Preliminary study on characteristics and changes of annual runoffs and sediment loads of Changjiang River main channels

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Tasks

- Correlation among annual runoffs and sediment loads, their influential factors, and flow-sediment relationship is established
- 4 types of analytical methods on annual runoffs and sediment loads are summarized ---- probability-statistics analysis, fitted-line analysis, correlation analysis and accumulated-curve analysis
- Based on 1950-2005 observed data of five key hydrographic gauging stations ---- Cuntan, Yichang, Jianli, Hankou and Datong, characteristics and changes of annual runoffs and sediment loads of Changjiang River main channels are preliminarily analyzed

Contents

1. Runoff-sediment load, influential factors and flow-sediment relationship
2. Four types of analytical methods on annual runoffs and sediment loads
3. Preliminary analysis on annual runoffs and sediment loads

1. Runoff-sediment load, influential factors and flow-sediment relationship (1/3)

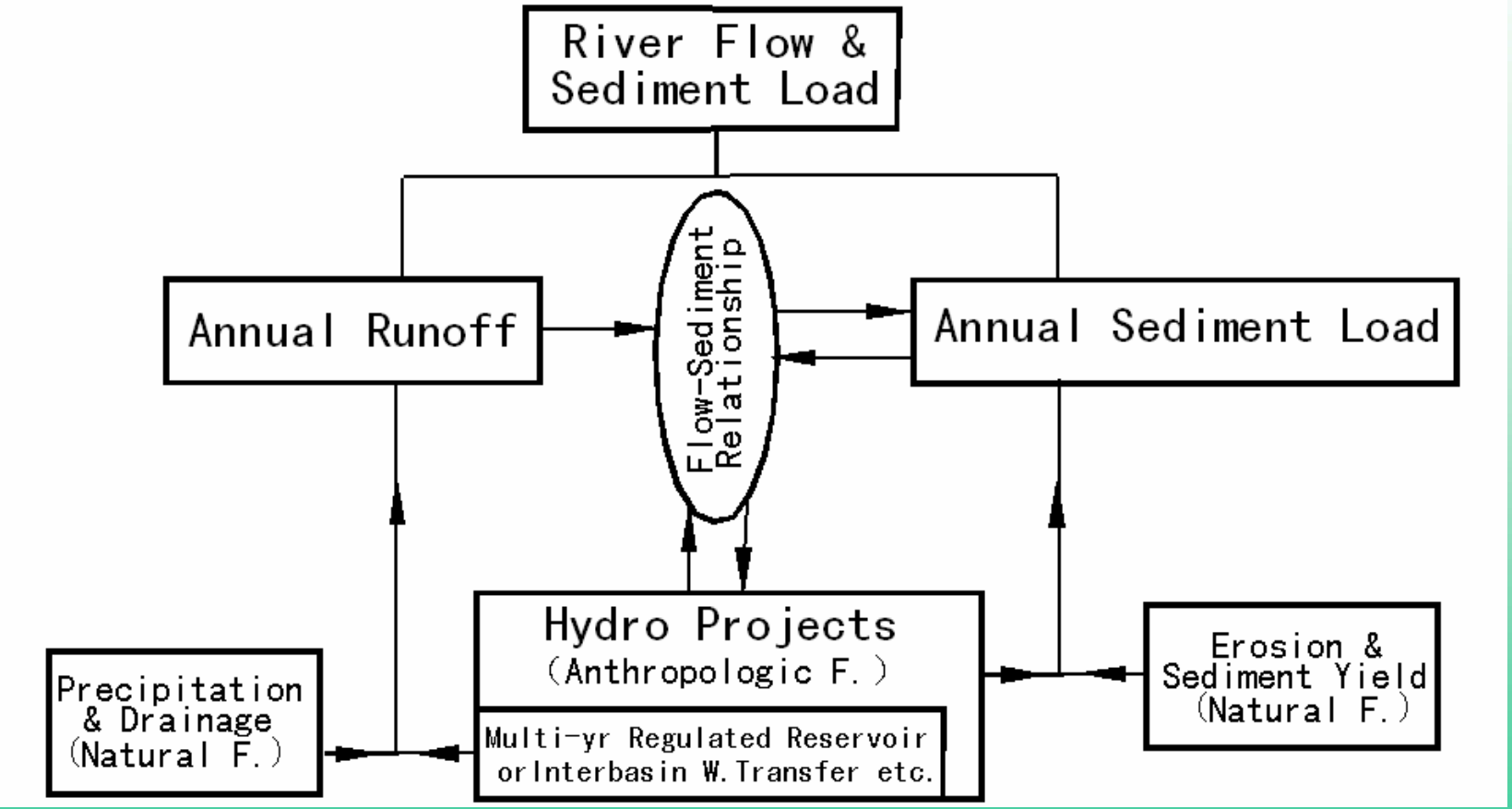


Fig.1. Runoffs and sediment loads, influential factors and flow-sediment relationship

