XVIII World Water Congress
International Water Resources Association (IWRA)

Assessment and Prediction of water security and obstacle diagnosis in the Yellow river Basin

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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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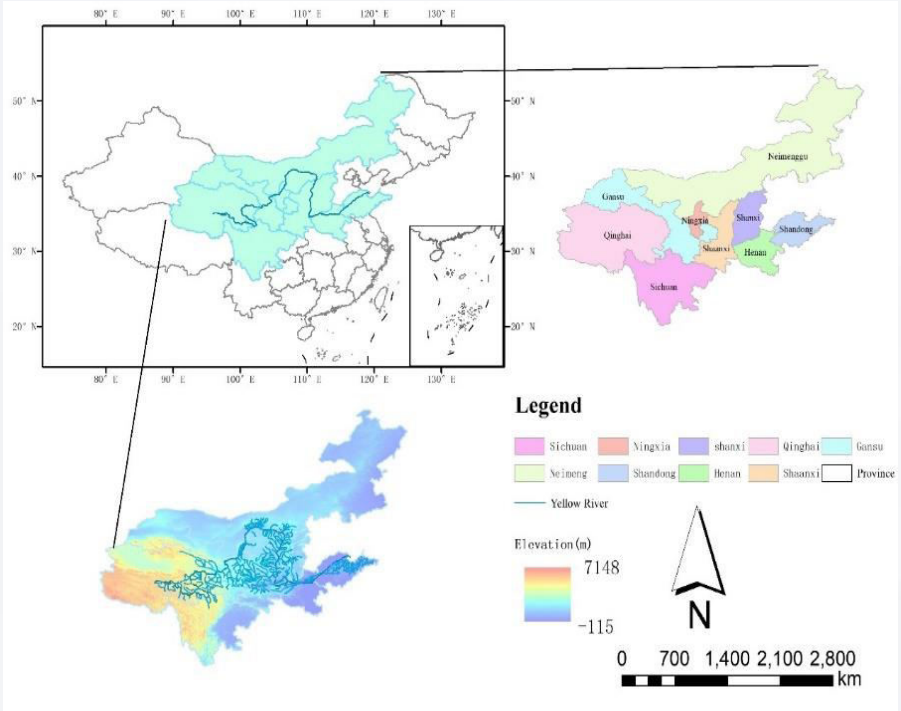
Introduction:

- The Yellow River Basin is a **crucial region** for resource enrichment, food production, and ecological protection in China. It plays an **indispensable role** in maintaining national water security and promoting **stable economic and social development**.

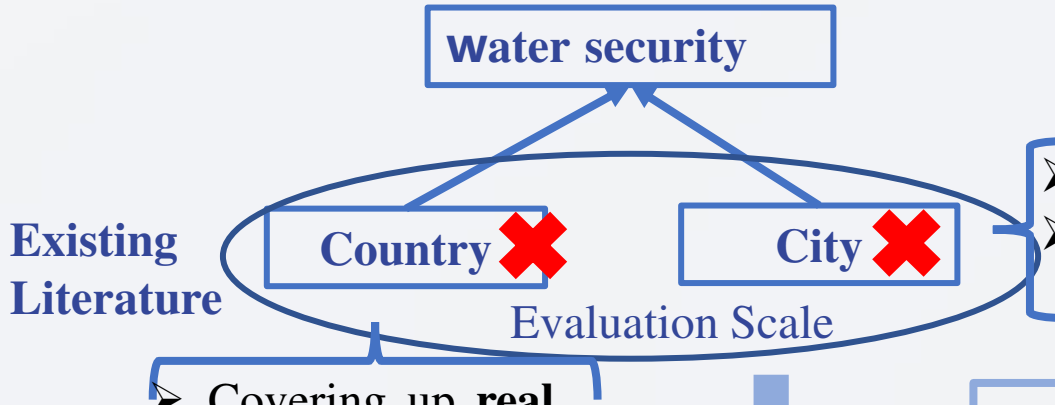
- After a long period of arduous exploration and unremitting efforts, the governance in the Yellow River Basin has made **great achievements**. However, the outstanding ecological and environmental problems still exist, and **the water quality of the basin is still below the national average**.

