

Research of China Water Resources Supply and Demands

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Background

- 1. General Situation of Water Resources in China**
- 2. Climate Changes and its Impact on Water Resource in the Past 50 Years in China**
- 3. Analysis of Water Supply Ability of China**
- 4. Analysis of Water Resource Demands in China**
- 5. Forecast of Water Demands**

Background

Water resource is essential natural resources. Shortage of water is now one of key restricting factor of the development of Chinese society and economy.

Water resources research is also an important content of AIM research. We had a lot of discussion wit Japanese team in 2005. After that, we think, according to the situation in China, it is better to simplify the model. If we can propose a simple model, based on it, we can have further discussion. This is benefit for the water model development.

Depending on the framework of “Water use model and available water resource model (Presented by Dr. Hijioka, Tsukuba, March,2004) and situation in China, the basic idea of China water resources model from IGSNRR team was proposed and was sent to Japanese team. Then, we have done some research on China’s water supply and demand.

1. General situation of water resources in China

From 2001, Ministry of Water Resources, P.R. China conducted the second national water resources appraisal, the draft result are as tab1.

Table 1-1 Annual average precipitation volume and water resources amount in different regions of China (1959-2000 series)

Region	Item	Annual average precipitation volume		Annual runoff volume (100 million m ³)	Ground water resources (100 million m ³)		Total (100 million m ³)
		mm	100 million m ³		Resources amount	Amount not overlap	
Six regions in the North	Total	328.3	19886	4365	2461	893	5259
	Percentage in the whole nation (%)		32.2	16	29.9	86.2	18.5
Four regions in the South	total	1214.4	41900	23010	5760	143	23153
	Percentage in the whole nation (%)		67.8	84	70.1	13.8	81.5

2.Climate Change and Its Impact on Water Resource in The Past 50 Years of China

2.1 Comparison of Annual Average Air Temperature

The annual average temperature in each basin appears increasing trend, and temperature increase range of north is higher than the south.

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The annual average temperature in each basin appears increasing trend, and temperature increase range of north is higher than the south.

Region name	Spring	Summer	Autumn	Winter	Year
Songhuajiang	1.0	0.5	0.4	1.4	0.8
Liaohu	0.8	0.4	0.3	1.3	0.7
Haihe	0.7	0.5	0.6	1.2	0.7
The Yellow River	0.2	0.0	0.4	0.8	0.3
The Huaihe River	0.4	-0.1	0.4	0.6	0.4
The Yangtze River	0.0	-0.1	0.4	0.3	0.1
Rivers in the southeast	0.1	0.2	0.5	0.4	0.3
Zhujiang	0.0	0.4	0.6	0.5	0.4
Rivers in the southwest	-0.1	0.2	0.1	0.0	0.1
Rivers in the northwest	0.2	0.2	0.5	1.3	0.5
Nationwide	0.2	0.0	0.3	0.6	0.3

Table 2-3 comparison of temperature on average in year and season level of ten major water resource district (unit: °C)

2.2 Comparison of Precipitation Volume in Two Periods

Nationwide, Precipitation takes the trend of reducing.

Table 2-7 The difference of precipitation between two periods

Region name	Spring	Summer	Autumn	Winter	Year
Songhuajiang	-0.2	17.2	-1.8	-0.4	10.3
Liaohe	3.8	-22.5	-11.7	-2.3	-33.9
Haihe	7.8	-55.4	-9.9	-2.6	-60.8
The Yellow River	0.5	-10.8	-17.2	-0.2	-28.0
The Huaihe River	-12.5	-33.7	-9.2	1.9	-55.8
The Yangtze River	-20.0	50.0	-6.0	9.3	30.5
Rivers in the southeast	18.1	51.8	-10.5	5.1	67.2
Zhujiang	24.6	-10.5	-1.2	18.7	33.6
Rivers in the southwest	4.3	-47.0	1.5	0.9	-47.7
Rivers in the northwest	1.5	5.3	1.6	0.1	8.7
Nationwide	2.8	-5.6	-6.5	3.1	-7.6

2.3 Impact of Climate Changes on Water Resource

The precipitation does not change much on a nation level, the surface water resource amount and the total water resource amount slightly increased. Runoff and gross water resource increase in the south while decrease in the north.

Table 2-17 Contrast of water resource between periods 1980~2000 and 1956~1979

Water Basin name	1956-1979		1980-2000		Difference	
	Surface Water	Water resource in Total	Surface Water	Water resource in Total	Surface Water	Water resource in Total
	(10 ⁸ m ³)	(%)	(%)			
Songhuajiang	1217.8	1403.6	1374.3	1574.5	12.8	12.2
Liaohé	435.2	524.9	390.1	480.3	-10.4	-8.5
Haihe	288	421.1	170.5	316.7	-40.8	-24.8
The Yellow River	661	743.6	565.2	675.4	-14.5	-9.2
Huaihe	741	961	633.4	868.5	-14.5	-9.6
Northwest rivers	1163.7	1303.9	1189.4	1290.8	2.2	-1
The Yangtze River	9513	9613.4	10221.3	10323.9	7.4	7.4
Rivers in the southeast	2557	2591.7	2740.8	2767.7	7.2	6.8
The Zhujiang River	4685	4708.1	4787.7	4802	2.2	2.2
Rivers in the southwest	5853	5853.1	5742.9	2742.9	-1.9	-1.9
North area	4506.7	5358.1	4322.9	5206.1	-4.1	-2.8
South area	22608	22766.3	23492.6	23636.4	3.9	3.8
Nationwide	27114.7	28124.4	27815.5	28842.5	2.6	2.6

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3. Analysis of Water Supply Ability of China

3.1 Current Water Supply Situation

Table 3-2 Water supply situation of China in 2003 (Unit: 100 Million m³)

Water basin name	Water supply amount				Utilization ratio of water resource (%)	Sea water
	Surfac water	Groundwater	Others	Total		
Nationwide	4286.01	1018.11	16.30	5320.42	19.19	217.96
6 basins in Northern	1463.26	885.46	6.21	2354.93	44.78	47.2
4 basins in Southern	2822.73	132.67	10.08	2965.49	13.21	170.76

3.2 Current Water Supply Ability

Water supply ability refers to water that can be supplied by water supply projects under the water supply assurance rate under current situation. According to the investigation, the water supply ability in year 2000 is shown in Table 3-3.

Table 3-3 The water supply ability under the year 2000's condition of water supply facilities (Unit: 100 million m³)

Water basin name					Water supply ability of electromechanical wells
	Water Storage	Drawing Water	Transferring water	Subtotal	
Nationwide	1715	3384	229	5328	1129
6 basins in Northern	530	1293	191	2014	1033
4 basins in Southern	1185	2091	38	3314	96

3.3 Analysis of Water Supply ability of The Whole Country in Future

From the three national planning report, we can see that the current total water supply ability as table 3-4.

Table 3-4 water supply ability statistics table of national water resources development plan (Unit: 100 million m³)

Programmin g level year	The plan of water supply and demand in middle and long term of the whole nation	The general program outline of the national water conservancy development	The tenth five-year plan of Chinese water conservancy development and programs in 2010
1993	5640		
1998		5623	
2000	5600~5820	5820	5820
2003		6200~6300	
2005			6200
2010	6460~6670	6700~6900	6600~6700
2030	7800~8200		
2050	8500~9000		

In fact, by saving water and lower the water demand in the economic and social activity, the actual amount of water used is less than the available amount of water in different level year.

