Supplement

Temporal shift of groundwater fauna in South-West Germany

Fabien Koch[1], Philipp Blum[1], Heide Stein[2], Andreas Fuchs[2], Hans Jürgen Hahn[2], Kathrin Menberg[1]

[1]Institue of Applied Geoscience (AGW), Karlsruhe Institute of Technology (KIT), Kaiserstraße 12, 76131 Karlsruhe, Germany
5 [2]Institute for Environmental Sciences, University-Kaiserslautern-Landau (RPTU), Fortstraße 7, 76829 Landau, Germany

Table S 1: List of all parameters of the LUBW annual catalogue used in this study (Landesanstalt für Umwelt 2022b).

Parameter	Unit	Parameter	Unit	Parameter	Unit	Parameter	Unit
Physical-chemical complete analysis		**Heavy metals**		**Pesticides**		**Hydrocarbons**	
acid capacity up to pH 4.3	[mmol/l]	arsenic	[mg/l]	atrazine	[µg/l]	benzene	[µg/l]
calcium	[mg/l]	barium	[mg/l]	bromacil	[µg/l]		
chloride	[mg/l]	beryllium	[mg/l]				
dissolved oxygen concentration	[-]	boron	[mg/l]				
dissolved oxygen saturation	[mg/l]	cadmium	[mg/l]				
DOC (dissolved organic carbon)	[mg/l]	cobalt	[mg/l]				
electric conductivity	[%]	cooper	[mg/l]				
fluoride	[mg/l]	lead	[mg/l]				
iron	[mg/l]	lithium	[mg/l]				
magnesium	[mg/l]	molybdenum	[mg/l]				
manganese	[mg/l]	nickel	[mg/l]				
nitrate	[mg/l]	mercury	[mg/l]				
ortho-phosphate	[mg/l]	selenium	[mg/l]				
pH-value	[-]	silicate	[mg/l]				
phosphorous	[mg/l]	strontium	[mg/l]				
potassium	[mg/l]	thallium	[mg/l]				
sodium	[mg/l]	uranium	[mg/l]				
spectral absorption coefficient at 436nm	[1/m]	zinc	[mg/l]				
sulphate	[mg/l]						
sum alkali metals	[mmol/l]						
temperature	[°C]						

10

Table S 2: Parameters of the PHATE-analysis.

