

Supplementary Materials for
**Shifted sediment-transport regimes by climate change and amplified
hydrological variability in cryosphere-fed rivers**

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Text S1 Introduction and results of the partial least squares structural equation modeling (PLS-SEM)

Partial least squares structural equation modeling (PLS-SEM) is one of the most popular statistical methods used for analyzing the complex causal relationships between multiple variables in the field of ecology, hydrology, and social sciences (65-67). In PLS-SEM, the relationships between variables are defined in a *structural model* by users based on expert knowledge. In a structural model, the intensity of causal effects between variables, referring to as *path coefficients*, is estimated by the PLS algorithm, which aims to maximize the explained variance of the structural model (68). The estimated path coefficients, ranging from -1 to 1, indicate the strength and direction of the relationships among factors. Larger coefficients indicate a stronger relationship between the variables, while smaller coefficients suggest a weaker relationship. The relative importance of each variable to the dependent variable (e.g., SSC) can be determined by the *total effect*, which represents the combined direct and indirect effects of a predictor variable on the dependent variable (68). The coefficient of determination (R^2) for the structural model is used to assess the prediction performance of the entire model, and when R^2 greater than 0.7 the model is considered to be satisfactory (69, 70). The significance levels (*p*-value) of path coefficients are estimated by bootstrapping, which involves repeatedly sampling the dataset, e.g., 5000 times to obtain stable results, and generating a distribution of path coefficients to assess their significance (71).

In the study, the analysis of PLS-SEM is performed in the software SmartPLS (72) and the structural models for four basins are constructed according to the state-of-the-art understanding of the responses of sediment transport to various hydrogeomorphic processes (Fig. 4 and conceptual frameworks in ref.(1)). The framework consists of six variables (temperature, rainfall, effective snowmelt (SM), runoff, runoff surges (RS), and SSC) for nival-impacted basins Qiaqiga and Qiemo and only consists of five variables (without effective snowmelt) for non-nival basins Xiehela and Yingluoxia.

PLS-SEM results are summarized in Fig. S4. For the four studied cryosphere-fed river basins, R^2 is consistently greater than 0.8, indicating the satisfactory prediction performance of the four models. The dominant controlling factors vary remarkably across studied basins. According to the values of total effects, runoff has the greatest relative importance at the glacial and pluvial basins; runoff surges show the largest relative importance at the nival basin; temperature shows the largest relative importance at the mixed-regime basin. This corroborates the better performance of the rating curve method at glacial and pluvial basins (higher R^2 in Table S4). Among all the controlling factors, runoff surges display the most direct control on SSC in all four basins, with path coefficients ranging from 0.33 to 0.90 (*p*-value < 0.05). This aligns with the significantly high correlation between runoff surges and SSC (first column in Fig. 3). Although runoff shows relatively high importance (total effects ranging from 0.58 to 1.00), the relatively low path coefficients between runoff and SSC indicate that runoff exerts a higher indirect influence on SSC through the mediating effects of runoff surges, especially for the nival basin (Qiaqiga, Fig. S4B) where the direct causal relation between runoff and SSC is insignificant. This is supported by the results of SAT-M optimal variable selection (Table S4) where the parameter of runoff is calibrated as zero and thus runoff is excluded from the SAT-M model function of Qiaqiga. The impacts of climate factors on SSC differ among different cryospheric basins. For example, temperature minimal impacts the SSC in the pluvial basin (Yingluoxia, Fig. S4C) but is the dominant factor in the mixed-regime basin (Qiemo, Fig. S4D), exhibiting both significant direct (e.g., activating sediment sources) and indirect effects (e.g., through hydrological processes). By contrast, the impact of rainfall on SSC is minimal in the mixed-regime basin (Fig. S4D) but is more important in the pluvial basin by regulating hydrological processes (Fig. S4C). This is also in line with the results of SAT-M optimal variable selections in Table S4, where temperate is excluded from the model function of Yingluoxia and rainfall is excluded from the model function of Qiemo.

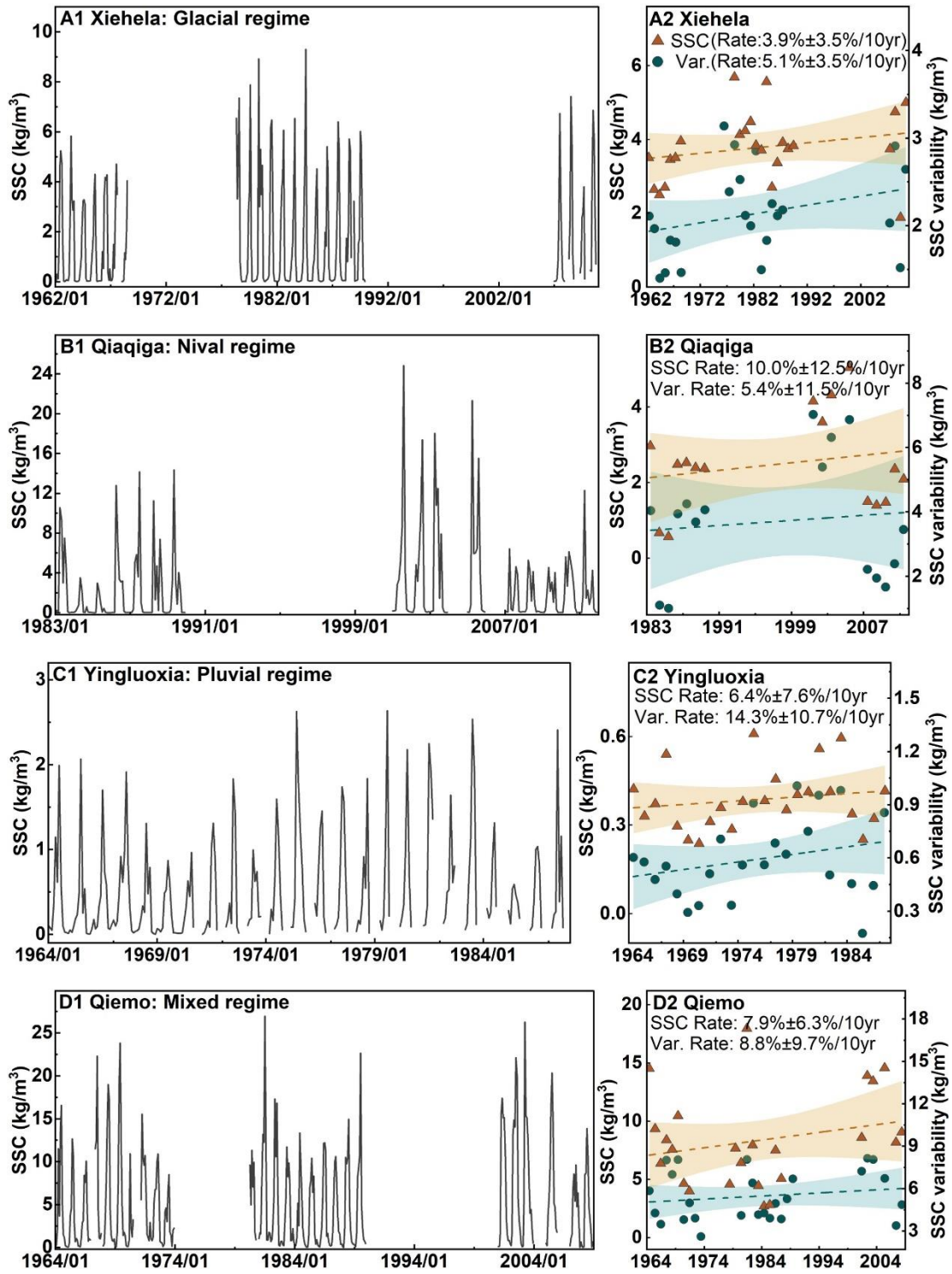


Fig. S1. Observations of monthly suspended sediment concentration (SSC) and annual SSC and its variability (Var.) at Xiehela (A1-A2, glacial regime), Qiaqiga (B1-B2, nival regime), Yingluoxia (C1-C2, pluvial regime), and Qiemo (D1-D2, mixed regime). Monthly SSC observations are shown in black lines. The annual SSC and its variability are shown as brown triangles and green dots. The dashed lines are fitted linear trends and all show positive trends with increased annual SSC and its variability. Shaded areas denote the 95% confidence interval of the best-fit line.

