Supplement of Hydrol. Earth Syst. Sci., 22, 4047–4060, 2018
https://doi.org/10.5194/hess-22-4047-2018-supplement

Hydrology and Earth System Sciences
Open Access
EGU

Supplement of

Hydrological effects of climate variability and vegetation dynamics on annual fluvial water balance in global large river basins

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Table S1. The validated parameter of eq. (14) and simulation accuracy of R based on the estimated n with the validated parameters for each basin

ID	Validated basin	Model coefficients			R simulation accuracy		
		a	b	c	R^2	RMSE	MAE
1	Amur	5.05	-0.36	-0.05	0.90	32.7	26.4
2	Aral	0.39*	0.77*	0.04	0.80	7.9	6.1
3	Columbia	0.58***	0.47	-0.06	0.27	12.2	9.9
4	Congo	0.92	0.10	-0.36***	0.94	12.8	10.7
5	Danube	0.42	0.81	-0.21	0.22	39.4	35.4
6	Indigirka	0.02	2.37***	-0.02	0.85	16.1	13.1
7	Indus	0.26*	0.57	0.59*	0.82	11.6	9.3
8	Kolyma	0.34*	0.98**	-0.20	0.60	19.2	16.5
9	Lena	0.39***	0.71**	0.19	0.84	9.0	7.1
10	Mackenzie	0.28*	0.91**	-0.04	0.95	6.3	5.2
11	Mississippi	1.06*	-0.03	0.00	0.81	8.9	6.9
12	Niger	0.03	2.22*	0.03	0.63	24.3	18.3
13	Nile	0.99***	-0.17	0.06	0.80	14.1	10.4
14	Northern Dvina	1.53*	-0.33	-0.01	0.64	10.8	8.9
15	Ob	0.34	0.61	0.30**	0.85	14.3	11.5
16	Olenek	0.33	0.76*	0.10	0.82	10.3	8.4
17	Parana	0.35***	0.60*	0.39	0.76	11.4	8.3
18	Pearl	2.90	-0.10	-0.16**	0.80	15.7	12.9
19	Pechora	0.09	1.40*	-0.01	0.97	21.8	17.2
20	Senegal	0.44	0.44	0.06	0.87	16.5	13.1
21	Volga	1.48***	-0.04	-0.41*	0.82	4.0	3.3
22	Yangtze	0.29	0.87	-0.02	0.76	13.4	10.3
23	Yellow	0.45	0.30	-0.06	0.92	19.3	15.6
24	Yenisei	0.86	0.28	-0.01	0.58	11.0	9.1
25	Yukon	0.32	0.79*	0.02	0.80	6.0	4.7
26	Amur	0.13	1.06	0.12	0.43	16.4	14.4
	All basins	0.29***	0.86***	-3.3***	0.92	68.2	45.8

'*', '**' and '***' represent the validated parameter are significant at the level of p = 0.1, p = 0.05 and p = 0.01, respectively.

Table S2. The validated parameter for the cross-variation of *n*.

ID	Validated basin	*a*	*b*	*c*	ID	Validated basin	*a*	*b*	*c*
1	Amur	0.28^{***}	0.88^{***}	-0.32^{***}	14	Northern Dvina	0.29^{***}	0.86^{***}	-0.33^{***}
2	Aral	0.28^{***}	0.87^{***}	-0.33^{***}	15	Ob	0.28^{***}	0.90^{***}	-0.29^{***}
3	Columbia	0.27^{***}	0.90^{***}	-0.31^{***}	16	Olenek	0.29^{***}	0.86^{***}	-0.33^{***}
4	Congo	0.29^{***}	0.86^{***}	-0.32^{***}	17	Parana	0.28^{***}	0.87^{***}	-0.33^{***}
5	Danube	0.29^{***}	0.88^{***}	-0.13^{***}	18	Pearl	0.32^{***}	0.77^{***}	-0.36^{***}
6	Indigirka	0.29^{***}	0.85^{***}	-0.33^{***}	19	Pechora	0.29^{***}	0.87^{***}	-0.32^{***}
7	Indus	0.29^{***}	0.86^{***}	-0.33^{***}	20	Senegal	0.30^{***}	0.83^{***}	-0.33^{***}
8	Kolyma	0.27^{***}	0.88^{***}	-0.32^{***}	21	Volga	0.26^{***}	0.91^{***}	-0.33^{***}
9	Lena	0.28^{***}	0.88^{***}	-0.32^{***}	22	Yangtze	0.29^{***}	0.85^{***}	-0.34^{***}
10	Mackenzie	0.29^{***}	0.86^{***}	-0.33^{***}	23	Yellow	0.34^{***}	0.76^{***}	-0.39^{***}
11	Mississippi	0.29^{***}	0.86^{***}	-0.33^{***}	24	Yenisei	0.26^{***}	0.90^{***}	-0.32^{***}
12	Niger	0.29^{***}	0.86^{***}	-0.33^{***}	25	Yukon	0.29^{***}	0.85^{***}	-0.33^{***}
13	Nile	0.28^{***}	0.87^{***}	-0.33^{***}	26	Amur	0.30^{***}	0.83^{***}	-0.32^{***}

'***' represent the validated parameter are significant at the level of $p = 0.01$

Table S3. The change points of runoff and the change rates of meteorological and vegetative factors after change points