1. Runoff-sediment load, influential factors and flow-sediment relationship (2/3)

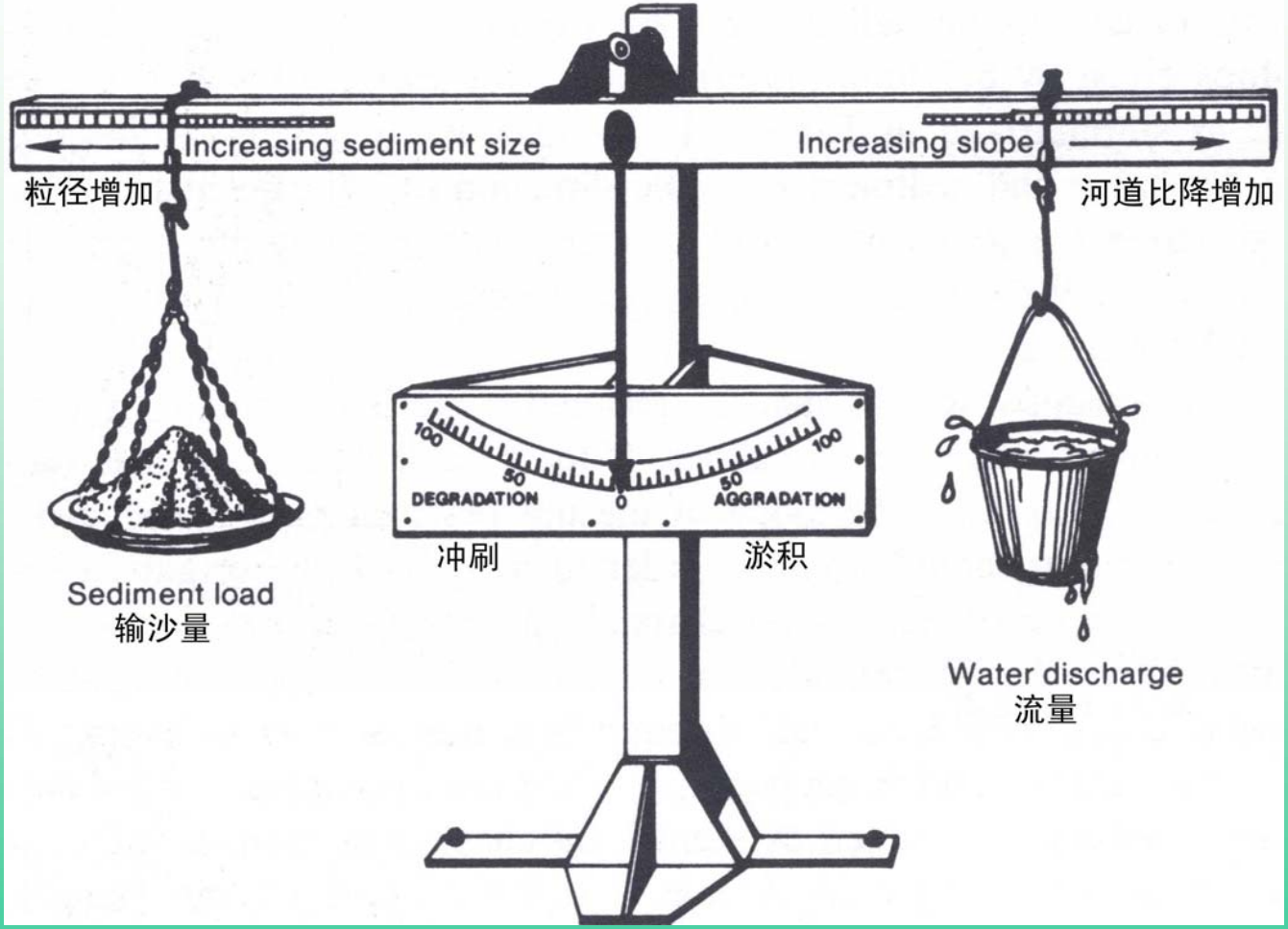
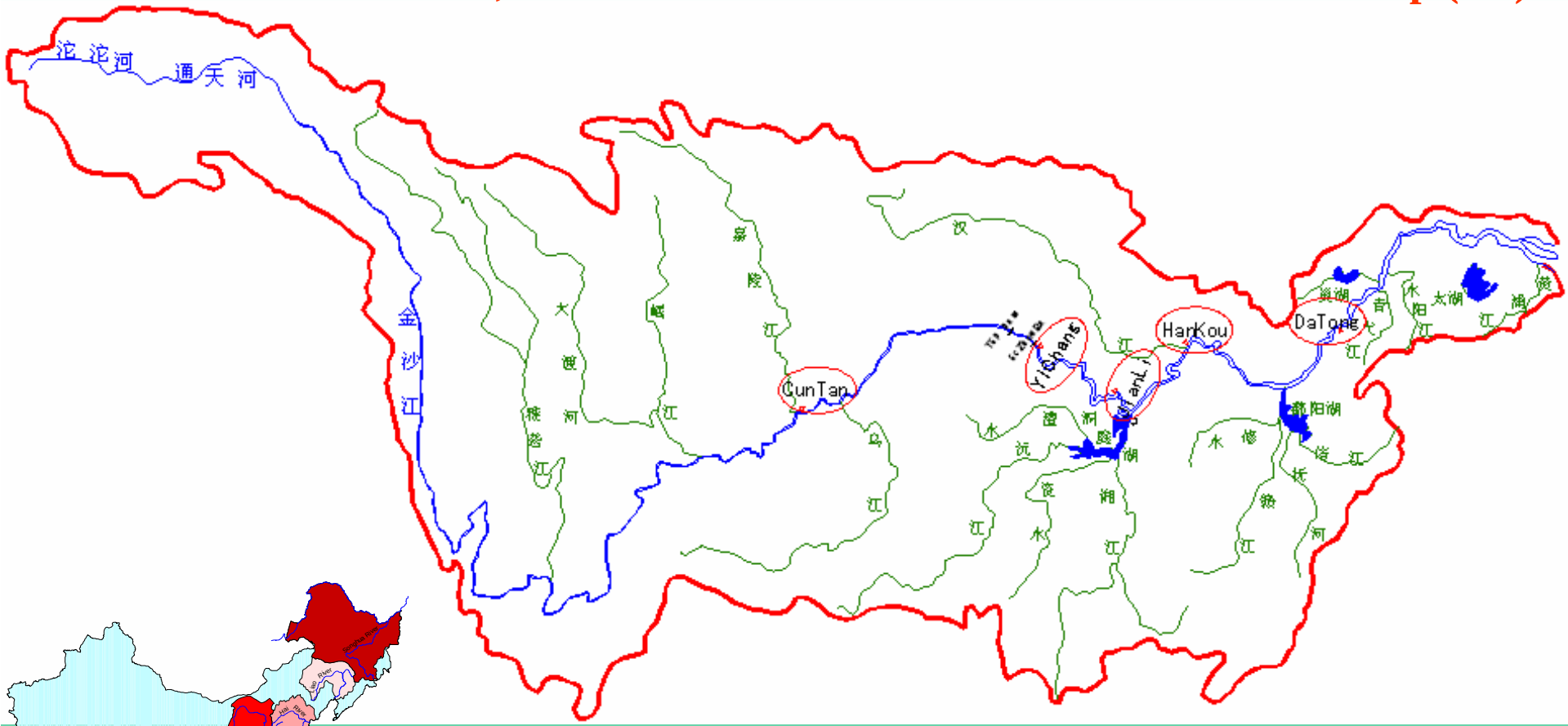


