Supplement of Geosci. Model Dev., 19, 41–56, 2026
https://doi.org/10.5194/gmd-19-41-2026-supplement

Geoscientific Model Development
Open Access
EGU

Supplement of

Integration of the Global Water and Lake Sectors within the ISIMIP framework through scaling of streamflow inputs to lakes

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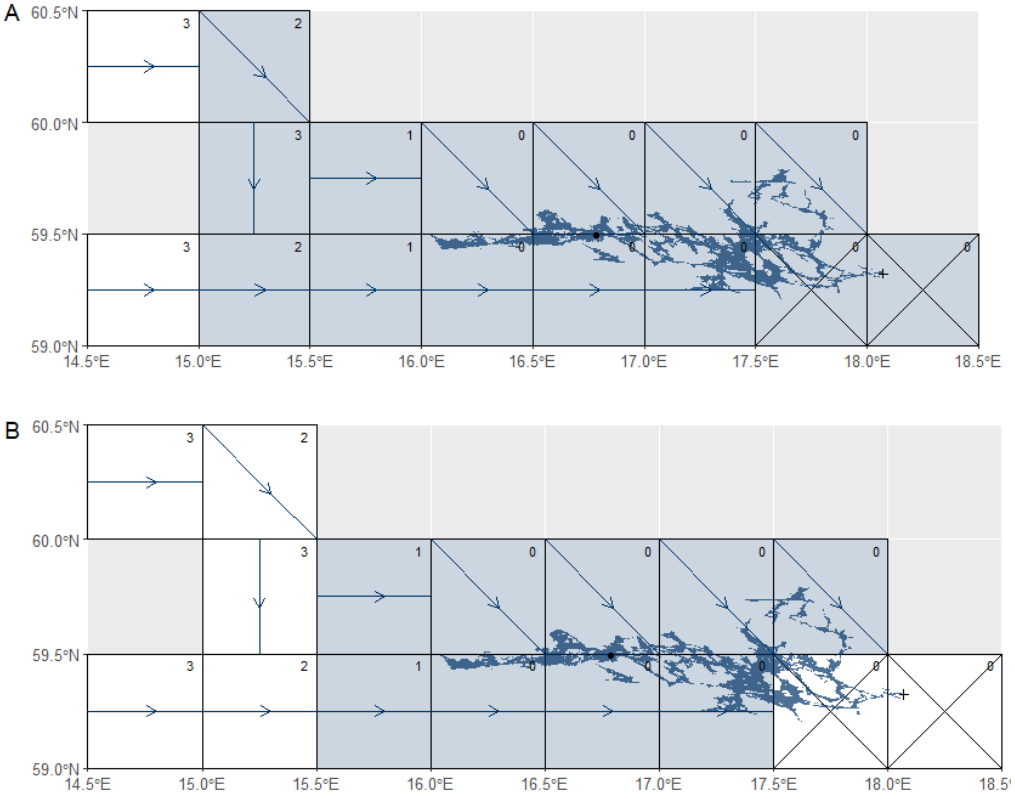


Figure S1. Catchment-lake scheme for lake Mälaren – 102 (A_{lake} = 1083.13 km^2, $A_{catchment}$ = 22682 km^2 and A_{grid} = 1580 km^2) for the approach I.b ($A_{lake} \leq A_{grid}$) (A) and for the approach II ($A_{lake} > A_{grid}$) (B). The dot and cross denote the lake centroid and the pour point, respectively. The arrows indicate the flow direction, and the numbers indicate the grid cell levels. The blue-shaded grid cells represent those selected for the streamflow estimation, according to the workflow (Figure 2).

Table S1. Catchment-lake study site features, including lake latitude and longitude, lake surface area (A_{lake}, km^2), lake elevation (Elevation, masl), catchment area ($A_{catchment}$, km^2), catchment-to-lake ratio (A_{lake} A_{lake}^{-1}), mean catchment slope (Mean slope, m m^{-1}), maximum catchment slope (Max. slope, m m^{-1}) and minimum catchment slope (Min. slope, m m^{-1}). The lake identifier is sourced from HydroLAKES database (Messager et al., 2016).

Lake	Name	Latitude	A_{lake} [km^2]	Elevation [masl]	$A_{catchment}$ [km^2]	$A_{catchment}$ A_{lake}^{-1}	Mean slope [m m^{-1}]	Max. slope [m m^{-1}]	Min. slope [m m^{-1}]
102	Mälaren	59.49	1083.13	3	22682.20	20.94	0.000823	0.003598	0.000001
104	Vättern	58.33	1888.04	88	6369.10	3.37	0.001630	0.004284	0.000001
105	Vänern	58.88	5486.23	44	48421.00	8.83	0.001995	0.005671	0.000001
1052	Akkajaure	67.67	258.33	431	5935.60	22.98	0.003406	0.015031	0.000001
1057	Stora Lulevatten	67.22	220.73	355	10040.50	45.49	0.002501	0.012112	0.000001
1061	Parkijaure	66.83	121.65	283	5344.50	43.93	0.002452	0.004336	0.000911
1068	Hornavan	66.25	224.59	410	3491.40	15.55	0.001274	0.002144	0.000267
1072	Uddjaure	65.97	247.51	402	5502.30	22.23	0.001457	0.002862	0.000183
1079		65.72	199.93	404	6373.90	31.88	0.001644	0.002862	0.000183
1081	Storuman	65.26	168.89	338	7272.70	43.06	0.002553	0.006968	0.000430
1092	Flåsjön	64.11	109.35	251	1401.00	12.81	0.001556	0.002692	0.000891
1097		64.02	145.02	268	6246.80	43.08	0.001102	0.002007	0.000425
1104	Storsjön	63.08	488.65	279	11305.10	23.14	0.002176	0.007385	0.000001
1150	Siljan	60.86	290.88	144	12084.50	41.54	0.002427	0.006322	0.000001
1165	Sommen	58.02	128.96	146	1893.30	14.68	0.001973	0.002037	0.001904
11564		67.85	29.26	452	939.70	32.12	0.000001	0.000001	0.000001
11566		67.86	24.18	307	7563.40	312.80	0.004494	0.012683	0.000001
11616	Satisjaure	67.50	81.71	437	1233.40	15.09	0.004272	0.012683	0.000001
11693		66.73	21.05	150	11316.20	537.59	0.002925	0.012112	0.000074
11697	Randijaure	66.73	51.34	267	6270.70	122.14	0.004664	0.012112	0.000911
11734		66.52	47.69	462	1461.60	30.65	0.005119	0.010306	0.001410
11749		66.40	29.00	411	3979.80	137.23	0.001793	0.003056	0.000001
11794		66.11	51.90	506	615.10	11.85	0.012281	0.012281	0.012281
11842	Storovan	65.73	51.84	330	3005.60	57.98	0.002207	0.002583	0.001831
11864		65.52	30.65	652	325.70	10.63	0.007050	0.008319	0.005781
11877		65.56	81.61	383	4856.30	59.51	0.003845	0.006968	0.000001
11973		64.57	30.34	437	597.40	19.69	0.005010	0.007313	0.002706
12000		64.40	28.86	251	1461.00	50.62	0.001370	0.002692	0.000047
12058		64.05	21.85	269	1734.80	79.40	0.002337	0.003849	0.000825
12247		62.79	22.46	480	1661.90	73.99	0.002809	0.003221	0.002396
12316		62.45	50.56	229	5246.10	103.76	0.001318	0.002381	0.000001
12423		62.05	63.59	352	8357.00	131.42	0.003060	0.003786	0.001700
12533		61.52	36.19	404	4538.40	125.40	0.002279	0.003642	0.000387
12623		60.97	14.52	44	234.80	16.17	0.001722	0.002172	0.001271

12681		60.67	11.56	277	121.00	10.47	0.002650	0.002650	0.002650
12727		60.36	59.90	43	28039.40	468.10	0.002524	0.006322	0.000001
12729		60.42	15.70	268	286.10	18.22	0.004721	0.005671	0.003770
12791		60.07	34.77	102	2213.30	63.66	0.001580	0.002107	0.001273
12809	Erken	59.84	23.14	15	138.70	5.99	0.000386	0.000418	0.000353
12936		58.85	47.68	21	2192.60	45.99	0.000769	0.001469	0.000069
12965	Roxen	58.49	94.55	34	13228.50	139.91	0.001402	0.002095	0.000001
13020		57.68	14.94	91	290.40	19.44	0.002158	0.002158	0.002158
13030		57.54	15.42	220	151.80	9.84	0.001727	0.002095	0.001360
13057		57.13	23.35	185	522.20	22.36	0.000715	0.001360	0.000070
13120		56.42	19.80	93	154.80	7.82	0.003994	0.003994	0.003994
13126		56.27	22.53	81	444.90	19.75	0.001087	0.001087	0.001087
13175		55.99	16.76	-2	3918.60	233.81	0.000606	0.001087	0.000125
137598		68.52	7.16	349	2507.60	350.22	0.001762	0.003325	0.000725
140992		67.33	3.65	457	113.40	31.07	0.003005	0.003005	0.003005
141844		66.82	5.04	116	513.40	101.87	0.001700	0.001700	0.001700
142240		66.66	7.68	64	1272.30	165.66	0.001369	0.001369	0.001369
142660		66.50	8.06	53	11793.10	1463.16	0.002241	0.004818	0.000074
143213		66.20	5.25	404	150.10	28.59	0.002144	0.002144	0.002144
145192		65.17	5.07	508	153.80	30.34	0.006968	0.006968	0.006968
147907		63.94	5.93	278	432.20	72.88	0.002007	0.002007	0.002007
148104		63.85	1.06	304	101.00	95.28	0.004540	0.005231	0.003849
149126		63.59	7.07	218	7006.40	991.00	0.002382	0.008504	0.000425
149804		63.22	5.97	189	104.20	17.45	0.004527	0.004527	0.004527
151109		62.63	2.67	37	246.60	92.36	0.000556	0.000556	0.000556
151471		62.54	6.61	119	6349.80	960.64	0.001634	0.002584	0.000001
152117		62.34	1.42	389	3362.90	2368.24	0.003612	0.003786	0.003438
152977	Hasselasjön	62.08	8.36	108	610.00	72.97	0.000348	0.000348	0.000348
153185		61.96	7.22	343	508.60	70.44	0.003479	0.003479	0.003479
157766		59.54	3.58	116	527.10	147.23	0.001647	0.002699	0.000595
158251		59.11	6.04	66	701.80	116.19	0.002690	0.002690	0.002690
158481		58.95	1.86	5	265.00	142.47	0.001501	0.001501	0.001501
159827		57.44	2.12	53	366.40	172.83	0.002974	0.002974	0.002974
160157		57.06	4.94	171	599.50	121.36	0.001360	0.001360	0.001360
1235053		64.96	0.56	270	8378.80	14962.14	0.001889	0.005781	0.000001
1287757		60.03	0.34	20	383.50	1127.94	0.000193	0.000193	0.000193

Table S2. Catchment-lake study site features and performance evaluation of the scaling streamflow from grid cells to catchment scale by comparing simulations with reference streamflow values. The lake identifier is sourced from HydroLAKES database (Messager et al., 2016).

