



Environmental flow assessment in China:

A review of river classification methods

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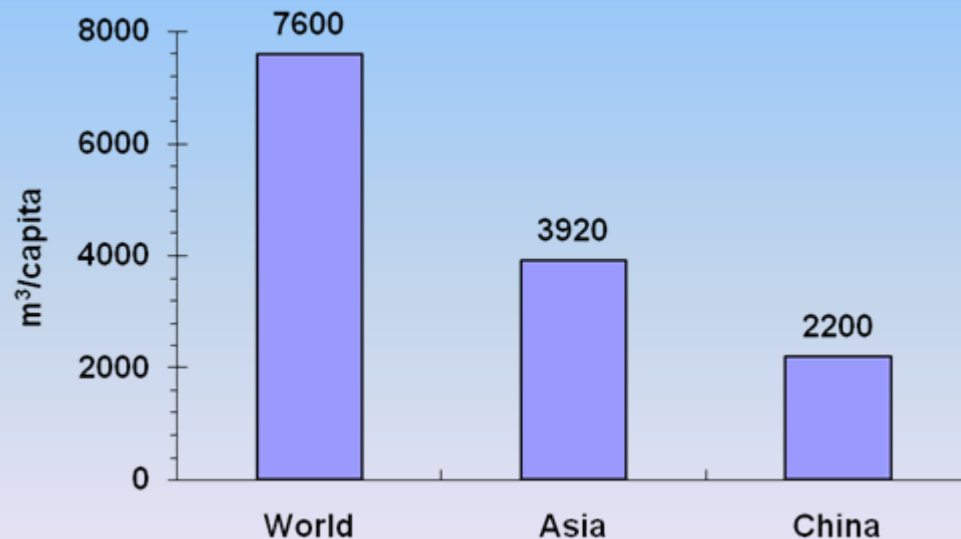
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General introduction of water resources in China



- Total amount of water resources in China – 6th after Brazil, Russia, Canada, US, Indonesia in the world.
- Per-capita amount - 2200 m³, only about 1/4 of the world average.



Ecosystem deterioration due to water shortage



- River courses running dry →

- Wetlands shrinking

- Water pollution ↙



Environmental flow can protect ecosystem health

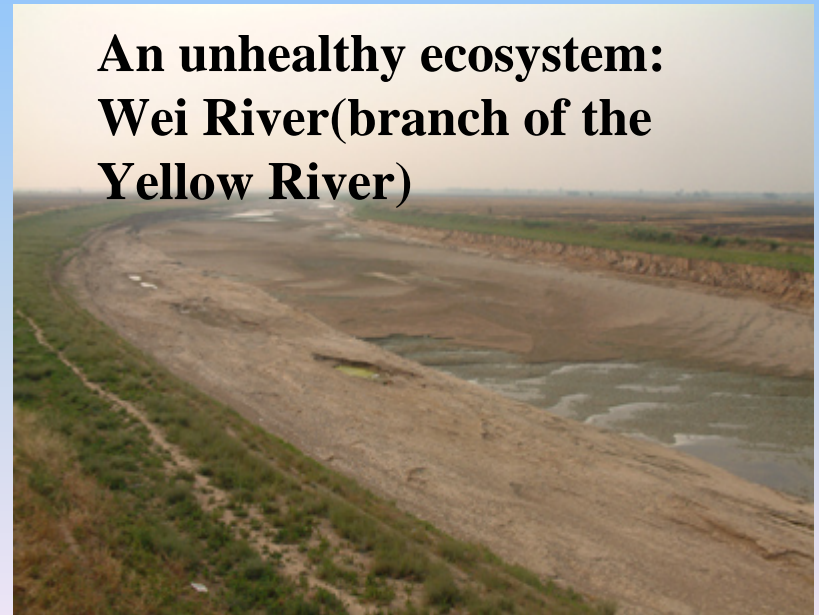


- Characteristic of a healthy river system
- Maintain ecosystems and their functions
- Environmental flows should be considered in integrated water resources management

A healthy ecosystem



**An unhealthy ecosystem:
Wei River(branch of the
Yellow River)**



How to meet environmental flow?