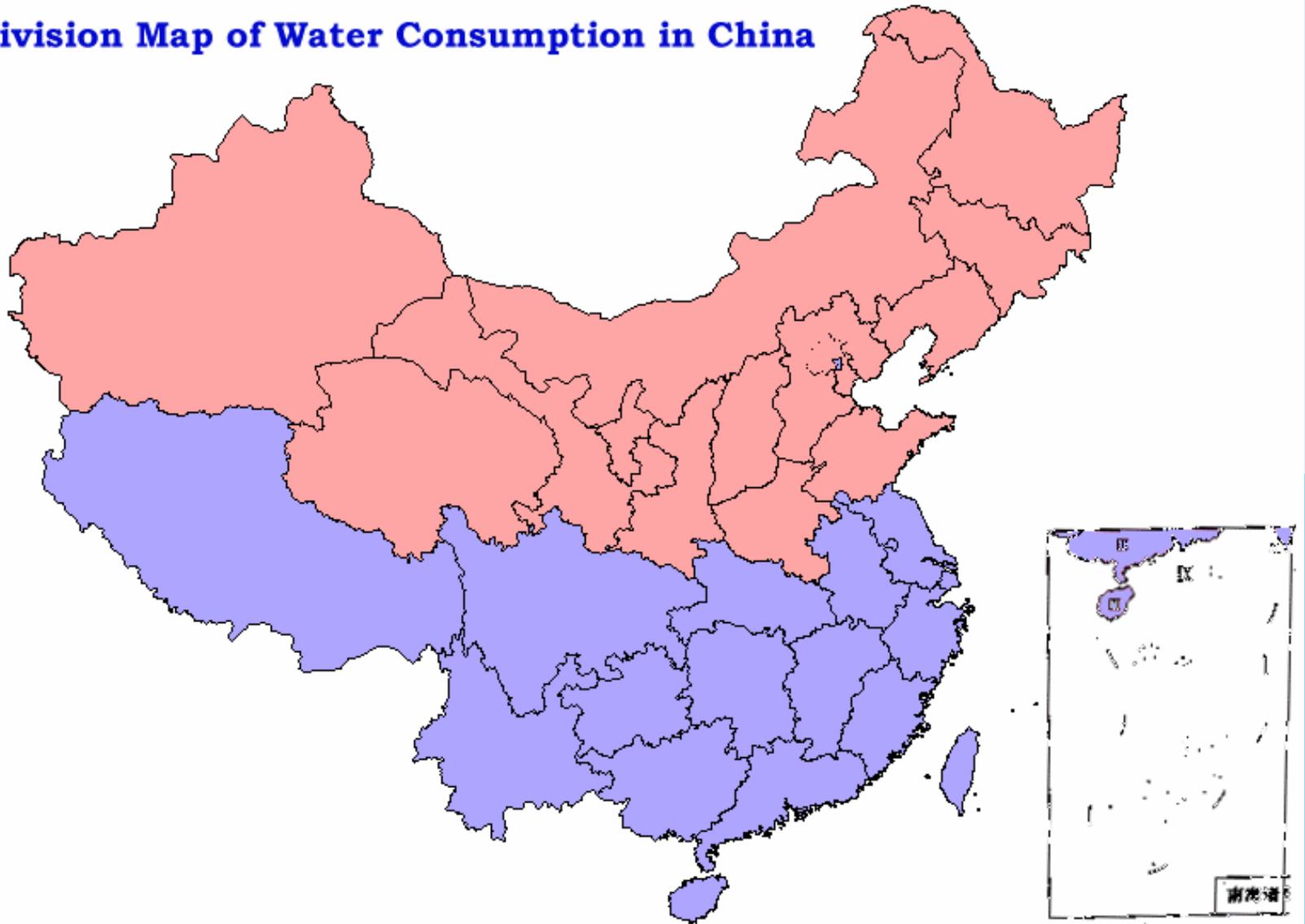
4. Analysis of Water Resources Demands in China

4.1 Current Situation of Water consumption

4.1.1 Division of Water Consumption in China

In order to analyze the difference water consumption between northern and southern area, we divided the whole country into 2 divisions. Fig.

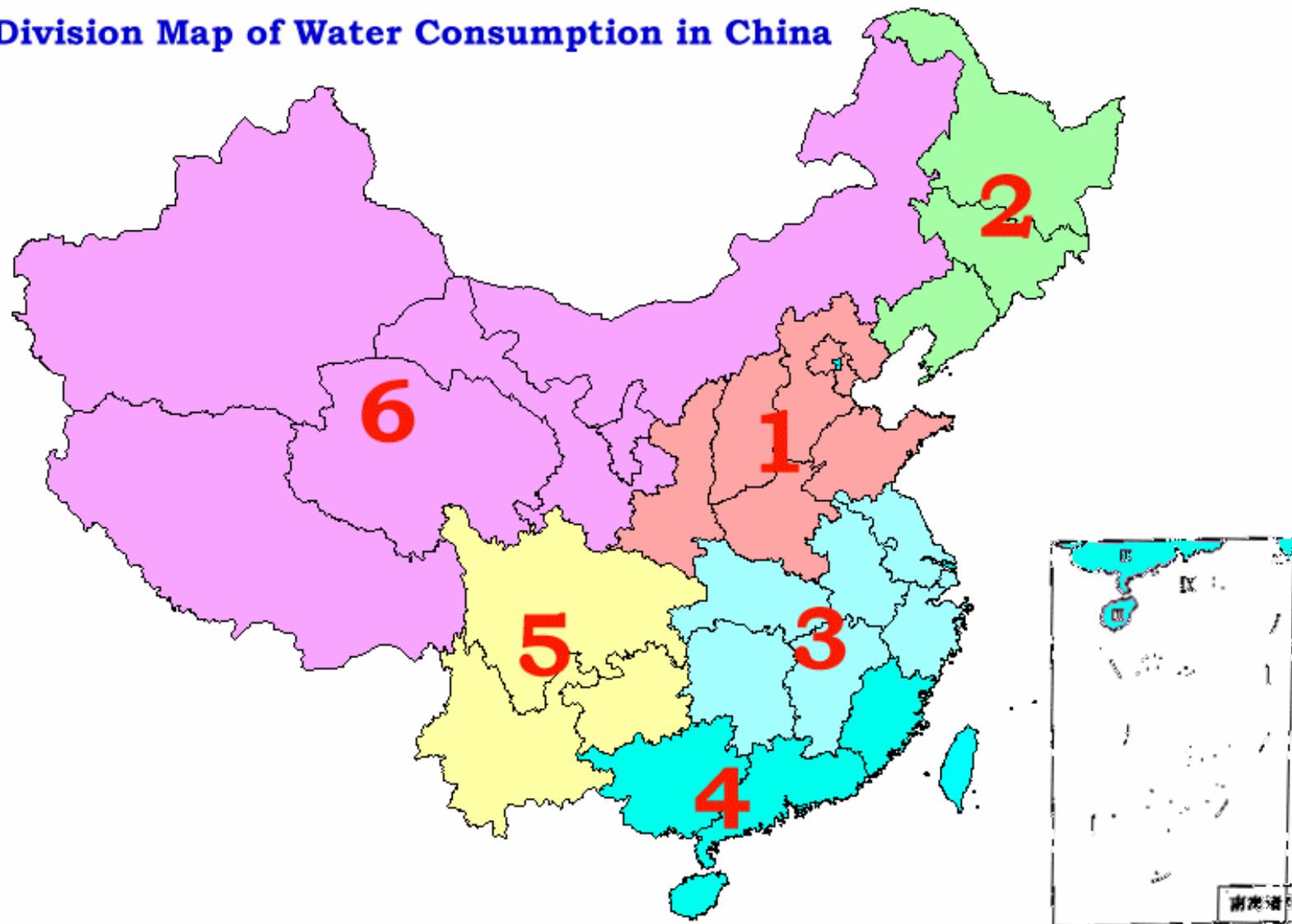
Division Map of Water Consumption in China



4.1.2 Six Division of Water Consumption

According to the water resources situation and water consumption in China and by consulting the division of the national standard: “*The standard of water quantity for city’s residential use (GB/T50331-2002)*”, the whole country is divided into six Divisions. See following fig.

