Pfannerstill et al. 2014
- Guse et al. 2014
- Abbaspour at al. 2015

Run's

Windows 7 PC 1 – 8 CPUs

Windows 7 PC 2 – 8 CPUs

Linux HPC – 34 CPUs

Assembling 50 run's of 20 simulations

Runtime for one Iteration with 1000 simulations: 4 – 8 days

Objective Function

Post-Processing in Windows 7

Primary: NSE
Secondary: RSR, PBIAS

Calibration results

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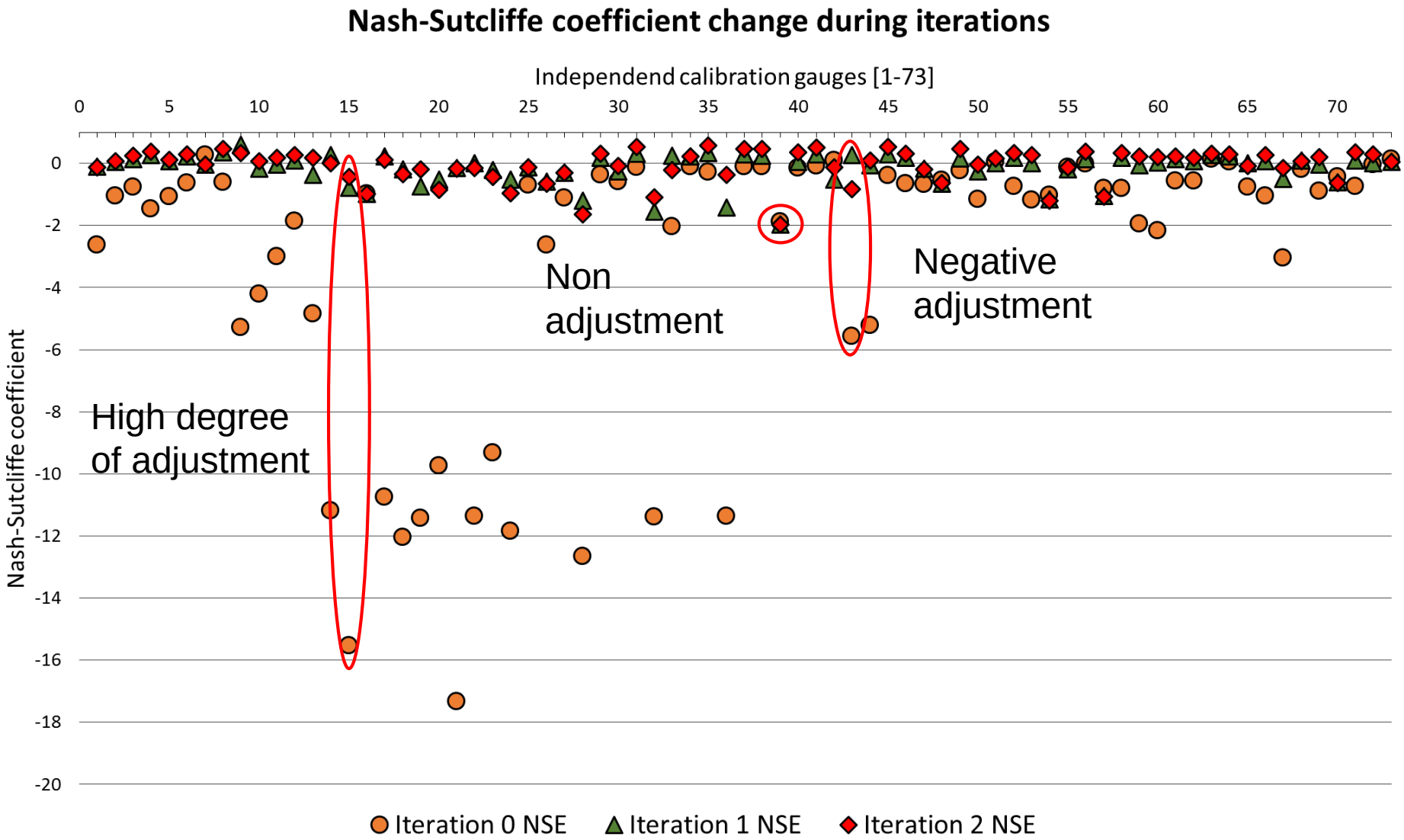
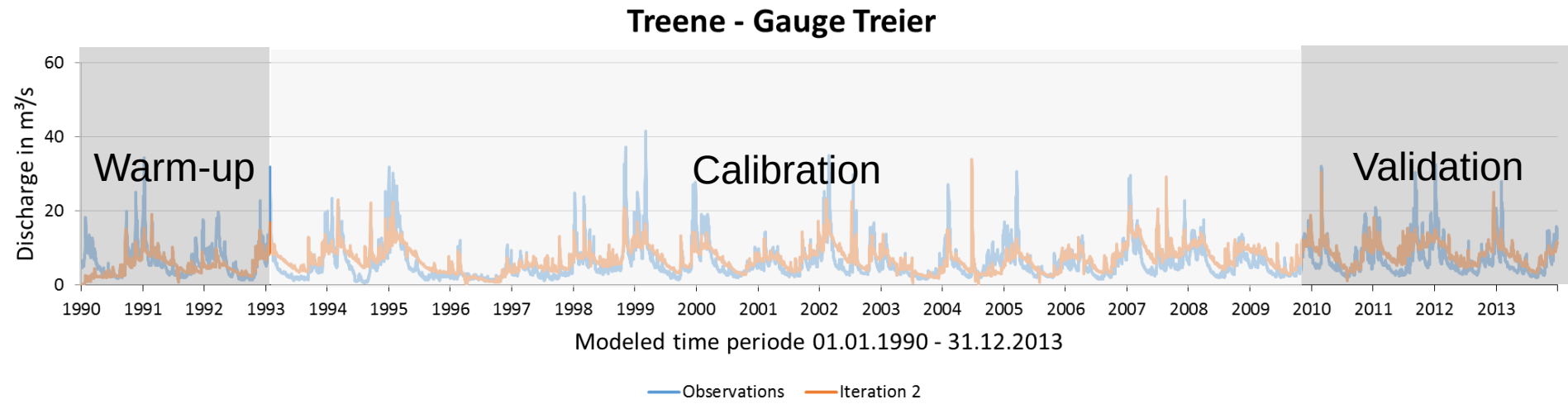
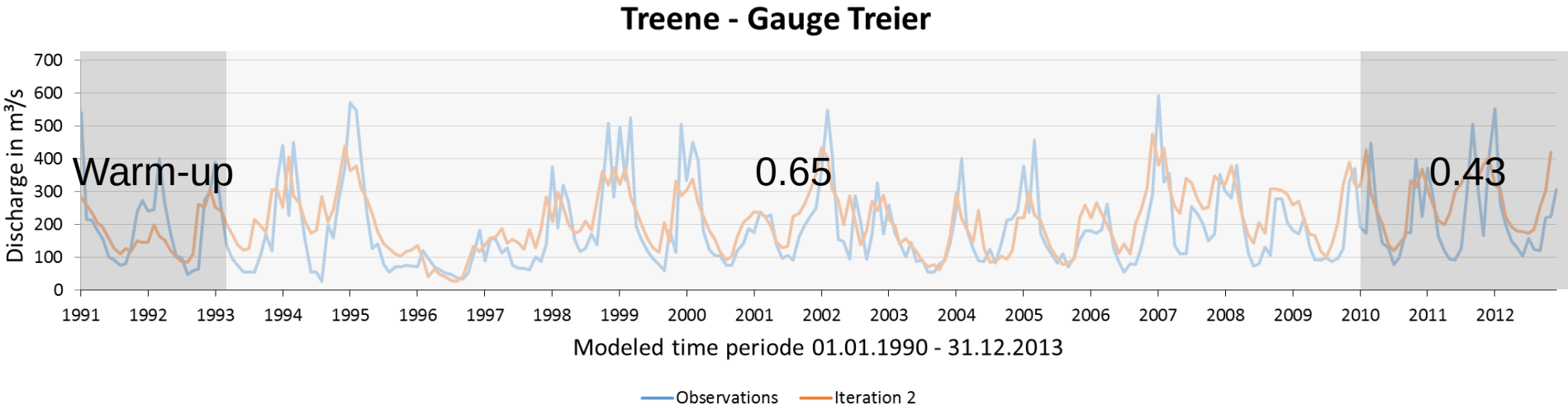


