

河流生态廊道修复关键问题与对策

Key problems and Countermeasures of river corridor restoration

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一、河流生态问题

Key issues of river ecosystem

二、生态流量确定

Determination of ecological flows

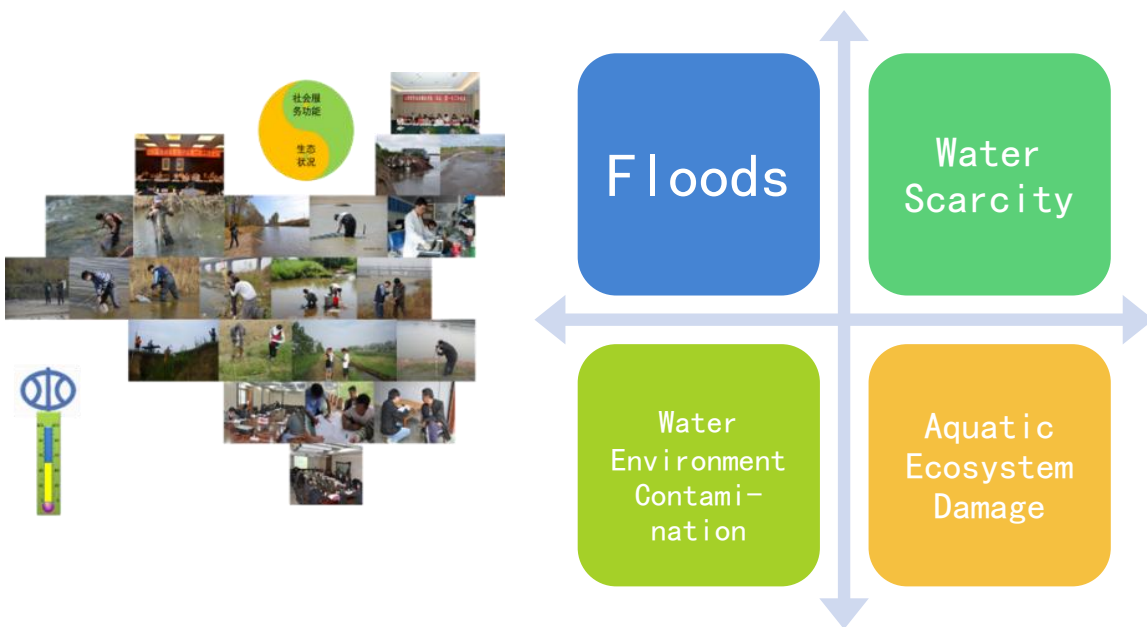
三、河流廊道修复

Restoration of degraded River corridor

1、河流生态问题

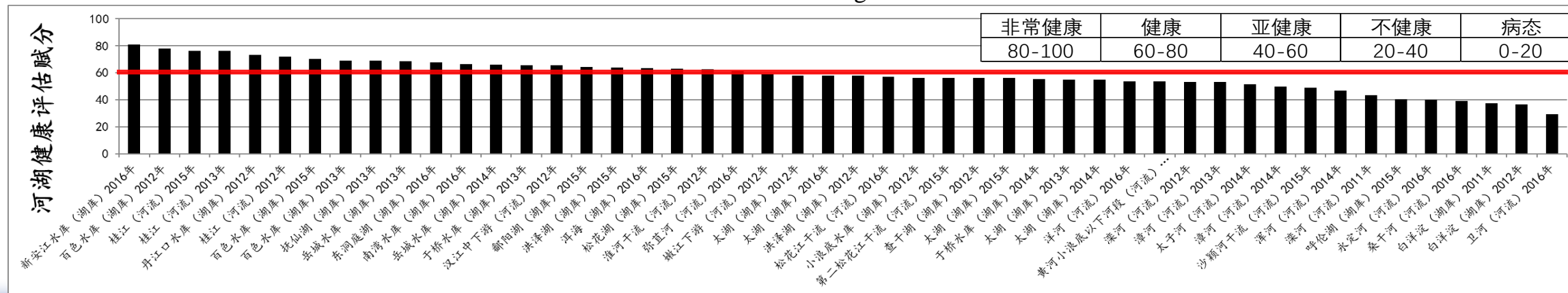
Key issues of river ecosystem

River Health: Small share of healthy river in China.



In the 46 river and lake bodies evaluated, around 60% are graded as unhealthy or sub-healthy, **showing an overall low level of health of key rivers and lakes in China**, which are manifested in the following aspects:

- **Hydrological integrity**: insufficient ecological flow, serious variation of river runoff;
- **Physical integrity**: lake area shrinkage and natural wetland deterioration, over disturbance of shore zone, bad connectivity of rivers and lakes.
- **Chemical integrity**: **Serious eutrophication of lakes and reservoirs and low satisfaction rate of water function zones.**
- **Biological integrity**: Widespread damage of aquatic life integrity, bad living conditions of key sensitive organism.
- **Sustainability of social service function**: Water supply function can not be guaranteed.