- **Scientific assessment** of water security and identification of **major obstacles** are key to accurately addressing water security issues and ensuring water security.



Literature review (three gap) :

GAP 1:



- Neglecting the **spatial effects** of water flows;
- ignoring **larger issues** such as downstream transfers and "free-riding" on pollution management.

- Covering up **real problems** at the local level

Based on the principles of integrated water resources management, **Hydrological boundaries** are an integrated approach to water resources management.

GAP 2:

Evaluation dimensions are relatively **homogenous**, mainly assessing a single aspect of water security, **such as water quantity and quality**, and the literature on comprehensive considerations of forecasting is lacking.

GAP 3:

Focusing on evaluating the state of water security, there is little literature that explores what are **the main obstacles** that affect water security to accurately make long-term planning.

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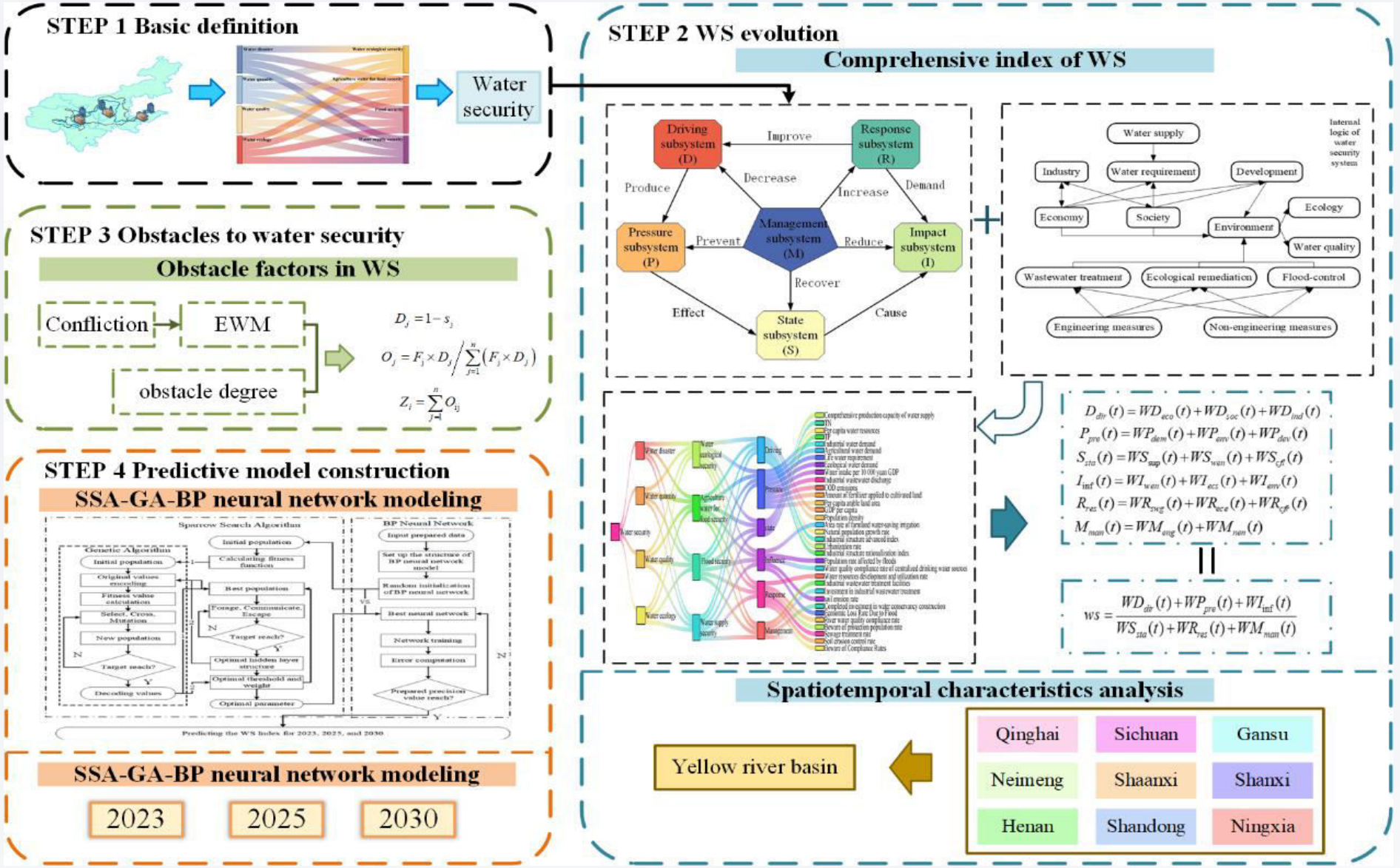
Core content & Methodology:



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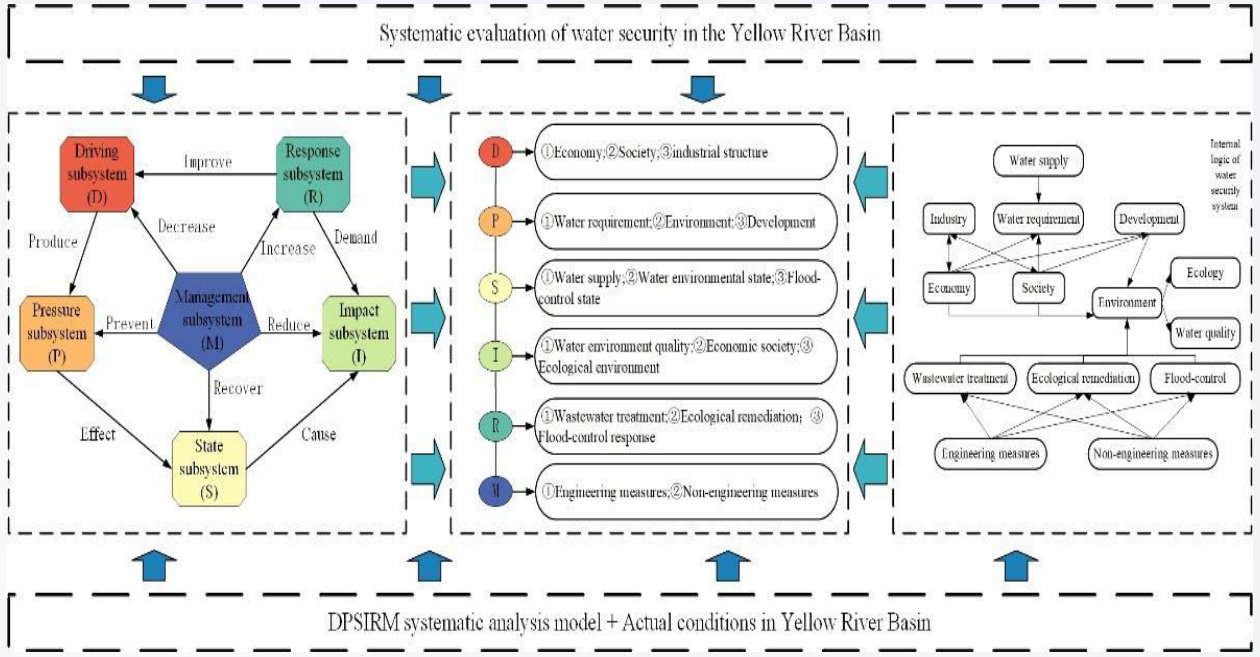
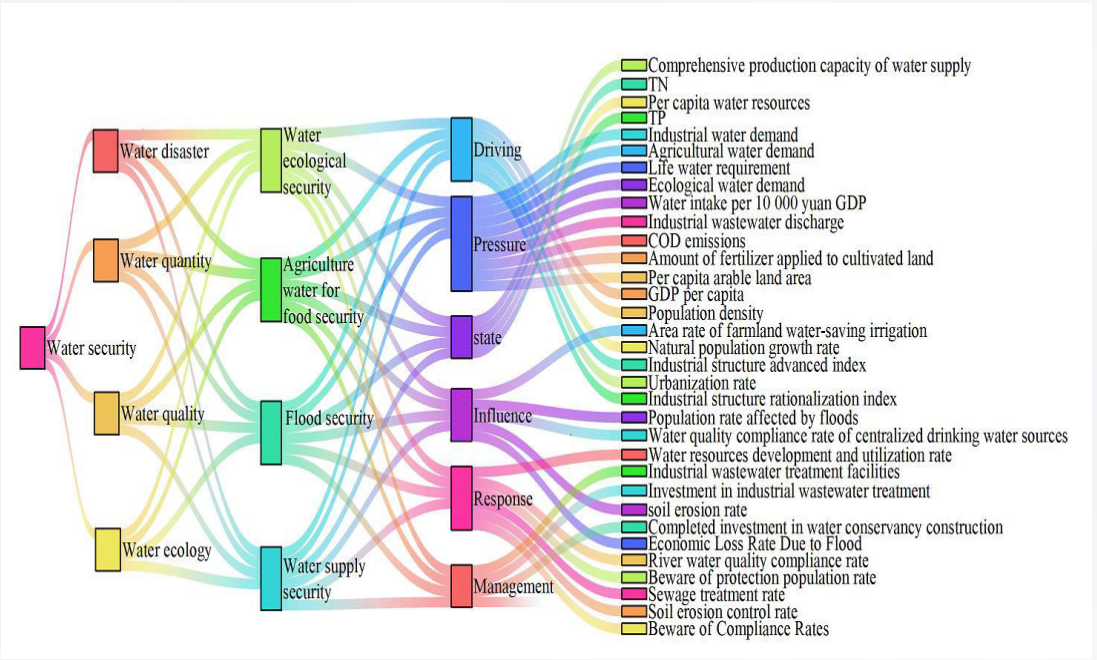
Results:

Water security：

A **state** in which water resources are available in **sufficient quantity and quality** to meet human needs for normal survival and stable development of the economy, society and natural ecosystems of humankind on the basis of intergenerational equity, while **minimizing the negative impacts** of water-related disasters, in a reasonable time and cost.





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Results:

Composite index of the overall water security in the Yellow River Basin for the period 2012-2020

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020
Basin	1.672	1.483	0.927	0.915	0.746	0.873	0.882	0.843	1.015

Danger (V)	Insecurity (IV)	Criticality (III)	Relative Safety (II)	Safety (I)
3≤	(3,1]	(1, 0.8]	(0.8,0.3]	(0.3,0]

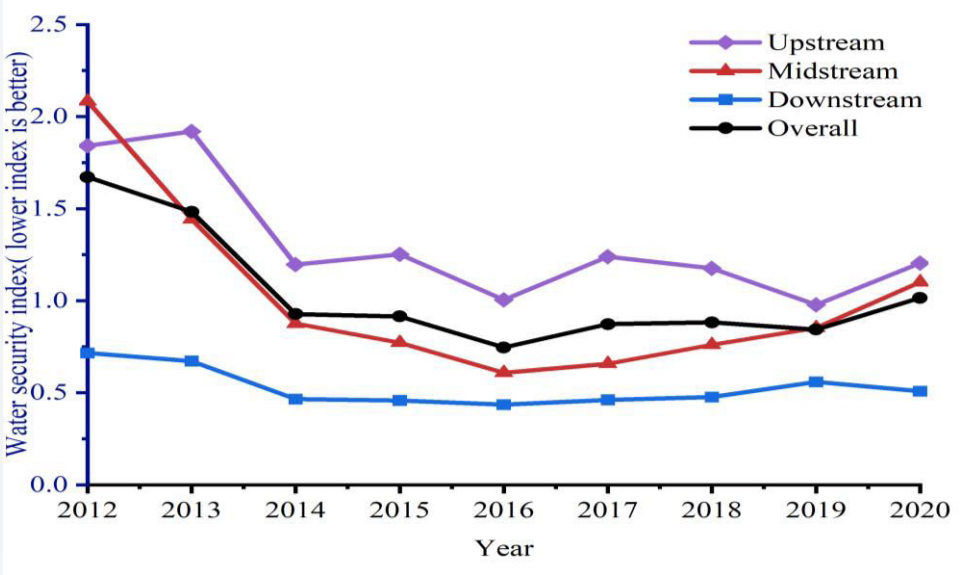
Overall:

The state of water security in the Yellow River Basin is excellent news from 2012 to 2016 . **Two stages could be divided**.

- 2012-2016, the comprehensive index decreased by 55.38% from 1.672 to 0.746, indicating that the state of water security showed an **improving trend**.
- 2016-2020, the index increases from 1.295 to 1.357, which means that the water security in Yellow River Basin has taken a turn for the worse.

From the upstream and downstream of view:

- **Upstream**: The state of water had shifted from hazardous to criticality from 2012 to 2020.
- **Midstream**: The sate of water security had undergone a U-shaped change.
- **Downstream**: The changes were relatively stable, mainly in a critical state.



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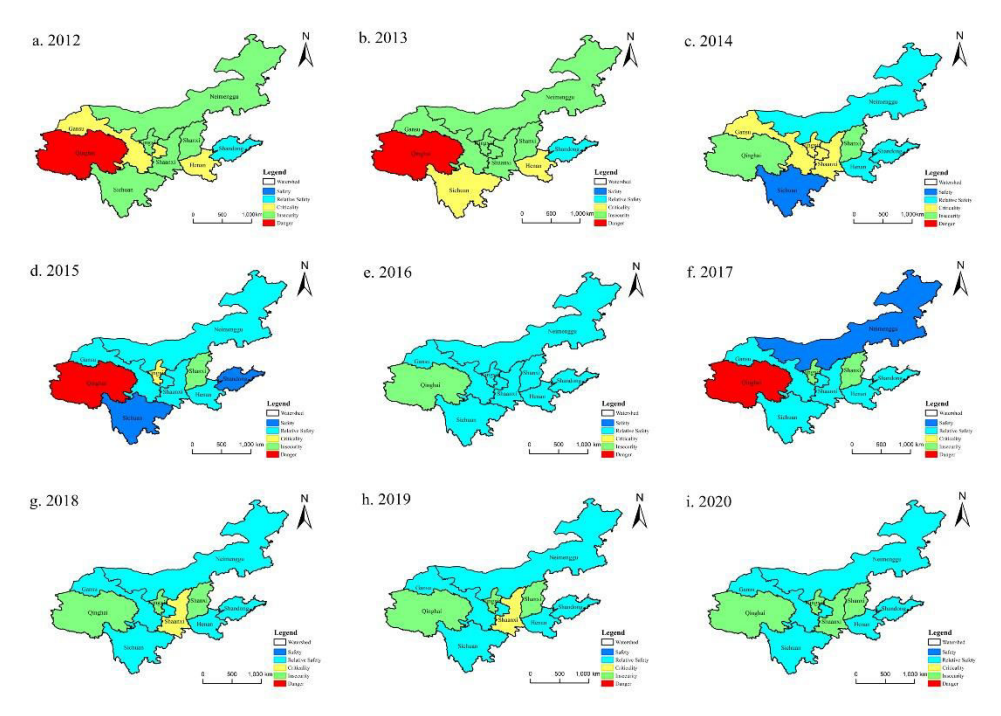
Results:



The obstacle factors(sample data)