- Policy on environmental flow
- Researches on environmental flow

Policy on environmental flow in China

- China's first Water Law was passed in 1988.
- In this law environmental flow was first legally considered to protect ecosystems.
- China's second Water Law was passed in 2002.
- In this law there are four items on environmental flow.



Concept of ecological environment water requirements in China

Implementation of Water Law in China



- **Ministry of Water Resources (MWR) is responsible for management and supervision of national water resources under Water Law.**
- **MWR grants its 7 river basin committees to manage the water resources within their popedoms.**

Implementation problems of Water Law in China



- **No necessary enforcement measures and detailed rules and regulations to ensure complete performance of Water Law in China.**
- **For the river basin committee, the legislative position and power confirmed in the current Water Law are still unclear.**
- **Detailed rules and regulations for water resources management should be formulated.**

Application of methods of environmental flows in China



- Lookup tables
- Desktop methods
- Functional assessment methods
- Habitat modelling methods
-



River classification method

- Characters of rivers
 - River system
 - Topographical pattern
 - Runoff depth
 - Drought index
 - Hydraulic project

River classification method

➤ With the application of spatial analysis of GIS, expert judgment and qualitative analysis, **10** regions, **44** subregions and **406** sections are divided in China.



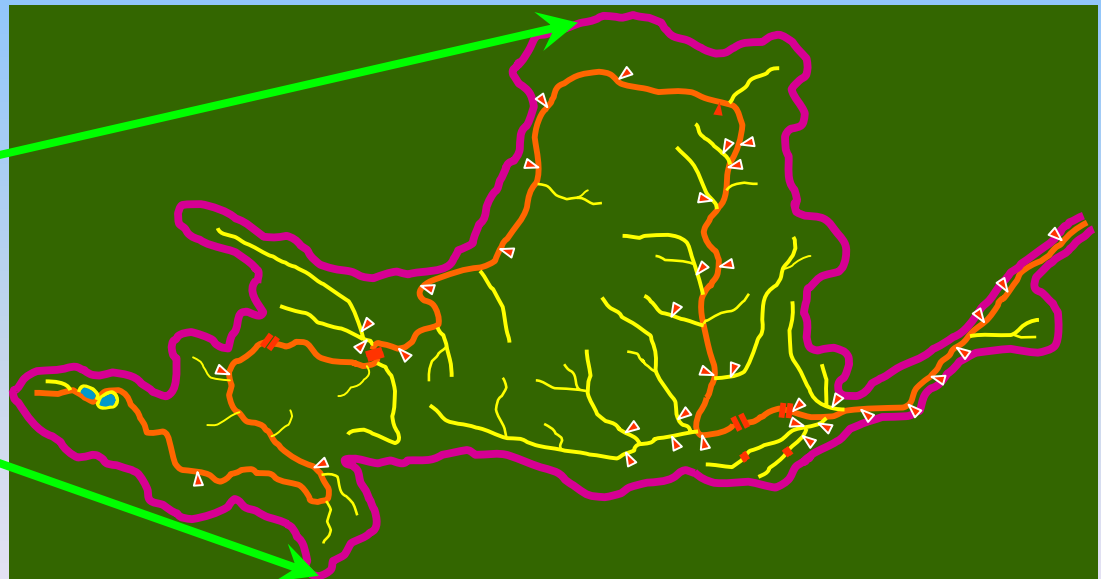
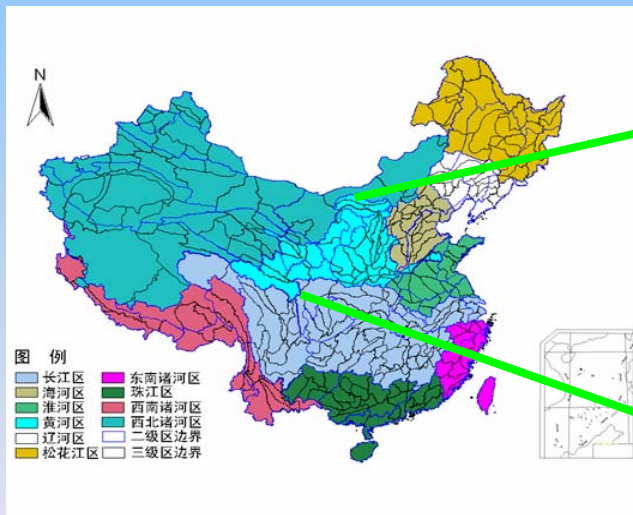
Two grades classification



