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黄河流域水资源承载力评价及分区管控策略研究

Evaluation of water resources carrying capacity and regional management strategy in the Yellow River Basin

马 睿

MA RUI

General Institute of Water Resources and Hydropower Planning and Design(GIWP), MWR

XVIII WORLD WATER CONGRESS Water for All Harmony between Humans and Nature

第18届 世界水资源大会 水与万物: 人与自然和谐共生

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一、黄河流域基本情况及空间特点 自然规律

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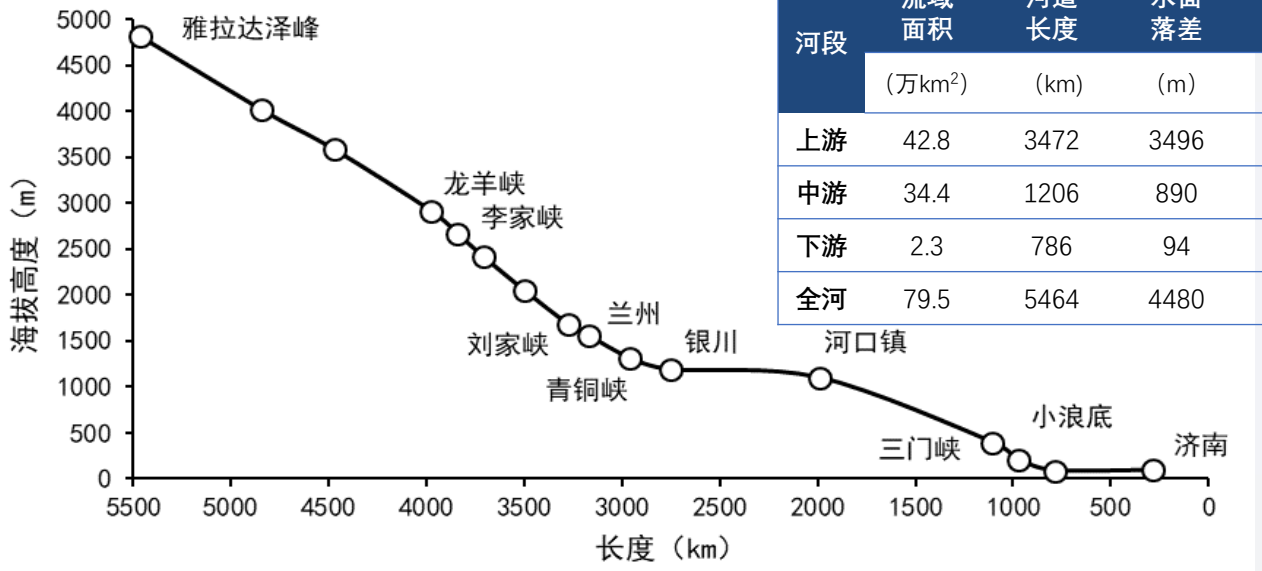
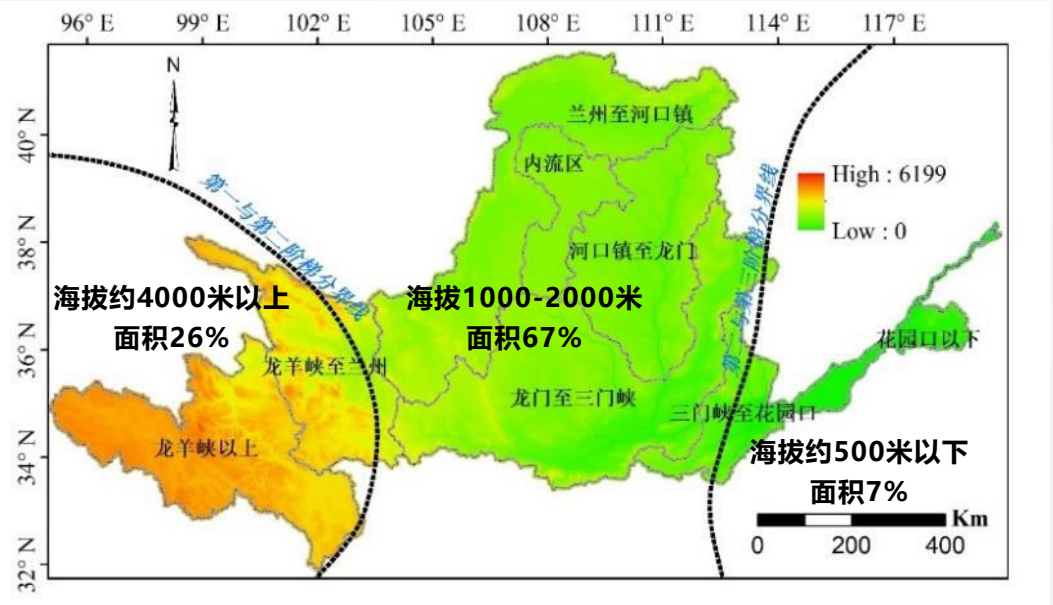
■三维地理空间分布变化较大 High variability in three-dimensional geospatial distribution

The large changes in the geographical space of the basin objectively increase the difficulty of water resources development and utilization.



河段	流域面积	河道长度	水面落差	平均比降
	（万km²）	（km）	（m）	（‰）
上游	42.8	3472	3496	1.01
中游	34.4	1206	890	0.74
下游	2.3	786	94	0.11
全河	79.5	5464	4480	0.82

黄河干流沿河纵剖面图 Longitudinal profile of the main stream of the Yellow River



黄河流域地形阶梯
Terrain ladder of Yellow River basin

■气温、降水等自然条件空间分布异质性较强

Higher heterogeneity in the spatial distribution of natural condition

- From the perspective of climatic zoning, the basin spans four climatic zones.
- From the perspective of precipitation evapotranspiration, the amount of precipitation and evaporation of water surface in the basin varies greatly with temperature, terrain and geographical location.
- From the perspective of water resources distribution, the water in the basin is concentrated in the upper reaches, and the surface water resources above Lanzhou account for 57%.

流域所属气候分带
Climatic zones to which the watershed belongs

1956-2016系列降水等值线
1956-2016 series of precipitation contours

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■生态系统丰富多样 Ecosystems are rich and diverse

- **An ecological corridor running east to west.** Taking the main stream of the Yellow River as a vein, it connects the Qinghai-Tibet Plateau, the Loess Plateau and the North China Plain.
- **A variety of important ecological function areas.** Sanjiangyuan, Qilian Mountains. Loess Plateau, five desert sands.
- **Numerous important ecological reserves.** There are 17 natural plateau lakes, Dongping Lake and Wuliangsu lakes, and estuarine delta wetlands.

