Chapter 1: Introduction

1.1. Problem Statement

In the southeastern suburb of Beijing lies an oddity that draws geologists rather than tourists: an unnatural cone-shaped depression in the ground. Should these same geologists continue their tour into the western suburbs, they will find another site. Here the ground has subsided drastically, revealing bedrock. Both sites show clear evidence of groundwater overpumping.

Aside from over-withdrawal of water from the ground, Beijing residents in second floor buildings are finding that at certain times during the summer, only strange burps come out of their taps. They explain that water pressure isn't strong enough during dry spells to bring water to anyone above the first floor. Additionally, last year (1999), Beijing residents were forced to draw upon the city's water reserve for the first time in ten years (Kwang, 2000). Arguably, farmers in the municipality have had it worse. During the dry years of the 1980s, the State Council reallocated the Miyun reservoir away from agricultural use for urban use. Even industry, which holds priority over agriculture faces the prospect of "dry taps in three years if nothing is done" (Kwang, 2000).

Today, scientists, policy makers, and the public alike unanimously agree that Beijing is experiencing a "hydrological state of emergency." In response this situation, the Ministry of Water Resources met with the Beijing Municipal Government and water resource experts from around China in January 2000 to discuss the city's water shortage problem and draft contingency plans (Kwang, 2000). Part of the problem was that water prices were ridiculously low. For example, the price of water for agricultural use needed to be tripled in order to just meet production costs (Xinhua, 04/25/99). Grossly underpriced water resulted in a tap water company in the red, lacking money to fix leaky taps, thus leading to more waste.

Foreign and domestic newspaper accounts of the water situation is Beijing are dramatic. One would have great difficulty finding an article on Beijing's water situation without the use of the word "crisis." But journalists need to sell newspapers and a particularly grim situation sells more than a problematic situation with a clear and implementable solution. This paper examines the water problem in Beijing and the potential solution through efficient water pricing. More specifically, this paper asks: *How do institutional goals and directives impact on water pricing policy in Beijing?*

1.2. Framework

This paper is concerned with two main issues: policy-making and institutions. It merges traditional analytical methods of policy decision-making with analysis of the institutions that affect policy-making process. But before beginning, it is important to define what is meant by institutions. One definition of institutions is "a set of rules that human beings impose on themselves… to organize ourselves for progress, rather than to dissipate our energies in random directions" (Wang, 1996). They exist both formally, in the form of codified laws, policies, rules, mandates, practices, regulations, and informally, in the form of *guanxi*, personality, culture, tradition, history etc. The topic of Chinese institutions is broad enough to fill a small library. Thus, this paper only attempts to skim the surface of this topic. In order to impress upon the reader the importance of institutions, discussion of them will be woven throughout this paper; I draw actors from governmental agencies, derive objectives from laws, policies and agency mandates, and acknowledge the role and presence of histories, ideologies, and culture in affecting policy formation.

A typical analysis of policy options is conducted by first deriving the objectives or goals of various relevant actors/agents, and then generating a series of alternatives/options. Next the objectives and alternatives are compared, often in matrix form to derive the best solution(s) based on the established objectives.

While this paper is based on this method of analysis, it will extend it by adding emphasis (weight) to the role of the institutions. Due to the unique nature of government power and authority in China, being both authoritarian and fragmented, the power structure and thus the power to influence decisions of the various actors should be considered. Thus in a state such as China, the implementability of policies should be given greater emphasis. My submission is that even when one has chosen the alternative that fulfills the objectives to the best possible extent, in China, without the backing of the appropriate agents these alternatives will not be implemented.

Figure 1.1 depicts the framework of this paper in graphical form. This paper will primarily be divided into three sections: identification of the actors and their power to influence, derivation of their multiple objectives, and generation of various alternatives for water pricing based on water pricing theory.

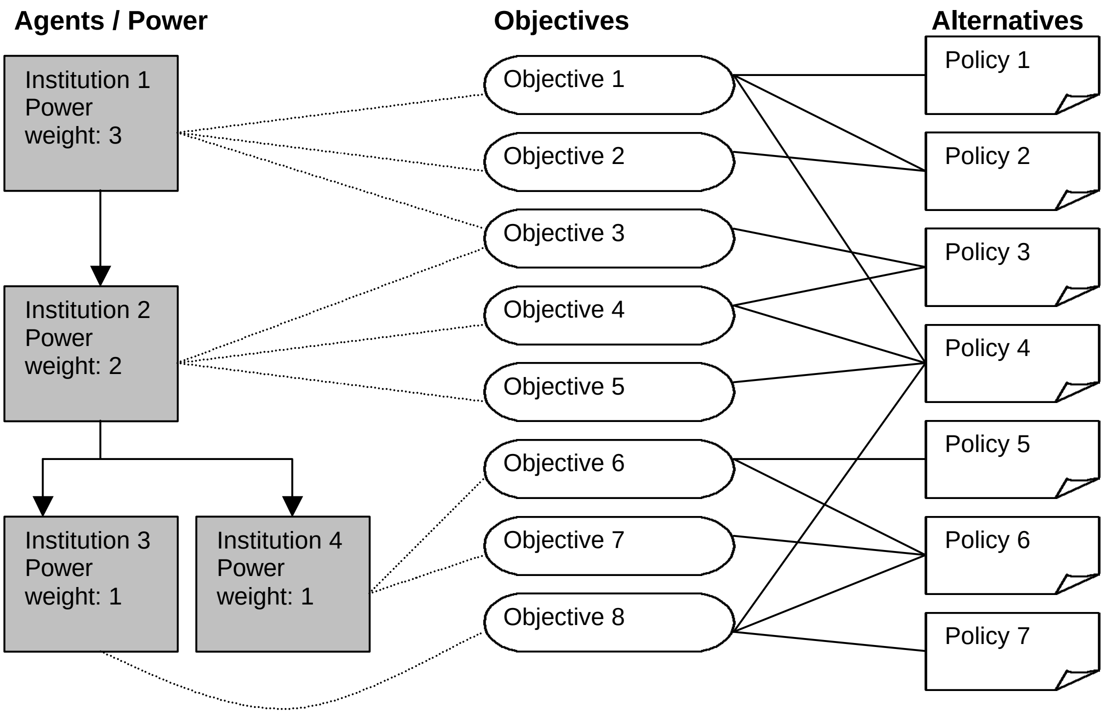


Figure 1.1. Framework diagram.

1.3. Methodology

The majority of information used in this study was collected through library, Internet, and other secondary sources. Both Chinese and English sources were used to attain different perspectives from both Chinese and Western scholars. Primary research, in the form of interviews with Chinese bureaucrats and citizens, was conducted, but only on a very limited basis. While a more extensive series of interviews and surveys was considered, in the end, a lack of time and access to subjects meant that secondary sources had to act as the foundation for this report. The primary analytical method applied is *multiple criteria decision making model*. This method involves deriving multiple objectives from stakeholders (or actors), generating a set of policy alternatives, and determining how well each alternative fulfills each objective (based on a set of criteria). Given information and time constraints, this study applies a simplified version of this method, using rough estimates and subjective judgement, rather than measurable criteria. Other analytical methods applied include analytical hierarchy process (AHP) to derive weights, and weighted average method to quantitatively analyze our problem.

1.4. Purpose

What is the ultimate purpose of this analysis? What insight do we wish to gain? There are numerous reasons for conducting a study such as this.

First and most obviously, water issues in Beijing are nearing a crisis level. Short of moving the capital (a suggestion which is being discussed and considered by the Chinese government), China cannot ignore the problem but must attempt to face and solve it. Demand management techniques, such as water pricing, appear a logical method to control water use. If it is to be better applied in the future, we must determine what the problems with its current application are, and why these problems occur. Understanding the root of a policy and all the factors affecting it will allow for new policies to be better designed.

Second, this paper aims at revealing the logic behind seemingly illogical decisions. While on the surface, low subsidized water prices leading to waste and financial instability appear entirely without logic, an understanding of the conflicting institutional goals that affect the formation of policy reveals some sense of order. Perhaps this report will facilitate the understanding other Chinese policy initiatives.

Finally, this report both reveals the limitations of the planner in a highly political state, and guides the planner in directing policy initiatives to the right institutions. One might criticize this study for emphasizing the inability of the planner to bring about positive change, in a situation where politics, rather than good judgement and planning, determines policy. However, the intention of this paper is not to show the planner's bound hands, but to emphasize the need to address politics and political power in making policy recommendations. It emphasizes the need to identify the key power holders, and their mandates and objectives, the need to consider institutional rivalries and discord, which may need to be first resolved, and the need to understand how relations of power can result in implementation difficulties. Finally, this study does not in any way downplay the importance of finding the best solution given multiple objectives, while recognizing the possibility of constrained implementation.

1.5. Organization

The water situation in Beijing is the starting point for this paper (Chapter 2). This chapter describes the water demand and supply situation, as well as the history of water pricing in China. Since the main inspiration for this paper is Beijing's "hydrological crisis", it is important to first understand the context.

After firmly establishing the context, we describe the actors involved. Chapter 3 will first detail how these actors were chosen. A short-list of the most relevant actors will then be generated after filtering out agencies which may have influence over water resources but do not deal with water pricing. A short description of each actor, including their mandates and concerns, will be provided with more details to follow in Appendix C. These mandates will be extracted from general descriptions of these actors, as well as relevant policies and legislation related to these actors.

By the beginning of Chapter 4, the formal organization of actors will have been established. Chapter 4 begins by ranking these actors and deriving power coefficients from their formal power relations. The importance of informal power will be explored in the latter half of this chapter, however, since information is lacking, no attempt will be made to analyze or quantify the effect of informal power.

The goals and objectives of these actors will be outlined in Chapter 5. This chapter will begin with the goals most closely associated with water pricing, and end with goals that are of high national priority, but with perhaps lower relevance. A summary of objectives will be provided at the close of this chapter.

Chapter 6 delves into economic theories of water pricing to create a set of alternatives. Where possible case studies will be provided to illustrate, and key advantages and disadvantages will be highlighted. Appendix A is associated with this chapter and acts as reference material on the economic foundations of water pricing.

Finally, Chapter 7 inputs the information from Chapters 3-6 into a series of matrices. Analytical methods will be applied to derive "best solutions" and conclusions will be drawn.

Box 1.1. Outline of this report

Ch. 1 & 2: Introduction
-introduction to the water situation in Beijing
-history of water pricing in Beijing
-a look at current water pricing in China

Ch. 3: Actors
-description of institutions and their mandates

Ch. 4: Power
-relations and ranking of power

Ch. 5: Objectives
-goals for water pricing policy design

Ch. 6: Alternatives
-water pricing options

Ch. 7: Summary
-objectives by alternatives matrix
-conclusions

Chapter 2: Water Supply and Demand in Beijing

2.1. China's Water Situation

In the past two decades, the world's attention has been increasingly drawn towards the People's Republic of China for a multitude of reasons. Most noteworthy is perhaps China's exorbitant economic growth since the 1980s; growth which has literally transformed quaint fishing villages into metropolises in a matter of a few decades. But any economist will concede that economic growth, which relies on natural and human resource inputs, inevitably places strain on the environment. Additionally, while controlling the population explosion is a top-level priority for the Chinese government, population growth remains magnificent and further jeopardizes availability of natural resources, including water resources.

Although China as a whole, containing one-sixth of the world's freshwater resources, appears well-endowed, numerous factors contribute to severe water problems. First, China has the world's largest population, and thus per capita water resources are insignificant, and in many places quite scarce. Each Chinese citizen only has access to a quarter of the water the average world citizen has access to. Additionally, population trends predict that by 2025, China will have less than 1,500 m^3/year/person water resources. For reference, the "World Bank considers that countries with less than 2,000 m^3 per capita to have serious problems especially in drought periods and those with less than 1,000 m^3 per capita face chronic water problems" (Tisdell, 1997).

The other important factor is that distribution of water is extremely uneven. In northern China per capita water resources are only 750 m^3/person/year, while in the south, this amount is 3,400 m^3/person/year. For comparison, Canadians have access to 98,000 m^3/person/year and Americans 9,400 m^3/person/year. The world average is 7,100 m^3/person/year.

2.2. Water Supply in Beijing

For the sake of our study, Beijing is defined by the official administrative boundary. This area includes Beijing's urban core and suburbs (herein known as Beijing City) as well as the towns and villages within the larger Beijing Municipality. There are other ways to define Beijing. A more natural science-based study may choose to define Beijing by its watersheds and river basins. Since our primary purpose is to examine the institutional constraints on water pricing, it is useful to keep within the effective boundary of Beijing's municipal-level institutions and governmental bureaus. Additionally, data is typically collected and organized on the basis of administrative districts.

Set in the middle of the Hai River Basin, Beijing is bordered by the Huabei peidmont plain to the southeast and the mountains to the northwest. The longitude is 115^{o}20' – 117^{o}30' east, and the latitude is 39^o 25'-41^{o}00' north.

Beijing Municipality is 16,800 km^2 with a small urban core of 87 km^2, near suburban districts of 1,283 km^2, distant suburban districts of 3,198 km^2, and eight rural counties of 12,400 km^2. Population and thus human activity, is most concentrated in the urban core of Beijing. The city core contains 2.6 million people (1991), near suburban districts contain 4.1 million, distant suburban districts contain 1 million, and rural counties contain 3.4 million (Nickum, 1994). Density is high in Beijing with a municipal average density of 639 persons/km^2. In spite of a high population base, annual natural growth is strictly controlled at 0.268% (Jiang, 1998).

2.2.1. Climatic Conditions

Beijing is in a temperate zone with a continental monsoon climate. Yearly average temperatures are 11-12 ^{o}C, with a range from -2.8^{o}C in winter to 42.6^{o}C in summer.

Yearly average precipitation for the entire municipality is 606.5 mm, with 1032.7 mm in the mountains and 348.5 mm in the plains (1990 figures from Beijing Public Utilities Bureau, 1993). This translates to an approximate total annual rainfall volume of 10.17 billion m^3, with about 2.3 billion m^3 of annual runoff (Beijing Surveying and Mapping Institute, 1994). The potential for evapotranspiration is about 900 mm per year, which while being surprisingly high compared with total rainfall, is one of the lowest rates in the region. Fortunately, this "natural deficit … is readily compensated for by the inflowing Yongding and Chaobai rivers" (Beijing Surveying and Mapping Institute, 1994).

Beijing's precipitation is unevenly distributed throughout the year (see Table 2.1) with 85% of it concentrated in the months from June to September (Jiang, 1998). There have been instances when 40-70% of a year's rainfall occurred in three wet summer days. Additionally, precipitation varies from year to year. The record low in Beijing was 242 mm (in 1869) and the record high was 1,406 mm (in 1959). Typically, Beijing has cycles of several consecutive wet years followed by several consecutive dry years. Such extreme variation in precipitation leads to regular occurrence of floods and drought. In fact, in the 552 years between 1396 and 1948, Beijing recorded 387 floods and 407 relatively large droughts (Nickum, 1994).

Table 2.1. Monthly average precipitation and temperature in Beijing (Beijing Municipal Statistical Agency, 1999).