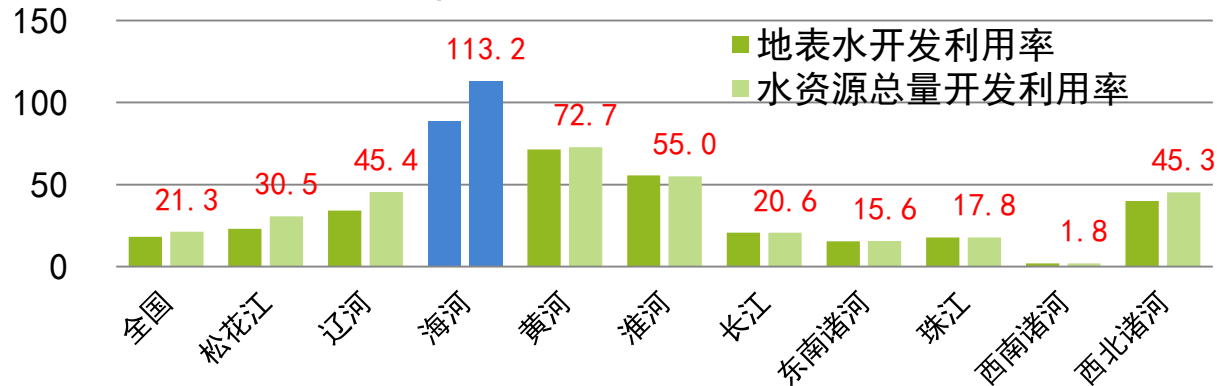


1、河流生态问题

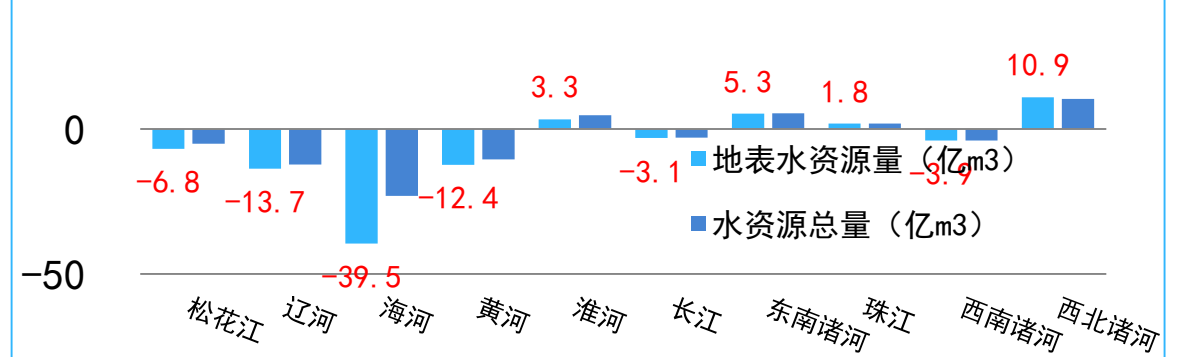
Key issues of river ecosystem

- **Ecological Flow:** Special water regime, water resource scarcity, over exploitation of water resources in some river-basins.
- China is one of the countries whose **precipitation and river runoff are obviously concentrated within the year with a big annual variation**; 60%-80% of the precipitation and runoff are concentrated in the flood season, especially in North China.
- Water resources in North China is **highly developed**, with an obvious decrease of water regime in recent years.
- **Serious ecological problems:** river stop-running in North China; the variation of hydrological rules caused by cascade hydropower development and dam control

Development Rate of Water (%)



Water Resources Volume of 2001-2016 VS 1956-2000



1、河流生态问题

Key issues of river ecosystem

- The goal of building a beautiful China with ecological improvement and restoration of rivers

President Xi said in 2018:

We need to let people resee the beautiful scene of lucid water, and lush banks with fish swimming in the rivers.

Target put forward in the 14th Five-Year-Plan for water and eco-environment protection and restoration:

To achieve the harmonious coexistence of human and water with every river full of water with fish swimming in water plants.

- *MWR Guidelines on the determination and guarantee of ecological flows of rivers and lakes*
- NDRC Master plan of key projects for nationwide protection and restoration of major ecosystems (2021-2035)
- Ministry of Agriculture and Rural Affairs: The 10 year fishing ban along the Yangtze River



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2、生态流量确定

Determination of ecological flows

生态流量定义 Definition of Ecological Flow

Ecological flow of rivers and lakes

Refers to the flow (including water volume and level) and its process of required quality that need to be kept within rivers and lakes to maintain the structure and function of aquatic ecosystem, such as rivers and lakes.

MWR Guidelines on the determination and guarantee of ecological flows of rivers and lakes

- *Environmental flows* describe the quantity, timing, and quality of freshwater flows and levels necessary to sustain aquatic ecosystems which, in turn, support human cultures, economies, sustainable livelihoods, and well-being. aquatic ecosystems include rivers, streams, springs, riparian, floodplain and other wetlands, lakes, freshwater dependent coastal water bodies, including lagoons and estuaries, and groundwater-dependent ecosystems (GDEs).