Division Map of Water Consumption in China



4.1.3 Current Situation of Water Consumption in China

Water consumption in different divisions in 2004 is listed in table 4-1.

Table 4-1 China water consumption in 2004 (Unit: 100 million m³)

AREA	Agricultural	Industrial water consumption	Urban domestic consumption	Rural domestic consumption	Eco-environmental water consumption	Total
China	3585.68	1228.87	360.44	290.74	82.06	5547.79
The northern area	1665.77	264.92	118.69	98.18	35.49	2182.86
The southern area	1919.91	973.95	241.78	192.55	46.57	3364.94
First district	533.51	132.82	59.24	64.01	9.9	799.48
Second district	338.4	89.38	38.01	18.76	4.31	488.86
Third district	998.43	590.52	118.22	89.16	34.24	1831.07
Fourth district	592.45	250.62	89.77	54.93	9.07	986.84
Fifth district	303.08	132.47	33.46	46.79	3.25	519.04
Sixth district	819.31	43.06	21.77	17.08	21.28	922.51

4.2 The Historical Changes of Water Consumption in China

4.2.1 Industrial Water Consumption

The trend of industrial water consumption increase along with industry increase was controlled effectively.

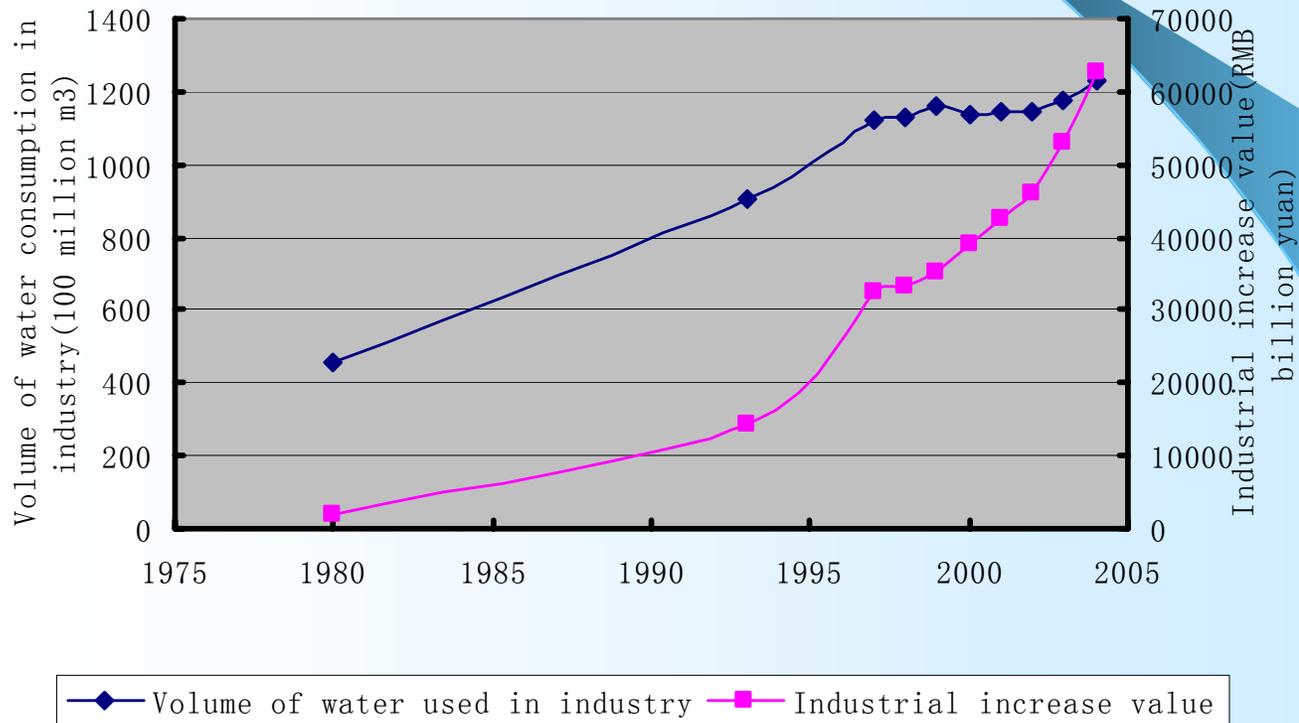


Figure 4-1 Changes of industry water consumption in China

4.2.2 Farmland Irrigation Water Consumption Volume

The total volume of farmland irrigation water consumption went into zero increase (Figure 4-2)

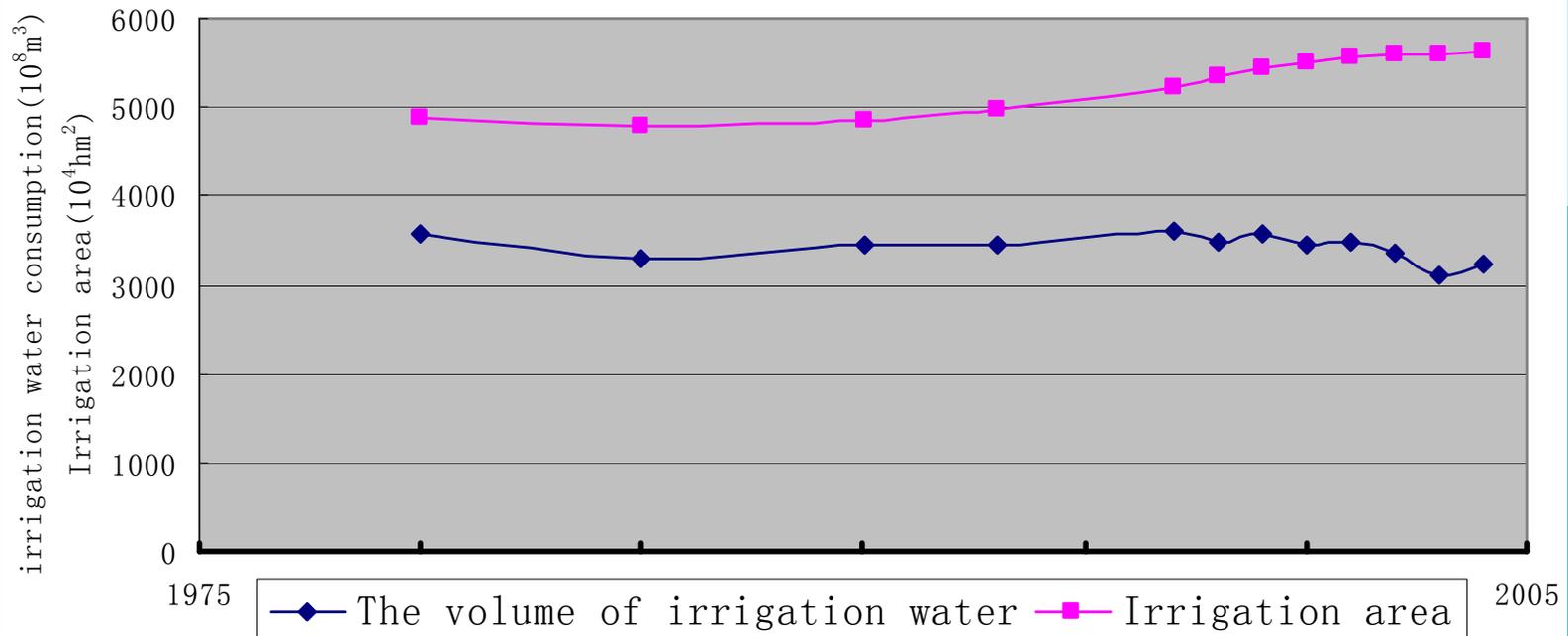


Figure 4-2 The historical changes of farmland irrigation water consumption and irrigation area in China