	Precipitation (mm)	Average Temp (C)
January	1.3	-3.9
February	26.3	2.4
March	4.3	7.6
April	54.7	15.0
May	61.5	19.9
June	142.9	23.6
July	247.9	26.5
August	114.4	25.1
September	4.7	22.2
October	61.8	14.8
November	11.3	4.0
December	0.6	0.1

2.2.2. History of Beijing's Water Resources

From the very birth of Beijing (then called Dadu) by the Mongols, water was of great concern. At the time, the Mongols struggled with water issues such as "municipal water supply in the world's largest city at the time, flood avoidance, and transportation of grain through the Grand Canal" (Nickum, 1994).

Although droughts are a recurrent feature of Beijing's climate, from the founding of New China, floods were a greater threat than drought. In the 1950s and 60s, 83 reservoirs, including Beijing's two largest - Guanting and Miyun, were built in the Beijing region, primarily for flood control and irrigation (Nickum, 1994). During this period Beijing experienced an "expanding water economy." Growth of industry and irrigated agriculture at this time created great demand for water. New water supply technologies, such as large dams and power wells, met this additional demand, and water use increased dramatically. Water appeared abundant and an unsustainable demand pattern emerged.

In the 1972 flowing rivers, springs and streams dried up and Beijing faced its first major drought in decades. The water table dropped sharply as scarce precipitation was not able to replenish groundwater stocks. The amount of water flowing into Beijing's many reservoirs dwindled, and farmers were forced to turn to already overpumped groundwater to irrigate their fields. What once was an "expanding water economy" became a "maturing water economy" as the development of new water sources placed increasingly greater strain on the environment. By the 1980s, gross overpumping of groundwater led to rapid subsidence at a rate of about half a meter per year (Nickum and Marcotullio, 1999). By the 1990s, annual water volume flowing into the Guanting reservoir fell to 0.4 billion m^3 from 1.93 billion m^3 in the 1950s (Guo, 2000). Conditions have not improved since the 1990s. In fact, the added effect of water pollution has left the Miyun reservoir as the sole surface drinking water source; the Guanting Reservoir is now deem only suitable for industrial use and irrigation (Guo, 2000).

The next few sections examine Beijing's water sources in more detail.

2.2.3. Surface Water

Between 30 – 50 % of Beijing's water supply comes from rivers, streams and reservoirs. The Beijing area contains more than 100 rivers and streams and is crossed by five river systems: Yongding, Chaobai, the North Grand Canal, Daqing, and Jiyun Canal (see Figure 2.1 and Box 2.1). The runoff formation area of these rivers, stemming from the mountainous region to the north of Beijing at elevations of over 100 m above sea level, serve as the main catchment for surface water for the municipality. These five river systems have a total local catchment area of 16,800 km^2 with 62% of that located in mountainous areas (Beijing Surveying and Mapping Institute, 1994) and 38% from the plains. Ninety percent of these surface waters are from areas outside the municipality (Beijing Public Utilities Bureau, 1993).

These five watersheds can be grouped into three hydrological regions based on their primary function. The main surface water system for urban water supply stems from the Chaobai River (which hails from the joining of the Chao and Bai Rivers), which feeds into Miyun reservoir, and the Jiyun canal (Figure 2.3). Industrial water supply is drawn primarily from the Yongding river system (which includes the Guanting reservoir) and the Daqing river system. Finally, the North Grand Canal, which passes directly through the core of Beijing, serves as a residual water drainage, or waste sink, for the city. In addition to these five watersheds, there is a complex network of man-made canals in Beijing. These include the Gaoliang River (built in Tang and Liao Dynasties), the Jinshui River (Jin Dynasty), and the modern Jiyun Channel.

Beijing has a total of 83 reservoirs with the largest being Guanting, Huairou and Miyun. These three water bodies alone yield a combined storage capacity of 9.3 billion m^3, or 92% of the total of all reservoirs in the area (Beijing Surveying and Mapping Institute, 1994). Today, these reservoirs are highly threatened. The Guanting reservoir was severed from the urban water supply system in 1997 for several reasons. First, it had been experiencing a serious silting problem. Additionally, wastewater from nearby steel mines and wineries created deposits that caused the water quality to fall below national drinking water standards (Guo, 2000). And finally, the quantity of water entering the reservoir has decreased so significantly, due to upstream use and climate change, that it is difficult to maintain low ambient pollutant concentrations. Miyun reservoir now acts as the primary source of urban drinking water from surface water. However, it too has experienced decreasing water levels (with a total drop of 67 meters since the 1950s) and increasing concerns over contamination (Sun, D., 2000).

To divert water from the Yongding river and the Miyun Reservoir, two diversion works were built in the 1950s and 1960s: the Yongding Canal the and Jingmi Channel, with respective lengths of 25 and 110 kms, and respective maximum discharge capacities of 35 and 70 m^3 per second (Beijing Surveying and Mapping Institute, 1994).

Box 2.1. Beijing Municipality's 5 river basins and 3 major reservoirs
(Beijing Surveying and Mapping Institute, 1994 and Beijing Municipal Environmental Protection Bureau, 1990)

Yongding River
- origin: Inner Mongolia and Shangxi Province
- length: 650 km, with a 165.5 km section in Beijing
- catchment area in Beijing: 3,168 km^2, 18.9% of the municipality's total area

North Grand Canal: most important drainage outlet for Beijing
- origin: runs southward from Tongxian county in Beijing municipality
- catchment area in Beijing: 4,423 km^2, 26.3% of the municipality's total area

Daqing River
- origin: Hebei Province, located mostly in Hebei with an extension in the southern periphery of Beijing
- tributaries: Juma, Dashi, and Xiaoqing
- catchment area in Beijing: 2,219 km^2, 13.2% of the municipality's total

Chaobai: the largest river system in Beijing area
- origin: Hebei Province
- tributaries: two major tributaries in its upper reaches, the Chao and the Bai, run through numerous narrow valleys and have swift currents
- catchment area in Beijing: 5,613 km^2, 33.4% of the municipality's total

Jiyun Canal
- origin: Hebei Province
- catchment area in Beijing: 1,377 km^2 in Beijing, 8.2% of the municipality's total area

Miyun Reservoir
- purpose: built in 1959 as long term balancing reservoir
- max capacity: 4.3 billion m^3
- surface area: 180 km^2
- main sources: Chao River and Bai River
- Baihe dam is the main dam and water outlet of Miyun Reservoir
- Miyun reservoir drainage area is 18,000 km^2 and composes of Chaohe and Baihe and covers 9 counties

Huairou Reservoir
- original purpose: terminal reservoir of Miyun Reservoir Drinking Water Project; regulate, slow, homogenize water from Miyun
- max capacity: 98 million m^3
- surface area: 12 km^2
- main source: Miyun Reservoir

Guanting Reservoir
- location: 80 km northwest of Beijing
- date of construction: 1952
- max capacity: 2.1 billion m^3
- in 1988 original dam raised and capacity increased to 4.2 m^3
- in recent years due to the increase of water consumption in the upstream and decrease of water source, the reservoir actually supplies 300 million m^3/year

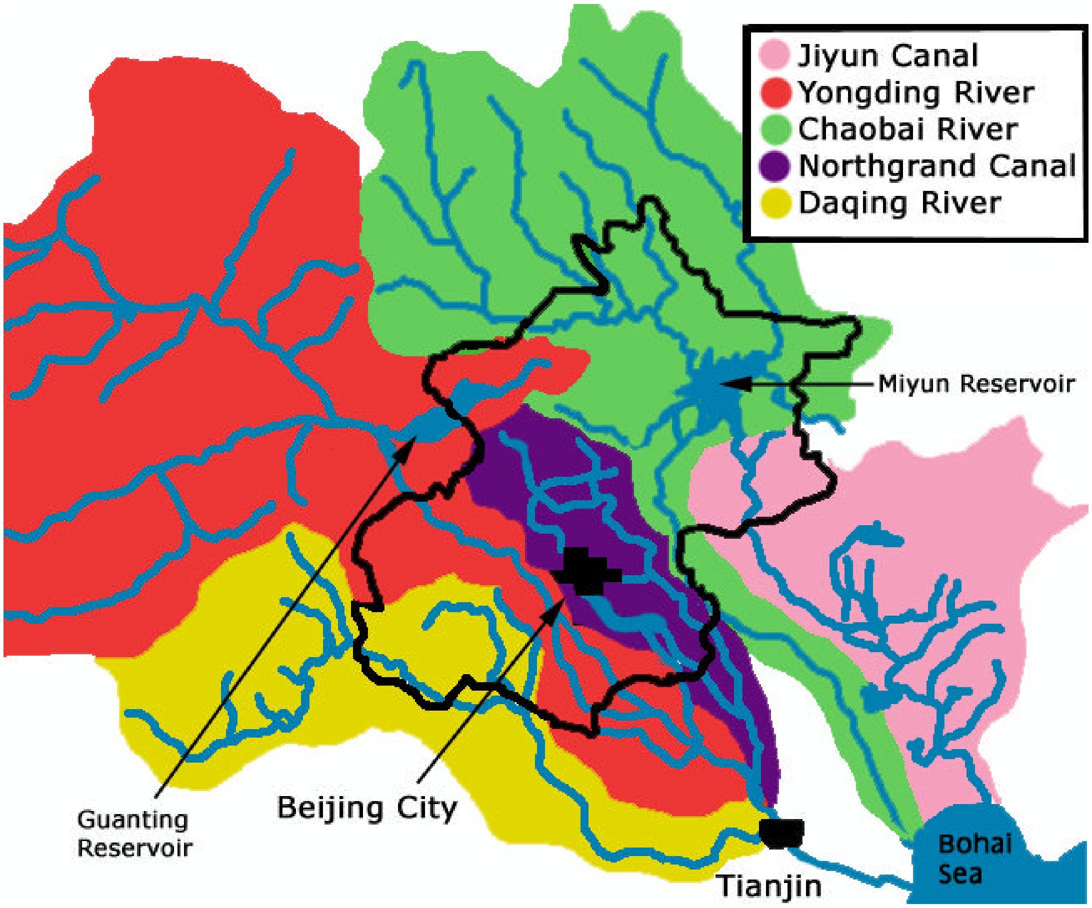


Figure 2.1. The five major river watersheds of Beijing. The black outline denotes the Beijing administrative boundary. Beijing City is denoted, also in black, within the larger boundary. Note the city of Tianjin to the southeast of Beijing.

Total surface water resources vary drastically from year to year depending on rainfall. In fact, rainfall levels make the difference between dry rivers from November to May and flooding banks from July to August. On average, surface water resources amount to approximately 2.05 billion m^3 on a year with average rainfall, 1.33 billion m^3 in a semi-dry year, and 700 million m^3 in a dry year (Beijing Surveying and Mapping Institute, 1994). Table 2.2 shows this breakdown by river system.

On average, however, river flow volume has steadily decreased since the 1950s.

Table 2.2. Multi-year average of river systems in Beijing Municipality (Jiang, 1998).

	Total area (km^2)	Several Year (mm)	Different Guaranteed Levels of Yearly Precipitation (billion m^2)				Several Year (mm)	Different Guaranteed Levels of Yearly Flow Rates (billion m^3)			
			Ave.	50%	75%	95%		Ave.	50%	75%	95%
Jiyun River	1,377	653.2	0.8995	0.8635	0.6882	0.5038	167.2	0.2303	0.18	0.1075	0.0591
Chaobai River	5,613	620.4	3.4825	3.3367	2.6402	1.9089	156.5	0.8748	0.7115	0.4392	0.2372
North Grand Canal	4,423	611.2	2.7033	2.5534	1.9919	1.3678	115.0	0.5088	0.3652	0.1883	0.1119
Yongding River	3,186	549.7	1.7414	1.6641	1.3180	0.9545	109.2	0.3459	0.2049	0.1031	0.0699
Daqing River	2,219	613.8	1.3620	1.2803	0.9870	0.6601	166.3	0.3691	0.2141	0.1071	0.0738
Beijing Total	16,800	609.7	10.1887	9.698	7.6035	5.3951	142.8	2.3289	1.6757	0.9942	0.5519

2.2.4. Groundwater

Groundwater supplies 50-70% of Beijing's water, depending on rainfall. Beijing's groundwater resources are unevenly distributed with the mountainous region, where water is stored in the crevices of bedrocks and karst formations, being more rich and plentiful than the plains. "Beijing's groundwater recharge from the nearby mountains is the most abundant on the north China plain. Until recently, artesian wells and springs were common in the western suburbs of the city" (Nickum, 1994). The highest yielding aquifers are in Miyun, Huairou, and Shunyi districts to the northeast of the city (Beijing Public Utilities Bureau, 1993).

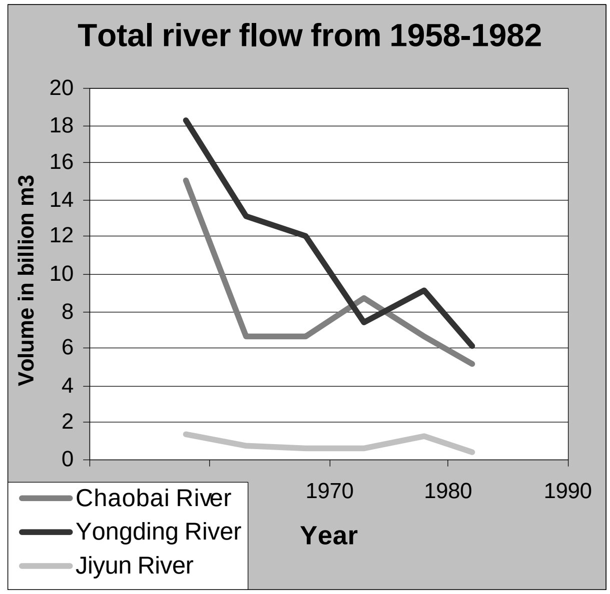


Figure 2.2. Total river flow volume of the Chaobai, Yongding, and Jiyun Rivers, 1958-1982 (from Jiang, 1998).

To exploit these resources, a total of 4,700 wells, 2000 private urban boreholes, and 40,000 agricultural boreholes have been sunk at an annual tapping capacity of 2.5 billion m^3 (Beijing Surveying and Mapping Institute, 1994). The rate of natural replenishment is approximately 3.95 billion m^3 per year, of which 2.96 billion m^3 are recharged from flat areas (Beijing Surveying and Mapping Institute, 1994). The rate of groundwater extraction differs however throughout Beijing, with many areas extracting water at much higher rates than replenishment.

Overexploitation is the greatest problem facing groundwater in Beijing. As discussed in section 2.2.2, after the great drought of 1972, groundwater extraction rates increased dramatically. Farmers compensated for lack of river flow by relying more heavily on groundwater. "The amount of water drawn from the aquifers increased from 983 million m^3 in 1979 to 1,691 million m^3 two years later as rural surface water use collapsed from nearly 2,000 million m^3 to about 750 million m^3" (Nickum and Marcotullio, 1999). At the same time, new technologies were introduced to more easily tap these aquifers. "Pump wells, powered by diesel or, in favorably located areas, by electricity, tapped the aquifers underlying the extensive littoral plain. As elsewhere on the plain, the area under irrigation expanded rapidly in Beijing during the early 1970s" (Nickum, 1994). As a result, by the early 1980s, water tables were dropping at a rate of 0.5 – 1 meter per year, aggregate overpumping reached 210 million m^3, and "the aquifer in the western suburbs had been pumped down to bedrock. A pronounced cone of depression showed up in the southeastern part of the city where the chemical industry is located" (Nickum, 1994).

