EGU2020

Effects of climate and LULC variables on runoff and sediment discharge: a comprehensive evaluation

Huilan Zhang, CC Meng, YJ Wang, YQ Wang， M Li

Beijing Forestry University

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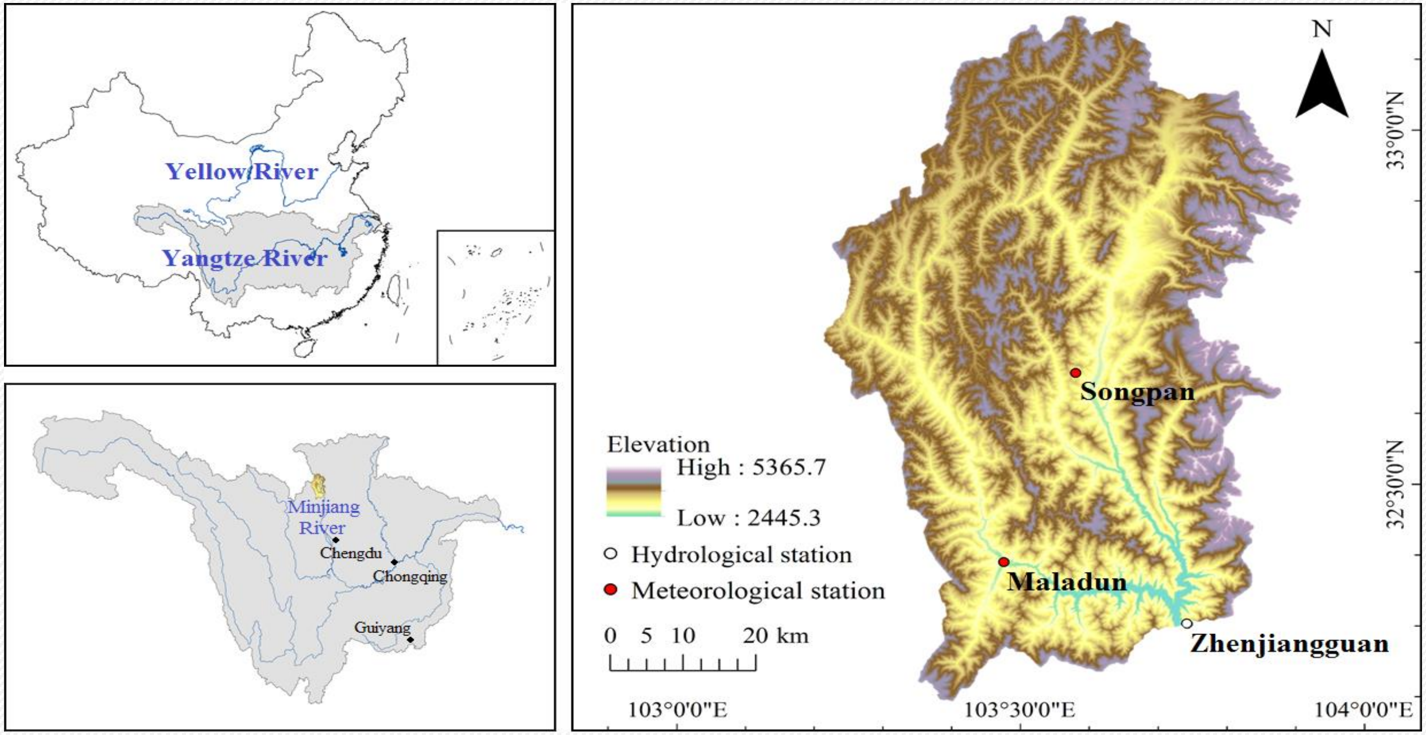
1 Scientific issue

- **Responses of hydrological variations to climate change and Land Use and Land Coverage(LULC) variables analyzed in a comprehensive manner.**