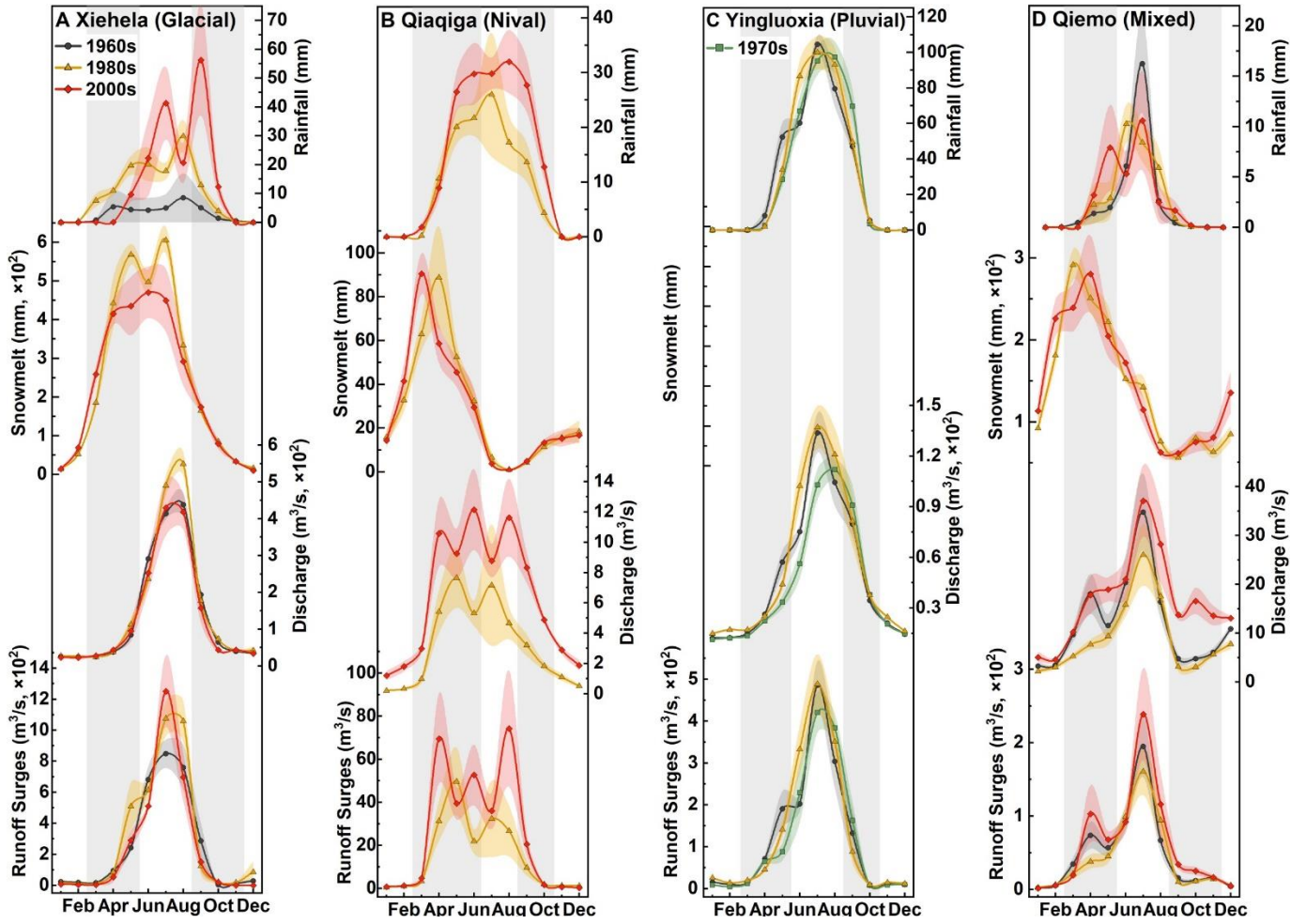


Fig. S2. Changes in the monthly hydroclimatic variables during different periods at Xiehela (panel A, glacial regime), Qiaqiga (panel B, nival regime), Yingluoxia (panel C, pluvial regime), and Qiemo (panel D, mixed regime). The changes in snowmelt are not shown in Yingluoxia due to insufficient snowmelt data before 1987. The shaded areas denote standard deviations. Grey vertical bars denote spring and autumn.

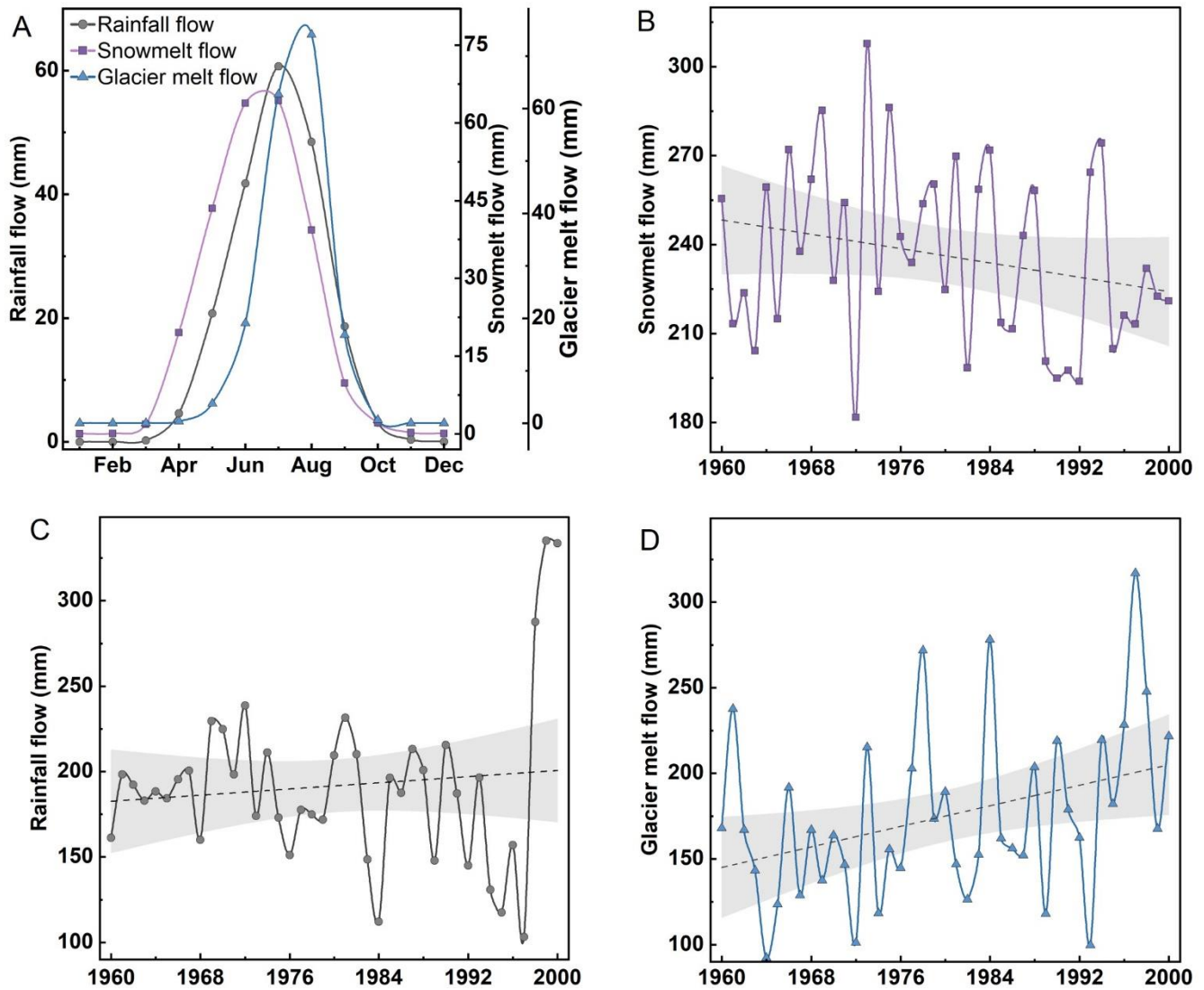
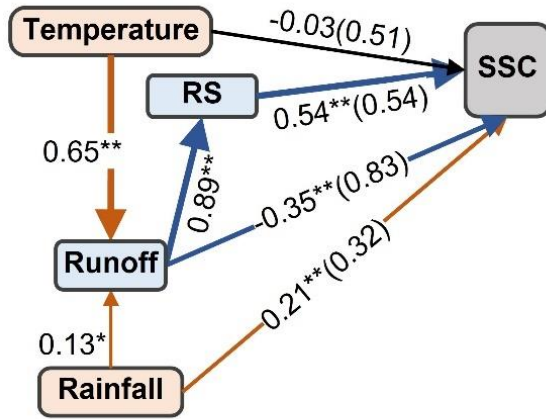
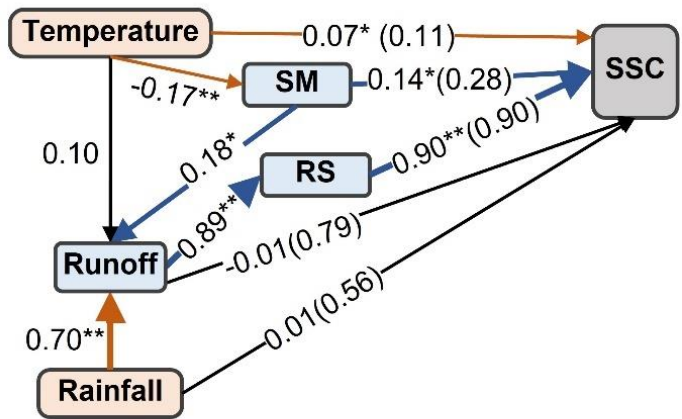


Fig. S3. Monthly pattern and annual trends of runoff components at the glacierized Xiehela watershed based on hydrological simulations from 1960 to 2000. (A) Monthly pattern of runoff components. (B-D) Trends of annual rainfall flow, snowmelt flow and glacier melt flow, respectively. The runoff simulations are based on a hydrological model – the Model of Water Availability in Semi-Arid Environments. Details on model calibration and runoff simulation can be found in ref. (25).