Three grades classification

River classification method

- The Yellow River is **the second largest river (5,000 km) in China.**





River classification method

- Different types of water requirements
 - consumptive
 - non-consumptive
- The integrated environmental flow requirements can be calculated as follow:

$$W_a = \sum_{i=1}^n W_i + \text{MAX} (W_{j1}, W_{j2}, \dots, W_{jm})$$

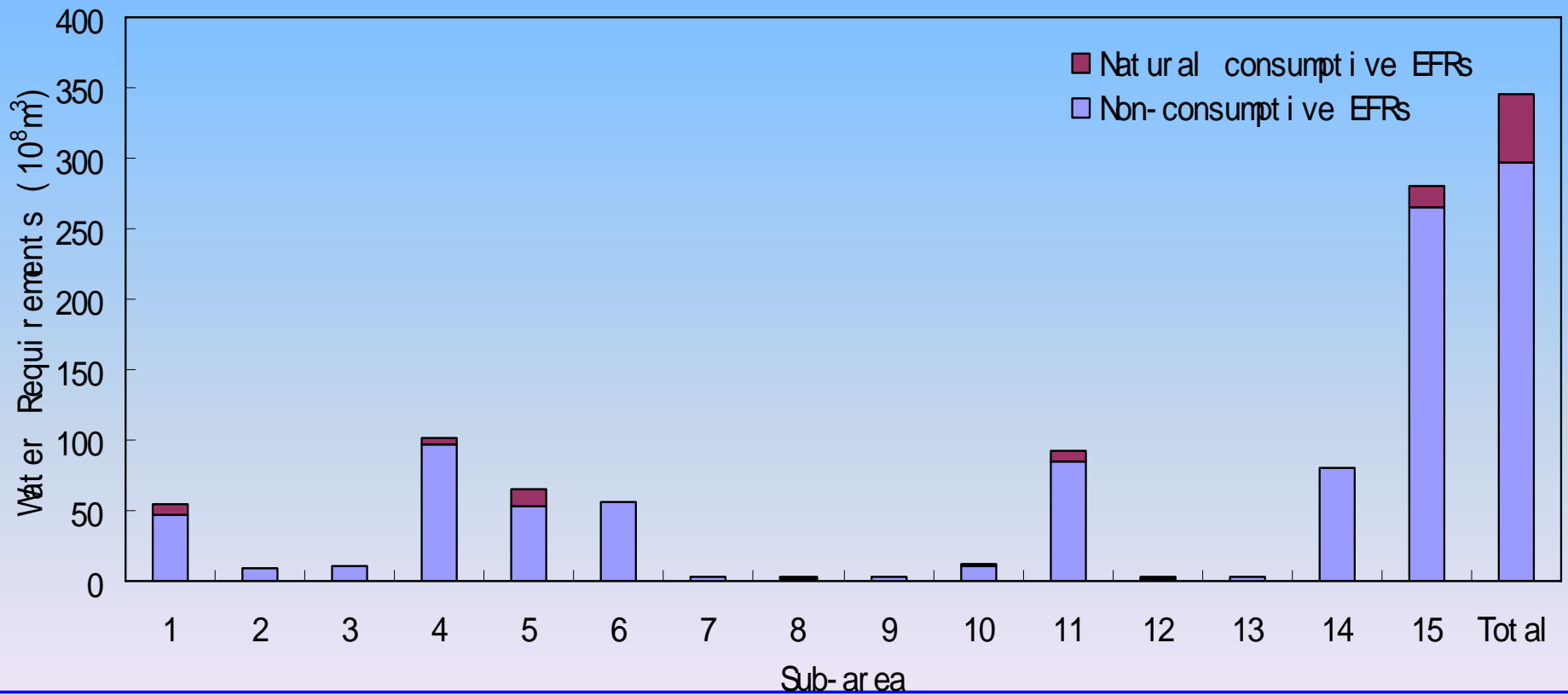
W_a are environmental flows;