The Brisbane Declaration (2018)

- An hydrological regime consistent with the achievement of the environmental objectives of the WFD in natural surface water bodies as mentioned in Article 4(1).

EU: Working definition for ecological flows in the context of the WFD

2、生态流量确定

Determination of ecological flows

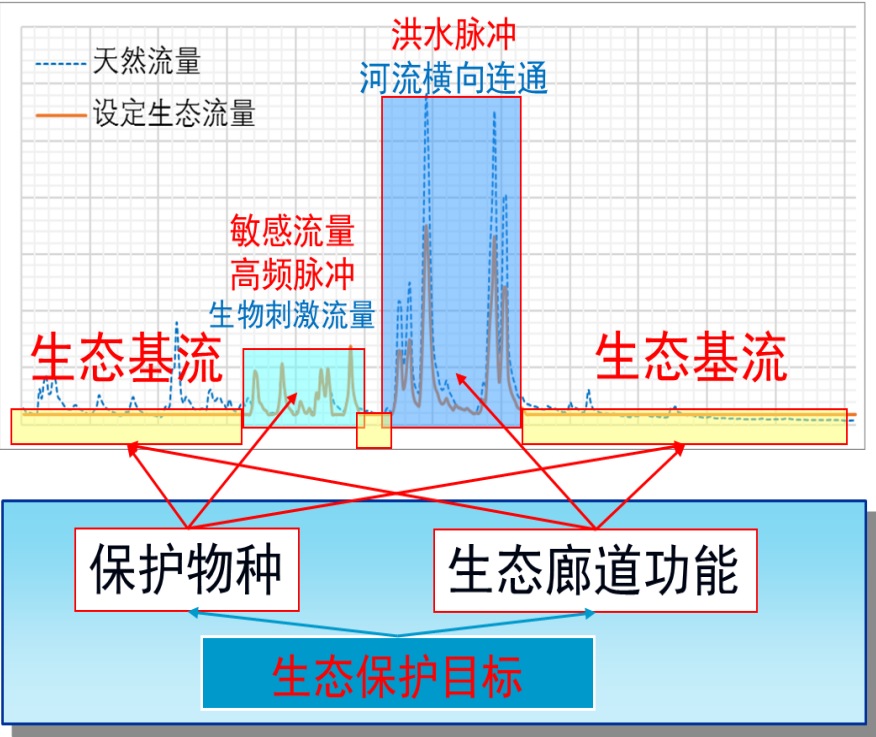
基本水文条件需求 Basic hydrological conditions

- ①

Identification of major targets for eco-protection, including species and corridor function
- ②

Identification of requirements for basic hydrological conditions: The whole-year flow process consisting of ecological base flow and ecological flow in sensitive periods.
- ③

Optimized water allocation to guarantee the ecological flow: The coordination of water use for life, production and ecosystem.



生态保护目标分组		涉及保护名录
1、物种	鱼类等水生生物及重要生境维持	自然保护区、种质资源保护区
2、功能	2.1 枯水河槽及河道纵向连通功能维持	
	2.2 河口或尾间生态功能维护	河口生态维持 尾间湖泊湿地保护
	2.3 河湖横向连通性维护及沿岸水生生物与重要生境保护	河谷林草维持 湿地生态保护
		自然保护区 重要湿地、湿地公园
		涉水景观生态维持 风景名胜区涉水景观

2、生态流量确定

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生态保护对象及基本水文条件需求确定

for basic hydrological conditions

Identification of protected targets and the requirements

Dam-controlled rivers: Ecological Flow determination of Huaihe River and Shaying River based on the correlation of hydrology and bottom dwelling organisms

摄食类群 (FFGs) 与1daymax

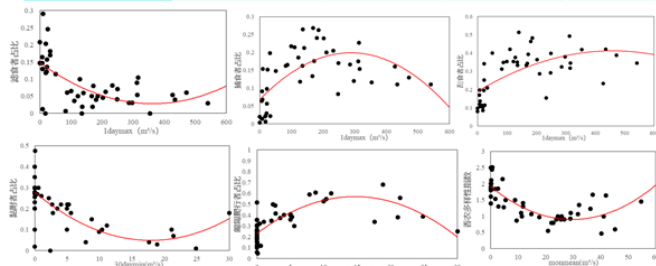
FFGs组分	a	b	c	R ²
滤食者	0.9×10^{-6}	-0.0007	0.1477	0.62
集食者	-0.4×10^{-7}	-0.0002	0.2848	0.43
捕食者	-2.0×10^{-6}	0.0009	0.0678	0.42
刮食者	-1.0×10^{-6}	0.0010	0.1902	0.49
撕食者	1.0×10^{-6}	-0.0010	0.2996	0.51

