Spatial capability of the catchment model HYPE to simulate nitrate and phosphorus concentration in the mixed land use Selke catchment, Germany

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Study Catchment: Selke

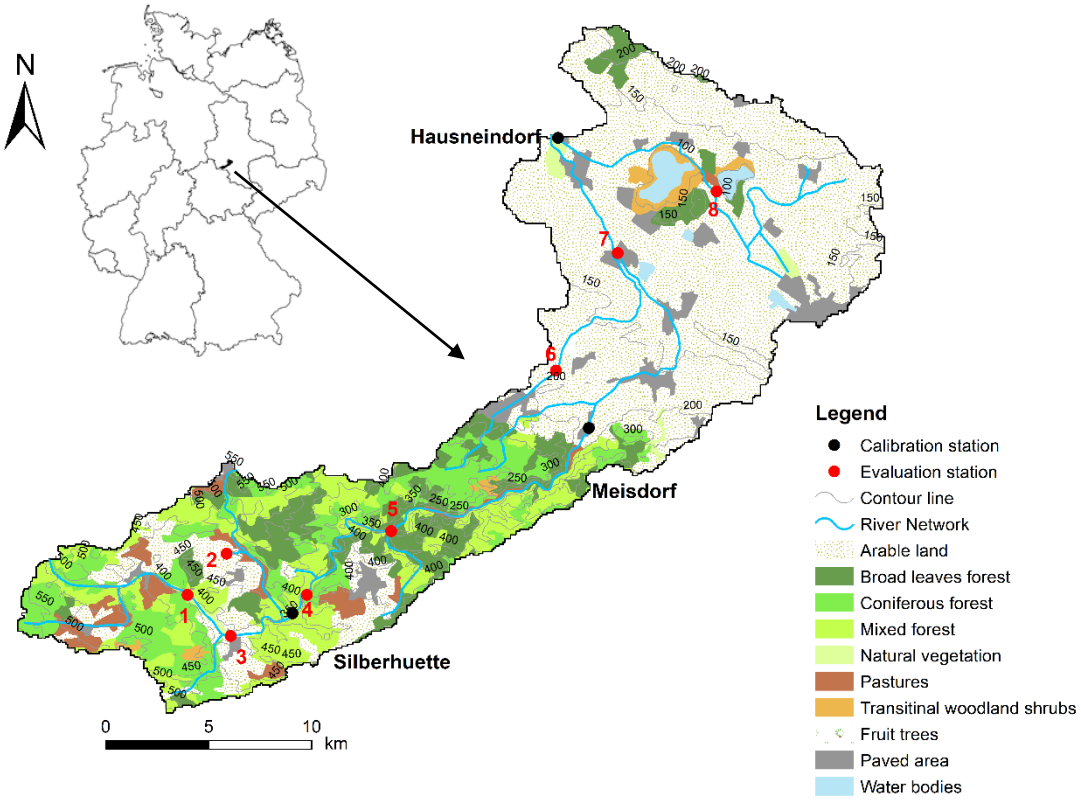

Figure Selke catchment in central Germany. The Selke catchment and its dominant landuse classes. The black dots indicate the three main gauging stations (Silberhuette, Meisdorf and Hausneindorf) used for the model calibration. The red dots correspond to the location of the eight internal stations used for the spatial validation of the model. The grey lines shows the contour elevation.

