

RECENT STATUS AND CHARACTERISTICS OF SOIL EROSION IN THE REGION

Recent Status of Soil Erosion

Data on water and soil conservation in the upper reaches of the Yangtze indicate that the soil erosion-prone areas in the region covered 352,000 sq.km. in 1985, accounting for 35 per cent of the total area of which 133,000 sq.km. was lightly eroded with an annual average soil erosion modulus of 500-2500 T/km²; medium-eroded areas (111,000 sq.km.) with a soil erosion modulus of 2,500-5,000 T/km² heavily eroded areas (72,000 sq.km.) with a soil erosion modulus of 5,000-8,000 T/km² and extra heavily eroded areas (10,000 sq.km.) with a soil erosion modulus of 8,000-13,500 T/km² (Table 4.1). In terms of the tributaries of the upper reaches of the Yangtze, soil erosion-prone areas of the Jinsha Basin cover 135,400 sq.km., accounting for 38.4 per cent of the total soil erosion-prone area. The Jialing and the Min River areas account for 26.3 per cent and 14.0 per cent of the area respectively (Survey Team of the Ministry of Water Resources and Electric Power 1986).

Table 4.1: Soil Erosion Areas and Moduli in the Upper Reaches of the Yangtze

Classification of Soil Erosion	Area of Soil Erosion (sq.km.)	Percentage	Soil Erosion Modulus (T/km ²)
Total	352000	35% against total area	
Light	133000	37.8% against 352000	500-2500
Medium	111000	31.5% against 352000	2500-5000
Heavy	72000	20.4% against 352,000	5000-8000
Extra Heavy	10000	2.8% against 352,000	8000-13500

Source: Survey Team of the Ministry of Water Resources and Electric Power 1986

In terms of provincial statistics, the soil erosion-prone areas in Sichuan Province total 247,000 sq.km., accounting for 70.1 per cent of the total soil erosion-prone area. Most of these areas are distributed throughout the hilly and low mountainous areas of the Sichuan Basin. For example, the Giong River which drains the centre of the Sichuan Basin and is a first order tributary of the Fujiang, had 4329.2 sq.km. of drainage area and 3277.8 sq.km. of soil erosion-prone area in 1983, accounting for 75.7 per cent of the total drainage area in 1983 and being 40.4 per cent over the total area recorded in 1957. The annual average soil erosion modulus is 4335.2 T/km² in the basin. Sichuan Academy of Agriculture Sciences has carried out work on the regionalisation of soil erosion in the province and this is summarised in Table 4.2 (Sichuan Academy of Agricultural Sciences 1980). Detailed data on the status of soil erosion in the high area of soil-water conservation in the upper reaches of the Yangtze are given in Table 4.3.

Soil Erosion on Dry Sloping Farmland

The plains in the upper reaches of the Yangtze are small. About 80 per cent of the total farmland is situated on the slopes of the hills, low mountains, and middle mountain areas, and 70 per cent of farmland is on slopes that do not have any protection. The slope gradient for most of the sloping farmland in hilly areas in the Sichuan Basin ranges from 5°-20°. A considerable amount of sloping farmland is found on slopes with a > 25° slope gradient. In Sichuan Province, eight districts have farmland on > 25° steep slopes, accounting for 10-20 per cent of the total area of each prefecture. They are Yibin District (12.1%), Da County District (12.3%), Fulin District (15.3%), Yaan District (15.6%), Ganzhi District (15.8%), Aba District (16.6%), Guangyuan District (17.7%), and Xichang District (18.2%). In some counties (cities), farmland on steep slopes accounts for > 60 per cent of the total area. For example, farmlands on steep slopes in Jin Kou, a district administered by Leshan City, and Chengkou County administered by Wanzian District, account for 71.7 per cent and 66.4 per cent of the total area respectively.

Table 4.2: Distribution of Different Types of Soil Erosion in Sichuan Province

Soil Erosion Type	Presented (%) against total soil erosion-prone area	Distribution throughout the Province
Heavy sheet erosion and gully erosion	2.9	Suining, Anyue, Lexhi, Ziyang, and Santai - counties in the central hilly areas of the Sichuan Basin
Medium and light sheet erosion	24.1	The rest of the area of the Central Sichuan Basin and the mountains in the eastern Sichuan Basin
Heavy sheet soil erosion and light gully soil erosion	1.0	Mingshan, Jianjiang, and Leshan Counties
Medium sheet soil erosion and localised heavy sheet soil erosion	23.5	Daba Mountains, Min Mountains
Medium sheet soil erosion and solution	23.4	Fringed mountains in the southern Sichuan Basin and the Daliang Mountain Area
Light sheet soil erosion	2.1	Lushan, Tianquan, Baoxing counties in the upper reaches of the Qingyi
Soil erosion by wind erosion and by collapse	1.3	Valleys in the upper reaches of the Min Dong River and Xi River Basin in the Tibet District and in the Liusha River Basin in Hanyuan district
Light sheet soil erosion and medium gully soil erosion	14.3	Tibet District
Soil erosion by wind and glaciation	7.3	Western Mountains of Sichuan Province
Erosion in paddy	0.1	Western Plain of Sichuan Basin

Source: Sichuan Academy of Agricultural Sciences 1980

Table 4.3: Status of Soil Erosion In the High Area of Soil-Water Conservation in the Upper Reaches of the Yangtze

(Area: sq.km./Unit : Erosion loss: 10⁴ T erosion modulus T./km² annum)