流域生态功能区分布图
Distribution of ecological functional zones in the watershed

分类	湖泊名称
天然高原湖泊（17个）	幕错干、错热洼坚、哈丘错干、兴错、尕海湖、日格错岔玛、岗纳格玛错、龙热错、阿涌贡玛错、鄂陵湖、阿涌哇玛错、阿涌尕玛错、扎陵湖、桌让错、尕拉拉错、寇察、冬草阿隆

一、黄河流域基本情况及空间特点 自然规律

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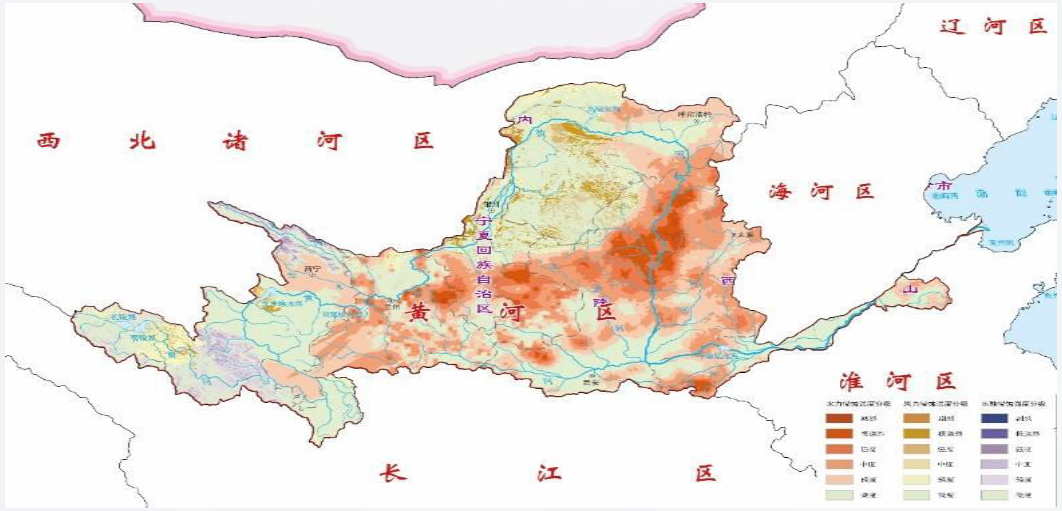
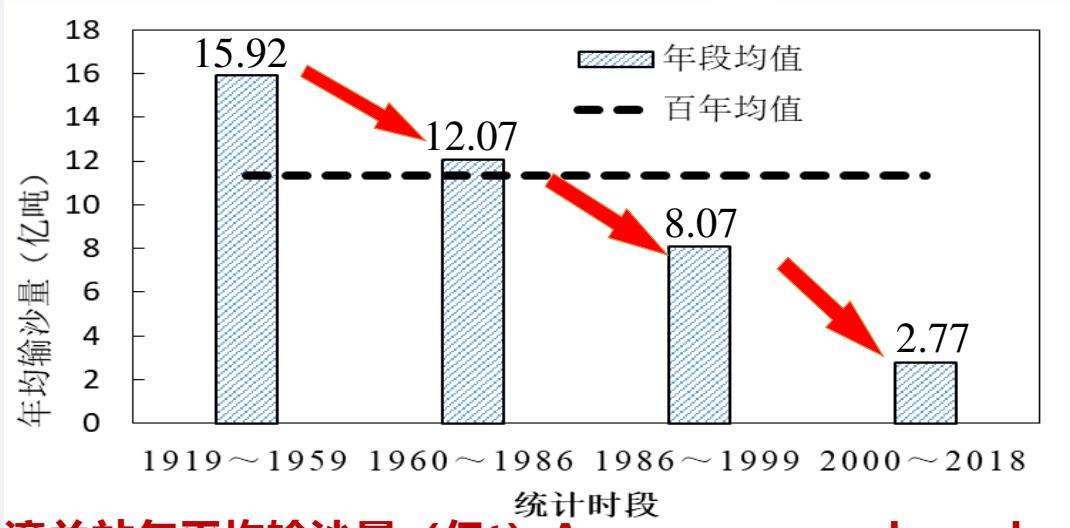
■水少沙多，水沙异源

Less water and more sand, water and sand heterogeneous source

- The basin has a large area of soil erosion, with an area of 465,000km², accounting for 58% of the total area of the watershed.
- Water and sand heterogenous characteristics are obvious, the middle reaches of the sand transfer accounts for 93%, surface water resources account for 36%, sediment mainly from the middle reaches of the Loess Plateau area.
- The amount of sediment entering the Yellow River has decreased in recent years, from 1.6 billion tons to 277 million tons.



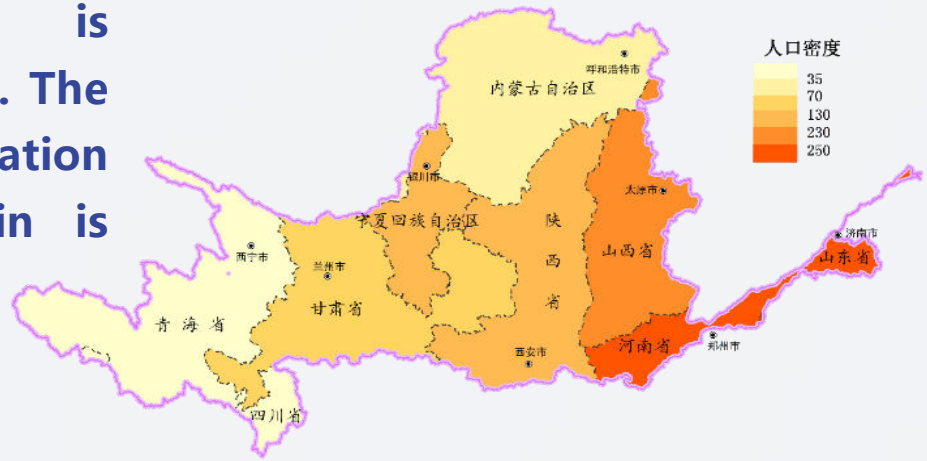
水土流失分布图 Soil erosion maps



潼关站年平均输沙量（亿t）Average annual sand transport at Tongguan Station (billion tons)

■人口分布情况 Population distribution

- The population is about 120 million. The beneficiary population outside the basin is about 146 million.

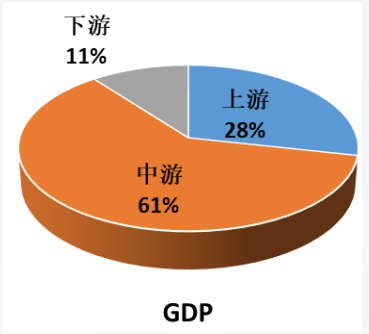


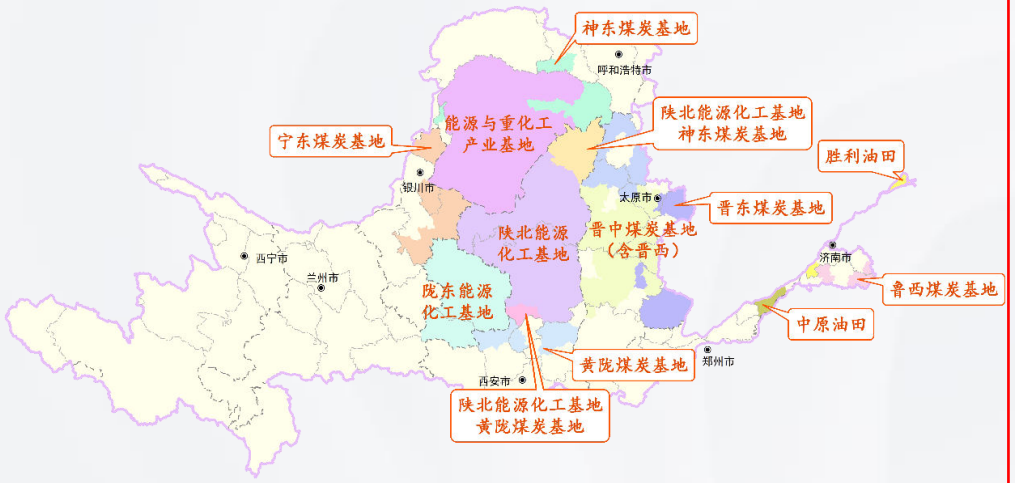
■粮食安全情况 Food security situation

- Cultivated land area 250 million Acres, effective irrigated area 129 million acres, and there are 52 large irrigation districts.