Fig.2. Illustration of Lane's formula on flow-sediment relationship $QS \propto Q_S D_{50}$

1. Runoff-sediment load, influential factors and flow-sediment relationship (3/3)



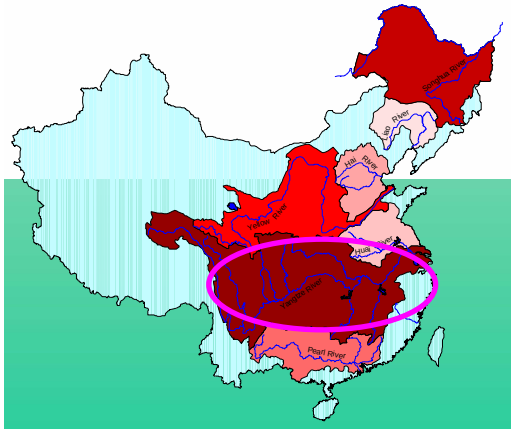


Fig.3. Five key hydrographic gauging stations of Changjiang River

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2. Four types of analytical methods on annual runoffs and sediment loads
---- Method 1: probability-statistics analysis

Objective: to study spatial and temporal characteristics and changes of annual runoffs and sediment loads

Approaches: probability analysis & statistics analysis

Recurrent time (yr)	500	100	50	10	2	Avg.	Variation Coefficient C_v	Deviation Coefficient C_s
Frequency (%)	0.2	1	2	10	50			
Annual runoff W (10^8m^3)	5900	5550	5390	4950	4330	4364	0.10	0.49
Annual sediment Load Gs(10^8t)	9.07	8.24	7.81	6.64	4.70	4.71	0.32	-0.55