Region	Province	Area of Land	Soil Erosion Prone Area and Erosion Loss											
			Total				Light				Medium			
			Area	% of total land area	Average annual erosion loss	Average erosion modulus	Area	% of total soil erosion-prone area	Average annual erosion loss	Average erosion modulus	Area	% of total soil erosion prone area	Average annual erosion loss	Average erosion modulus
Total		304030.42	170544.90	56.09	77250.88	4530	56600.16	33.19	8702.77	1540	57634.77	33.79	21737.94	3770
Lower reaches of Jinsha and Bijie district	Subtotal	118752.45	63498.30	53.47	27692.65	4360	25526.65	4360	25526.98	1580	20350.32	32.05	7766.00	3820
	Yunnan	65921.80	33671.00	51.08	12175.10	3620	16162.08	48.00	2585.93	1600	11010.42	32.70	4183.93	3800
	Guizhou	25607.00	13310.00	51.98	8032.20	6040	4260.00	32.00	690.12	1620	3460.00	26.00	1377.08	3980
	Sichuan	27223.65	16517.30	60.67	7485.35	4530	5104.90	30.91	765.74	1500	5879.90	35.60	2204.96	3750
Southern Gansu and Southern Shanxi	Subtotal	48238.50	22774.78	42.21	9705.26	4260	8113.11	35.62	1216.97	1500	7928.17	34.81	2963.33	3740
	Gansu	38199.50	18152.26	47.52	7924.55	4360	6507.59	35.85	976.14	1500	5981.17	32.95	2242.94	3700
	Shanxi	10039.00	4622.52	46.05	1780.71	3850	1605.52	24.73	240.83	1500	1947.00	42.12	720.39	3700
Middle-lower reaches of Jialing	Sichuan	112674.40	70096.66	62.21	31674.96	4520	20436.89	29.16	3065.53	1500	25032.85	35.71	9387.32	3750
Three Gorges	Subtotal	24367.07	14175.16	58.17	8178.01	5770	2523.18	17.80	378.48	1500	4323.43	30.50	1621.29	3750
	Sichuan	18777.40	11118.93	59.21	6556.29	5900	1892.07	17.02	283.81	1500	3256.32	29.29	1221.12	3750
	Hubei	5589.67	3056.23	54.68	1621.72	5310	631.11	20.65	94.67	1500	1067.11	34.92	400.17	3750

Soil Erosion Prone Area and Erosion Loss

Heavy				Extra Heavy				Serious			
Area	% of total soil erosion prone area	Average annual erosion loss	Average erosion modulus	Area	% of total soil erosion-prone area	Average annual erosion loss	Average Erosion Modulus	Area	% of total soil erosion prone area	Average annual erosion loss	Average erosion modulus
38068.66	22.32	24635.66	6470	13782.20	8.08	14781.4	10700	4459.11	2.62	73933.30	16580
10350.91	16.30	6640.33	6415	5283.75	8.32	5804.93	10990	1986.34	3.13	3439.60	17320
4511.91	13.40	2797.38	6200	1447.85	4.30	1665.03	11500	538.74	1.60	942.80	17500
2396.00	18.00	1605.00	6700	1996.00	15.00	2300.00	1152	1198.00	9.00	2060.00	17200
3443.00	20.84	2237.95	6500	1839.90	11.14	1839.90	10000	249.60	1.51	436.80	17500
4577.06	20.10	2953.88	6450	1700.82	7.47	1819.31	10707	455.62	2.00	751.77	16500
3870.06	21.32	2515.54	6500	1337.82	7.37	1438.16	10750	455.62	2.51	751.77	16500
707.00	15.30	438.34	6200	363.00	7.85	381.15	10500	n.a.	n.a.	n.a.	n.a.
18462.89	26.34	12000.88	6500	4402.03	6.28	4402.03	10000	1762.00	2.51	2819.20	1600
4677.80	33.0	3040.57	6500	2395.60	16.90	2754.94	11500	255.15	1.80	382.73	15000
3805.96	34.23	2473.87	6500	1912.53	17.20	2199.44	11500	252.05	2.26	378.08	15000
871.84	28.52	566.70	6500	483.07	15.81	555.53	11500	3.10	0.10	4.65	1500

Source: Commission Office for Soil-Water Conservation 1990

In Bijie District, Guizhou Province, farmland on $> 15^\circ$ slopes accounts for 50 per cent of the total farmland. In Hezhang County District, the soil erosion from farmland on $> 25^\circ$ slopes accounts for 70 per cent of the total soil erosion.

Low Frequency of Soil Erosion and Short Duration of Rainy Periods

Some field work on soil erosion carried out in Suining County, Sichuan Province, suggests that the precipitation intensity - 10mm/h can be used as the critical precipitation intensity in Sichuan Basin at the point where soil erosion begins. According to weather data on the precipitation regime, the number of rainy days with a 10mm/h precipitation intensity coincides with a precipitation rate of >25 mm/day and the number of heavy soil erosion days coincides with the number of rainstorms (>50 mm/day).

Table 4.4 lists data from the Anning Basin on annual precipitation, runoff, and sediment discharge (Chai Zong Xin 1985).

Table 4.5 lists data from the Qiong Basin on precipitation, runoff, and sediment discharge (Commission Office for Soil-Water Conservation 1988).

Jinsha River has the highest annual erosion rate of up to 466 million tons, accounting for 33.2 per cent of the total. Next comes the Jialing River accounting for 27.1 per cent of the total, then the Min River, and a section of the mainstream of the Yangtze JIang in eastern Sichuan Province account for 13.8 per cent and 12.8 per cent of the total respectively.

Characteristics of Soil Erosion in the Upper Reaches of the Yangtze JIang

There is a pronounced seasonality in soil erosion. There are variations in annual precipitation and soil erosion. Accordingly, the annual precipitation in the region is concentrated in the period ranging from May to September. Therefore, soil erosion caused by water takes place mainly in the same period; especially from June to August. For example, in the Anning River area of the Xichang Prefecture of Western Sichuan Province, annual precipitation, runoff, and sediment discharge are variable and mutually effective. This is shown in Table 4.4 and in Figure 4.1.

The variation in soil erosion has seasonal characteristics, depending upon the natural conditions as well as upon anthropogenic activities. The variations have been divided into four stages.

