

Fenhe (Fen He)

Map of River

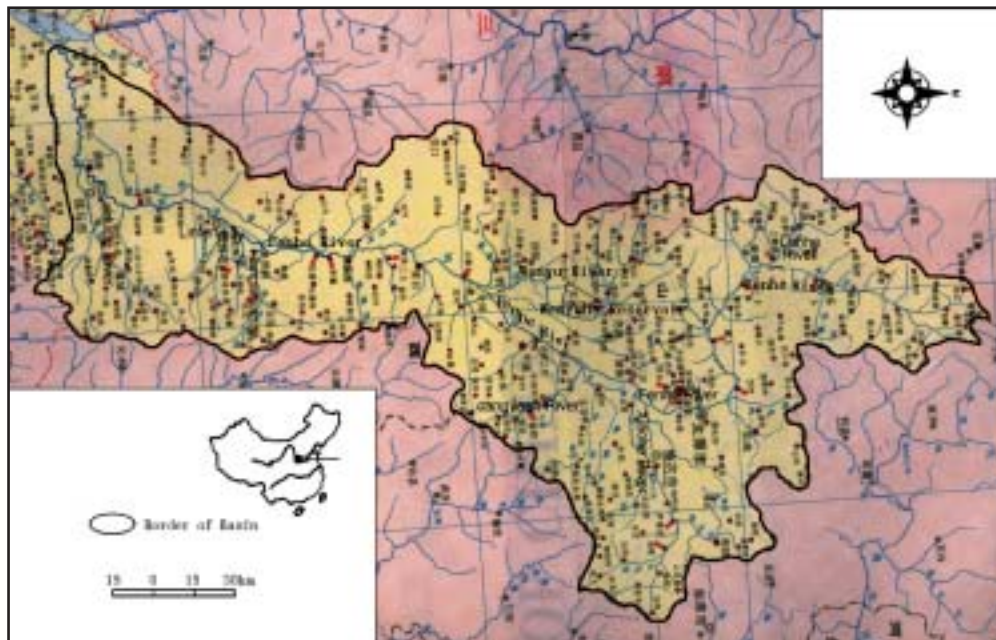


Table of Basic Data

Name(s): Fenhe (in Huanghe River)		Serial No. : China-10
Location: Shanxi Province, Northern China	N 35° 34' ~ 38° 53'	E 110° 34' ~ 111° 58'
Area: 39,471 km ²	Length of the main stream: 694 km	
Origin: Mt. Guancen (2,147 m)	Highest point: Mt.Woyangchang (2,603 m)	
Outlet: Huanghe	Lowest point: 365 (m)	
Main geological features: Hard layered clastic rocks, Group of hard massive metamorphic rocks		
Main tributaries: Lanhe (1,146 km ²), Xiaohe (3,894 km ²), Changyuanhe (2,274 km ²), Wenyuhe (3,979 km ²), Honganjiandong (1,123 km ²), Huihe (2,060 km ²)		
Main lakes: -----		
Main reservoirs: Fenhe (723 × 10 ⁶ m ³ , 1961), Wenyuhe (105 × 10 ⁶ m ³ , 1970), Fenhe II (under construction)		
Mean annual precipitation: 493.2 mm (1971 ~ 1990) (basin average)		
Mean annual runoff: 48.7 m ³ /s at Hejin (38,728 km ²) (1971 ~ 1990)		
Population: 3,410,700 (1998)	Main cities: Taiyuan, Linfen, Yuci, Houma	
Land use: Forest (24%), Rice paddy (2%), Other agriculture (29%), Water surface (2%), Urban (6%), Uncultivated land (20%), Others (17%)		

1. General Description

The Fenhe is a main tributary of The Yellow River. It is located in the middle of Shanxi province. The main river originates from northwest of Mt. Guanqing and flows from north to south before joining the Yellow River at Wanrong county. It flows through 18 counties and cities, including Ningwu, Jinle, Loufan, Gujiao, and Taiyuan. The catchment area is 39,472 km² and the main channel length is 693 km. Forests cover about 30% of total basin area. Upstream, the river zigzags through the Luliang mountains. The middle and downstream reaches flow through the Taiyuan and Lingfen basins. In these basins the depth of yellow soil is about 10-30 m, and it is the main source of soil erosion in Shanxi province.