栖息类群 (HTGs) 与30daymin

HTGs组分	a	b	c	R ²
黏附者	7.0×10^{-4}	-0.0256	0.278	0.53
匍匐爬行者	-1.6×10^{-3}	0.0462	0.2325	0.60
游泳者	1.0×10^{-4}	0.0047	0.1205	0.43
营巢者	0.3×10^{-3}	-0.0156	0.3008	0.41
攀爬者	0.3×10^{-3}	-0.0052	0.0449	0.45

Shannon index与monmean

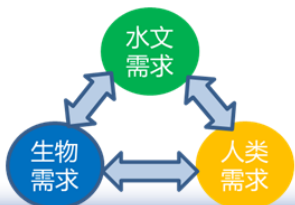
多样性	a	b	c	R ²
	1.15×10^{-3}	-0.068	1.91	0.62



目标函数

$$F = a_1ED + a_2HD + a_3SD$$

ED为底栖生态目标；HD为自然水文情势目标；SD为社会服务目标：

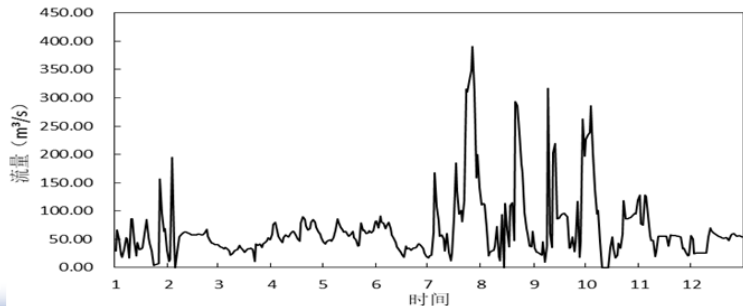
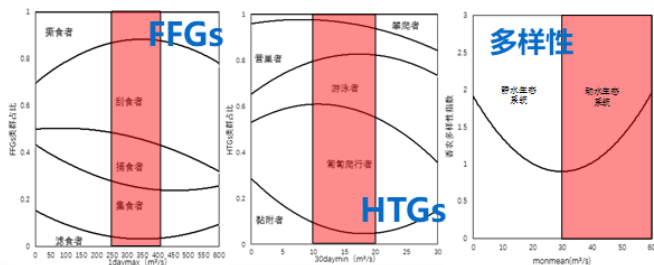


约束条件

- 1、底栖群落结构恢复需求
- 2、主要水文扰动指标改变最小
- 3、人类社会服务需求约束（防洪、灌溉、发电等）

生态流量方案

底栖生物水流阈值



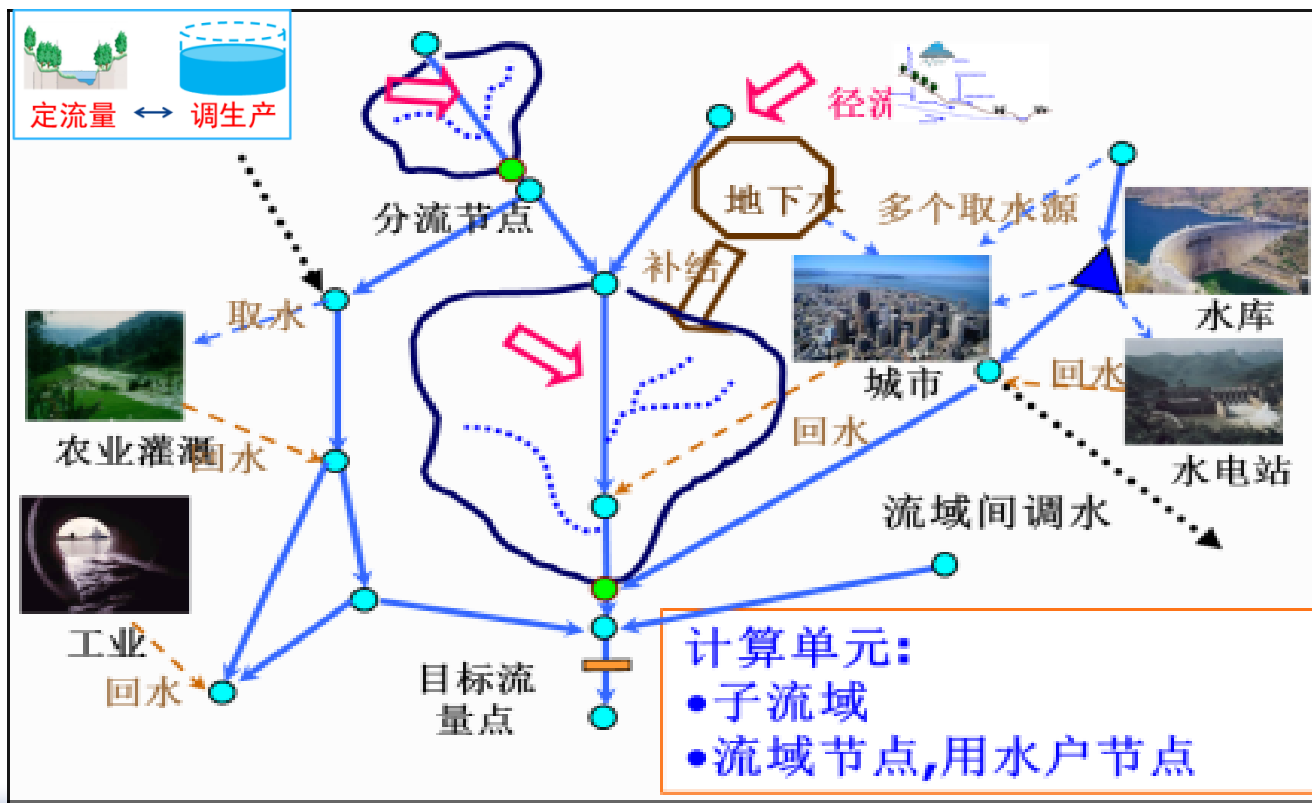
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生态流量/用水协调 Ecological flow/coordination of water use