Calibration results



Daily values NSE: 0.50



Monthly values NSE: 0.60

Calibration results – flow duration curves

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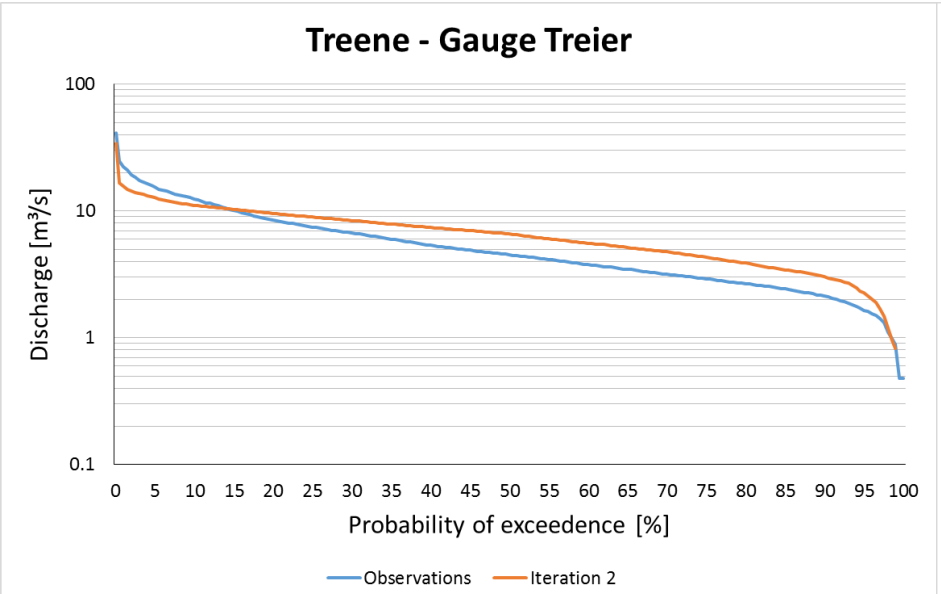
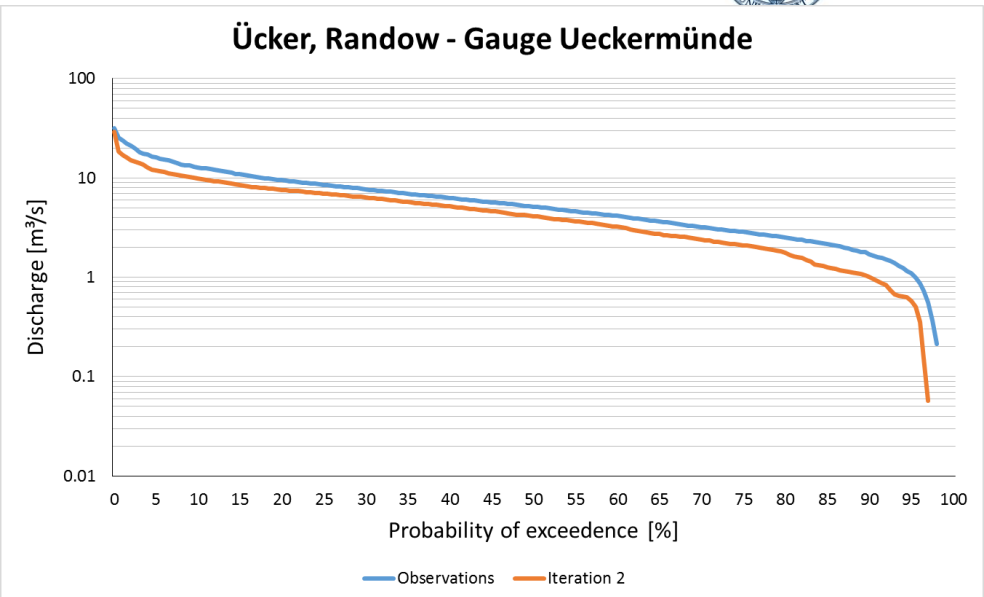
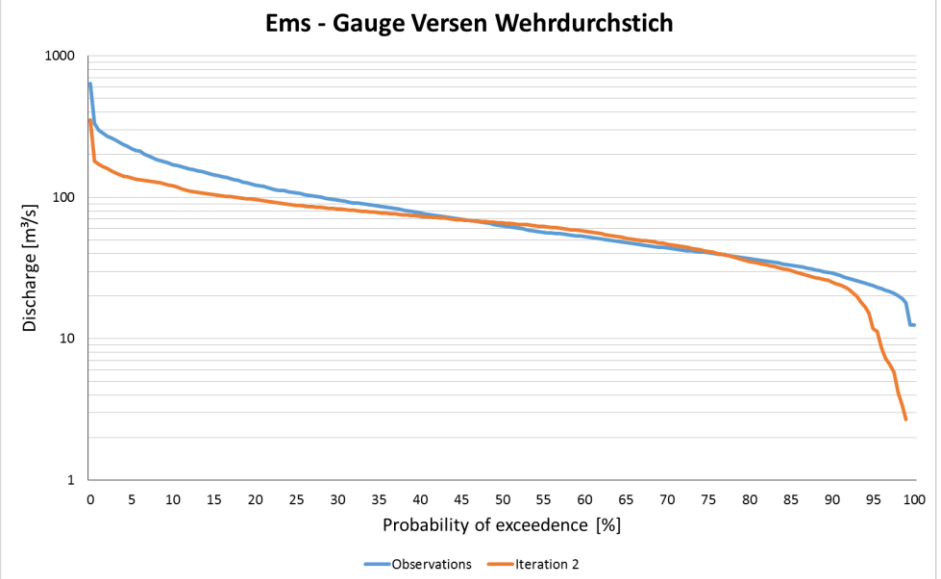
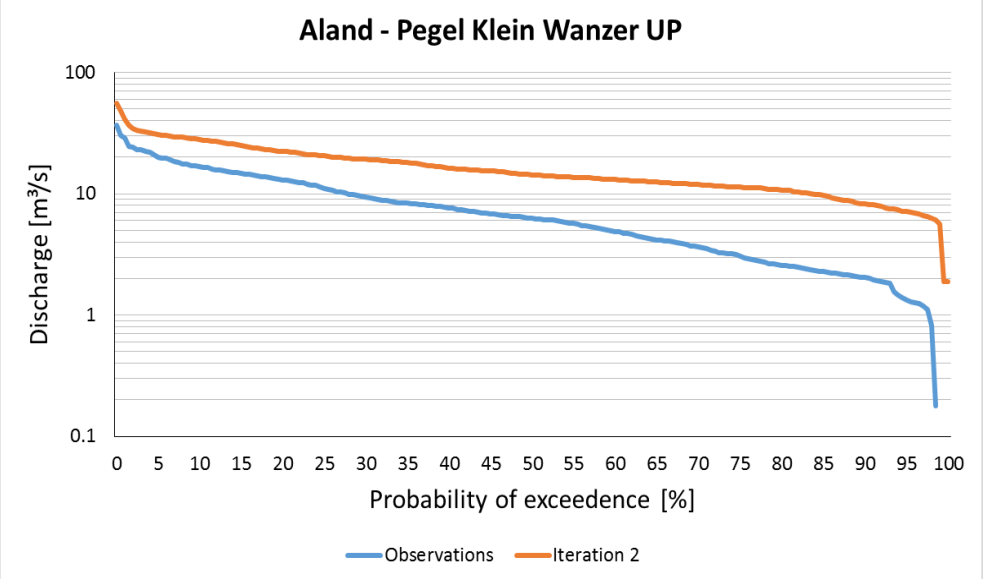