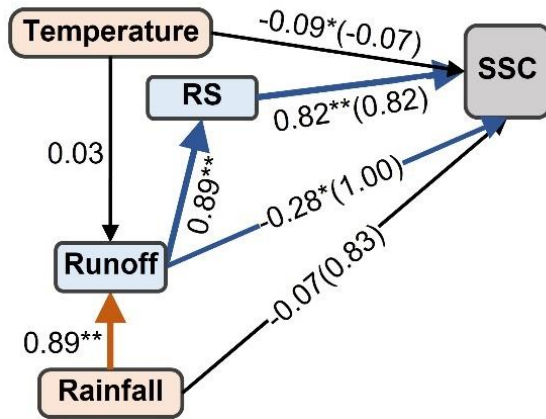
A Xiehela: Glacial regime (R^2 : 0.93)



B Qiaqiga: Nival regime (R^2 : 0.92)



C Yingluoxia: Pluvial regime (R^2 : 0.90)



D Qiemo: Mixed regime (R^2 : 0.82)

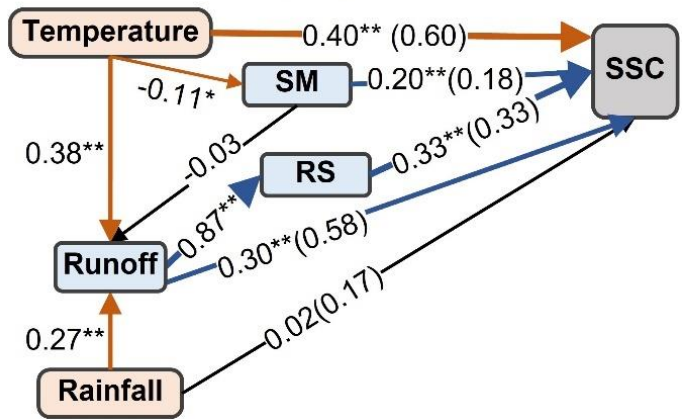


Fig. S4. Partial least squares structural equation model (PLS-SEM) of causal effects among temperature, rainfall, runoff, effective snowmelt (SM), runoff surges (RS), and suspended sediment concentration (SSC) in (A) Xiehela, (B) Qiaqiga, (C) Yingluoxia, (D) Qiemo. Path coefficients are marked above arrows and the significance level $p < 0.05$ and $p < 0.001$ are represented by asterisk * and double-asterisk **, respectively. Total effects of each variable on SSC are labelled in the brackets. The arrows of path coefficients starting from a climatic variable are displayed in orange; the arrows starting from a hydrological variable are displayed in blue; the arrows with insignificant path coefficients are displayed in black. The thickness of arrows indicates the absolute value of path coefficients, with a thicker arrow indicating a higher path coefficient. Coefficient of determination (R^2) of each model is labelled at the top right corner of each panel.

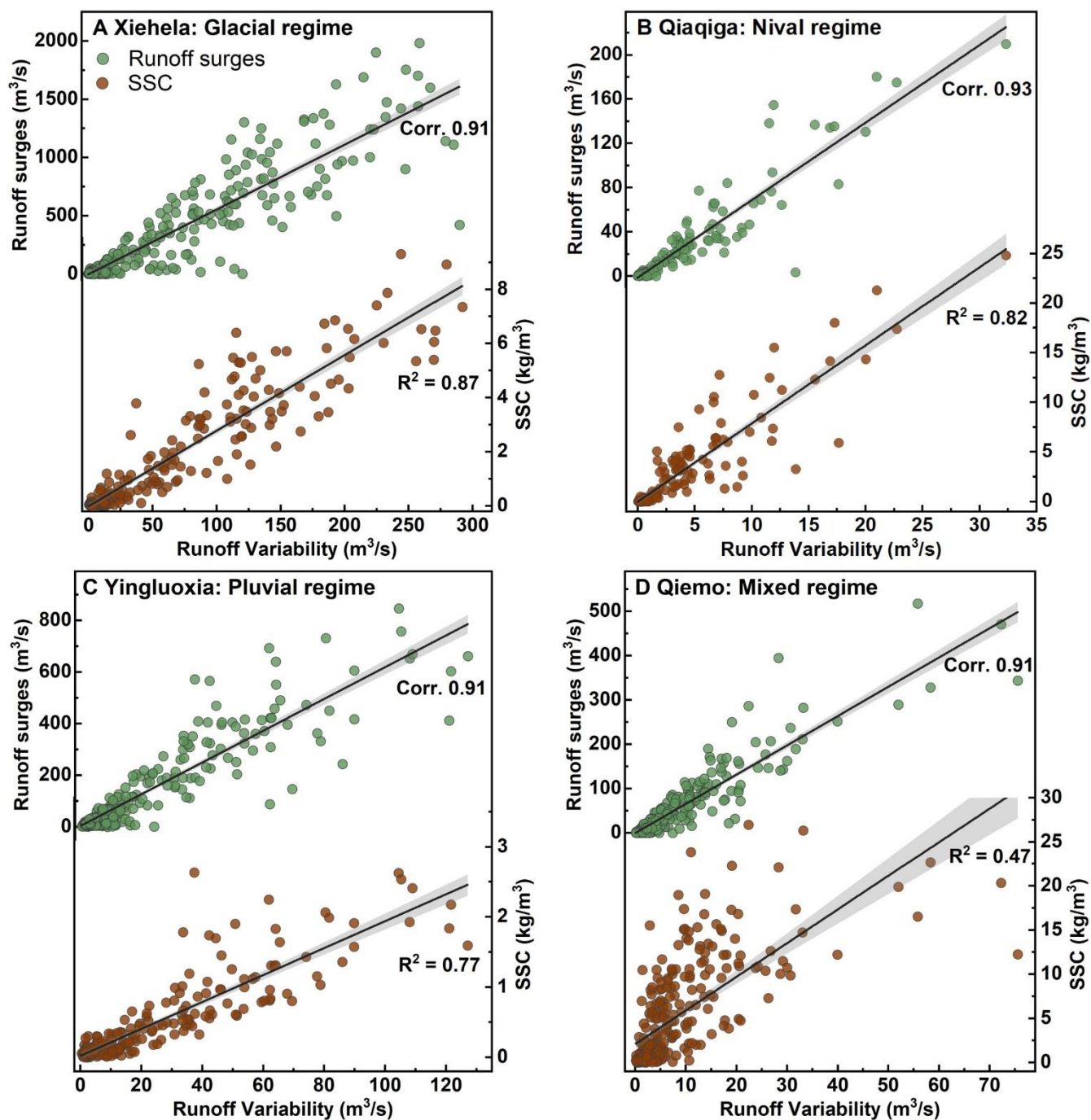


Fig. S5. Relationship between runoff variability, runoff surges and suspended sediment concentration (SSC) at Xiehela (A, glacial regime), Qiaqiga (B, nival regime), Yingluoxia (C, pluvial regime) and Qiemo (D, mixed regime). The black lines denote the fitted linear correlations and the shaded areas indicate the 95% confidence interval.