Lake	Name	Latitude	Longitude	A_{lake} [km^2]	$A_{catchment}$ [km^2]	A_{grid} [km^2]	*MBE*	*RMSE*	*NRMSE*	*NSE*	*KGE*	KGE_r	KGE_b	KGE_g	Frequency	Approach	*N*
102	Mälaren	59.49	16.79	1083.13	22682.20	1580.45	8.67	107.96	0.15	0.37	0.71	0.72	1.04	1.06	monthly	I.b	14
102	Mälaren	59.49	16.79	1083.13	22682.20	1580.45	9.10	35.83	0.24	0.28	0.55	0.85	1.05	1.42	yearly	I.b	14
104	Vättern	58.33	14.49	1888.04	6369.10	1626.57	-1.38	16.80	0.12	0.60	0.79	0.79	0.97	1.00	monthly	II	
104	Vättern	58.33	14.49	1888.04	6369.10	1626.57	-1.28	7.74	0.28	0.02	0.42	0.76	0.97	1.52	yearly	II	
105	Vänern	58.88	13.55	5486.23	48421.00	1603.57	-15.93	103.16	0.10	0.62	0.77	0.85	0.97	1.17	monthly	II	
105	Vänern	58.88	13.55	5486.23	48421.00	1603.57	-16.34	39.77	0.09	0.87	0.93	0.94	0.97	1.04	yearly	II	
1052	Akkajaure	67.67	17.48	258.33	5935.60	1170.43	29.56	97.53	0.16	0.39	0.65	0.91	1.24	1.24	monthly	I.b	5
1052	Akkajaure	67.67	17.48	258.33	5935.60	1170.43	28.93	30.07	0.37	-0.98	0.74	0.94	1.24	0.90	yearly	I.b	5
1057	Stora Lulevatten	67.22	19.21	220.73	10040.50	1195.35	-23.67	120.61	0.18	0.24	0.57	0.66	0.87	1.23	monthly	I.b	8
1057	Stora Lulevatten	67.22	19.21	220.73	10040.50	1195.35	-24.52	39.07	0.36	-0.88	0.34	0.36	0.87	1.00	yearly	I.b	8
1061	Parkijaure	66.83	18.93	121.65	5344.50	1220.18	36.90	62.25	0.17	0.31	0.38	0.84	1.56	0.79	monthly	I.b	4
1061	Parkijaure	66.83	18.93	121.65	5344.50	1220.18	36.70	38.82	0.68	-7.25	0.37	0.74	1.56	0.89	yearly	I.b	4
1068	Hornavan	66.25	17.53	224.59	3491.40	1244.92	-7.31	36.98	0.09	0.75	0.82	0.87	0.88	0.96	monthly	I.b	2
1068	Hornavan	66.25	17.53	224.59	3491.40	1244.92	-7.37	13.77	0.26	-0.12	0.52	0.54	0.88	0.94	yearly	I.b	2
1072	Uddjaure	65.97	17.85	247.51	5502.30	1269.56	6.63	44.27	0.09	0.72	0.85	0.87	1.08	0.97	monthly	I.b	4
1072	Uddjaure	65.97	17.85	247.51	5502.30	1269.56	6.53	15.93	0.23	0.08	0.63	0.64	1.08	0.98	yearly	I.b	4
1079		65.72	18.21	199.93	6373.90	1269.56	10.75	51.55	0.10	0.64	0.82	0.87	1.12	1.04	monthly	I.b	5
1079		65.72	18.21	199.93	6373.90	1269.56	10.63	18.33	0.24	0.02	0.68	0.70	1.12	0.97	yearly	I.b	5
1081	Storuman	65.26	16.71	168.89	7272.70	1294.11	32.15	87.26	0.11	0.64	0.63	0.84	1.25	0.78	monthly	I.b	5
1081	Storuman	65.26	16.71	168.89	7272.70	1294.11	32.05	43.98	0.45	-1.72	0.37	0.43	1.25	0.89	yearly	I.b	5
1092	Flåsjön	64.11	15.86	109.35	1401.00	1342.90	9.56	13.55	0.13	0.05	0.28	0.78	1.60	0.67	monthly	I.a	1
1092	Flåsjön	64.11	15.86	109.35	1401.00	1342.90	9.53	9.96	0.66	-7.23	0.34	0.77	1.59	0.82	yearly	I.a	1
1097		64.02	15.36	145.02	6246.80	1342.90	1.19	59.01	0.08	0.65	0.67	0.81	1.01	0.73	monthly	I.b	4
1097		64.02	15.36	145.02	6246.80	1342.90	0.97	19.80	0.21	0.36	0.61	0.64	1.01	0.85	yearly	I.b	4
1104	Storsjön	63.08	14.41	488.65	11305.10	1391.29	-46.59	129.33	0.12	0.46	0.56	0.76	0.79	0.71	monthly	I.b	8
1104	Storsjön	63.08	14.41	488.65	11305.10	1391.29	-46.82	56.61	0.42	-1.71	0.44	0.59	0.79	1.32	yearly	I.b	8
1150	Siljan	60.86	14.77	290.88	12084.50	1510.36	37.28	84.21	0.13	-0.10	0.57	0.65	1.25	0.96	monthly	I.b	8
1150	Siljan	60.86	14.77	290.88	12084.50	1510.36	37.05	39.28	0.34	-0.98	0.68	0.90	1.25	0.83	yearly	I.b	8
1165	Sommen	58.02	15.22	128.96	1893.30	1626.57	-0.79	9.07	0.23	0.05	0.52	0.52	0.94	1.05	monthly	I.a	1
1165	Sommen	58.02	15.22	128.96	1893.30	1626.57	-0.75	3.33	0.33	-0.37	0.28	0.67	0.94	1.63	yearly	I.a	1
11564		67.85	19.23	29.26	939.70	1170.43	-1.21	10.16	0.12	0.58	0.72	0.77	0.91	0.87	monthly	I.a	1
11564		67.85	19.23	29.26	939.70	1170.43	-1.24	2.05	0.24	0.16	0.69	0.71	0.90	0.99	yearly	I.a	1
11566		67.86	20.75	24.18	7563.40	1170.43	30.86	71.73	0.23	-0.34	0.52	0.82	1.40	1.21	monthly	I.b	6
11566		67.86	20.75	24.18	7563.40	1170.43	30.60	33.64	0.66	-5.64	0.40	0.56	1.39	0.89	yearly	I.b	6
11616	Satisjaure	67.50	18.55	81.71	1233.40	1195.35	-14.26	25.09	0.14	0.51	0.56	0.87	0.58	1.00	monthly	I.a	1