Cutting the model into the main basins

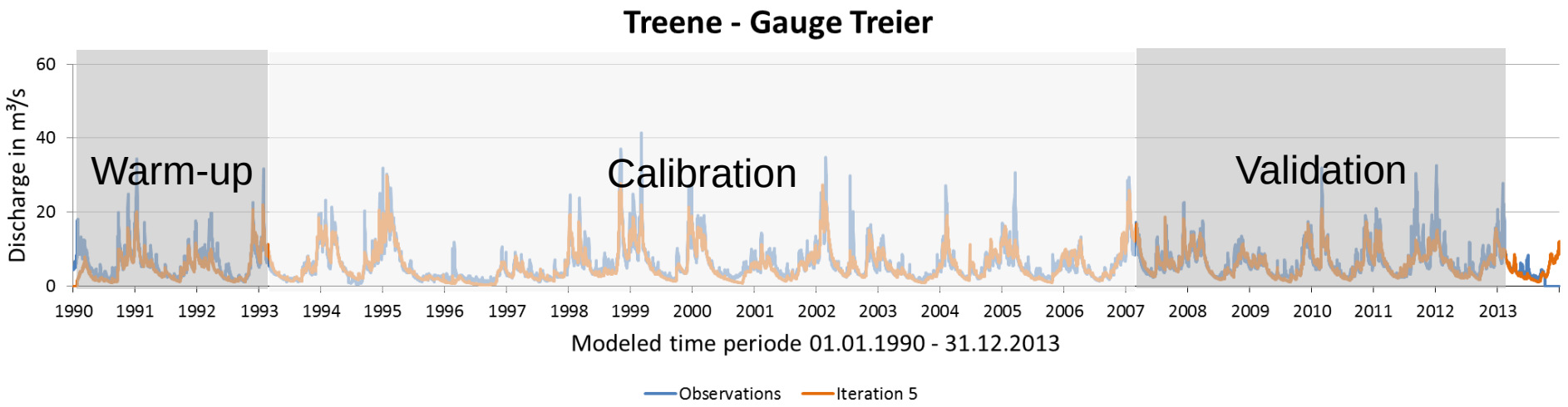
Why?

- Long runtimes in the calibration process
- Finding an appropriate calibration strategy was barley possible
- No satisfying results

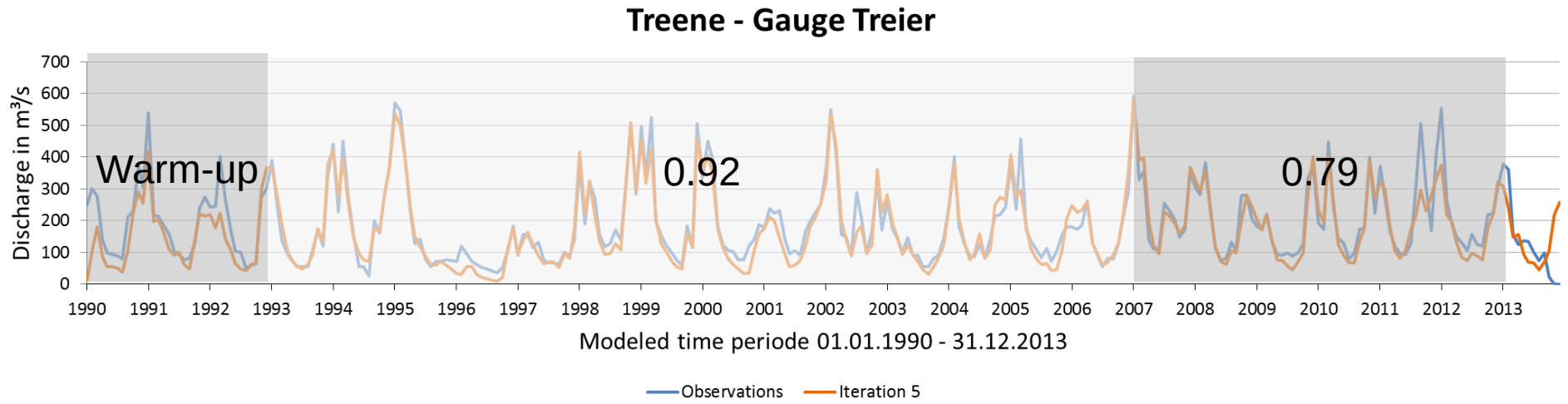
After this Step:

- Very good calibration results occurred with short runtimes
- Finding suitable calibration strategies is possible
- Improvment of results (e.g. the Treene basin)