ID	Basin	Changepoint of *R*	*R*	*E*	*Pe*	*PET*	*n*	*NDVI*	*SI*
1	Amazon	1998	8.5	-1.0	3.4	1.1	-9.4	3.4	0.3
2	Amur	1998	-16.4	-0.3	-5.8	3.0	4.5	-1.3	24.9
3	Aral	1994	-14.8	12.8	5.2	3.8	12.4	-0.8	-6.1
4	Columbia	1999	-10.7	1.2	-4.4	4.2	2.1	-1.7	15.7
5	Congo	1997	4.1	-2.5	-0.8	0.7	-15.5	1.0	3.5
6	Danube	1988	-12.5	16.4	5.2	5.5	27.3	6.4	1.4
7	Indigirka	1990	-7.0	4.4	-3.4	2.4	5.0	5.5	5.1
8	Indus	1998	-16.7	-4.5	-9.0	1.7	2.3	3.4	24.6
9	Kolyma	1990	-9.6	0.4	-5.0	0.9	3.7	4.2	16.9
10	Lena	1995	14.3	4.7	9.2	-1.3	0.3	1.1	-3.8
11	Mackenzie	1989	-13.3	6.2	-3.5	2.3	10.5	-2.7	13.1
12	Mississippi	1998	-20.1	5.0	-2.0	0.0	15.1	1.3	8.7
13	Niger	1990	27.9	7.7	13.7	0.6	-2.6	6.5	-4.1
14	Nile	1995	14.7	3.2	5.7	1.9	-2.9	3.1	12.5
15	Northern Dvina	2000	-7.1	6.7	-1.1	2.2	9.4	1.3	8.5
16	Ob	1998	7.5	4.7	5.9	1.8	0.9	-0.8	-7.0
17	Olenek	1988	13.9	10.7	12.6	-1.9	4.5	6.2	-20.5
18	Parana	1998	-6.6	2.0	0.1	1.6	4.6	-1.1	2.9
19	Pearl	1991	16.3	2.9	10.1	-0.7	-0.5	-1.6	19.0
20	Pechora	1990	20.4	-3.9	11.1	0.7	-10.2	2.7	-12.4
21	Senegal	1993	28.3	15.3	16.9	0.9	1.7	7.6	-9.3
22	Volga	1994	-8.9	4.1	-1.2	2.3	6.8	3.8	1.6
23	Yangtze	2000	-4.5	5.9	-0.6	3.0	5.2	-0.3	-3.2
24	Yellow	1990	-10.1	3.2	-0.3	2.9	5.1	2.6	24.2
25	Yenisei	1996	2.1	3.9	3.1	1.1	2.3	1.6	12.1
26	Yukon	1994	-8.0	-28.4	-15.6	2.2	-18.9	-3.4	8.9

Table S4. Contributions to the long-term mean changes of R and E from P_e, SAI, M and E_0 changes.

		Contributions to R changes				Contributions to E changes			
ID	Basins	P	E0	M	SSI	P	E0	M	SSI
1	Amazon	63.7	-10.1	25.5	-0.7	19.8	22.3	55.4	-2.5
2	Amur	-59.9	-11.2	4.2	24.6	-51.7	13.5	13.6	21.2
3	Aral	-13.2	-9.3	-21.4	56.1	33.9	7.0	-10.1	48.9
4	Columbia	-69.3	-15.5	4.0	11.2	-44.5	28.1	11.5	15.9
5	Congo	26.2	-8.1	-30.8	34.9	-7.8	10.1	-37.7	44.4
6	Danube	17.3	-19.0	59.4	-4.4	17.8	18.9	51.1	12.2
7	Indigirka	-54.3	-6.5	30.2	-9.0	-21.4	11.2	58.0	9.4
8	Indus	-82.8	-3.8	-4.2	9.1	-74.7	5.6	15.1	-4.6
9	Kolyma	-67.0	-3.7	-13.3	16.0	-45.6	6.1	31.2	-17.0
10	Lena	94.7	3.8	0.7	0.8	85.3	-10.6	-0.7	3.5
11	Mackenzie	-54.1	-6.2	16.5	23.3	-20.1	10.7	64.3	-4.8
12	Mississippi	-36.8	-0.2	-20.4	42.7	-17.4	0.2	51.5	-30.9
13	Niger	79.1	-1.6	15.9	3.5	81.4	1.4	15.6	1.6
14	Nile	61.8	-8.1	-13.4	16.7	68.1	6.8	-11.2	13.9
15	Northern Dvina	-29.0	-11.7	-19.8	39.6	-6.1	15.4	39.3	-39.2
16	Ob	83.5	-9.5	-1.9	5.2	70.1	17.1	7.1	-5.7
17	Olenek	82.5	2.9	6.2	8.4	54.2	-7.5	34.0	-4.3
18	Parana	-25.0	-29.2	24.7	21.1	2.2	38.1	27.0	32.7
19	Pearl	96.4	2.2	0.3	1.1	83.5	-9.8	1.8	5.0
20	Pechora	76.6	-0.9	8.4	14.1	30.7	2.7	52.3	-14.3
21	Senegal	86.4	-2.2	7.9	3.5	94.6	0.9	4.5	0.0
22	Volga	-41.3	-13.5	39.6	-5.6	-12.0	20.2	49.6	18.1
23	Yangtze	-26.2	-19.1	-11.6	43.1	-4.6	24.6	-19.8	51.0
24	Yellow	-10.9	-22.1	-18.6	48.4	-6.4	23.2	-20.8	49.6
25	Yenisei	60.7	-10.0	-8.7	20.6	42.2	14.7	-11.4	31.7
26	Yukon	-63.8	-1.3	19.6	15.3	-25.7	2.6	-20.8	50.9