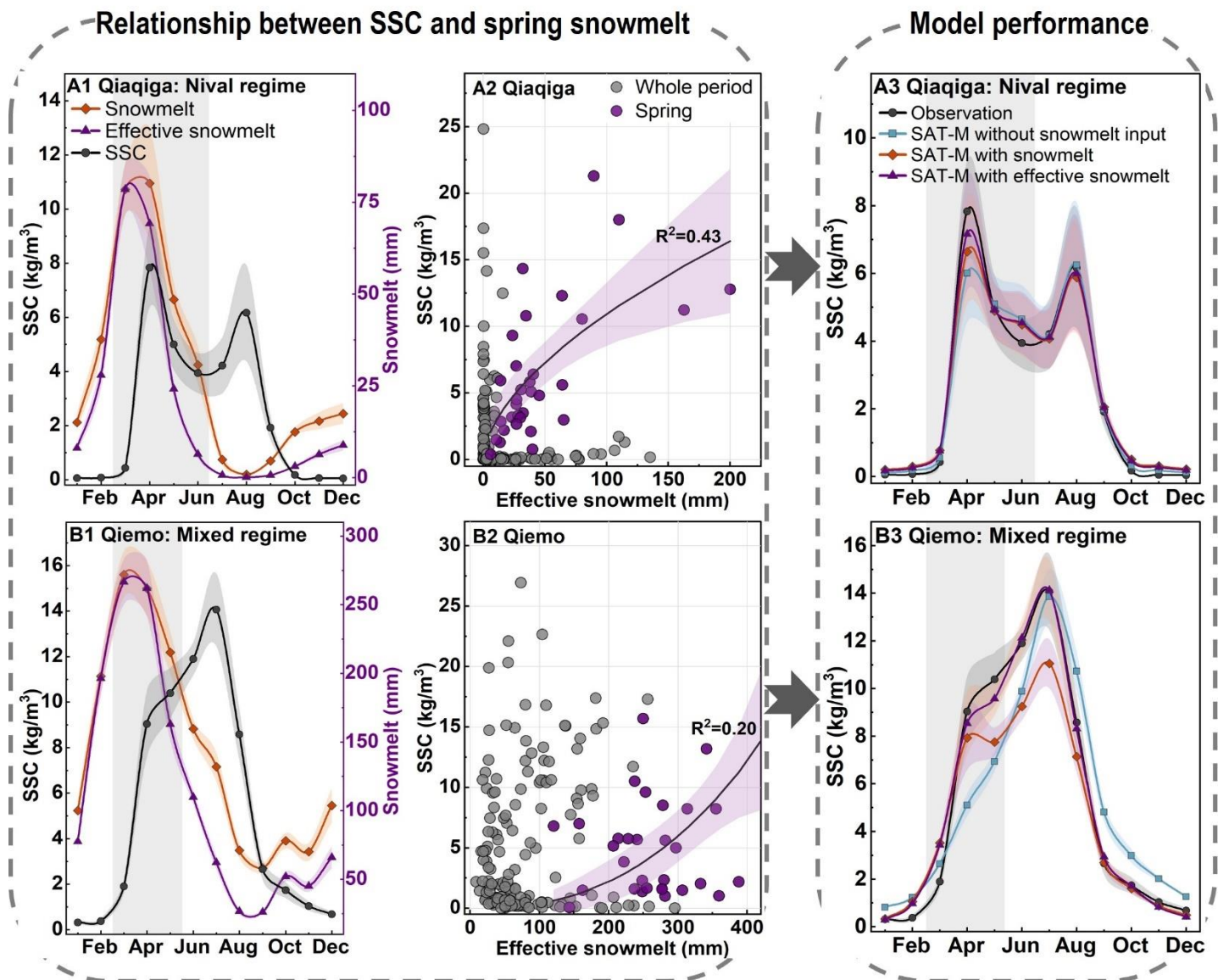


Fig. S6. Monthly patterns of snowmelt and suspended sediment concentration (SSC), best-fit relationships between snowmelt and SSC, and the performance of the SAT-M model with/without snowmelt input at Qiaqiga (A1-A3, nival regime) and Qiemo (B1-B3, mixed regime). Effective snowmelt is constrained by the normalized difference vegetation index (NDVI; details in Methods). The shaded areas denote the standard deviation. Grey vertical bars denote the spring period.

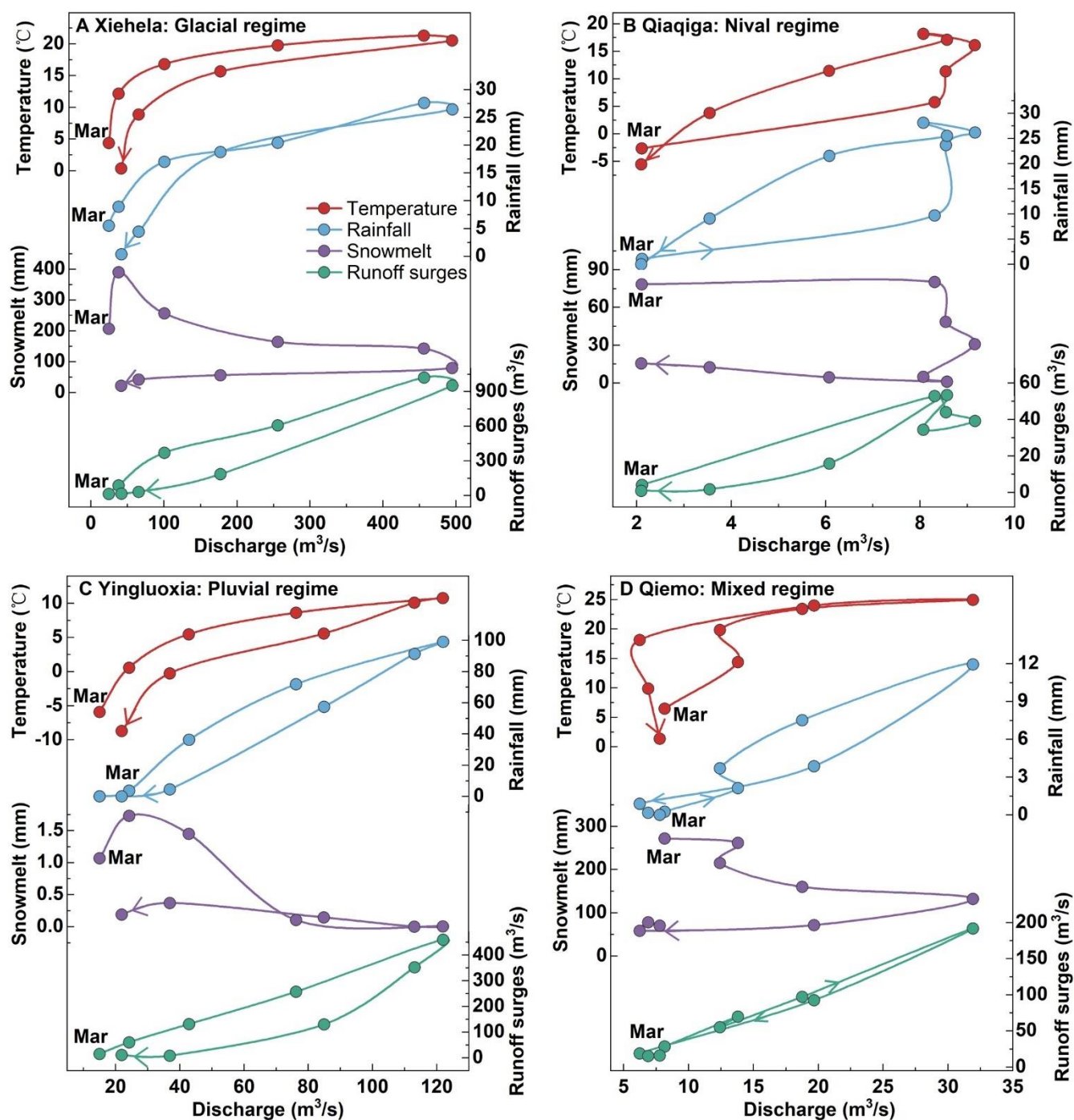


Fig. S7. Hysteresis in hydroclimate variables-runoff relationships at Xiehela (A, glacial regime), Qiaqiga (B, nival regime), Yingluoxia (C, pluvial regime) and Qiemo (D, mixed regime). Ordinate axis shows the monthly average values of hydroclimatic variables from March to November. Observations in winter (December to February) are not shown due to near-zero values of SSC during the frozen period. Arrows indicate directions of hysteresis patterns.