Today, water table levels have dropped by more than 40 meters below the surface (Nickum, 1994) with a total of about 4 billion m^3 of groundwater (1.8 billion m^3 in urban areas) overdraft (Guo, 2000). The current rate of groundwater extracted is about 2.5 billion m^3 per year, with about 60% going to agricultural, 20% to domestic, and 20% to industrial use (Beijing Public Utilities Bureau, 1993). Most large industrial customers rely on self-provided wells for their water resources. The one exception is the Shoudu Iron and Steel Complex in the western suburbs which draws water directly from the Guanting Reservoir (Nickum, 1994). Additionally, eight waterworks in Beijing's supply a combined capacity of 1.015 million m^3 of groundwater per day to urban residents (see Table 2.5 and Figure 2.3). An additional 57 urban wells scattered throughout Beijing's core add 0.115 million m^3 per day to this figure.

2.2.5. Total Water Resources

As noted earlier, total available water resources fluctuate greatly from year to year. The average amount of total water resources available is about 6.28 billion m^3/ year (Jiang, 1998). Table 2.3 provides a breakdown of water resource availability. As you can see, total water resources are formed by four parts: (1) precipitation forming surface water, (2) precipitation forming groundwater, (3) runoff forming groundwater, and (4) water entering from other provinces (both in surface and groundwater form). According to this table, the past multi-year average total was 6.28 billion m^3. However, future estimations show only a 50% chance of attaining even 5.514 billion m^3.

Table 2.3. Total past and estimated future water resources in billion m^3 by source (Jiang, 1998).

	Multi-year average	Guaranteed 50%	Guarantee 75%	Guarantee 95%
(1) Mountain area, plains river runoff	2.3	1.84	1.22	0.851
(2) Plains precipitation penetration into groundwater	1.303	1.238	0.978	0.69
(3) Mountain area supplying plains groundwater	0.627	0.596	0.471	0.332
(4) Total water entering from out of province	2.05	1.840	1.290	0.8
Total	**6.28**	**5.514**	**3.959**	**2.673**

However not all water resources are usable; how much depends on economic and technological conditions. Table 2.4 provides expected levels of usable water resources based on reliability rates. This translates to about 3.9 billion m^3 of water available in a medium water year, and 3.2 billion m^3 of water available in a low water year (Beijing Surveying and Mapping Institute, 1994).

Table 2.4. Total anticipated water resources by probability of attainment, in billion m^3 (Jiang, 1998).

	50%	75%	95%
Surface water	2.051	1.333	0.659
Groundwater	2.633	2.633	2.633
Total	**4.684**	**3.966**	**3.292**

2.2.6. Tap Water Supply System

Since water pricing efforts in Beijing are largely directed towards urban users, the tap water supply system is of particular interest. In order to understand the movement of water from Beijing's reservoirs, rivers and aquifers into homes and factories in the urban core, it is important to look at the operations of the Beijing Waterworks Company (henceforth known as the BWWC).

The BWWC has been providing the municipality with tap water since 1910. At the beginning of 1948, Beijing's waterworks network was only 364 km in length, supplying water to a population of 6 million. About thirty percent of the population shared the meager 50,000 m^3/day of tap water. After the founding of New China, water supply developed rapidly.

Today the BWWC operates nine major waterworks[1] and five minor ones (see Table 2.5). In combination, they produce 1.8 million m^3/day (at peak demand), just enough to meet the city's needs (Beijing Public Utilities Bureau, 1993).

Seven of the primary waterworks (No. 1, 2, 3, 4, 5, 7, 8) draw from groundwater sources and are scattered throughout the urban core (see Figure 2.4). The other two (No. 9 and Tiancunshan waterworks) draw from surface water reservoirs.

Figure 2.3 depicts Beijing's primary surface water system. Urban water supply draws largely from the Miyun Reservoir-Chaobai River watershed (depicted in green in Figure 2.3) from the reservoir, through the Jingmi Channel to the Huairou Reservoir, where water is extracted by the No. 9 waterworks (see Figure 2.4). Additional water is drawn from the Huairou through the lower reach of the Jingmi to its final destination of Tuancheng Lake, where it is extracted by the Tiancunshan waterworks. Water from the Guanting Reservoir-Yongding River watershed is also extracted for urban water supply. This path is depicted in pink in Figure 2.3.

[1] Waterworks are water treatment plants for drinking water.

Table 2.5. Beijing's urban drinking water treatment plants (Beijing Public Utilities Bureau, 1993)

Waterworks	Water Resource	Capacity (1,000 m^3/day)
No. 1	Groundwater	50,000
No. 2	Groundwater	90,000
No. 3	Groundwater	280,000
No. 4	Groundwater	50,000
No. 5	Groundwater	30,000
No. 7	Groundwater	35,000
No. 8	Groundwater	480,000
No. 9	Surface water	500,000
Tiancunshan	Surface water	170,000
Total		**1,685,000**

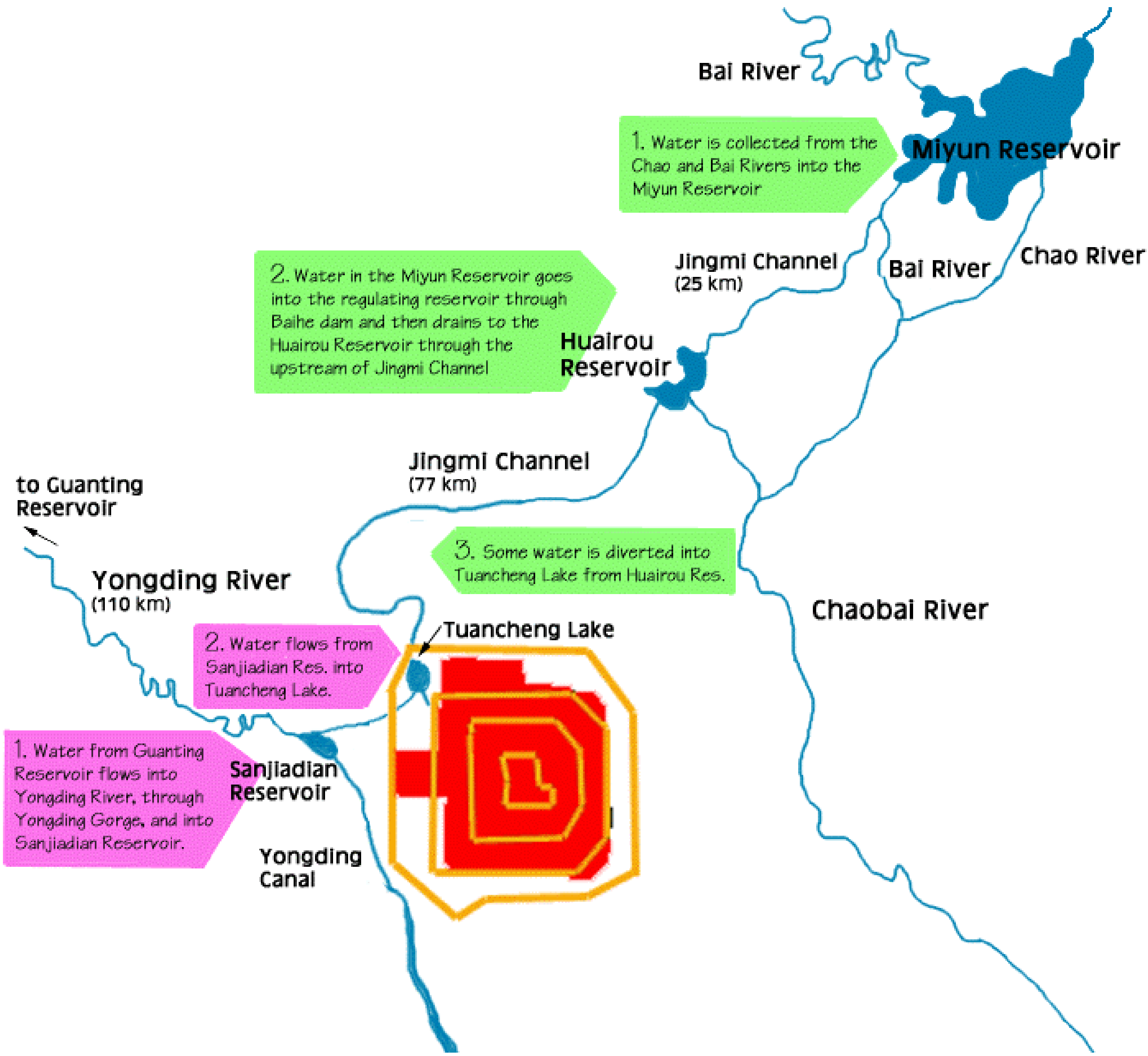


Figure 2.3. Beijing's primary surface water drinking system.

Figure 2.4 contains a detailed image of the urban core, where drinking water treatment plants are located. Groundwater-based plants (No. 1, 2, 3, 4, 5, 7) are located in the urban core alongside surface water-based waterworks. "Waterworks No. 6 supplies water for industry from surface water and has an independent distribution system" (Beijing Public Utilities Bureau, 1993). The newest water plant, waterworks No. 9, extracts water from the Huairou reservoir (at a rate of 500,000 m^3/day), the Tiancunshan waterworks draws from Tuancheng Lake (at a rate of 340,000 m^3/day), and the Chengzi waterworks draws from Sanjiadian Reservoir (at a rate of 40,000 m^3/day).

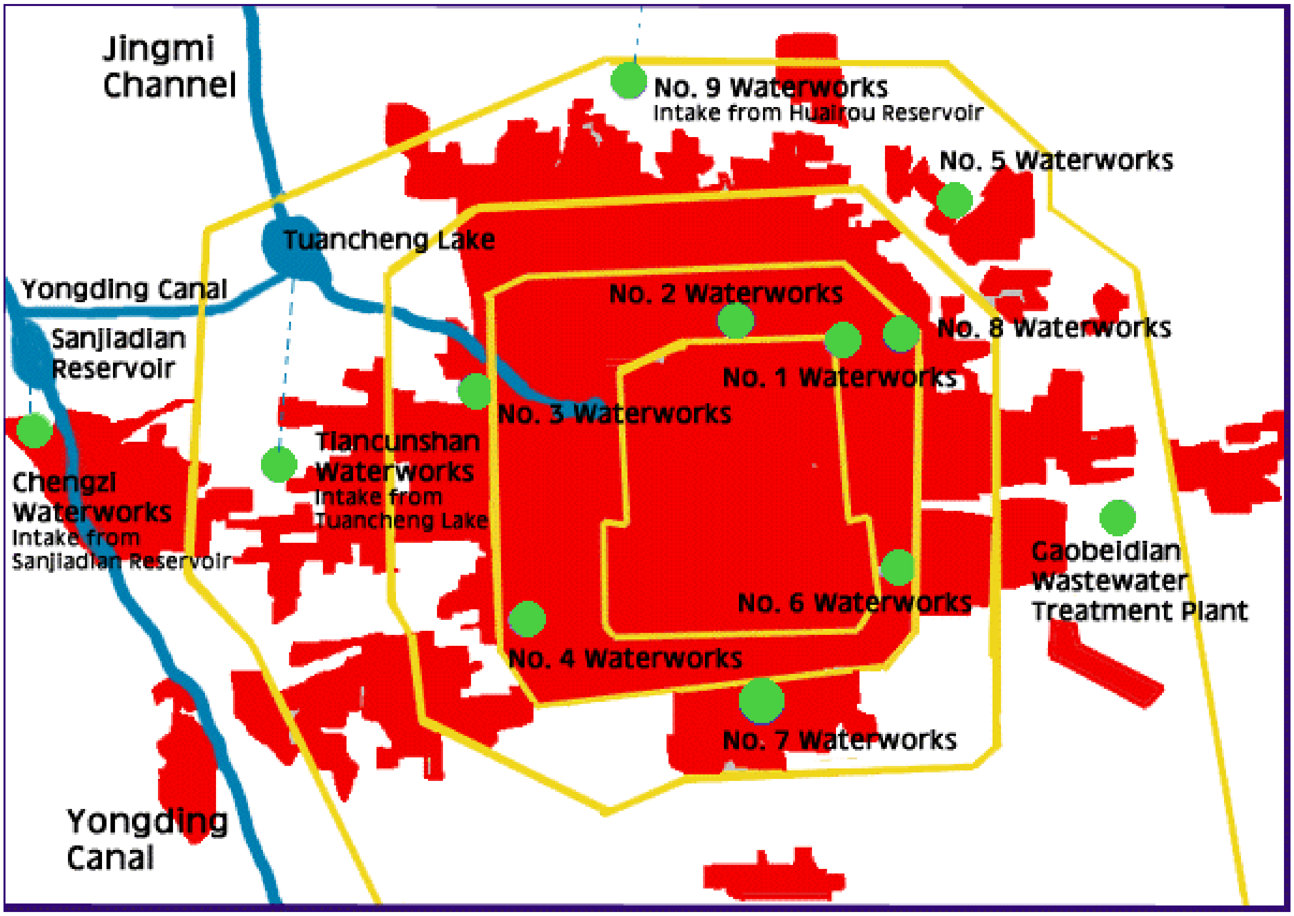


Figure 2.4. Waterworks in Beijing's urban core.

2.2.6.1. Water Meters

Universal water metering in Beijing was established in 1981 with the installation of 600,000 meters. The following year, a 40% reduction in water use was recorded (Beijing Hydraulic Society, 1997). Many households inhabiting more traditional style housing continue to share a water main and therefore a single water meter.

Meters are built, installed, repaired, calibrated, and replaced by the Water Meter Factory of BWWC. The Meter Checking Department of the Beijing Waterworks Company checks these meters on a monthly basis. Bills are sent to customers who either directly pay at the office of the BWWC or at specified banks within 2 weeks of accepting the bill. About ninety-five percent of urban household and industrial users are billed, and only water for fire fighting is free of charge (Beijing Public Utilities Bureau, 1993).

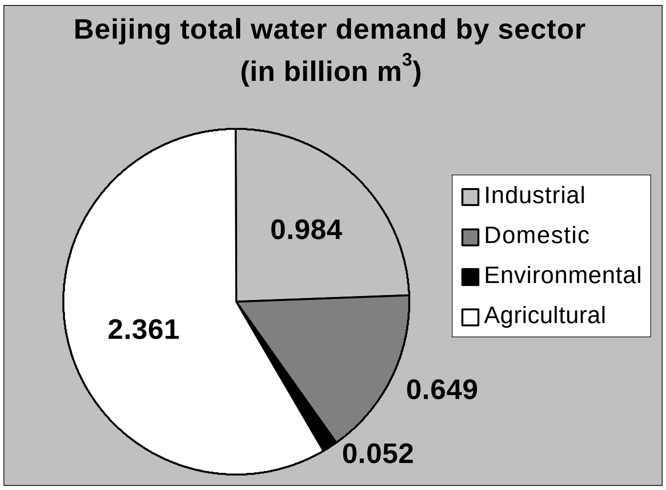
2.3. Water Demand in Beijing

As of 1998, total water demanded by the municipality on the whole was 4.046 billion m^3 (see Table 2.6). This includes water demanded by industry (comprising 24.32% of total use), households (16.04%), agriculture

(58.35%), and environment including public watering of trees, street cleaning, and fire fighting (1.29%) (see Figure 2.5). About 18.78% of this total water demand is fulfilled by tap water (759 million m^3 per year).