4.2.3 Water Consumption for Residential Living

The total volume of water consumption for residential living increased linearly. (Figure 4-5)

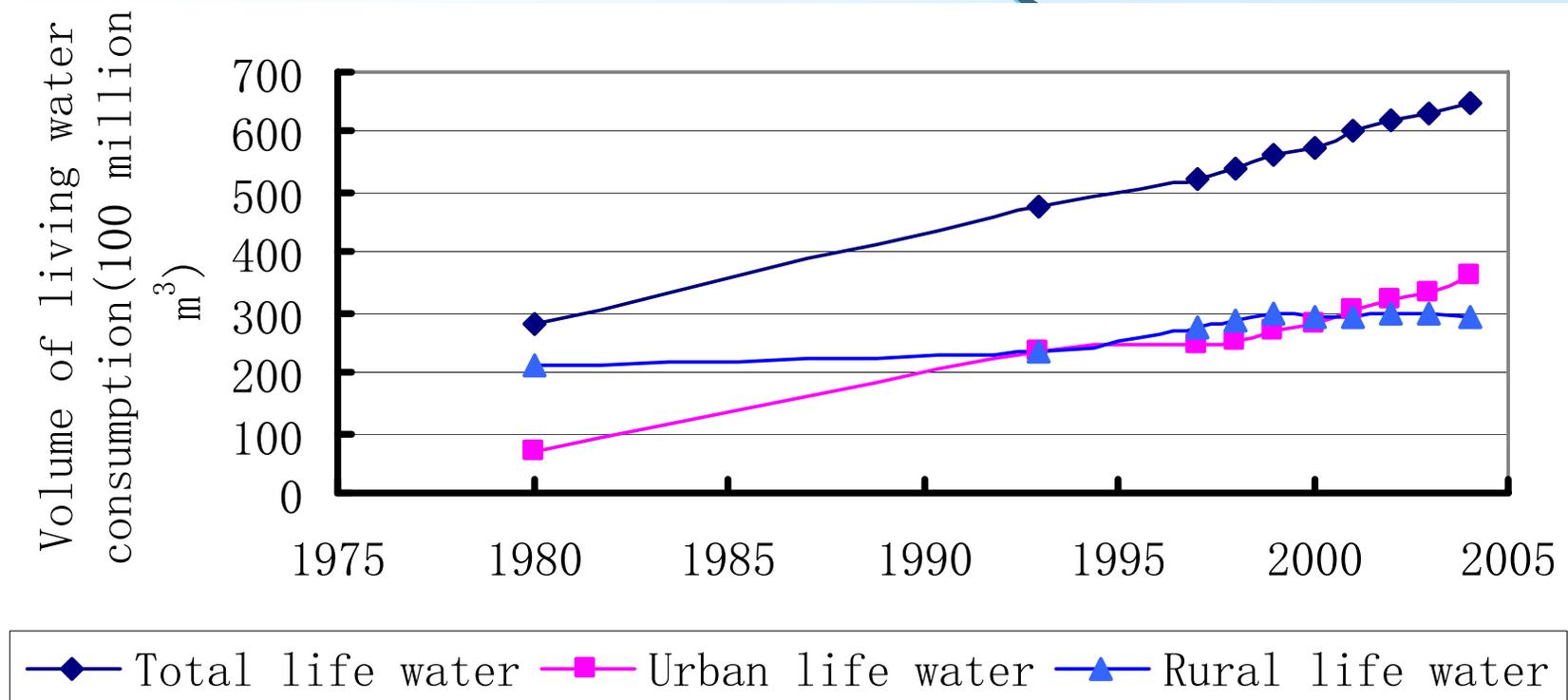


Figure 4-5 Changes of volume of domestic water consumption in China

4.2.4 Changes of National Water Consumption Volume of China

The trend of water consumption increase along with economic increase was controlled effectively. It makes the total volume of national water consumption a zero increase trend. (Figure 4-6)

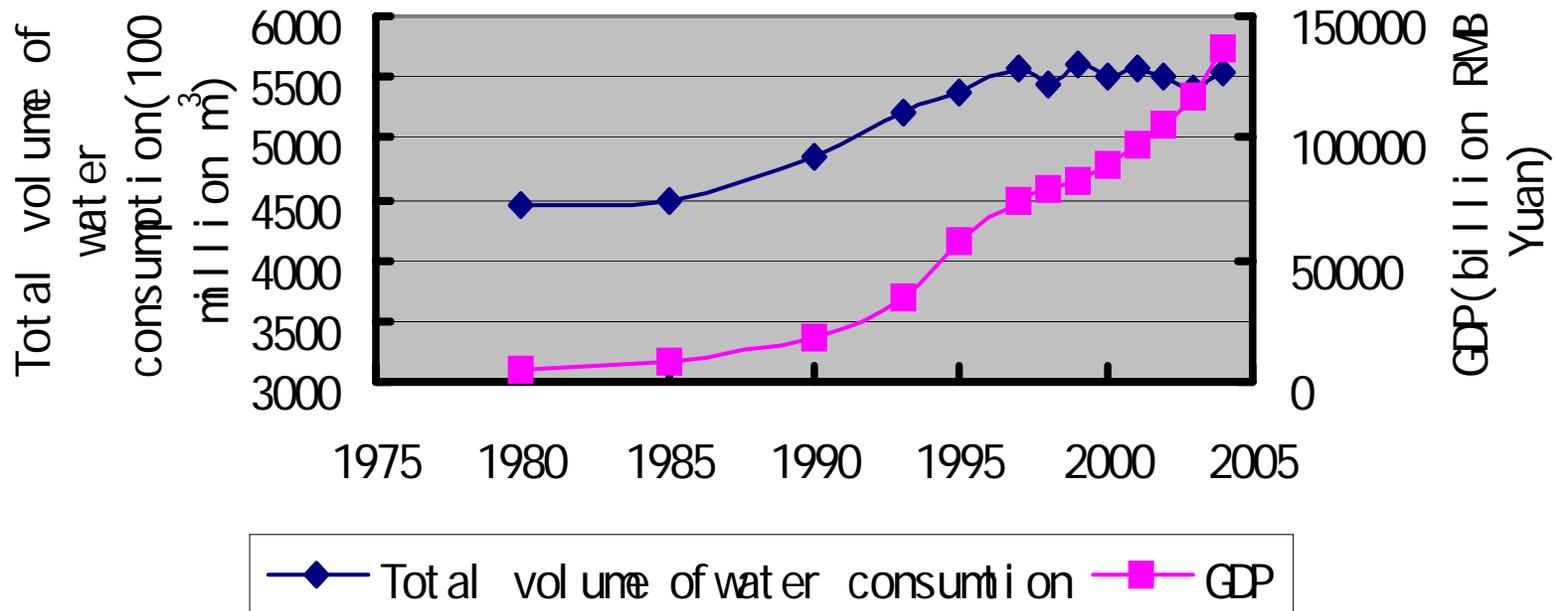


Figure 4-6 Changes of total volume of water consumption and GDP in china

4.3 The Structure of Water Demands Planning Index System

When making water demand planning, we choose some indexes to represent the water demand level. Table 4-2.

