Impact of Point Rainfall Data Uncertainties on SWAT Simulations

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Motivation

- Input data uncertainties are increasingly recognised
- Rainfall data are most important input data for rainfall runoff models
- Point rainfall data are associated with systematic and random errors

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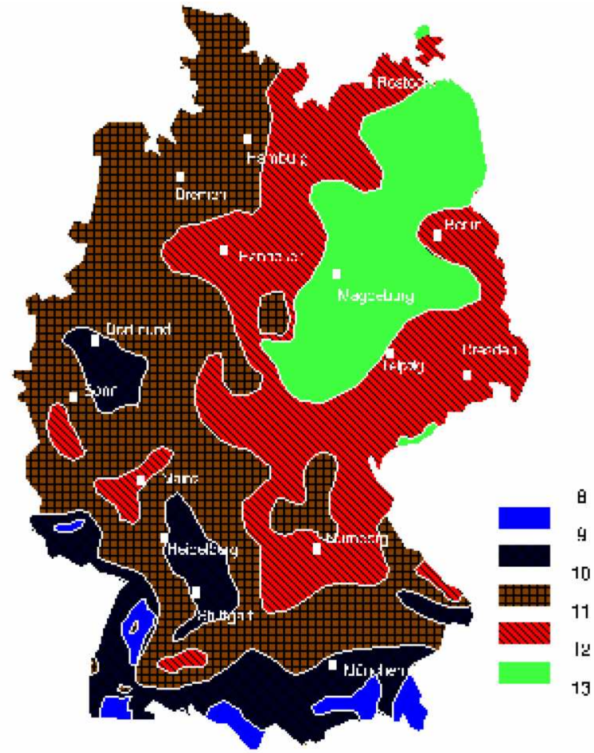
Systematic point rainfall measurement errors

- Mean correction (%) of the average annual precipitation total (1961/90)

- Moderate wind-sheltered sites in Germany



Source: (WMO, 1998)

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Mean correction (%) of precipitation in the Weiße Elster River Basin

Shelter class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
a	31.6	33.5	26.9	18.3	12.5	10.4	10.8	10.5	12.6	15.5	21.8	26.5	**18.2**
b	23.3	24.5	20.3	15.1	11.2	9.8	10.0	9.5	11.5	12.7	16.8	19.8	**14.6**
c	17.3	17.9	15.5	12.7	10.1	8.8	9.1	8.5	10.2	11.0	13.3	15.0	**12.0**
d	11.5	11.8	10.7	10.0	8.6	7.7	8.0	7.5	8.7	8.8	9.5	10.3	**9.3**

Time series 1961/90, according to Richter (1995)

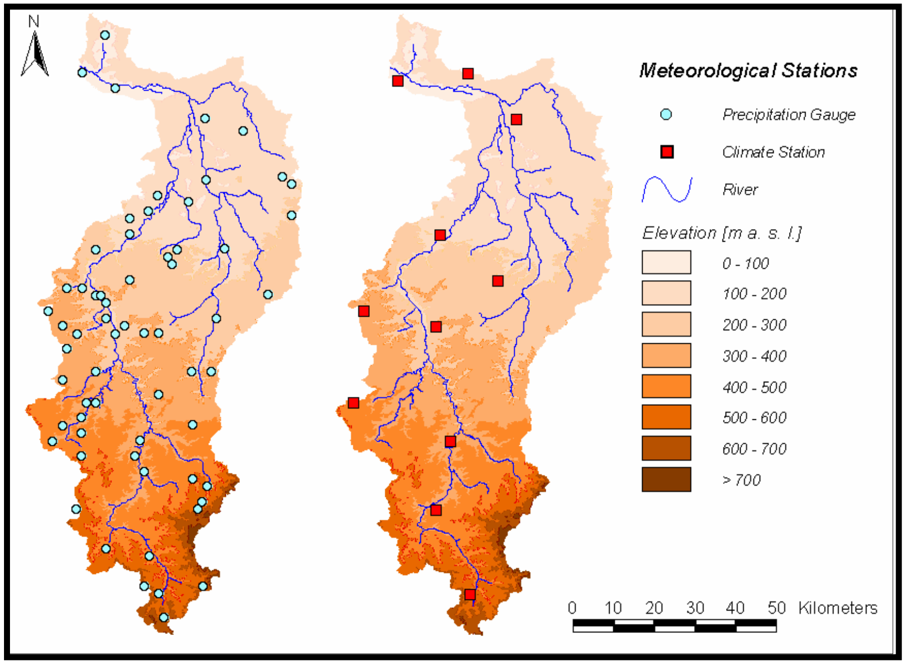
Objectives

- Investigate the impact of systematic and random rainfall point measurement errors
- Assess simulated discharge and nitrogen with SWAT
- Analyse scaling effects of these errors