■能源产业情况 Energy industry situation

- The distribution of the middle reaches industry is relatively concentrated.



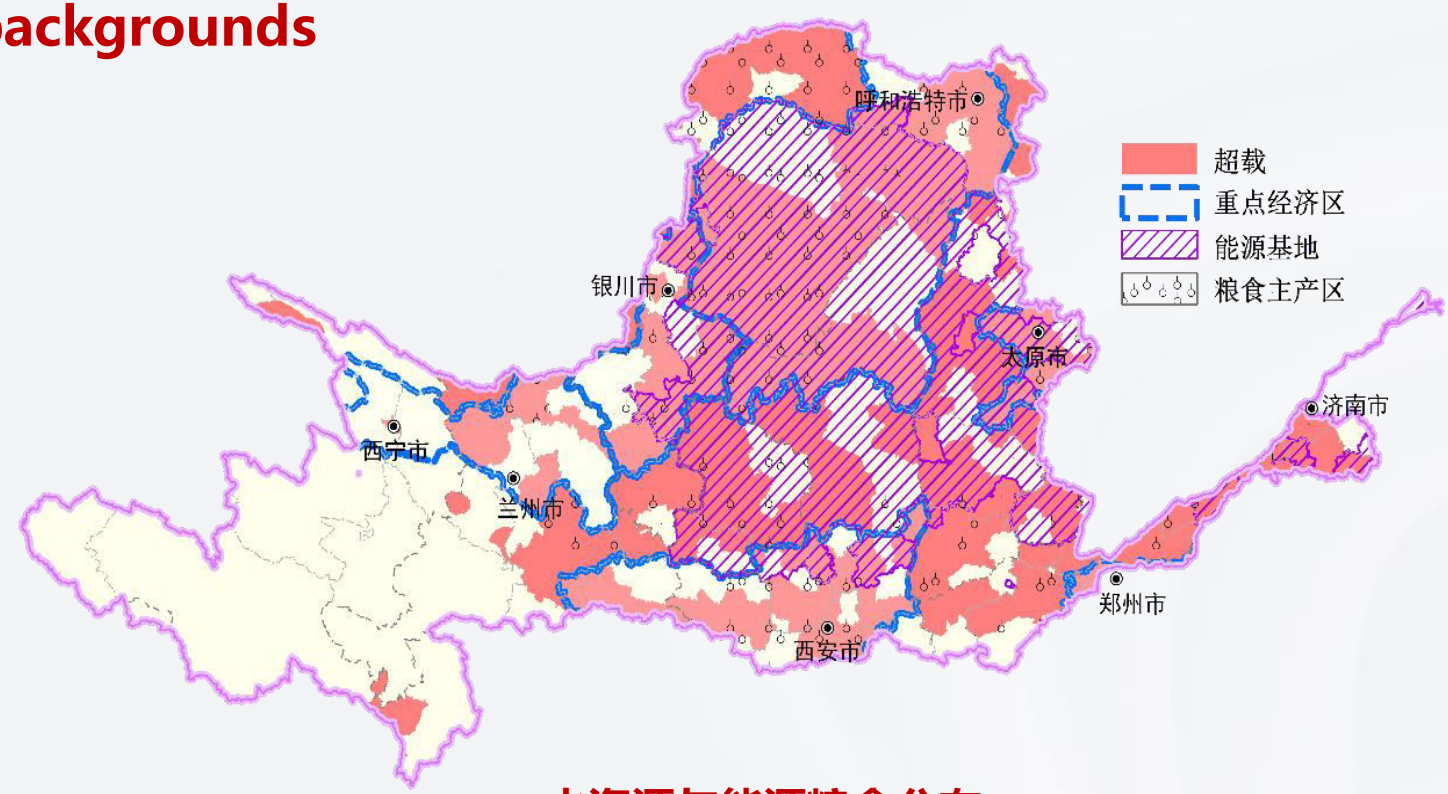


- "Energy Basin", Coal reserves account for about 50% of the country's total reserves.

■水与人口、土地、粮食、能源空间分布本底不匹配

Mismatch between water and spatial distribution of population, land, food and energy backgrounds

- **Water resources** are concentrated in the upper reaches of the basin, with average multi-year runoff accounting for 57% of the basin and less than 10% of the arable land resources.
- **Cultivated land resources** are mainly concentrated in Hetao, Fen-Wei and downstream plain areas with better irrigation conditions, and the cultivated land area accounts for 67%.



水资源与能源粮食分布
Water resources and energy food distribution

二、黄河流域水资源承载状况评价

■ Evaluation Methodology of Water Resource Carrying Capacity

- 采用多因子综合评价模型，综合评价黄河流域水资源承载状况
- Using multi-factor comprehensive evaluation model, to comprehensive evaluate the water resources carrying capacity of Yellow River basin

评价指标	度量标准	水资源承载状况判别			
		严重超载	超载	临界超载	不超载
用水总量	用水总量控制指标	≥用水总量控制指标的 1.2 倍	用水总量控制指标的 1（含）～ 1.2 倍	用水总量控制指标的 0.9（含）～ 1 倍	< 用水总量控制指标的 90%
地下水开采量	地下水可开采量控制指标	≥地下水可开采量控制指标的 1.2 倍或开采深层承压水	地下水可开采量控制指标的 1（含）～ 1.2 倍	地下水可开采量控制指标的 0.9（含）～ 1 倍	< 地下水可开采量控制指标的 90%
水功能区水质达标率	$Q \le 0.4Q_0$	$0.4Q_0 < Q \le 0.6Q_0$	$0.6Q_0 < Q \le 0.8Q_0$	$Q > 0.8Q_0$	水功能区水质达标率
污染物入河量	$P > 1.2P_0$	$1.1P_0 < P \le 1.2P_0$	$P_0 < P \le 1.1P_0$	$P \le P_0$	污染物入河量

