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Characterization and Classification of River Network Types

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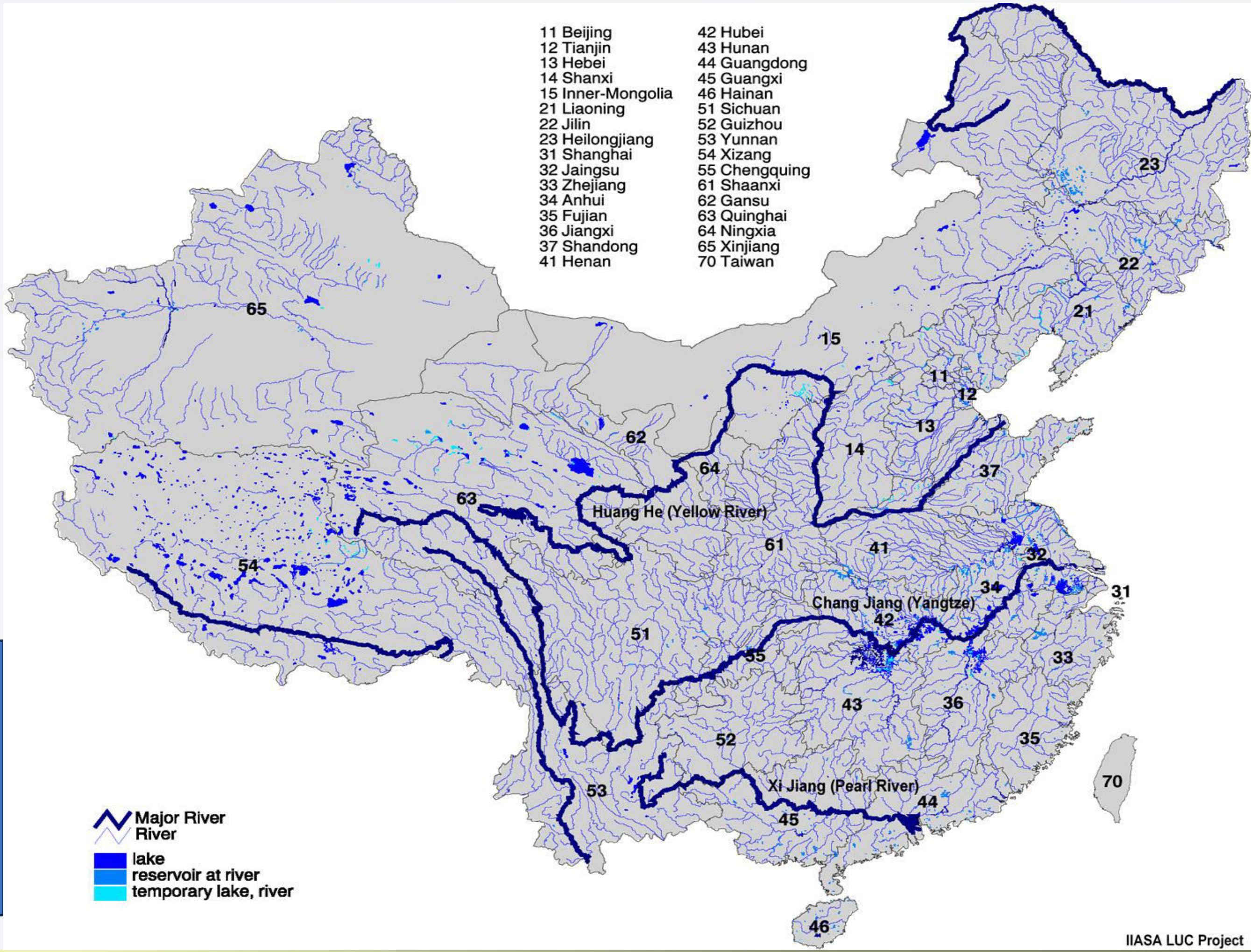
Introduction

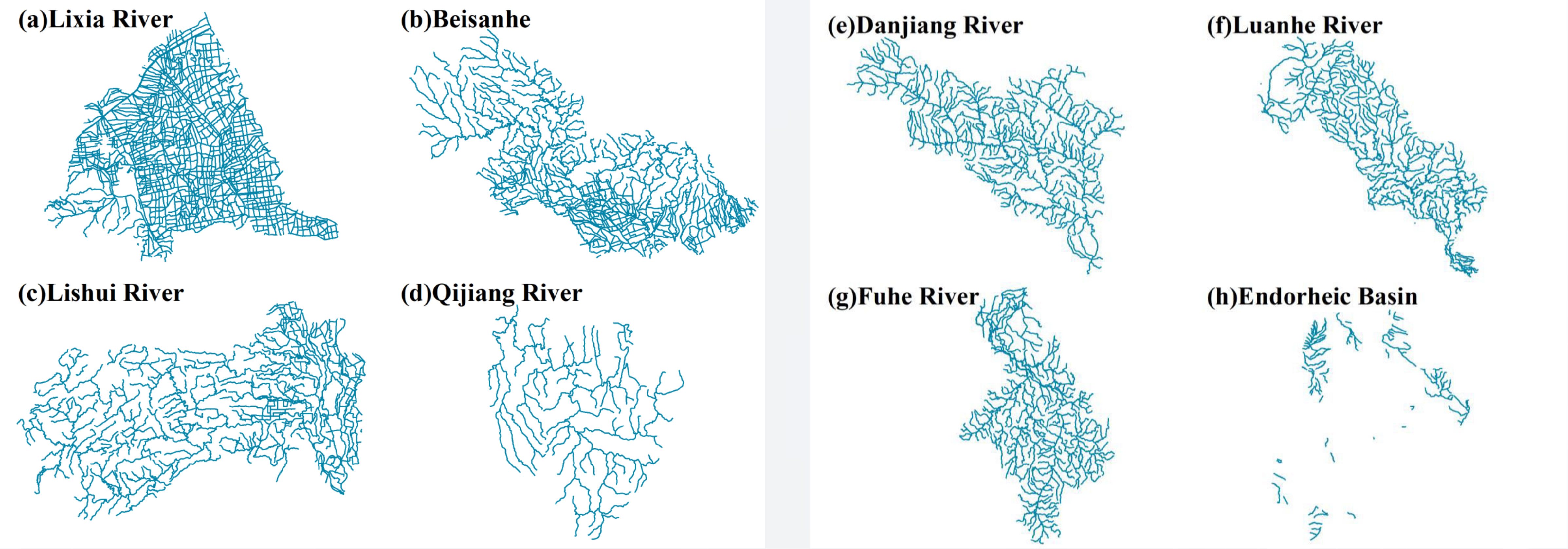
➢ **In nature, rivers are always connected together in various forms to constitute a specific type of river network.**

Various river network types have different impacts on the water regime changes in the basin, especially in terms of the speed of flood accumulation after heavy rain, the appearance momentum and duration of flood peaks, and so on.