Climate change

Land use and land coverage

2 Study area



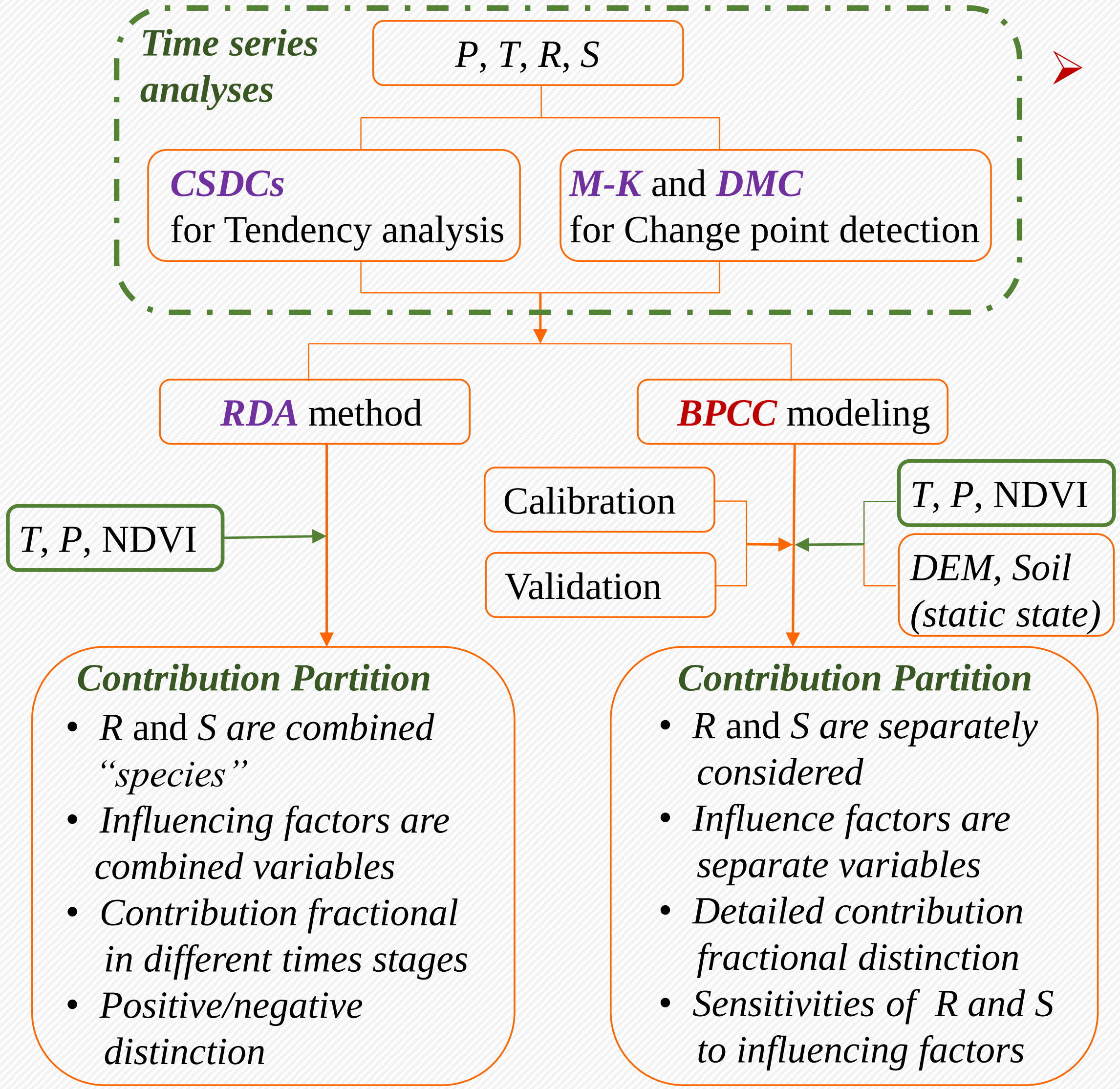
- **Source watershed of runoff and sediment into the Three Gorges Reservoir;**
- **Featured by significant LULC changes in the local hydrological environment over last decades;**
- **Very few terraces, dams or reservoirs were constructed.**