Table 4-2 The index system of water demand planning quota

First class		Second class	Third class
System 1 (comprehensive water use)	Comprehensive water use	Per capita comprehensive water use	—
		ten thousand Yuan GDP water consumption	—
System 2 (categorized water use)	Domestic water use	Urban	family use
			public use
		Rural	family use
			livestock and poultry feedlots
	Producing and managing water use	Architecture	
			Tertiary Industry
		Industry	High water use industries (generating electricity by thermal power, paper making, steel and iron, petrochemical Industry and Textile Industry)
			generally industry
		Agriculture	Irrigation
	Forestry, Hunting and Fishing		
	Eco-environmental water use	Rivers and lakes	—
		lawn	—

4.4 Current situation and change of water demand planning index

4.4.1 The volume of comprehensive water consumption per capita

It remains stable and shows the trend of descending within a small range. Shown as figure 4-9, it keeps stable between 450 and 410 m³ / person.year.

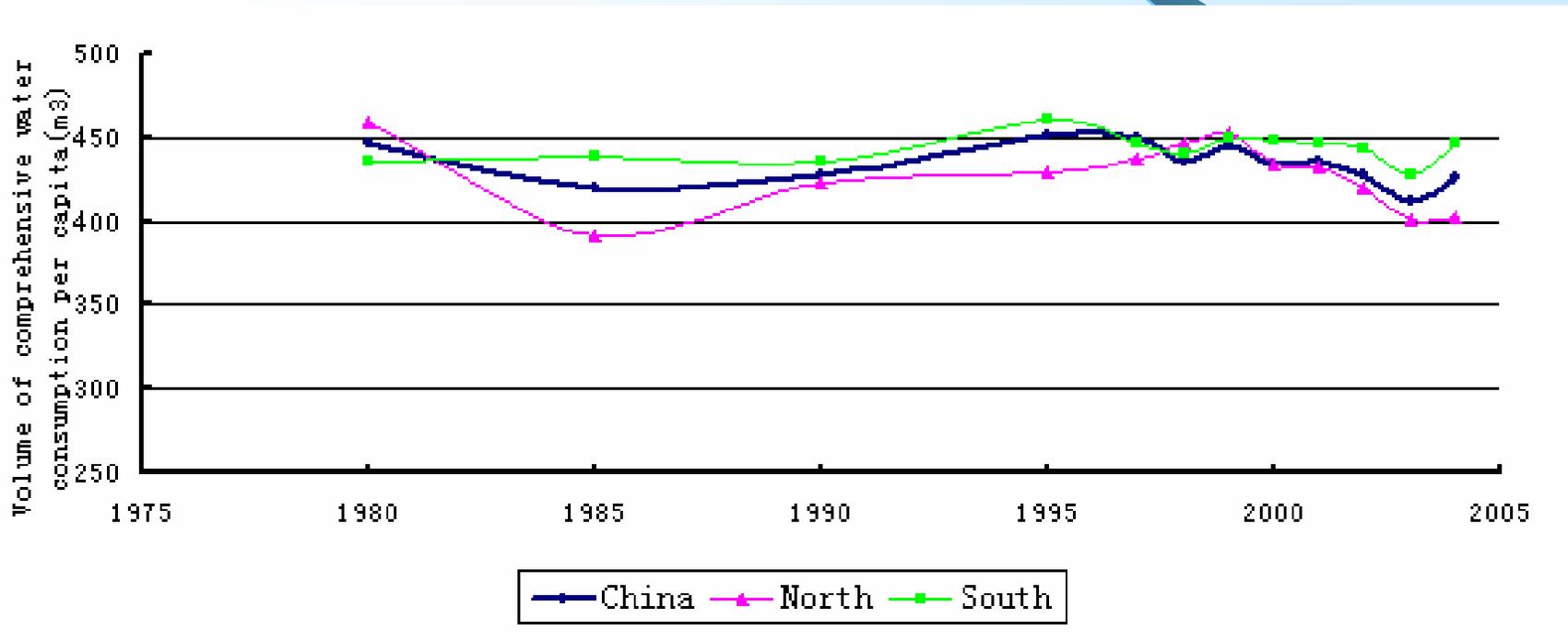


Figure 4-9 Changes of volume of comprehensive water consumption per capita in the northern and southern area of China

4.4.2 Water Consumption Volume Per Ten Thousand Yuan GDP

It showed the trend of descending rapidly. figure 4-12.

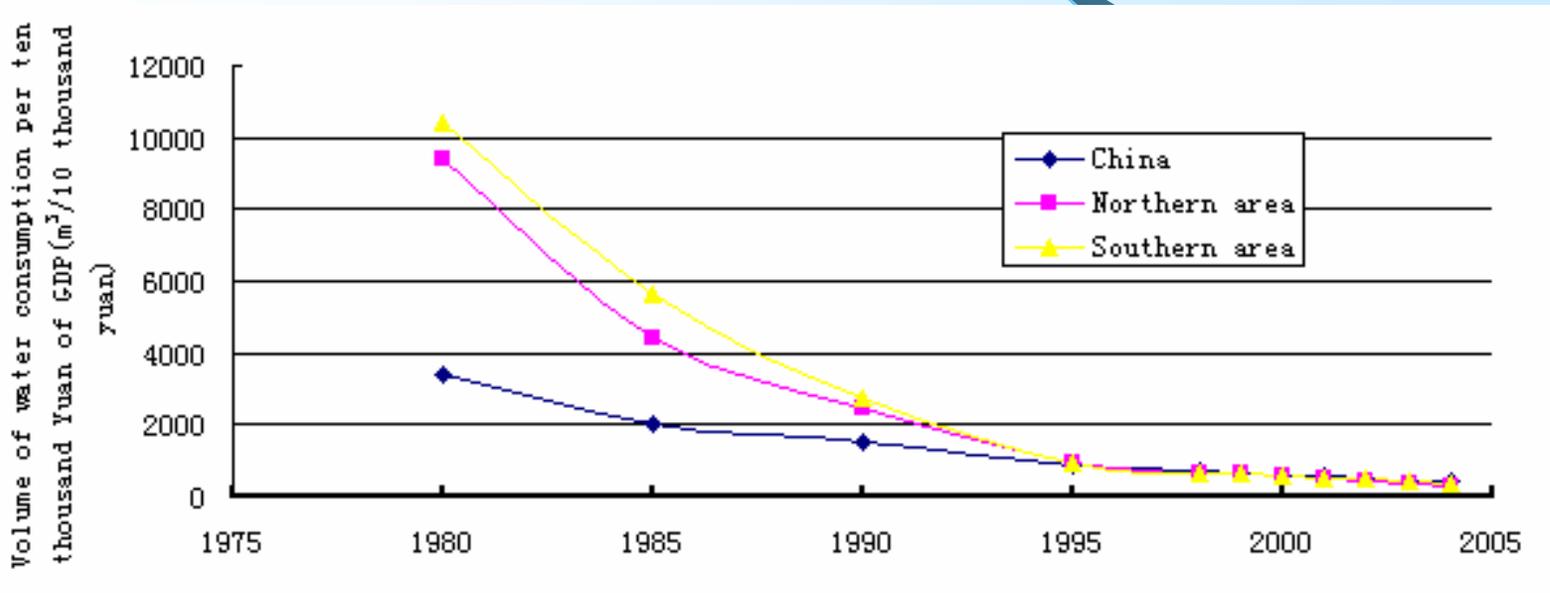


Figure 4-12 Changes of water consumption per ten thousand Yuan GDP in north and south of China

4.4.3 The Volume of Farmland Irrigation Water Consumption Per Hectare

It had the trend of descending year by year. Shown as figure 4-15.