11616	Satisjaure	67.50	18.55	81.71	1233.40	1195.35	-14.31	14.99	0.71	-6.26	0.42	0.61	0.58	0.92	yearly	I.a	1
11693		66.73	20.22	21.05	11316.20	1220.18	-5.86	129.06	0.19	0.17	0.60	0.66	0.97	1.22	monthly	I.b	9
11693		66.73	20.22	21.05	11316.20	1220.18	-6.77	34.77	0.30	-0.32	0.38	0.38	0.97	1.07	yearly	I.b	9
11697	Randijaure	66.73	19.28	51.34	6270.70	1220.18	50.62	76.17	0.18	0.08	0.30	0.91	1.68	0.89	monthly	I.b	5
11697	Randijaure	66.73	19.28	51.34	6270.70	1220.18	50.38	51.53	0.77	-9.96	0.26	0.83	1.68	0.75	yearly	I.b	5
11734		66.52	16.34	47.69	1461.60	1220.18	1.71	20.37	0.09	0.74	0.77	0.86	1.06	0.83	monthly	I.a	1
11734		66.52	16.34	47.69	1461.60	1220.18	1.70	5.85	0.20	0.16	0.36	0.50	1.06	0.61	yearly	I.a	1
11749		66.40	18.55	29.00	3979.80	1244.92	0.54	41.17	0.14	0.55	0.76	0.82	1.01	1.16	monthly	I.b	3
11749		66.40	18.55	29.00	3979.80	1244.92	0.33	9.12	0.19	0.38	0.69	0.75	1.00	1.18	yearly	I.b	3
11794		66.11	14.61	51.90	615.10	1244.92	5.11	16.06	0.11	0.60	0.56	0.80	1.25	0.70	monthly	I.a	1
11794		66.11	14.61	51.90	615.10	1244.92	5.09	5.26	0.26	-0.36	0.73	0.97	1.25	0.92	yearly	I.a	1
11842	Storovan	65.73	17.11	51.84	3005.60	1269.56	15.11	38.99	0.10	0.60	0.57	0.83	1.31	0.76	monthly	I.b	2
11842	Storovan	65.73	17.11	51.84	3005.60	1269.56	15.08	18.97	0.56	-3.19	0.42	0.52	1.31	1.08	yearly	I.b	2
11864		65.52	14.78	30.65	325.70	1269.56	-3.99	9.83	0.11	0.60	0.65	0.83	0.70	0.96	monthly	I.a	1
11864		65.52	14.78	30.65	325.70	1269.56	-3.99	4.36	0.32	-0.76	0.62	0.93	0.70	0.78	yearly	I.a	1
11877		65.56	15.32	81.61	4856.30	1269.56	28.34	71.69	0.11	0.60	0.63	0.85	1.30	0.84	monthly	I.b	3
11877		65.56	15.32	81.61	4856.30	1269.56	28.29	33.34	0.38	-1.48	0.48	0.65	1.30	0.76	yearly	I.b	3
11973		64.57	15.05	30.34	597.40	1318.56	5.99	9.74	0.13	0.30	0.39	0.85	1.56	0.80	monthly	I.a	1
11973		64.57	15.05	30.34	597.40	1318.56	5.98	6.16	0.73	-5.81	0.40	0.88	1.56	0.82	yearly	I.a	1
12000		64.40	16.02	28.86	1461.00	1342.90	6.64	15.79	0.10	0.58	0.42	0.81	1.31	0.56	monthly	I.a	1
12000		64.40	16.02	28.86	1461.00	1342.90	6.57	7.32	0.39	-1.93	0.59	0.76	1.31	0.87	yearly	I.a	1
12058		64.05	18.33	21.85	1734.80	1342.90	9.12	17.22	0.13	0.54	0.49	0.84	1.41	0.74	monthly	I.a	1
12058		64.05	18.33	21.85	1734.80	1342.90	8.99	9.56	0.65	-5.52	0.55	0.89	1.40	1.17	yearly	I.a	1
12247		62.79	13.59	22.46	1661.90	1415.32	-4.18	17.56	0.13	0.55	0.63	0.77	0.82	0.78	monthly	I.a	1
12247		62.79	13.59	22.46	1661.90	1415.32	-4.29	4.50	0.26	-0.34	0.66	0.94	0.81	1.28	yearly	I.a	1
12316		62.45	15.28	50.56	5246.10	1439.25	-5.41	31.70	0.09	0.65	0.77	0.81	0.91	0.90	monthly	I.b	3
12316		62.45	15.28	50.56	5246.10	1439.25	-5.57	9.24	0.17	0.46	0.54	0.91	0.91	1.44	yearly	I.b	3
12423		62.05	14.15	63.59	8357.00	1439.25	49.91	73.65	0.19	-0.30	0.24	0.83	1.73	0.84	monthly	I.b	5
12423		62.05	14.15	63.59	8357.00	1439.25	49.69	52.70	0.89	-15.99	0.22	0.89	1.72	1.27	yearly	I.b	5
12533		61.52	13.52	36.19	4538.40	1463.07	12.48	25.72	0.09	0.70	0.71	0.89	1.20	0.82	monthly	I.b	3
12533		61.52	13.52	36.19	4538.40	1463.07	12.32	13.67	0.25	-0.30	0.76	0.89	1.20	0.91	yearly	I.b	3
12623		60.97	16.93	14.52	234.80	1510.36	-2.75	4.49	0.12	0.24	0.45	0.84	0.52	0.80	monthly	I.a	1
12623		60.97	16.93	14.52	234.80	1510.36	-2.75	2.90	0.59	-2.84	0.47	0.83	0.52	1.13	yearly	I.a	1
12681		60.67	14.43	11.56	121.00	1510.36	-0.92	1.94	0.13	0.33	0.46	0.79	0.63	0.66	monthly	I.a	1
12681		60.67	14.43	11.56	121.00	1510.36	-0.92	1.01	0.33	-1.58	0.52	0.88	0.63	0.73	yearly	I.a	1
12727		60.36	17.10	59.90	28039.40	1533.84	117.50	204.60	0.16	-0.15	0.55	0.71	1.34	0.93	monthly	I.b	18
12727		60.36	17.10	59.90	28039.40	1533.84	116.63	118.48	0.49	-2.44	0.58	0.95	1.33	0.76	yearly	I.b	18
12729		60.42	12.52	15.70	286.10	1533.84	0.26	2.91	0.12	0.55	0.70	0.76	1.05	0.84	monthly	I.a	1
12729		60.42	12.52	15.70	286.10	1533.84	0.24	0.64	0.13	0.60	0.81	0.87	1.05	1.12	yearly	I.a	1

12791		60.07	15.57	34.77	2213.30	1533.84	5.78	16.97	0.11	0.44	0.55	0.73	1.23	0.72	monthly	I.a	1
12791		60.07	15.57	34.77	2213.30	1533.84	5.74	6.84	0.26	-0.40	0.71	0.83	1.22	0.94	yearly	I.a	1
12809	Erken	59.84	18.60	23.14	138.70	1557.20	-0.29	0.73	0.12	0.47	0.63	0.75	0.80	0.83	monthly	I.a	1
12809	Erken	59.84	18.60	23.14	138.70	1557.20	-0.29	0.36	0.31	-0.18	0.62	0.80	0.80	1.26	yearly	I.a	1
12936		58.85	16.60	47.68	2192.60	1603.57	4.25	9.92	0.15	0.26	0.59	0.72	1.26	0.86	monthly	I.a	1
12936		58.85	16.60	47.68	2192.60	1603.57	4.23	5.17	0.34	-1.07	0.63	0.88	1.26	1.23	yearly	I.a	1
12965	Roxen	58.49	15.63	94.55	13228.50	1626.57	-9.04	50.70	0.23	-0.76	-0.07	0.73	0.90	2.04	monthly	I.b	8
12965	Roxen	58.49	15.63	94.55	13228.50	1626.57	-8.87	23.85	0.49	-2.80	-0.77	0.79	0.91	2.75	yearly	I.b	8
13020		57.68	16.11	14.94	290.40	1649.44	0.07	1.63	0.09	0.47	0.66	0.71	1.02	0.84	monthly	I.a	1
13020		57.68	16.11	14.94	290.40	1649.44	0.07	0.38	0.10	0.72	0.75	0.92	1.03	1.24	yearly	I.a	1
13030		57.54	14.85	15.42	151.80	1649.44	0.06	0.74	0.15	0.52	0.71	0.74	1.04	0.88	monthly	I.a	1
13030		57.54	14.85	15.42	151.80	1649.44	0.06	0.35	0.26	0.05	0.60	0.62	1.04	1.13	yearly	I.a	1
13057		57.13	15.00	23.35	522.20	1672.19	1.97	3.11	0.22	-0.11	0.44	0.72	1.43	0.79	monthly	I.a	1
13057		57.13	15.00	23.35	522.20	1672.19	1.96	2.24	0.68	-6.08	0.43	0.72	1.43	1.26	yearly	I.a	1
13120		56.42	14.85	19.80	154.80	1717.31	-0.05	1.24	0.10	0.69	0.68	0.84	0.98	0.72	monthly	I.a	1
13120		56.42	14.85	19.80	154.80	1717.31	-0.04	0.28	0.09	0.82	0.87	0.92	0.99	1.11	yearly	I.a	1
13126		56.27	14.32	22.53	444.90	1717.31	1.61	3.10	0.16	0.24	0.51	0.76	1.38	0.81	monthly	I.a	1
13126		56.27	14.32	22.53	444.90	1717.31	1.63	1.92	0.33	-1.23	0.58	0.84	1.38	1.02	yearly	I.a	1
13175		55.99	14.22	16.76	3918.60	1739.67	12.84	23.97	0.13	0.48	0.58	0.82	1.30	0.78	monthly	I.b	2
13175		55.99	14.22	16.76	3918.60	1739.67	13.00	15.80	0.32	-1.10	0.63	0.81	1.31	1.07	yearly	I.b	2
137598		68.52	22.00	7.16	2507.60	1120.32	-38.41	59.54	0.13	0.11	0.28	0.87	0.30	1.14	monthly	I.b	2
137598		68.52	22.00	7.16	2507.60	1120.32	-38.43	39.47	0.88	-13.23	0.20	0.61	0.30	0.94	yearly	I.b	2
140992		67.33	20.72	3.65	113.40	1195.35	0.62	1.66	0.11	0.19	0.42	0.67	1.41	0.75	monthly	I.a	1
140992		67.33	20.72	3.65	113.40	1195.35	0.61	0.68	0.31	-2.02	0.24	0.63	1.40	0.47	yearly	I.a	1
141844		66.82	22.89	5.04	513.40	1220.18	0.44	4.60	0.12	0.60	0.52	0.80	1.06	0.57	monthly	I.a	1
141844		66.82	22.89	5.04	513.40	1220.18	0.41	0.94	0.18	0.18	0.62	0.65	1.06	0.88	yearly	I.a	1
142240		66.66	22.22	7.68	1272.30	1220.18	1.98	14.38	0.11	0.40	0.39	0.65	1.12	0.53	monthly	I.a	1
142240		66.66	22.22	7.68	1272.30	1220.18	1.90	3.09	0.19	0.10	0.48	0.66	1.12	0.63	yearly	I.a	1
142660		66.50	20.58	8.06	11793.10	1244.92	-116.76	177.06	0.15	0.45	0.60	0.84	0.65	1.09	monthly	I.b	9
142660		66.50	20.58	8.06	11793.10	1244.92	-118.03	124.02	0.54	-5.12	0.50	0.65	0.64	0.97	yearly	I.b	9
143213		66.20	17.26	5.25	150.10	1244.92	-1.10	3.19	0.12	0.54	0.60	0.80	0.69	0.85	monthly	I.a	1
143213		66.20	17.26	5.25	150.10	1244.92	-1.11	1.22	0.35	-1.29	0.62	0.81	0.69	0.90	yearly	I.a	1
145192		65.17	15.77	5.07	153.80	1294.11	0.86	2.87	0.10	0.57	0.50	0.78	1.27	0.64	monthly	I.a	1
145192		65.17	15.77	5.07	153.80	1294.11	0.86	1.05	0.38	-1.33	0.58	0.69	1.27	0.93	yearly	I.a	1
147907		63.94	15.26	5.93	432.20	1367.15	2.82	4.89	0.14	0.13	0.17	0.65	1.54	0.47	monthly	I.a	1
147907		63.94	15.26	5.93	432.20	1367.15	2.81	2.95	0.66	-5.20	0.40	0.79	1.53	0.81	yearly	I.a	1
148104		63.85	17.97	1.06	101.00	1367.15	-1.62	3.53	0.16	0.30	0.40	0.81	0.53	0.67	monthly	I.a	1
148104		63.85	17.97	1.06	101.00	1367.15	-1.64	1.66	0.77	-8.69	0.45	0.86	0.53	1.25	yearly	I.a	1
149126		63.59	16.25	7.07	7006.40	1367.15	12.88	47.97	0.06	0.79	0.82	0.90	1.09	0.88	monthly	I.b	5