⇨

- **Significance in the change of runoff and sediment discharges**
- **Determinant elements:**
  - ✓ **Climate change**
  - ✓ **LULC variables**

3 Methodology – comprehensive evaluation

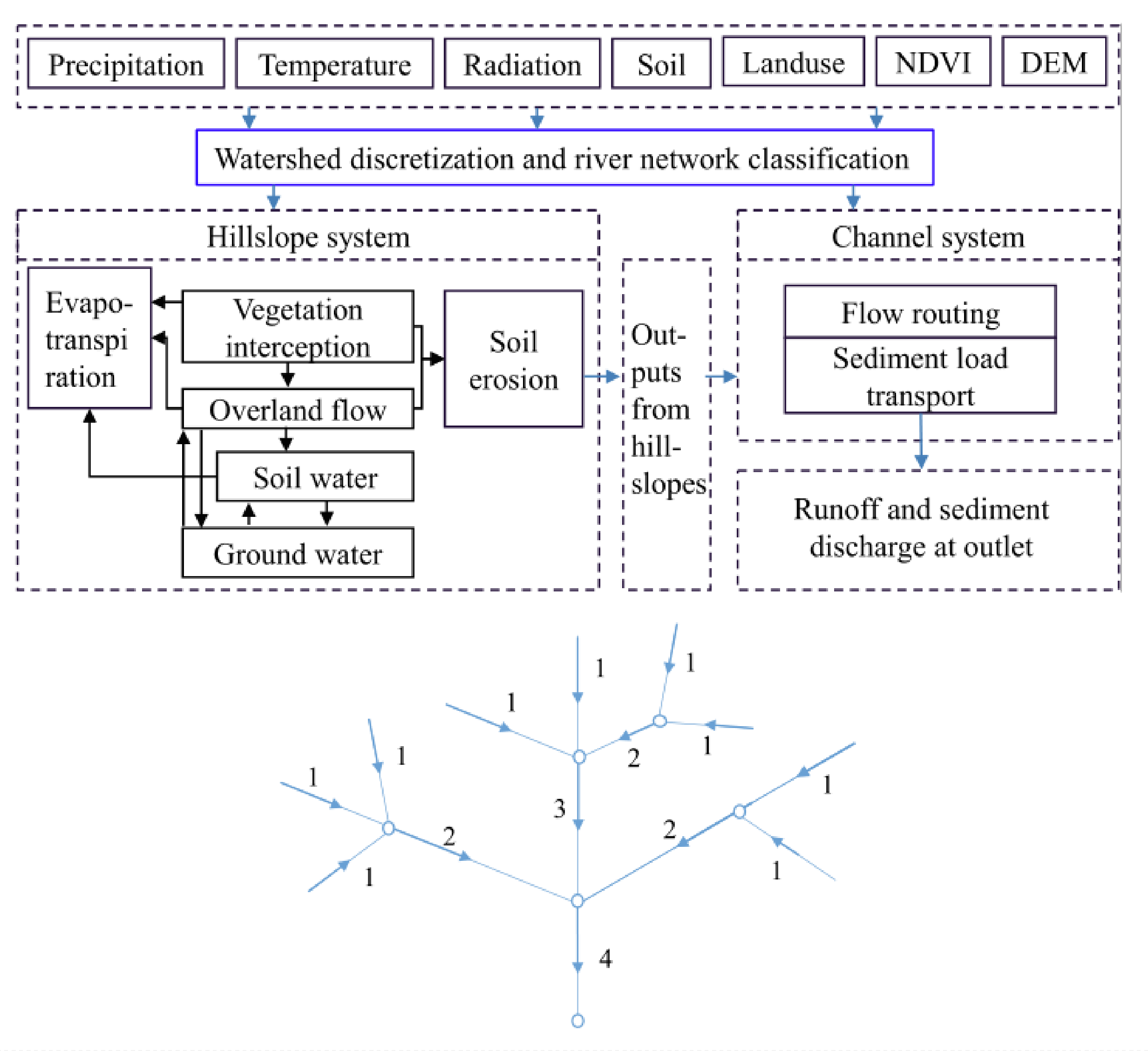
- **Statistical methods:**
  - ✓ CSDCs: Cumulative Standard Deviation Curves
  - ✓ M-K: The rank-based Mann-Kendall test
  - ✓ DMC: Double Mass Curve
  - ✓ RDA: Redundancy Analysis