The Weisse Elster Basin: Study area

Overview

Catchment area:	5360 km²
River length:	253 km
Mean discharge:	25.2 m³/s
Rainfall gauge stations:	49
Discharge gauge stations:	18



Land use

Agricultural land:	62%
Forest:	23%
Urban areas:	13%

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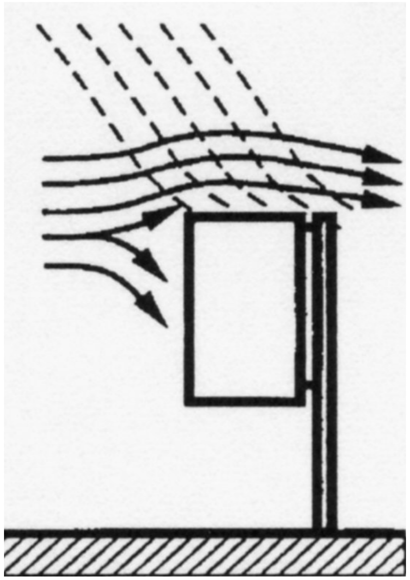
Methodological approach

- Add randomly generated correctionvalues to uncorrected rainfall measurement values
- Assume Gumbel error distribution of PDFs
- Standard deviations of PDFs are defined by the correction factor
- Generate 200 time series for each rainfall gauge station (DUE)
- Compare SWAT simulations with respect to variables and scales



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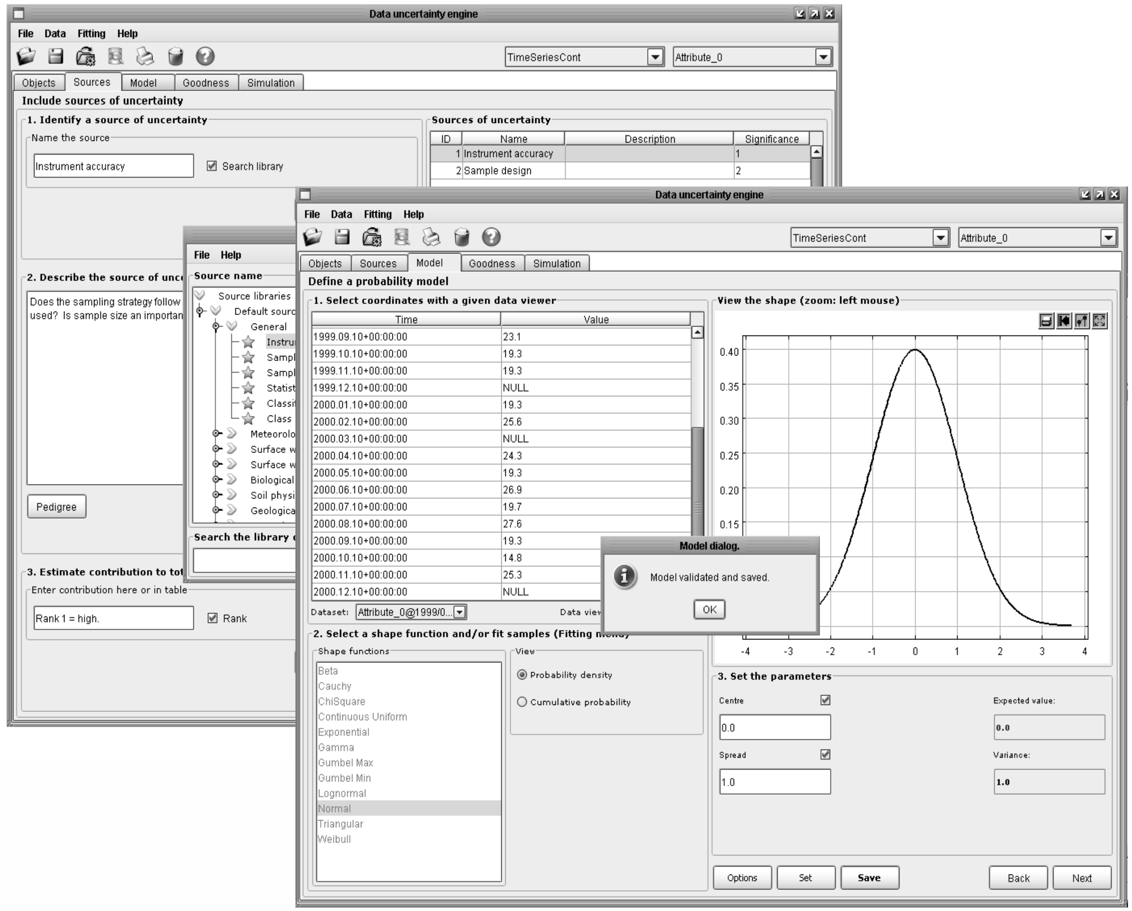
Data Uncertainty Engine (DUE)

