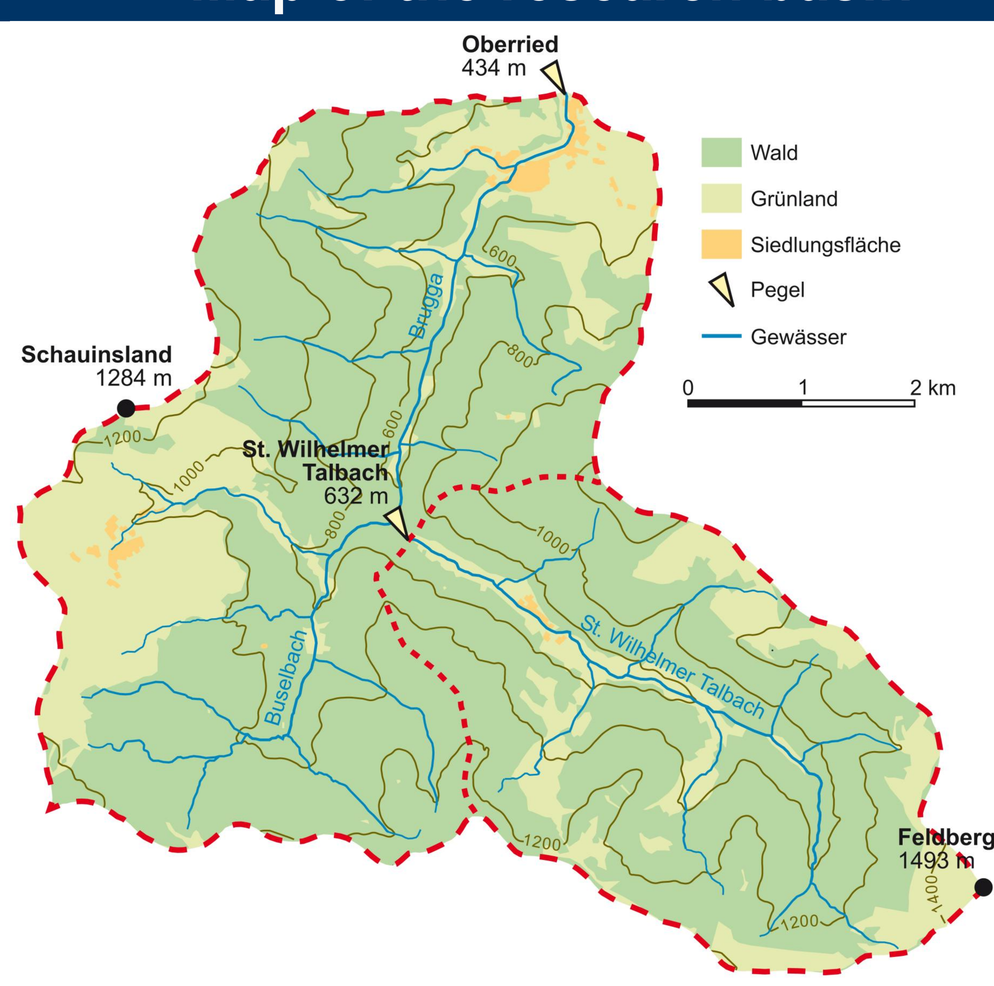
Brugga

Brugga basin, Germany

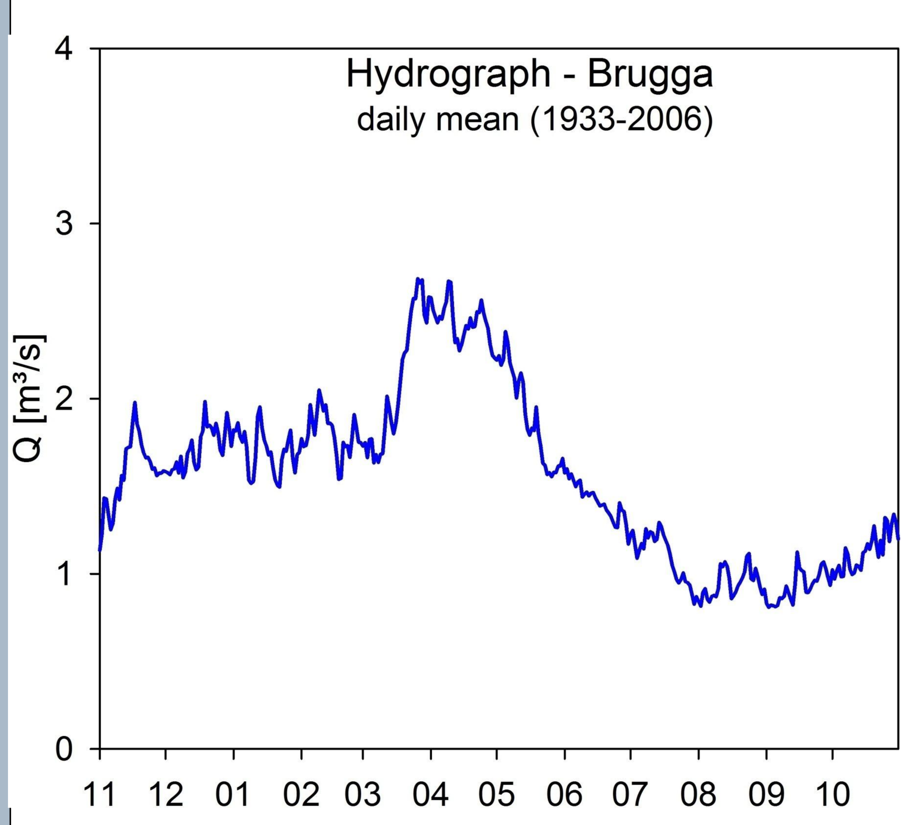
Basin characteristics

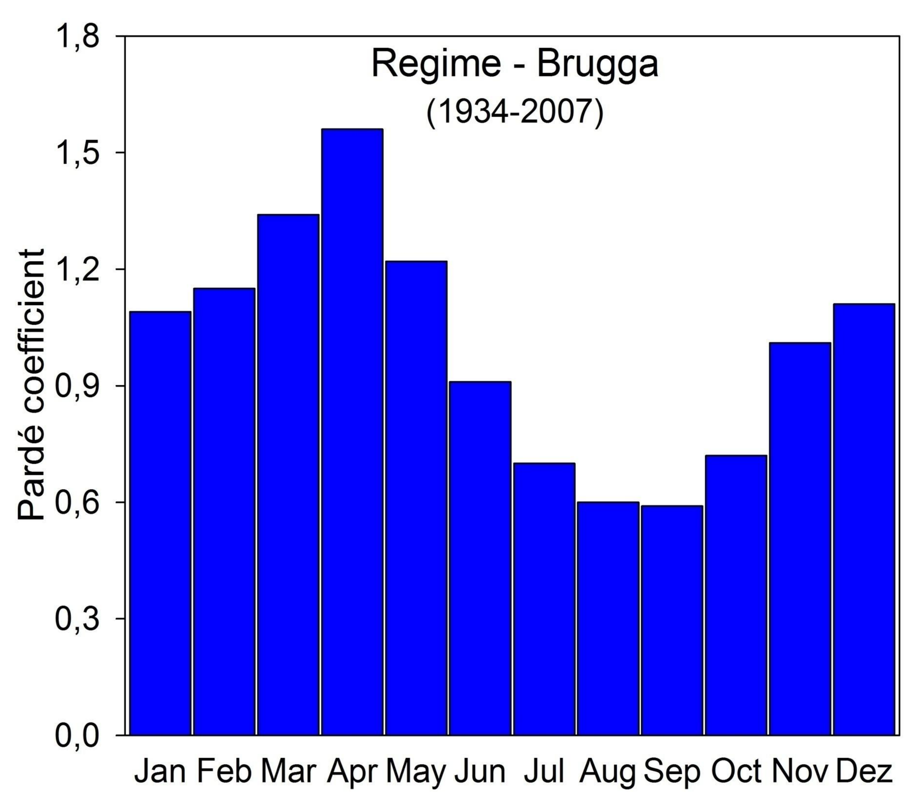
River Basin / River Basin (according EU-WFD)	Brugga/ Rhein
Operation (from… to…)	From 1933 to now
Gauge coordinates / Gauge datum:	E: 3421750 m N: 5311600 m Datum: 308 m.a.s.l.
Catchment area:	40,1 km²
Elevation range:	1493 m.a.s.l. (Feldberg) – 434 m.a.s.l. (Oberried)
Basin type: (alpine, mountainous, lowland)	Mountainous
Climatic parameters: (mean precipitation, temperature and others)	P=ca. 1730 mm T=ca. 7.7°C ETP=ca. 566mm
Land use:	Forest: 75.7; grassland: 21.8; acres: 1.5; impervious: 0.9
Soils:	Brown earth, gley soil, podzol
Geology:	Gneiss, Migmatite; Quaternary overlaying strata
Hydrogeology: (Type of aquifers, hydraulic conductivity)	Basement: connected fissures, n:0.1-2.1%, $k=10^{-10}-10^{-5}$ ms^{-1} ; Quaternary strata: extremely variable parameters
Characteristic water discharges: (Q_{min}, Q_{max}, Q_{mean})	Qmin:0.2; Qmax: 33.6; MQ:1.55 [m³/s]