Tab.1. Partial results of probability analysis at Yichang station

2. Four types of analytical methods on annual runoffs and sediment loads
---- Method 1: probability-statistics analysis

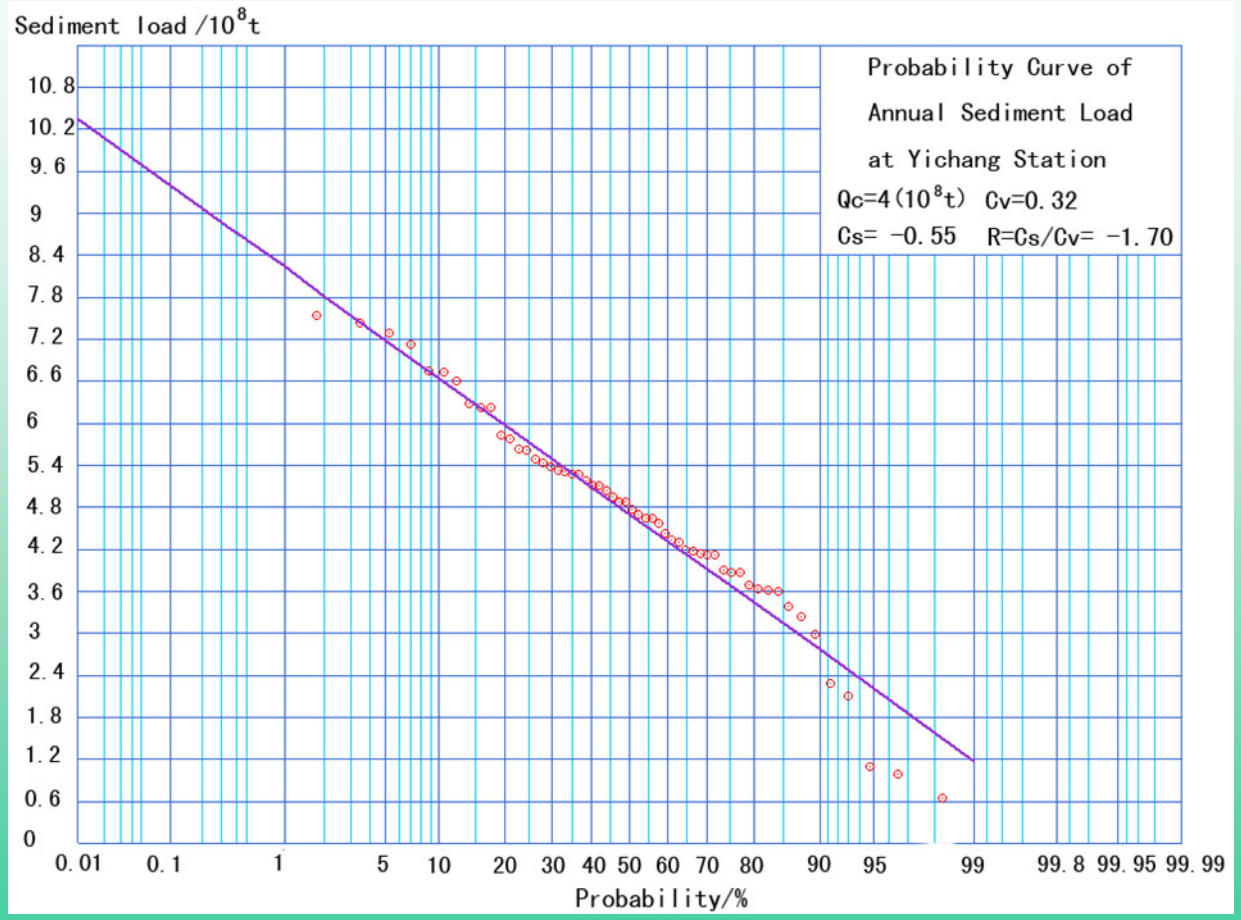

Fig.4. Probability curve of annual sediment loads at Yichang station

2. Four types of analytical methods on annual runoffs and sediment loads
---- Method 1: probability-statistics analysis

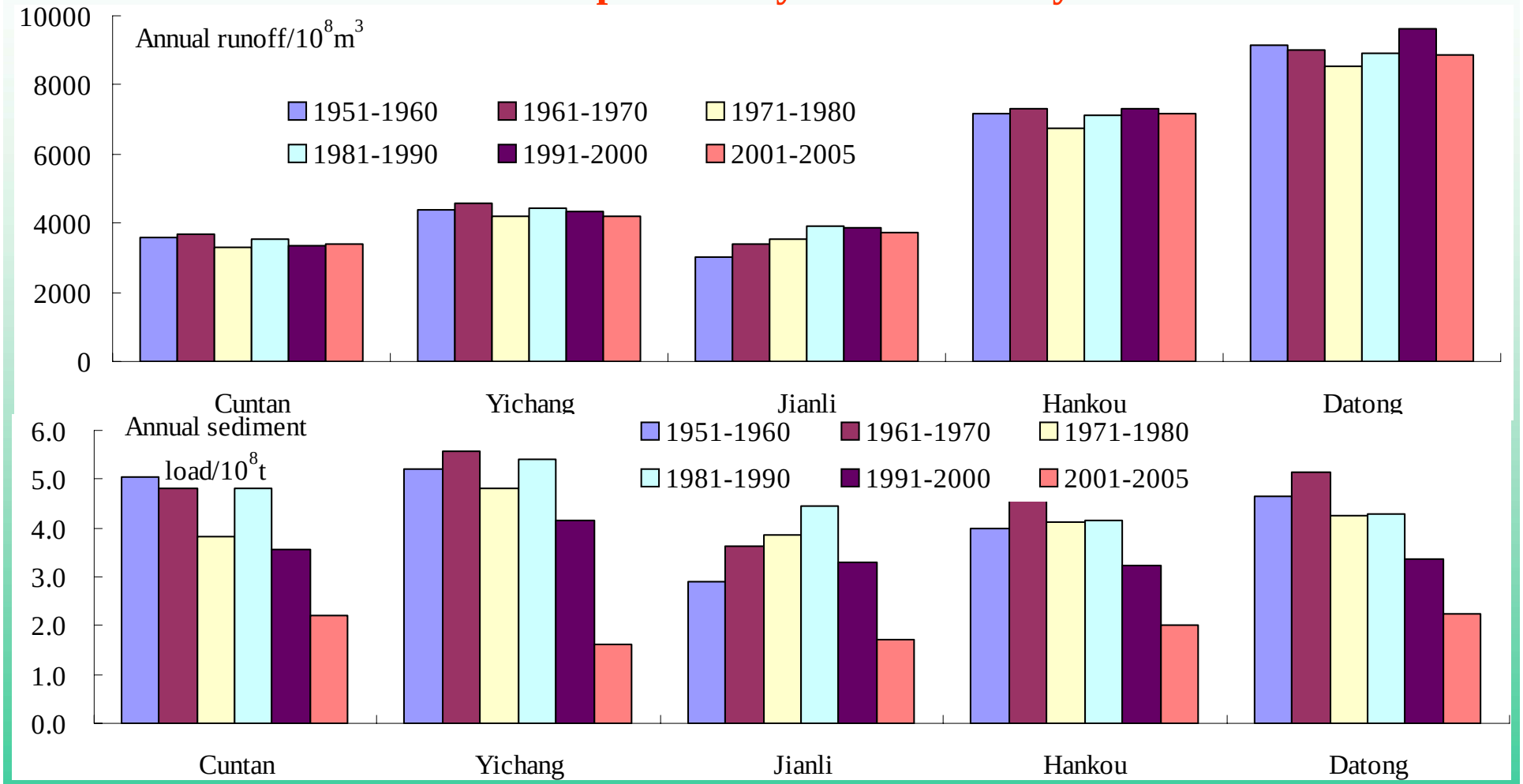

Fig.5. Statistic analysis of annual runoffs and sediment loads at five key stations of Changjiang River

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2. Four types of analytical methods on annual runoffs and sediment loads
---- Method 2: fitted-line analysis

Objective: to study quantitative and qualitative changes of annual runoffs and sediment loads

Approaches: regression-line analysis & moving-average-line analysis

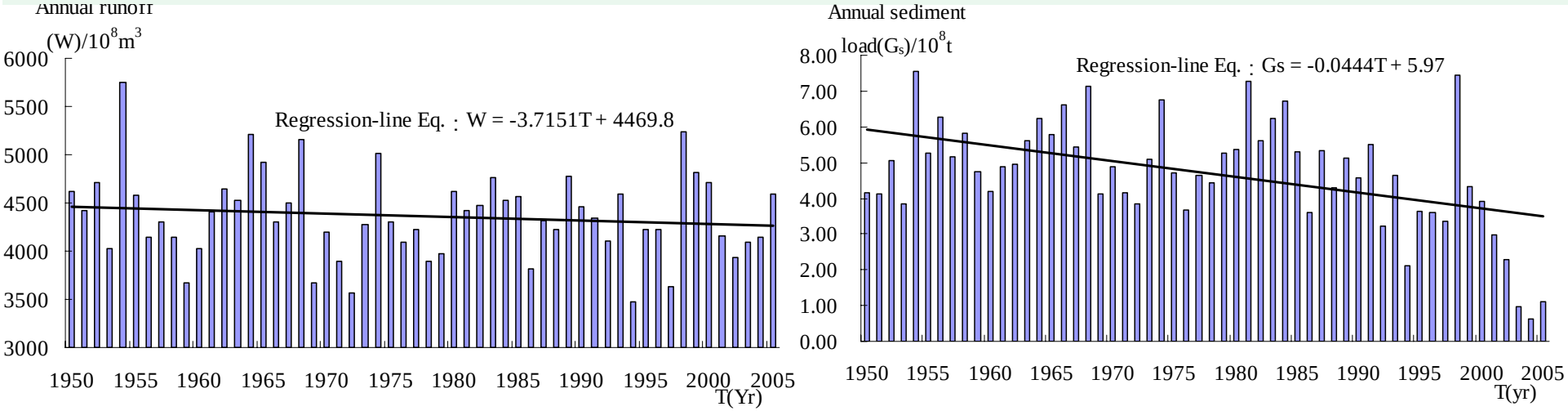

Fig.6. Regression-line analysis of annual runoffs and sediment loads at Yichang station