$\text{MAX}(a, b)$ denotes the maximum of variables;

W_i is the consumptive water volumes;

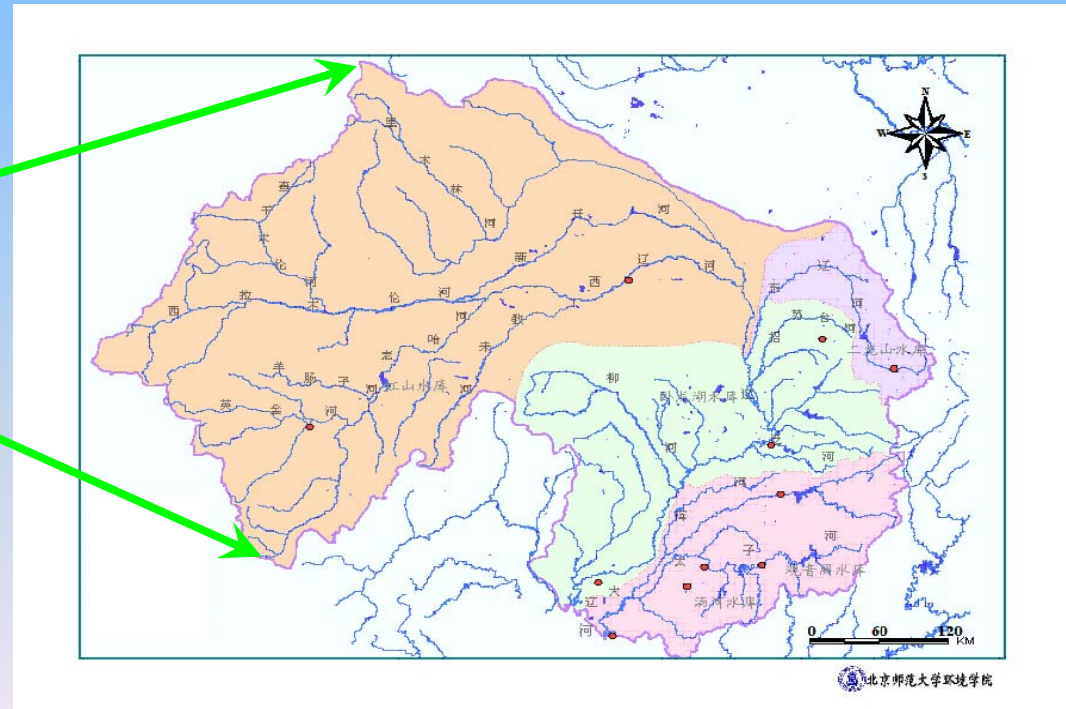
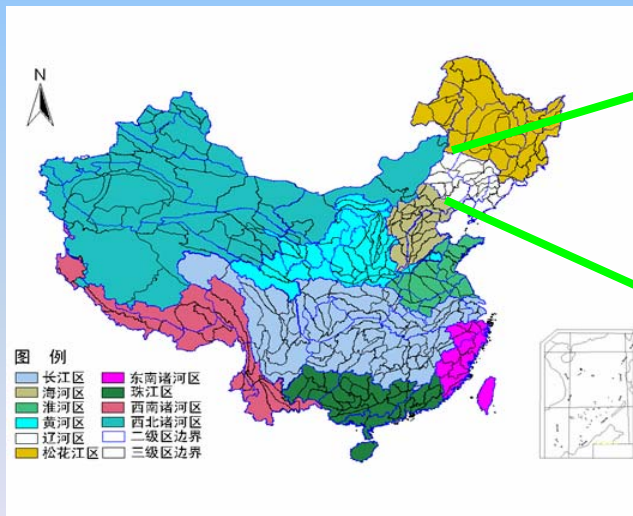
W_j is the non-consumptive water volumes;