- 1) In the dry season - a period of light soil erosion.
- 2) In the early rainy season - a period of heavy soil erosion. This is because soil erosion occurs on the farmlands in hilly and mountainous areas that are exposed to precipitation, therefore the soil erodes easily. The soil loss in this period accounts for 50 per cent of the total annual amount. According to Chongqing's data on water and soil conservation, soil erosion on the uncultivated and open land in May accounts for 58 per cent of the total annual amount in the region.
- 3) In mid-rainy season - a period of medium soil erosion. Rainy season means the maximum precipitation months, and this varies from place to place, although, in general, it ranges from the final ten days of June to the final ten days of August. The soil erosion is comparatively less than in previous periods because of the dense coverage by crops.
- 4) End of the rainy season - a light soil erosion period. From September to October, precipitation is characterised by a long rainfall duration and a low precipitation intensity. In addition, with a high average of mature crops, the soil does not erode so easily.

Table 4.4: Variations in Annual Precipitation, Runoff, and Sediment Discharge in the Anning River Basin

Item	Month/Data	January	February	March	April	May	June	July	August	September	October	November	December	Annual
P	Amount (mm)	2.5	4.0	7.7	28.1	110.8	195.5	213.2	163.4	185.7	113.9	24.1	10.2	1059.1
	Percentage against total	0.2	0.4	0.7	2.7	10.5	18.5	20.1	15.4	17.5	10.7	2.3	1.0	100.0
Runoff	Amount $10^6 m^3$	1.9	1.4	0.7	0.9	1.0	7.2	11.3	10.7	14.3	12.7	5.0	3.1	70.2
	Percentage	2.7	2.0	1.0	1.3	1.4	10.3	16.1	15.2	20.4	18.1	7.1	4.4	100.0
Sediment discharge	Amount $10^4 t$	0.55	0.31	0.20	0.63	17.05	129.81	192.48	110.99	191.26	79.19	4.59	1.77	728.83
	Percentage	0.08	0.04	0.03	0.09	2.34	17.81	26.41	15.23	26.24	10.86	0.63	0.24	100
Sediment Concentration	g/m ³	28.0	23.9	26.4	54.7	635.4	1829.81	1617.49	999.81	1285.4	565.8	87.6	59.9	1024.6

* Precipitation data are based on records from Anning Bridge, Xichang, and Hetan Stations on the mainstream of the Anning River. Runoff sediment and sediment concentration data are based on records from Lantan Station located at the mouth of the Anning River.

Source: Chai Zong Xin 1985

Table 4.5: The Variation in Annual Precipitation, Runoff, and Sediment Discharge in Qiongliang Basin

Item	Month Data	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual	Maximum Month		Max. three months		Max. five months	
		Amount (mm)	15.7	16.3	26.7	70.7	112.5	1248	179.9	157.2	152.0	79.3	36.2	15.8	986.9	Months	Amount	Months	Amount	Months
P	Percentage against total	1.6	1.7	2.7	7.2	11.4	12.6	18.2	15.9	15.4	8.0	3.7	1.6	100			1.6	1.7	2.7	7.2
Runoff	Amount (10 ⁶ m ³)	0.1483	0.2635	0.3430	0.5705	0.7444	1.3639	2.8024	2.0984	1.8103	1.0600	0.5050	0.1918	11.91	Runoff	Amount (10 ⁶ m ³)	0.1483	0.2635	0.3430	0.5705
	Percentage	1.25	2.38	2.88	4.79	6.25	11.62	23.52	17.35	15.20	8.90	4.24	1.61	100		Percentage	1.25	2.38	2.88	4.79
Sediment discharge	Amount (10 ⁴ T)	0.23	0.034	0.045	0.721	2.812	6.013	43.788	41.741	16.203	1.013	0.394	0.023	112.6	Sediment discharge	Amount (10 ⁴ T)	0.23	0.034	0.045	0.721
	Percentage	0.02	0.03	0.04	0.64	2.32	5.34	38.87	37.07	14.36	0.90	0.35	0.03	100		Percentage	0.02	0.03	0.04	0.64

Source : Commission Office for Soil-Water Conservation 1988

The number of rainy days (> 25 mm/day) varies from place to place. Generally in the mountainous areas of western and northeastern Sichuan Province, the number of rainy days varies from 10 and 18 days (e.g., in the Wu Bash). In northwestern Yunnan Province, the number ranges from three to 8 days, and hence the number of days when soil erosion is heavy is less and the frequency of soil erosion occurrence lower than in other areas described.

The days when daily precipitation is > 25 mm mainly occur from May to October and are concentrated in July and August. For example, in the Emel Mountain Area, the days with precipitation of > 25 mm fall in July (4.76) and August (6.8). The total number of days in July and August account for 62.5 per cent of the total annual number of days when precipitation is > 25 mm. In Yibin District, the days in August having a precipitation of > 25mm account for 33 per cent of the total number of days, indicating that soil erosion occurrences are concentrated in the rainy season (Chengdu Institute of Mountain Disasters and Environment 1988).

Regionalisation of Soil Erosion in the Upper Reaches of the Yangtze JIang

The regionalisation of soil erosion programmes are meant to help in water and soil conservation. The soil erosion process, as a whole, involves many factors and their interactions, producing certain types of soil erosion at specific locations. The factors affecting soil erosion are climate, topography, soil, vegetation, and human activities (Integrated Survey Team for Soil-Water Conservation in the Yangtze River Basin 1986).

Principles of the Regionalisation of Soil Erosion

In programmes dealing with the regionalisation of soil erosion, five principles should be considered,

- 1) The natural factors contributing to soil erosion should basically be the same.
- 2) Types of soil erosion should be similar.
- 3) Socioeconomic development differences should not be too disparate.
- 4) The ways in which water and soil conservation and natural resource uses are handled should basically be the same.
- 5) Administrative and physical boundaries should be taken into consideration (Integrated Survey Team for Soil-Water Conservation in the Yangtze River Basin 1986).

Criteria for Regionalisation of Soil Erosion

A lot of work has been carried out on the regionalisation of soil erosion. Because the Yangtze is a system, the regionalisation of the basin should be considered first.