New calibration results

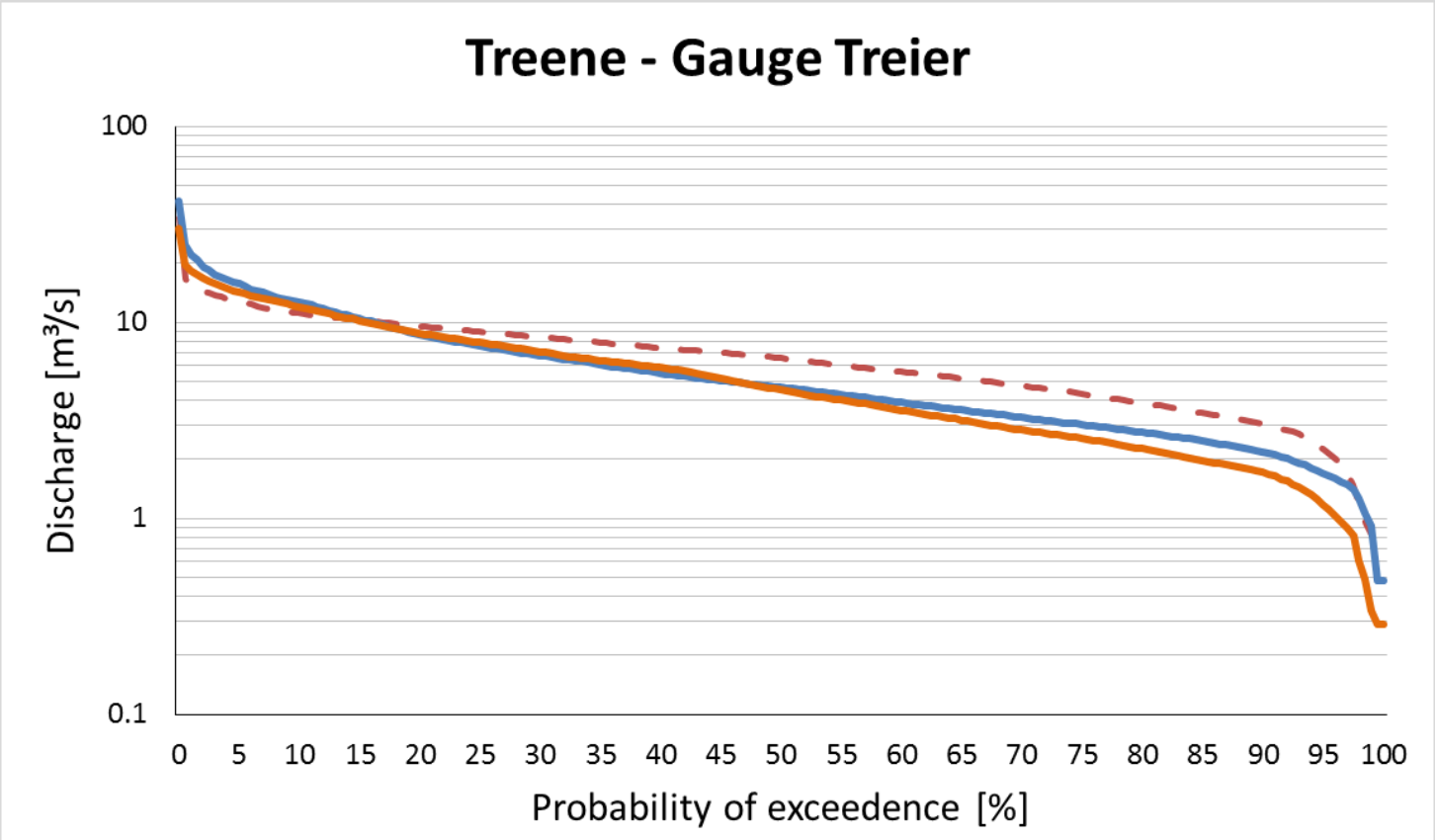


Daily values NSE: 0.74



Monthly values NSE: 0.83

New calibration results



Objective Function (Monthly)	Calibration (1993-2006)	Validation (2007-2012)	Classification (Moriasi et al. 2007)
NSE	0.92	0.79	Very good (0.75-1.0)
RSR	0.27	0.44	Very good (0.5- 0.0)
PBIAS	-7.9	-9.1	Very good (< ± 10)

Conclusion

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Model Setup
Soil Water Assessment Tool (SWAT)

Data
(1990 – 2013)

- DGM 25
- BÜK 200
- LBM (Corine Classes)
- 215 Timelines (daily values – precipitation, temperature, relative humidity, wind speed, solar radiation)

Automated calibration and validation via SWAT-CUP

Calibration on 72 gaurding stations

By using the High Performance Computing Cluster FU Berlin

Scenarios

On the basis of the spatial distribution

- via the suitability map of cultivated areas for SRC

Culture-specific parametrization

- via measurement of SRC specific values (like LAI and Stomata conductivity)

Proportion willow SRC

Proportion poplar SRC

Thanks!

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