River classification method

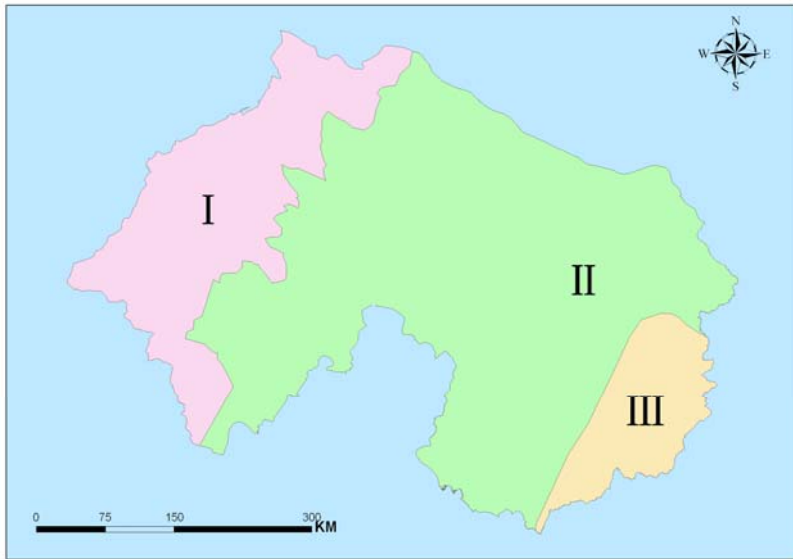


River classification method

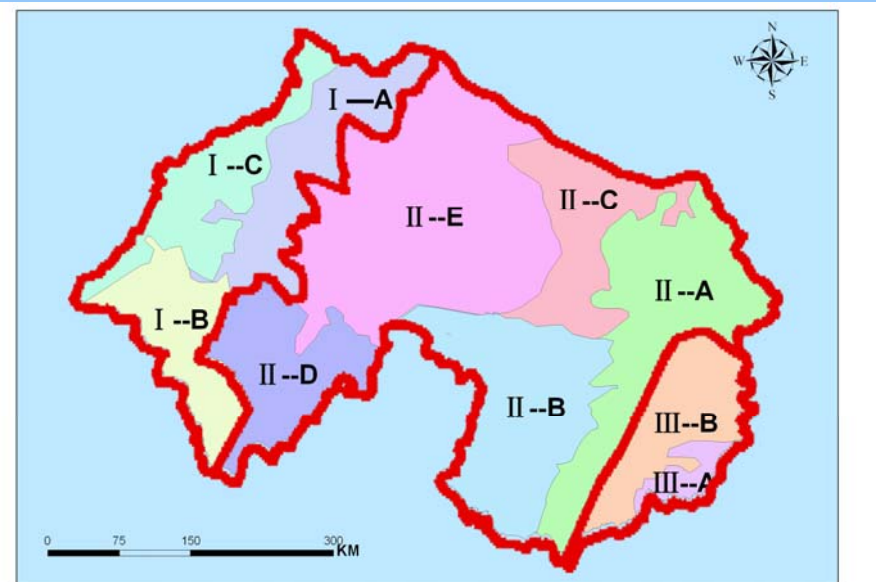
- The Liao River is the largest river in Liaoning Province, Northeast China
- Area - 2.2 million km²