The Liaohe River basin has a limited water resource volume but a high degree of development and a serious degradation of aquatic eco-environment, showing a prominent contradiction of water use for production and ecosystem protection.

Integrated water use coordination model with a reasonable ecological flow

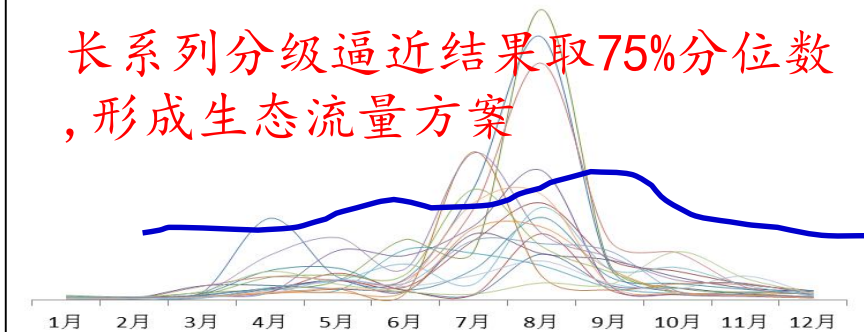


Readjustment of water use VS Ecological flow plan

Overall water use coordination: increasing ecological flow while ensuring the life water use and adjusting the industrial and agricultural water use volume

- Guarantee rate for agriculture: 70-75%, damage degree 50-90%;
- Guarantee rate for industry: 90-95%, damage degree 70-90%;

长系列分级逼近结果取75%分位数, 形成生态流量方案





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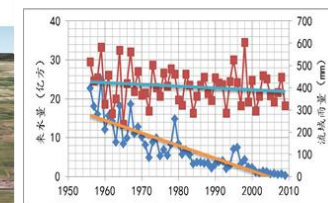
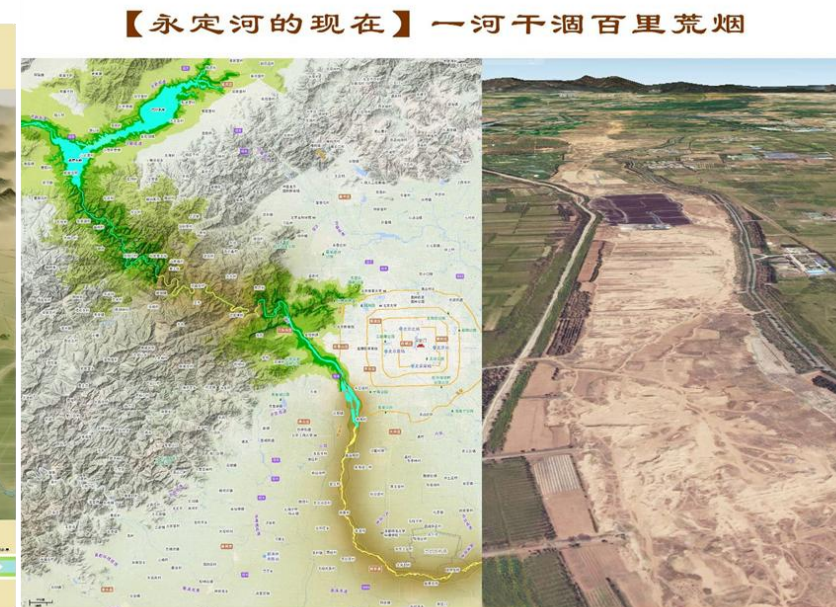
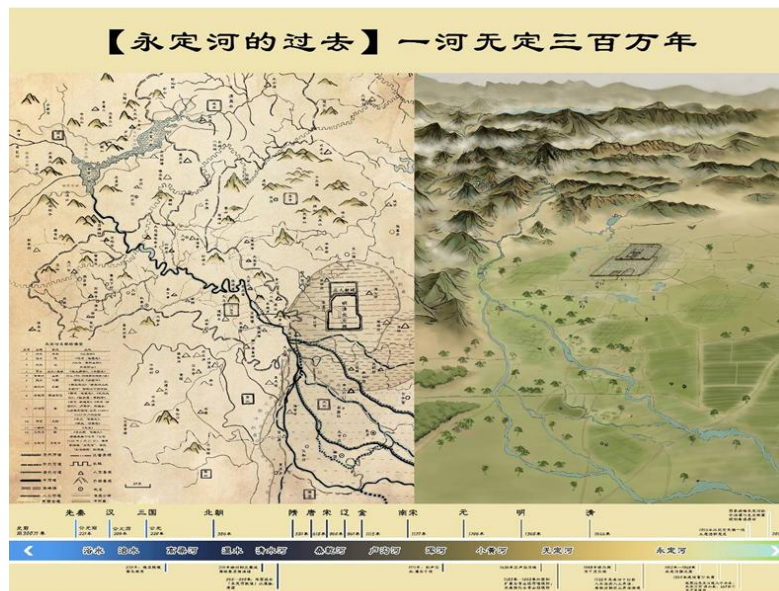
Restoration of degraded River corridor