Table Characteristics Selke catchment

	Selke
Mean elevation (m)	104-469
Area (km^2)	438
Geology	Schist and claystone in the mountain area, tertiary sediments in the lowland areas
Dominated vegetation type	Forest and agriculture
Forest Share (%)	35.4
Arable land share(%)	52.3
Mean annual precipitation (mm/a)	Mountain areas: 792
	Lowland areas: 450
Mean NO_3^--N concentration (mg l^{-1})	3.91
Mean TP concentration (mg l^{-1})	0.18

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Objectives and Methodology

Setup the HYPE model for NO_3^--N and TP concentrations in the heterogeneous Selke catchment using multi-site and multi-objective calibration.	The HYPE model was setup for three main stations (Silberhuette, Meisdorf and Hausneindorf) and eight internal stations. These stations were considered as outlet of corresponding catchments. HYPE was calibrated and validated from 1994 to 1998 and 1999 to 2014 respectively for discharge, NO_3^--N and TP concentrations only at three main stations using multi-site calibration approach.
Test the capability of HYPE to represent the measured NO_3^--N and TP concentrations at eight internal gauging stations that were not considered for calibration	Spatio-temporal validation of the HYPE model was further tested at eight internal stations for NO_3^--N and TP concentration simulations. At internal stations, HYPE evaluation was based on Percentage BIAS (PBIAS %) and mean values of observed concentration against simulated concentrations.
Analyse the predictive uncertainty of HYPE for NO_3^--N and TP.	DiffeRential Evolution Adaptive Metropolis (DREAM) tool was used for predictive uncertainty analysis at outlet of the Selke catchment (Hausneindorf) for discharge, NO_3^--N and TP concentrations. Three different criteria ARIL (Average Relative Interval Length), PCI (Predicted Confidence Intervals) and PUCI (Percentage of observed concentrations connected by Unit Confidence Interval) were used for uncertainty analysis.

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Model evaluation at three main stations for calibration and validation period

Table. Model evaluation of discharge (Q), nitrate-N (NO3--N) and total phosphorous (TP) simulations at the stations Silberhuette, Meisdorf and Hausneindorf for calibration and validation period.

Variable	Station	Calibration (1994-1998)		Validation (1999-2014)	
		NSE	PBIAS (%)	NSE	PBIAS (%)
Q	Silberhuette	0.87	-4.80	0.76	11.9
	Meisdorf	0.85	0.45	0.73	3.02
	Hausneindorf	0.84	2.14	0.71	18.0
NO_3^--N Load	Silberhuette	0.93	-2.10	0.72	2.40
	Meisdorf	0.90	6.40	0.77	-16.1
	Hausneindorf	0.74	-5.70	0.70	-2.50
TP Load	Silberhuette	0.48	-20.0	0.52	-10.0
	Meisdorf	0.53	11.5	0.46	-20.0
	Hausneindorf	0.13	-19.1	0.20	6.50

- Results showed that discharge was well represented at all three main stations during both calibration (1994 to 1998) an validation (1999 to 2014) periods with lowest Nash Sutcliffe Efficiency (NSE) of 0.71 and maximum Percentage BIAS (PBIAS) of 18%.
- HYPE also could reproduce seasonal dynamics of NO_3^--N and TP concentrations with low predictive uncertainty at three main stations, reflected y PBIAS values in the ranges of -16% to 7% and -12% to -20% for NO_3^--N and TP load simulations, respectively.

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Model evaluation at internal stations for NO_3^-–N (mg l^{-1})