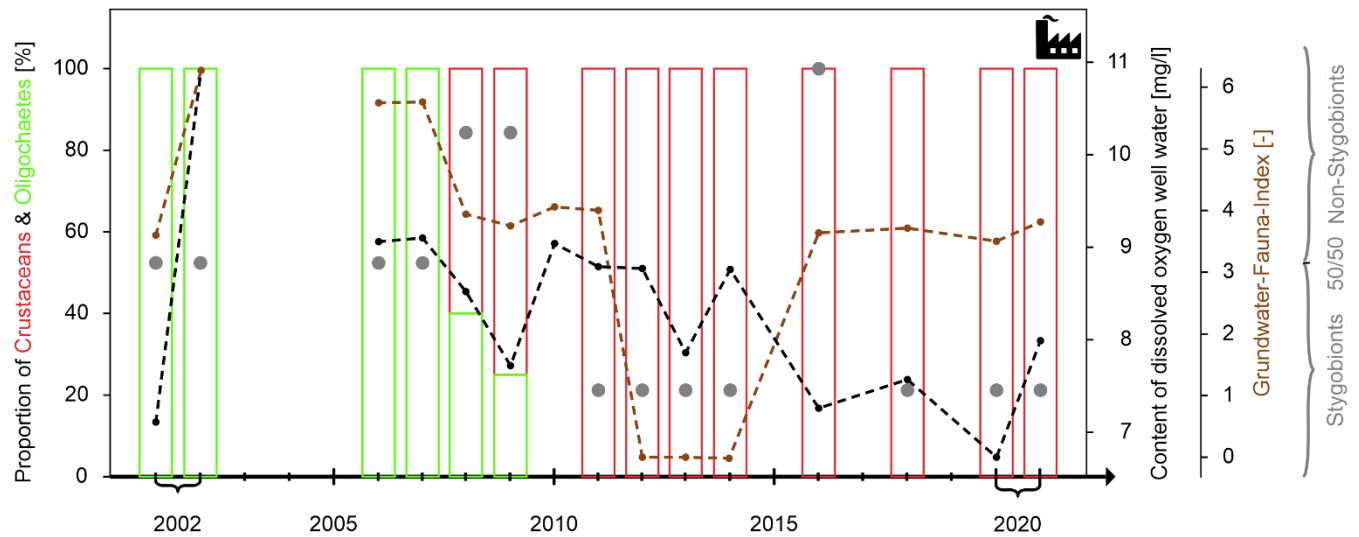| Parameters	Unit
Physical	
temperature well water	[°C]
detritus content (classes with estimated values)	[-]
amount of sediment	[ml]
Biotical	
number of taxa	[-]
total abundance	[-]
proportion of Crustaceans (acc. to Griebler et al., 2014)	[%]
proportion of Oligochaetes (acc. to Griebler et al., 2014)	[%]
proportion of stygobiont to non-stygobiont individuals	[-]
abundance Amphipods	[-]
abundance Cyclopoids	[-]
abundance Harpacticoids	[-]
abundance Nematodes	[-]
(Hydro-)geological	
geological unit	[-]
well depth	[m]
Assessment scheme	
Groundwater-Fauna-Index (GFI)	[-]
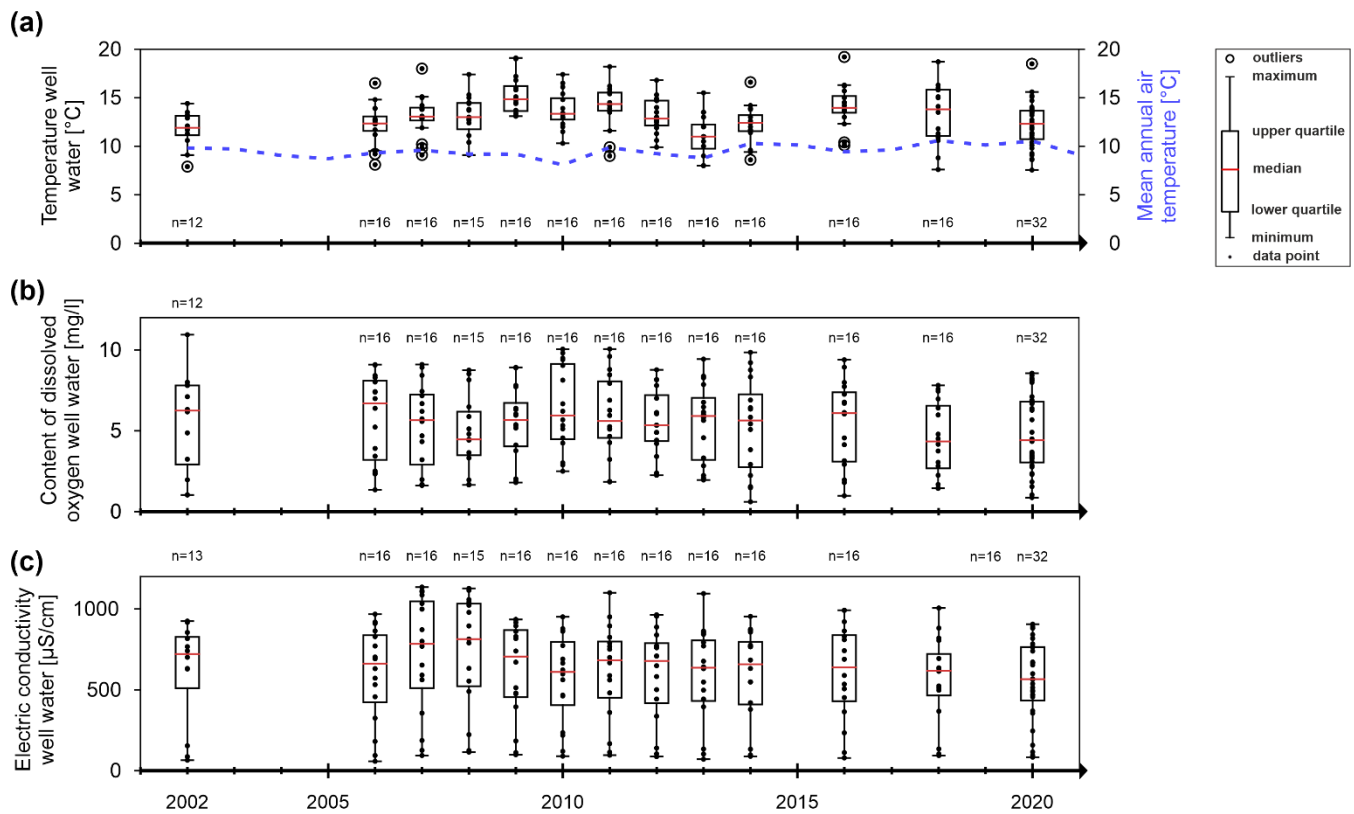
Figure S 1: Boxplots of important abiotic parameters between 2022 and 2020: (a) temperature of the well water; (b) content of dissolved oxygen of the well water and (c) electric conductivity of the well water. For comparability of results, only data from June to September were used for 2002 and 2020, and the same monitoring sites as in subsequent years. "n" indicates the number of measuring points. No sampling was conducted in years with no boxplot.