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中国北方水资源短缺流域—河流断流问题突出

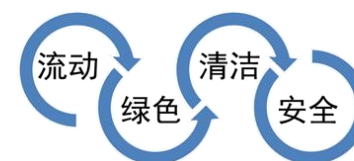
Riverbasin in North China with water scarcity-Serious problem of zero flow



范围		2005-2014年平均	
起始断面	终止断面	干涸天数	断流天数
官厅水库	三家店	0	120
三家店	卢沟桥	0	365
卢沟桥	梁各庄	360	365
梁各庄	屈家店	365	365
屈家店	防潮闸	0	365
平均		121	316

枯水情势
洪水风险

□ 河流自然水文过程基本消失
□ 河流廊道生态状况退化严重



- Yongding River used to be one of the four major rivers with the most serious flood threat.
- However, it has witnessed zero flow since 1980s in its downstream reaches, with an average of 316 days of no flow annually from 2005 to 2014. There had been a 121-day of total dry-up with a complete loss of river functions.

3、河流廊道修复

Restoration of degraded River corridor

■ 永定河—河流修复规划 The restoration plan of Yongding River

国家发展和改革委员会
水利部 文件
国家林业局

发改农经〔2016〕2842号

The master plan for the comprehensive treatment and ecological restoration of Yongding River
December 1, 2016

Future

2020

The green ecological corridor of the River basically taking shape.

2025

The building of the green ecological corridor basically completed.

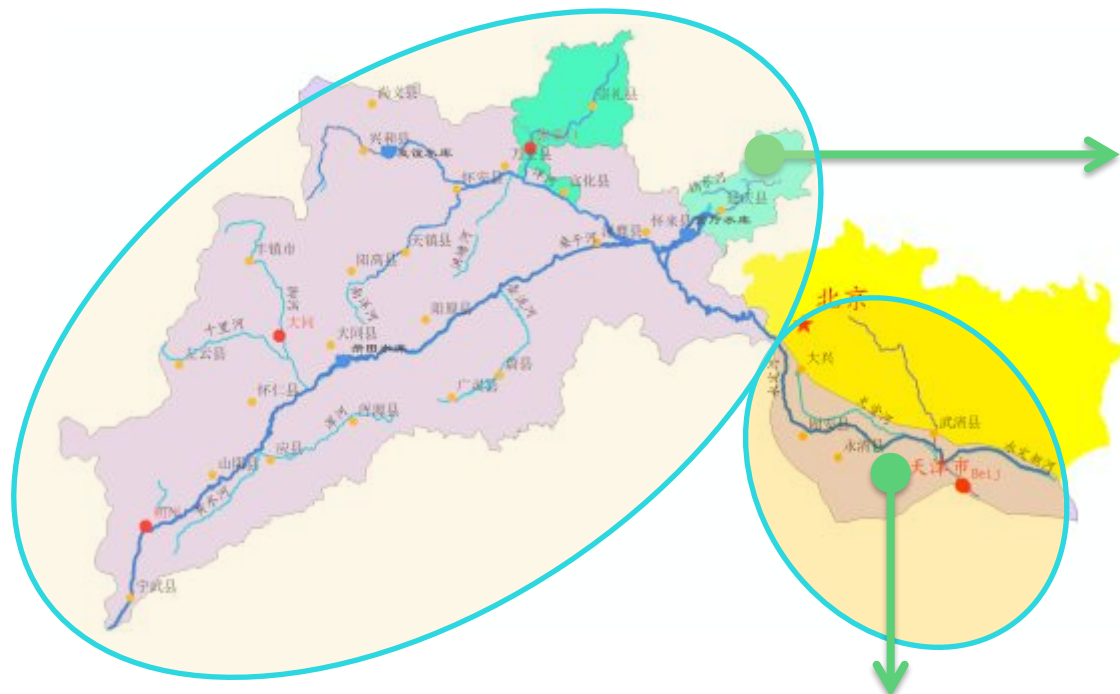
The river that is flowing, lucid, clean and safe is basically restored.