Table 2.6. Water demand in Beijing by source and sector (Jiang, 1998).

	Total	Industry	Domestic	Environment	Agricultural
Guanting Reservoir	0.331	0.258	0.021	0.005	0.047
Miyun Reservoir	0.519	0.204	0.119	0.039	0.157
Other water reservoirs, river flow	0.319	0.008			0.311
Surface water total	1.169	0.47	0.14	0.044	0.515
Groundwater	2.64	0.514	0.509		1.617
Industrial receding water	0.068			0.008	0.06
Wastewater	0.169				0.169
Total	**4.046**	**0.984**	**0.649**	**0.052**	**2.361**



Typical of less developed nations, agriculture and rural activities in China account for 88% of water demand, industry 10%, and households 2%. Beijing however is atypical with its greater emphasis on industrial and domestic users. It is slightly closer to industrialized nations with a water use ratio of 39:47:14 (agricultural:industrial:domestic) (Merrett, 1997).

Daily demand is harder to estimate, and figures are available only for daily demand of urban tap water. As of 1998, the tap water company supplied a daily capacity of 1.8 million m^3/day (at peak demand season). Actual water demanded on the other hand, is much harder to estimate. Many households simply live with dry taps for parts of the day, and thus their unfilled demand is unmeasured. However, one estimate places daily water demand for tap water at 3.01 million m^3/day by year 2000 (Beijing Public Utilities Bureau, 1993).

Total volume of water demanded has been increasing steadily since 1950. Nickum (1994) found that "Beijing's urban water use, industrial and domestic, increased by forty times in 35 years (1950-1985)" (Nickum, 1994). Statistical yearbooks show a fairly steady increase in tap water demand in the past two decades (see Figure 2.6) rising from 0.459 billion m^3 in 1987 to 0.759 billion m^3 in 1998.

The critical problem with rising demand is that it aggravates the water deficit. As we have found in section 2.2.5, total volume of water supply hovers at 4 billion m^3 per year. Table 2.7 provides estimates of water demand and water supply for Beijing in the years 2000 and 2020 (this was taken from work done by Jiang in the late 1990s). As you can see, there is more than a 50% chance of a water deficit in 2000. By 2020, there is more than a 50% chance that the water deficit will be greater than 2 billion m^3 per year. Thus efforts are clearly needed to target these deficits. But what sectors should be targeted? What are these water demand projections founded upon? The next few sections look at the demand trends for each particular sector.

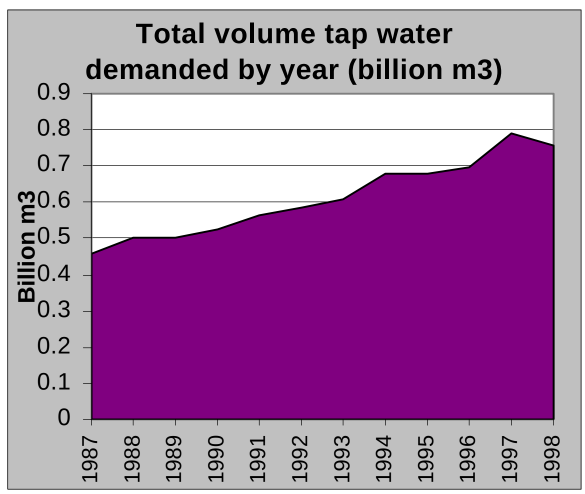


Figure 2.6. Total volume of tap water demanded in Beijing from 1987-1998 (Beijing Municipal Statistical Yearbooks, 1988-1999).

Table 2.7. Estimated demand and supply balance in 2000 and 2020 (Jiang, 1998).

	Year 2000			Year 2020		
	50%	**75%**	**90%**	**50%**	**75%**	**90%**
Estimated demand	4.538	4.813	4.813	6.075	6.37	6.37
Estimated supply	4.094	3.721	3.854	3.854	3.521	3.196
Municipal Deficit	**0.444**	**1.092**	**1.377**	**2.221**	**2.849**	**3.174**

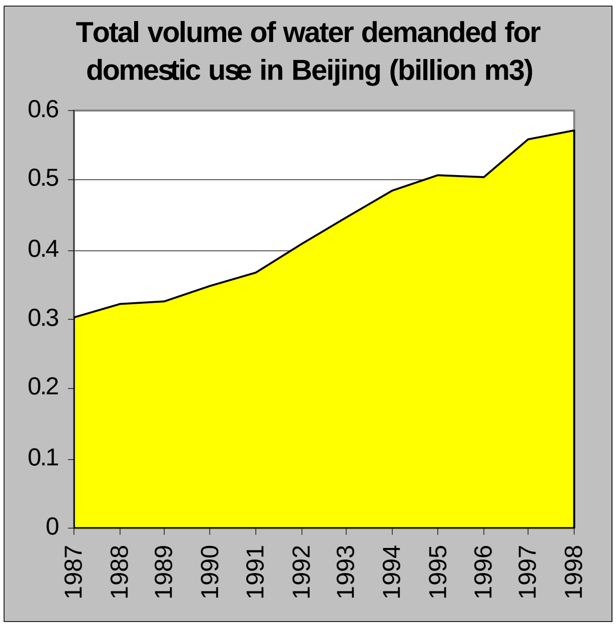


Figure 2.7. Total domestic water demand in Beijing, 1987-1998 (Beijing Municipal Statistical Agency, 1982-1999).

2.3.1. Domestic Demand

Current annual domestic water demand in Beijing is about 649 million m^3. This has increased dramatically in the past few decades (see Figure 2.7). In 1987, total volume of domestic water demand in Beijing was 303.22 million m^3. By 1998, this figure had risen 53% to 570 million m^3.

Per capita demand is also increasing at about the same rate (see Figure 2.8). Daily per capita water consumption has increased 67.3% from 160.4 l/person/day in 1987 to 238.2 l/person/day in 1998 (Beijing Municipal Statistical Agency, 1988-1999). In certain districts of Beijing, per capita consumption exceeds 300 litres daily, reaching as high as 2,000 litres/day in first-class hotels (Ross, 1988). Beijing has risen from a mid-level water consumer to a high level consumer[2] in the span of two decades (see Figure 2.10 for comparison).

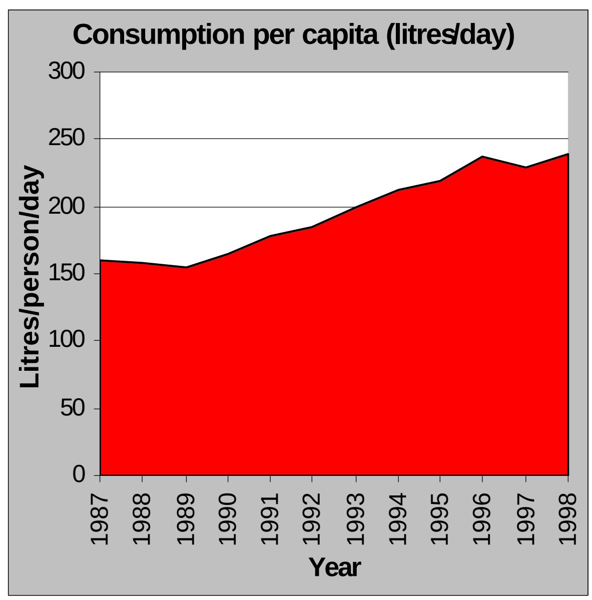


Figure 2.8. Beijing domestic water consumption per capita from 1987-1998 (litres/day) (Beijing Municipal Statistical Agency, 1988-1999).

Although water demand has already increased significantly, there are many indications that it will increase further. The following few sections provide explanations as to why analysts anticipate further growth.

2.3.1.1. Population Growth

Population trends in Beijing echo those of the rest of China: extreme and rapid growth. Several factors contribute to the growth of cities such as Beijing. First, migration to the cities from the impoverished rural countryside is increasing as high rates of economic growth in urban centers outpace economic growth in rural areas. In 1994, over 2.87 million people lived in Beijing without official residency (Chang, 1998).

Another factor is natural population growth. While the national government has made significant achievements in population control through policies

[2] High use nations, such as Canada, US, Japan and Australia, consume over 250 litres/person/day. Mid-level consumers such as Denmark, Finland, France, Austria, UK, Korea, Ireland consume 130-180 litres/person/day. Low use nations, such as Portugal, Belgium, Germany, consume 100-130 litres/person/day.

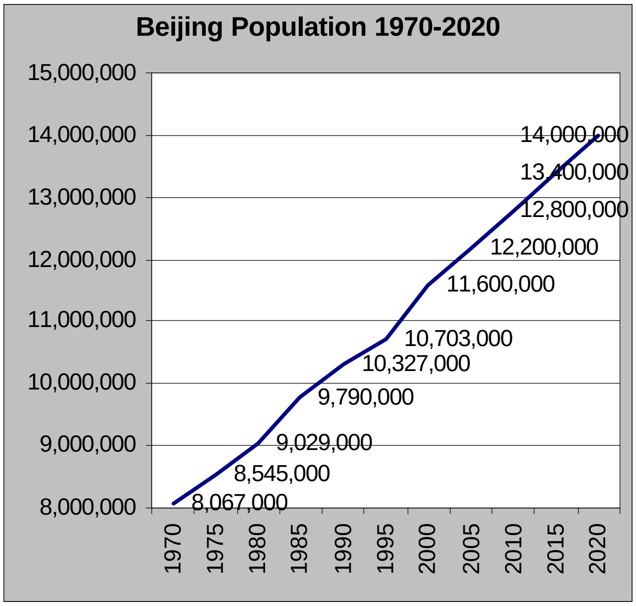


Figure 2.9. Population of Beijing Municipality, 1970-2020 (Beijing Municipal Statistical Agency, 1988-1999 and Beijing Public Utilities Bureau, 1993).

such as family planning, the population continues to grow quickly due to an extremely large population base.

Although Beijing's rate of population growth is stabilizing at around 2.5 percent annually due to government policies to restrict fertility and movement, growth in absolute numbers continues to soar. In 1970, Beijing's population was about 8 million. Ten years later, population rose to 10.3 million and twenty years later it was at 11.6 million[3] (see Figure 2.9). By 2020, the estimated official population will be 14 million.

2.3.1.2. Income Increase

Another reason for the anticipated increase in domestic water demand, is that incomes are increasing in Beijing and throughout much of China. The relationship between income and water demand is called the *income effect* (see Box 2.2).

There are several ways to measure real income increase. One may look at increase in per capita GDP, average wage, or average income. In China, some records are difficult to attain since earnings are often made in the informal sector where they are not formally recorded. The more easily recorded measures are average wage and GDP per capita. Both of these show an increasing trend that has impacted and will continue to impact water demand in the nation's capital.

Average wages in Beijing have risen from 2,312 yuan/year in 1989 to 12,285 yuan/year in 1998 (see Table 2.9). That is a five-fold increase at an average annual rate of 20.76%! While this number is probably deceptively high because inflation is not accounted for, it is nonetheless astonishing. Li (1999) shows that between 1978 and 1995 the consumer price level increased 200%, but incomes increased 900% in Beijing.

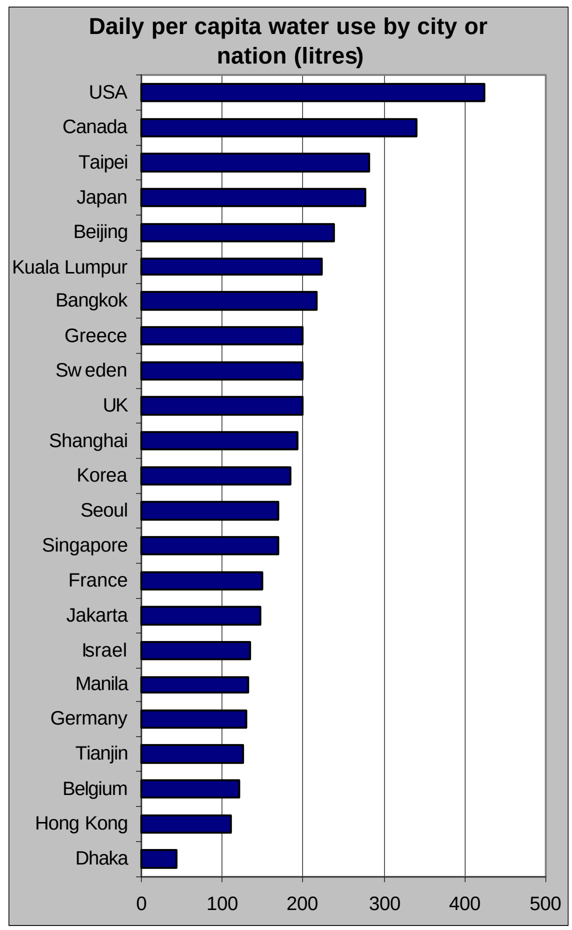


Figure 2.10. Per capita water consumption in other cities and nations from the 1990s (in litres/day) (Chreod, 1999, Borch, 1995, OECD 1999).

[3] This figure is likely an underestimate, as floating population, which is difficult to calculate, is omitted.

Box 2.2. China's income effect (elasticity)
The income effect may be loosely defined as the correlation between water demand and income level. This effect may be calculated as the rate of change of water quantity demanded (Q) divided by the rate of change in income (I). This is denoted by the following formula:

$$I_e = \frac{(Q_2 - Q_1)}{(I_2 - I_1)} \times \frac{I}{Q}$$

It is anticipated that when incomes rise, people will spend more money and thus demand more water, and vice versa. However, this effect is not constant. At very low incomes when people are consuming very little water the income effect will be larger, as people spend their newfound income on improving their living conditions. At very high incomes where people are already high water consumers, the income effect is less dramatic. This is because water is a *basic good* that has limitations on how much a person wants or needs. In contrast, a luxury good (such as fine wine for example) would have a greater income effect as incomes grow.

While little research has been conducted on how water demand in China responds to changes in income, one study of Shanghai's domestic water market determined an income elasticity of 0.22, which is consistent with international experience (UNDP and PRC Ministry of Construction, 1999). This means that every increase in income by 1% will show a corresponding increase in water demand by 0.22%, on average.

Another study by Hu (1999) of the entire China found a greater income effect. Hu found income effects ranging from a high of 0.77 for those with incomes around 876 yuan/month, to a low of 0.69 for income earners making 2599 yuan/month. Elston (1999) extended this work further and found that people earning less than 500 yuan/month had a large income effect of 0.78 while those earning more than 10,000 yuan/month had a very low income effect of 0.35. Table 2.8 summarizes the results of these two studies.

Table 2.8. Income effect and household income (Hu, 1999, Elston, 1999).

Household income yuan/month	**Consumption Litres/person.day**	**I_e**	**% of household income on tariff**
500		0.78	
876	87	0.77	0.53
1089	103	0.76	0.50
1255	114	0.75	0.48
1466	129	0.74	0.46
1736	146	0.73	0.44
2021	163	0.71	0.43
2599	194	0.69	0.40
3000		0.63	
4000		0.58	
5000		0.53	
7500		0.43	
10,000		0.35	

The significance of this table is that urban demand for tap water will continue to rise along with increasing per capita incomes, but at a rate that tapers off at with higher incomes.