二、黄河流域水资源承载状况评价

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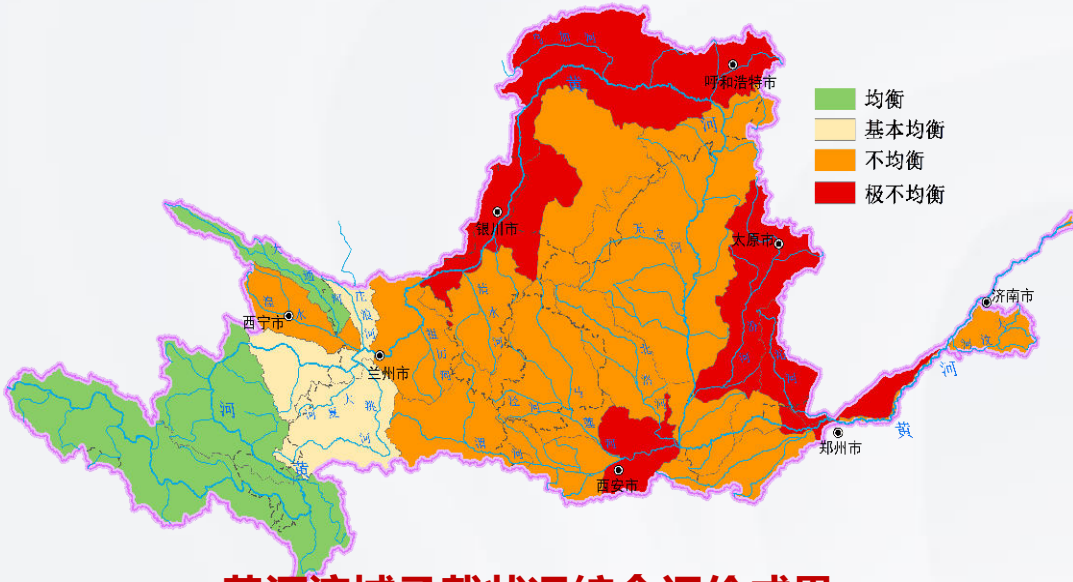
■ Evaluation Result

The results show that most of the basin area is in the state of "severe overload" or "overload" (74% of the basin area), involving 110 million people in 8 provinces and districts

The overloaded areas are mainly distributed in the upstream Ning-meng River section, the He-tao Plain, the middle reaches of the Fen-Wei Plain and the downstream river channel beach area.

均衡状态	主要范围	面积（万km^2）	水资源量（亿m^3）	人口（万人）	能源产量（亿t）	粮食产量（万t）	GDP（万亿元）
不超载	河源至龙羊峡、大通河	14.7	233.9	106	/	14.6	0.024
临界状态	大夏河与洮河、龙羊峡至兰州	5.8	75.9	494	/	125.0	0.110
超载	湟水、内陆河等	39.6	273.9	6 175	12.92	2232.4	2.800
严重超载	宁蒙河段、汾渭平原、下游等	19.5	119.0	5 206	5.97	2160.0	3.040