Province	Year	Index					
		1		2		3	
Qinghai	2018	R(37.0)	R3,R5,R1	M(25.6)	M2,M3,M1	S(21.1)	S2
	2020	R(36.2)	R3,R6,R1	M(24.6)	M2,M3,M1	S(23.6)	S2
Sichuan	2018	R(27.05)	R3,R1,R2	D(22.8)	D5,D4,D1	P(20.9)	P2,P3,P7
	2020	I(30.7)	I4,I2,I3	D(20.9)	D5,D6,D1	R(17.4)	R6,R1,R2
Gansu	2018	I(37.9)	I1,I5,I2	S(27.4)	S2,S1,S3	M(21.4)	M3,M2,M1
	2020	I(40.0)	I3,I4,I5	S(24.5)	S1,S2,S3	M(20.5)	M2,M3,M1
Ningxia	2018	D(26.7)	D3,D4,D6	S(23.3)	S2,S1,S3	M(21.5)	M2,M3,M1
			.....				

◆ Qinghai & Sichuan

The main obstacle factors are sewage treatment rate, comprehensive production capacity of **water supply** and **water consumption** per 10000 yuan GDP.

Area rate of **farmland water-saving irrigation** and **industrial structure** are the main obstacle factors.

◆ Gansu

The water unsafe is caused by the cross action of insufficient **comprehensive production capacity of water supply**, **large arable land per capita** and **high agricultural water demand**.

◆ Ningxia & Neimongol

The wastewater treatment facilities are not perfect and the industrial structure is unreasonable

Industrial structure advanced index, **urbanization rate** and per capita water resources.

◆ Shaanxi & Shanxi

Comprehensive production capacity of water supply, **per capita water resources**, **area rate of farmland water-saving irrigation** ……

◆ Henan & Shandong

Industrial water requirement, **Industrial structure**, **economic loss rate due to Flood.**

Wastewater discharge, **water requirement**, **per capita water resource** ……

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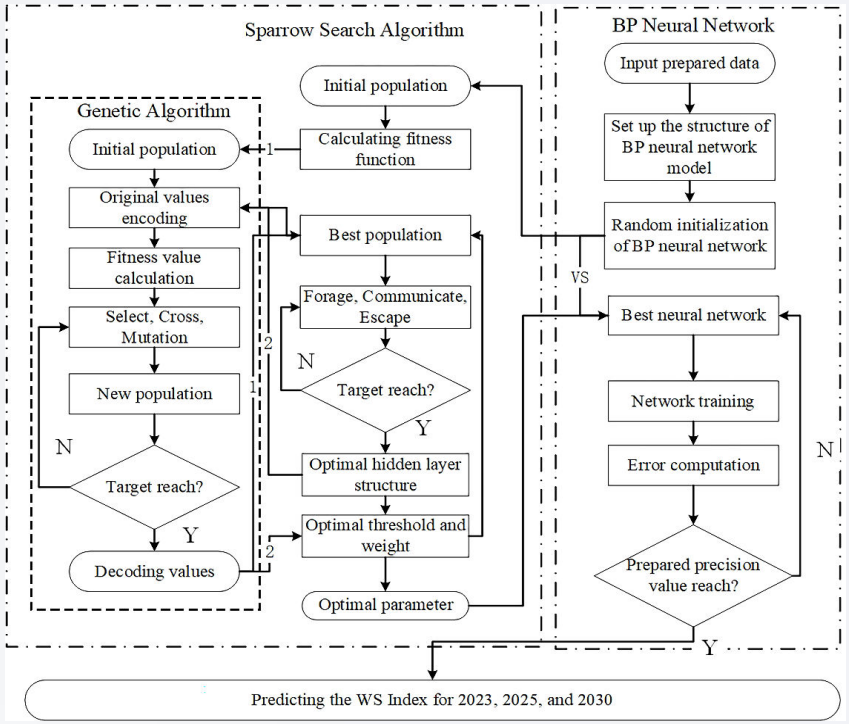
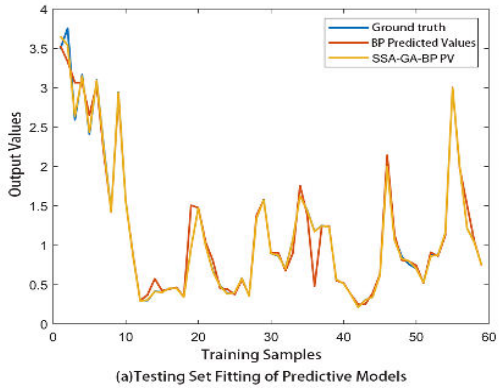
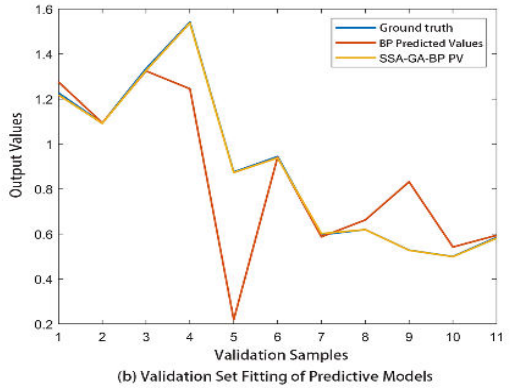