The Northwest Institute of Water and Soil Conservation has carried out some work on the regionalisation of soil erosion in the Yangtze Basin by using a three-level regionalisation system. The first level in the system is known as the collective belt, then the belt is divided into small areas called zones, then further into sub-zones.

The area of a soil erosion belt is based on topography, climate, vegetation, soil, land use, and impacts of land use on soil erosion. According to these factors, the Yangtze JIang Basin can be divided into eight belts.

- (I) The Yunnan - Guizhou Plateau Belt.
- (II) The Sichuan Basin Belt.
- (III) The hill and mountain areas south of the Yangtze.
- (IV) The Qin Ba Dable Mountain Belt.
- (V) The Wuling Mountains.
- (VI) The Plains' Belt in the middle-lower reaches of the Yangtze
- (VII) The Hengduan Mountain Belt.
- (VIII) The Qinghai-Tibetan Plateau.

The second level in the context of regional soil erosion is the "zone" and is based on soil erosion intensity. To determine the soil erosion intensity of each particular type, both the soil erosion-prone area and the modulus of soil erosion have been taken into consideration. Soil erosion intensity is classified into five categories; namely, extra light, light, medium, heavy, and extra heavy.

The "sub-zone" is the lowest level of the system and it is based on the combination of major types of soil erosion in each "sub-zone". There are usually not more than three major types of soil erosion.

Figure 4.2 and Table 4.6 shows the regionalisation scheme for the Yangtze Basin.

The Commission Office for Soil-Water Conservation (1990) has divided the region into four areas.

1) **Extra Light Soil Erosion Region**

The upper and middle reaches of the Jinsha, Yalong, and Dadu, the upper reaches of the Min, Bailong, and the Chengdu Plain falling into this region, accounting for an area of 0.4742 million sq. km. In the high mountains of the region, natural soil erosion is prevalent because of the low population and good vegetation.

2) **Light Soil Erosion Region**

Mountains on the northeastern and northwestern fringe of Sichuan Basin, the middle and lower reaches of the Wu, and the upper reaches of the Ji are in this region and cover a total area of 0.1762 million sq. km. The annual surface erosion is 209.15 million tonnes.

3) **Medium Soil Erosion Region**

The middle-lower reaches of the Jialing, lower reaches of the Min and Yalong, the upper reaches of the Wu, the Chishui River Basin, the Niluan River Basin, the Huang Basin, and sections of the basin of the Upper Reaches of the Yangtze from Chongqing to Yichang are in this region. The total coverage of the region is 0.24131 million sq.km. with annual surface erosion of 769.94 million tonnes.

4) **Heavy Soil Erosion Region**

The region covers the upper reaches of the Jialing, the middle and lower reaches of the Bailong, the lower reaches of the Yalong Basin with a total area of 0.1120 million sq.km. The annual surface erosion is 383.52 million tonnes of which 120.23 million tonnes are a result of gravitational erosion.

Table 4.6: The Soil Erosion Regionalisation Scheme in the Yangtze Basin

Zone	Sub-zone	Soil Erosion Intensity	Region	Major Natural Environmental Conditions	Soil Erosion Type
I. Yunnan-Guizhou Plateau	Jinsha Valley	Extremely heavy soil erosion	Zhaotong	High mountains and deep valley; yellow mountain soil and red soil; one crop per annum; dry farmland accounts for 85% of the total farmland.	Squamosse erosion on barren land; sheet erosion on farmland.
			Yongren	Purple soil, hot and dry.	Squamosse erosion on barren land; gully erosion on forest land.
			Dayao	Purple soil with shallow topsoil.	Squamosse erosion and gully erosion.
			Weixin	Yellow mountain soil; secondary forests dominate in the foothills and low mountains.	Squamosse erosion on barren and forest land; sheet erosion on farmland.
			Bijie	Limestone is prevalent; purple stone can be observed in the mountain basins.	Squamosse erosion on forest land and sheet erosion on farmland.
			Hezhang	Red soil.	Squamosse erosion on forest land and barren land; rill erosion on farmland.
			Heishuitou	Red soil; mountains and hills.	Squamosse erosion on barren land; gully erosion on forest land.

Source: Northwestern Institute of Soil and Water Conservation, CAS, 1986

Zone	Sub-zone	Soil Erosion Intensity	Region	Major Natural Environmental Conditions	Soil Erosion Type
I.	Eastern plateau of Yunnan Province and southwestern mountains of Sichuan Province	Heavy soil erosion	Kunming	Major agricultural area in Yunnan Province; most of the area has no natural forest.	Concealed erosion; squamose erosion on barren land.
			Wuding	Most of the farmland is dry and has little paddy land.	Sheet erosion on farmland; squamose erosion on forest land and barren land.
			Chuxiong	Purple entisol and real entisol; topsoil less than 50cm.	Sheet erosion on dry farmland; concealed erosion on paddy; squamose on forest land.
			Binchuan	Purple stone and limestone; red soil and paddy soil; dry and warm.	Squamose erosion on barren land; gully erosion on farmland in the foothills.
			Xichang	Mountain red soil; deforestation and overgrazing are serious; steep slope cultivation is popular; one of the rainstorm centres in China.	Gully erosion and sheet erosion on sloping farmland; concealed erosion on paddy; squamose erosion on forest land.
			Huili	Low mountains and foothills; outcrop of purple stone; low natural vegetation coverage; popular steep slope cultivation.	Sheet erosion and gully erosion on steep farmland; squamose erosion on forest land.
			Liangshan	Mountains and valley; forest distributed on high mountains and farmland in valleys and hills.	Squamose erosion on barren and forest land in high mountains; sheet erosion and gully erosion on farmland in valleys and foothills.
			Shuimian	Mountain area in Dadu River Basin; dry and hot in valley; 30% of the total farmland is on slopes of > 30°.	Gully erosion on farmland; squamose erosion on forest land.
			Daxiangling	2,000 masl with natural forest, few human activities.	Squamose erosion on forest land.