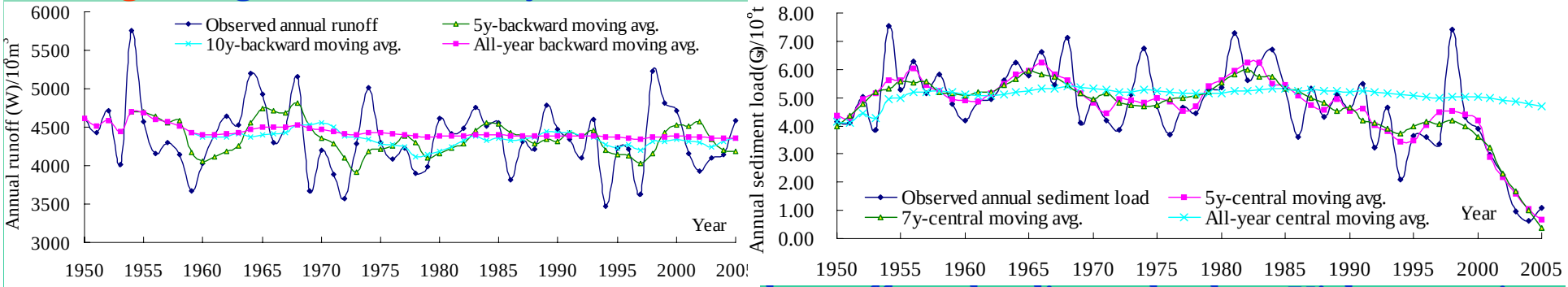

Fig.7. Moving-average-line analysis of annual runoffs and sediment loads at Yichang station

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2. Four types of analytical methods on annual runoffs and sediment loads
---- Method 3: correlation analysis

Objective: to study characteristics and changes of the flow-sediment relationship

Approach: regressing analysis

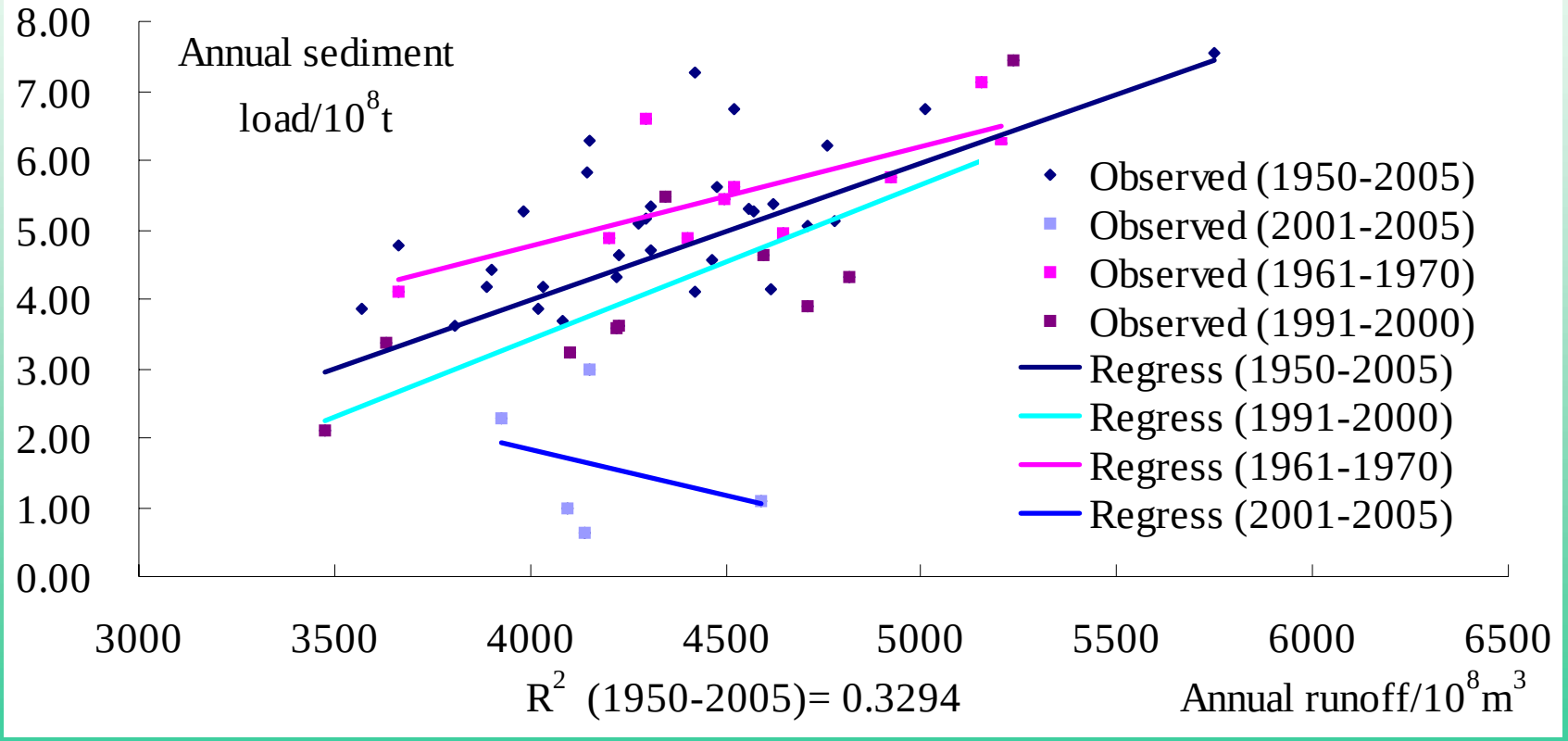


Fig.8. Flow-sediment relationship at Yichang station

2. Four types of analytical methods on annual runoffs and sediment loads
---- Method 4: accumulated-curve analysis

Objective: to study relative changes of annual runoffs and sediment loads in order to further explore reasons behind the changes