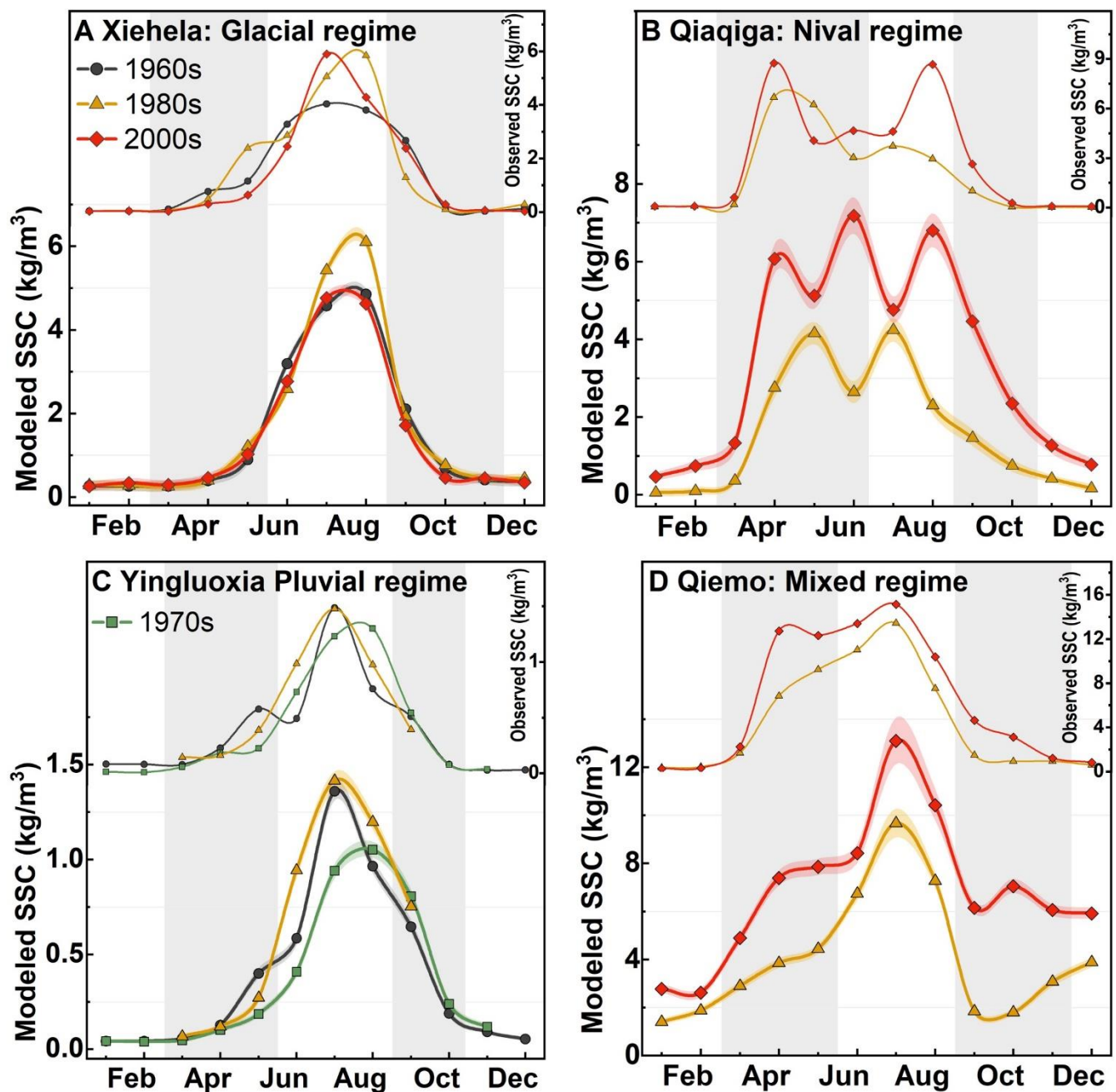


Fig. S8. The poorly reproduced sediment regime shifts yielded by sediment rating curves (lower lines) and observed sediment regime shifts (upper lines) at Xiehela (A, glacial regime), Qiaqiga (B, nival regime), Yingluoxia (C, pluvial regime) and Qiemu (D, mixed regime). The shaded areas are the estimated uncertainty (standard deviation) in rating-curve simulations from ten times cross-validation. Grey vertical bars are seasonal bars denoting the spring and autumn.

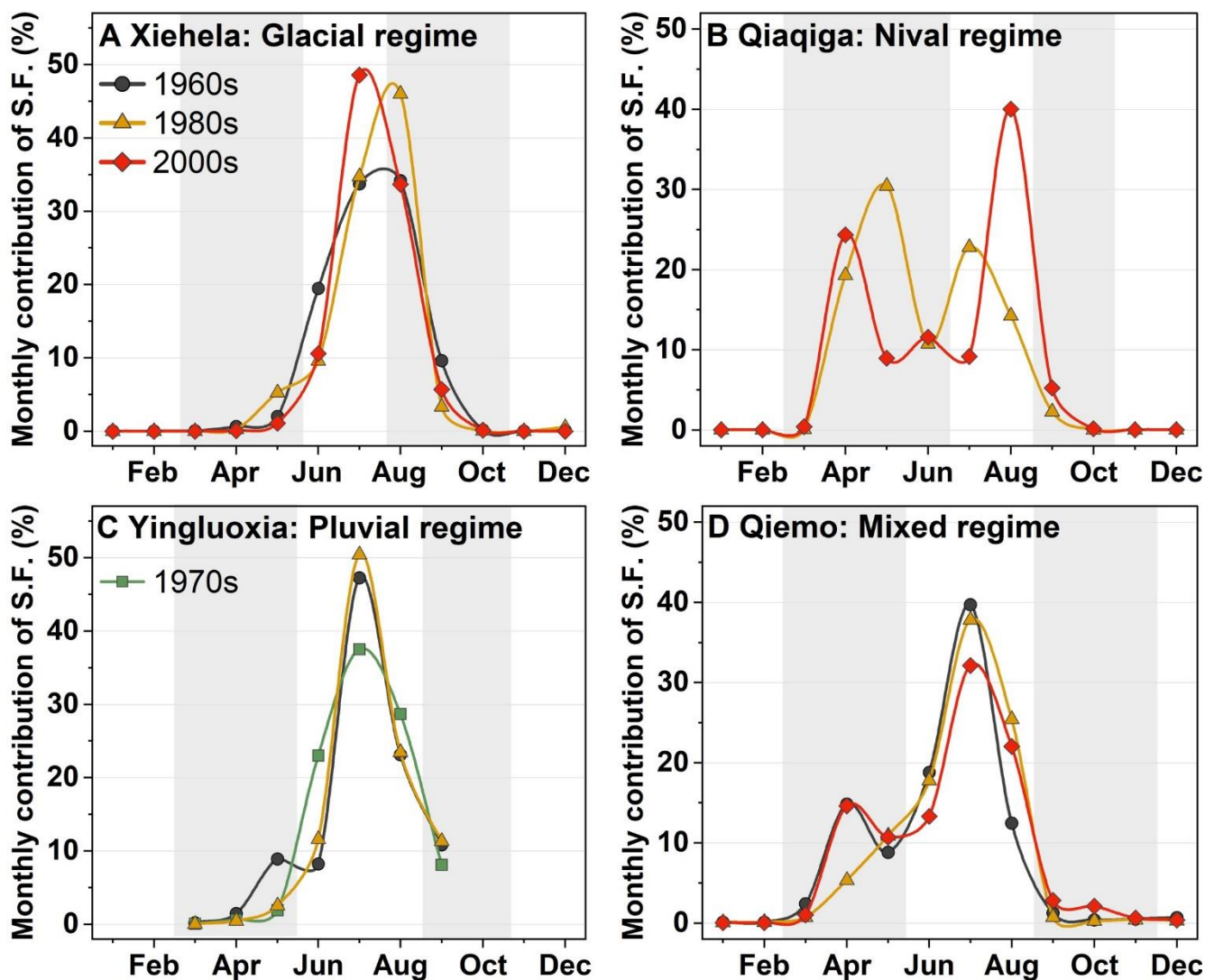


Fig. S9. Monthly contributions (in percentage) of suspended sediment fluxes (S. F.) to the annual total at Xiehela (A, glacial regime), Qiaqiga (B, nival regime), Yingluoxia (C, pluvial regime) and Qiemo (D, mixed regime). Grey vertical bars are seasonal bars denoting the spring and autumn.