Schematic diagram of methodology

- **Self-developed Hydrologic-based modeling:**
  - ✓ BPCC fully-distributed Basic Pollution Calculation Center

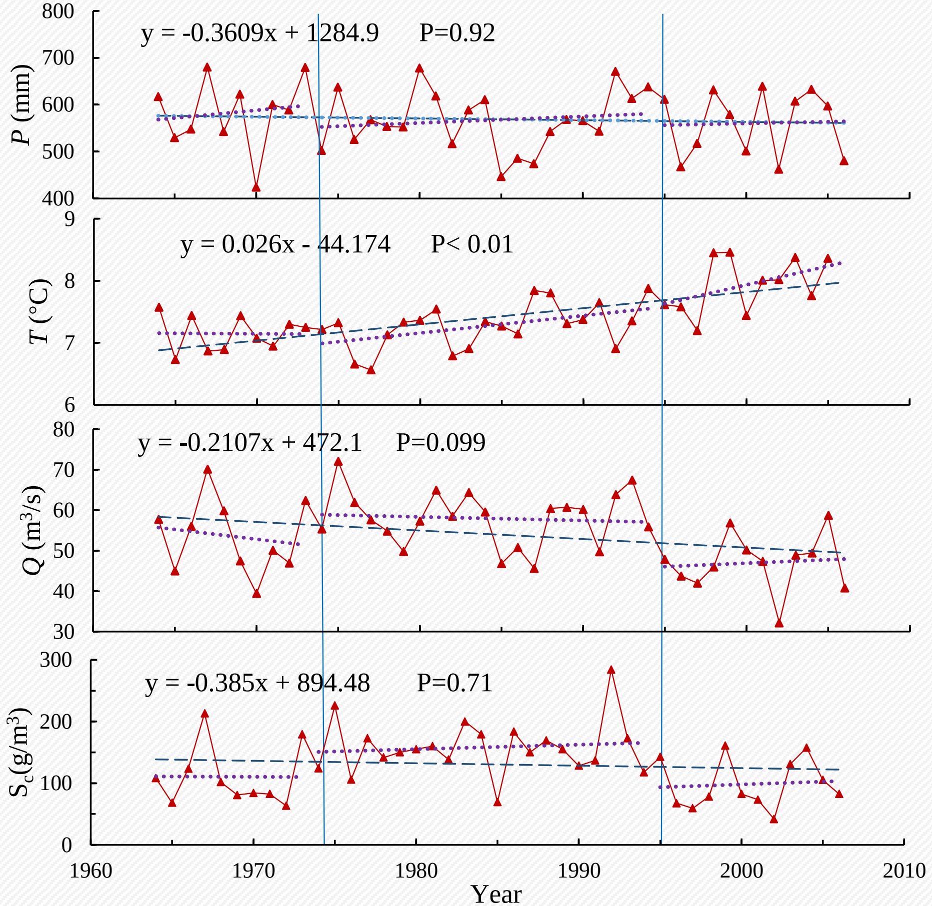
3 Methodology – comprehensive evaluation



Schematic diagram of BPCC structure and the “+1” grading method of river network.