Approach: double-accumulated curves

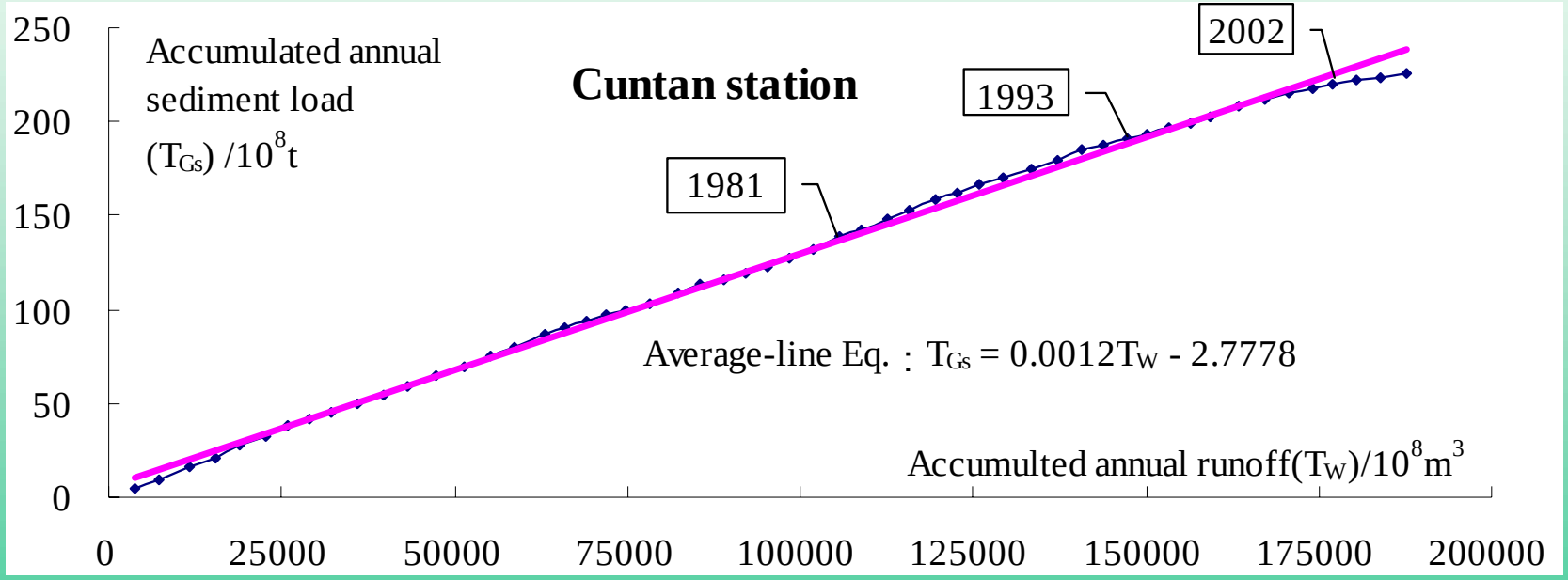
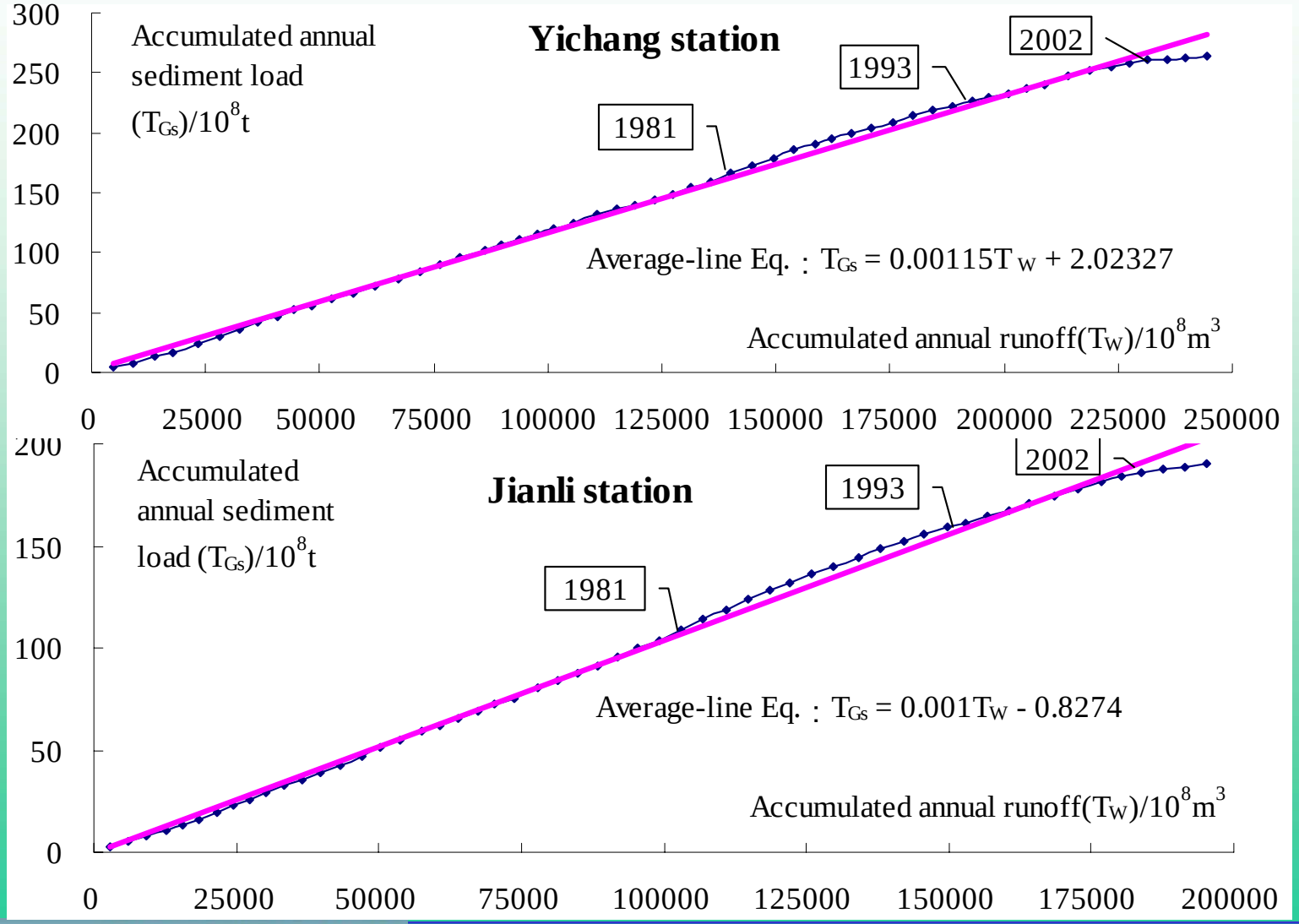