The identification and classification of river network types in watersheds is the premise of hydrological research.



Introduction



Schematic diagram of the types of river networks

(a) reticulated; (b) mixed type A; (c) mixed type B; (d) rectangular;(e) parallel; (f) dendritic; (g) fan-shaped; (h) radial

Study area and data

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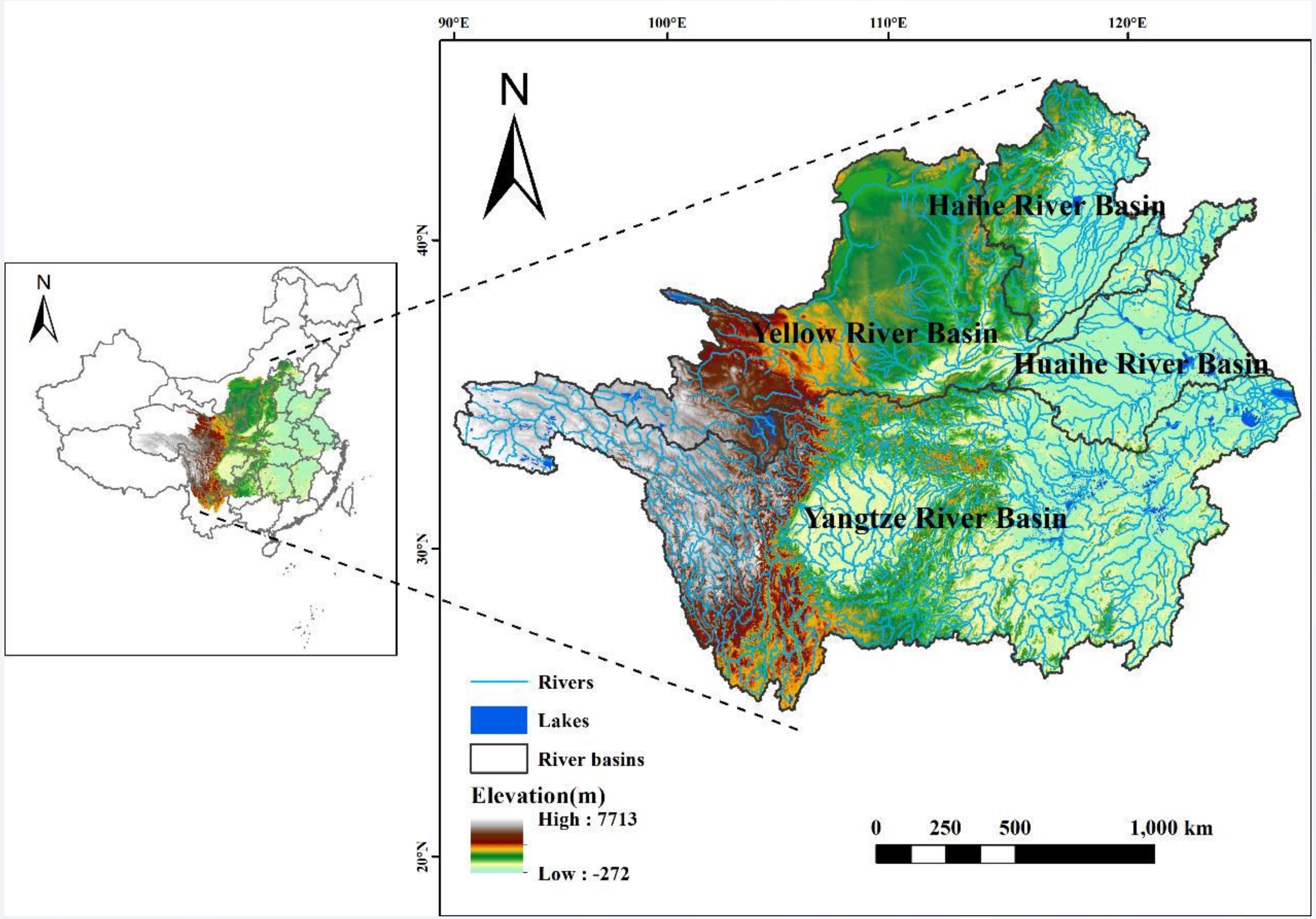
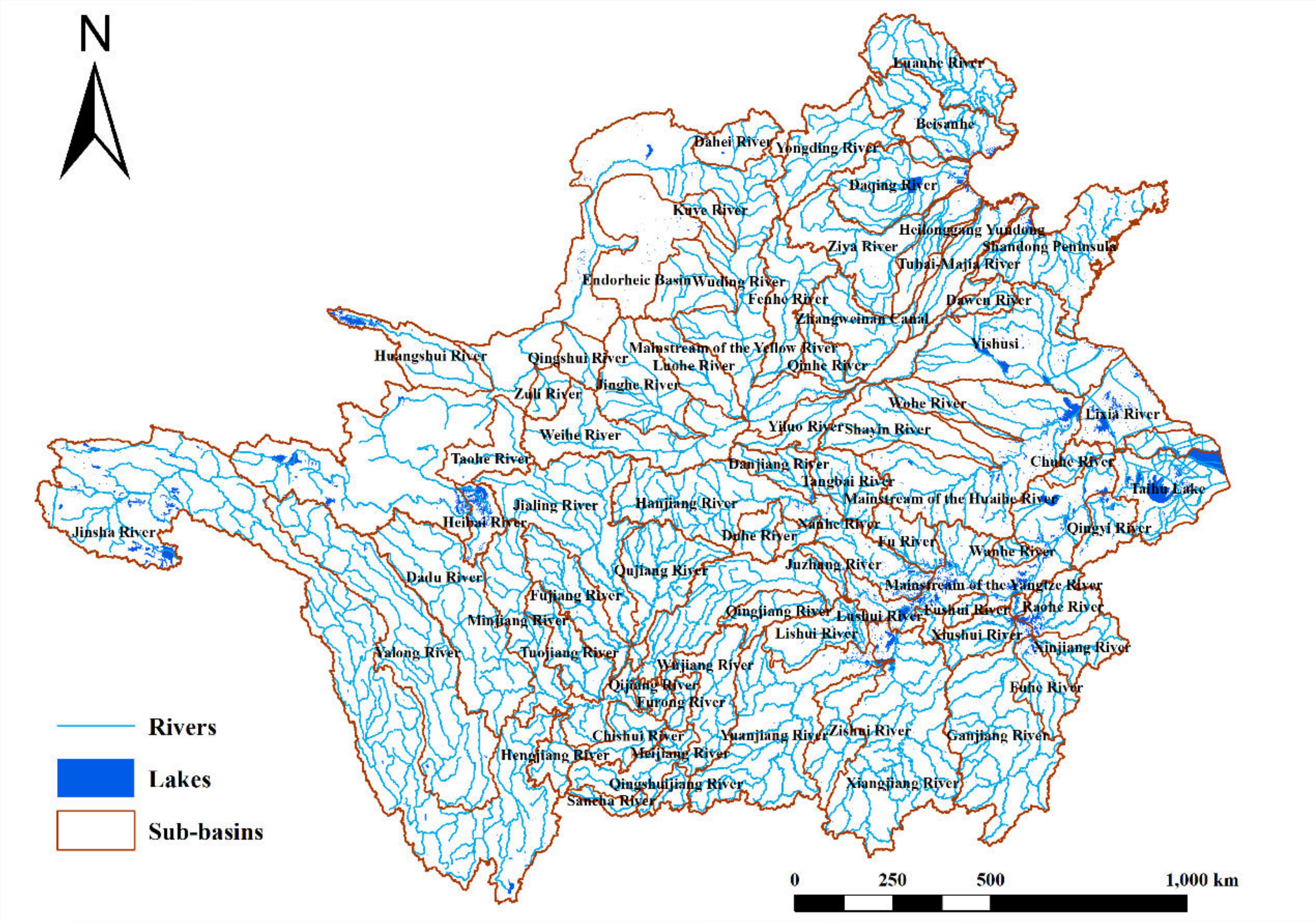
90°~125°E , 23°~43°N