- Characterisation and assessment of uncertainty in data
- Generates time series including systematic and random errors
- Monte Carlo based approach using pdf's



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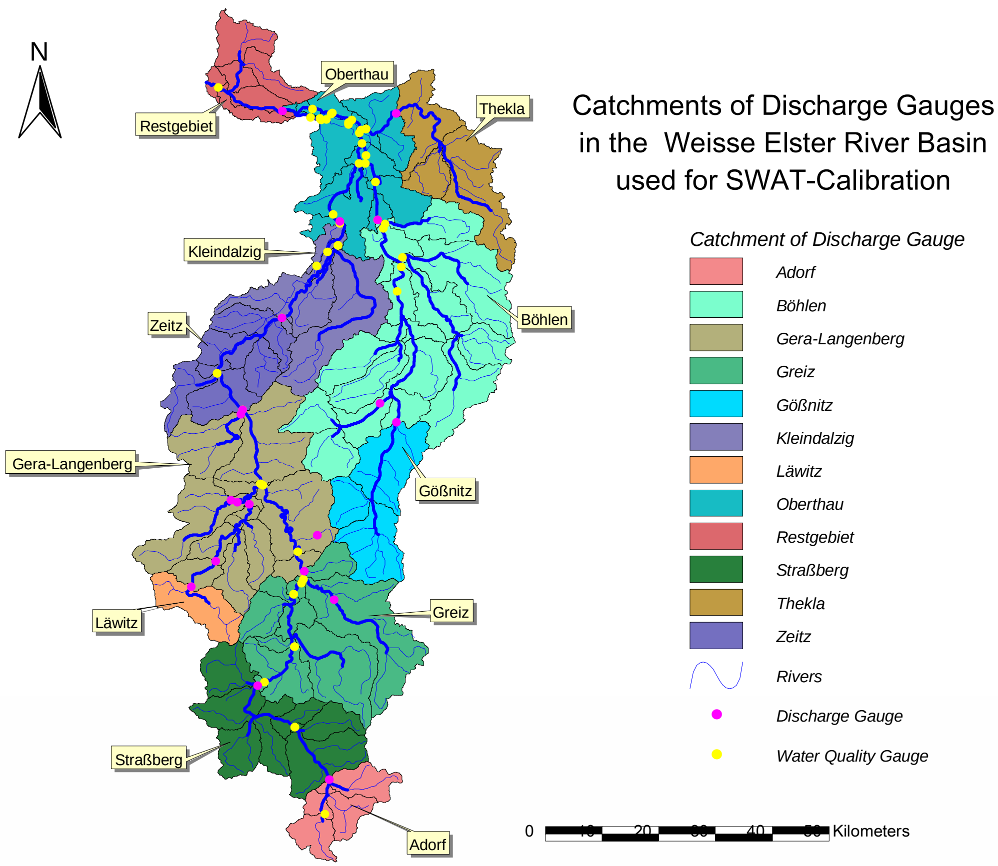
Calibration discharge gauge stations