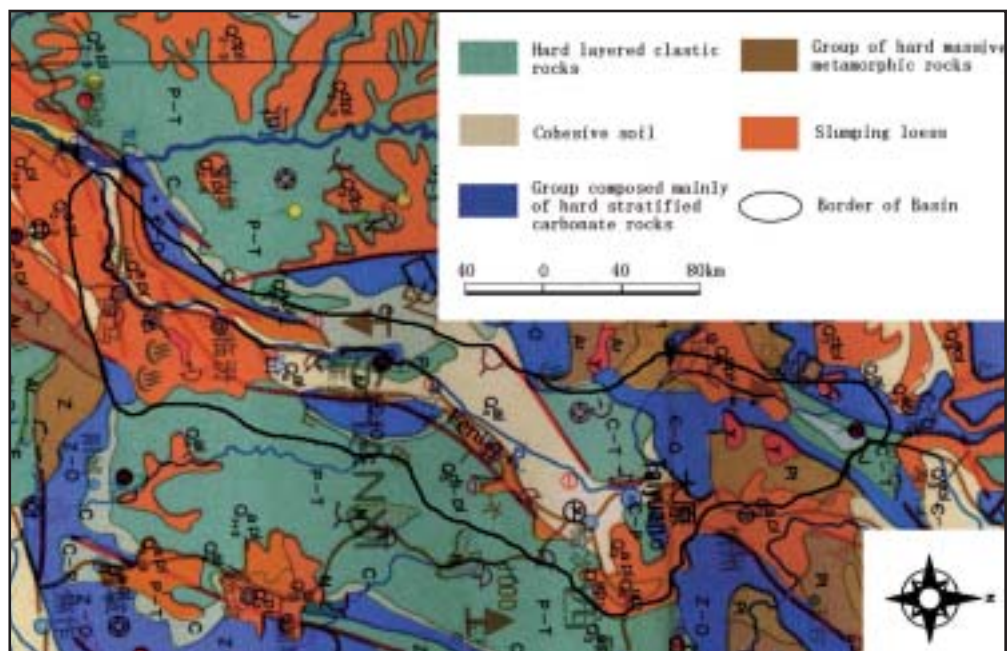
The average annual precipitation for the basin is 544 mm. It varies from 500 mm in the upstream reaches to between 500 - 600 mm in the lower reaches. The precipitation of the basin is concentrated in the June-September period when more than 60% of the annual rainfall occurs. The annual discharge at the Hejin station was 48.7 m³/s for the period of 1934-1979. The average annual volume of runoff was 2.06 billion m³ for the period of 1919-1979 and 2.66 billion m³ for the period of 1956-1979.

There are two large reservoirs, the Wenyu and the Fenhe, located on the tributary Wenyu river and main stream of the Fenhe River respectively. The Fenhe II reservoir is under construction.

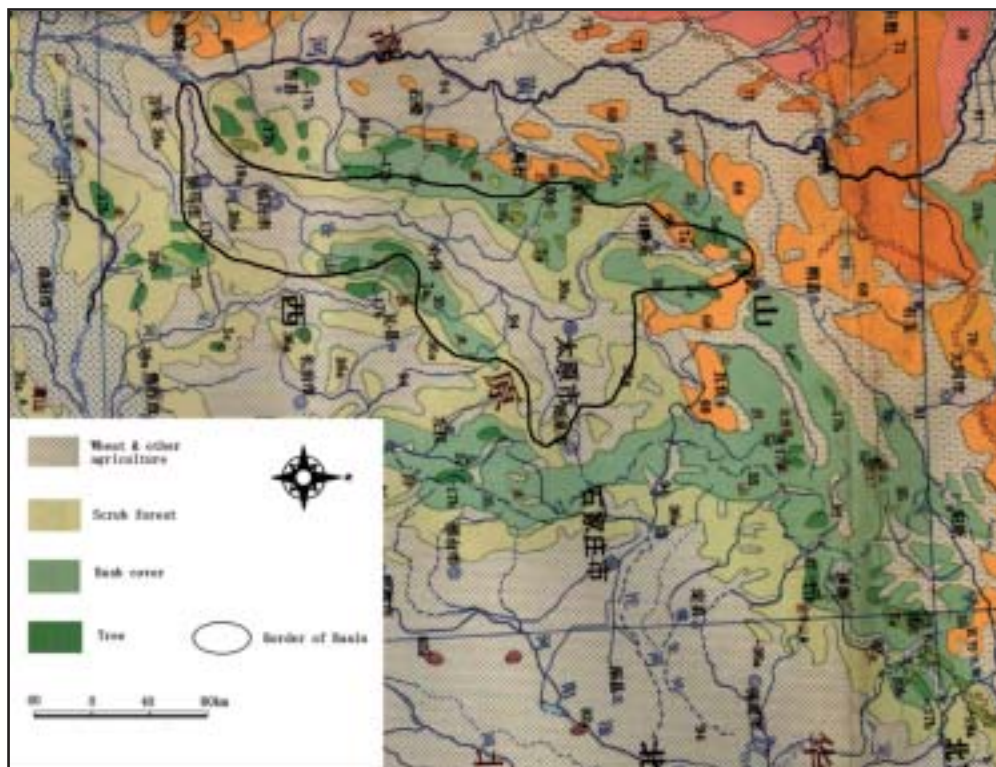
Shanxi is an industrial priority province in China, specialising in metallurgy, coal, energy and chemistry. The population of the catchment was 3,410,700 in 1998. The climate is cold and dry. There is very little cultivation land for paddy rice. The main crops are wheat, corn, and potatoes.