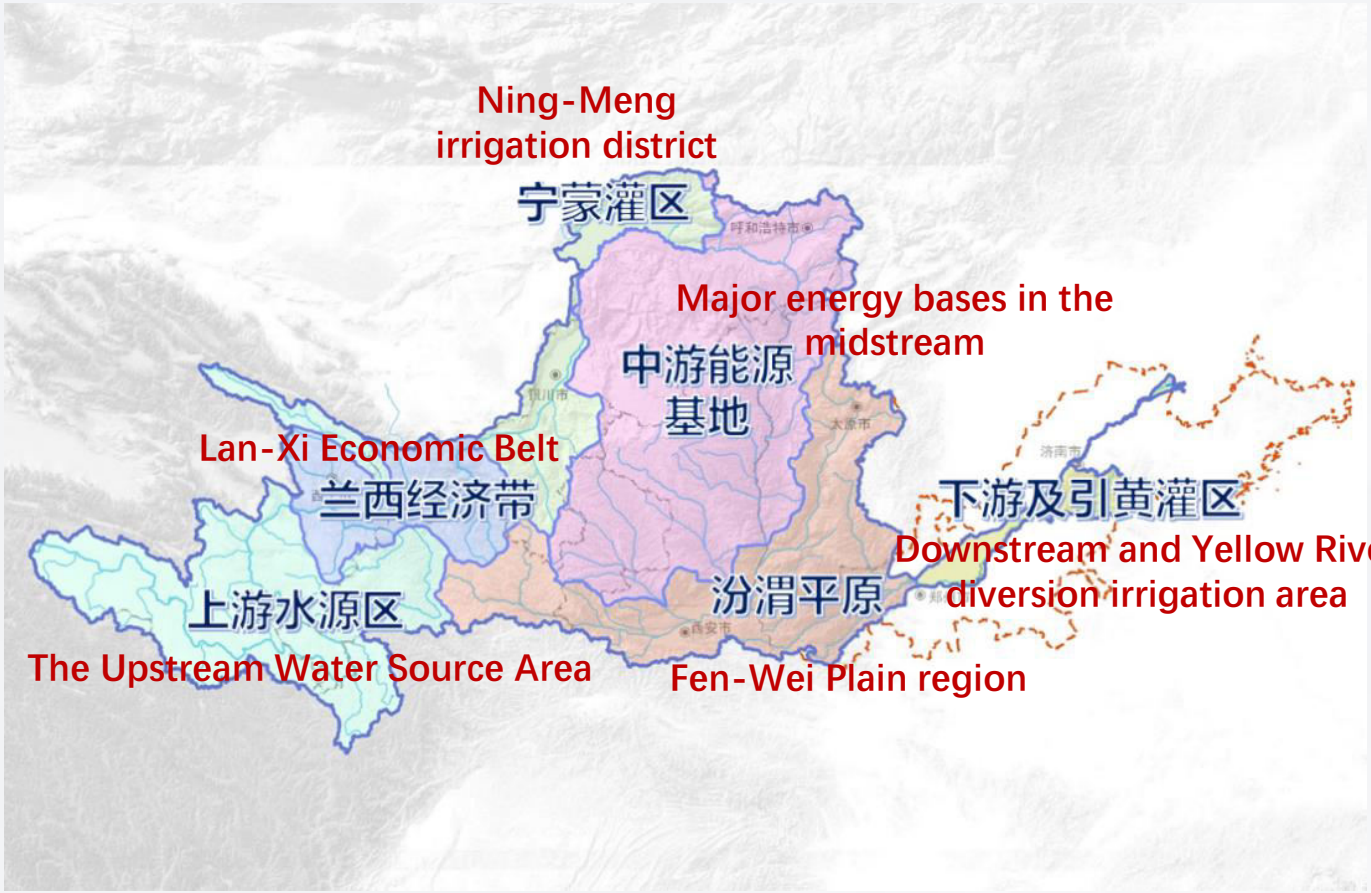


黄河流域承载状况综合评价成果

Evaluation Result

■ 黄河流域保护发展分区 Protection and Development Zone of Yellow River Basin

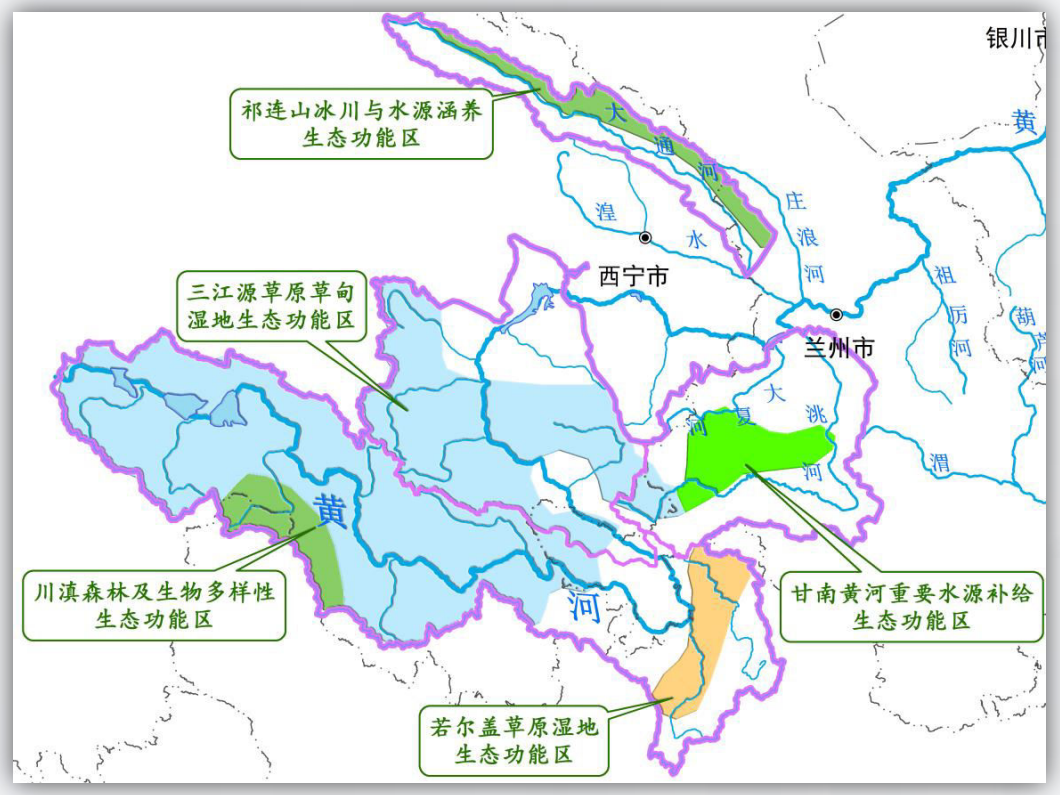
According to the characteristics of economy and society, and the function orientation of territorial space, the key points of protection and development, the protection and development zone of Yellow River Basin has divided into **six regions**.



■ 上游水源区 The Upstream Water Source Area

【基本情况】Basic Information

- The area is a national important ecological functional area and the main water-producing area of the basin, with water production accounting for about half of the whole basin. The area is sparsely populated, with a total population of 4 million; The economy is weak, with per capita GDP of only 15,000 yuan.



三、黄河流域保护发展分区重点

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■上游水源区—— 保护生态、涵养水源

The Upstream Water Source Area——Protect ecology and conserve water

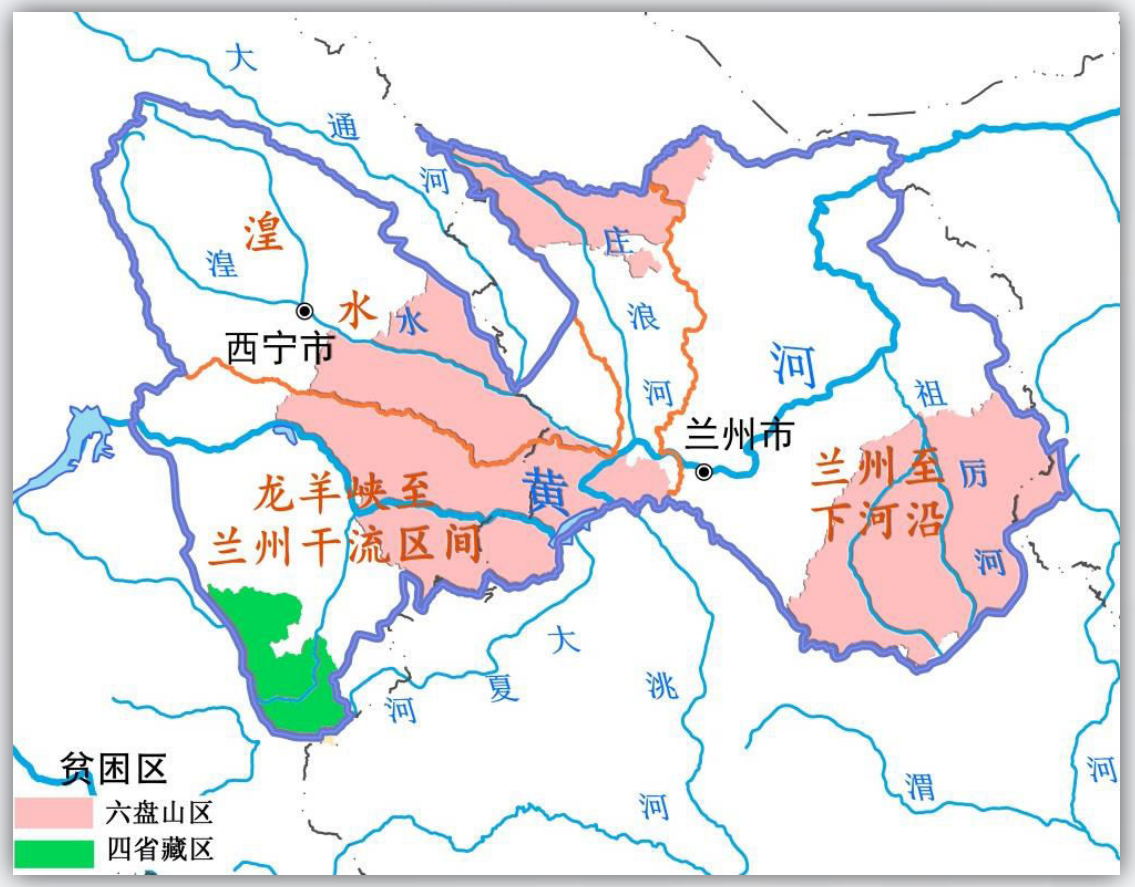
【发展方向】Direction of Development

- Protecting the ecology and water sources, protecting the Chinese Water Pagoda, through the protection of the five major The ecological function area builds an ecological barrier in the west.

■兰西经济带　Lan-Xi Economic Belt

【基本情况】Basic Information

- It is an important urban agglomeration and key economic development zone in the northwest China.
- The region has a thin economic development base, Water resource is the important factor restricting the economic and social development of this region.



■兰西经济带—— 合理利用、提高承载力

Lan-Xi Economic Belt——Rational utilization and improvement of bearing capacity

【发展方向】Direction of Development

- Insisting on water to determine the city, guaranteeing the rigid demand for water for the economic development of Lan-Xi and Lan-Bai urban agglomerations and the poverty-stricken areas of Liupan Mountain to fight against poverty, and solving the contradiction of imbalance and incoherence between regions.
- Further strengthen water conservation, water efficiency to reach the domestic advanced level.

■宁蒙灌区　Ning-Meng irrigation district

【基本情况】Basic Information

- The national important main grain producing area, has unique conditions for Yellow River diversion.
- The amount of self-produced water resources is the least, accounting for 1.3% of the basin, and the water consumption is larger, accounting for 29% of the basin water consumption.
- The irrigated area accounts for about 20% of the whole basin. Agricultural water consumption accounts for 90% of the total water consumption.