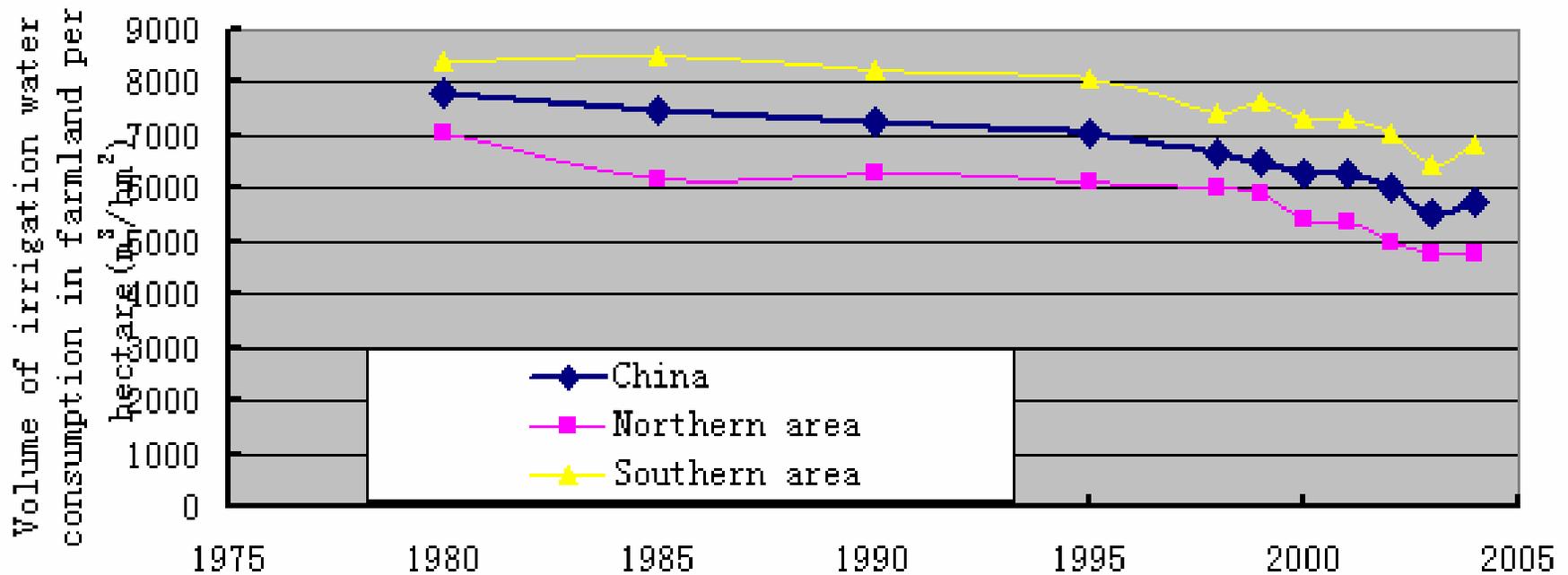


Figure 4-15 Changes of volume of irrigation water consumption in farmland per hectare in northern and southern area of China

4.4.4 The domestic water consumption per capita

It showed an ascending trend. Shown in figure 4-18.

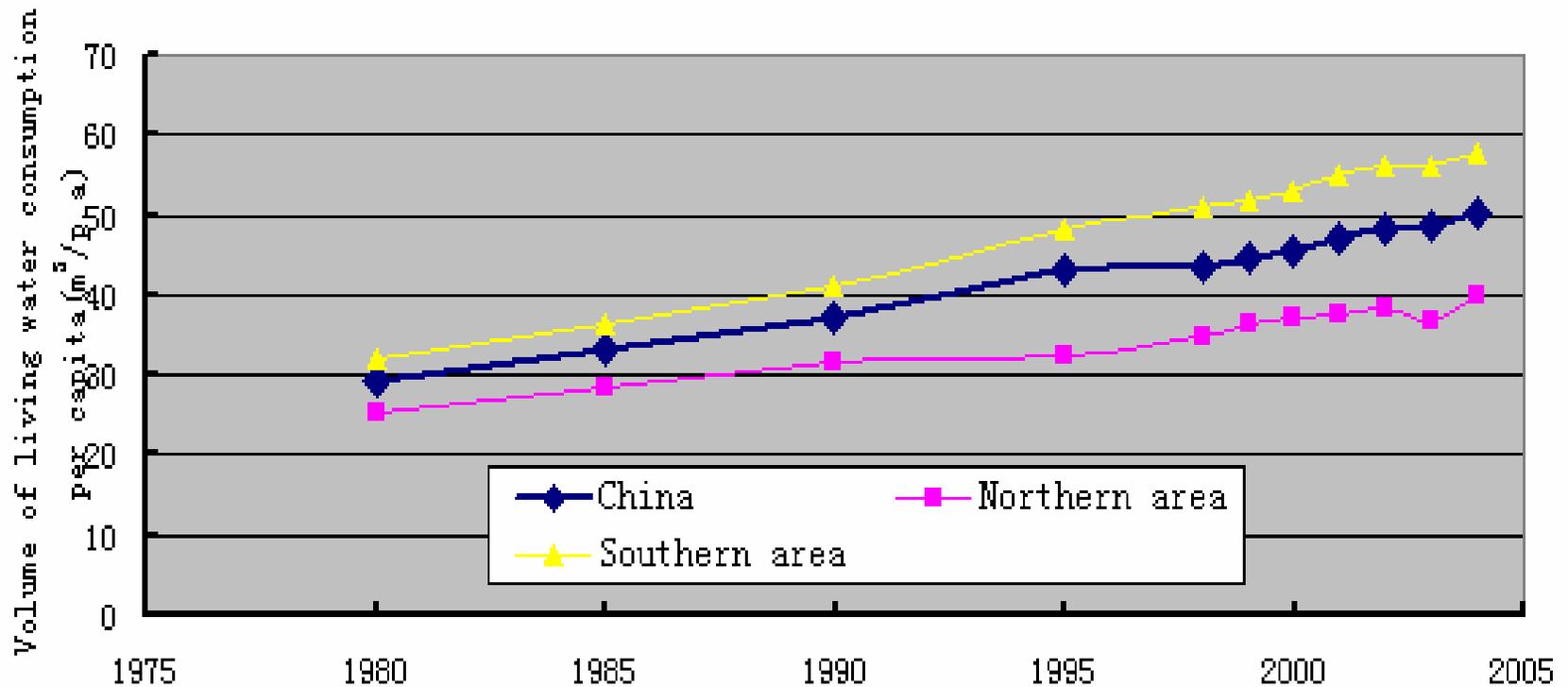


Figure 4-18 Changes of living water consumption per capita in northern and southern area of China

4.4.5 The urban domestic water consumption amount per capita

It showed an ascending trend . figure 4-21.