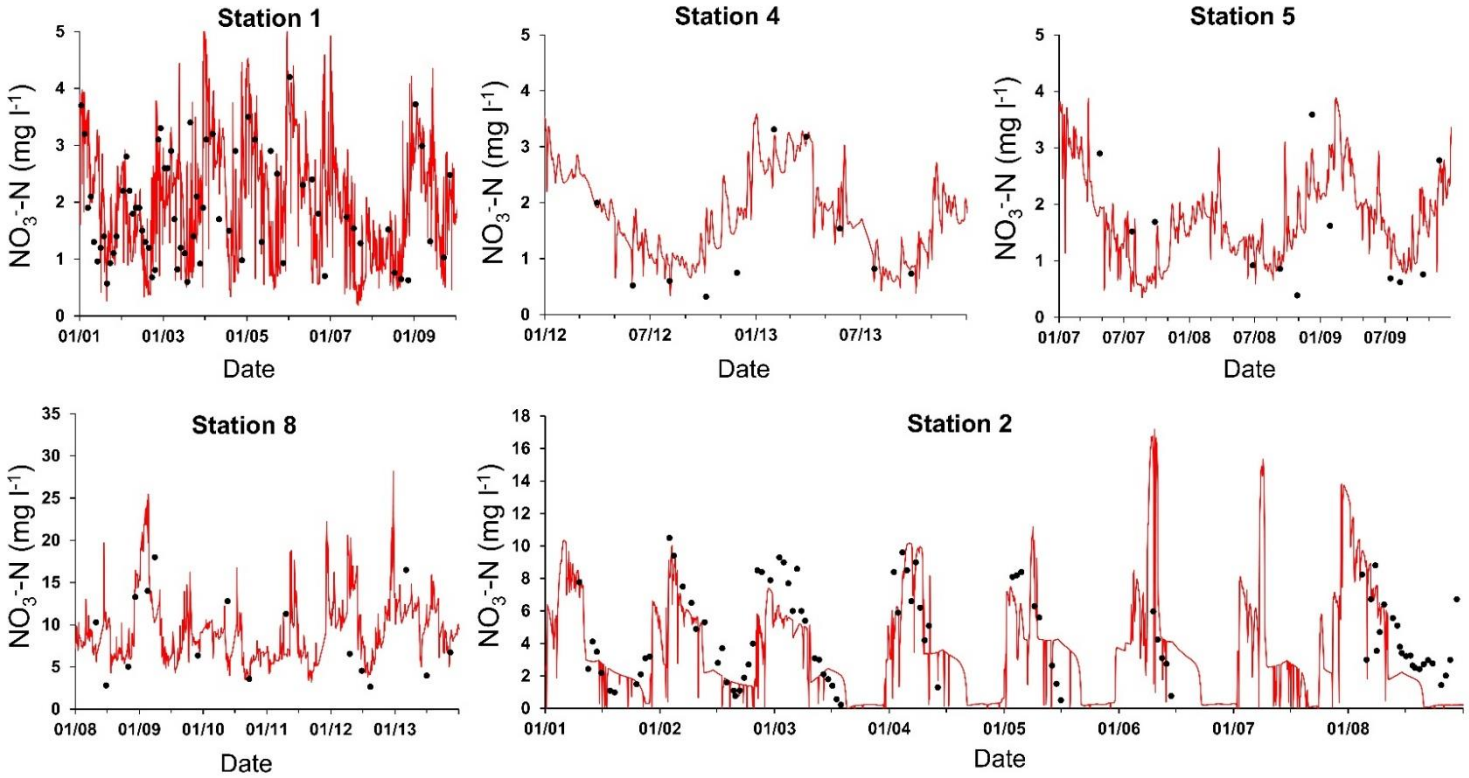

Table Model evaluation of nitrate-N (NO_3-N) simulations at internal stations

Stations	NO_3-N (mg/l)		
	PBIAS (%)	Mean-Sim	Mean-Obs
1	2.53	2	1.9
2	-9	4.35	4.52
4	3.92	1.67	1.60
5	-3	1.90	1.92
8	14.2	9.47	8.46

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Model evaluation at internal stations for TP concentration