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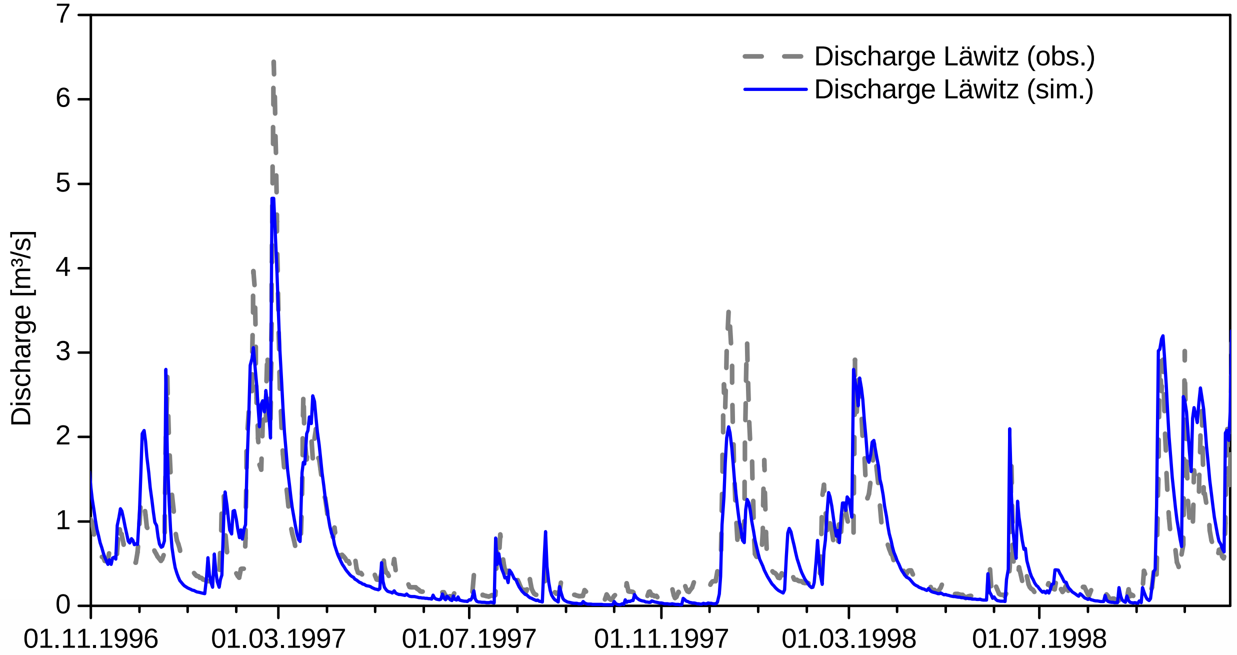
SWAT calibration
discharge gauge station Läwitz (98 km²)



- Reasonable calibration results
- Problems to represent the discharge dynamics

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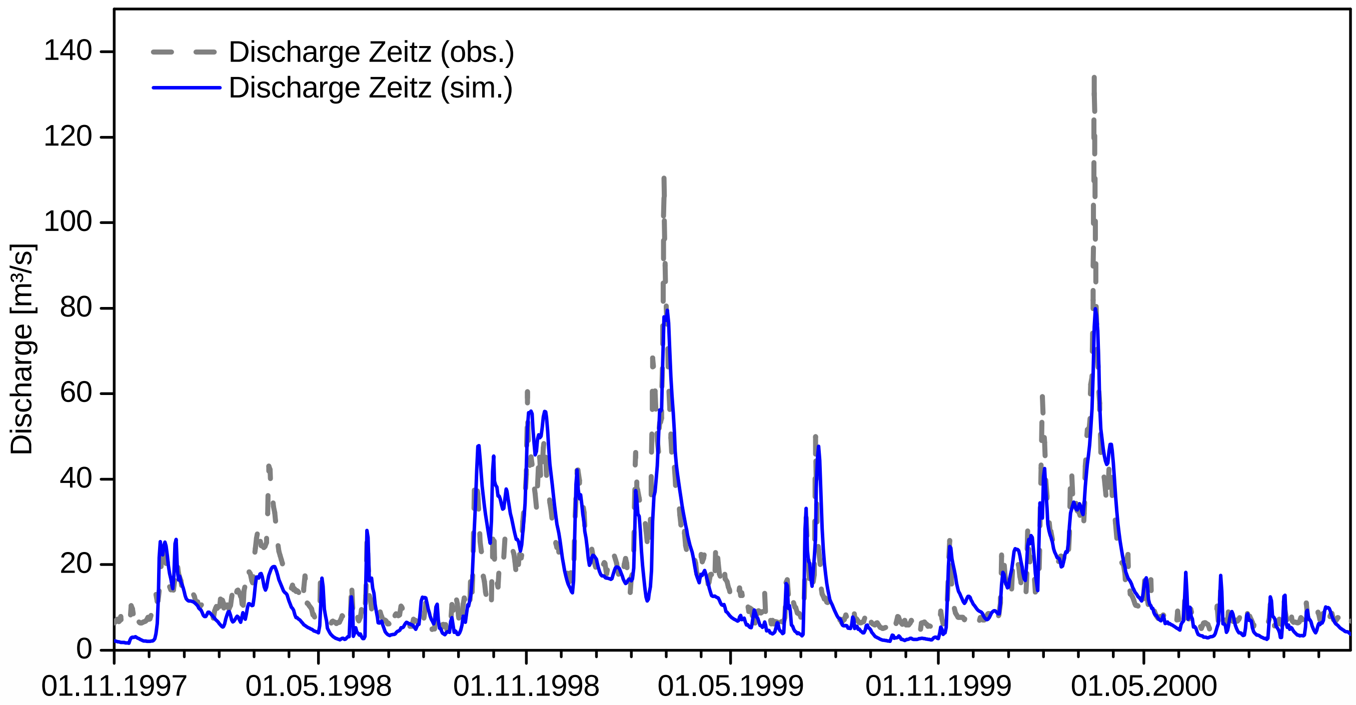
SWAT calibration
discharge gauge station Zeitz (2504 km²)