Additionally, many industries show exceptional growth in wages. For example, as of 1994, the average monthly income of employees in the telecom industry was 1300 yuan, and in the airline industry, 1242 yuan (Li, 1999). The 20,000-50,000 international firms established in China pay wages as high as 2-4 times the level of state-owned enterprises. "In 1996, basic level secretaries at foreign invested enterprises earned an average income of RMB 20,000 per annum. Receptionists at top US investment banks in Shanghai command salaries as high as RMB 96,000 a year. Today many local business professionals command monthly salaries in excess of US $4000" (Li, 1999).

GDP per capita in Beijing showed similar growth. This figure was 12,009 yuan person/year in 1996 and 18,520 yuan/person/year in 1998 (Chreod, 1999). The Chreod study (1999) found that per capita GDP rose an average of 10.9% per year between the years 1990 and 1997 in the Bohai sea area (of which Beijing is a part).

Increased income leads to direct increases in the level of water demanded. While increased water demand partly stems from more liberal use of tap water by households who no longer have to give water fees important budgetary consideration, most of the extra demand results from a change in lifestyle towards the increased use of high water-consuming appliances and practices. The next section will look at how this cultural-economic shift towards a popularization of what were formerly considered luxury goods affects water demand.

Table 2.9. Average Wage (yuan/year), 1989-1998 (Beijing Municipal Statistical Agency, 1989-1999).

	Ave. Wage (yuan/year)	Percentage increase from previous year
1989	2,312	
1990	2,653	14.7%
1991	2,877	8.4%
1992	3,462	20.33%
1993	4,780	38%
1994	6,540	36.82%
1995	8,144	24.52%
1996	9,579	17.62%
1997	11,019	15%
1998	12,285	11.48

2.3.1.3. Increased Demand for Luxury Goods

Higher wages lead to the natural quest for improved living conditions. Part of that improvement means larger apartments for Beijingers. The Beijing Municipal Statistical Yearbooks show that from 1989 to 1998, average floor space per resident increased from 8.01 m^2 per person to 14.96 m^2. Not only are people moving to larger units, but people are moving into newly constructed apartments with modern amenities such as in-house tap water and toilet facilities. The average Beijing household will likely see a huge increase in water usage as they switch from nightstools to flush toilets, since about one-third of total water usage is used for toilet flushing, according to UK studies. The installation of showers and baths will also have impacts, as studies in the UK show that 17% of domestic water is spent on bathing and showering (Merrett, 1997).

More floor space in conjunction with increased income is leading to an increased demand for luxury appliances, such as dishwashers and washing machines. In fact, "between 1990 to 1997 ownership of washing machines (per 100 households) increased from 78 units per 100 urban households to 90 units per 100 urban households, a 13% increase" (Chreod, 1999). Since in the UK, 12% of domestic water use was spent on washing clothes[4], the use of newly acquired washing machines in Beijing will surely have an impact on water supplies.

Some analysts predict that the thirst for luxury water-consuming appliances has not yet ended in Beijing. Between 2000 and 2020, per capita purchasing power is expected to increase on the order of 3 to 5 times (Chreod, 1999) leading to more spending on consumer goods.

2.3.2. Industrial Demand

Total industrial water demand has demonstrated an overall rising trend from the founding of New China to about 1980, when it peaked at 1.18 billion m^3 (see Figure 2.11). Since 1980, there has been a decline in industrial water use to 870 million m^3 by 1989 (Jiang, 1998). This unusual pattern, complete with peaks and drops, is driven by two forces working in opposition. First, industrial water demand is increasing with the expansion of the Chinese economy. Additionally, consumer demand for water-intensive goods and services may also contribute to increasing overall industrial demand. At the same time, there are opposing forces that work to reduce water demand, such as industrial restructuring away from the primary sector, and heavy industry towards light industry and the tertiary sector and technological innovation and fusion of foreign technologies. The next few sections will examine these forces in more detail.

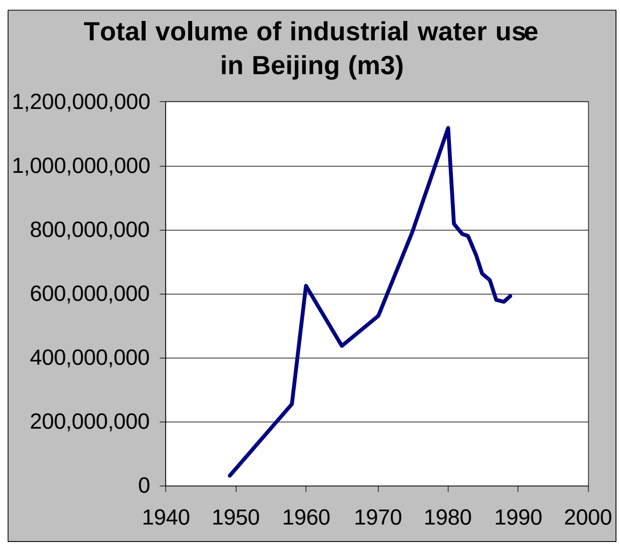


Figure 2.11. Total volume of industrial water use in Beijing, 1949-1989 (Jiang, 1998).

[4] In the UK, 32% of domestic water use went to toilet flushing, 17% to baths and showers, 12% to clothes washing, 35% to other internal uses such as dishwashing, and 3% to external uses such as car washing and lawn watering (Merrett, 1997).

2.3.2.1. Restructuring of Industry

When the Chinese Communist Party won power in 1949, it was decided that Beijing should no longer be a non-productive center of bureaucrats and civic institutions, but a productive city with an industrial foundation. As a result, the secondary sector was expanded and large factories were built in the city suburbs. Among these were chemicals, iron, steel and other heavy industries, textiles, electronics, and various light industries. This industrial development was laid out in the First Five-Year Plan (1953-1957), which called for development of secondary industries, such as electronic industries in the northeastern outskirts of the city and cotton textile industries in the northeastern outskirts of the city and in the western suburbs (Chang, 1998). The result of this effort was a 13.5% increase in total industrial value of output between 1949 and 1957 (Chang, 1998). By the end of this period, Beijing was completely transformed from an administrative city with industry accounting for only 5.5% of GDP in 1949, to a largely industrial city with industry accounting for 92% of GDP by 1962 (Chang, 1998).

The Second Five-Year Plan and the feverish but short-lived Great Leap Forward campaign (1958-1961), ushered Beijing into a period of heavy industrial development "with great emphasis on coal mining, thermal energy development, metallurgical industry, and industries producing machinery, chemicals, iron and steel" (Chang, 1998). As a result, the secondary sector became increasingly pronounced earning an increased share of GDP. By 1960, the secondary sector made up 64% of GDP while the primary sector fell to 7% of GDP (UNDP, 1994).

The 1970s saw continued growth of the secondary sector, with more emphasis on light rather than heavy industry. But this had little effect on Beijing which was still dominated by heavy industry. Between 1970 and 1979, the national government invested further in Beijing's heavy industry, "particularly in chemicals, machinery, and metallurgy" (Chang, 1998).

It was not until the 1980s that Beijing began to shift away from the secondary sector towards the tertiary sector. Figure 2.12 demonstrates this trend. Beginning in the mid-1990s, the tertiary sector began to contribute more to GDP than the secondary or primary sectors. The limitation of the secondary sector, particularly of heavy industry, was acknowledged during this period. "In July 1983, the General Urban Plan of Beijing was approved by the State Council containing a statement for the control of the development of heavy industries which consume energy and water, contaminate the urban environment and water, and occupy large acreages on urban land. The metallurgical industry and petrochemical industry should have been especially restricted" (Chang, 1998).

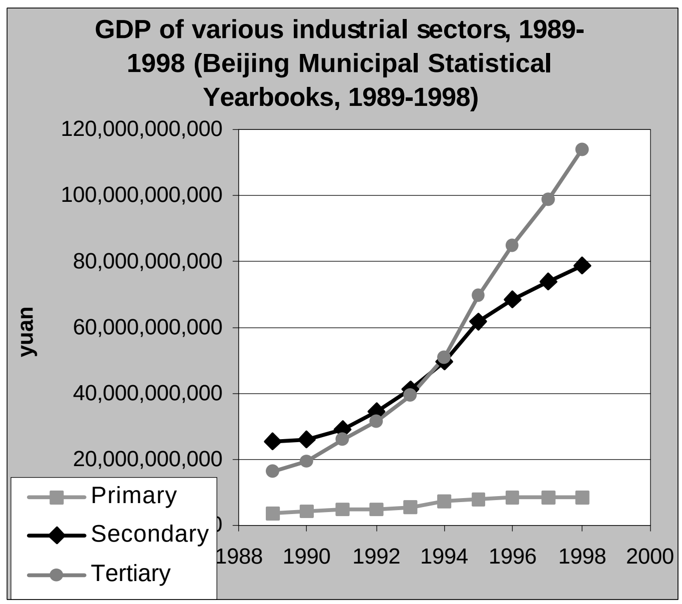


Figure 2.12. GDP of various industrial sectors in Beijing, 1989-1998 (Beijing Municipal Statistical Agency, 1989-1999).

Today, Beijing's suburbs continue to produce pig iron, steel, and other heavy industrial products, although at a less significant rate. Light industry, such as motor vehicles, woolen goods, beer and other alcoholic beverages, dominates over heavy industry. In total the secondary sector contributed to about 43% of municipal GDP in 1996 (Chreod, 1999b).

However, it is clear that the tertiary sector dominates over other sectors as the largest contributor to Beijing's GDP (56% in 1996) (Chreod, 1999) and employment (57.7%) (Yabuki, 1995). And there are reasons to believe that this sector will only continue to grow. First, in developed nations, the tertiary sector comprises of a very large portion of total GDP. The natural progression appears to be from primary to secondary to tertiary, and according to the World Bank "the share of services in China's GDP is still well below that of a typical low-income (let alone middle-income) country. This share could change dramatically over the next twenty-five years as China acquires the characteristics of middle-income market economies" (WB, 1997a).

Another reason to expect further tertiarization is because top levels of government have decreed it. In 1992, the State Council announced a policy for accelerating development of the tertiary sector on a national level. "This decision called for raising the growth rate for the tertiary industry above that for primary and secondary industries, and for the weight of tertiary industry in China's GNP and employment structure to 'reach the average level of developing countries'" (Yabuki, 1995). The Communist Party of China states in document No. 4 1992, that "in order to smoothly achieve the grand objective of socialist modernization, we must tightly grasp this opportunity to raise tertiary industry to a new level" (CCP, 1992). In response, Beijing established over 30 economic and technological development zones throughout the city and its suburbs in the 1990s. These zones aim at export-oriented firms, and have attracted numerous international blue chip companies in the past few years. The success of these zones means they will likely increase in size and scope over the next few decades.

Table 2.10. Water efficiency levels in m^3/10,000 yuan (Wang and Yan, 1998).

Direct Water Consumption by Industry (m^3 / 10,000 yuan)	
Primary sector	
Agriculture	3187.25
Electric power, steam and hot water supply	1339.14
Mining industry	324.33
Non-metallic minerals mining industry	193.62
Coal and gas production	180.20
Coal mining	126.12
Average for primary sector	**891.77**
Average for primary sector without agriculture	**432.68**
Secondary sector	
Heavy Industry	
Building materials and non-metallic mineral products	150.38
Chemical industry	144.52
Metallurgical industry	139.85
Paper and stationary manufacturing	103.61
Petroleum processing	48.67
Average for heavy industry	**117.41**
Light Industry	
Textile industry	88.14
Food processing industry	82.17
Machinery maintenance	61.63
Instrument and meter Manufacturing	59.43
Metal products	50.05
Timber processing & furniture making	49.95
Mechanical industry	43.16
Other industry	36.10
Electric machinery and equipment manufacturing	30.14
Transport equipment manufacturing	26.03
Electron and communication equipment manufacturing	20.47
Sewing and leather processing	18.10
Average for light industry	**47.11**
Average for secondary sector	**67.79**
Tertiary	
Cargo transportation, post and telecommunications	83.60
Trading	53.40
Passenger transport	46.72
Catering	42.64
Construction	8.97
Finance and insurance	5.46
Average for tertiary sector	**40.13**

But what impact does industrial restructuring have on water demand? Table 2.10 compares the water use rates per yuan of output in various sectors. As you can see, the primary sector is the least efficient in terms of water use, requiring on average much more water to produce a unit of output. Even if agriculture, which is a heavy water consumer, is removed from the calculation, the primary sector still consumes on average about six times the amount of the secondary sector. Water use in the secondary sector varies dramatically between heavy and light industry. On average, heavy industry uses twice as much water to produce the same value of output. Thus shifting from heavy industry to light industry should reduce overall industrial water demand. Finally, while the tertiary sector uses on average the least amount of water per unit output, it does not vary significantly from light industry.

With rapid industrial restructuring, one would expect a constant decline in water demand from 1949 to the present. However, this is not the case (as shown in Figure 2.11). While there has been a shift towards light industry and the tertiary sector, much of the water-saving effect is counter-balanced by the overall expansion of the economy, as discussed further in section 2.3.2.2.

2.3.2.2. Economic Growth

While some sectors have declined in relative terms, all sectors have grown in absolute terms. Beijing's entire economy experienced great expansion since 1949 as demonstrated in Figure 2.13. According to this chart, total GDP in Beijing increased from 45.59 billion yuan in 1989 to 201.13 billion yuan in 1998. Figure 2.12 also provides evidence of absolute growth. If you note carefully, you will notice that all sectors (including the primary sector) show a positive growth trend since 1949.

Clearly absolute growth in all sectors would lead to water demand increase. This hypothesis is supported by fitting a linear relationship into Figure 2.11 to reveal a general rising trend. But sharp drops in Figure 2.11 appear inconsistent. This is because there is one more crucial factor that affects industrial water demand: technological innovation.

Figure 2.13. Beijing GDP, 1988-1998 (Beijing Municipal Statistical Agency, 1989-1999).

2.3.2.3. Technological Efficiency

Technological innovation and importation has allowed for water usage reduction in Beijing. According to Guo (2000) industrial water usage descended from "98 m^3 per ten thousand yuan industry output in 1991 to 50 m^3 per ten thousand yuan industry output in 1998" (Guo, 2000) due to better technologies. Specifically, industrial water recycling technology has greatly reduced industrial water demand. Water reuse is the reason why Beijing's industrial output has increased 650%, while industrial water demand has only increased 57.5%, in the last 15 years, (Lee, 1998). Wastewater reuse rates have increased significantly in the past two decades in Beijing: 45.3% in 1980, 80% in 1993, 87.7% in 1995 (Beijing Public Utilities Bureau, 1993), and 91.4% in 1996 (Lee, 1998). Table 2.11 provides examples of water reuse rates in various industries in Beijing. As you can see, progress has been made to reuse water in some sectors, particularly heavy industry.

While reuse rates are high, there is still room to adopt better technologies from western industries. For example, steel-making in China requires 2-3 times as much water as in the west, and breweries require 4 times as much water. "Beijing's Capital Steel Works uses twice as much water per tonne of finished steel as do Shanghai mills and four times as much as the typical Western rate" (Smil, 1993). Undoubtedly, technology will continue to improve, making Beijing's industry increasingly water-efficient.

Table 2.11. Water reuse rates for various sectors in Beijing (Wang and Yan, 1998).