River classification method

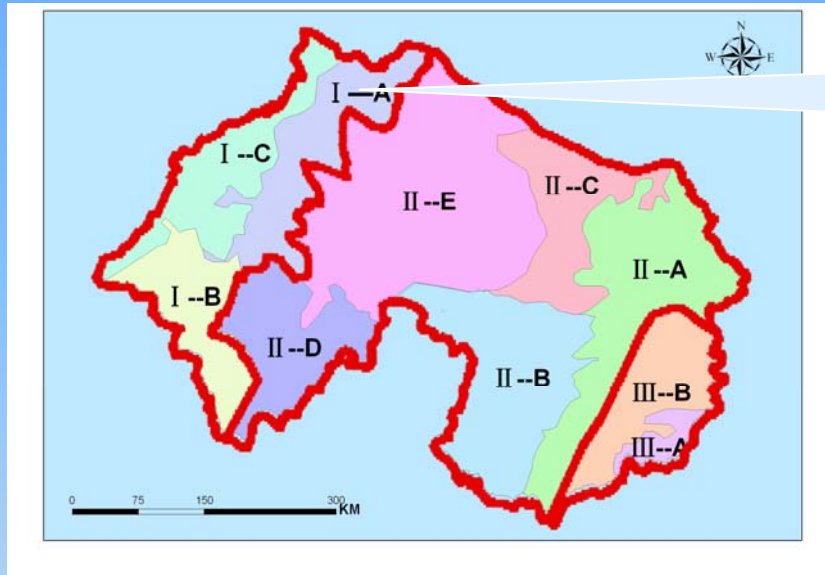


- There are 3 sections and 10 subsections in the basin.



➤ IHA
Indicators of Hydrological
Alteration

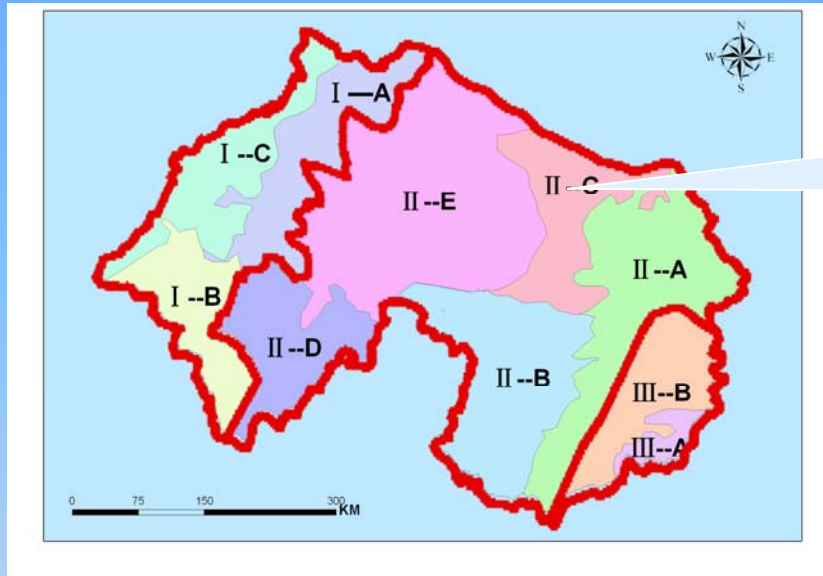
River classification method



I-A
Zhengjiatun Site

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Min	0.00	0.00	0.00	50.45	0.83	0.00	6.90	23.50	3.10	11.10	2.10	0.50	8.21
Suitable	0.00	0.00	0.00	75.25	15.00	54.90	42.20	119.00	38.90	55.10	19.85	0.95	35.10
	90-day min	1-day max	3-day max	7-day max	30-day max	90-day max	Zero days	Date min	Date max				
Min	0.02	92.1	87.23	79.61	60.33	26.47	107	5	210				
Suitable	0.19	349	262.7	219.7	146.1	87.37	50	27	222				