- ◆ Natural restoration enters into a virtuous circle
- ◆ Raise of ground water table

3、河流廊道修复

Restoration of degraded River corridor

■ 永定河—河流廊道修复重大问题 Major challenges in the river corridor restoration of the Yongding River

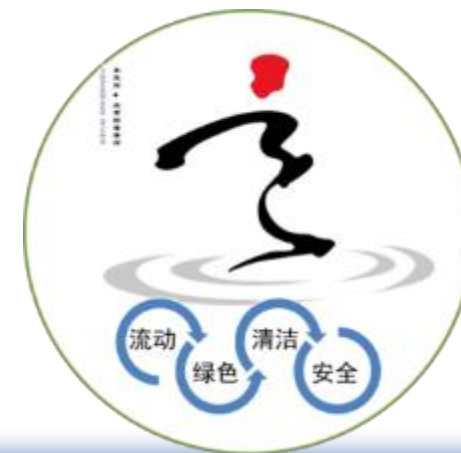


How to ensure and allocate the water from upstream inflow (from Guanting Reservoir, the water diverted from the Yellow River and from Yangtze River)

Focusing on the water: Coordinate the water from multiple sources including the recycled water and the upstream inflows, to ensure the flow volume for the ecological corridor and to maintain a *flowing* river.

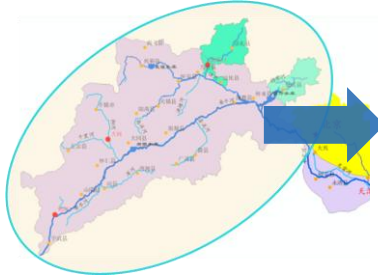
How to restore a dry-up river channel

Focusing on the Corridor : Based on the available water resources, reasonably restore the river landscape units and create the proper living conditions for the basic connectivity of the ecological corridor of the River.



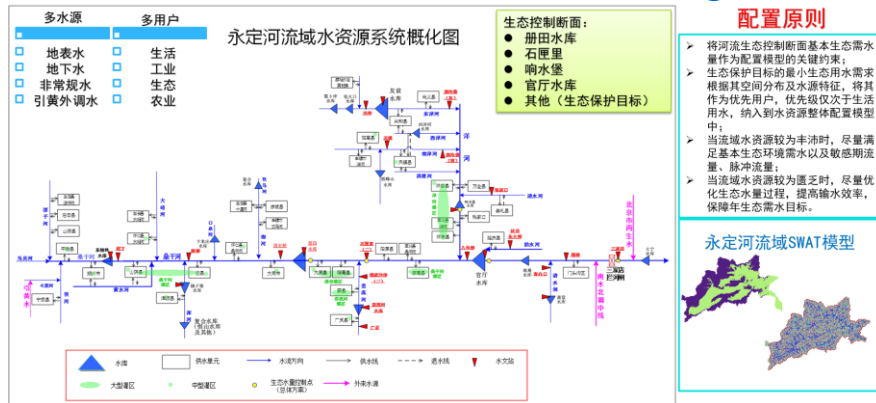
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How to effectively increase and ensure the total upstream inflow volume?

Upstream Yongding River: Analysis of water saving potential + Optimized water resource allocation + Ecological water supplementation + Coordinated regulation



- **Water saving plan:** Water saving potential analysis, water saving and energy reduction, control of water use outside the channel.
- **Optimized water resource allocation.** Use of multiple water sources, including the ground water, recycled water, water diverted from The Yellow River.



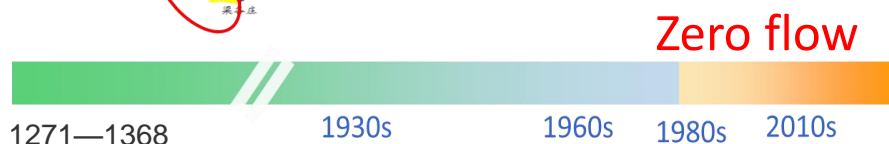
- **Water supplementation:** Putting forward the plan of water supplementation process and joint regulation of upstream reservoirs in line with the requirement of the protected targets.