2. Geographical Information

2.1 Geological Map



2.2 Land Use Map

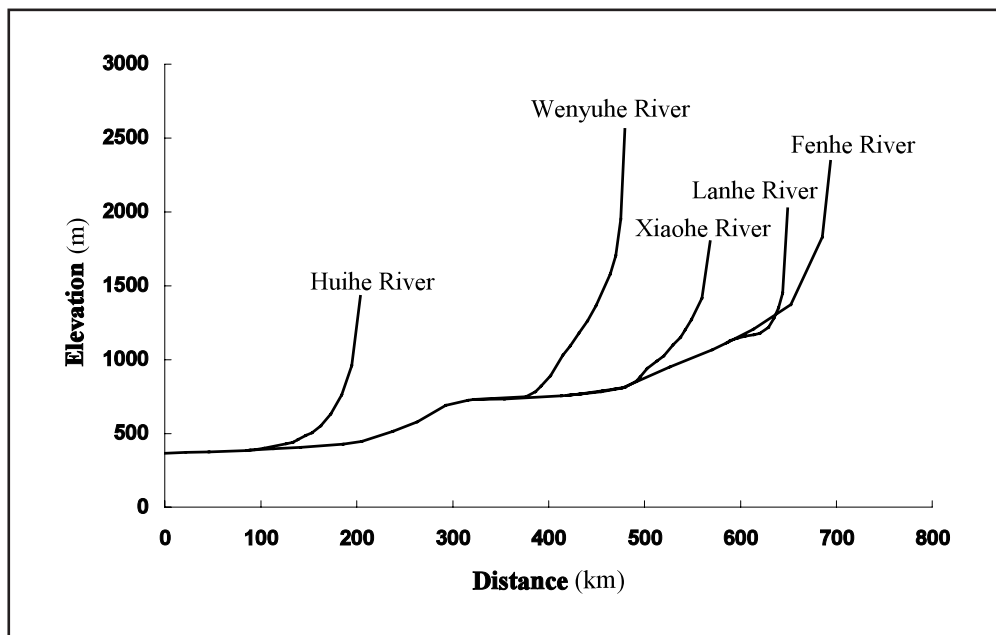


2.3 Characteristics of the River and the Main Tributaries

No.	Name of river	Length [km] Catchment area [km ²]	Highest peak [m] Lowest point [m]	Cities Population (1990)	Land use [%] (2000)
1	Fenhe (Main River)	694 39,471	2,341 365.8	Taiyuan, + Linfen 2,108,200	F (24.24) L (2.47)
2	Lanhe (Tributary)	61.9 1,146	1,420 1,117		P (2.0) OA (29.25)
3	Xiaohe (Tributary)	148.9 3,894	1,150 758.5	Yuci 238,600	U (5.5)
4	Changyuanhe (Tributary)	93 2,274	1,450 752		UL (19.92) O (16.62)
5	Wenyuhe (Tributary)	157.9 3,979	1,040 730	Xiaoyi 112,900	
6	Honganjianhe (Tributary)	84.7 1,123	1,410 438.2		
7	Huihe (Tributary)	118.4 2,060	1,130 386		