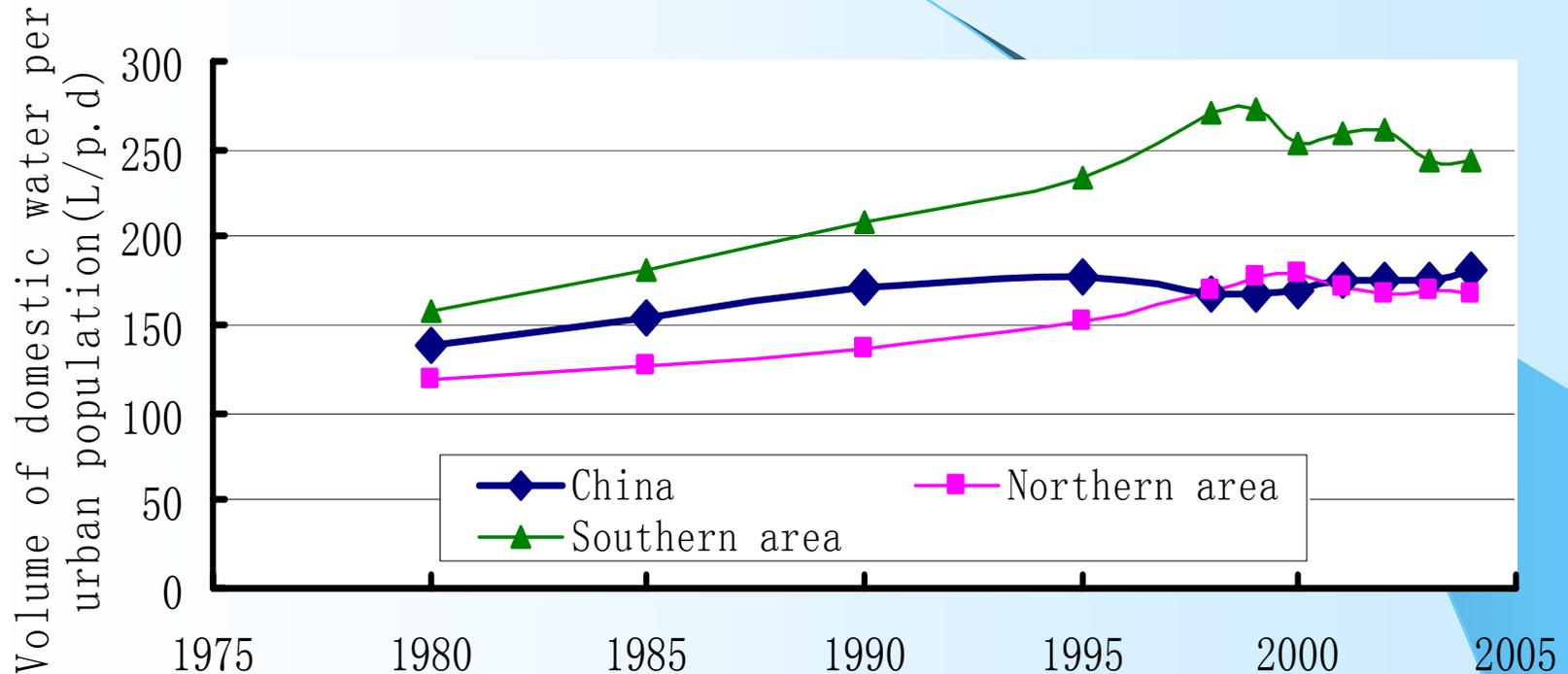


Figure 4-21 Changes of urban domestic water consumption per capita in north and south

4.4.6 The rural domestic water consumption per capita

It showed an ascending trend. figure 4-24.

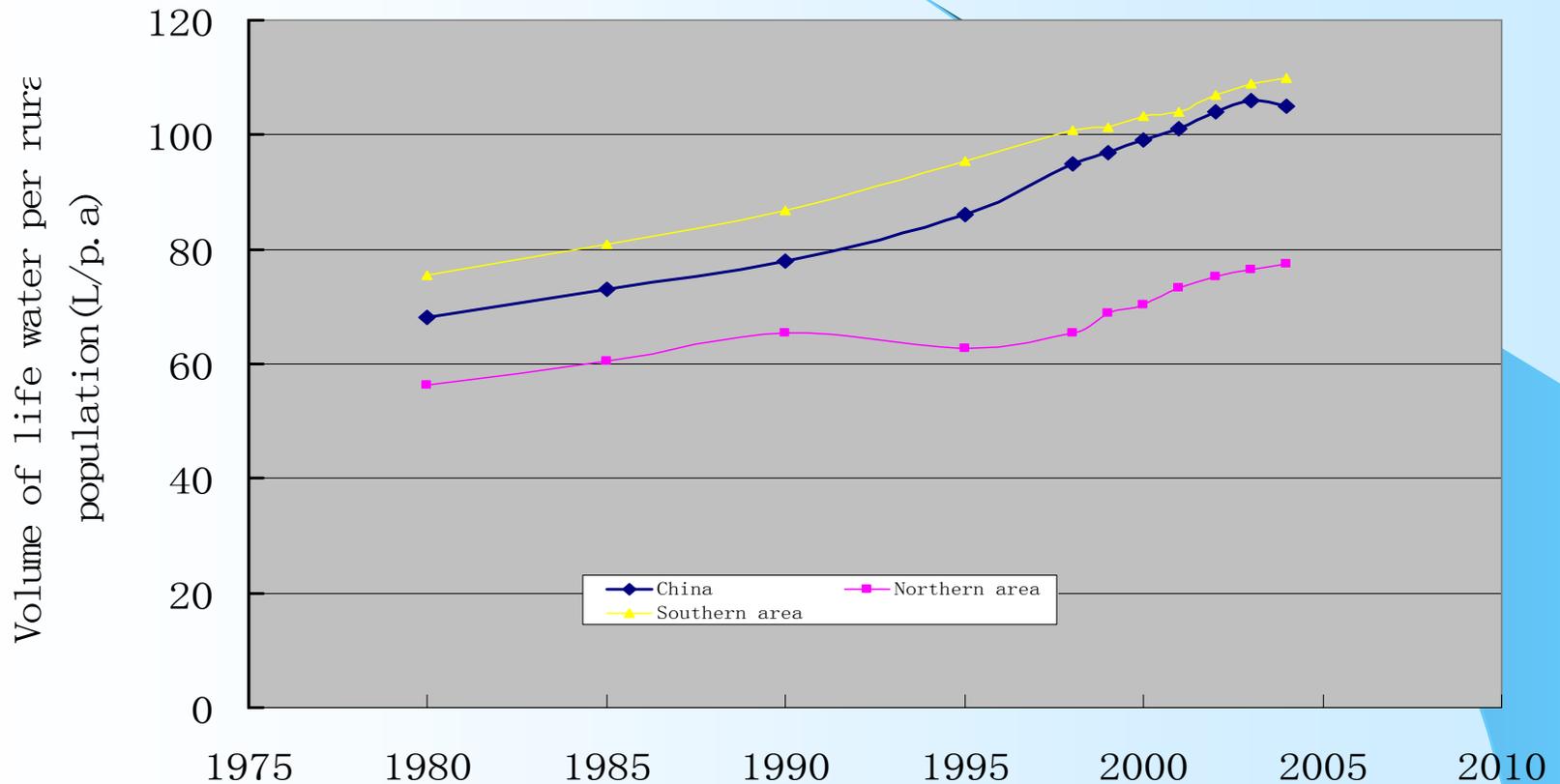


Figure 4-24 Changes of domestic water consumption per rural population in the northern and southern area of China

4.4.7 The water consumption amount per ten thousand Yuan of industrial added value

It showed a rapidly descending trend year by year. Shown in figure 4-27.