4 Results

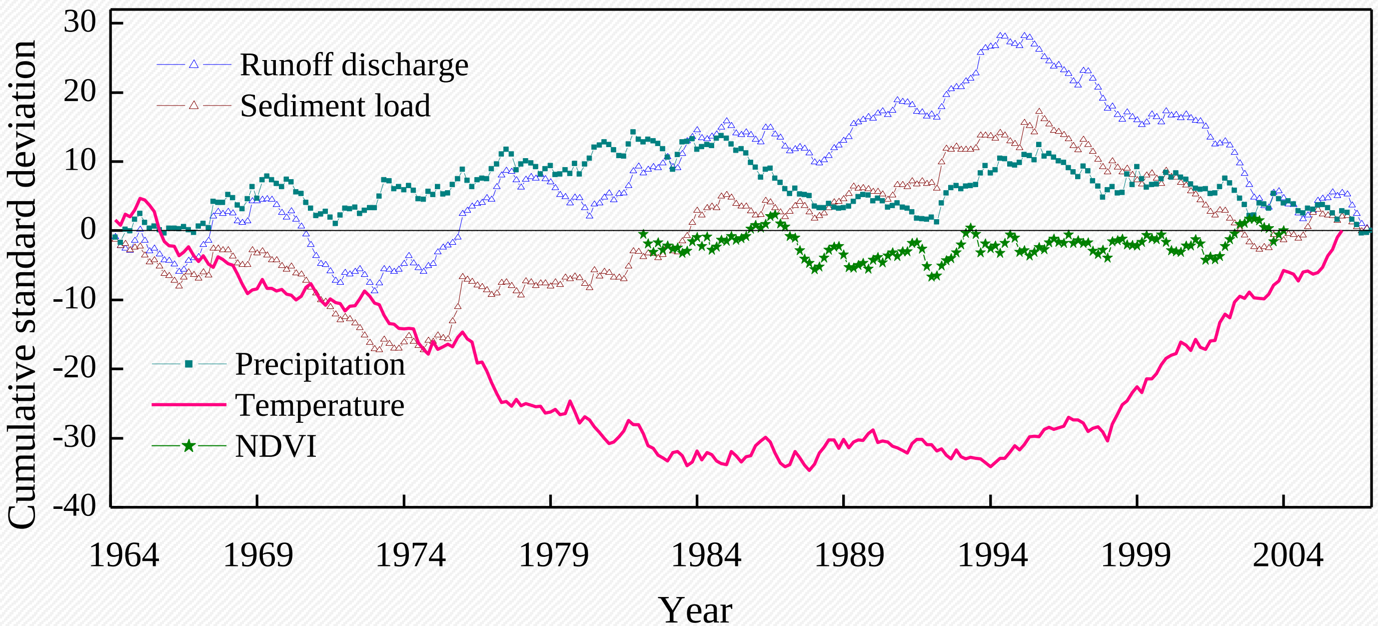
(1) Variations of hydro-meteorological components