■宁蒙灌区—— 节水提效、水土平衡

■ Ning-Meng irrigation district——Save water, improve the utilization efficiency of water resources, and achieve the balance of water and soil resources

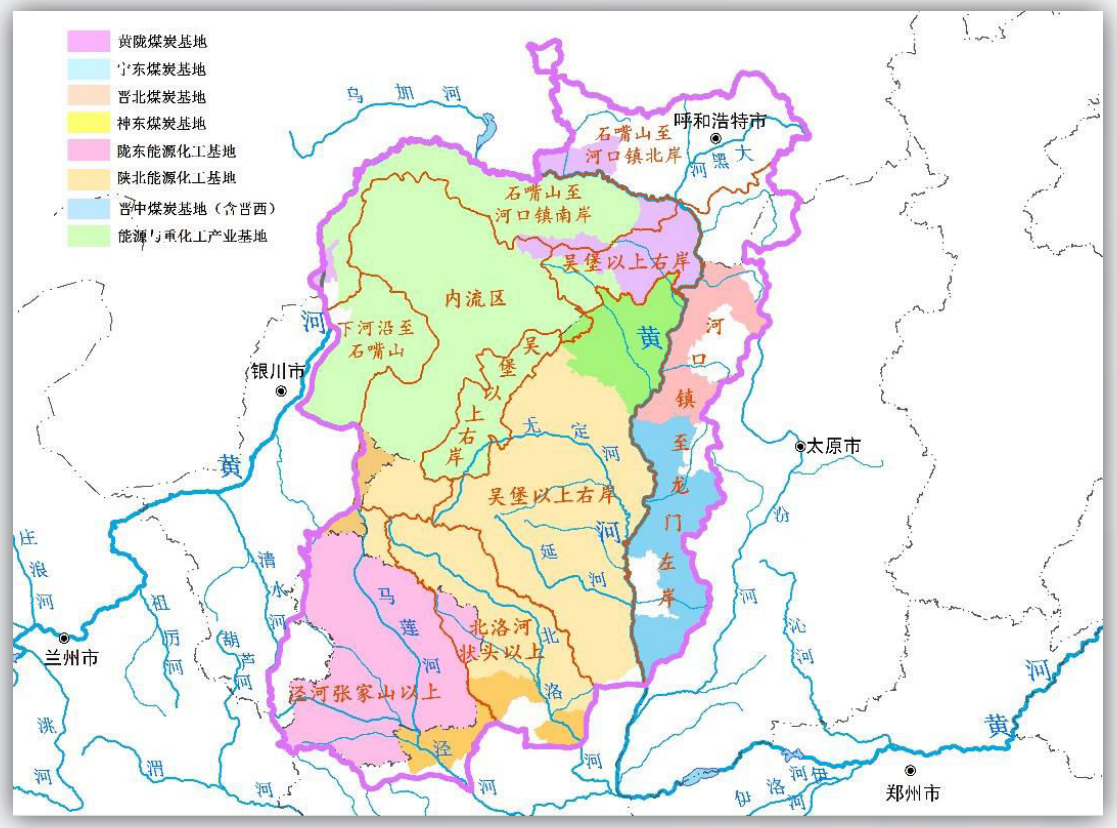
【发展方向】Direction of Development

- Insisting on the determination of land by water, coordinating the relationship between water and irrigated area and food production, strengthening water conservation in agriculture, reducing agricultural water consumption, and supporting the balanced development of the regional economy, society and ecology through the efficient use of water resources.

■ 中游主要能源基地　Major energy bases in the midstream

【基本情况】Basic Information

- It is the important national energy bases, with raw coal production accounting for nearly 80% of the total output of the basin.
- It is the main source of Yellow River sediment, with the annual average sediment volume accounts for more than 60% of the sediment volume entering the downstream.



■中游主要能源基地——保障供水、协调水沙

Major energy bases in the midstream——Ensure the safety of water supply and coordinate the relationship between water and sediment

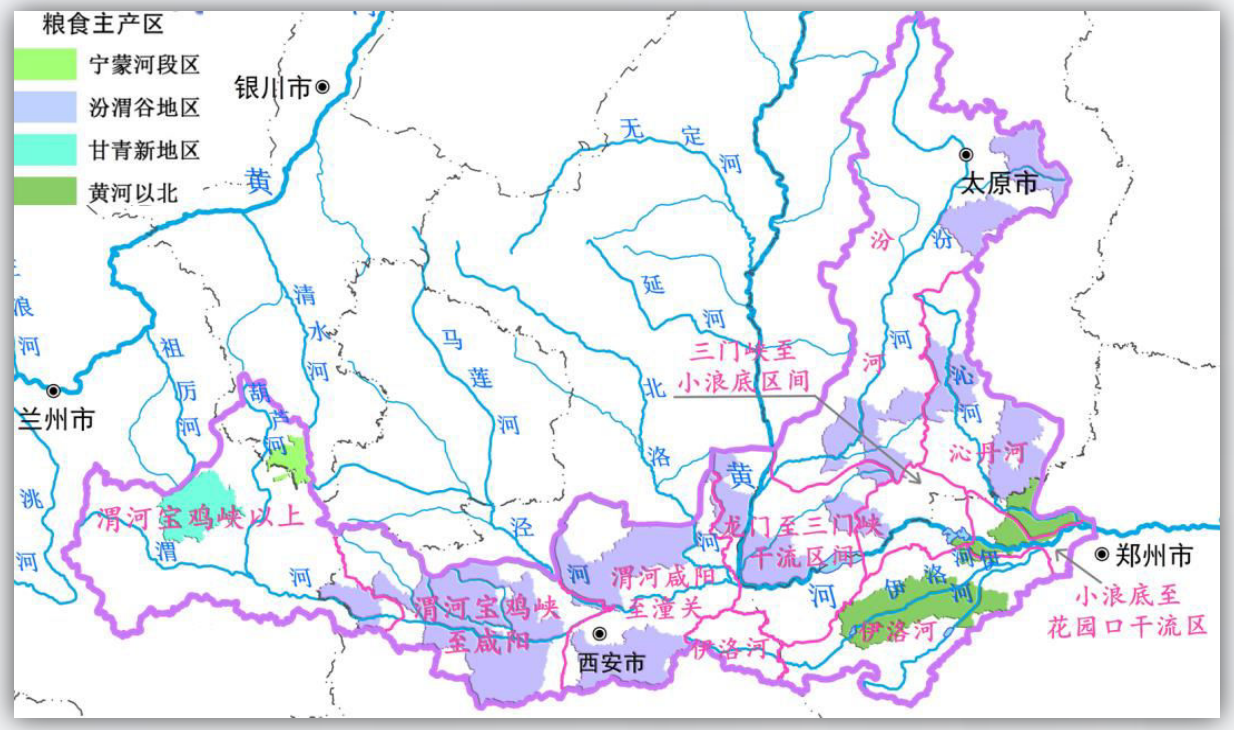
【发展方向】Direction of Development

- **Focus on guaranteeing the national energy development strategy and the rigid demand for water for urban development, and on the basis of rationalizing the industrial structure and improving the level of water conservation, increase the supply of water. Tightly grasp the water-sand relationship regulation of the "bull nose", improve the watersand regulation system; repair the Daihai and other key rivers and lakes ecological environment.**

■汾渭平原区　Fen-Wei Plain region

【基本情况】Basic Information

- It is a relatively concentrated area of population and industry. Population, GDP and irrigated area distribution accounted for **51%, 46% and 38%** of the whole basin.
- The current situation is characterized by a high degree of water resource exploitation and utilization in the region, and the water ecological environment of the river Deterioration of the environment and over-exploitation of groundwater.