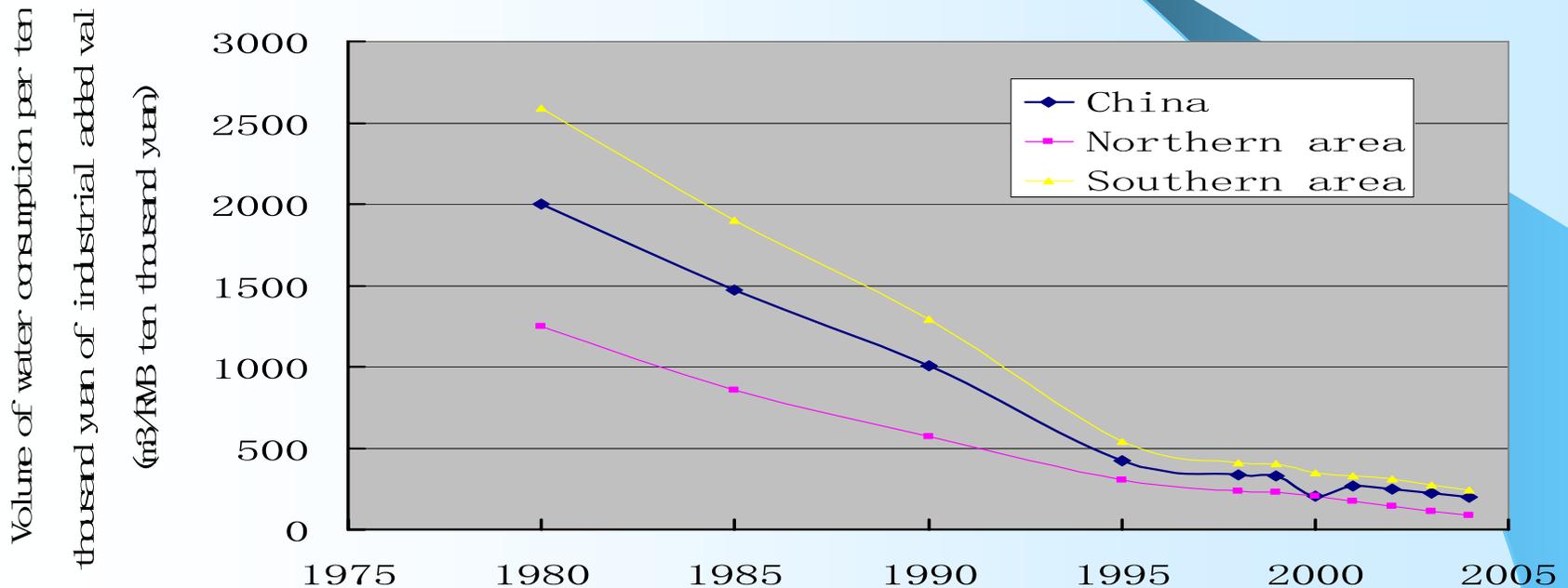


Figure 4-27 Changes of water consumption volume per ten thousand Yuan of industrial added value in south and north

4.4.8 The ration index of water consumption (water fetching) per unit industrial product

It showed a rapidly descending trend year by year.

4.5 Forecast of Water Demands

4.5.1 Methods of Water Demand Forecast

There are many methods for forecasting the water demand, such as the ration method of comprehensive water consumption per capita, water consumption per 10 thousand Yuan GDP, integrated water consumption for residential living per capita, etc.

(1) The ration method of comprehensive water consumption per capita

It is a method for predicting the total water demand according to the change of population and comprehensive water consumption per capita. It has good stability, and the trend of its development and change are very obvious too.

(2) Trend analysis approach of water consumption growth

It is a kind of method to predict water demand in the future according to the historical development trend. Using this method, we need a lot of historical data .The precision of research results depending on the length of the data time sequence and representative of the data. Furthermore, use this method, the predict year will not be very far away from now days.

(3) The relevant analysis approach of key factors

This method is based on statistics data to confirm the relation between predicting target and the influence factor, to disclose the inherent law between total water consumption and the water demand, and to set up regression predicting model through analysis.

4.5.2 Choosing the methods of water demands forecast

we use The ration method of comprehensive water consumption per capita as the basic forecasting method .The relevant analysis approach of key factors and Trend analysis approach of water consumption growth was taken as assistant methods to check and adjust the forecasting results.

4.5.3 Forecast of China Gross Water Demands

(1) Total population forecast in China

The results of Chinese peak population forecasted by various population research institutes are not same, but the peak of total population is 1460~1550 million (Tab.4-15).

Table 4-15 Forecast of Chinese population increase (Unit: 100 million person)

Year	Institute of Population, Renmin University of China (Medium scheme)	Institute of Population, Nankai University (Medium scheme)	Chinese Population Data and Research Center (Scheme 2)	U.N. (Medium scheme)
2000	12.71	12.73	12.96	12.78
2010	13.60	13.71	13.77	13.73
2020	14.35	14.49	14.72	14.18
2030	14.79	15.09	15.75	14.969
2040	14.85	15.34	15.44	15.05
2050	14.56	15.30	15.22	14.78

(2) Water supply ability

From data of the three national planning report, we can see the ability for water supply will reach 6500~6900 100 million m³ **in year 2020.**

(3) Forecast of comprehensive water consumption per capita

According to the historical data, its changing range is 410~450m³/p.a.

In the water consumption forecast, three schemes are studied out, their results are: 450 m³/p.a in high scheme, 430 m³/p.a in medium scheme, 410m³/p.a in low scheme respectively.

4.6 The Forecasting Results of Gross Water Demands in China

The Results are shown in table 4-18 and table 4-19.

Table 4-18 The forecast results of total water demand in China

Year Forecasting content		Planning base year	Planning level year				Prospective year
		2003	2010	2020	2030	2033	2050
Total population (100 million person)		12.972	13.530	14.363	14.721	14.734	14.353
Integrated water use per capita (m ³ /person)	High scheme	417	450	450	450	450	450
	Medium scheme	417	435	435	435	435	435
	Low scheme	417	420	420	420	420	420
Total water demands (100 million m ³)	High scheme	5410	6088.5	6463.4	6624.5	6630.3	6458.9
	Medium scheme	5410	5885.5	6247.9	6403.6	6409.3	6243.6
	Low scheme	5410	5682.6	6032.5	6182.8	6188.3	6028.3
Planning added water demand (100 million m ³)	High scheme		678.5	1053.4	1214.5	1220.3	1048.9
	Medium scheme		475.5	837.9	993.6	999.3	833.6
	Low scheme		272.6	622.5	772.8	778.3	618.3

Tab4-19 The results of water supply and demands forecast (Unit: 100 million m³)

Year	Gross Water Demands	Domestic Water Demands	Eco-environm ent Water Demands	Production Water Demands		
				Industrial	Agricultur al	Total
(2004) Current	5548	651	82	1224	3586	4815
2010	5886	744	100	1283	3759	5042
2020	6248	909	100	1424	3815	5239
2030	6404	1058	100	1524	3722	5246

5. Cocullution

According to analysis of water supply ability, forecasting results of China water resource supply and demand are listed in Tab.4-20. It can be seen that if the future water resource planning of China can be implemented, water supply can satisfy water demand.

**Tab4-20 The forecast of China water resource supply and demands
(Unit: 100 million m³)**

Level Year	Water Supply Ability	Water Demands
2004	5548	5548
2010	6400~6700	5886
2020		6248
2030	7800~8200	6404



The end

Thanks