Tendency scheme analyses

4 Results

(1) Variations of hydro-meteorological components

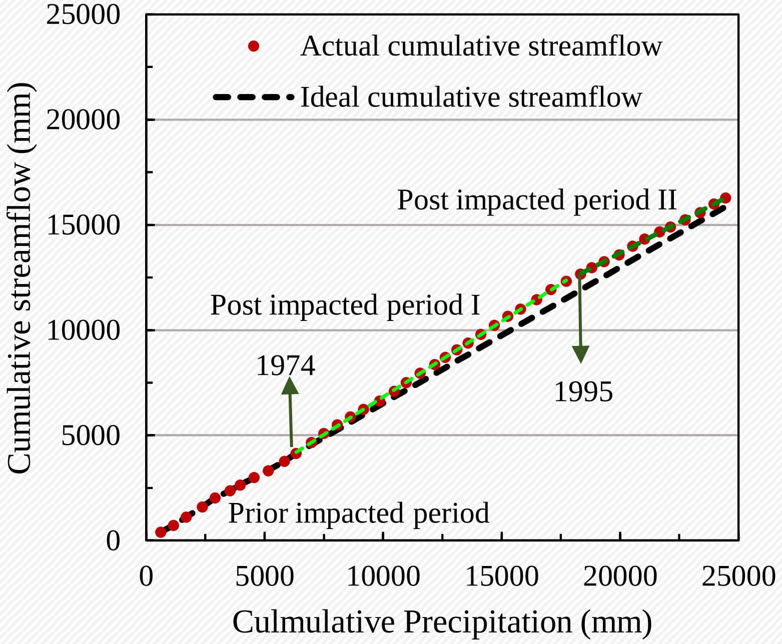


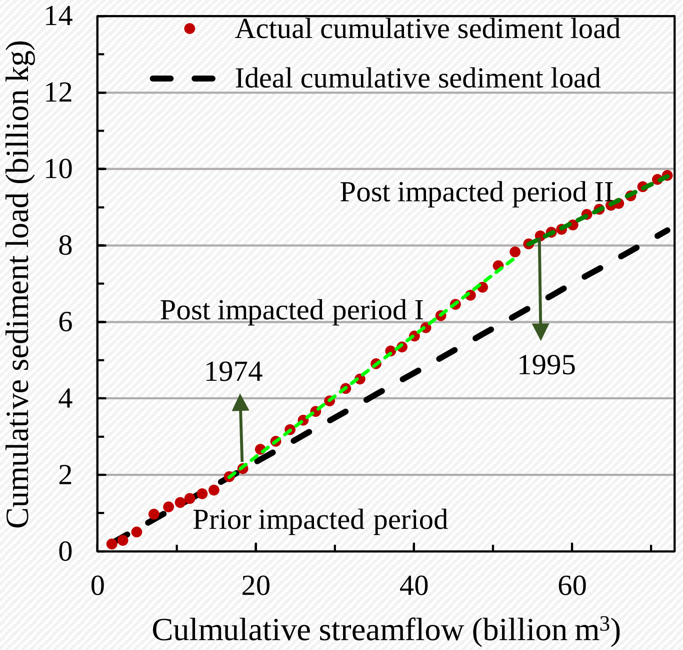
The CSDCs analyses

- Drop(1964-1974)-rise(1975-1994)-drop(1995-2003) scheme of streamflow and sediment discharge;
- The inconsistency of inflection points between stream-sediment discharges and climate variables (P, T) and LULC(Land Use and NDVI) reflects magnitudes of attributions vary according to different time stages.