三、黄河流域保护发展分区重点

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■汾渭平原区——优化配置、修复生态

Fen-Wei Plain region——Optimize allocation and restore water ecology

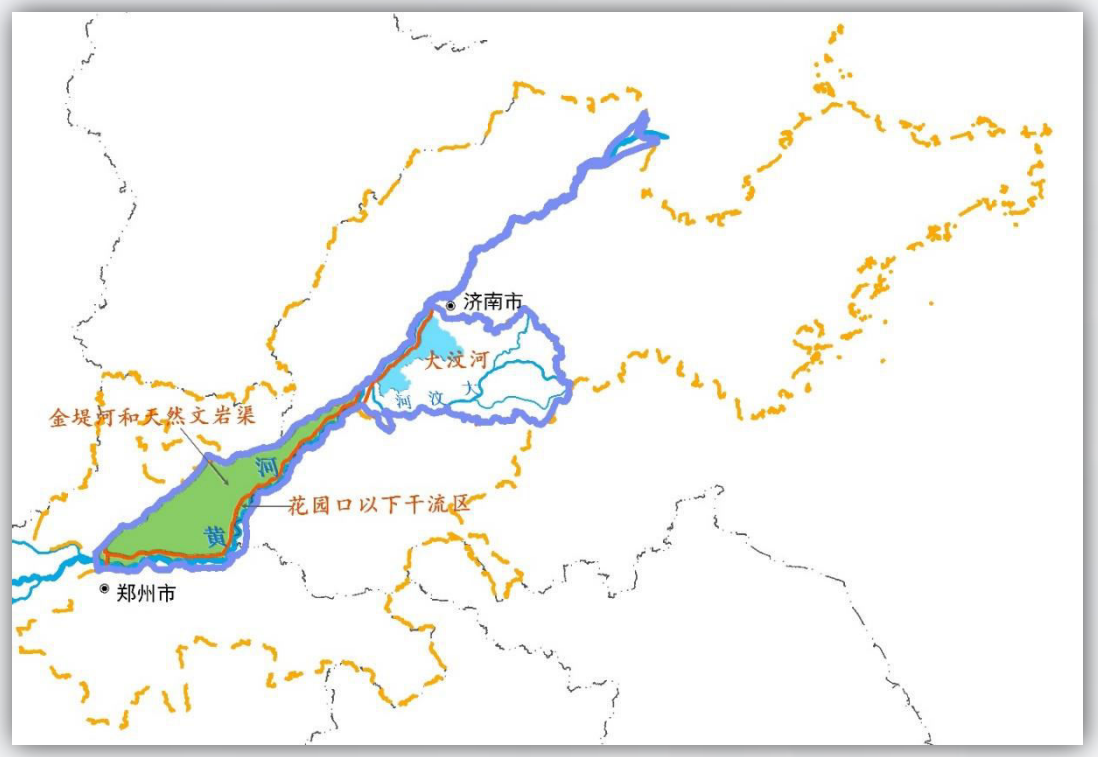
【发展方向】Direction of Development

- Focusing on coordinating the water-food-energy development relationship, optimizing and adjusting the economic structure, reducing the utilization rate of water resources development, strengthening ecological and environmental protection, and improving the carrying capacity of water resources in densely populated and economically important areas.

■下游及引黄灌区　Downstream and Yellow River diversion irrigation area

【基本情况】Basic Information

- A large number of yellow irrigation areas are concentrated in continuous, with an effective irrigated farmland area of about 44.6 million mu, which is an important grain, cotton and oil production base in China. The population density is about 4 times of the average level of the basin. The shortcomings of flood control are prominent, and the situation of "hanging rivers on the ground" is grim.



■下游及引黄灌区—— 调整结构、综合治理

Downstream and Yellow River diversion irrigation area——Structural adjustment and comprehensive treatment

【发展方向】Direction of Development

- Focusing on coordinating water-sand relations, comprehensive management of river channels and beach areas, maintaining the ecology of estuarine deltas, and ensuring flood control and safety, increase the ecological flow within the river channels, promote the health of river ecosystems, and improve biodiversity.

四、黄河流域分区管控对策措施

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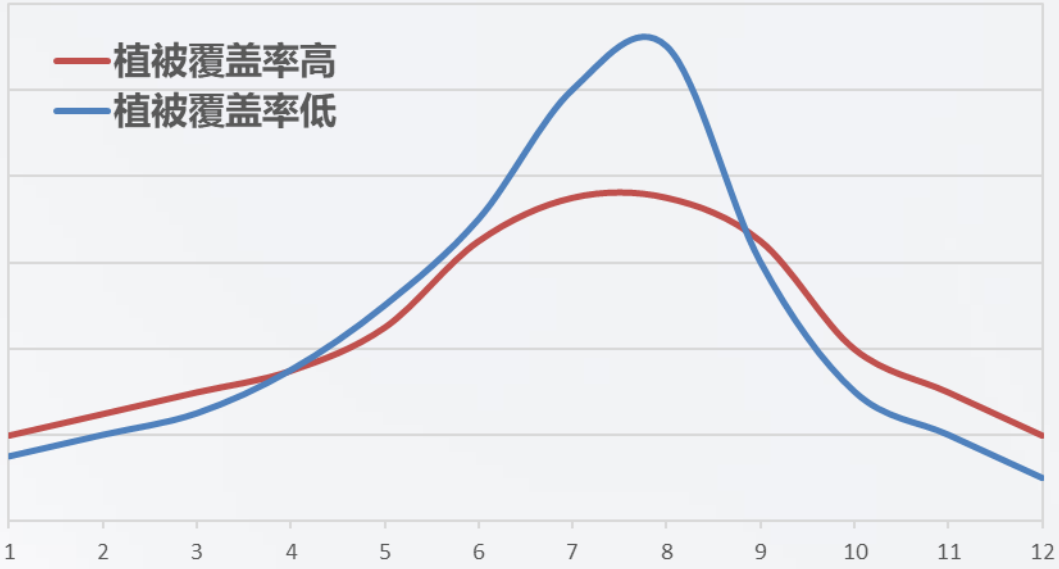
■ 1.加快推进水生态环境治理与修复 Accelerating water ecosystem management and restoration