149126		63.59	16.25	7.07	7006.40	1367.15	12.61	18.33	0.18	0.52	0.78	0.87	1.09	0.85	yearly	I.b	5
149804		63.22	18.18	5.97	104.20	1391.29	-0.38	1.61	0.11	0.61	0.69	0.80	0.86	0.80	monthly	I.a	1
149804		63.22	18.18	5.97	104.20	1391.29	-0.39	0.46	0.18	0.29	0.76	0.90	0.86	1.16	yearly	I.a	1
151109		62.63	17.75	2.67	246.60	1415.32	-1.41	3.36	0.11	0.51	0.57	0.83	0.71	0.73	monthly	I.a	1
151109		62.63	17.75	2.67	246.60	1415.32	-1.42	1.54	0.27	-0.53	0.70	0.91	0.71	0.96	yearly	I.a	1
151471		62.54	15.82	6.61	6349.80	1415.32	-12.74	44.17	0.11	0.57	0.73	0.78	0.84	0.97	monthly	I.b	4
151471		62.54	15.82	6.61	6349.80	1415.32	-12.95	15.27	0.22	0.23	0.56	0.92	0.84	1.40	yearly	I.b	4
152117		62.34	13.77	1.42	3362.90	1439.25	-3.06	25.22	0.10	0.64	0.78	0.81	0.93	0.93	monthly	I.b	2
152117		62.34	13.77	1.42	3362.90	1439.25	-3.20	6.25	0.18	0.36	0.58	0.85	0.93	1.38	yearly	I.b	2
152977	Hasselasjön	62.08	16.78	8.36	610.00	1439.25	0.29	4.07	0.09	0.74	0.86	0.87	1.04	0.95	monthly	I.a	1
152977	Hasselasjön	62.08	16.78	8.36	610.00	1439.25	0.27	0.93	0.13	0.76	0.84	0.92	1.04	1.13	yearly	I.a	1
153185		61.96	14.66	7.22	508.60	1463.07	0.93	2.96	0.08	0.79	0.84	0.92	1.14	0.96	monthly	I.a	1
153185		61.96	14.66	7.22	508.60	1463.07	0.91	1.43	0.25	0.24	0.73	0.88	1.13	1.20	yearly	I.a	1
157766		59.54	11.84	3.58	527.10	1557.20	1.81	4.21	0.09	0.57	0.54	0.80	1.22	0.64	monthly	I.a	1
157766		59.54	11.84	3.58	527.10	1557.20	1.81	2.21	0.29	-0.56	0.72	0.83	1.22	1.05	yearly	I.a	1
158251		59.11	14.67	6.04	701.80	1580.45	0.62	4.63	0.13	0.55	0.79	0.81	1.06	1.05	monthly	I.a	1
158251		59.11	14.67	6.04	701.80	1580.45	0.64	1.75	0.24	0.14	0.54	0.85	1.07	1.43	yearly	I.a	1
158481		58.95	11.25	1.86	265.00	1603.57	-3.00	6.78	0.13	0.34	0.49	0.74	0.70	0.68	monthly	I.a	1
158481		58.95	11.25	1.86	265.00	1603.57	-2.98	3.28	0.32	-1.12	0.64	0.81	0.70	0.96	yearly	I.a	1
159827		57.44	16.29	2.12	366.40	1672.19	-1.89	3.67	0.12	0.36	0.52	0.78	0.65	0.76	monthly	I.a	1
159827		57.44	16.29	2.12	366.40	1672.19	-1.87	1.95	0.34	-1.92	0.42	0.88	0.65	1.44	yearly	I.a	1
160157		57.06	14.91	4.94	599.50	1672.19	-2.03	5.30	0.17	0.33	0.55	0.65	0.80	0.80	monthly	I.a	1
160157		57.06	14.91	4.94	599.50	1672.19	-2.00	2.27	0.30	-0.39	0.68	0.83	0.80	1.19	yearly	I.a	1
1235053		64.96	17.62	0.56	8378.80	1318.56	-3.55	93.82	0.09	0.76	0.84	0.87	0.98	0.90	monthly	I.b	6
1235053		64.96	17.62	0.56	8378.80	1318.56	-3.84	22.15	0.17	0.58	0.73	0.77	0.98	0.86	yearly	I.b	6
1287757		60.03	18.14	0.34	383.50	1533.84	-0.66	2.78	0.09	0.63	0.73	0.81	0.88	0.85	monthly	I.a	1
1287757		60.03	18.14	0.34	383.50	1533.84	-0.65	1.12	0.21	0.40	0.63	0.84	0.88	1.31	yearly	I.a	1

Table S3. Catchment-lake study site features and performance evaluation of the scaling streamflow from grid cells to catchment scale by comparing simulations with observed streamflow values. The lake identifier is sourced from HydroLAKES database (Messager et al., 2016).

Lake	Name	Latitude	Longitude	A_{lake} [km^2]	$A_{catchment}$ [km^2]	A_{grid} [km^2]	*MBE*	*RMSE*	*NRMSE*	*NSE*	*KGE*	KGE_r	KGE_b	KGE_g	Frequency	Approach	*N*
102	Mälaren	59.49	16.79	1083.13	22682.20	1580.45	32.97	110.74	0.13	0.21	0.64	0.71	1.20	0.98	monthly	I.b	14
102	Mälaren	59.49	16.79	1083.13	22682.20	1580.45	33.16	50.32	0.22	-0.08	0.70	0.82	1.20	1.13	yearly	I.b	14
104	Vättern	58.33	14.49	1888.04	6369.10	1626.57	-2.12	21.94	0.26	-0.92	0.19	0.45	0.94	1.58	monthly	II	
104	Vättern	58.33	14.49	1888.04	6369.10	1626.57	-2.08	8.65	0.17	0.47	0.73	0.76	0.95	1.10	yearly	II	
105	Vänern	58.88	13.55	5486.23	48421.00	1603.57	-62.81	192.56	0.19	0.23	0.58	0.60	0.88	0.93	monthly	II	
105	Vänern	58.88	13.55	5486.23	48421.00	1603.57	-61.96	84.50	0.14	0.56	0.84	0.89	0.88	0.98	yearly	II	
1150	Siljan	60.86	14.77	290.88	12084.50	1510.36	-7.74	101.76	0.18	0.23	0.47	0.52	0.95	0.77	monthly	I.b	8
1150	Siljan	60.86	14.77	290.88	12084.50	1510.36	-8.12	17.87	0.13	0.69	0.86	0.87	0.95	0.97	yearly	I.b	8
12423		62.05	14.15	63.59	8357.00	1439.25	-3.07	77.41	0.14	-0.93	0.14	0.58	0.97	1.75	monthly	I.b	5
12423		62.05	14.15	63.59	8357.00	1439.25	-3.13	10.72	0.10	0.77	0.74	0.93	0.97	1.25	yearly	I.b	5
12791		60.07	15.57	34.77	2213.30	1533.84	8.59	17.70	0.11	-0.24	0.47	0.66	1.40	0.91	monthly	I.a	1
12791		60.07	15.57	34.77	2213.30	1533.84	8.60	9.56	0.33	-1.31	0.55	0.84	1.40	0.87	yearly	I.a	1
12809	Erken	59.84	18.60	23.14	138.70	1557.20	0.34	0.63	0.18	0.11	0.39	0.68	1.42	0.70	monthly	I.a	1
12809	Erken	59.84	18.60	23.14	138.70	1557.20	0.34	0.39	0.30	-0.47	0.43	0.82	1.43	0.68	yearly	I.a	1
12965	Roxen	58.49	15.63	94.55	13228.50	1626.57	2.33	42.39	0.26	-0.07	0.46	0.73	1.03	1.47	monthly	I.b	8
12965	Roxen	58.49	15.63	94.55	13228.50	1626.57	2.24	11.55	0.13	0.77	0.87	0.91	1.03	1.09	yearly	I.b	8
142240		66.66	22.22	7.68	1272.30	1220.18	3.62	13.36	0.15	0.44	0.38	0.69	1.26	0.53	monthly	I.a	1
142240		66.66	22.22	7.68	1272.30	1220.18	3.60	3.99	0.26	-0.31	0.53	0.87	1.25	0.62	yearly	I.a	1
152977	Hasselasjön	62.08	16.78	8.36	610.00	1439.25	-0.35	3.94	0.08	0.73	0.85	0.86	0.95	1.04	monthly	I.a	1
152977	Hasselasjön	62.08	16.78	8.36	610.00	1439.25	-0.27	1.38	0.14	0.59	0.79	0.81	0.96	1.07	yearly	I.a	1

Table S4. Performance evaluation of the streamflow by comparing reference with observed streamflow values. The lake identifier is sourced from HydroLAKES database (Messager et al., 2016).