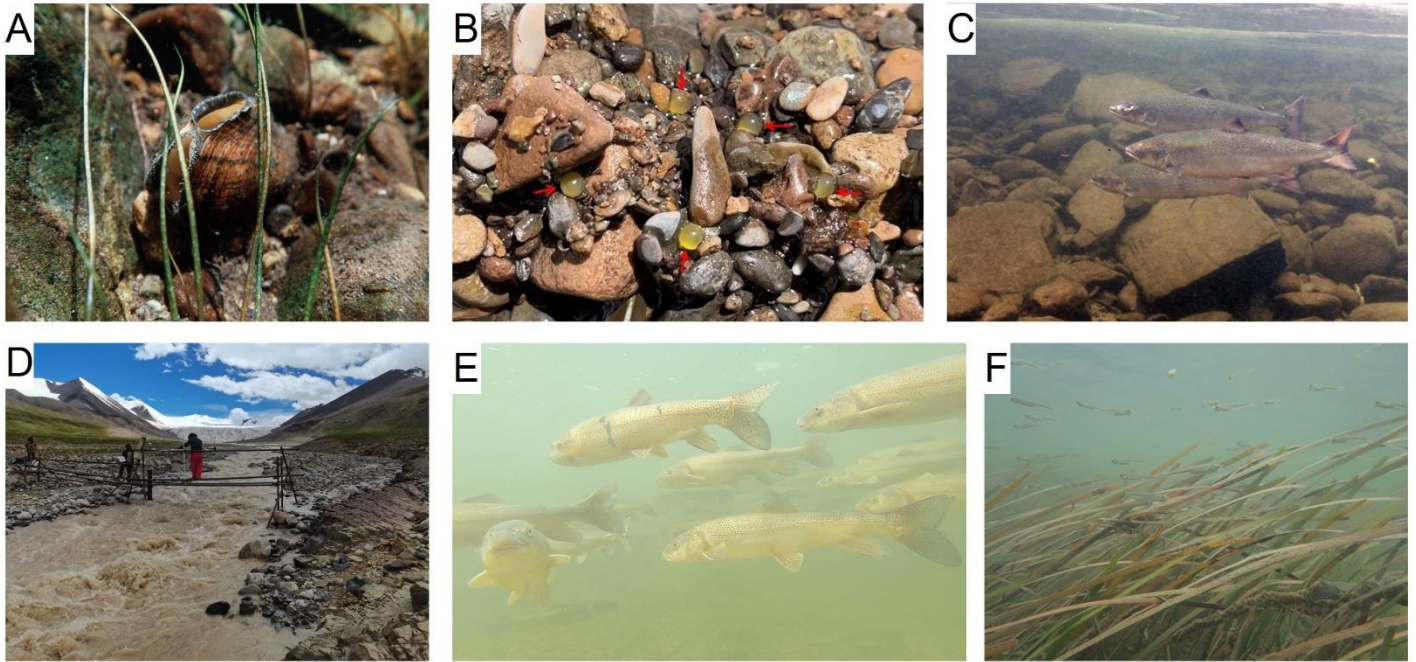


Fig. S10. Impacts of fluvial sediment transport on aquatic ecosystems. (A) A brook floater (a type of benthic macroinvertebrate) filter feeding as it is anchored into the sediment of a stream bottom. Photo courtesy of Ayla Skorupa, US Geological Survey. (B) Naturally reproduced fertilized eggs (round yellow pellets marked by red arrows) of *Schizopygopsis microcephalus* found in spawning ground in rivers on the Tibetan Plateau. Photo courtesy of Y. Zhou. (C) Atlantic salmon live and shelter in the river bottom of the boulder-dominated river. Photo courtesy of NOAA Fisheries. (D) A muddy proglacial river during the summer melting season in a headwater river from the Tibetan Plateau. Photo courtesy of S. Wang. (E) A turbid river during high-flow period affecting the survival and spawning environment of *Schizopygopsis microcephalus*, a medium and large-sized fish endemic to the Tibetan Plateau. Photo courtesy of Y. Zhou. (F) Degraded water quality and turbid water threatens Eelgrass beds throughout the northeastern U.S. Photo courtesy of Eastern Ecological Science Center, US Geological Survey.

Table S1.**Basic information of the four studied cryosphere-fed river basins.**

Station information	Xiehela	Qiaqiga	Yingluoxia	Qiemmo
Hydrological regime	Glacial regime	Nival regime	Pluvial regime	Mixed regime
Location of the hydrological station (longitude, latitude)	79.62, 41.57	75.73, 39.7	100.18, 38.82	85.57, 38.13
Basin area (km ²)	12987	3676	10011	27358
Glacier coverage (%)	18.6	0	0.3	2.1
Permafrost coverage (%)	58	43.8	50.3	66.3
Water flux (km ³ /yr)	4.4	0.2	1.5	0.4
Sediment flux (km ³ /yr)	18.4	2.2	2.2	5.3
Available meteorological station	Aheqi; Akesu	Tuernaote; Kashi; Wuqia	Yeniugou; Qilian	Qiemmo
Observation period	1962-1968; 1978-1989; 2007-2010	1983-1989; 2001- 2003; 2005; 2007- 2011	1964-1987	1964-1973; 1980- 1989; 2001-2003; 2005; 2007-2008

Table S2.

Decadal change rates of hydro-climatic variables. For monthly trends, the decadal change rates are calculated by fitting a linear regression model based on the available monthly data (e.g., removal of the data-gap years). The change rates in spring, summer and autumn are the weighted average of monthly change rates. Annual change rates are calculated from mean annual data. ** and * mark statistically significant trends at 5% and 10% significance levels, respectively. SSC is suspended sediment concentration.

Unit: %/10yr	SSC	Temperature	Rainfall	Extreme rainfall days	Snowmelt	Discharge	Runoff surges
Xiehela (glacial regime)							
Mar	** -25.2	** 7.0	4.9	18.9	** 15.4	0.6	** -20.7
Apr	-11.6	** 2.5	-1.8	-12.8	-1.5	2.9	-1.4
May	-11.2	* 1.3	* -2.4	-1.5	** -12.3	1.5	0.9
Jun	** -6.6	** 1.6	0.0	0.9	2.4	-3.2	* -6.5
Jul	9.1	** 1.1	* 10.6	** 18.2	** -11.0	4.1	** 13.0
Aug	2.1	** 1.3	3.3	2.7	-9.8	-0.5	-2.3
Sep	-2.7	** 1.8	** 25.9	** 26.5	* 5.6	-4.3	* -24.9
Oct	* 29.4	** 3.6	** 31.9	34.4	2.6	** -6.4	9.4
Nov	7.1	** 76.8	-3.3	—	-2.3	* -4.3	-7.8
Spring	** -11.8	** 2.5	* -0.9	-0.7	** -3.5	1.7	** -4.4
Summer	** 1.8	** 1.4	* 5.1	** 8.4	** -5.4	0.1	** 2.8
Autumn	* 0.1	** 4.6	** 26.6	** 28.0	* 3.7	** -4.8	* -21.4
Unit	%/10yr	°C/10yr	mm/10yr	%/10yr	%/10yr	%/10yr	%/10yr
Annual	* 3.9	** 0.36	* 12.1	* 9.7	** -3.3	** 5.1	0.84
Qiaqiga (nival regime)							
Mar	** 59.0	** 31.3	30.4	-57.1	** 17.1	** 43.5	29.5
Apr	10.8	** 13.9	-12.5	-37.0	* -18.1	* 30.6	* 33.4
May	-22.2	** 6.6	8.3	9.9	-11.5	8.1	-10.2
Jun	11.5	** 4.5	9.0	27.2	-8.0	* 31.4	* 30.6
Jul	1.0	* 1.8	13.1	6.7	-15.7	9.5	7.0
Aug	23.5	* 1.7	* 26.0	26.5	-2.4	26.0	22.2
Sep	** 47.3	* 2.7	** 42.8	** 59.9	3.5	** 43.3	** 40.7
Oct	** 70.9	** 19.2	** 35.0	** 56.3	9.2	** 41.0	5.4
Spring	** 2.5	** 8.8	5.7	9.6	* -4.5	** 25.0	* 18.8
Summer	14.4	* 1.7	* 19.0	16.3	-13.3	18.0	16.1
Autumn	** 49.2	** 6.7	** 39.8	** 58.5	7.7	** 42.4	** 37.4
Unit	%/10yr	°C/10yr	mm/10yr	%/10yr	%/10yr	%/10yr	%/10yr
Annual	10.0	** 0.52	** 25.6	* 20.6	-1.7	** 27.6	16.6
Yingluoxia (pluvial regime)							
Mar	* 44.4	-6.9	-53.5	—	—	** 10.3	** 27.6
Apr	-19.2	-75.8	** -92.4	* -240.0	—	1.2	** -24.0
May	-26.1	-2.3	* -21.5	* -68.9	—	-12.6	-21.5
Jun	* 42.2	2.2	** 24.7	* 39.7	—	** 28.6	* 36.2