Zone	Sub-zone	Soil Erosion Intensity	Region	Major Natural Environmental Conditions	Soil Erosion Type
	Central mountains of Guizhou Province	Medium erosion	Guiyang	Foothills with small plains.	Squamoso erosion on barren land; concealed erosion on paddy land.
			Zunyi	Purple stone is distributed throughout the foothills, no natural forest.	Squamoso erosion on barren land; sheet erosion on farmland; concealed erosion on paddy land.
			Meitan	Mountains with large forest areas.	Sheet erosion and gully erosion in purple stone mountains; squamoso erosion on barren land; sheet erosion on sloping farmland.
	Northern mountains of Guizhou Province	Light erosion			
II. Sichuan Basin	Central hills of Sichuan Basin	Extremely heavy erosion	Nanchong Ziyang	Agricultural area	Sheet erosion and gully erosion on farmland.
	Eastern low mountains and hills of Sichuan Basin	Heavy erosion	Wanxian	Agricultural area	Sheet erosion on farmland; concealed erosion on paddy land; squamoso erosion on barren land.
			Chongqing	High anticlinal mountains and hills	Sheet erosion on farmland; squamoso erosion on forest land.
				Low mountains, foothills with wide valleys;	Sheet erosion on farmland, concealed erosion on paddy land; squamoso erosion on forest land.

Zone	Sub-zone	Soil Erosion Intensity	Region	Major Natural Environmental Conditions	Soil Erosion Type
			Xishui	Fold zone in northwestern part; anticline in southwestern part; low mountains and hills in eastern part.	Sheet erosion on farmland; concealed erosion on paddy land.
			Wusheng	Foothills and wide valleys; farmland accounts for 35-45% of total area.	Sheet erosion on farmland; concealed erosion on paddy land.
			Quixian	High hills and narrow valleys; farmland accounts for 16-26% of total area; vegetation coverage 60%.	Sheet erosion on dry farmland; squamose erosion on forest land.
	Central low mountains hills of Sichuan Basin	Medium erosion	Nan Bu	Middle hills and wide valleys; farmland accounts for 40% of total area.	Sheet erosion on dry farmland; concealed erosion on paddy land.
Hills			Zigong and Lezhi	Foothills and wide valleys; high reclamation ratio; 60-70%.	Sheet erosion on dry farmland; concealed erosion on paddy land.
	Fringe low mountains and hills of Sichuan Basin	Light erosion	Tongjiang	Extended range of Daba Mountains; rich in forest with 80% coverage.	Sheet erosion on dry farmland; squamose erosion on forest land.
			Mianyang	Hills; high reclamation ratio.	Sheet erosion on dry farmland; concealed erosion on paddy land; gully erosion on steep slope farmland.
			Yaan and Muchuan	Rich in natural vegetation with 80% coverage.	Sheet erosion on dry farmland; squamose erosion on forest land.
			Leshan	Foothills; rare natural vegetation and forest on small scale; high reclamation ratio.	Sheet erosion on dry farmland; concealed erosion on paddy land; squamose erosion on forest land.

Zone	Sub-zone	Soil Erosion Intensity	Region	Major Natural Environmental Conditions	Soil Erosion Type
	Chengdu Plain	Light erosion		Rare natural vegetation; dense population; high reclamation ratio; two crops or three crops per annum; annual average temperature: 17°C; annual precipitation about 1,000mm.	Concealed erosion on paddy
	Southern mountains and hills of Jianxi Province	Extremely heavy erosion	Ganzhou	Red soil with shallow topsoil.	Sheet erosion on dry farmland; gully erosion on steep slopes.
			Guangchang and Ningdu	Red soil and purple soil; rare natural vegetation.	Gully erosion and squamose erosion on barren and forest land.
			Dongxiang	Red soil developed on red stone of tertiary period, shallow topsoil.	Sheet erosion on dry farmland; squamose erosion on barren and forest land; gully erosion on hill tops.
			Nanchang	Red soil developed on red stone of tertiary period.	On hills, squamose erosion on barren land; gully erosion on hilltops; sheet erosion and rill erosion on cash crop land; concealed erosion on paddy.
	Hills of Hunan and Jiangxi provinces	Heavy erosion	Guoan	Foothills; red soil developed on red stone of tertiary period; rare natural vegetation.	Squamose erosion and gully erosion on barren land; sheet erosion on dry farmland.
			Jian	Red soil.	Sheet erosion on dry farmland; squamose erosion on forest land.
			Hengyang	Hills; rare natural vegetation.	Squamose erosion on barren land; gully erosion on steep slopes; sheet erosion on dry farmland.

Zone	Sub-zone	Soil Erosion Intensity	Region	Major Natural Environmental Conditions	Soil Erosion Type
			Changsha	Red soil.	Squamosse erosion and gully erosion on barren land; concealed erosion on paddy land.
			Pingjiang		Squamosse erosion on barren and forest land; gully erosion on small scale in some locations.
			Shaoyang		Squamosse erosion on barren land; sheet erosion on forest land; concealed erosion on paddy land.
			Tongsha and Yangxin	Mountains; rich in natural vegetation with 60-80% coverage.	Squamosse erosion on barren and forest land; sheet erosion on dry farmland; gully erosion on steep slopes.
			Jianxin	Hills in northern part of the region; low mountains in southern part of the region.	Squamosse erosion on forest land; concealed on paddy land; gully and sheet erosion in some locations.
			Tianmu and Wuyi mountains	Brown soil, grey-brown soil, red soil and yellow soil, rich in natural forest.	Squamosse erosion on forest land and barren land; sheet erosion and ripple erosion on cash crop land.
			Yihuang	Brown soil, red soil, and purple soil; higher forest coverage.	Squamosse erosion on forest land and barren land; sheet erosion on dry farmland.