Fig.9. Double-accumulated curves at 5 key stations of Changjiang River

Notes: Markers of "1981", "1993" and "2002" show respectively years of initial operation of Gezhouba Project, ending of Gezhouba Project downstream souring, and initial impounding of TGP

2. Four types of analytical methods on annual runoffs and sediment loads
---- Method 4: accumulated-curve analysis



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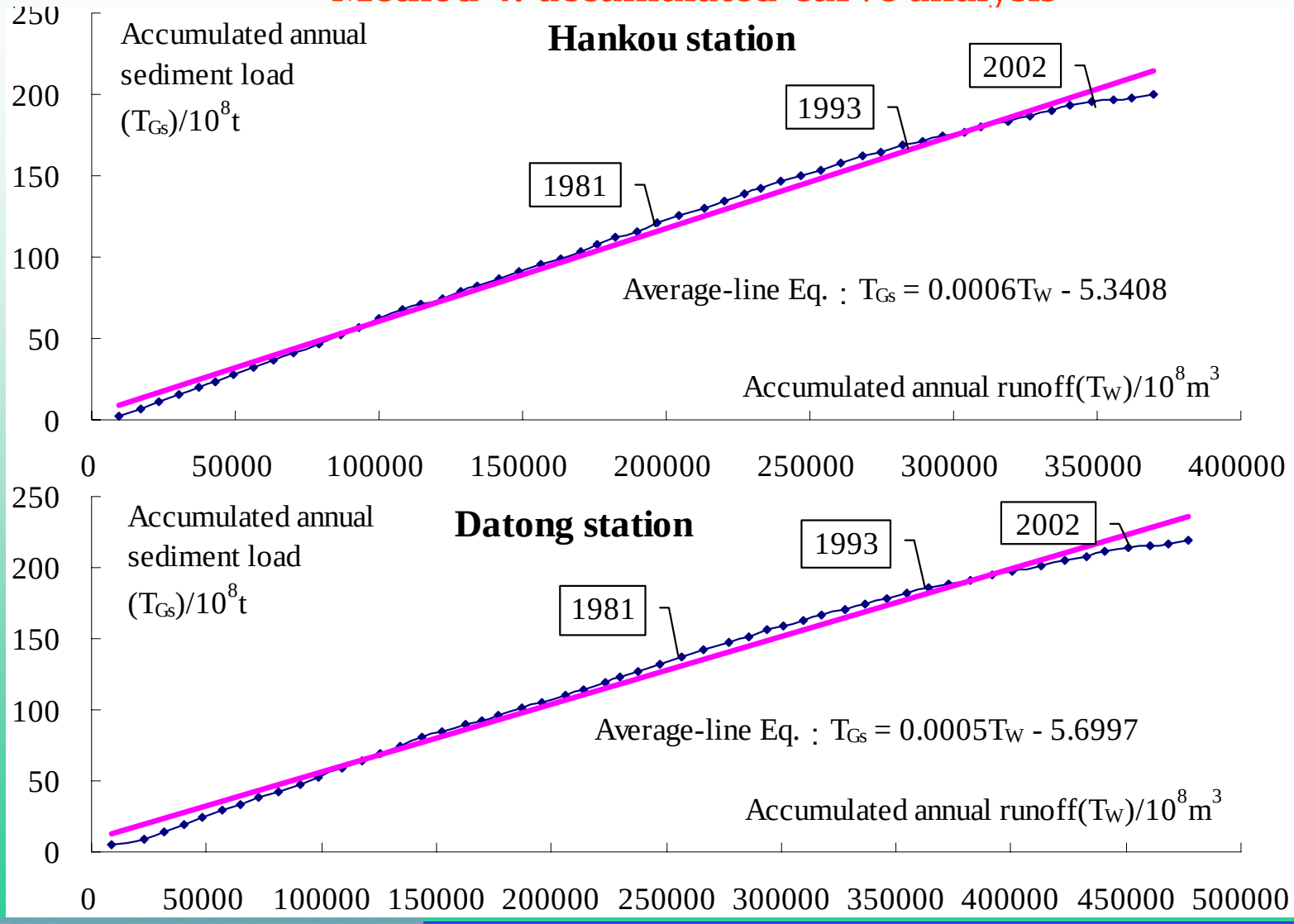