Lake	Name	Latitude	Longitude	*MBE*	*RMSE*	*NRMSE*	*NSE*	*KGE*	KGE_r	KGE_b	KGE_g	Frequency
102	Mälaren	59.49	16.79	31.66	119.55	0.16	0.24	0.56	0.64	1.19	0.83	monthly
102	Mälaren	59.49	16.79	32.17	38.46	0.22	0.13	0.73	0.87	1.19	0.86	yearly
104	Vättern	58.33	14.49	3.03	25.64	0.31	-1.25	0.24	0.39	1.07	1.45	monthly
104	Vättern	58.33	14.49	2.94	9.43	0.22	0.33	0.47	0.63	1.07	0.64	yearly
105	Vänern	58.88	13.55	-25.90	136.73	0.14	0.60	0.71	0.79	0.95	0.81	monthly
105	Vänern	58.88	13.55	-25.32	57.00	0.10	0.80	0.86	0.92	0.95	0.89	yearly
12423		62.05	14.15	-51.94	77.45	0.23	-1.20	-0.34	0.53	0.57	2.18	monthly
12423		62.05	14.15	-51.70	53.28	0.55	-4.30	0.56	0.90	0.57	0.97	yearly
12791		60.07	15.57	4.17	17.94	0.17	-0.53	0.48	0.65	1.19	1.33	monthly
12791		60.07	15.57	4.24	5.76	0.32	-0.13	0.60	0.72	1.20	0.78	yearly
12809	Erken	59.84	18.60	0.69	1.27	0.40	-2.72	-0.14	0.27	1.86	0.84	monthly
12809	Erken	59.84	18.60	0.70	0.73	0.57	-5.03	-0.01	0.75	1.87	0.55	yearly
12965	Roxen	58.49	15.63	14.20	31.24	0.20	0.41	0.62	0.75	1.18	0.78	monthly
12965	Roxen	58.49	15.63	14.86	22.19	0.29	0.08	0.35	0.74	1.18	0.43	yearly
142240		66.66	22.22	1.20	7.08	0.08	0.85	0.88	0.93	1.08	0.95	monthly
142240		66.66	22.22	1.18	3.07	0.21	-0.02	0.59	0.60	1.08	0.99	yearly
152977	Hasselasjön	62.08	16.78	-0.31	2.78	0.06	0.88	0.92	0.94	0.96	1.04	monthly
152977	Hasselasjön	62.08	16.78	-0.18	1.10	0.11	0.78	0.79	0.89	0.98	0.82	yearly

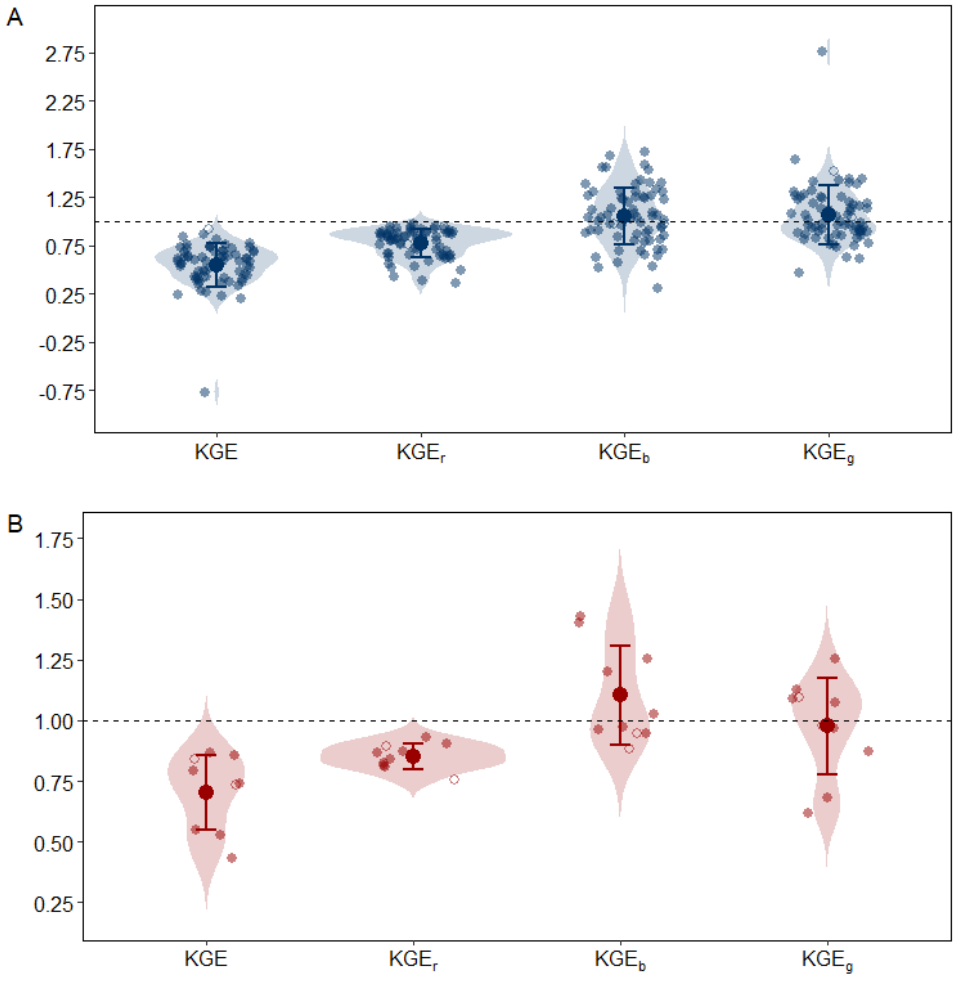


Figure S2. Kling-Gupta efficiency (*KGE*) and its components, timing (KGE_r), bias (KGE_b) and variability (KGE_g), when comparing yearly simulations of scaled streamflow with reference data from the HYPE model (A) and observed data (B) of streamflow. Filled dots correspond to study sites where $A_{lake} \leq A_{grid}$ (approach I) and unfilled dots corresponds to study sites where $A_{lake} > A_{grid}$ (approach II). The horizontal dashed line marks where *KGE* and its components equal 1, representing a perfect match.

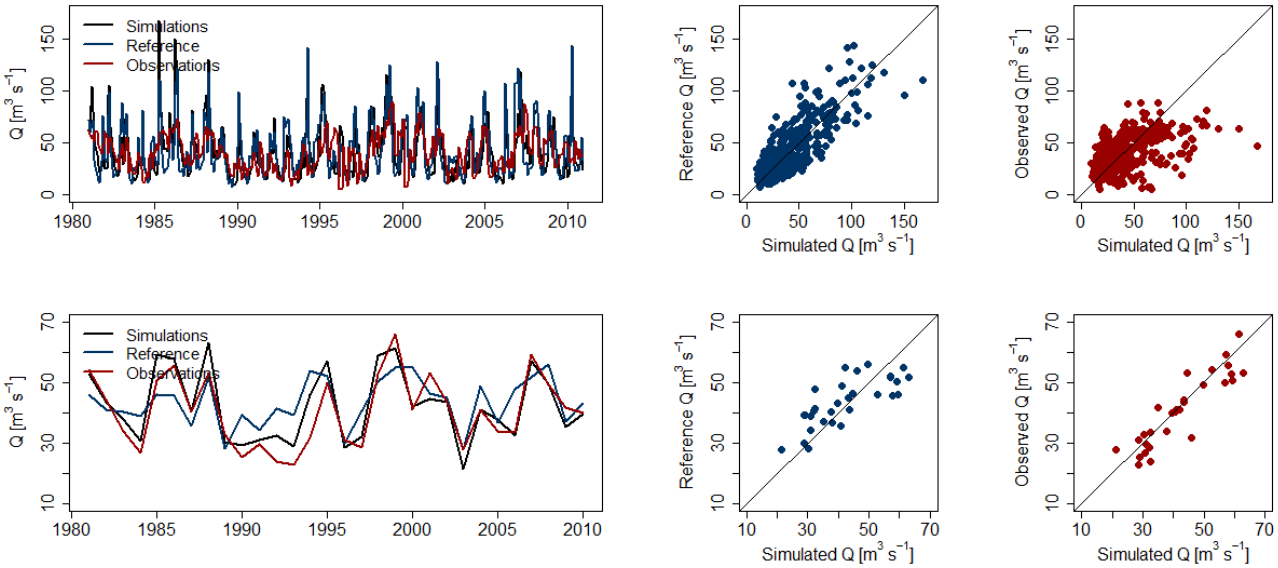


Figure S3. Monthly (upper row) and annual (lower row) comparison of simulated (black), reference (blue) and observed (red) streamflow for lake Vättern (104) over a 30-year period.