Map of the research basin

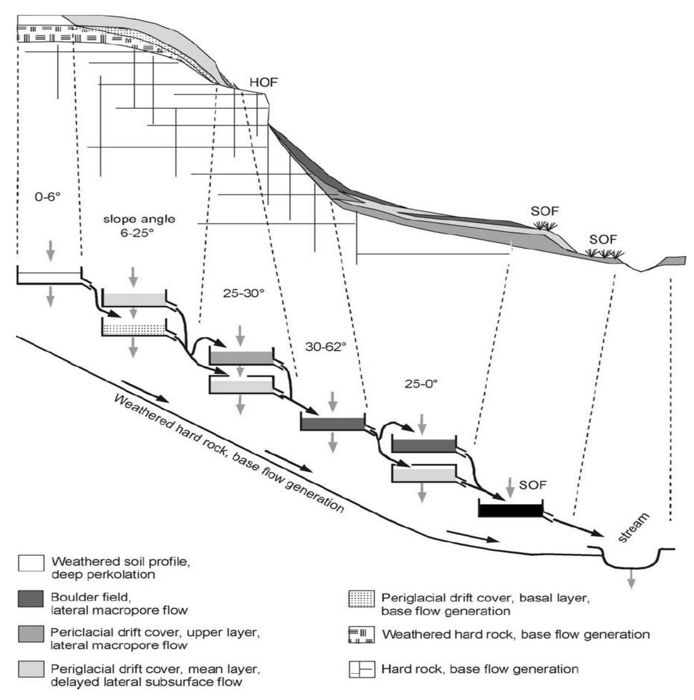


Mean hydrograph / Pardé flow regime





Special basin characteristics (hydrogeology, lakes, reservoirs etc.)



Instrumentation and data

Measured hydrological parameters	Measuring period	Temporal Resolution	Number of Stations
Discharge	1933 – now	daily , 10 min	2
Springs	1998 - now	weekly, 10 min	2
Temperature, EC, pH	1995 – now	10 min (95-99) weekly (99-now)	1
^{18}O (Q and P), ^{2}H (P)	Q: 1998-now; P:1995-now	weekly	2 (Q + P)
Major ions	1998-now	weekly	1
Silicate	1998 – 2004	weekly	1
Precipitation	1994 – now	daily	3
Climate parameters (temperature, humidity, radiation, wind)	1994 – now	daily	3

Applied models

1. Precipitation-Runoff Modeling system (PRMS); Mehlhorn, 1998
2. Tac (tracer aided catchment model), TOPMODEL, HBV, PRMS; Uhlenbrook, 1999
3. Tac^D (tracer aided catchment model, distributed); Uhlenbrook , 2002
4. Mixing models (with two and three components); Didszun, 2004
5. Catchment water quality model (non point source model, NPSM); Eisele et al. 2001

Main scientific results

1. Tracer experiments:
   Groundwater residence time in the lower Quaternary strata and basement: 920 d; Groundwater dynamic in the lower Quaternary strata and basement: 340 d (double porous medium)
   Modeling with PRMS(tracer based conceptualization, validation and calibration):
   direct runoff: 16%; indirect runoff out of the upper Quaternary strata: 52% and out of lower Quaternary strata and basement: 32%

2. Development of a semi distributed rainfall runoff model (Tac). Tracer data can serve as multi-response data to assess and validate a model.
   Direct runoff is generated on saturated and impervious areas and on steep permeably boulder fields. It can amount 50 % of total runoff, long term portion is ca. 10%
   Two underground flow system: 1-hillslope groundwater, ca. 70% of total runoff, mean residence time of 2-3 years; 2-critaline fissured aquifer system, ca. 20% of total runoff, mean residence time of 6-9 years.
   Further development of the semi distributed model Tac to the distributed model Tac^D.

3. The hydrochemical distinguishing between upland springs, hill slope water and stream water is possible. But flowpaths in hillslopes feature a great heterogeneity. Neither depth nor position of hillslope water have systematic influence on the natural tracer concentrations.
   The spatial heterogeneities is clearly scale dependent. They are much more pronounced in small subcatchments but reduce with increasing catchment size.

4. The applied model proved to be applicable in a mesoscale catchment performing satisfactory results for the simulation of stream flow. The simulated nitrate concentrations were strongly controlled by the nitrogen input, the water movements and the nitrogen reactions in the different sub-areas. The simulation of nitrogen transport for the validation period showed only an agreement with the measured concentrations for the mean values, but the short time dynamics of the measured curve could not be fitted.

Key references for the basin

1. Mehlhorn J. (1998): Tracerhydrologische Ansätze in der Niederschlags-Abfluß-Modellierung. Freiburger Schriften zur Hydrologie, Band 8, Universität Freiburg.
2. Uhlenbrook S. (1999): Untersuchung und Modellierung der Abflußbildung in einem mesoskaligen Einzugsgebiet. Freiburger Schriften zur Hydrologie, Band 10, Universität Freiburg.
   Uhlenbrook S. et al. (2004): Hydrological process representation at the meso-scale: the potential of a distributed, conceptual catchment model. Journal of Hydrology, Vol.291, No.3-4, P 278-296
3. Didszun J. (2003): Experimentelle Untersuchungen zur Skalenabhängikeit der Abflussbildung. Freiburger Schriften zur Hydrologie, Band 19, Institut für Hydrologie der Universität Freiburg.
4. Eisele M., et al. (2001): Application of a catchment water quality model for assessment and prediction of nitrogen budgets. Phys. Chem. Earth (B) Vol. 26, No.7-8, P. 547-551

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