4 Results

(1) Variations of hydro-meteorological components



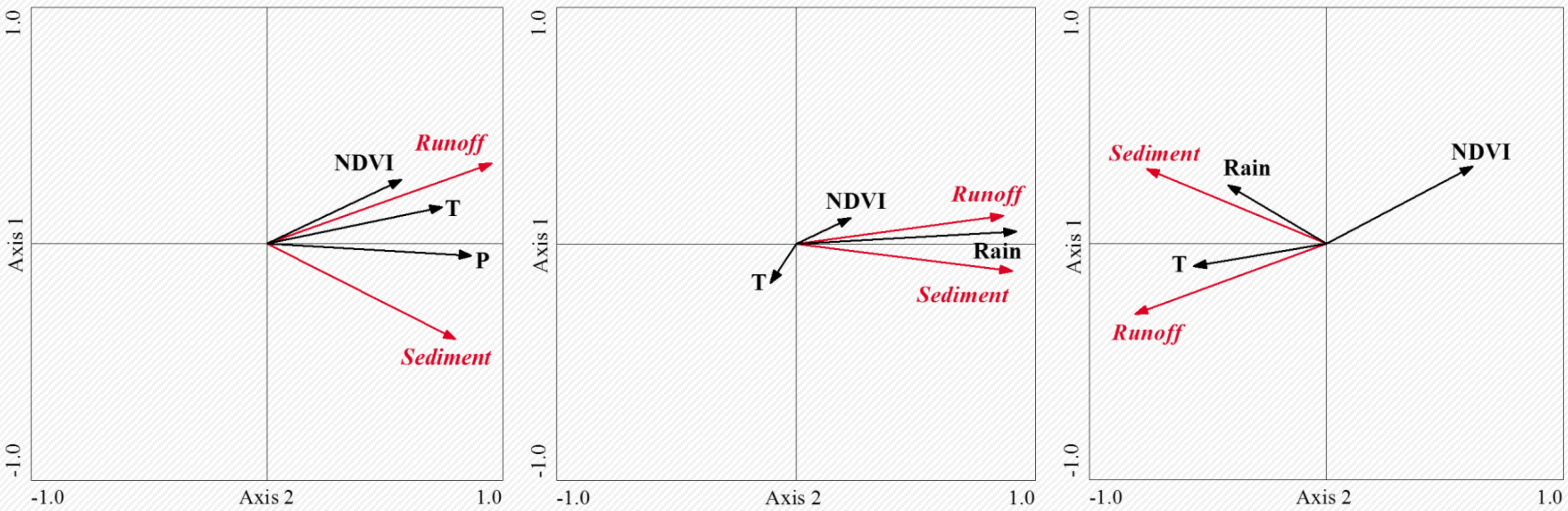


The DMC analyses

- **Changing points were identified by different methods(**CSDC, M-K and DMC**): 1974 and 1995, which showed consistent with climate change and the projects of Reforestation and Returning Farmland to Forest in China.**

4 Results

(2) Contribution quantification by RDA statistic method

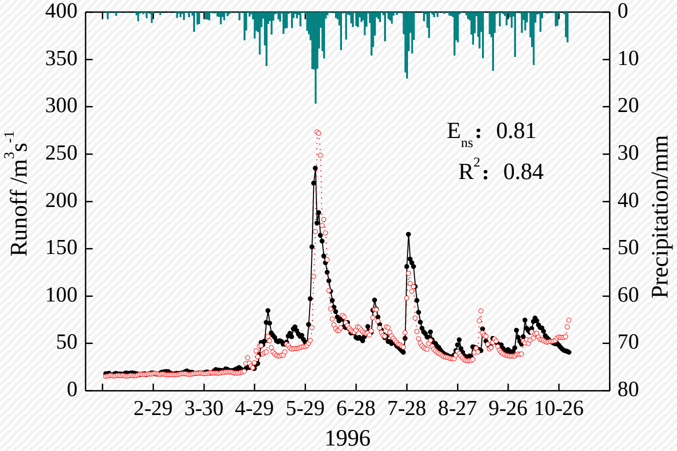


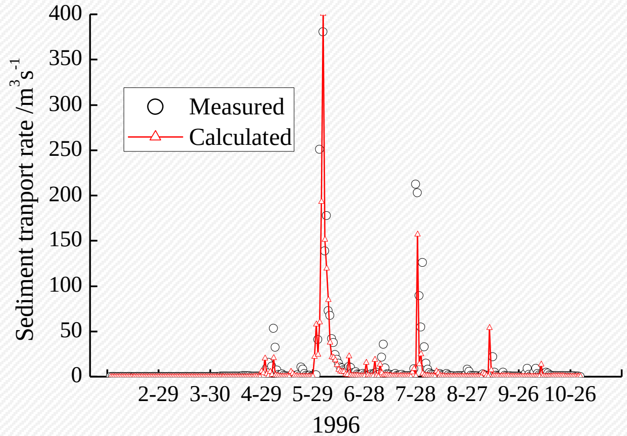
The RDA analyses during (a) 1980-2003, (b) 1990-1994, and (c)1995-1999