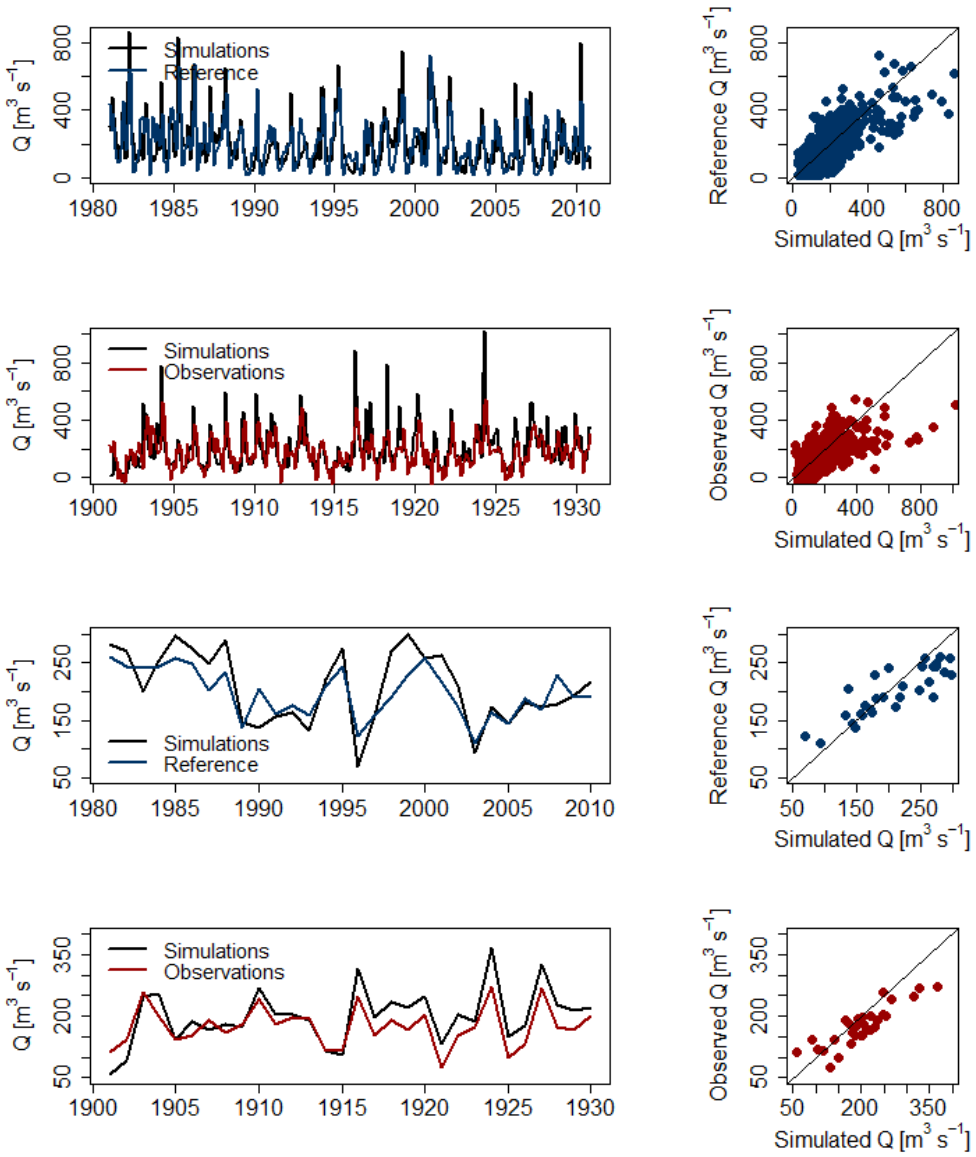
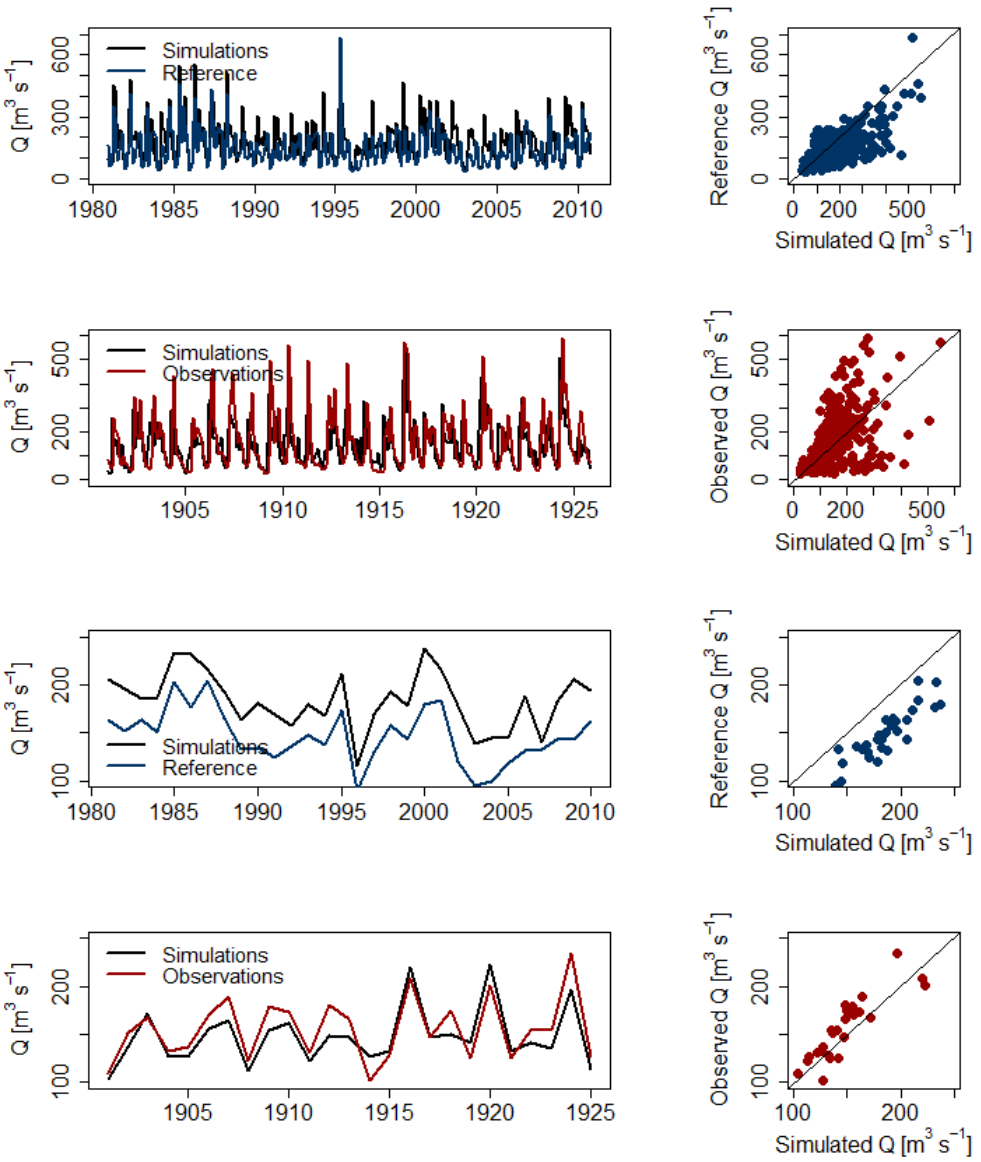


Figure S4. Monthly and annual comparison of simulated (black), reference (blue) and observed (red) streamflow for lake Mälaren (102) over a 30-year period.



35 **Figure S5. Monthly and annual comparison of simulated (black), reference (blue) and observed (red) streamflow for lake Siljan (1150) over a 30-year period for comparison of simulated and reference streamflow and over a 25-year period for comparison of simulated and observed streamflow.**

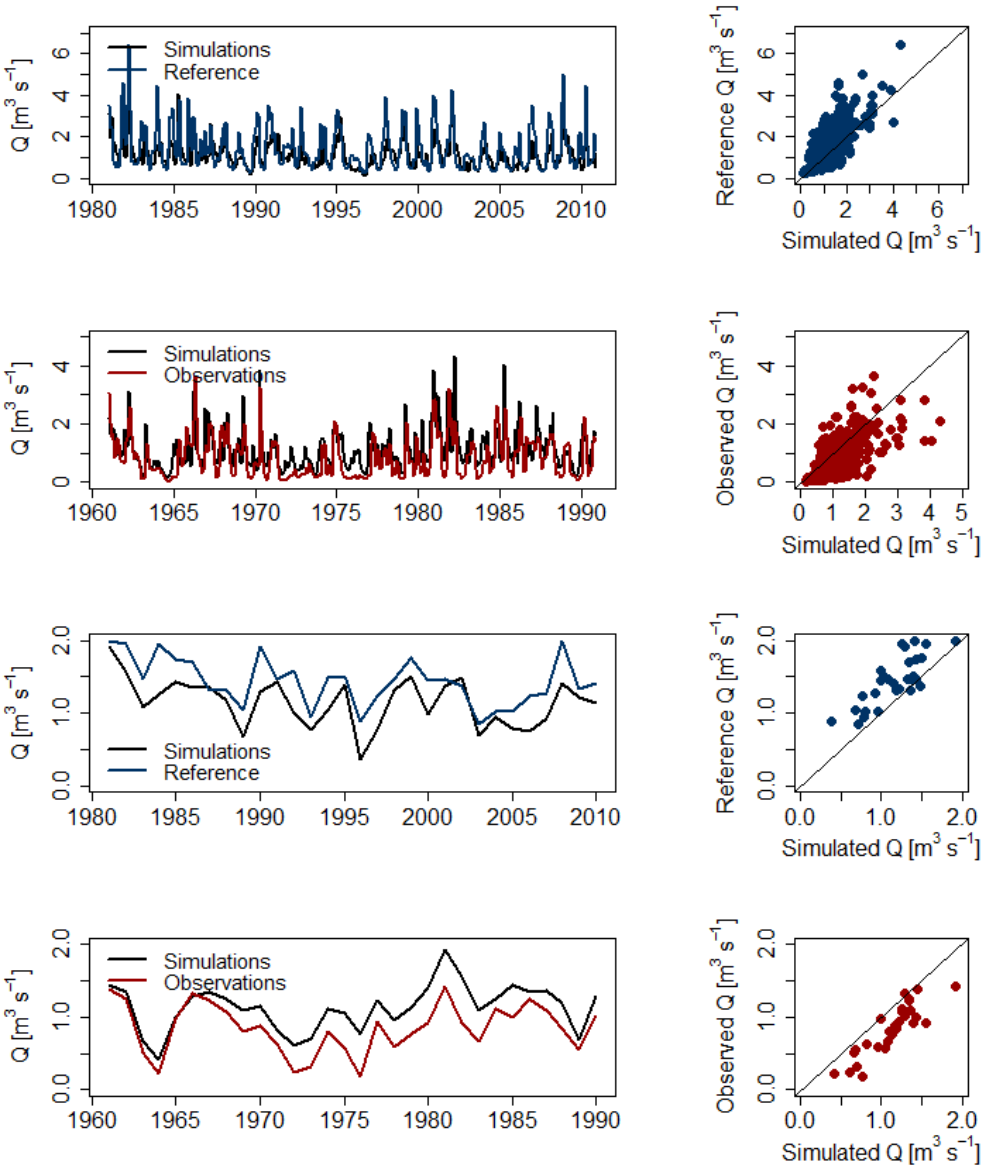


Figure S6. Monthly and annual comparison of simulated (black), reference (blue) and observed (red) streamflow for lake Erken (12809) over a 30-year period.