- The Yellow River Basin
- The Haihe River Basin
- The Huaihe River Basin
- The Yangtze River Basin

Pass through 23 provinces and municipalities.



Study area and data



71 sub-basins

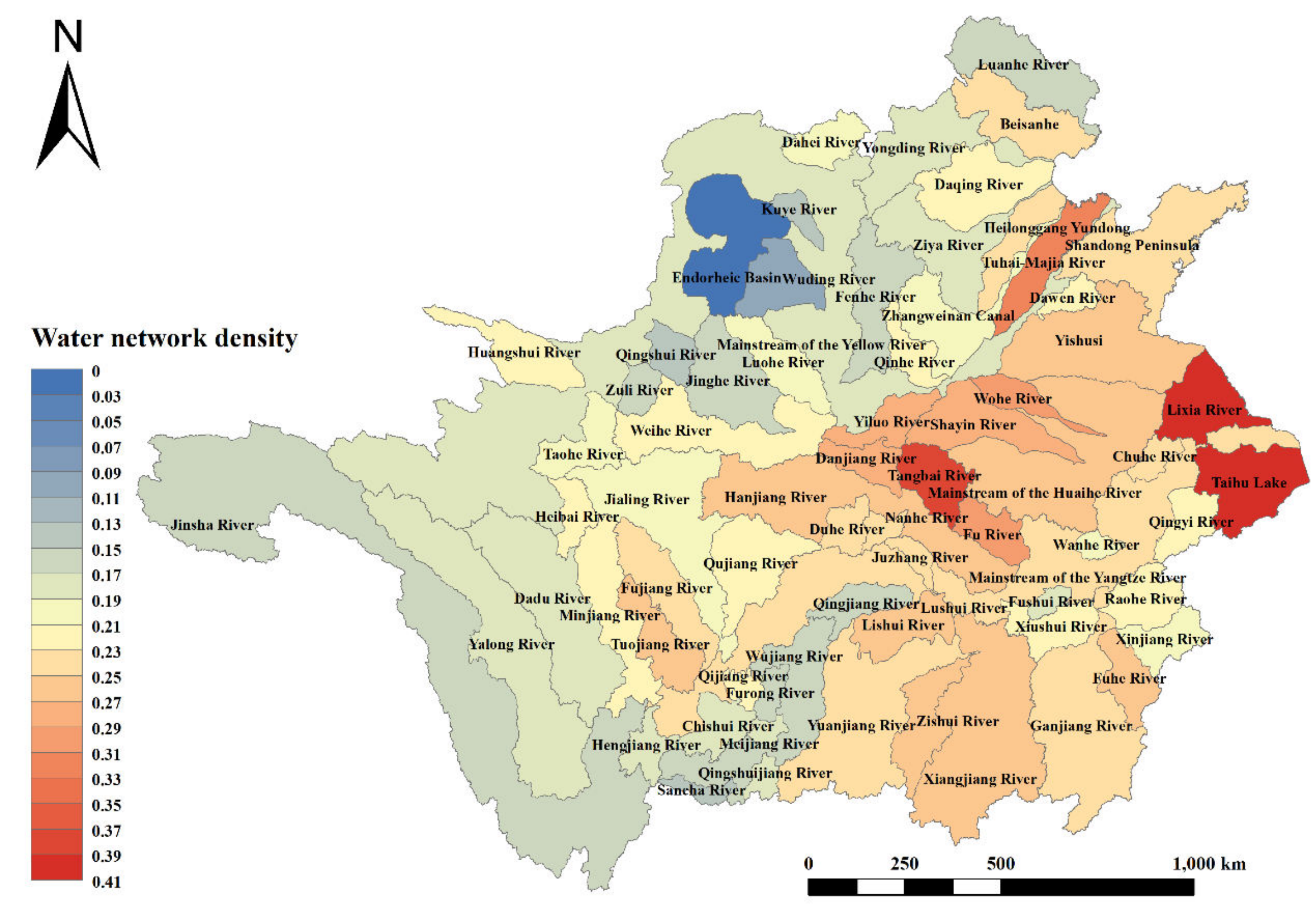
- The Yellow River Basin: 17
- The Haihe River Basin: 8
- The Huaihe River Basin: 6
- The Yangtze River Basin: 40