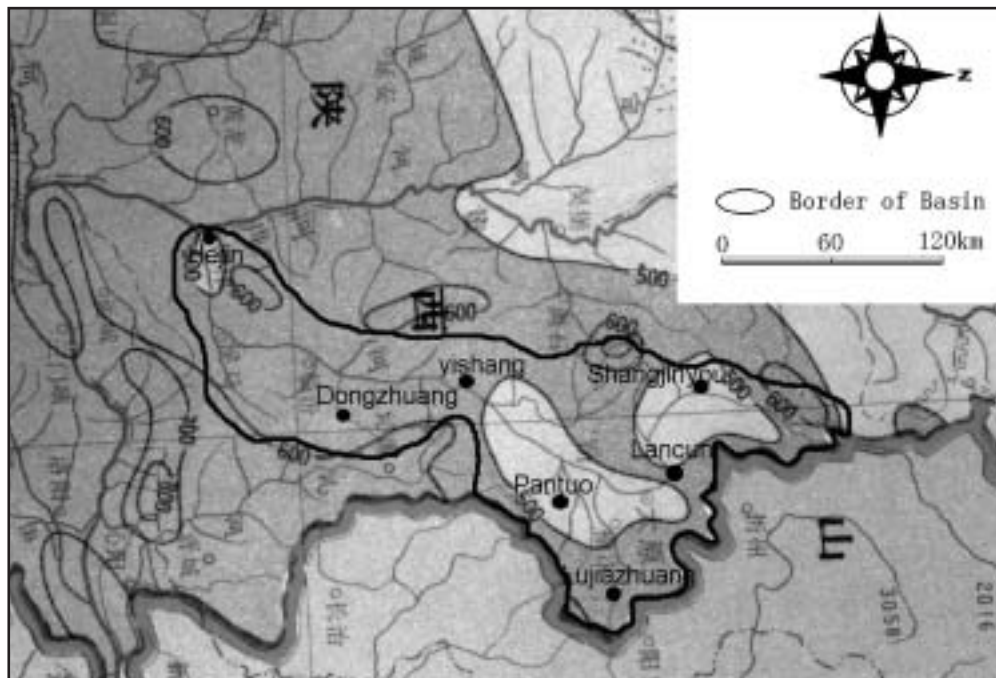
F: Forest L: Lake, River, Marsh P: Paddy rice, OA: Other Agriculture U: Urban UL: Uncultivated land
O: Others

2.4 Longitudinal Profiles



3. Climatological Information

3.1 Annual Isohyetal Map and Observation Stations



3.2 List of Meteorological Observation Stations

No.	Station	Elevation [m]	Location	Observation period	Mean annual precipitation ¹⁾ [mm]	Mean annual evaporation ¹⁾ [mm]	Observation items ²⁾
	Lancun	880	N 38° 00' E 112° 26'	1934 ~ present	525	986	P (TB)
	Yishang	760	N 37° 00' E 111° 50'	1958 ~ present	540	1,157	P (TB), E
	Hejin	379	N 35° 34' E 110° 48'	1934 ~ present	490	1,008	P (TB), E
	Shangjingyou	1,150	N 38° 10' E 111° 49'	1954 ~ present	438		P (TB), E
	Lujiazhuang	900	N 37° 44' E 113° 03'	1953 ~ present	474	1,395	P (TB), E
	Pantuo	970	N 37° 13' E 112° 29'	1954 ~ present	483		P (TB), E
	Dongzhuang	599	N 36° 13' E 111° 52'	1965 ~ present	536		P (TB), E

Evaporation used with 20 Evaporation vessel

1) Period for the mean is from 1971 to 1990

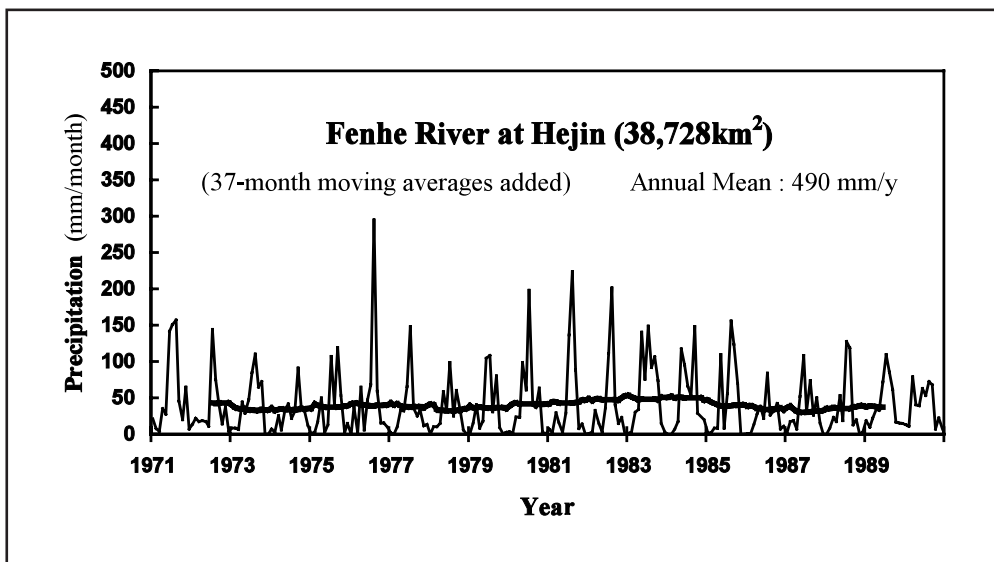
2) P: Precipitation E: Evaporation TB: Tipping bucket with recording chart