Zone	Sub-zone	Soil Erosion Intensity	Region	Major Natural Environmental Conditions	Soil Erosion Type
	Southern fault mountains of the Yangtze River Basin	Medium erosion	Xiushui	Mountain areas with altitudes ranging from 600 to 1000 masl; brown soil, grey-brown soil, yellow soil, red soil, and purple soil; rich in natural vegetation.	Squamoso erosion on forest land and barren land; gully erosion on cash crop land.
			Luoxiao Mountain	Brown soil, red soil, and yellow soil; purple soil in scattered locations; rich in natural vegetation.	Squamoso erosion on forest and barren land; Gully erosion in some low mountains and hills.
			Daoxian	Hilly area.	Squamoso erosion on barren and forest land; sheet erosion on dry farmland.
IV. Qin-BaDabie mountains	Valleys, low mountains, hills in Hanshui River Basin	Extremely heavy erosion	Hanzhong and Ankong	Agricultural area.	Sheet erosion on dry farmland; Squamoso erosion on barren land; concealed erosion on paddy land.
			Zhenan	Deforestation is serious.	Squamoso erosion on barren land; sheet erosion and sheet erosion on dry farmland.
			Guangyuan and Huicheng	Loess; less precipitation.	Squamoso erosion on barren land; gully erosion and sheet erosion on dry farmland.
	Dahong-Dabie Mountains	Heavy erosion	Yuexi and Yingshan	Deforestation is serious.	Squamoso erosion on forest land; gully erosion on barren land.
			Hongnan and Macheng	Low mountains and foothill area; large amount of sloping farmland.	Sheet erosion and gully erosion on dry farmland.
			Suixian and Anlu	Hilly area; red soil; higher reclamation ratio.	Sheet erosion on dry farmland; concealed erosion on paddy land.

Zone	Sub-zone	Soil Erosion Intensity	Region	Major Natural Environmental Conditions	Soil Erosion Type
			Dahongshan	Low mountain and hill areas.	Squamoso erosion on forest and barren land; sheet erosion on dry farmland.
			Wanyuan		Squamoso erosion on forest and barren land; sheet erosion on dry farmland.
	Daba Mountains	Medium erosion	Wushan and Zigui	Low mountain and hill areas; purple stone is predominantly distributed; deforestation is serious.	Sheet erosion on dry farmland; squamoso erosion on barren land; denudation on outcrops.
	Northern Qingling Mountain and Motianling Mountains	Light erosion	Fuping	High mountain area; farmland accounts for 3% of total area; rich in natural vegetation.	Squamoso erosion on forest and barren land; sheet erosion on dry farmland.
			Xigu	Higher forest coverage in southern part.	Squamoso erosion on forest land and barren land; sheet erosion on dry farmland.
			Motianling mountains	Mountain area with altitudes ranging from 500 to 2,300 masl; annual average temperature ranging from 14°C to 15°C; annual precipitation 700-900mm; rich in natural vegetation; farmland accounts for 10% of total area.	Squamoso erosion on forest land; sheet erosion on dry farmland.
	Nanxiang Basin	Extremely light erosion		Agricultural area with high reclamation ratio.	Sheet erosion on dry farmland.
V. Wuling Mountains	Hills and low mountains of Western Hunan Province	Heavy erosion	Yanling	Purple stone is widely distributed.	Sheet erosion on dry farmland and cash crop land; squamoso erosion on barren land.

Zone	Sub-zone	Soil Erosion Intensity	Region	Major Natural Environmental Conditions	Soil Erosion Type
			Sangzhi		Squamosse erosion on forest and barren land; sheet erosion on dry farmland.
	Northern part of Wuling Mountain	Medium erosion	Qianjiang	Deforestation is serious.	Squamosse erosion on barren land; sheet erosion on dry farmland.
			Lichuan	Mountain area; rich in natural forest with 80% coverage.	Squamosse erosion on forest land; sheet erosion on dry farmland near settlements.
	Wuling-Xuefeng Mountain	Light erosion	Hafeng	High mountain area; rich in natural forest.	Squamosse erosion on forest and barren land; denudation on outcrops.
			Bajing	Shallow topsoil; Karst well developed.	Squamosse erosion on forest and barren land; sheet erosion on dry farmland.
			Jinping	Mountain area, rich in forest.	Squamosse erosion on forest and barren land.
VI. Plain in middle and lower reaches of the Yangtze River	Lacustrine plain and alluvial plain	Medium erosion	Nanjing	Foothills; yellow-cinnamon soil; yellow-brown soil, and paddy soil.	Squamosse erosion on barren land; sheet erosion on dry farmland; concealed erosion on paddy land.
			Hefei		Sheet erosion on dry farmland; concealed erosion on paddy land.

Zone	Sub-zone	Soil Erosion Intensity	Region	Major Natural Environmental Conditions	Soil Erosion Type
	Jiangnan Plain, Boyang lacustrine plain and Boyong alluvial plain	Light erosion	Jiangnan Plain Wishui and Wangjiang Lacustrine plain and alluvial plain by Boyang Lake	Total lake surface accounts for 20% of the total area. Red soil.	Concealed erosion. Concealed erosion on paddy; sheet erosion on dry farmland. Concealed erosion.
	Yangtze River Delta	Extremely light erosion	Zhongdian		Natural erosion on grassland; sheet erosion on dry farmland.
	North-western mountains of Yunnan Province	Medium erosion	Lijiang Jinkuang		Squamos erosion on forest and barren land; sheet erosion on sloping farmland. Squamos erosion on barren land; gully erosion on forest land.
VII. Hengduan Mountains	Jiajinshan Mountain	Light erosion		Altitude ranging from 400 - 4000 masl; yellow soil, mountain brown soil, and mountain meadow soil; annual precipitation is from 700 to 1,000mm mainly falling during June, July, and August.	Squamos erosion on forest and barren land; sheet erosion on dry farmland.
	Kandian, Daocheng and Batong	Extremely light erosion		Altitude ranging from 2500 - 7000 masl.	Squamos erosion on grassland; sheet erosion on farmland.