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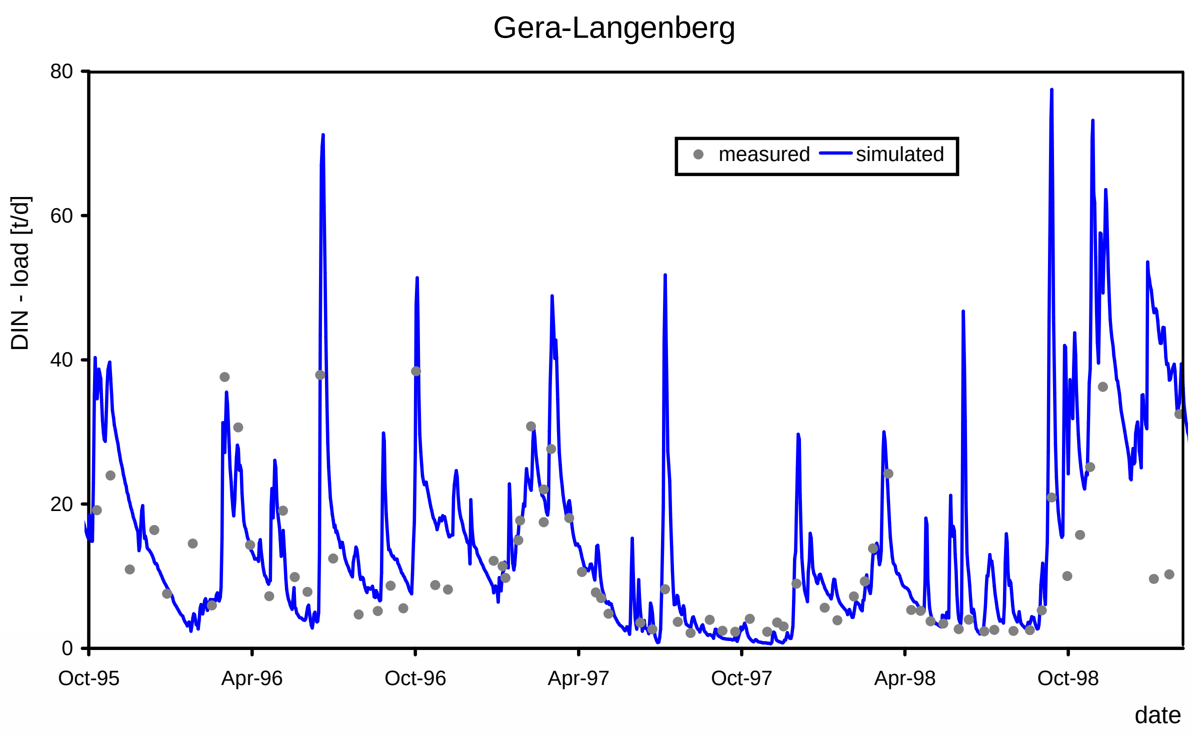
SWAT calibration of DIN load, gauge station Gera-Langenberg (2186 km²)



- Reasonable agreement between observed and simulated DIN loads
- Slightly overestimated nitrogen loads
- Oversimplified representation of nitrate denitrification in the aquifer