Metallurgical industry	89.93
Electrical power and steam and hot water supply	86.06
Chemical industry	83.63
Coal & gas product industry	80.48
Textile industry	68.64
Timber processing and furniture manufacturing	63.52
Electron and communication equipment manufacturing	60.80
Building material and non-metallic minerals products	59.86
Mechanical industry	57.74
Metallic minerals mining industry	55.06
Electron machinery & equipment manufacturing	54.73
Paper and stationary manufacturing	53.55
Transportation equipment manufacturing	53.37
Instrument & meter manufacturing	50.54
Food processing industry	49.41
Machinery maintenance	42.09
Petroleum processing	33.97
Non-metallic minerals mining industry	23.06
Metal products	20.55
Coal mining	16.85
Other industry	13.22
Agriculture	12.17
Public affairs and resident services	11.19

2.3.2.4. Luxury Goods Industry

The final factor which can impact industrial water usage is the expansion of the luxury goods sector. For example, automobile washing, luxury hotels, and bottled water are increasingly sought-after luxury goods which are known to have excessive impacts on water demand and quality. These three culprits are targeted by the municipal government in setting water prices. In fact, the highest water price bracket (currently at 3 yuan/m^3) is on water used for luxury public baths, car washing, and bottled water production. Luxury hotels for foreigners face the second highest price bracket at 2.70 yuan/m^3.

Beijingers are showing increased interest in these products. For example, "in the 1980s, it was rare to find Chinese guests in three star hotels. Today in Chengdu, 10-15% of hotel guests in four or five star hotels are domestic Chinese businesspeople or tourists" (Li, 1999). Bottled water is also gaining popularity, transforming bottled water companies such as Wahaha into mega-corporations in the span of less than a decade. Automobile ownership has increased dramatically in the past few decades, leading to the mushrooming of car washes around the city.

While the growth of these water-intensive industries may have impacts on total water demand, it is nonetheless purely speculative as no known studies have been conducted on this topic.

2.3.3. Agricultural Demand

While China is a primarily agricultural country, Beijing has moved steadily away from agriculture as its economic activity. Additionally, there are forces of change which affect the nature of agriculture in both Beijing and China.

The history of Chinese agriculture since the founding of New China stems largely from two irrigation campaigns. The first occurred in 1957-58 when over 100 million people were mobilized to construct ditches, reservoirs and irrigation works. Most of Beijing's irrigation works, including the many reservoirs dotting the countryside, were constructed at this time. While this project increased the amount of irrigated agriculture, it also led to wastage "due to the neglect of technical considerations and such ancillary functions as watershed vegetation" (Ross, 1988). The second campaign occurred in the 1970s with the drilling of hundreds of thousands of tube wells in the North China Plain. During this period, surface water resources were beginning to feel the strain of improper and excessive use, leading farmers to turn to groundwater. These wells played an important role in increasing the area of irrigated agriculture. "For example, paddy area increased from 21,000 hectares in 1973 to 102,000 hectares in 1980 in the municipalities of Beijing and Tianjin, which include substantial tracts of farmland in suburban counties" (Ross, 1988). However, the excessive use of wells "not only flooded fields but also aggravated drainage and salinization problems" (Ross, 1988). From 1949 to the 1970s, agricultural water demand expanded as irrigation became more technologically feasible. Before 1980, agricultural water use was on a rising trend, growing at about 1.03-1.67% per annum (calculated from the whole of China by Ross, 1988).

Beginning in the 1980s, agricultural water use fell. Agricultural water use is currently 2.361 billion m^3 per year, while in 1993 it was 3.43 billion m^3, and in 1980, 3.581 billion m^3 (Chreod, 1999). Between 1980 and 1993, it fell 4% (or about 0.31% per year on average). A much more drastic drop in agricultural water use was recorded for the period between 1993 and 1999, when demand fell 31.1% (or about 5% per year).

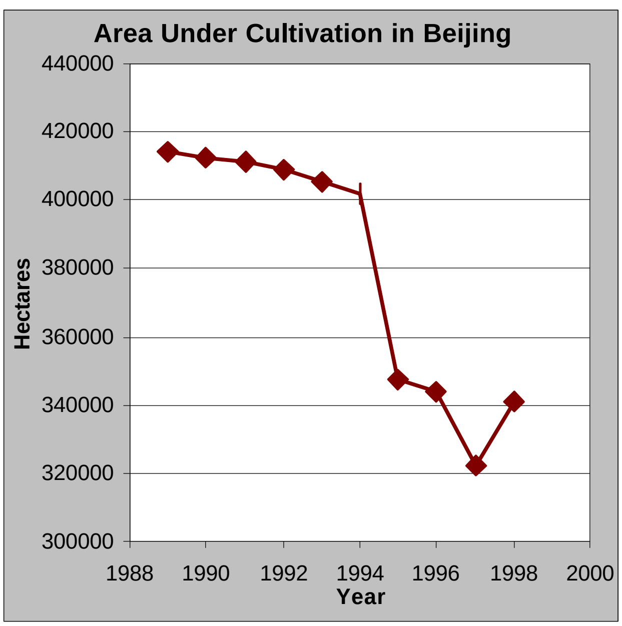


Figure 2.14. Area under cultivation in Beijing, 1989-1998 (Beijing Statistical Agency, 1990-1999).

There are several reasons for this decline but the most important is a decline in grain production. In the Beijing region "irrigation is primarily used to produce grain (corn and wheat), and secondarily vegetables. Beijing's grain output increased during the 1980s, e.g., from 2.18 million metric tons (mmt) in 1984 to 2.65 mmt in 1990. Since then, grain production has fallen, reaching 2.37 mmt in 1996. One of the reasons for this decline is no doubt the reduction in water supply and effective increases in the cost of what water is available and the means of applying it to field crops" (Nickum, 1994). The total area under cultivation has dropped progressively since the 1980s (see Figure 2.14).

A change in lifestyle has changed the nature of agricultural production in the Beijing region. A taste for meats, fruits and vegetables accompanied by an increase in income has led farmers to abandon grains in favour of these crops. Water shortages have also prompted farmers to switch from irrigated crops, such as rice and grain, to less water intensive crops and dryland crops, such as sorghum and millet.

The importance the agricultural sector dropped markedly after the 1970s in what is called the "historic transformation of the Chinese economy" (Yabuki, 1995). The relative contribution of agriculture to Beijing's GDP (as discussed in section 2.3.3.) dropped from 23% in 1949, to 7% by 1960, to 4% in 1980. Agriculture became an increasingly unimportant source of family income in Beijing also. In the 1950s and 1960s, almost 80% of the labour force in Beijing's rural counties was in agriculture, but by 1984, this figure had fallen to 68% (Yabuki, 1995). By 1996, this number had further dropped to 41% (Nickum and Marcotullio, 1999). In 1984, agricultural provided 24.1% of total rural incomes in Beijing, but only 7.3% by 1996 (Nickum and Marcotullio, 1999).

Aside from "rural economic diversification …both within agriculture (away from crop farming towards other branches such as animal husbandry, forestry and aquaculture), and away from agriculture towards other sectors such as industry, commerce and services" (White, 1993), adoption of "green revolution" technologies such as pesticide and fertilizer use, mechanization, and use of new plant varieties have contributed to improved water efficiency.

2.4. Water Pricing in Beijing

Now that we have a sense of the water supply and demand situation, we have to consider the current water pricing context in Beijing.

2.4.1. Trend towards Pricing

There has been a definite trend towards increasing water prices in China. There are examples from throughout the country (see Table 2.12). For example, the price bureau in Taiyuan, Shanxi recently announced that water prices will quadruple over the next five years in order to recover supply costs. "Shanghai recently increased tap water prices between 25 to 40 percent to fund water quality improvement programs and to make sewage self-financing" (WRI, 1999). Jinan, in Shangdong Province, is considering an increase in its water prices by 30% to cover the cost of sewage treatment (Zou and Zhou, 1999).

Average water prices are showing increases. The average water tariffs in 1988 were 0.12 yuan/m^3 (domestic), 0.24 yuan/m^3 (industrial), and 0.18 yuan/m^3 (commercial). By the late 1990s these figures were 0.4389 yuan/m^3, 0.6721 yuan/m^3, and 0.8713 yuan/m^3, respectively (Frederiksen et al., 1993). However, while tariffs are rising, they are still far below efficient levels. Qingdao, Shandong is often exemplified as a Chinese city with progressive water prices. Here water is priced at 1.20 – 2 yuan/m^3, which is some of the most expensive water in China. Not surprisingly, water in Qingdao is used "more efficiently than elsewhere in China" (US Embassy in Beijing, 1997). Table 2.12 lists some recent price hikes by city or county governments throughout China (Zheng, 1999).

However, there are still many examples of grossly underpriced water in all sectors throughout the country. For example, the city of Dalian charges 0.22 yuan/m^3 for industrial water, and 0.13 yuan/m^3 for domestic water, which is far lower than the 0.70 yuan/m^3 cost of treating this water (Yu and Jia, 1997). Nationally in 1997, only 40% of water supply costs were recovered through water tariffs (Yu and Jia, 1997). The sector with the worst cost recovery record is the agricultural sector. Only 27.7% of the cost to produce irrigation water is recovered through tariffs (Wang and Huang, 2000). The UNDP and Ministry of Construction (1999) came to a similar conclusion for tap water: "On the whole, current water prices remain about half the average level needed for self-sustaining [tap] water company operations."

But in order to understand how the current situation came about, we must examine the historical development of water pricing in China.

Table 2.12. Examples of rising water rates throughout China (Zheng, 1999).

City or county	Year	Water price (yuan/m3)					
		Residential		Enterprises, organizations and commercial		Commercial (special)	
		Old	New	Old	New	Old	New
Baoqing	1999	1.50	1.80	2.80	3.40	3.80	4.50
Jixian	1999	1.50	1.80	2.50	3.00		3.00
Jidong	1998	1.00	1.40	2.00	3.00		4.50
Mulan	1998	1.90	2.40	3.00	3.50		
Tonghe	1998	2.00	2.50	3.00	3.50		
Hailin	1998	1.30	1.50	2.30	2.50	3.30	3.50
Yanshou	1998	2.10	2.50	2.50	3.00	2.50	3.50
Dongning	1998	1.00	1.04	2.25	3.00	2.50	3.25
Shuifenghe	1998	1.20	1.40	2.30	2.50	2.50	3.00
Du'erbote	1998	1.70	1.80	2.20	2.60		3.00
Nahe	1998	1.20	1.50	1.80	2.30	1.80	2.60
Fangzheng	1998	2.30	2.50	3.00	3.50	5.00	5.50

2.4.2. History of Water Pricing in China

From the founding of New China in 1949 until 1964, both surface and groundwater were effectively free. In most cases, usage was not metered and households did not pay their own bills. Instead, their work unit (danwei) paid the charges for all residents. Cost of water supply was completely subsidized by central authorities with the exception of some minor fees for maintenance of facilities. The reason for this was partly ideological: it was believed that since water does not embody the value of human labour, it should be commonly owned and free to all. There were also practical reasons for negligible water fees. In the 1950s, attempts were made to collect water fees from farmers for irrigation water. These fees were to be earmarked for use within the water supply system for system maintenance and management (Ross, 1988). However, the government failed systematically to collect these fees for several reasons. First, fees were not calculated on a volumetric basis. Additionally, the system faced political turmoil, and evasion by ratepayers.

"The problem was aggravated by the lack of democratic control over irrigation districts and other institutions. That alienated peasant and other consumers from the resource management authority. Most decisions were made at the production brigade level on up, yet peasants only had the right to directly elect officials at the lowest level, the production team. Higher levels controlled both political and economic power, and thus were able to impose their preferences without due regard for the peasants' wishes concerning water resources and other issues… In leftist periods, water usage fees were actually condemned for encouraging the people to become cunning protectors of their own interests with regard to their fair share of deliveries rather than willing defenders of their collective interest. Therefore, fees were either disregarded or collected on a flat-rate or area-served basis. Peasants derided the system with such slogans as 'If you pay the water charges you will suffer a loss; if you don't you will gain an advantage'" (Ross, 1988).

Further, in the early phases of New China's development, strong emphasis was placed on increasing agricultural production, which meant expanding irrigated agriculture. The Ministry of Water Resources and Electrical Power was thus given the dual conflicting mandate of both expanding and encouraging irrigated agricultural and collecting fees for irrigation. Not surprisingly, water fees collected in this period were virtually nonexistent.

In 1964, the Ministry of Water Resources and Electrical Power held the first meeting on water resources management, in Guangxi. On the agenda was a discussion on implementing water fees. The following year, the Ministry of Water Resources and Electric Power was granted authority for the management and collection of water tariffs through the State Council-issued Irrigation Waterworks Fee Assessment, Calculation and Management Method. Rules were also set that year for the collection of water fees to allow water providers self-sufficiency. Tariffs were to be applied towards covering water supply infrastructure construction, operation, and maintenance costs. Unfortunately, although these rules were well-intentioned, they failed to provide an institutional process through which water supply companies could raise water prices. In other words, water prices would remain very low for more than a decade because water supply companies were not empowered to raise water prices.

In 1979, another meeting was held by the Ministry of Water Resources in which the topic of water rates would again appear on everyone's lips. This time, the meeting was held in Dongguan, Guangdong and the topic was water reservoir management. While discussing options for best practices in operating and managing reservoirs, water rates as a means of recovering supply costs was discussed. This meeting would be the true birthplace of universal water pricing in China.

In the 1980s, market-based mechanisms for water allocation would gain further legitimization, although not without resistance. A series of conferences in the early 1980s, the most notable of which was a national water conservancy meeting in Beijing in May 1981, began to endorse "breaking the 'big water pitcher' mindset under which water was provided without regard to need and with no incentive for efficiency" (Ross, 1988). The result of this conference was a set of draft water management regulations that "endorsed a shift in emphasis from the construction of new facilities to the improved management of existing installations. That involved setting fees according to volume of usage and reallocation of water in time of scarcity from less valuable agricultural uses to industry" (Ross, 1988). Although reformers largely prepared these regulations, even the more conservative officials agreed that marketization of water supply was necessary.

In 1982, the State Council officially declared (in document #1, 1982) that urban and rural water use fees should be reset. A year later, Premier Zhao Ziyang was seen in the Northwest promoting water conservation, including water fees, to farmers. He "acknowledged the benefits of irrigation but insisted that water was in short supply and could not be made available in substantially increased volumes except at prohibitive cost to the economy as a whole. He advised farmers in the Northwest to practice dryland farming…Zhao also demanded that farmers pay more for the water they used by replacing flat-rate pricing based on the area irrigated with volume-based rate schedules. He implied that industry's priority was higher than agriculture's, so that some water actually would have to be reassigned from farming to other uses, as had already occurred in the Beijing area during the recent drought" (Ross, 1988).

Two years later, the first major piece of water pricing legislation was passed. Ironically, this precedent setting piece of legislation was aimed at irrigation water pricing – the sector which today is the most under priced. The Irrigation Waterworks Fee Assessment, Calculation and Management Method was issued in 1985 (State Council decree #94) and was essentially a revision of the 1965 document. This method, which provided instructions on how to determine, collect, and administer irrigation water prices, aimed for rational utilization of water resources, promotion of water conservation, and guarantee of sufficient funds for water conservancy projects (also known as irrigation waterworks).

As one of the earliest pieces of legislation concerning water pricing, the Irrigation Waterworks Fee Assessment, Calculation and Management Method established many principles which would be the basis upon which later water pricing related documents would be set. Some of these principles included eliminating existing flat-rate systems and adopting volume-based progressive rates using cost of water supply as the basis for setting water prices, and allowing for a margin of profit for the water supply company to be calculated into water price (see Appendix B.10 for more information).