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Gauging station			Cuntan	Yichang	Jianli	Hankou	Datong
Basics	Location		Upstream-CR & TGP-incoming	Middle-CR & TGP-outlet	Middle-CR &Lower-JR	Middle-CR	Lower-CR
	Control Basin Area/km^2		86.66	100.55		258.8	170.54
	Statistic time		1952-2005	1950-2005	1951-2005	1954-2005	1953-2005
Main Results	Method1 (W) /10^8m^3	All-year Avg.	3477	4364	3551	7117	9034
		1951-1960 Avg.	3575	4377	3015	7153	9155
		1961-1970 Avg.	3689	4552	3387	7317	8989
		1971-1980 Avg.	3285	4187	3516	6764	8517
		1981-1990 Avg.	3518	4433	3893	7108	8897
		1991-2000 Avg.	3361	4336	3860	7288	9616
		2001-2005 Avg.	3400	4183	3724	7167	8865
		Cv	0.11	0.10	0.12	0.12	0.14
		Cs	0.25	0.49	-0.02	0.85	1.09
		P=1%	4460	5550	4510	9530	12900
	Method1 (Gs) /10^8t	All-year Avg.	4.18	4.71	3.45	3.84	4.14
		1951-1960 Avg.	5.06	5.20	2.89	3.99	4.65
		1961-1970 Avg.	4.80	5.56	3.63	4.67	5.13
		1971-1980 Avg.	3.83	4.80	3.86	4.12	4.26
		1981-1990 Avg.	4.80	5.41	4.45	4.17	4.27
		1991-2000 Avg.	3.55	4.17	3.29	3.24	3.37
		2001-2005 Avg.	2.21	1.60	1.73	2.00	2.24
		Cv	0.31	0.32	0.27	0.25	0.25
		Cs	0.23	-0.55	-0.41	-0.56	-0.21
		P=1%	7.40	8.24	5.61	6.07	6.57
	Method2	M_W	-0.0014	-0.0009	0.0051	-0.00001	0.0002
		M_{GS}	-0.0104	-0.0094	-0.0016	-0.0102	-0.0119
	Method3/R^2		0.69	0.57	0.33	0.05	0.19
	Method4		See Fig.9				
Conclusions	Changes of annual runoffs		Slight decrease	Slight decrease	Slight Increase	Stable	Stable
	Changes of annual sediment loads		Decrease	Decrease	Slight decrease	Decrease	Decrease
	Flow-sediment relationship		Good	Acceptable	Poor	Random	Random

Tab.2. Analysis on annual runoffs and sediment loads of Changjiang River

3. Preliminary analysis on annual runoffs and sediment loads ---- Results

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3. Preliminary analysis on annual runoffs and sediment loads ----Conclusions

(1) Characteristics of annual runoffs & sediment loads

From upstream to downstream, annual runoffs increase while annual sediment loads keep relative stable, and flow-sediment relationship becomes gradually random

(2) Changes of annual runoffs & sediment loads

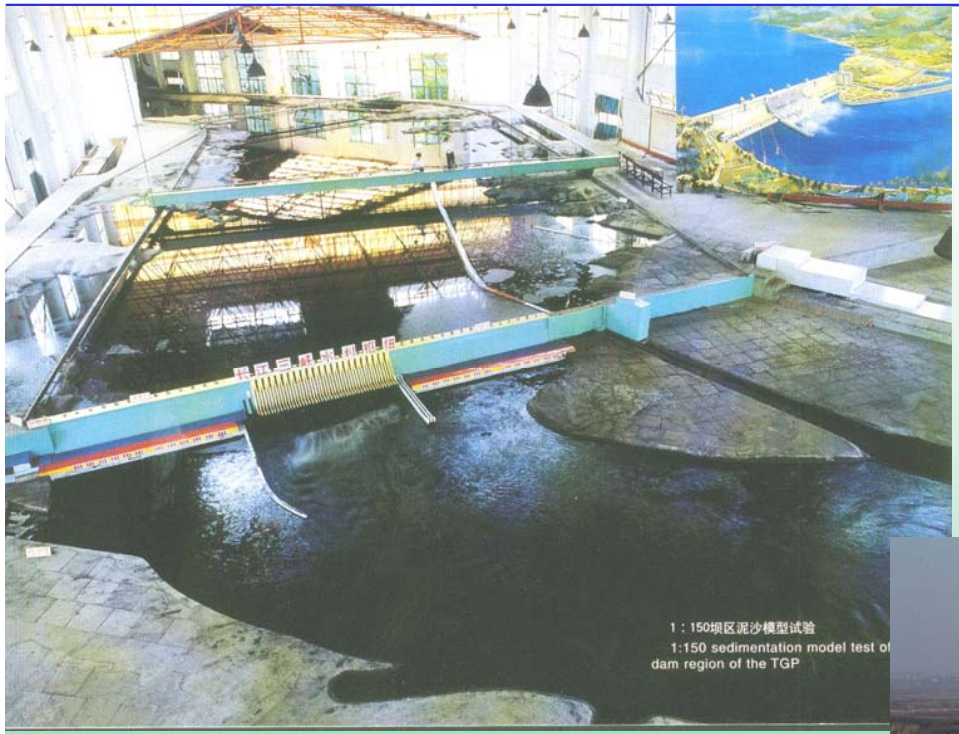
During 1950-2005, annual runoffs basically keep unchanged, while annual sediment loads show slight declination with average decreasing rates of about 1% and further featured with sensible decrease in 1990s and obvious reduction after 2000; fluctuations of annual sediment loads are roughly 10-times larger than annual runoffs

(3) Relationship between change of runoff-sediment load & hydro projects

For impacts of Gezhouba Project and TGP during 135m-NWL impounding stage, changes of upstream incoming runoffs and sediment loads are the dominant factors responsible for downstream runoffs and sediment loads changes and scouring, and their influences are relatively larger than effects of the Projects' regulation on downstream flow and sediment transport

3. Preliminary analysis on annual runoffs and sediment loads ---- Further issues

- Quantitative contribution of each influential factor to changes of annual runoffs and sediment loads
- Separate quantitatively the influences of changes of upstream incoming runoffs and sediment loads and TGP operation on downstream runoffs, sediment loads and scouring
- Correlation between changes of runoffs and sediment loads and river fluvial processes etc.



thanks

➢ **Flood-control Physical Model of TGP Downstream Channels**

➢ **Sediment Physical Model of Dam Region of TGP (Three Gorges Project)**

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