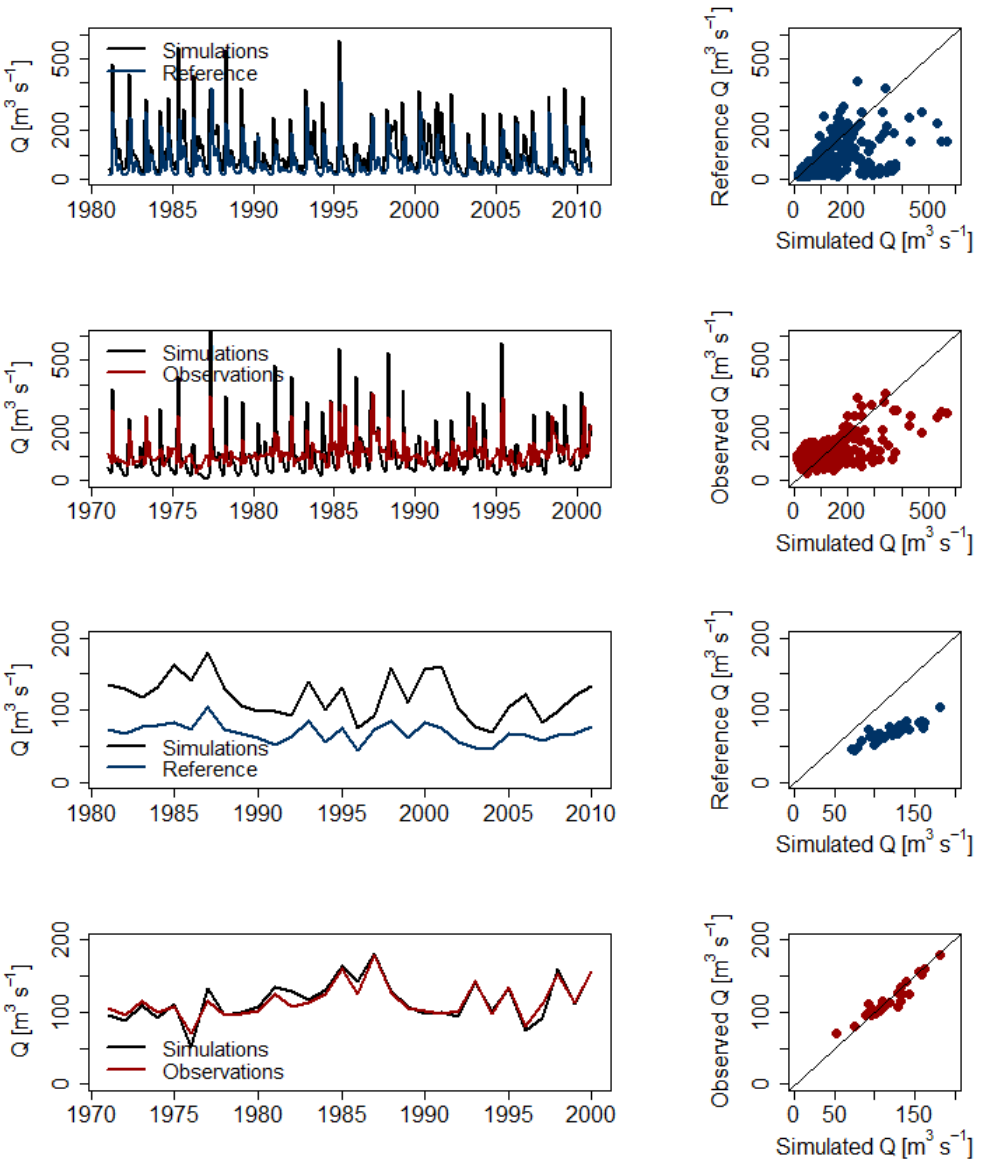


Figure S7. Monthly and annual comparison of simulated (black) and observed (red) streamflow for lake 12423 over a 30-year period.

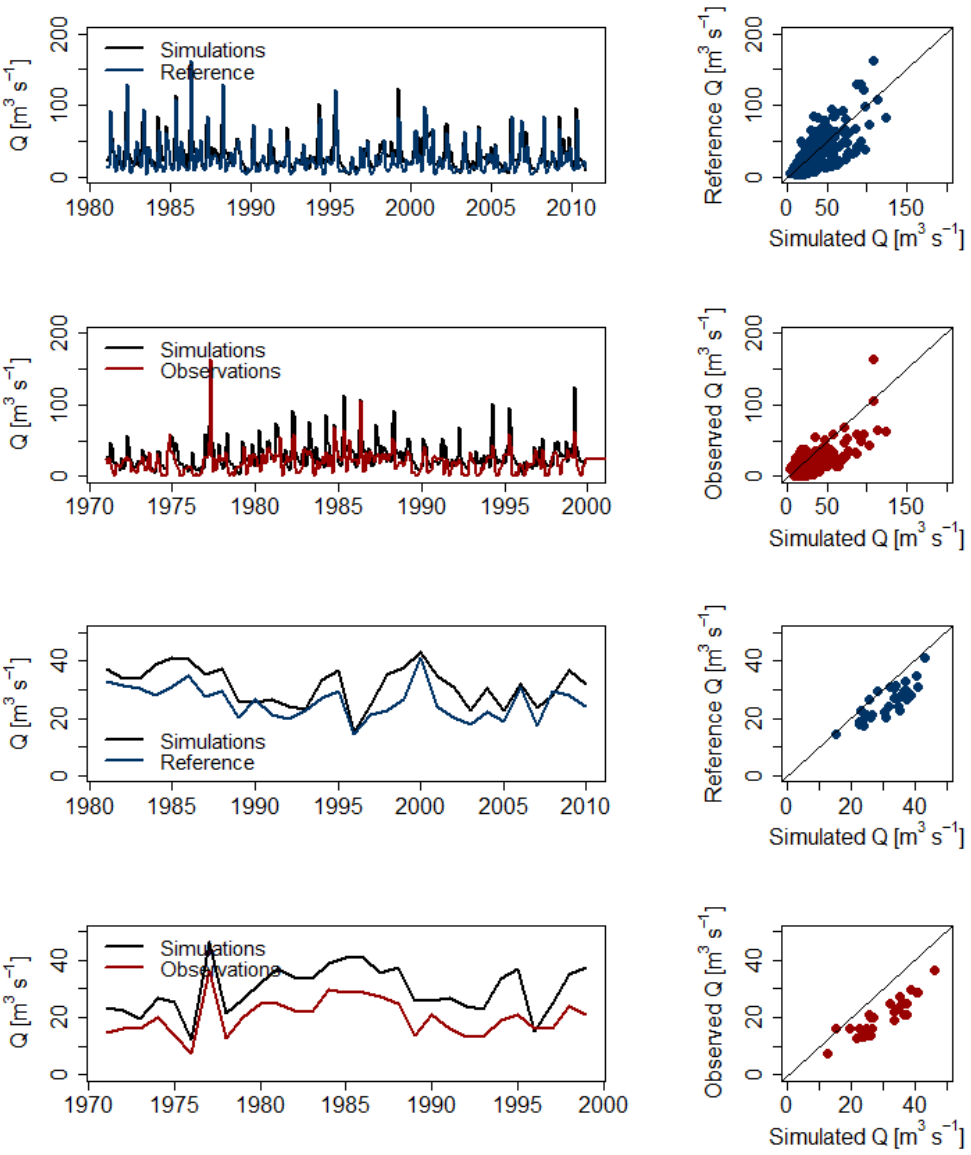


Figure S8. Monthly and annual comparison of simulated (black) and observed (red) streamflow for lake 12791 over a 30-year period.

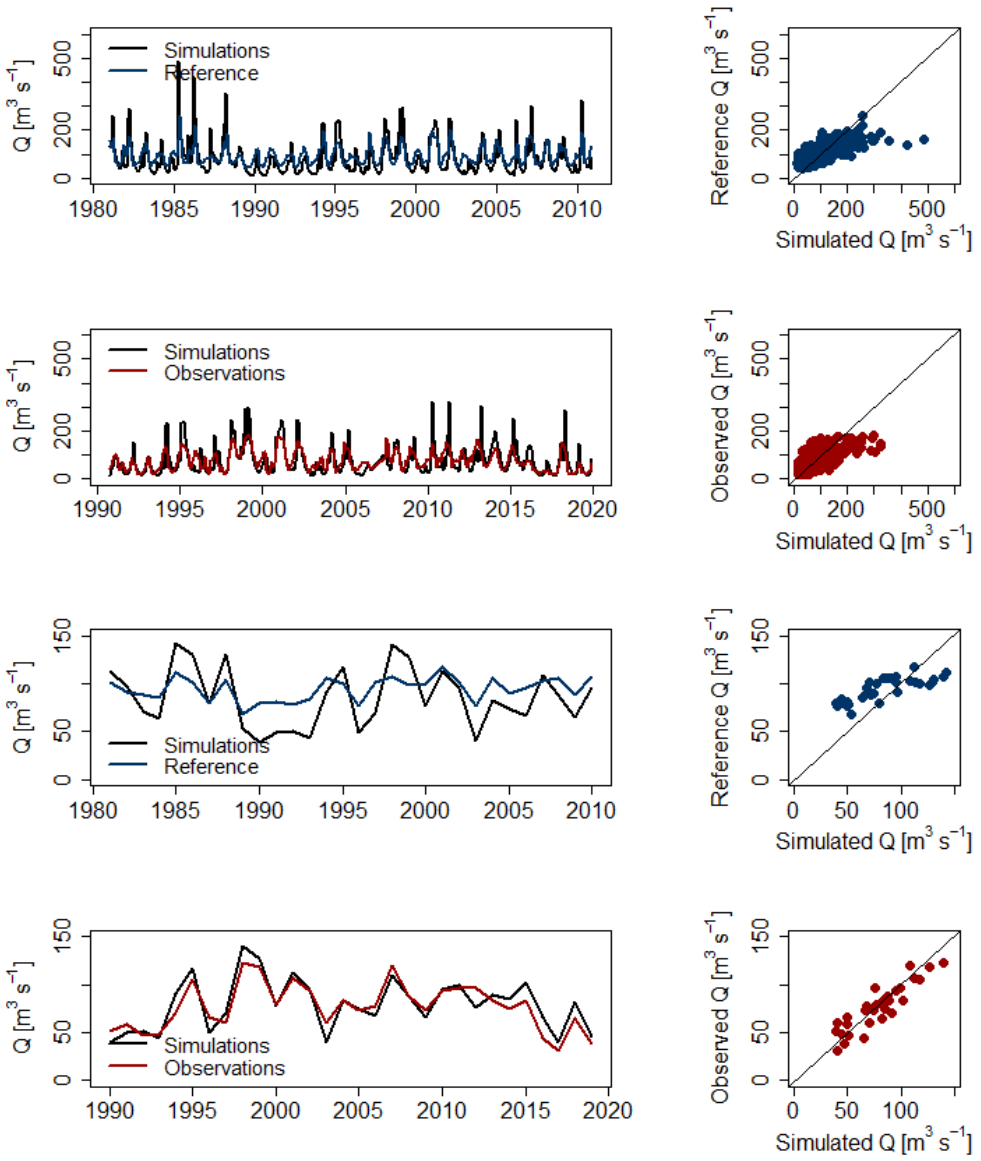


Figure S9. Monthly and annual comparison of simulated (black) and observed (red) streamflow for lake Roxen (12965) over a 30-year period.