Zone	Sub-zone	Soil Erosion Intensity	Region	Major Natural Environmental Conditions	Soil Erosion Type
VIII. Qinghai-Tibetan Plateau	Maowen Mountain	Medium erosion	Wenchuan	Less precipitation with low intensity and even distribution.	Sheet erosion on farmland.
			Jiuding Mountain and Tiancheng Mountain	Altitude is more than 2,000 masl.	Squamosse erosion on forest land and grassland, sheet erosion on farmland in some locations.
	Aba high mountains, deep valleys, and plateau	Light erosion	Aba	Annual precipitation is about 1,000mm with 50% falling in June through August; acid humus soil, rich in natural vegetation.	Natural erosion.
			Marekan	Rich in natural forest and grassland.	Natural erosion.
	Ganzi, Yushu Plateau	Extremely light erosion	Head of the Yangtze River	High mountains, alpine desert, glacier; altitude is more than 5,000 masl.	Natural erosion.
			Yushu	Grassland, glacier, and alpine desert; animal husbandry area.	Natural erosion.
			Ganzi	Grassland, glacier, and forest land; podzolic soil, bog soil.	Natural erosion.

Source: Northwestern Institute of Soil and Water Conservation, CAS, 1986.

Work on regionalisation of soil erosion in Sichuan Province has been carried out by the Commission for Soil-Water Conservation 1988, and it points out that the total erosion in Sichuan Province amounts to 1,207 million tonnes; the annual erosion modulus is 2,133 T/sq.km./annum. Detailed data are in Table 4.7.

Table 4.7: Regionalisation of Soil Erosion in Sichuan Province

Soil Erosion Region	Soil Erosion-Prone Area			Soil Erosion Loss		
	Area (sq.km.)	% of total land area of Sichuan	% of total erosion area	Average (T/sq.km.)	Total amount (10 ⁴ T)	% of total soil erosion loss
Extra light (a)	316,904.02	56.0		250	7,922	6.6
Light	73,904.61	13.1	29.7	1,500	11,086	9.2
Medium	91,178.23	16.1	36.6	3,750	34,192	28.3
Heavy	59,485.24	10.5	23.9	6,500	38,665	32.0
Extra Heavy	21,568.37	3.8	8.7	11,500	24,804	20.6
Serious	2,680.40	0.5	1.1	15,000	4,020	3.3
Total	248,816.49	44.0	100		120,689	100

Source : Commission Office for Soil-Water Conservation 1988

Note that the total soil erosion area does not include the extra light soil erosion area.

The Chengdu Institute of Mountain Disasters and Environment has divided the Wu Basin into three soil erosion intensities according to the guidelines laid down by The Ministry of Water and Energy of the People's Republic of China, which stipulate six categories as follows:

extra light soil erosion	< 500 T/sq.km./annum,
light soil erosion	500-2500 T/sq.km./annum,
medium soil erosion	2500-5000T/sq.km./annum,
heavy soil erosion	5000-8000T/sq.km./annum,
extra heavy soil erosion	8000-15000T/sq.km./annum, and
serious soil erosion	> 15000T/sq.km./annum.

1) Heavy-Medium Soil Erosion Region

The plateau and mountains in the upper reaches of the Wu cover a total area of 20,130.123 sq.km., accounting for 23.26 per cent of the total basin area. The average erosion modulus is 4,499.4 T/sq.km./annum; surface erosion and gully erosion are prevalent in the region.

2) Light Erosion Region

This region is in the middle reaches of the Wu and covers an area of 25,001.65 sq.km., accounting for 28.89 per cent of the total Wu Basin. The soil erosion-prone area in the region covers 1,16,030.0 sq.km. accounting for 46.41 per cent of the total regional area. Most of the counties in the region have an average modulus of 2,300 T/sq.km./annum. Squamose erosion is prevalent in the region with gully erosion in a few localities.

3) Heavy-Medium Soil Erosion Region

This region is located in the lower reaches of the Wu with a total area of 4,14,206.61 sq.km., accounting for 47.85 per cent of the total Wu Basin. In this region, the soil erosion-prone area covers 20,709.1 sq.km. The average erosion modulus in the region ranges from 6,086.0 sq.km./annum to 5,000.0 T/sq.km./annum. Squamose erosion is prevalent in the region. Sloping farmlands are prone to surface erosion, and, in some localities, gully erosion can be seen.

The Hengduan Mountains

The Hengduan Mountains are latitudinally located between 27° to 31°N and longitudinally between 98° to 103°E. They are bordered by the Qinghai (Tibetan) Plateau to the north, the Sichuan Basin to the east, the Yunnan-Guizhou Plateau to the south, and the Lancang River to the west.

A vertical distribution of climate, vegetation, soil, and human activities is distinctively observed in the Hengduan Mountains. Annual average precipitation in this region ranges from 700 to 1,100mm. The rainy season is from June to September, and the region experiences pronounced wet and dry seasons.

Most of the region is still in the natural erosion stage because of its inaccessibility, scarce population, and comparatively little human activity. Nevertheless, in devegetated areas and on steep sloping farmlands, soil erosion is heavy, especially in the valleys and inter-montane basins. Medium to heavy soil erosion is widespread because of extensive cultivation and deforestation. In this region, soil erosion varies both vertically and horizontally.

Vertically, alpine desert and glacial erosion can be found in places more than 4,300masl, and, in places below 2,500masl, sheet erosion on farmlands and scale erosion on forested lands occur. Horizontally, in the northern and northwestern parts of the region, natural erosion is prevalent on grasslands. In northern parts of the region, forested lands and grasslands are subject to natural erosion and scale erosion and gully erosion can be found locally.

Qinghai-Tibetan Plateau

The elevation of the headstream of the Yangtze River is more than 5,600masl where frost cleft and wind transportation are prevalent and the secondary factor is glacial erosion. In the valleys, soil erosion is not obvious because of the dense vegetation cover.

The upper reaches of the Dadu River and the Min River flow throughout the high mountains and deep valleys, where light scale erosion on grazing lands and light sheet erosion on farmlands occur, but generally natural soil erosion is prevalent. In the Yalong Valley, soil erosion is not obvious because of the dense vegetation cover and fewer farmlands.