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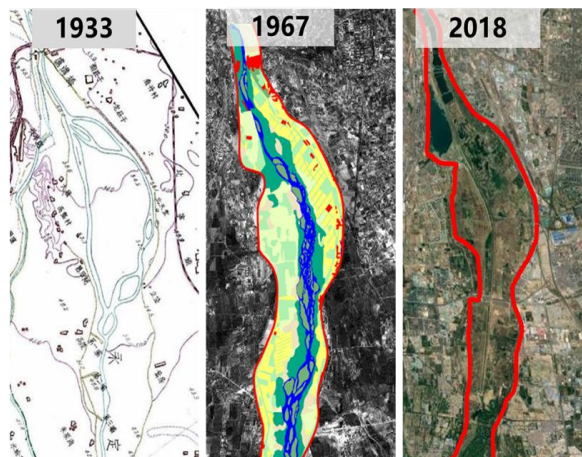
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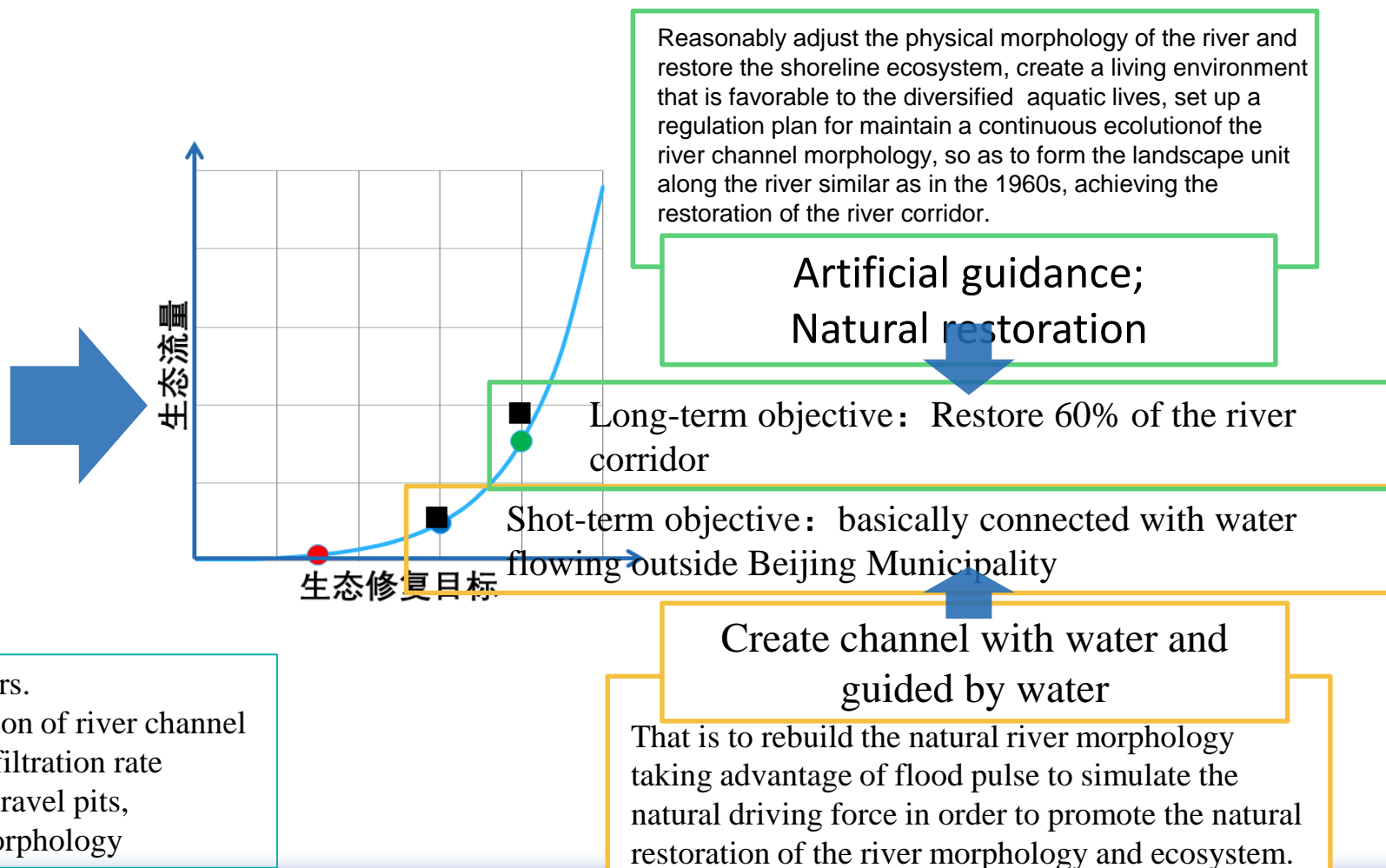
How to restore the desertified downstream river channel ?



元《卢沟运筏图》：永定河大量漂流运送冀西北山地木材，卢沟桥附近繁忙情景。



- Zero flow of 40 years.
- Serious desertification of river channel leading to a high infiltration rate
- Multiple sand and gravel pits, disordered river morphology



Reasonably adjust the physical morphology of the river and restore the shoreline ecosystem, create a living environment that is favorable to the diversified aquatic lives, set up a regulation plan for maintain a continuous evolution of the river channel morphology, so as to form the landscape unit along the river similar as in the 1960s, achieving the restoration of the river corridor.

Artificial guidance;
Natural restoration

Long-term objective: Restore 60% of the river corridor

Shot-term objective: basically connected with water flowing outside Beijing Municipality

Create channel with water and guided by water

That is to rebuild the natural river morphology taking advantage of flood pulse to simulate the natural driving force in order to promote the natural restoration of the river morphology and ecosystem.

Thanks