Methodology

River network density

- The river network density is **the ratio of the total length of the water system to the area of the basin**, indicating the length of the river per square kilometer.
- The river network density can **reflect the development degree of the river network in the basin** and characterize the development degree of surface runoff.

$$V=L/F$$



Methodology

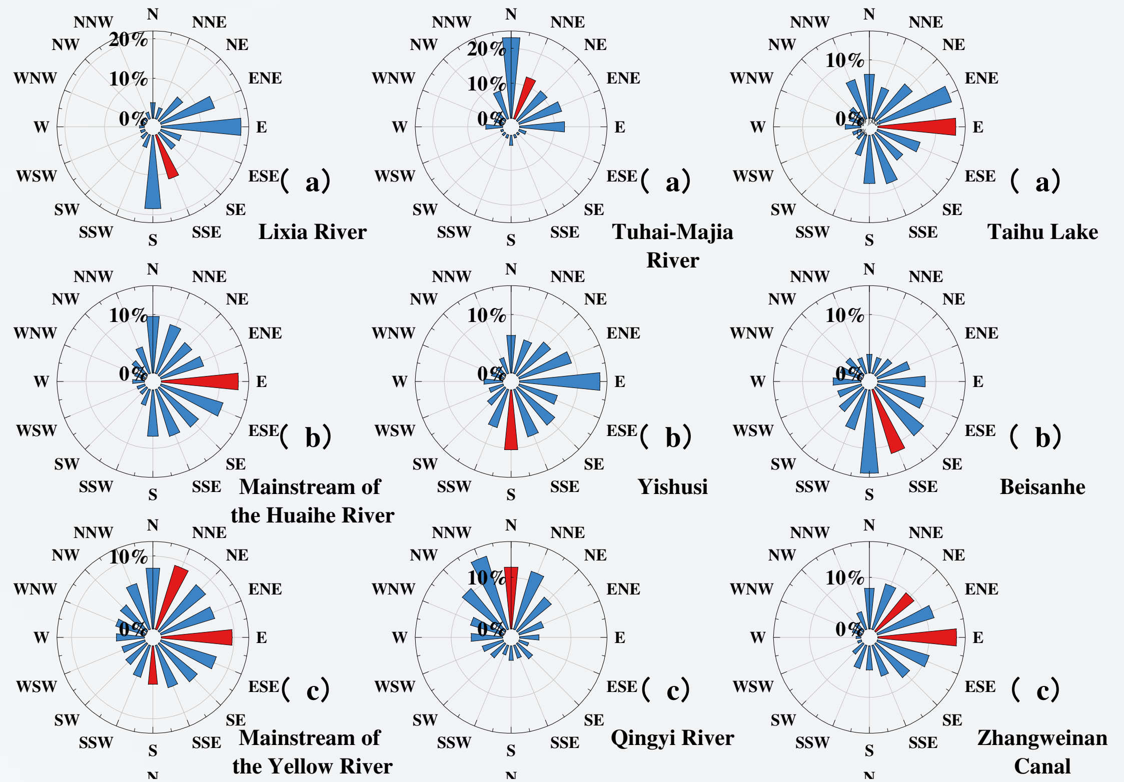
River flow direction

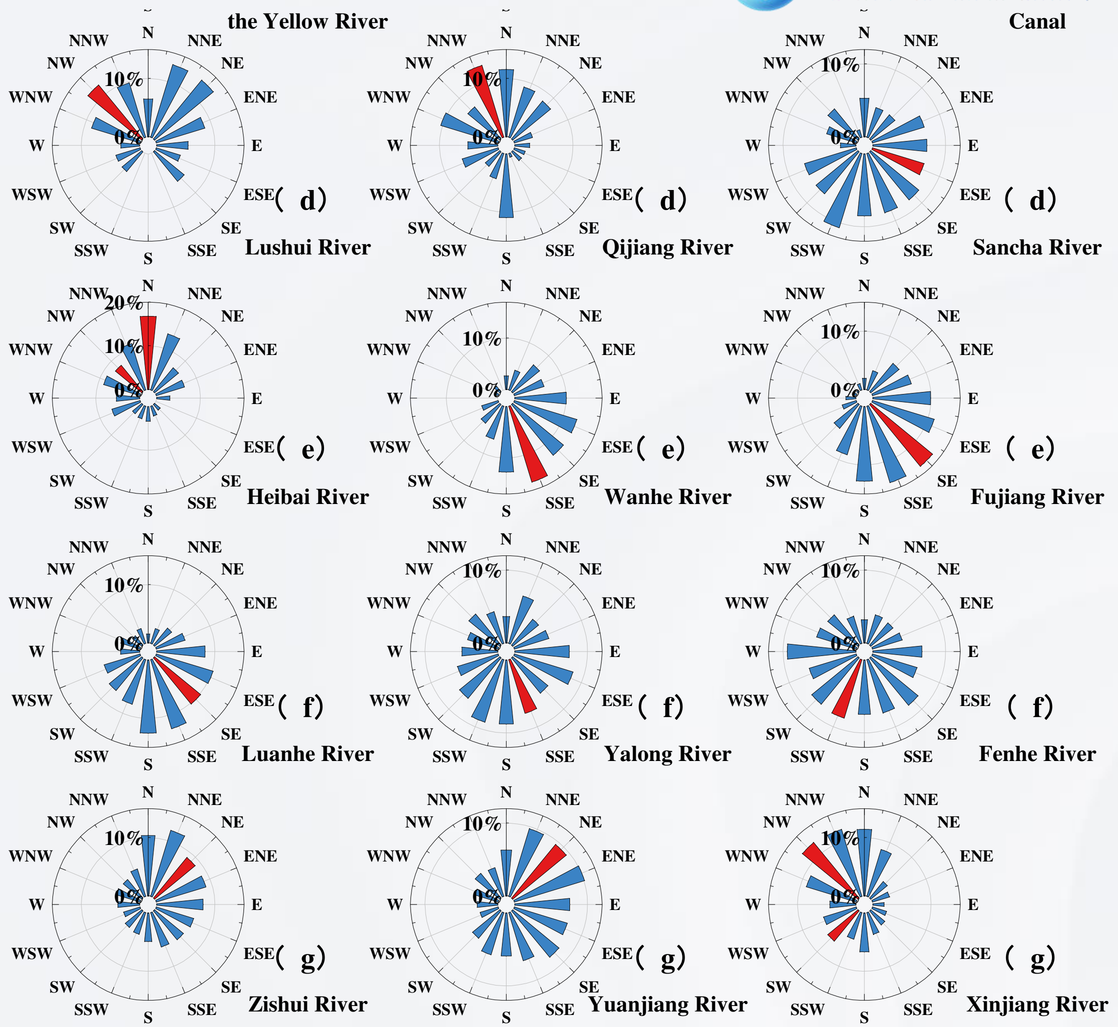
- **Compared with the tributary junction angles, the information reflected by the change of river flow direction is more direct and comprehensive.**