3.3 Monthly Climate Data

Station: Taiyuan

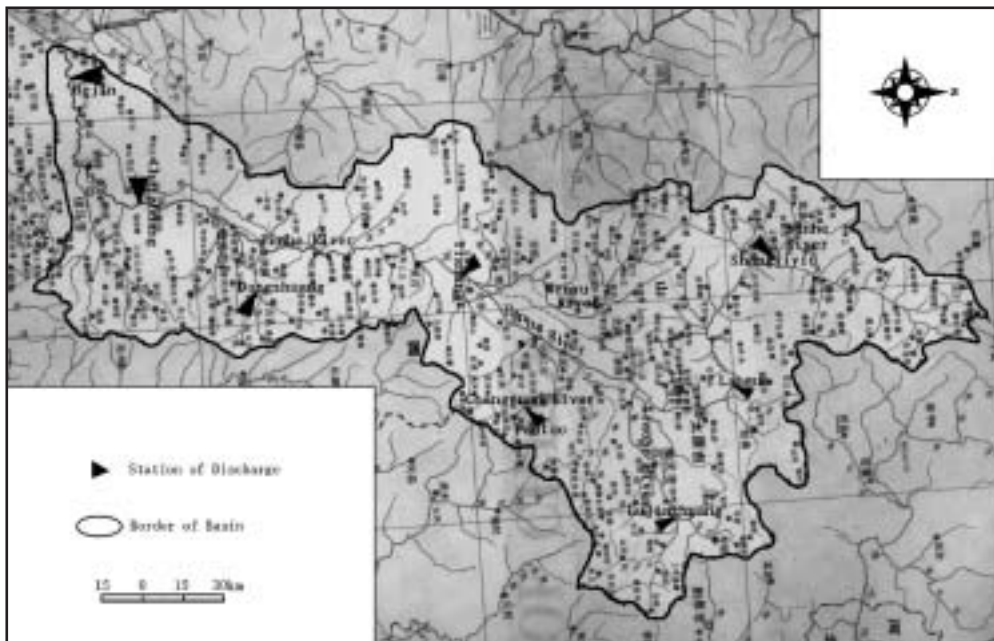
Observation item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Period for the mean
Temperature [°C]	-6.0	-2.9	3.8	11.7	17.9	21.6	23.3	21.8	16.1	10.0	2.3	-4.4	9.6	1961~1990
Precipitation [mm]	2.9	6.3	10.7	23.8	35.3	54.6	120.2	94.4	64.3	29.1	12.1	3.2	456.8	1961~1990
Evaporation [mm]	47.7	65.0	131.6	214.6	272.9	253.7	205.0	174.5	133.0	111.5	65.9	44.2	1,719	1961~1990
Solar radiation [MJ/m ² /day]	8.77	10.1	14.3	18.4	18.7	20.1	18.3	17.0	13.0	11.5	9.47	8.12	14.0	1982~1985
Duration of sunshine [hr]	182.2	172.5	210.9	223.2	268.0	263.4	235.0	228.5	204.9	210.4	182.5	173.6	2,555	1961~1990