Province	Year	Real value	SSA-GA-BP neural network predictive model		BP neural network predictive model	
			Predictive value	Relative error (%)	Predictive value	Relative error (%)
Qinghai	2019	1.426	1.419	0.707	1.410	1.123
	2020	2.943	2.936	0.228	2.936	0.224
Sichuan	2019	0.456	0.453	0.549	0.454	0.342
	2020	0.344	0.341	0.945	0.344	0.113
Gansu	2019	0.582	0.579	0.582	0.587	0.798
	2020	0.356	0.355	0.342	0.350	1.551
Ningxia	2019	1.443	1.437	0.388	1.437	0.404
	2020	1.177	1.175	0.164	1.176	0.101
Neimongol	2019	0.343	0.345	0.607	0.552	60.862
	2020	0.619	0.617	0.334	0.625	0.975
.....						

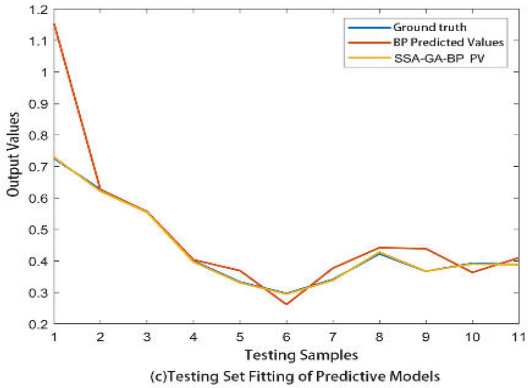
The **genetic population size** was set to **30**, the number of genetic iterations was set to **10**, the value of crossover probability was set to **0.6**, the mutation probability was set to **0.08**, the sparrow population size was **60**, the maximum number of iterations was set to **5**.