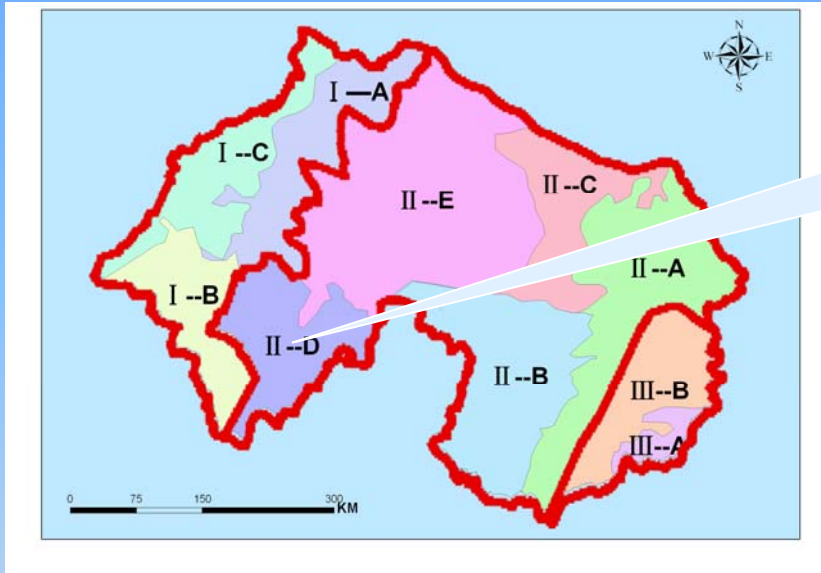
River classification method



II-C
Wangben Site

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year	
Min	0.00	0.00	0.10	1.67	5.14	4.09	4.09	4.09	4.09	5.29	1.56	0.22	2.53	
Suitable	4.09	4.09	4.09	4.09	4.09	31.10	34.90	33.20	6.34	6.76	5.12	3.79	11.80	
	1-day min	3-day min	7-day min	30-day min	1-day max	3-day max	90-day max	Zero days	Base flow	Date min	Date max	Lo pulse #	Hi pulse L	Rise rate
Min	0	0	0	0	21.6	18.73	5.612	85	0	340	278	2	1	0.25
Suitable	1.77	1.793	1.859	2.787	249	183.5	47.91	0	0.4163	356	153	0	14	0.9