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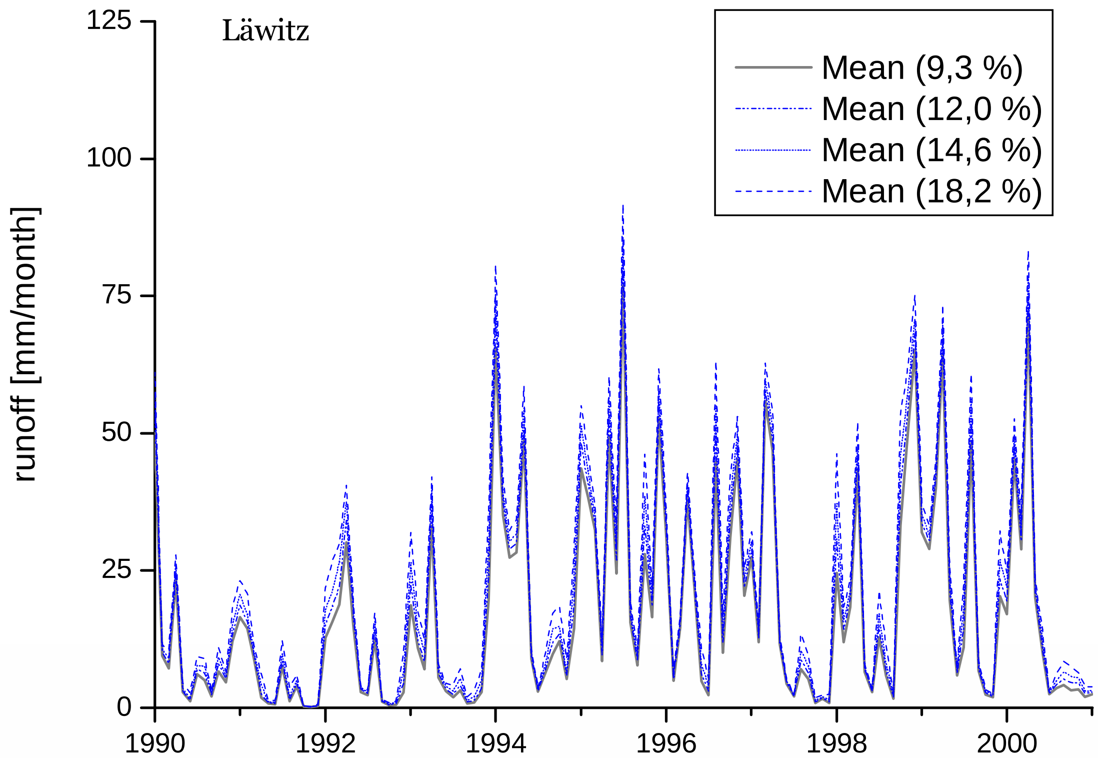
Mean simulated discharge using four different correction factors



- Systematic errors of mounthly values
- Large differences in the case of low flows

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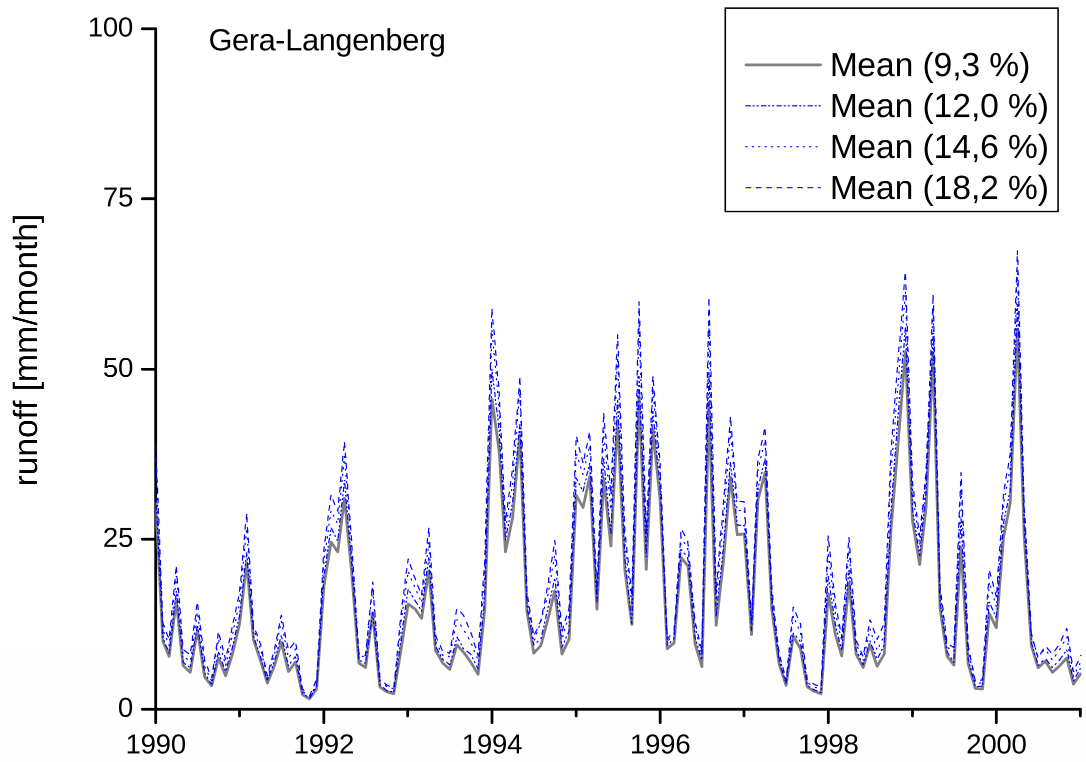
Mean simulated discharge using four different correction factors