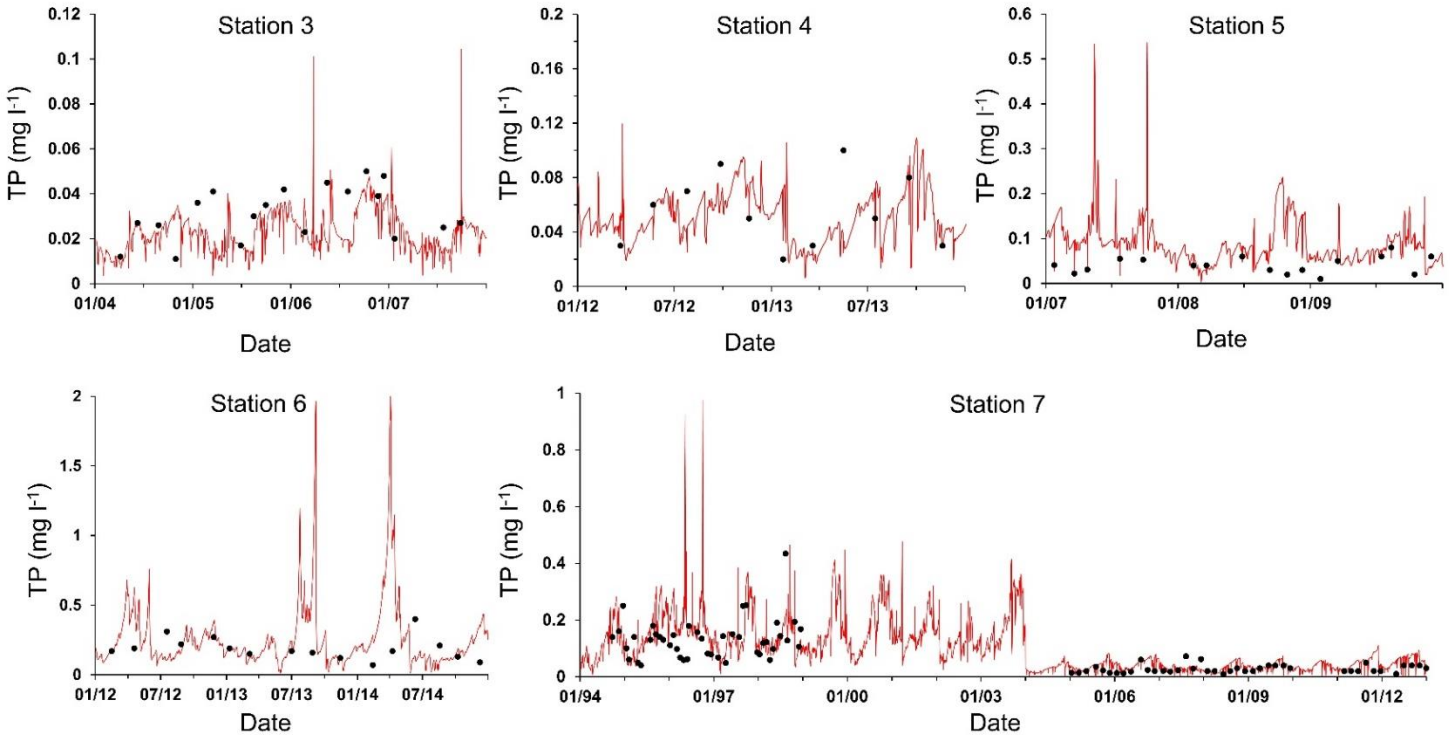

Table Model evaluation of total phosphorous (TP) simulations at internal stations

Stations	TP (mgl^{-1})		
	PBIAS (%)	Mean-Sim	Mean-Obs
3	-25	0.023	0.031
4	-22	0.036	0.051
5	20	0.049	0.042
6	34	0.300	0.200
7	13	0.092	0.081

Summary

- The HYPE model presented well discharge, NO_3^--N and TP concentrations for both calibration and validation period.
- Multi-site calibration approach was used during calibration process which assures the model performance at main station and also at internal gauging stations that were not included in calibration process.
- At internal stations, the model could represent reasonably well the seasonal variation of nutrient concentrations with PBIAS values in the ranges of -9.00% to 14.2% for NO_3^--N and -25% to 34% for TP concentration simulations.
- Spatial and temporal evaluation of the HYPE model exhibits its capability to be used as scientific decision tool to test the efficiency of spatially targeted mitigation measures to reduce the nutrient loads.
- Availability of such kind of vast water quality data from authorities can be used efficiently when best hydrological and water quality model is at hand for scientific and decision making tool.

THANKS

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