(a)Testing Set Fitting of Predictive Models



(b) Validation Set Fitting of Predictive Models



(c)Testing Set Fitting of Predictive Models

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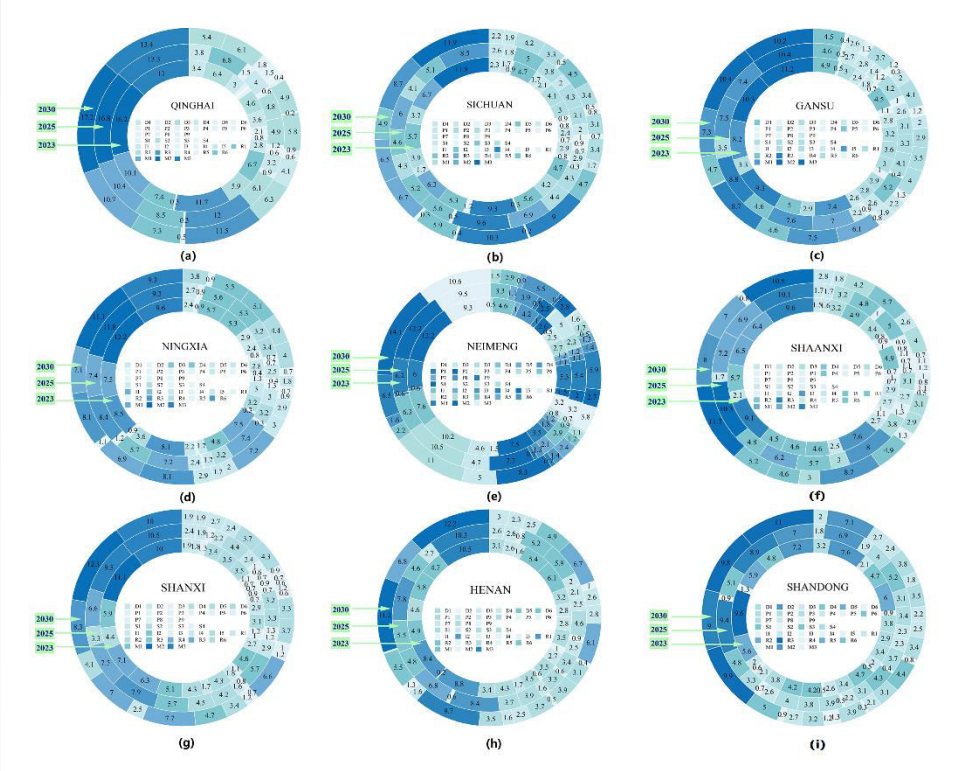
Results :

Predicted results

Year	Qinghai	Sichuan	Gansu	Ningxia	Neimongol	Shaanxi	Shanxi	Henan	Shandong	watershed
2023	1.555	0.844	0.392	0.598	0.133	0.426	3.007	0.199	0.940	0.826
2025	1.490	1.060	0.868	1.084	0.446	0.496	2.711	0.599	1.704	0.930
2030	0.313	0.129	0.748	1.824	2.875	0.841	1.422	0.364	1.714	0.428



- **Qinghai, Sichuan, Shaanxi, Shanxi and Henan** are all provinces where the state of water security has improved significantly.

- **Gansu, Ningxia, Shandong and Neimongol** are among the provinces where water security is likely to deteriorate.

1. The deterioration of water security in Gansu Province is mainly caused by **COD emission** and **water requirement** increasing with the decreasing in the number of wastewater treatment facilities. So is Shandong.

2. The increase of **industrial wastewater discharge, TP and TN further aggravated the unsafe factors** of water environment in NeiMongol so that the water quality is the main reason.

Countermeasures and Proposals:

The results of water security assessment, prediction and obstacle degree analysis in the Yellow River Basin show that **the improvement of water conservancy facilities**, **industrial structure**, **conservation and intensive water resources** and **rational development** as well as **utilization** are the keys to improve the level of water security

Yellow River Basin:

- Actively carry out the reinforcement and "update and upgrade" of long-standing water conservancy facilities,
- Conservation and intensive management of industrial and agricultural water resources,
- From the perspective of policy norms, it is necessary to carry out unified planning from the five dimensions of **water resource supply and demand security**, **flood control security**, **ecological security, water quality security** and the construction of a modern water management system to form a "1+N" policy system.

Province (several samples):

- **Qinghai** Province also needs to "eliminate the hidden dangers of the stock and achieve normal management" as the goal from the source control.
- Water infrastructure improvement and digital linkage management is a common problem in **Ningxia, Shanxi, Shaanxi and Henan,** and it is necessary to propose sustainable and targeted facility measures according to the basic conditions of each province.
- To improve sewage treatment facilities, control water environmental pollution and continuously carry out real-time dynamic monitoring of water quality are the keys to improve the water safety level in **Shandong Province**.

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THANK YOU

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