- Comparable differences with increasing catchment size

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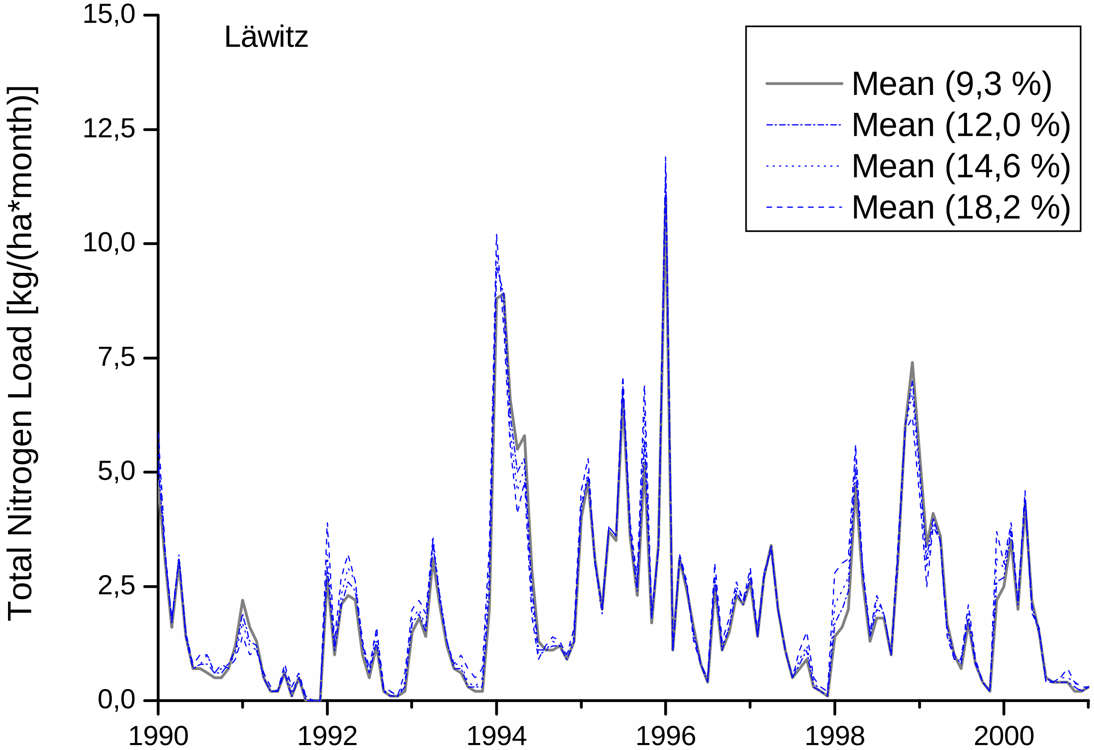
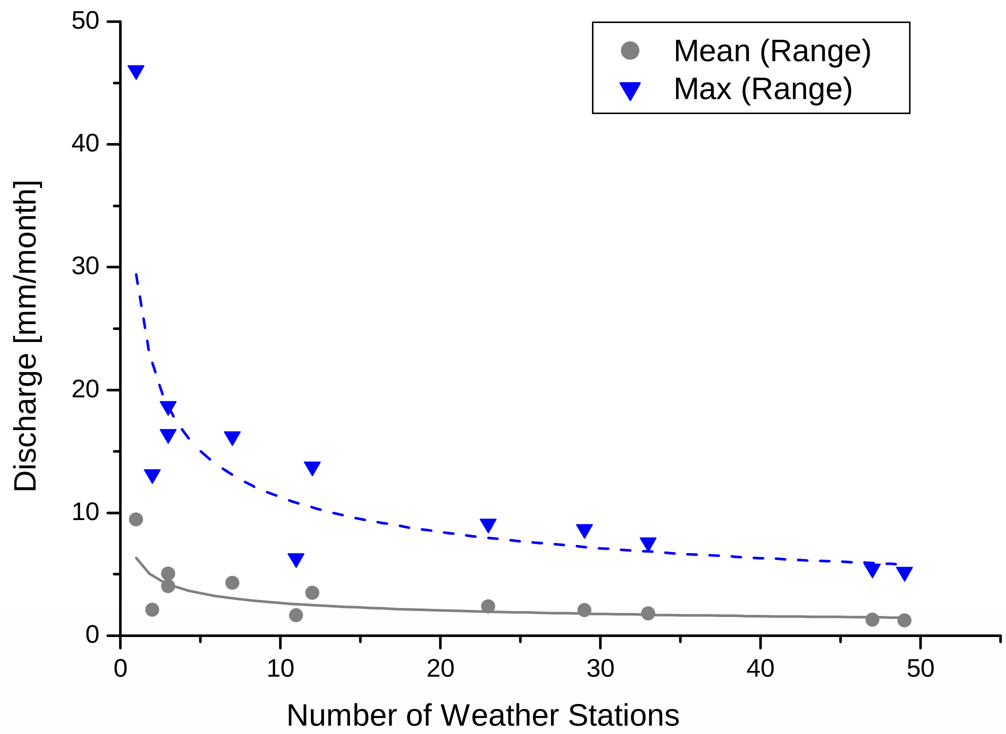
Mean simulated nitrogen using four different correction factors