- **Climate change played a dominant role， accounting for around 80% of the total decline;**
- **Driven factors affect runoff and sediment load differently in different time stages, which were attested by the magnitude and positive-negative values of the factional contributions.**

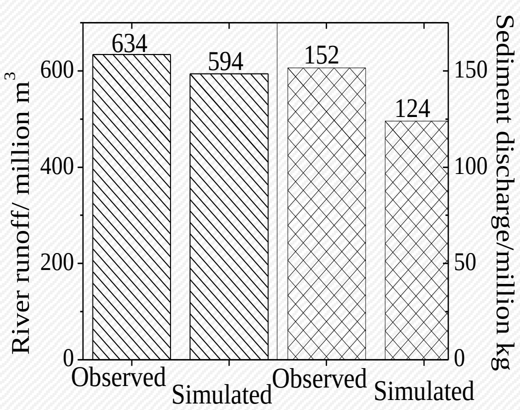
4 Results

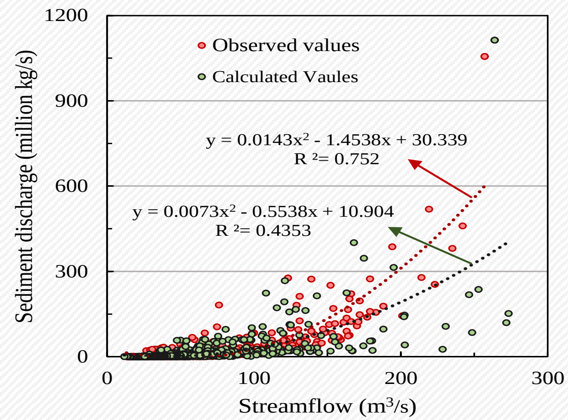
(3) Contribution quantification by BPCC modeling





Hydrologic and sediment processes (an example of calibration and verification)





Model performance evaluation

4 Results

(3) Contribution quantification by BPCC modeling

Table Basin runoff depth and sediment load calculated under different simulated conditions

Simulation scenarios	Runoff depth (Zhang, et al., 2010)				Sediment load			
	H_i/mm	ΔH_i /mm	$C_{i,H}$/%	$U_{i,H}$/%	D_i/10^6kg	ΔD_i /10^6kg	$C_{i,D}$/%	$U_{i,D}$/%
Basic scenario (1980) (H_0 and D_0)	401.9				767			
Scenario I: under fluctuations of 3 factors	369.1	-32.8	100		285.2	-481.8	100	
Scenario II: under fluctuation of P	389	-12.9	39.2	9.4	550.7	-216.3	44.9	10.7
Scenario III: under fluctuations of T	387	-14.9	45.4	2.4	523.4	-203.3	42.2	2.3
Scenario IV: under fluctuations of LUCC	396.7	-5.2	15.9	12.2	643.7	-123.3	25.6	19.7
Scenario V: under fluctuations of P&T	374.2	-27.7	84.5		380.7	-386.3	80.2	
Scenario VI: under fluctuations of P&LUCC	384	-17.9	54.6		475.1	-291.9	60.6	
Scenario VII: under fluctuations of T&LUCC	381.9	-20	61		461.1	-305.9	63.5	

- **Climate change played a dominant role，accounting for around 80% of the total decline; comparably, both runoff and sediment load are more sensitive to LUCC ;**
- **Sediment load is more sensitive to LULC compared with that of the runoff.**

4 Results

(4) Suggestions for attribution analyses

- The distribute hydrologic-based model provides more detailed information and potential inner mechanics of hydrologic and soil erosion processes: every individual driven factor could be specifically analyzed, sensitivity of runoff and sediment discharge to driven factors could be able to accurately calculated, and contributions rates of climate and LUCC changes for runoff and sediment loads are also separately calculated, which brings more insights into the different responses of runoff and sediment load to driven factors;
- Researchers and decision makers should keep deep understanding on merits and limitations of different methods to choose the most suitable one.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