The tributary junction angle is essentially determined by the flow direction of two intersecting tributaries, and the information reflected by these angles is the reprocessing of the information reflected by the flow direction.

$$f_i = n_i / \sum_{i=1}^{16} n_i$$

Methodology





Rose diagram of river flow direction for different river network types

(a) reticulated; (b) mixed type A; (c) mixed type B; (d) rectangular; (e) parallel; (f) dendritic; (g) fan-shaped

Methodology

River sinuosity

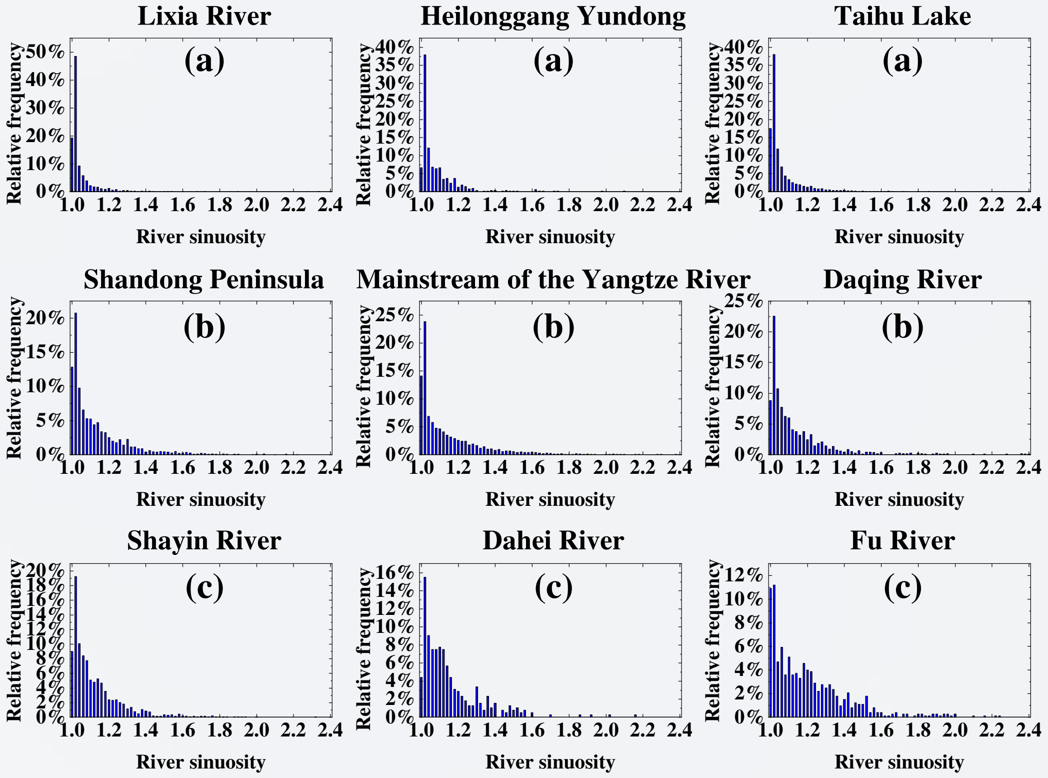
➢ **The river sinuosity is the ratio of the actual length of the river to the length of the river reach, to quantify the degree of river's tortuosity.**

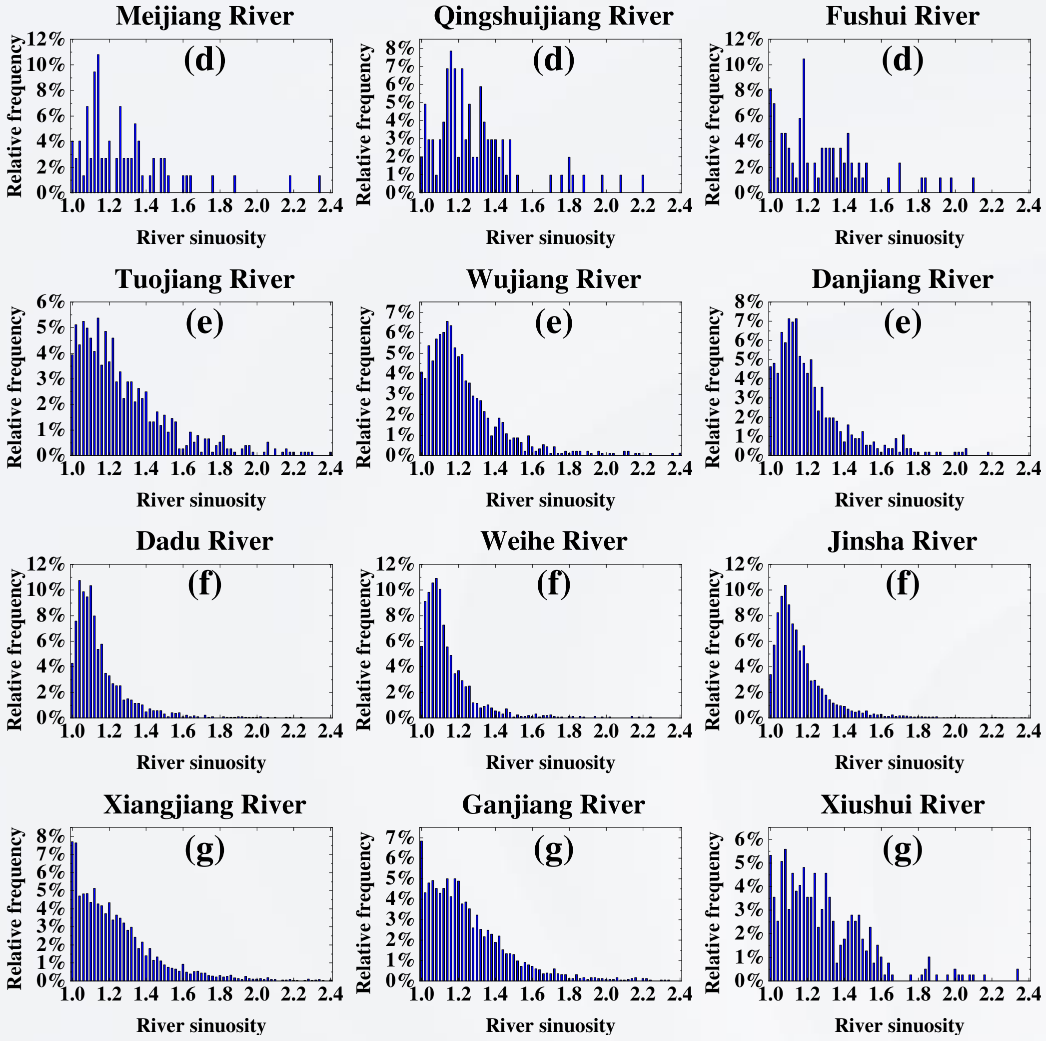
In GIS, rivers are stored as polyline segments, and the river sinuosity can be approximated as the length of the polyline segment divided by the length between the first and last endpoints. Assuming that the river segment consists of N points Pi, and P1 and PN are the endpoints, the river sinuosity SI is defined as:

$$SI = \sum_{i=1}^{N-1} L(P_i, P_{i+1}) / L(P_1, P_N)$$

where L represents the distance between two points (km).

Methodology





Relative frequency distribution of river sinuosity for different river network types

(a) reticulated; (b) mixed type A; (c) mixed type B;

(d) rectangular; (e) parallel; (f) dendritic; (g) fan-shaped

Results and discussion

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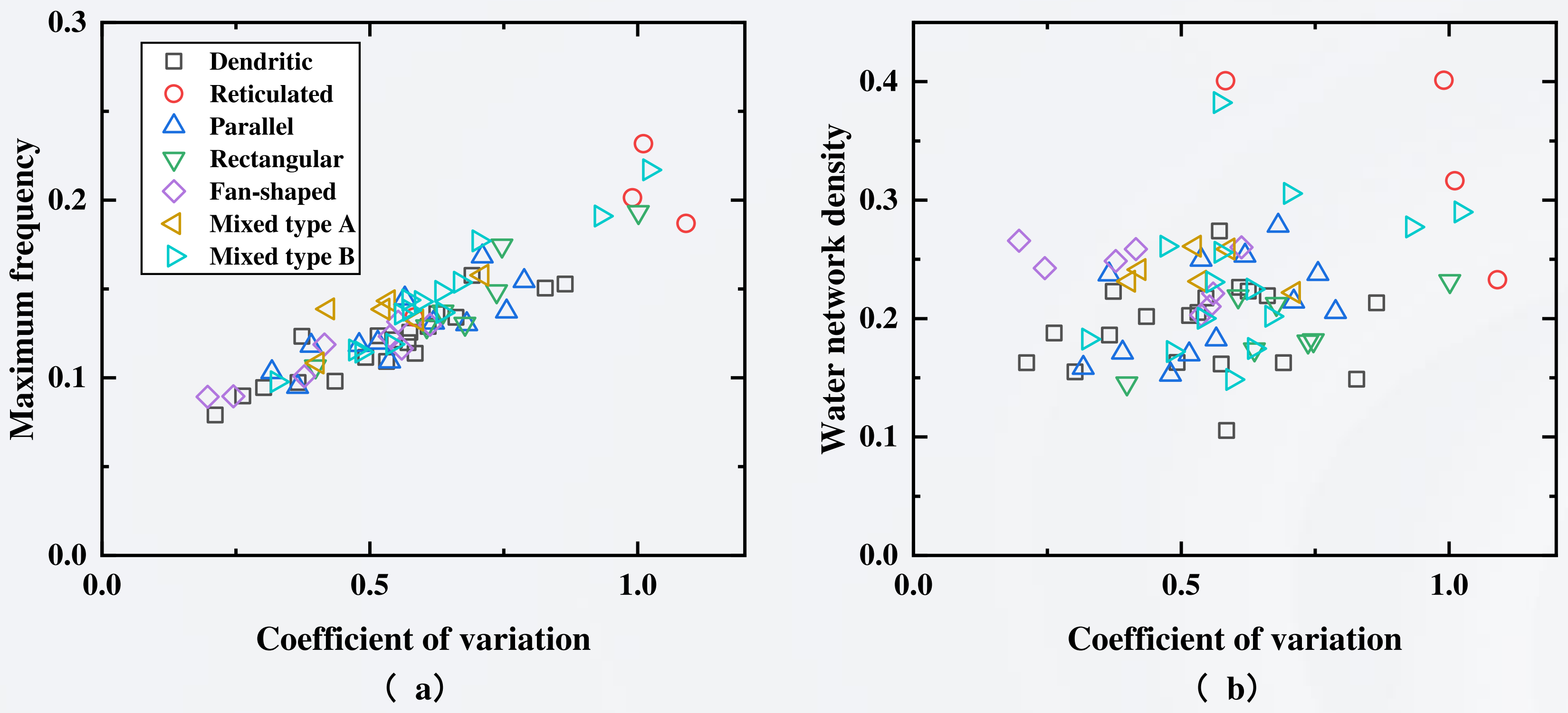
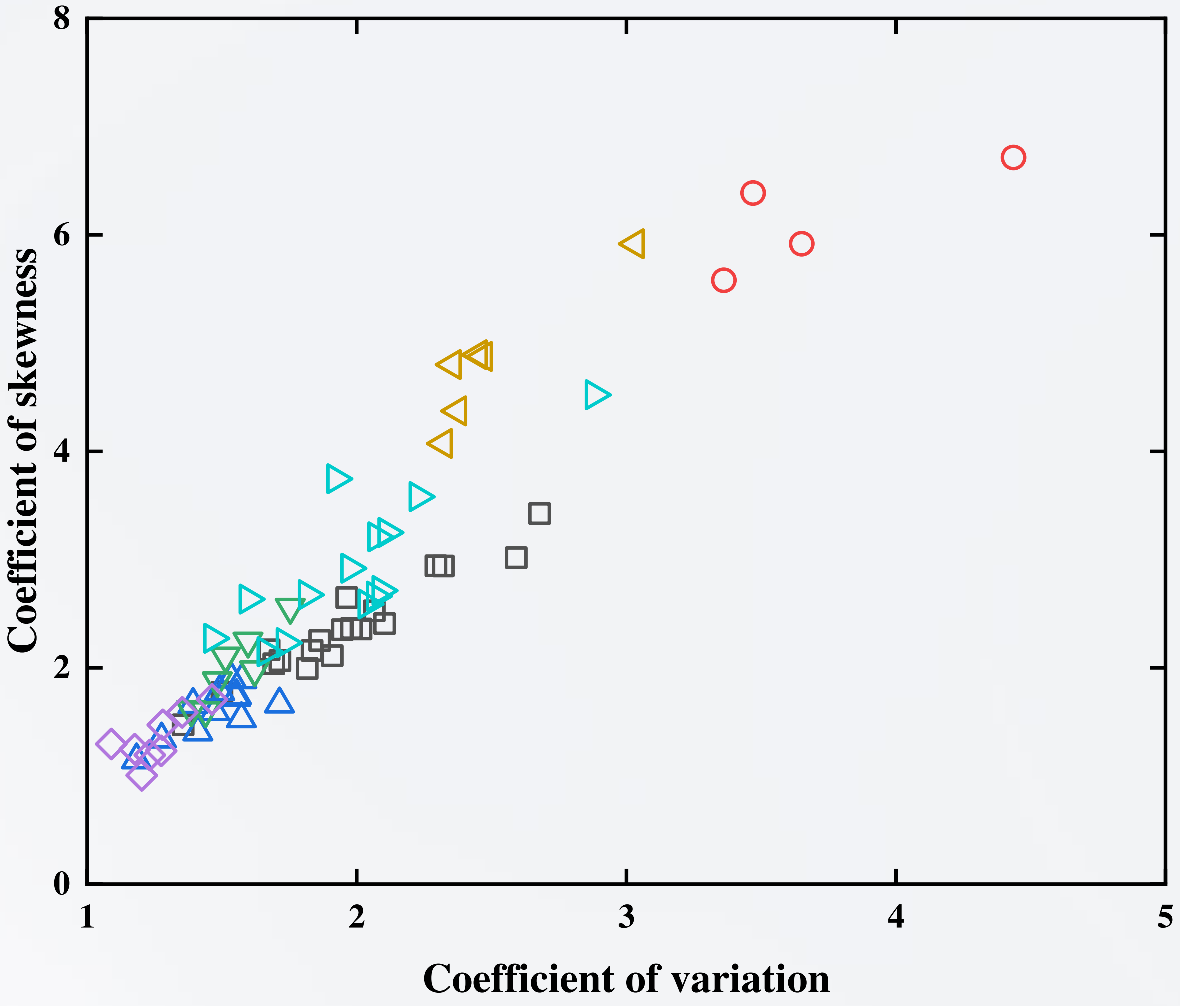
The distribution diagram of the variation coefficient of flow direction and the maximum frequency of flow direction in different river network types