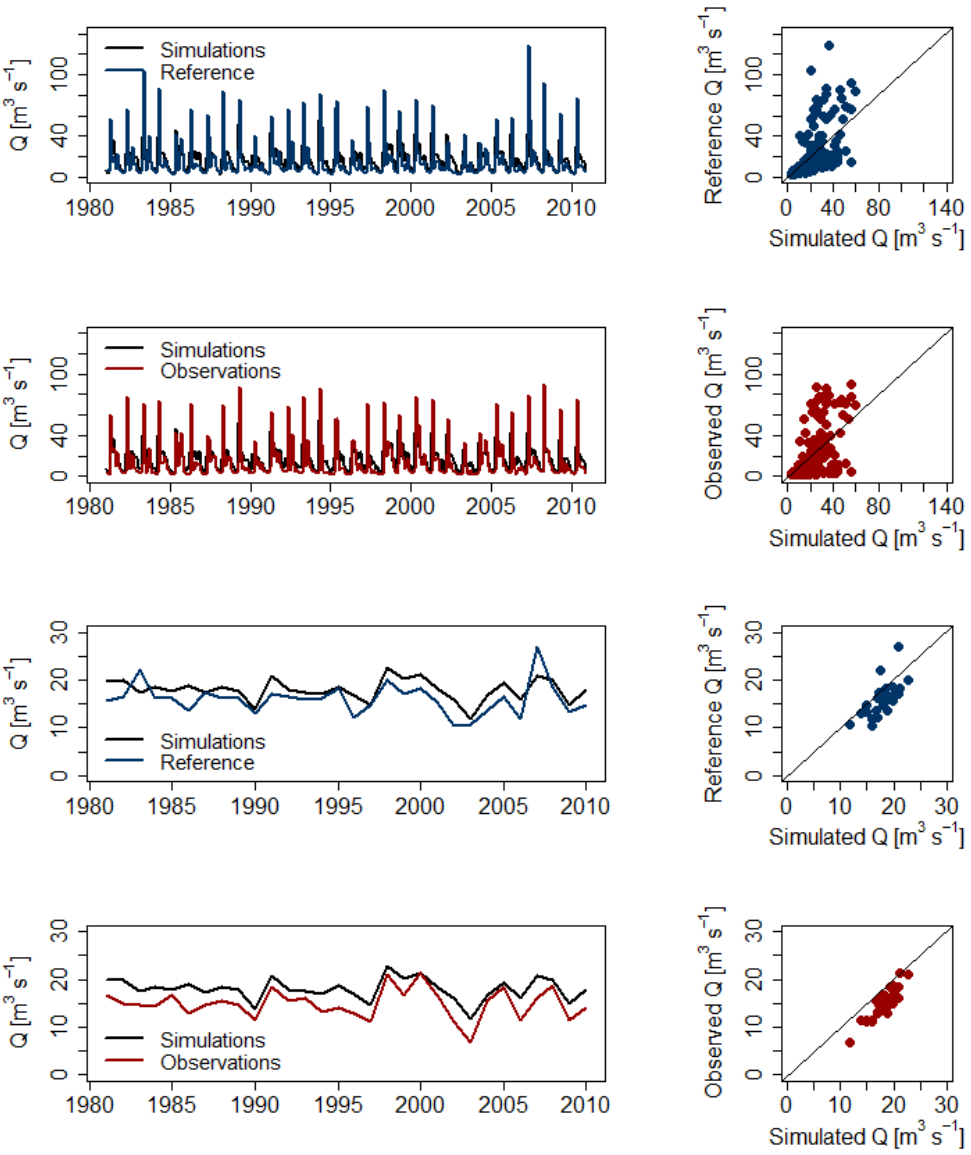
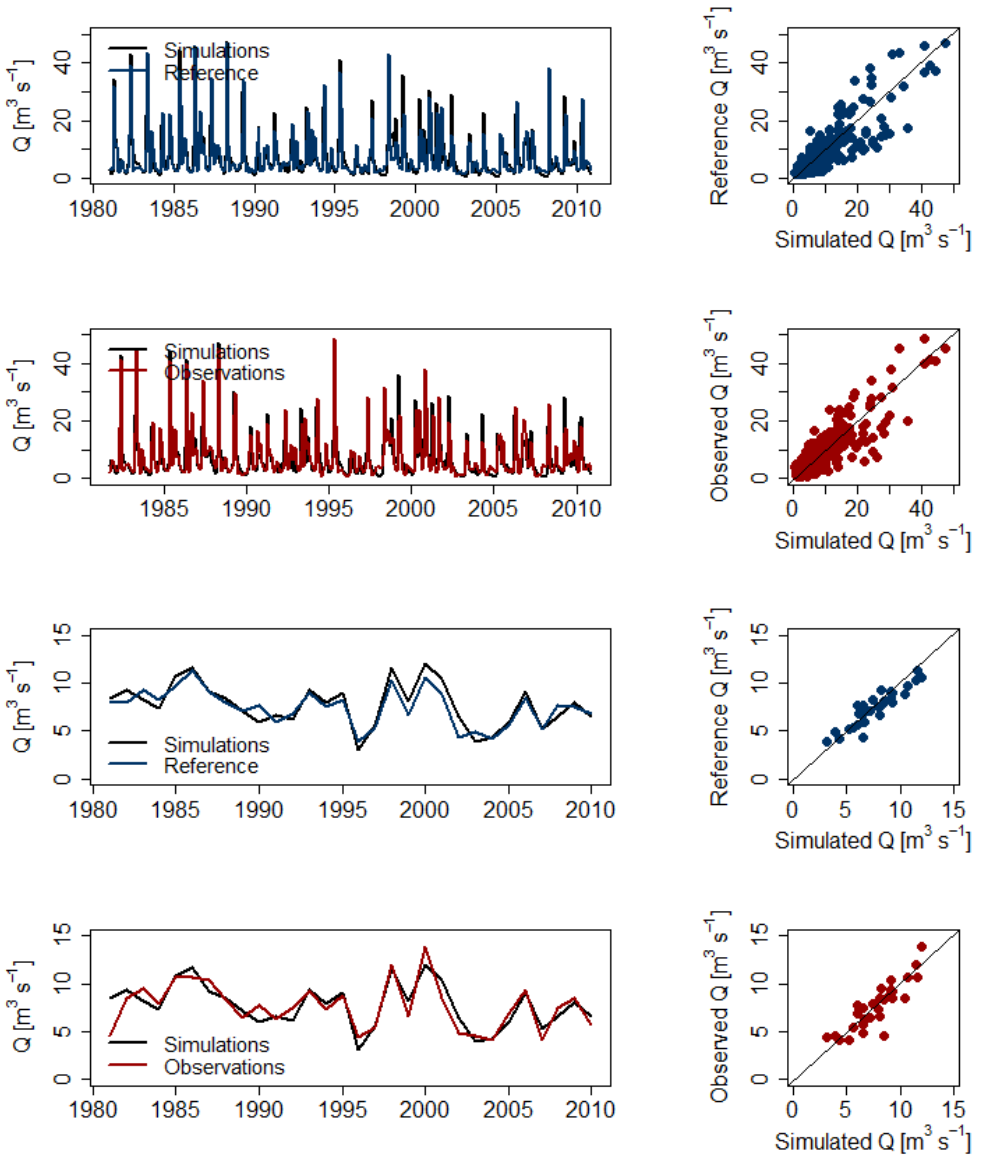


Figure S10. Monthly and annual comparison of simulated (black) and observed (red) streamflow for lake 142240 over a 30-year period.



55 **Figure S11. Monthly and annual comparison of simulated (black) and observed (red) streamflow for lake Hasselasjön (152977) over a 30-year period.**

S1. Assessment of atmospheric water exchange (precipitation and evaporation) and its influence on lake water balances at observed study sites.

The validation against observed data did not include the atmospheric water exchange over the lake surface (precipitation and evaporation), since we compared scaled lake inflow with observed lake outflow. We therefore estimated the potential atmospheric water exchange for the ten lakes included in this comparison. Potential evapotranspiration (*PET*, cm) was estimated using the empirical equation proposed by Hamon (1961), assuming that evaporation from a water surface is similar to potential evapotranspiration:

$$PET = \frac{0.021 \cdot H \cdot e_s}{T_{air}} \quad \text{(S1)}$$

where H is the number of daylight hours per day, e_s is the saturated water vapor pressure (mbar) and T_{air} is daily air temperature (°C). When $T_{air} \leq 0$, *PET* is assumed to be 0.

The saturated water vapor pressure (e_s) was calculated following Bosen (1960)

$$e_s = 33.8639 \cdot [(0.00738 \cdot T_{air} + 0.8072)^8 - 0.000019 \cdot (1.8 \cdot T_{air} + 48) + 0.001316] \quad \text{(S2)}$$

PET was calculated for the 10 lakes with available outflow observations for the period 1981-2010, using observed climate-related forcing data from the GSWP3-W5E5 climate forcing data set (Cucchi et al., 2020; Lange et al., 2021; Zhao et al., 2022) provided by ISIMIP3a. In addition, we calculated average *PET*, precipitation (P), the net balance *P–PET* and the contribution of *P–PET* to the lake water balance, which was then compared with streamflow inputs to assess their relative importance in lake hydrology (Table S5).

For the majority of the lakes, the atmospheric water exchange over the lake surface, expressed as *P–PET*, contributed less than 2% of the streamflow inputs, confirming that evaporation and precipitation can be considered negligible when comparing simulated streamflow inflows with observed outflows. However, for lakes with long water residence time, such as lakes Vänern and Vättern, residence times of 9.8 and 58 years respectively (Kvarnäs, 2001), the *P–PET* contribution was higher, approximately 22 % and 8.5 % respectively, reducing the accuracy of the comparisons in these two particular lakes.

Table S5. *PET, P, P-PET* and % contribution to *Q*.

Lake	Name	*PET* (mm year^{-1})	*P* (mm year^{-1})	*P – PET* (mm year^{-1})	% contribution to *Q*
102	Mälaren	595.55	655.51	59.96	2.05
104	Vättern	579.53	741.82	162.29	22.33
105	Vänern	588.39	838.67	250.28	8.51
1150	Siljan	520.26	734.40	214.14	1.98
12423		481.19	710.76	229.57	0.39

12791		537.47	741.36	203.89	0.71
12809	Erken	596.88	628.67	31.79	2.03
12965	Roxen	594.74	662.11	67.36	0.24
142240		628.83	630.56	1.72	<0.01
152977	Hasselasjön	510.18	732.70	222.52	0.76

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