Jul	-6.8	-1.8	-2.5	-16.1	—	1.0	-4.0
Aug	11.2	-2.7	7.7	10.0	—	7.2	5.9
Sep	-8.7	-3.1	-1.2	-5.0	—	-2.2	-15.1
Oct	-13.7	51.1	-29.9	—	—	3.5	-3.4
Spring	*-14.2	-8.2	**28.2	*-79.6	—	**4.3	**18.6
Summer	*19.0	-0.8	**11.1	*11.9	—	**14.2	*15.8
Autumn	-9.4	5.4	-3.2	-5.0	—	-0.5	-14.4
Unit	%/10yr	°C/10yr	mm/10yr	%/10yr	%/10yr	%/10yr	%/10yr
Annual	6.4	0.05	5.5	3.6	—	*6.0	2.2
Qiuemo (mixed regime)							
Mar	0.6	**5.3	-10.9	28.7	-4.0	3.1	-16.1
Apr	*13.7	**1.7	10.7	22.4	1.5	-7.0	1.9
May	*11.3	**1.3	**40.1	**60.9	*-8.0	**17.0	3.7
Jun	2.6	**2.1	4.4	-5.6	1.1	-0.5	0.2
Jul	5.1	**2.0	*-19.5	**30.4	-4.5	2.4	6.6
Aug	*14.3	**1.3	-1.8	-2.2	*-8.6	*17.1	9.6
Sep	**27.2	**2.2	**36.4	**109.4	-3.6	**46.6	**29.7
Oct	**37.4	**2.9	*45.3	—	-0.3	**49.0	**24.7
Nov	1.7	**29.1	*78.4	*112.0	8.6	**28.5	0.8
Spring	*11.2	**2.0	**27.3	**47.7	*-3.1	**3.6	1.6
Summer	*6.4	**1.8	*-7.3	**15.7	*-3.0	*5.6	5.7
Autumn	**24.9	**3.8	**43.3	**110.3	2.1	**40.5	**18.2
Unit	%/10yr	°C/10yr	mm/10yr	%/10yr	%/10yr	%/10yr	%/10yr
Annual	*7.9	**0.34	0.98	3.7	0.13	3.1	*9.5

Table S3.

Analysis of variance (One-way ANOVA) for seasonal suspended sediment concentration (SSC, kg/m³). ** and * mark the statistically significant changes of seasonal SSC at 5% and 10% significance levels, respectively.

Catchment	Group	Mean SSC	Standard Deviation		F Value	Significance
Spring						
Qiaqiga	1980s	4.03	4.13			
	2000s	4.52	4.97	vs 1980s	0.18	0.68
Qiaqiga (April)	1980s	6.66	4.77			
	2000s	8.75	6.87	vs 1980s	0.47	0.51
Qiaqiga (June)	1980s	3.03	1.16			
	2000s	4.65	3.74	vs 1980s	1.21	0.29
Qiemu	1960s	6.00	4.89			
	2000s	9.10	6.91	vs 1960s	3.18	*0.08
Summer						
Xiehela	1960s	3.58	1.18			
	1980s	4.58	1.85	vs 1960s	4.99	**0.03
	2000s	4.21	2.17	vs 1960s	1.20	0.28
Qiaqiga	1980s	3.33	4.07			
	2000s	6.63	6.63	vs 1980s	2.68	*0.10
Yingluoxia	1960s	0.91	0.61			
	1980s	1.14	0.71	vs 1960s	1.24	0.27
Qiemu	1960s	9.79	5.84			
	2000s	12.97	5.23	vs 1960s	3.55	*0.07
Autumn						
Qiaqiga	1980s	0.52	1.08			
	2000s	1.46	1.71	vs 1980s	3.22	*0.08
Qiemu	1960s	1.40	1.26			
	2000s	2.98	1.83	vs 1960s	11.93	**0.01

Table S4.

Description of model functions, overall model performance and model performance in summer. For each station, the suspended sediment concentration SSC_i (kg/m^3) for a given month i can be best estimated by the monthly Sediment-Availability-Transport model (SAT-M, Eq. 5 in the main text) and by the sediment rating curve (RC, Eq. 4 in the main text); Q_i is the monthly discharge (m^3/s); T_i is the monthly average temperature ($^{\circ}\text{C}$); R_i is the monthly rainfall (mm); RS_i is the monthly runoff surges (m^3/s , the sum of the daily discharge increase within a month, see Methods in Main Text for more details); and SM_i is the monthly snowmelt (mm). NSE is Nash-Sutcliffe efficiency coefficient, RE is Relative Error and R^2 is the coefficient of determination. Notably, the terms with parameters calibrated as zero are taken out.

Station	Model	NSE	RE (%)	R ²	Model function	
Xiehela (glacial)	SAT-M	0.92	2.75	0.92	$SSC_i = (0.0685 \times Q_i^{0.2659}) \times (e^{0.07 \times T_i + 0.013 \times R_i} + 0.0077 \times RS_i)$	
	RC	0.84	7.75	0.83	$SSC_i = 0.001 \times Q_i^{1.101}$	
Qiaqiga (nival)	SAT-M	0.93	3.34	0.93	$SSC_i = (1.4 \times 10^{-7} \times SM_i^{2.819}) \times (e^{0.048 \times T_i + 0.0046 \times R_i} + 0.419 \times RS_i)$	
	RC	0.71	6.22	0.72	$SSC_i = 0.354 \times Q_i^{1.188}$	
Yingluoxia (pluvial)	SAT-M	0.92	-0.93	0.90	$SSC_i = (0.021 \times Q_i^{0.330}) \times (e^{0.011 \times R_i} + 0.023 \times RS_i)$	
	RC	0.83	-2.87	0.78	$SSC_i = 0.001 \times Q_i^{1.455}$	
Qimeo (mixed)	SAT-M	0.90	0.74	0.90	$SSC_i = (0.153 \times Q_i^{0.337} + 0.0065 \times SM_i^{0.904}) \times (e^{0.103 \times T_i} + 0.0264 \times RS_i)$	
	RC	0.60	-2.79	0.62	$SSC_i = 0.800 \times Q_i^{0.780}$	
Station	Percentage difference between observations and simulations by SAT-M in summer			Percentage difference between observations and simulations by RC in summer		
	%	F-test	P-value	%	F-test	P-value
Xiehela (glacial)	0.9	0.019	0.89	5.3	0.61	0.44
Qiaqiga (nival)	-2.6	0.009	0.92	-9.7	0.15	0.70
Yingluoxia (pluvial)	1.2	0.016	0.90	-8.6	0.87	0.35
Qimeo (mixed)	0.0	0.001	1.00	-22.5	6.82	0.01

Table S5.**Random selection of 10 years for each cross-validation.**

Year	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9	Run 10
Xiehela (glacial regime)										
Year 1	1963	1963	1964	1962	1962	1962	1964	1964	1963	1963
Year 2	1967	1966	1966	1964	1963	1963	1966	1965	1966	1966
Year 3	1978	1967	1979	1978	1964	1967	1968	1966	1968	1967
Year 4	1981	1978	1981	1981	1965	1968	1980	1980	1978	1980
Year 5	1983	1981	1982	1982	1968	1978	1981	1982	1981	1982
Year 6	1985	1982	1985	1983	1979	1980	1884	1983	1986	1983
Year 7	1986	1985	1988	1985	1980	1981	1986	1986	1987	1985
Year 8	1987	1986	2008	2007	1981	1982	1989	1987	1988	1989
Year 9	2007	2009	2009	2008	1985	1989	2007	2007	2007	2007
Year 10	2010	2010	2010	2009	1986	2009	2009	2009	2010	2008
Qiaqiga (nival regime)										
Year 1	1983	1983	1983	1983	1983	1983	1985	1983	1983	1983
Year 2	1984	1985	1986	1984	1984	1985	1986	1986	1985	1984
Year 3	1987	1988	1987	1987	1985	1986	1987	1987	1987	1986
Year 4	1988	1989	1988	1988	1988	1987	1988	1988	1989	1988
Year 5	1989	2001	1989	2001	2001	1989	1989	1989	2001	1989
Year 6	2002	2005	2001	2002	2003	2001	2001	2002	2005	2001
Year 7	2005	2007	2002	2007	2008	2002	2003	2003	2008	2002
Year 8	2007	2008	2007	2008	2009	2003	2007	2005	2009	2007
Year 9	2008	2010	2010	2010	2010	2007	2008	2008	2010	2009
Year 10	2010	2011	2011	2011	2011	2009	2011	2010	2011	2010
Yingluoxia (pluvial regime)										
Year 1	1966	1965	1964	1966	1965	1964	1968	1965	1966	1966
Year 2	1967	1966	1968	1970	1966	1965	1969	1966	1967	1969
Year 3	1968	1967	1969	1976	1967	1966	1970	1971	1970	1970
Year 4	1971	1969	1971	1978	1970	1967	1974	1972	1972	1971
Year 5	1976	1970	1973	1979	1975	1970	1975	1973	1973	1974
Year 6	1979	1971	1979	1980	1981	1976	1981	1976	1975	1977
Year 7	1982	1972	1980	1983	1983	1979	1984	1977	1980	1980
Year 8	1983	1974	1981	1984	1984	1981	1985	1980	1983	1983
Year 9	1986	1980	1983	1985	1985	1983	1986	1984	1984	1984
Year 10	1987	1984	1987	1986	1987	1984	1987	1987	1987	1987
Qiemu (mixed regime)										
Year 1	1981	1980	1981	1980	1983	1980	1981	1981	1981	1981
Year 2	1982	1981	1982	1981	1984	1981	1983	1982	1982	1986
Year 3	1984	1985	1983	1982	1985	1982	1985	1983	1984	1987
Year 4	1985	1986	1985	1983	1986	1984	1986	1984	1986	1988

Year 5	1986	1987	1986	1986	1987	1987	1988	1985	1987	1989
Year 6	1987	1988	1987	1988	1988	1989	1989	1986	1988	2001
Year 7	1989	1989	1988	1989	1989	1989	2002	1988	2001	2002
Year 8	2001	2002	2002	2003	2003	2001	2003	1989	2002	2003
Year 9	2003	2005	2003	2005	2007	2005	2007	2003	2007	2005
Year 10	2007	2007	2005	2007	2008	2007	2008	2007	2008	2007

Table S6.