The distribution map of the variation coefficient of flow direction and river network density in the watersheds of different river network types

Various types of river network layout cannot be effectively distinguished according to the difference in flow direction and river network density.

Results and discussion

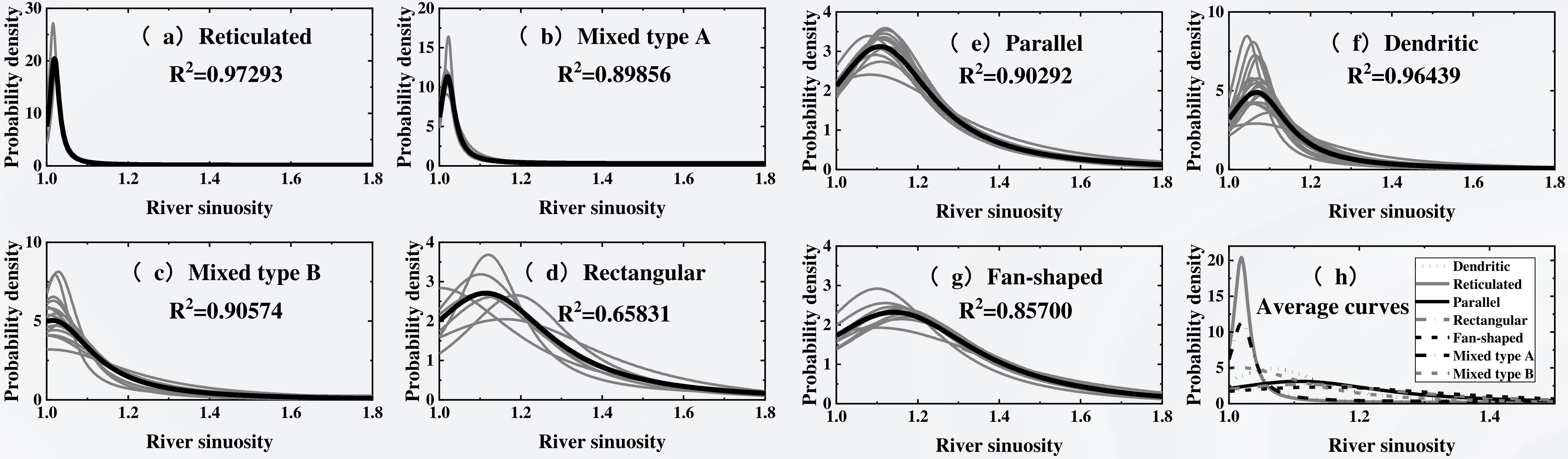


Variation coefficient and skewness coefficient of river sinuosity distribution

- Dentritic $Y=1.35X-0.26$, $R^2=0.92$
- Reticulated $Y=0.80X+3.17$, $R^2=0.40$
- Parallel $Y=1.18X-0.13$, $R^2=0.53$
- Rectangular $Y=2.53X-1.90$, $R^2=0.81$
- Fan-shaped $Y=1.52X-0.57$, $R^2=0.49$
- Mixed type A $Y=2.17X-0.60$, $R^2=0.81$
- Mixed type B $Y=1.62X-0.26$, $R^2=0.67$

Various types of river networks are relatively concentrated, and the coefficient of variation and skewness coefficient can be used to preliminarily determine the types of river networks.