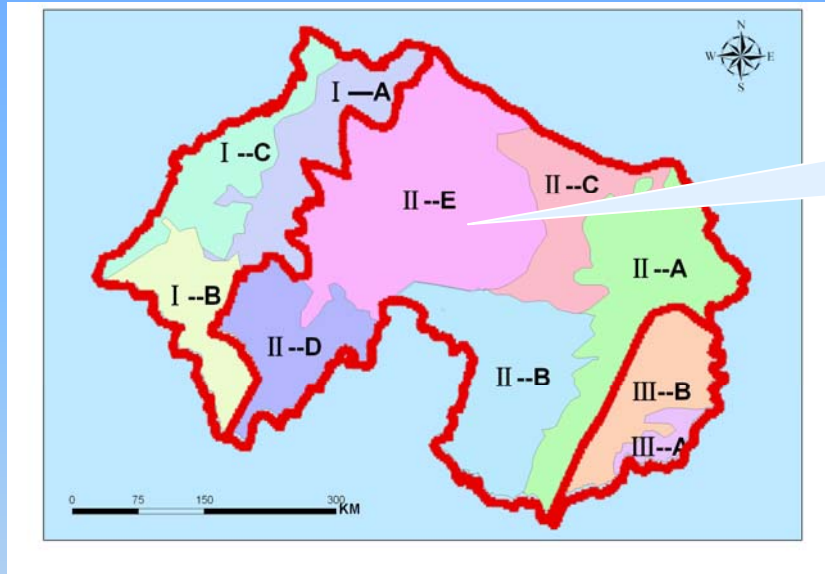
River classification method



II-D
Dongbaichengzi Site

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Min	0.00	0.00	1.37	0.68	0.04	0.10	0.31	0.80	0.66	0.27	0.11	0.00	0.36
Suitable	0.03	0.00	2.60	2.93	1.08	0.62	1.80	0.82	3.83	2.30	1.62	0.11	1.48
	3-day max	7-day max	30-day max	90-day max	Zero days	Hi pulse #	Hi pulse L	Rise rate	Fall rate				
Min	19	5.97	2.888	1.466	132	7	4	0.086	-0.034				
Suitable	9.533	10.49	5.011	2.552	48	9	5	0.09	-0.05				

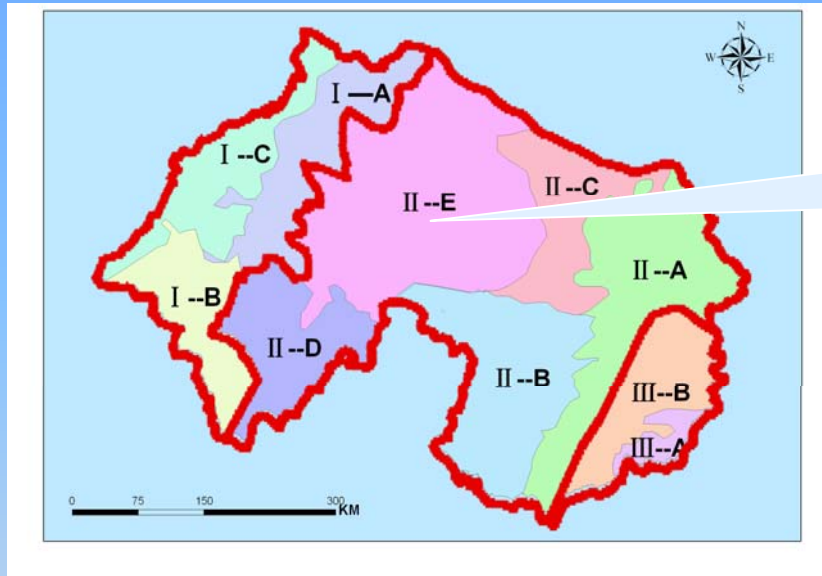
River classification method



II-E
Maixin Site

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Min	0.00	0.00	0.00	31.68	4.53	5.43	41.03	1.45	1.79	5.33	0.70	0.98	12.17
Suitable	3.74	1.68	30.13	42.20	7.67	12.43	48.34	16.89	15.42	44.32	4.67	8.15	19.64
	90-day min			Zero days			Lo pulse #		Hi pulse #		Reversals		
Min	0.06723			128			7		2		60		
Suitable	6.43			0			0		9		159		

River classification method



II-E
Fudedian Site

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Min	0.24	0.00	0.27	3.42	2.74	7.58	36.13	24.66	25.01	6.63	5.33	1.81	9.48
Suitable	0.67	0.15	0.36	5.40	7.88	42.06	43.23	267.68	96.77	10.61	5.61	1.91	40.20
	90-day min	Zero days	Date max	Fall rate									
Min	0.2932	41	193	-0.5									
Suitable	0.5322	0	238	-0.5									



Future environmental flow in China

- **Necessary enforcement measures and detailed rules to ensure the performance of Water Law.**
- **Localization of environmental flow methods developed in various parts of the world.**
- **Biological factors in the future environmental flow methods.**



Thank you for your attention!