Implementation of this method saw mixed results. By 1991, most provinces, autonomous regions, and municipalities directly under the Central Government implemented this method and issued new local water fee management methods. In some provinces, water prices were raised substantially (Wang and Huang, 2000). However, although overall water fees rose, the total amount collected fell far short of cost of supply (Smil, 1993).

Local authorities dragged their feet in implementing this method for several reasons. In the cities, politicians and industry were caught up in the frenzy of economic growth at this time and feared that increased tariffs would become an unwanted disturbance. In the countryside, poor management combined with peasant unrest[5] resulted in very little progress in increasing irrigation water prices. "Poor management, an expensive maintenance backlog, and untrained workers were also chronic problems that could not be expected to vanish merely upon the announcement of a change in policy" (Ross, 1988). Further, even minor irrigation water fee increases raised costs to farmers in the short run. This lead to dissension with peasants in some areas refusing to pay charges and even going as far as to dismantle and steal irrigation systems (Ross, 1988). Local officials for the most part supported local farmers over nationally regulations and often "ordered the sluice gates to be opened even when farmers were in arrears" (Ross, 1988).

By 1989, however, early water prices hikes were nullified by inflation. In the late 1980s and early 1990s, "many cities had overexploited or polluted nearby raw water sources and the need to tap distant sources

[5] The frustration of farmers against water prices were likely magnified at this time due to other agricultural reforms occurring in the 1980s (see section 5.11).

drove up the real costs of new supplies by over 7 percent per year. Recognizing an imminent water crisis, some cities began tariff increases in the late 1980s and recaptured some, but far from all, of the real revenue losses" (UNDP and PRC Ministry of Construction, 1999).

Although water prices increased considerably in the early 1990s, the principles behind water pricing did not experience radical change until 1997 (Zheng, 1999). In June 1997, the State Development Planning Commission (SDPC) issued Policies for the Water Resources Industry. This regulation required tariffs to be designed so as to recover costs. In May 1998, in response to the changing need of the socialist market economy, the Price Law of the People's Republic of China was enacted (see Appendix B.5). This law removed the final obstacles in the way of water tariff reform. Based on the Price Law, the SDPC and Ministry of Construction established the Management Method for Pricing Urban Water Supply, in the same year. This national method thoroughly detailed water pricing methods based on the principles of full cost recovery, reasonable profit margin, and sector-based pricing (see Appendix B.9). This method was made known to all provincial Price Bureaus in September 1998 and acts as foundation for all water pricing reforms.

2.4.3. Current Water Prices in China

It is difficult to determine water prices in China because they are constantly in a state of flux. Tap water companies provide the most reliable data, but these prices are limited to tap water, and therefore neglect self-extracted ground and surface water. Table 2.13 provides the current tap water prices in 128 Chinese cities as of July 2000. From this table, the calculated average water price for industrial use is 1.136 yuan/m^3, domestic use 0.853 yuan/m^3, commercial use 1.527 yuan/m^3, and tourist hotel use 1.692 yuan/m^3.

Table 2.13. Tap water prices in various Chinese cities, 2000 (National Price Bureau, 2000).

	Industry	Residential	Commerce	Hotel
Beijing	1.19	0.99	1.65	1.50
Tianjin	1.47	1.17	1.67	1.87
Hebei Province				
Shijiazhuang	0.96	0.55	1.01	1.18
Newly developed area of Shijiazhuang	1.15	0.65	---	1.35
Baoding	1.34	0.60	1.50	5.00
Zhangjiakou	1.26	0.65	1.08	1.80
Chengde	2.40	1.00	2.40	5.00
Canzhou	1.70	1.30	1.90	1.90
Shanxi Province				
Taiyuan	1.69	1.13	1.69	1.69
Datong	1.40	0.90	1.90	1.90
Yangquan	1.60	1.20	1.90	1.90
Changzhi	1.50	1.10	1.90	1.90
Linfeng	1.60	1.10	1.90	1.90
Jincheng	1.50	1.10	1.80	1.80
The Inner Mongolia Autonomous Region				
Huhhot	1.00	0.75	2.00	2.00
Baotou	1.13	0.95	2.50	2.50
Jining	2.40	1.80	2.50	2.50
Liaoning				
Shenyang	1.03	0.99	1.49	---
Anshan	1.93	1.00	3.00	3.00
Haicheng	1.60	1.00	4.00	4.00
Fushun	1.70	0.90	1.50	1.50
Benkou	1.10	0.70	1.30	1.30
Dandong	1.00	0.90	2.00	2.00
Jinzhou	2.00	1.10	3.50	---
Yingkou	2.00	1.50	3.50	3.50
Fuxin	1.90	1.00	3.00	3.00
Danyang	0.70	0.55	0.70	0.70
Liaoyang	1.41	1.02	1.40	2.02
Huludao	2.10	1.40	4.50	4.50
Jinlin Province				
Changchun	1.85	0.90	1.85	2.00
Jilin	1.80	1.00	1.80	3.00
Siping	2.70	1.60	3.50	3.50

Tonghua	1.60	1.10	2.30	2.30
Yanji	2.80	1.60	4.50	4.50
Heilongjiang Province				
QiQihar	1.00	0.70	1.00	1.50
Jixi	2.50	1.00	2.50	2.50
Daqing	1.10	0.70	---	---
Jiangsu Province				
Nanjing	0.75	0.56	0.97	1.15
Wuxi	0.85	0.55	0.85	0.85
Jiangying	0.85	0.65	1.05	1.05
Changzhou	0.96	0.63	1.10	1.10
Liyang	1.10	0.89	0.30	1.60
Nantong	1.18	0.93	1.44	1.77
Yangzhou	1.12	0.80	1.66	1.86
Taizhou	0.92	0.74	1.10	1.31
Xinhua	0.79	0.68	1.15	---
Zhenjiang	0.74	0.65	0.82	1.16
Jingjiang	0.76	0.63	0.84	0.96
Zhejiang Province				
Hangzhou	1.50	1.10	1.70	1.80
Ningbo	0.74	0.50	1.13	1.35
Huzhou	0.68	0.55	1.14	1.14
Shaoxing	0.73	0.44	1.20	1.20
Jinhua	0.58	0.49	0.83	0.83
Lanxi	0.75	0.69	0.75	1.10
Yi ÎÚ	0.88	0.73	1.08	1.08
Huangyan	1.26	0.94	1.71	1.71
Jiaojiang	1.98	1.85	2.30	3.25
Anhui Province				
Wuhu	0.82	0.68	0.80	1.25
Hefei	0.75	0.71	1.13	1.38
Fujian Province				
Fuzhou	0.78	0.94	0.78	1.15
Xiamen	0.95	1.28	1.48	---
Sanming	0.90	0.80	0.90	1.00
Shaowu	0.51	0.41	0.74	0.74
Jiangxi Province				
Nanchang	0.65	0.60	1.05	1.05
Jingdezhen	0.65	0.55	1.00	1.00
Jiujiang	0.85	0.65	0.85	0.85
Jian	0.75	0.57	0.90	0.90
Shandong Province				
Jinan	1.25	0.96	1.98	1.98
Qingdao	1.35	1.30	1.35	1.80
Gaomi	1.70	0.91	---	---
Weihai	1.10	1.17	2.20	2.20
Rizhao	1.12	1.17	3.20	3.20
Linxi	0.86	0.50	---	---
Liaocheng	0.95	0.80	1.10	1.10
Henan Province				
Zhengzhou	0.85	0.65	1.55	2.30
Kaifeng	0.80	0.65	1.00	1.00
Luoyang	1.00	0.90	1.50	1.50
Anyang	0.88	0.65	1.25	1.25
Xinxiang	0.94	0.75	1.13	1.89
Hubei Province				
Wuhan	0.88	0.62	1.44	1.66
Huangshi	0.65	0.55	1.00	1.00
Shiyan	0.75	0.55	0.95	0.95
Yidou	0.75	0.75	0.80	0.80
Jingzhou	0.56	0.56	0.56	0.78
Qianjiang	0.78	0.78	1.10	---
Tianmen	0.50	0.50		
Zhongxiang	0.55	0.55	0.70	0.70
Hunan Province				

Changsha	0.60	0.50	1.00	1.00
Zhuzhou	0.54	0.58	1.10	1.10
Xiangtang	0.83	0.72	1.30	2.37
Hengyang	0.81	0.71	0.81	0.81
Shaoyang	0.96	0.87	1.57	1.57
Yueyang	0.60	0.56	1.00	1.50
Changde	0.82	0.75	1.88	2.52
Lengshuijiang	0.73	0.73	0.73	0.73
Guangdong Province				
Guangzhou	1.17	0.70	1.50	1.85
Shenzhen	1.90	1.35	2.40	2.40
Zhuhai	1.45	1.02	1.52	2.17
Shantou	0.89	1.00	2.60	
Foshan	0.93	0.68	1.15	1.15
Maoming	1.41	1.12	1.51	1.51
Huiyang	2.80	2.75	3.80	4.00
Meizhou	1.21	0.95	1.41	1.94
Zhongshan	1.05	1.00	1.00	1.00
Guangxi Zhuang Autonomous Region				
Nanning	0.65	0.62	1.01	1.01
Liuzhou	0.93	0.72	1.25	1.25
Guilin	0.67	0.62	0.77	0.77
Beihai	0.90	0.80	1.30	1.30
Hechi	0.65	0.65	0.69	0.85
Sichuan Province				
Chengdu	1.15	0.85	1.55	1.55
Chongqing	1.19	0.94	1.96	1.96
Zigong	1.15	1.05	1.30	1.30
Mianyang	1.30	1.00	1.60	---
Leshan	1.40	1.10	1.60	1.80
Yunan Province				
Kunming	1.25	0.85	1.55	1.55
Geju	1.37	1.04	1.37	1.37
Shaanxi Province				
Xian	0.80	0.45	1.00	1.00
Baoji	1.11	0.78	1.11	1.11
Hanzhong	0.79	0.73	0.98	0.98
Gansu Province				
Lanzhou	0.45	0.39	---	---
Jiayuguan	0.54	0.50	0.54	0.54
Xinjiang Uygur Autonomous Region				
Urumqi	0.80	0.70	1.30	1.30
Kasa	1.00	0.60	1.00	1.00
Changji	1.00	0.50	1.00	1.00
Yinan	0.85	0.56		
Shihezi	1.07	0.72	1.40	1.40
Xinjiang petroleum management area	1.75	2.05	2.05	
Average	**1.136**	**0.853**	**1.527**	**1.692**

Self-extracted water is mainly used in rural Beijing, and almost exclusively by the agricultural sector. Water for irrigation, if priced at all, is grossly under-priced in China. Several sources place the average cost of irrigation water in the 1980s at around 0.003 yuan/m^3. By the late 1990s, this rate was still only 0.024 yuan/m^3 (see Table 2.14 and Table 2.15). In contrast, the cost of producing irrigation water tends to be much higher than the price. Several studies conclude that average irrigation water price tends to be only 10% of the cost of production (Smil, 1993; US Embassy in Beijing, 1997).

Table 2.14. National average irrigation water prices (yuan/m^3) (Wang and Huang, 2000).

Year	1980	1985	1988	1991	1997
Average price	0.001	0.003	0.006	0.01	0.024

Table 2.15. Irrigation water prices in the late 1990s (yuan/m^3) (Gu, 1999).

Beijing	0.02	Chongqing	0.03	Xining	0.03	Heilongjiang	0.024	Shaanxi	0.0039
Inner Mongolia	0.023	Hebei	0.075	Jiangsu	0.01	Anhui	0.042	Xinjiang	0.018
Shanghai	0.015	Jilin	0.03	Jiangxi	0.016	Henan	0.04	Tianjin	0.04
Fujian	0.035	Zhejiang	0.015	Hunan	0.032	Hainan	0.014	Yunnan	0.02
Hubei	0.04	Shandong	0.032	Guizhou	0.02	Ningxia	0.004	Qinghai	0.04
Sichuan	0.031	Guangxi	0.03	Gansu	0.03	Shanxi	0.062		

For the most part, water in China is charged at constant rates (rather than increasing or decreasing block rates; see sections 6.3.2.3 and 6.3.2.4 for details), however there are some recent experiments in applying increasing block prices. Tianjin city, for example, initiated a program in which domestic users are charged 2 yuan/m^3 for any block of water in excess of 8 m^3/person/month. Water within the allowable amount of 8 m^3/month is charged only 1.4 yuan/m^3.

Shenzhen is another progressive city which on June 1, 1994 reformed its tap water pricing system to allow for increasing block rates. Table 2.16 demonstrates how domestic, institutional, industrial and commercial users all face increasing block rates.

Table 2.16. Water rate schedule for Shenzhen (Shenzhen Waterworks Co., 2000).

Water Use Category	Tariff (yuan/m^3)	Tariff as of 06/15/00 (yuan/m^3)
Residential Water Use		
Domestic		
30 m^3/household/month or less	0.80	1.50
More than 30 m^3/household/month	1.20	2.00
Collective Household		
6 m^3/person/month or less	0.80	
Between 6 m^3 - 7.2 m^3/person/month	1.00	
Over 7.2 m^3/person/month	1.20	
Governmental, institutional and administrative, sanitation, municipal engineering and landscaping enterprises, non-profit organizations		
Within planned quota	1.10	
100%-120% of quota	1.45	
120%+ of quota	1.65	
Industrial Water Use		
Within planned quota	1.34	
100% - 120% of quota	1.75	
120%+ of quota	2.10	
Commerce, service trade and construction enterprises water Use		
Within planned quota	1.50	
100% - 120% of quota	1.95	
120%+ of quota	2.40	
Foreign vessel water use	3.50	

2.4.4. Water Prices in Beijing

The history of water pricing in Beijing essentially echoes that of the rest of China. Between Liberation and the Cultural Revolution, self-extracted water was free. Only tap water was charged for but at very low rates. In fact, not much change in price occurred until 1980. At the beginning of the 1980s, prices for self-extracted surface water were implemented for the first time. Rates were set at 0.008 yuan/m^3 for industrial, and 0.001 yuan/m^3 for agricultural water (Sun, F., 2000).

Additionally, in 1980 the Beijing Municipal Government and the Beijing Water Savings Office decreed that well water would be publicly managed, and no longer free. At this time there were 3641 wells in Beijing extracting upwards to 0.35 billion m^3 of water (Jiang, 1998). That year a new 0.02 yuan/m^3 water resources fee was charged on well water, with plans for increasing it to 0.10 yuan/m^3 by 1986 (this plan would be doomed to fail until the 1990s) (Jiang, 1998). On August 1, 1988, Beijing implemented the national Irrigation Waterworks Fee Assessment, Calculation and Management Method, and set volume-based irrigation water prices for the first time (Jiang, 1998).

Table 2.17. Beijing's water price schedule, 1983-1998. Please note that blanks indicate missing data – not zeros (Beijing Public Utilities Bureau, 1993, and Sun, F., 2000).