Results and discussion



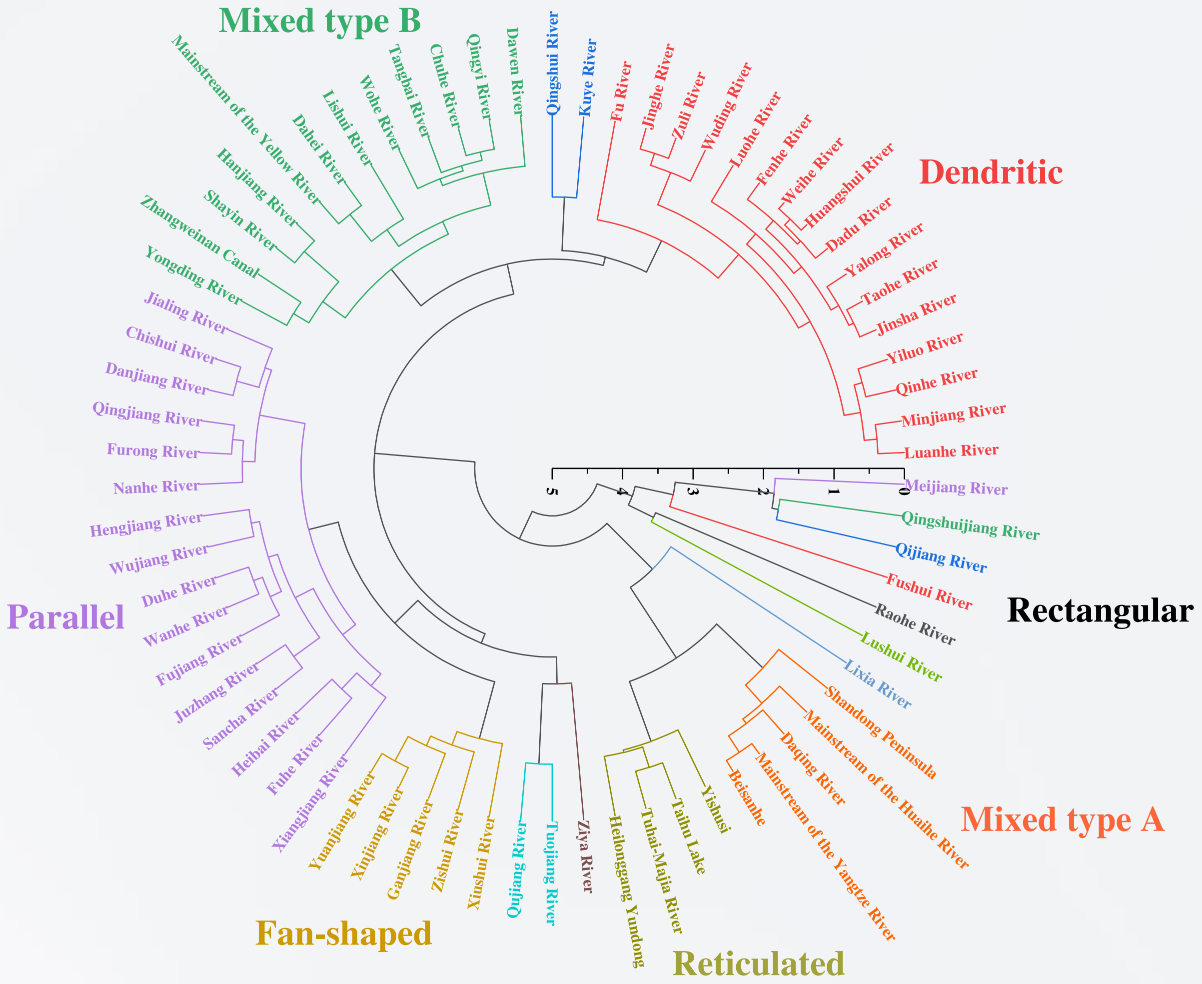
Fitting curves of the Cauchy distribution of river sinuosity for different river network types

Results and discussion

Cauchy distribution probability density function parameters of river sinuosity for different river network types

Type	Dendritic	Reticulated	Parallel	Rectangular	Fan-shaped	Mixed type A	Mixed type B
x_c	1.0442~1.1003	1.0159~1.0233	1.0805~1.1268	1.0000~1.1889	1.1000~1.1800	1.0157~1.0225	0.9905~1.0399
$\overline{x_c}$	1.0674	1.0191	1.1074	1.1143	1.1421	1.02	1.0147
w	0.0949~0.4154	0.0232~0.0355	0.2438~0.5209	0.2055~0.6244	0.3862~0.7433	0.0278~0.0693	0.0937~0.4626
$\bar{w}$	0.1872	0.0287	0.3151	0.391	0.4985	0.0427	0.2404
A	0.0239~0.0393	0.0146~0.0201	0.0269~0.0409	0.0233~0.0443	0.0337~0.0491	0.0123~0.0193	0.0226~0.0479
$\bar{A}$	0.0289	0.0182	0.0312	0.0338	0.0383	0.0149	0.0382
H	0.0598~0.1688	0.3363~0.5420	0.0500~0.0727	0.0451~0.0721	0.0421~0.0603	0.1776~0.3230	0.0659~0.1633
$\bar{H}$	0.1079	0.4161	0.0643	0.0571	0.0497	0.2327	0.1103
R^2	0.8574~0.9906	0.9393~0.9943	0.8060~0.9855	0.4934~0.7923	0.8011~0.9028	0.8566~0.9278	0.7778~0.9995

Results and discussion



- The shape parameters of the Cauchy distribution can provide **better identification results** than statistical data such as the coefficient of variation and skewness coefficient.
- The shape parameters of the Cauchy distribution were classified by hierarchical clustering analysis, and the obtained **results were consistent** with the qualitative classification results.

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THANKS!