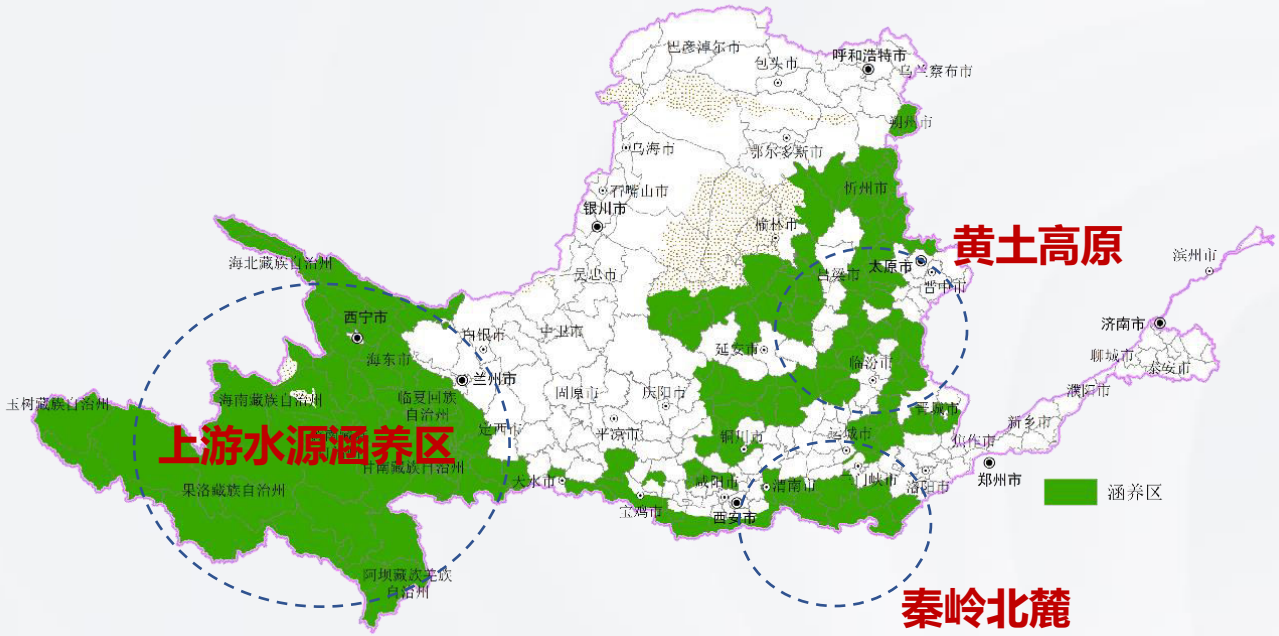
➢ 推进水源涵养区生态保护和修复 Promoting ecological protection and restoration of water conservation areas

- Upstream water source areas to do a good job of ecological protection, water conservation, the middle reaches focus on strengthening the Qinling central water tower ecological conservation and protection, and do a good job of protection and restoration of vegetation on the Loess Plateau.



水源涵养区植被覆盖度~产水量关系

Relationship between vegetation coverage and water yield in water conservation area



黄河流域地表水涵养区

Surface water conservation area of Yellow River basin

四、黄河流域分区管控对策措施

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1.加快推进水生态环境治理与修复　Accelerating water ecosystem management and restoration

➢ 保障河流生态流量（水量）　Safeguarding the ecological flow of rivers

- Comprehensively consider the amount of sand transported during the flood season, the ecological base flow during the non-flood season and the ecological water demand of estuarine wetlands, and deepen the study on the ecological discharge volume of the main control cross section, and the amount of sand transported by the mid-channels, etc.

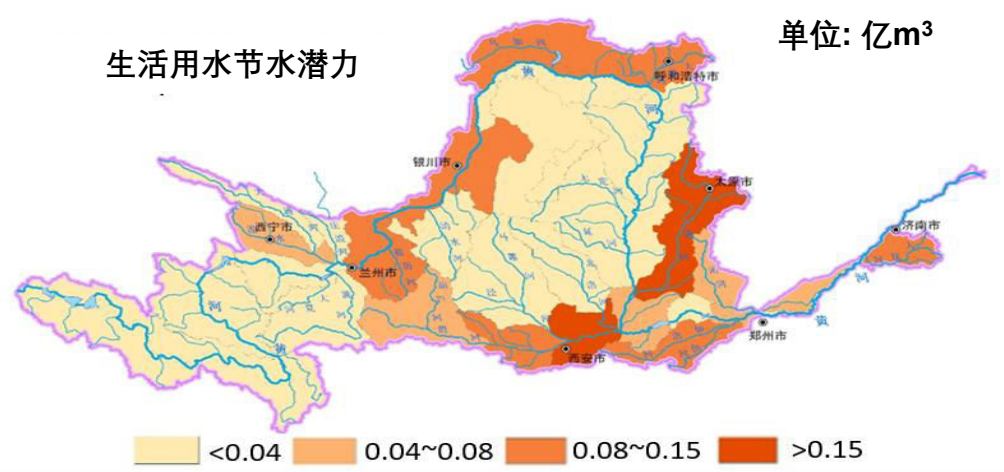
➢ 推进黄河流域河湖生态环境修复　Promoting ecological restoration of rivers and lakes

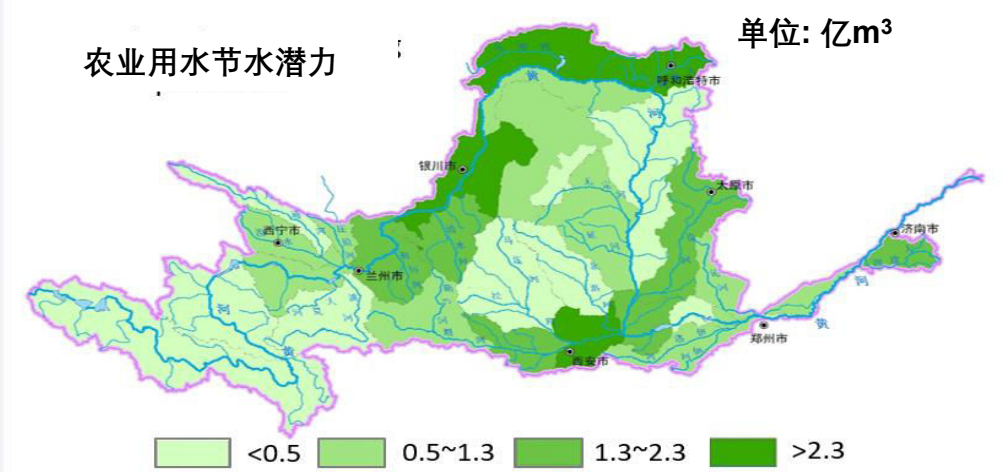
- With the focus on improving the quality and stability of the water ecosystem, we will jointly promote the control of groundwater overexploitation, the construction of ecological corridors in the main stream of the Yellow River, and the comprehensive management of major tributaries such as the Fenhe and Wei rivers, and the Wulangsuhai and Hongjiannao lakes.

■ 2.实施黄河流域深度节水控水行动

Deep implementation of water conservation and control actions in the Yellow River Basin

- Focusing on agricultural water-saving, vigorously promote the modernization of large and medium-sized irrigation areas and comprehensively implement agricultural water-saving and efficiency improvement.
- Promoting the Yellow River Basin to take the lead in building a water-saving river basin. Promote enterprises and parks to carry out transformation, upgrading and recycling to realize industrial water conservation and emission reduction; implement water supply pipeline network renovation and strengthen urban water conservation and loss reduction.





黄河流域节水潜力地区分布 Regional distribution of water-saving potential in the Yellow River Basin

■ 3.强化落实水资源最大刚性约束

Strengthening the implementation of the most rigid constraints of water resources

- **Determine land by water:** reasonable verification of irrigation scale, water-appropriate planting.
- **Determine production by water:** Strictly control the scale of high water-consuming industries.
- **Determine city and people by water:** rational planning of cities and population size.

■4.加快完善黄河流域水资源配置格局

Accelerating the improvement of water resources allocation pattern

The Yellow River water network is fully connected with the national backbone water network to deliver water to North China and Northwest China;

It is necessary to improve the construction of its own water network to create a model area for the construction of happy rivers and lakes, and a demonstration area for the high-quality development of water conservancy.

黄河流域在国家水网中的重要地位

The Yellow River basin plays an important role in the national water network

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Thank you!

马 睿

MA RUI

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