Evaluation of model performance in ten-time cross-validation. SAT-M is the monthly Sediment-Availability-Transport model; RC is the sediment rating curve. NSE is the Nash-Sutcliffe efficiency coefficient, RE is Relative Error and R^2 is the coefficient of determination. The summary records the mean values of the indicator $\pm$ standard deviations.

Model run	SAT-M						RC					
	Calibration			Validation			Calibration			Validation		
	NSE	RE	R^2	NSE	RE	R^2	NSE	RE	R^2	NSE	RE	R^2
Xiehela (glacial regime)												
Run 1	0.94	2.56%	0.94	0.90	-3.55%	0.90	0.85	4.83%	0.84	0.83	-2.58%	0.82
Run 2	0.93	2.77%	0.92	0.91	-2.99%	0.92	0.82	5.63%	0.81	0.84	10.03%	0.86
Run 3	0.90	0.19%	0.93	0.91	-5.01%	0.92	0.82	-3.54%	0.84	0.83	9.45%	0.82
Run 4	0.94	2.83%	0.94	0.90	-3.80%	0.90	0.85	4.91%	0.84	0.83	-4.55%	0.83
Run 5	0.91	2.50%	0.91	0.92	1.60%	0.91	0.80	6.21%	0.80	0.86	-0.14%	0.85
Run 6	0.92	2.32%	0.91	0.91	8.87%	0.91	0.79	7.04%	0.78	0.87	22.53%	0.89
Run 7	0.91	2.72%	0.91	0.92	-3.02%	0.92	0.70	-6.94%	0.73	0.79	-2.29%	0.83
Run 8	0.91	2.66%	0.91	0.91	-2.84%	0.90	0.79	5.38%	0.78	0.86	-4.95%	0.87
Run 9	0.93	2.17%	0.92	0.91	0.70%	0.92	0.70	-2.63%	0.77	0.78	-7.33%	0.80
Run 10	0.93	1.85%	0.92	0.91	2.08%	0.90	0.74	6.00%	0.74	0.81	5.33%	0.80
Summary	0.92±0.004	2.26%±0.24%	0.92±0.003	0.91±0.002	-0.80%±1.26%	0.91±0.003	0.79±0.02	2.69%±1.51%	0.79±0.01	0.83±0.01	2.55%±2.78%	0.84±0.01
Qiaqiga (nival regime)												
Run 1	0.93	3.13%	0.93	0.90	3.07%	0.90	0.70	7.14%	0.70	0.72	-1.80%	0.74
Run 2	0.93	3.09%	0.93	0.92	-4.74%	0.92	0.78	-0.24%	0.78	0.52	-7.73%	0.59
Run 3	0.92	5.72%	0.92	0.94	13.02%	0.94	0.70	6.50%	0.71	0.72	24.75%	0.74
Run 4	0.91	2.21%	0.91	0.89	0.72%	0.89	0.72	7.60%	0.72	0.70	-3.12%	0.70
Run 5	0.92	1.33%	0.92	0.93	-4.70%	0.93	0.73	4.06%	0.73	0.68	-2.11%	0.68
Run 6	0.93	-4.29%	0.94	0.91	20.94%	0.94	0.72	8.37%	0.72	0.66	45.84%	0.74
Run 7	0.93	1.21%	0.93	0.93	5.40%	0.93	0.73	8.15%	0.74	0.68	12.75%	0.68
Run 8	0.93	3.37%	0.93	0.89	18.10%	0.90	0.67	6.95%	0.68	0.77	27.81%	0.82
Run 9	0.90	3.07%	0.90	0.91	-3.65%	0.91	0.74	1.79%	0.74	0.65	-12.54%	0.67
Run 10	0.91	-1.04%	0.92	0.90	11.38%	0.92	0.74	3.44%	0.74	0.57	40.31%	0.73
Summary	0.92±0.003	1.78%±0.83%	0.92±0.003	0.91±0.005	5.95%±2.84%	0.92±0.01	0.72±0.01	5.38%±0.89%	0.73±0.01	0.67±0.02	12.42%±6.30%	0.71±0.02
Yingluoxia (pluvial regime)												
Run 1	0.95	-2.67%	0.94	0.89	-2%	0.86	0.86	0.04%	0.82	0.80	-0.76%	0.75
Run 2	0.93	0.42%	0.92	0.91	-11%	0.90	0.84	-1.80%	0.82	0.82	-9.28%	0.76
Run 3	0.95	-0.82%	0.94	0.89	1%	0.87	0.84	1.33%	0.80	0.82	2.69%	0.76
Run 4	0.92	-0.52%	0.89	0.92	-11%	0.91	0.85	-2.64%	0.78	0.80	-16.80%	0.79
Run 5	0.92	-1.34%	0.90	0.92	3%	0.89	0.82	-0.86%	0.78	0.83	0.10%	0.78

Run 6	0.94	-1.40%	0.93	0.87	-2%	0.83	0.85	-0.27%	0.82	0.80	-3.29%	0.74
Run 7	0.91	-0.93%	0.89	0.92	-6%	0.91	0.77	-0.71%	0.70	0.86	-2.80%	0.83
Run 8	0.94	3.41%	0.92	0.90	0%	0.88	0.86	-2.57%	0.81	0.81	-7.25%	0.76
Run 9	0.93	1.05%	0.91	0.91	6%	0.89	0.85	-0.81%	0.80	0.81	8.50%	0.76
Run 10	0.94	0.06%	0.93	0.90	-8%	0.88	0.85	0.20%	0.81	0.81	-4.65%	0.76
Summary:	0.93±0.004	-0.27%±0.50%	0.92±0.01	0.9±0.01	-3.05%±1.78%	0.88±0.01	0.84±0.01	0.81%±0.375%	0.79±0.011	0.82±0.01	3.35%±2.07%	0.77±0.01
Qiero (mixed regime)												
Run 1	0.86	1.15%	0.87	0.90	1.65%	0.89	0.60	3.04%	0.60	0.64	13.94%	0.65
Run 2	0.90	2.47%	0.90	0.89	0.09%	0.89	0.67	1.92%	0.65	0.54	-7.50%	0.59
Run 3	0.90	0.91%	0.90	0.88	-1.72%	0.87	0.67	2.45%	0.67	0.50	7.50%	0.47
Run 4	0.90	0.73%	0.90	0.89	-3.30%	0.90	0.66	2.63%	0.65	0.56	-3.62%	0.57
Run 5	0.90	1.78%	0.91	0.87	-11.52%	0.89	0.58	0.81%	0.58	0.64	-8.28%	0.62
Run 6	0.89	0.73%	0.88	0.90	4.27%	0.91	0.63	3.12%	0.58	0.67	1.67%	0.68
Run 7	0.90	1.60%	0.90	0.87	-4.98%	0.87	0.65	2.18%	0.65	0.55	-10.85%	0.53
Run 8	0.88	1.22%	0.88	0.92	-4.76%	0.91	0.62	1.69%	0.62	0.62	9.42%	0.60
Run 9	0.88	1.43%	0.88	0.88	1.36%	0.91	0.63	2.96%	0.63	0.55	5.61%	0.61
Run 10	0.90	1.54%	0.91	0.87	3.63%	0.86	0.66	4.21%	0.66	0.45	-25.44%	0.49
Summary:	0.89±0.004	1.36%±0.16%	0.89±0.004	0.89±0.005	-1.53%±1.44%	0.89±0.01	0.64±0.01	2.5%±0.28%	0.63±0.01	0.57±0.02	1.76%±3.53%	0.58±0.02

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