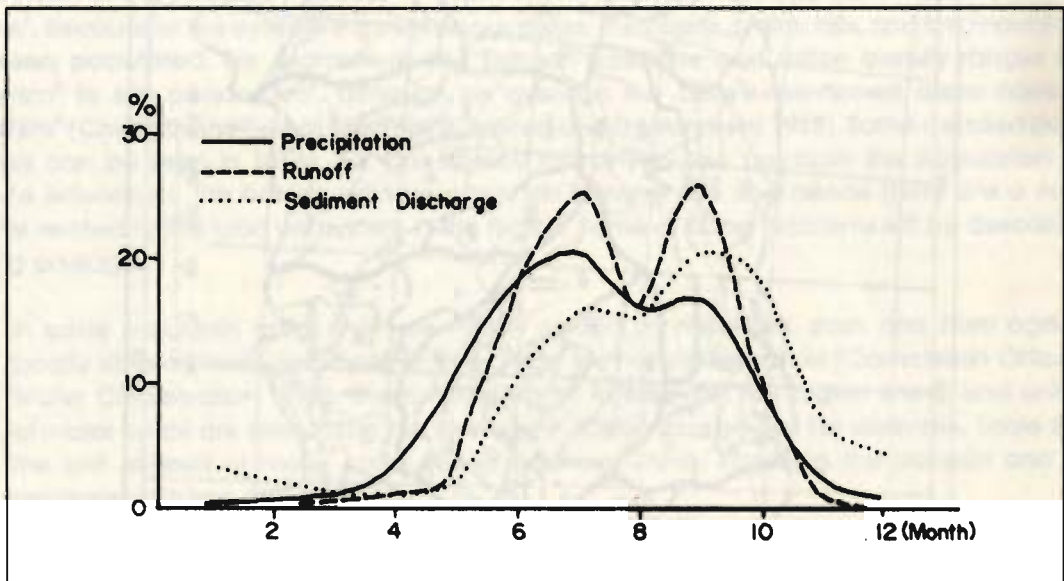
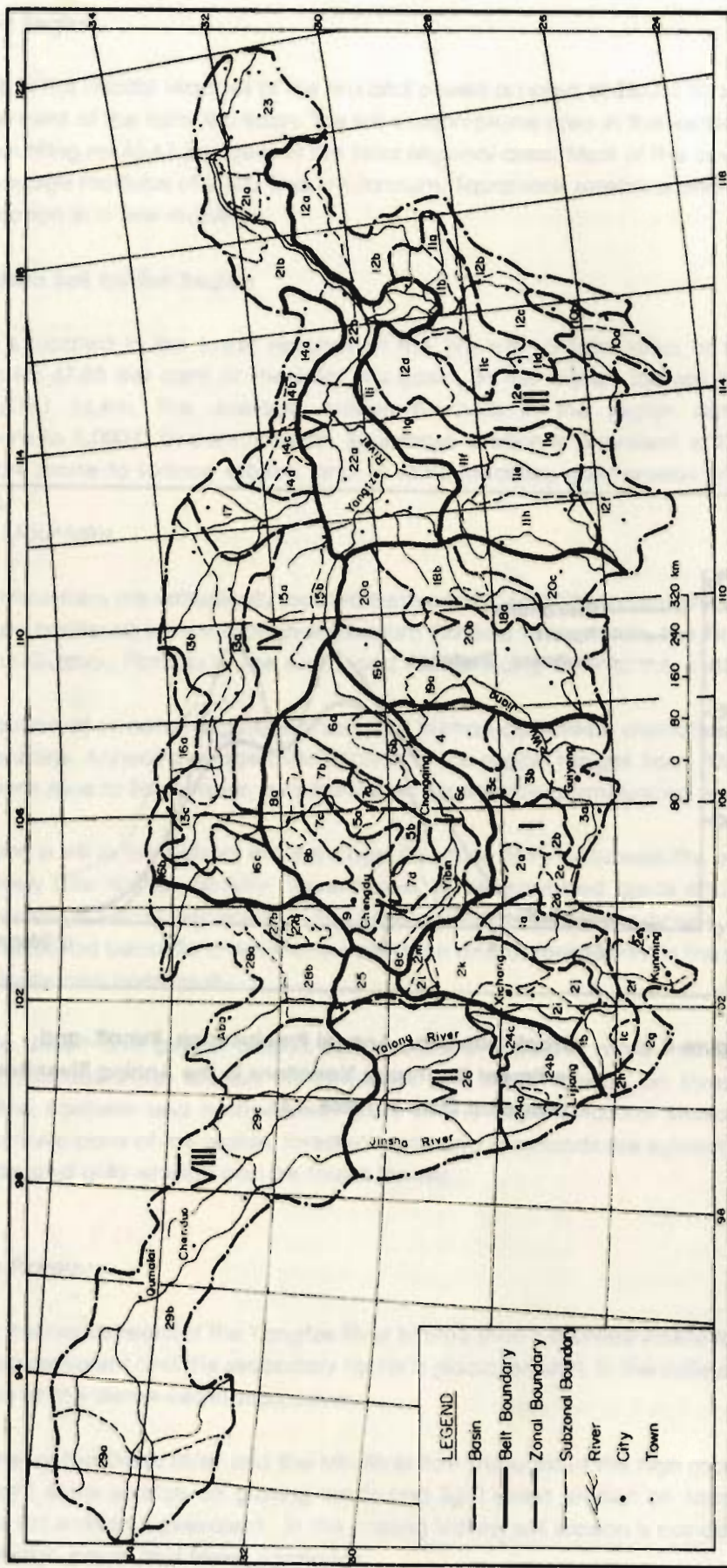


Figure 4.1: Graph Depicting Annual Precipitation, Runoff, and Sediment Discharge Variations in the Anning River Basin (based on Data in Table 4.4)

Figure 4.2: Regional Map of Soil Erosion in the Upper Reaches of the Yangtze



Source: Northwestern Institute of Soil and Water Conservation, CAS, 1986