3.4 Long-term Variation of Monthly Precipitation



4. Hydrological Information

4.1 Map of Streamflow Observation Stations



4.2 List of Hydrological Observation Stations

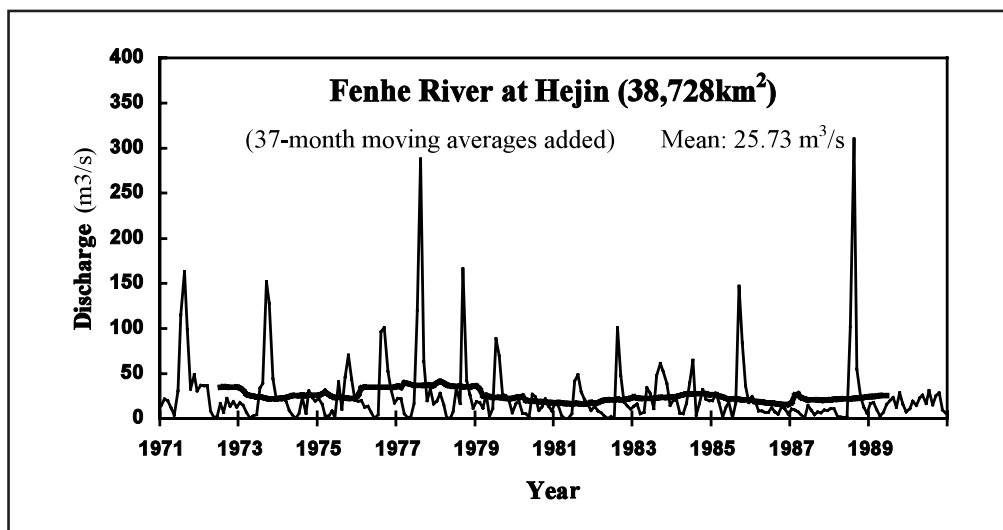
No.	Station	Location	Catchment area (A) [km ²]	Observation period	Observation items (frequency)
	Lancun	N 38° 26' E 112° 26'	7,705	1943 ~ present	H2, Q
	Yishang	N 37° 00' E 111° 50'	23,945	1958 ~ present	H2, Q
	Hejin	N 35° 34' E 110° 48'	38,428	1956 ~ present	H2, Q
	Shangjingyou	N 38° 10' E 111° 49'	1,140	1954 ~ present	H2, Q
	Lujiazhuang	N 37° 44' E 113° 03'	2,367	1953 ~ present	H2, Q
	Pantuo	N 37° 13' E 112° 29'	533	1954 ~ present	H2, Q
	Dongzhuang	N 36° 13' E 111° 52'	987	1965 ~ present	H2, Q

H2: manual water level Q: discharge

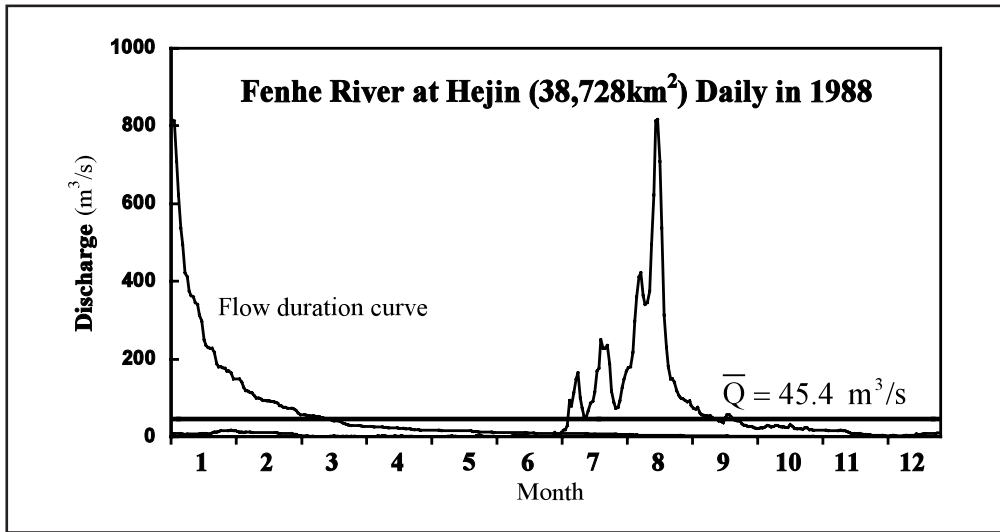
No.	$\bar{Q}^{1)}$ [m ³ /s]	$Q_{max}^{2)}$ [m ³ /s]	$\bar{Q}_{max}^{3)}$ [m ³ /s]	$\bar{Q}_{min}^{4)}$ [m ³ /s]	\bar{Q}/A [m ³ /s/100km ²]	Q_{max}/A [m ³ /s/100km ²]	Period of statistics
	10.1	1,480	446	0.44	0.13	19.21	1971 ~ 1990
	11.42	1,010	295	0	0.048	4.22	1971 ~ 1990
	25.73	804	356	0	0.066	2.08	1971 ~ 1990
	1.59	935	308	0.162	0.101	82.02	1971 ~ 1990
	3.12	788	324	0.316	0.132	33.29	1971 ~ 1990
	1.42	2,050	240	0.031	0.266	385	1971 ~ 1990
	1.54	1,680	387	0.095	0.156	170	1971 ~ 1990