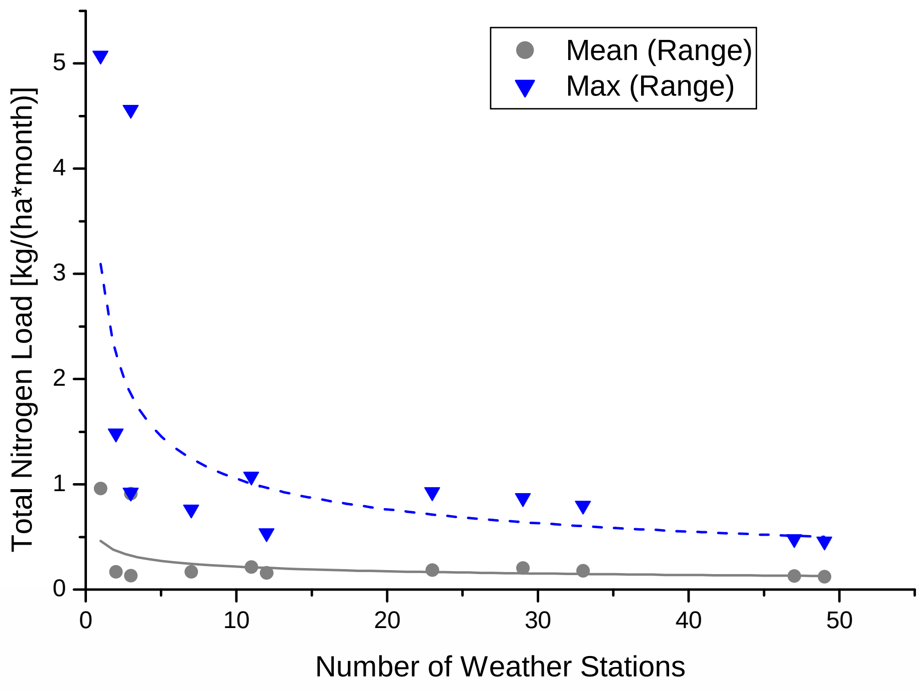
- Small effects on simulated nitrogen loads

Mean and maximum monthly error ranges of simulated discharge



- Correction factor of 18.2%
- Randomly generated rainfall time series
- Gumbel distribution
- Decrease of errors with increasing rainfall gauge stations

Mean and maximum monthly error ranges of simulated nitrogen



- Considerable mean errors only when using small numbers of stations
- Maximum errors in single month can still be significant

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Conclusions

- Systematic rainfall measurement errors can have considerable impact on simulated discharge and nitrogen
- These errors can be increased by random rainfall errors
- Effect of random error rapidly decreases with increase rainfall stations
- Nitrogen load calculations are much less sensitive to random precipitation errors than simulated discharge