Table S 3: Standard deviation of different faunistic and hydro-chemical parameters over time of each well. Wells with an asterisk * show stable hydro-chemical and faunistic conditions and a variance of less than 13.

Location of the well	Temperature well water [°C]	Content of dissolved oxygen well water [mg/l]	Electric conductivity well water [µS/cm]	Total abundance [-]	Number of species [-]	Proportion of Crustaceans [%]	Proportion of Oligochaetes [%]	Proportion of stygobionts to no-stygobionts [-]
Dahenfeld*	1.08	0.51	90.41	3.33	1.06	35.73	14.92	1.98
Zienken	1.41	2.61	53.47	77.32	1.49	0.62	0.62	1.12
Efringen-Kirchen	1.11	0.74	124.08	192.46	1.67	5.39	5.39	0.37
Kadelburg*	2.00	0.55	57.88	11.40	2.17	16.25	16.25	0.29
Schwäbisch Hall	1.56	1.45	97.23	115.85	2.12	22.26	22.26	4.01
Rohrdorf*	1.41	0.93	54.38	31.53	2.19	23.38	23.38	1.16
Furtwangen*	2.07	0.50	37.81	30.66	1.79	4.86	4.86	0.89
Riedlingen*	1.14	0.86	114.06	8.96	1.33	1.48	1.48	1.16
Weingarten	1.27	1.13	98.01	9.34	1.08	44.71	29.00	1.55
Hausen*	1.53	0.70	81.65	19.61	1.40	2.05	2.05	0.92
Balgheim*	0.87	1.16	107.63	21.25	1.02	2.77	2.77	0.75
Sankt Leon	1.25	0.78	47.08	46.23	2.25	35.38	35.38	3.55
Neckargartach	1.30	1.02	86.41	2.60	0.96	45.42	43.06	0.59
Todtnau*	1.41	0.54	12.20	3.42	1.60	34.77	4.29	2.64
Gaggenau	1.51	1.60	41.63	37.73	1.60	13.01	13.01	3.51
Brenden*	1.93	0.93	16.60	10.29	1.76	2.11	2.11	3.12

Neckargartach

Figure S 2: Temporal change of abiotic and faunal parameters over time in Neckargartach. The Groundwater-Faun-Index (GFI) changes from 6.3 in 2002 to 5.8 in 2007 and finally to 3.4 in 2020, which can be due to a decrease in the surface influence. This shows a clear connection between changes in GFI and land development. No sampling was conducted in years with no bar.
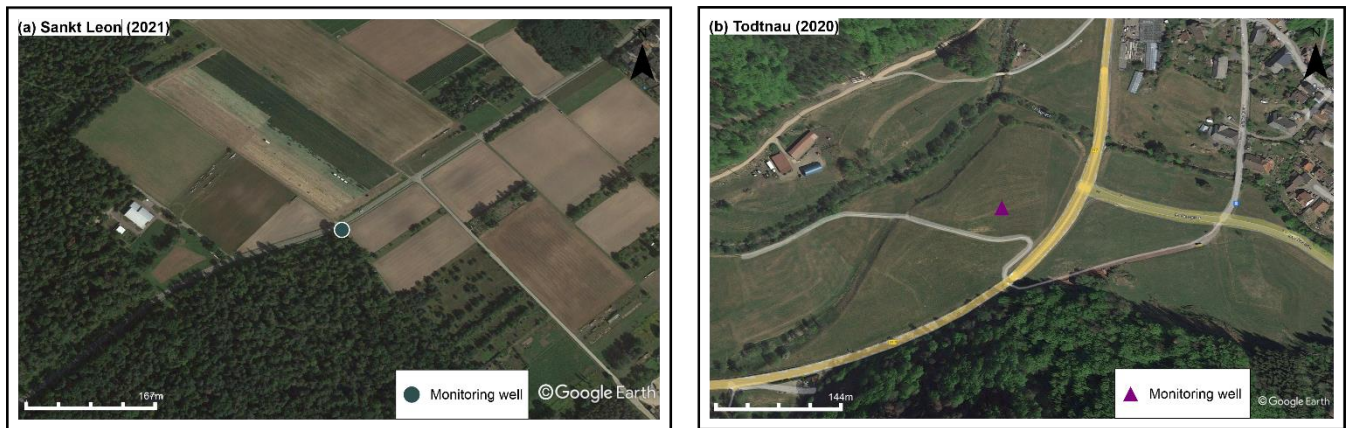

Figure S 3: Aerial image of the location of the monitoring well in Sankt Leon (a) and Todtnau (b) (Source: Google Earth Pro (Google LLC. 2022)). The surroundings of the wells have not changed over the investigation period (2002 – 2020).