1) Mean annual discharge 2) Maximum discharge 3) Mean maximum discharge 4) Mean minimum discharge

4.3 Long-term Variation of Monthly Discharge Series



4.4 Annual Pattern of Discharge Series



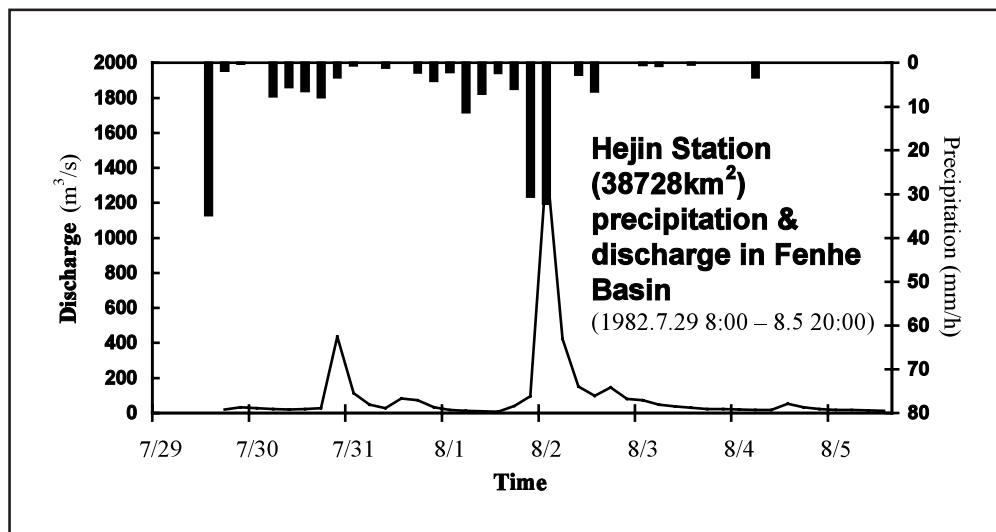
4.6 Annual Maximum and Minimum Discharges

Station: Lancun (7,705 km²)

Year	Maximum ¹⁾		Minimum ²⁾		Year	Maximum ¹⁾		Minimum ²⁾	
	Date	[m ³ /s]	Month	[m ³ /s]		Date	[m ³ /s]	Month	[m ³ /s]
1971	7.31	1,480	12	1.77	1981	8.3	159	11	0.28
1972	8.4	51.5	12	1.17	1982	8.2	1,420	3	0.34
1973	6.28	715	5	0.6	1983	7.28	353	12	0.13
1974	7.27	530	12	0.7	1984	8.12	71.2	12	0.19
1975	8.12	387	5	0.54	1985	5.12	507	2	0.13
1976	8.19	613	11	0.42	1986	7.19	81.9	12	0.11
1977	8.18	515	2	0.32	1987	8.3	48.0	12	0.028
1978	7.19	302	2	0.89	1988	8.14	479	3	0
1979	8.14	601	12	0.4	1989	7.17	163	1	0.005
1980	5.31	150	1	0.7	1990	8.11	304	6	0.07

1), 2) Instantaneous observation by recording chart

4.7 Hyetographs and Hydrographs of Major Floods



5. Water Resources

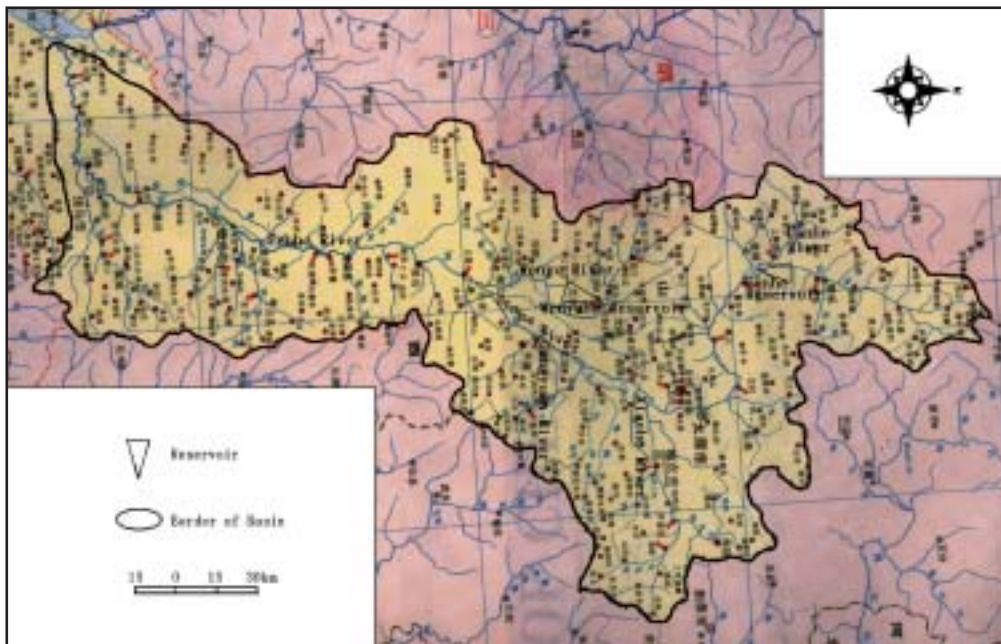
5.1 General Description

The Fenhe is a main tributary of the Yellow River and originates in the northeast mountains of Shanxi province.

The average annual precipitation for the basin is 544 mm. It varies from 500 mm in the upstream reaches to between 500 - 600 mm in the lower reaches. The precipitation of the basin is concentrated in June-September period when more than 60% of the annual rainfall occurs. However, according to the records from the Hejin hydrological station (38,428 km²), the distributions of precipitation and runoff have two distinct parts: a period of relative drought in 1934-1948 and a relatively wet period in 1949-1979. Floods are mainly caused by storms centred over the basin and there are typically two or three floods each year. The annual discharge at the Hejin station was 48.7 m³/s for the period of 1934-1979. The average annual volume of runoff was 2.06 billion m³ for the period of 1919-1979 and 2.66 billion m³ for the period of 1956-1979.

There are two man-made reservoirs in the basin, the Fenhe and the Wenyuhe, which were completed in 1961 and 1970 with capacities of 723 x 10⁶m³ and 105 x 10⁶m³ respectively. The main purpose of the Fenhe reservoir is flood control, with irrigation, fishery and water supply as additional benefits. The Wenyuhe reservoir is a project for irrigation and hydropower generation. The Fenhe II reservoir downstream of existing Fenhe reservoir will have a capacity 120 x 10⁶m³ when completed.

5.2 Map of Water Resource Systems



5.3 List of Major Water Resources Facilities

Major Reservoirs

Name of river	Name of dam	Catchment area [km ²]	Gross capacity [10 ⁶ m ³]	Effective capacity [10 ⁶ m ³]	Purposes ¹⁾	Year of completion
Fenhe River	Fenhe	5,268	723	464	A, F, P	1961
Wenyuhe River	Wenyuhe	1,876	105	91	A, F, P	1970

1) F: Flood control, P: Hydro-power

Major Interbasin Transfer

Name of transfer line	Name of rivers and places connected		Length [km]	Maximum capacity [m ³ /s]	Purposes ¹⁾	Year of completion
	From	To				
Wanjiazhai	Yellow	Fenhe	240.68	48	WS	2002

1) WS: Water Supply

5.4 Major Floods and Droughts

Major Floods at Hejin (Catchment area 38,728 km²)

Date	Peak discharge [m ³ /s]	Rainfall [mm] Duration	Meteorological cause	Dead and Missing	Major damages (Districts affected)
1982.8.2	1,420	704.8 7.29 ~ 8.2	Frontal rain	---	Linfen, Houma City

Major Droughts

Period	Affected area	Major damages and counteractions
1972.6 ~ 8	Taiyuan, Yuci cities	Water supply cut to 50%
1980.7	Jinle, Ningwu cities	Water supply cut to 47%

6. Socio-cultural Characteristics

The Fenhe flows from north to south through Taiyuan, the capital of Shanxi province. The basin is a typical karst area, with several springs, and water flowing from cracks in the rocks. There are many natural scenic features and also ancient constructions, more than 1000 years old, in the rock caves in Tianlong mountains. In and around the city are many Buddhist and Taoist temples. In the northern part of the city there is Wutai Mountain, one of China's four famous Buddhism Mountains.

7. References, Databooks and Bibliography

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