Sector	Beijing 1983	Beijing 1988	Beijing (1988-1991)	Beijing (1991-1998)	Beijing (1996-1998)
Tap water					
Domestic	0.12	0.12	0.12	0.30	1.00
Industrial, Commercial	0.21	0.25	0.25	0.45	1.30
Tourist Hotels			0.60	1.00	2.40
Tourist Guest Houses			0.40	0.60	1.50
Agricultural			0.02	0.05	
Industrial use from river	0.10	0.25			0.65
Government and Institutional	0.18	0.25			1.30
Groundwater	0.02	0.02	0.02	0.10	0.10
Surface water					
Surface water to industry	0.008	0.125	0.125	0.15	
Surface water to waterworks co.	0.005	0.051		0.08	
Urban gardens and agriculture	0.001			0.01 – 0.015	
Wastewater treatment				0.12	0.12

The next significant jump in water price occurred on December 20, 1991 when water rates for domestic users more than doubled. However, costs were still greater than collected revenues. This lack of cost recovery brought about a special public hearing in July 1998, the first of its kind. In this hearing, the Beijing Price Bureau solicited citizen input on raising water prices. "Concerns were raised on both sides of the issue, however, in September 1998, the rates were increased to 1.00 RMB (US $0.12) per cubic meter for domestic and 1.3 RMB (US $0.16) per cubic meter for industrial water use" (Yan and Stover, 1999).

Between September 1, 1998 and May 2000, water prices were adjusted twice. The most current prices are listed in Table 2.18.

Table 2.18. Beijing's water price schedule, 2000 (Beijing Price Bureau, 2000).

Item	Price (yuan/m^3)
Tap water	
Residential Building/ senior citizen's housing/ ecological use/ landscaping / public bathing us	1.30
Commercial use	1.60
Hotel, guest house and office building	1.80
Hotel for foreigners	2.70
Industrial use from river	0.80
Others	
For agricultural purpose	0.20
For luxurious public bathing with the admission fee of more Than 20 yuan per use, car washing industry and pure water producing industry use	3.00
Surface Water	
For Industrial consumption	0.40
For Industrial Injection	0.10
For Industrial recycling	0.08
For agricultural use in food production	0.03
For agricultural use in grain production	0.06
For tap water company use	0.30
For public park, lakes, entertainment and aesthetic use	0.06
Groundwater	
For mineral water and pure water production use	0.60
For other use	0.40
Wastewater treatment	
Domestic	0.30
Industrial	0.50

While these price increases aim at achieving cost recovery, in actuality, production costs have consistently risen faster than price. For example, in the early 1990s, when domestic water tariffs were 0.30 yuan/m^3, the true production cost was 0.42 yuan/m^3 (Beijing Public Utilities Bureau, 1993). When the government raised prices in 1998 to 1.00 yuan/m^3 for domestic water, it would appear as if this problem was solved. However, by that time, production costs had risen to 1.32 yuan/m^3 (Sun, F., 2000). The wastewater treatment fee of 0.10 yuan/m^3 for domestic sewage and 0.30 yuan/m^3 for industrial wastewater could not satisfy the normal operating cost of existing wastewater treatment, let alone build new treatment plants (Sun, F., 2000). Part of the problem is that water price adjustments are infrequent and discreet while costs rise continuously. Jiang (1998) notes that in the 42 years between 1952-1993, water prices in Beijing were adjusted merely 4 times. Table 2.19 shows that between 1985-1989, the supply cost increased about 10.9% per year, but the selling price changed only once. The total effect is that after four years, water production cost has risen 107.8% while water price has increased only 42.5%. Thus the price/cost ratio has actually descended by 65.3% (Jiang, 1998). Not surprisingly, tap water companies have neither the funds to maintain the current water supply infrastructure, nor to build new water supply installations.

Table 2.19. Beijing's water production cost-price ratio, 1985-1989 (Jiang, 1998).

	Production cost (yuan/m^3)	Average water price (yuan/m^3)	Production cost increase from previous year (%)	Total profit (yuan)
1985	0.093	0.153		32,565,600
1986	0.124	0.153	3.3	16,792,700
1987	0.15	0.153	21.0	8,116,500
1988	0.174	0.218	16.0	3,617,200
1989	0.193	0.218	10.9	3,398,100

Tap water prices in Beijing comprise of three components: production cost, taxes, and reasonable profit. About 85% of the water tariff goes to paying for the production of the water, 5-6% is a value-added tax (VAT), 7% is an urban construction tax, and 3% is an educational tax (Beijing Municipal Water Company 1999). Groundwater resource fees include the cost of monitoring, exploration, management, storage and transport (Jiang, 1998).

Over the years, Beijing has developed a fairly sophisticated system of water charges that include constant rates, increasing block rates, and flat fees. Most water prices in Beijing are charged on a constant rate. However, for industrial, commercial and institutional users, a regulation was enacted in 1989 (and revised in 1994) to apply an increasing block rate. Under this system, water users consuming more than 3000 m^3 per month are charged between two to thirty times the regular water price, depending on water source, season, and level of excess (see Table 2.20). While there is talk of plans to implement a similar increasing block pricing system for domestic users, at present domestic users continue to face a constant rate.

There is also an example of flat rate pricing in Beijing: groundwater pricing. On October 1989, the Beijing Municipal Government issued Regulations for Protection and Savings of Groundwater (decree #1) which requires all units opening or expanding wells to pay the Beijing Water Savings Office groundwater resources fees. These fees are a flat rate of 830 yuan/m^3 based on designed flow capacity. Thus, a well designed to extract 2 m^3 of water per day requires a one-time payment of 1660 yuan before the well may be built. However, this flat fee applies only to commercial, industrial, military and other public units (thereby omitting agricultural and domestic users).

Table 2.20. Above-quota rate schedule for Beijing, 1994.

	Cost as percentage of regular price by water use category			
	Standard for additional cost for Tap Water		Standard for additional cost for Well Water	
Level of water use in excess of acceptable planned levels	Regular Season	Summer Season (June-Aug)	Regular Season	Summer Season (June-Aug)
Below 10%	100%	300%	200%	600%
10-20%	200%	600%	400%	1200%
20-30%	300%	900%	600%	1800%
30-40%	400%	1200%	800%	2400%
40%+	500%	1500%	1000%	3000%

Chapter 3: Actors

This chapter describes the actors relevant to water pricing in Beijing, and their mandates and priorities. This information is largely drawn from laws and legislation, as well as general descriptions of duties. More detailed information on these laws is available in Appendix B.

3.1. Explanation of the Choice of Actors

Also known as *stakeholders*, *players* or *benefactors*, actors are parties who are in some way affected by the policy decision. Every policy analysis must first identify these actors. Actors may be directly affected, indirectly affected, positively or negatively affected, and may have power to influence the decision, or not. An example of each of these, in a hypothetical situation involving a decision to build a dam, is presented in Table 3.1.

Table 3.1. Sample of actors in a context with open-process decision-making.

	Power to influence	Powerless to influence
Directly Affected	-downstream rice farmers -downstream city -industries gaining hydropower -hydro power company	-citizens gaining hydropower -wildlife living in upstream forests
Indirectly Affected	-national ministry of economy promoting economy growth	-rice farmers in other areas of the country -out of country taxpayers paying national taxes used for project

This matrix exemplifies the policy-making context in a country with open-process decision-making. In such a situation special interest groups, such as the downstream rice farmers, can form a coalition and lobby the decision-maker towards their own interest. Thus the only groups who are powerless either do not have a voice (such as the natural environment or wildlife), experience too negligible an impact to prompt the formation of a lobby group (such as the citizens gaining slightly more hydropower), or are so indirectly affected that they are unaware of their being affected (such as citizens paying national taxes which are used to fund the project). In a situations with an open-process, groups can act on the behalf of stakeholders without a voice. For example, the World Wildlife Fund could lobby on behalf of the wildlife. Stakeholders who individually fail to perceive a collective impact, are commonly lobbied on behalf of by agencies protecting their interests also. For example, the hydro company would lobby on behalf of the citizens who stand to gain hydropower.

This matrix needs to be slightly revised for a country that does not make decisions based on an open-process, such as China. Non-governmental lobby groups, such as the WWF, ad hoc coalitions of downstream farmers, or groups of tour operators concerned with effects on upstream tourism, no longer have the power to influence, *unless* they have a governmental spokesperson. In many cases they do. For example, in a Chinese context, the National Environmental Protection Agency would have the mandate to protect endangered species, the Ministry of Agriculture would aim to protect agricultural land and farmer livelihoods, and the Ministry responsible for tourism would lobby on behalf of tour operators. The matrix would thus be revised into something such as Table 3.2.

Table 3.2. Sample of actors in a context without open-process decision-making.

	Power to influence	Powerless to influence
Directly Affected	-hydropower company -National Environmental Protection Agency -Ministry of Agriculture / downstream Municipal People's Congress -ministry in charge of the particular industry	-citizens gaining hydropower -wildlife living in upstream forests -downstream rice farmers -industries gaining hydropower
Indirectly Affected	- national ministry of economy promoting economy growth	-rice farmers in other areas of the country -out of country taxpayers paying national taxes used for project

Based on this matrix, this report will assume that all goals and actors are to some degree represented by a government agency, and can thus be accounted for indirectly. Additionally, although China has the reputation of a nation that quashes free speech and public opinion, it nonetheless aims to minimize unrest. Therefore, we can account for the public's goal (for example, the farmer's goal of minimizing losses, which we can denote as

x), within the government's goal to minimize unrest (which we can denote as f(x), or a function of the farmer's goal). In other words, the government's desire to minimize unrest is dependent upon the farmer's desire to minimize crop losses. However, many special interest groups lack governmental representation and thus remain powerless. While it is important to consider such parties, for the most part water pricing is relatively straightforward and does not involve many marginalized stakeholders. This study will therefore only count governmental agencies as *actors* with the presumption that they encompass the objectives of all stakeholders to some degree.

But just because a government agency has some legitimate authority and power to influence the decision-maker, does not imply that all agencies are made the same; or more importantly, granted the same level of power. In fact, Chinese agencies are structured along clear hierarchical lines of power, which will be described in the next section. Later, we examine how these top-down lines of power are sometimes violated through informal mechanisms.

3.2. Organizational Hierarchy

In the analysis of any policy, particularly in a politically-charged state such as China, it is crucial to "map" the lines of authority. Without familiarizing oneself with the empowered officials for the specific context, policy proposals risk being directed to the wrong authorities. As one analyst notes, "it is easy, for example, to end up speaking to a vice mayor of a municipality who in fact has no authority over the specific issues that are on the agenda of the foreign visitor" (Lieberthal, 1997).

3.2.1. Formal Hierarchy

China's governance structure is a multi-layered hierarchy. The various organs within this structure are divided by territory, function, and rank. As a result any policy initiative inevitably involves many separate organizations.

Territory

Figure 3.1 depicts the territorial divisions of government (with arrows leading from order-giving body to order-receiving body). In the case of Beijing (and other provincial-level municipalities), the province level is omitted and the municipal government reports directly to the central government.

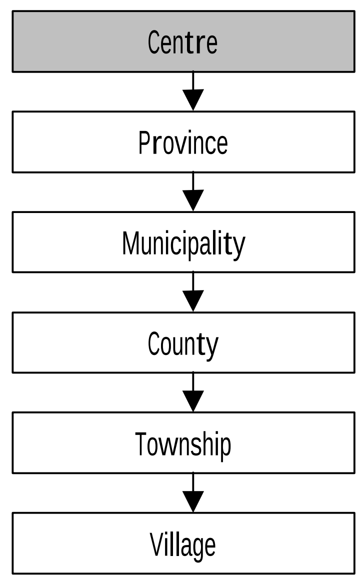


Figure 3.1. Hierarchy of territorial rank.

Function

Special agencies (or *xitong*) are mandated with responsibilities over particular matters. In the case of water resources, relevant functional agencies include the National Environmental Protection Agency (NEPA) and the Ministry of Water Resources (MOWR), to name a couple. These functional agencies are headed by a national-level ministry and have corresponding offices at provincial, municipal, county and village levels.

Rank

Every ministry, agency, bureau, and body within this organization hierarchy is given a rank (see Figure 3.3 for the relevant hierarchical ordering of water-related agencies). There are (from highest to lowest):

- **Executive Level**
  These are the highest branches of national government, and comprise of the National People's Congress (herein known as NPC) and the State Council (herein known as SC) and its Standing Committee. These top leaders are hand-chosen by the heads of the country. The executive bodies in turn appoint the leaders of the commissions and provinces.
- **Commissions**
  One level beneath the executive level are the 29 commissions. The purpose of the commissions is to aggregate interests and reinforce sectoral and regional perspectives. Thus, the head of the energy bureau, for example, would argue with other ministerial heads in the State Development Planning Commission for resource allocations to coal, petroleum, electricity, and nuclear power. In other words, while each ministry promotes its own department, the commission is charged with promoting the aggregation of departmental

interests. These interests are further aggregated in the State Council. "Each vice premier and state councilor is assigned responsibility for a set of sectors or functions, such as agriculture, finance or industries. Although such divisions of responsibility encouraged specialized expertise in policy-making, they also guaranteed that sector and region-based bargaining continued right up to the top of the government hierarchy" (Li, 1998).

- **Ministries**
  Most day-to-day governing decisions are made by China's 40 ministries and 29 commissions. Ministries are functionally-defined departments with local counterparts. They rank below commissions but equal with provincial people's congresses. Ministries are "home to the government bureaucracy and the policy experts for particular issues. Most of these organizations are headed by members or alternate members of the Chinese Communist Party's Central Committee. Much of the operational responsibility for ministries is held by assistant ministers who are often career employees of ministry" (Mastel, 1997). The purpose of the ministry is to lobby and act in favour of its functional responsibility. For example, the National Environmental Protection Agency is given the task of acting in the interest of the environment.
- **Provincial People's Congresses … Municipal People's Congresses**
  At the same level as ministries, the Provincial People's Congress (or in the case of Beijing, the Municipal People's Congress) is the highest level of authority at the provincial level. Provincial governors advocate "for their own territory's interests, they also are mediators of disputes among the autonomous, but interdependent, vertical hierarchies that intersect in their localities. Local leadership engages in this mediation with its own agenda" (Lampton, 1992). In other words, the Provincial People's Congress determines the outcome in conflicts between province-level functional departments, in the same way that the State Council and NPC arbitrate conflicts between national level ministries, commissions, or provincial governments. Similarly at the municipal level, Municipal People's Congresses hold authority over even lower ranked bureaus and agencies. Lampton (1992) describes this process as "an inverted sieve in which issues cannot be resolved at lower levels are kicked up to the next higher level able to negotiate a resolution" (Lampton, 1992). Additionally, provincial governors are authorized to appoint municipal mayors, and municipal mayors appoint county heads, and so on.

Units within the same rank cannot issue binding orders to each other. For example, a national-level ministry (such as the Ministry of Water Resources) holds equal rank with provincial governors and therefore cannot issue direct orders to the province. However, higher-ranking officials, such as the premier, vice premier and national commissions, which all out-rank the provincial governor, can issue authoritative commands. Communications flow up and down this hierarchy level by level – bypassing levels is rare. For example, it is unlikely that the provincial government would ever communicate directly with the county level, skipping the municipal level. This ensures that governments typically only have jurisdiction over the agency directly beneath them.

3.2.2. Legal Hierarchy

3.2.2.1. Relation of Laws to Actors

China's policies, laws, and legislation relate to actors in several ways. First, it is not entirely possible to discuss institutions without mention of policies and laws. As noted in section 1.4, policies and laws are integral parts of China's overall institutional framework. Second, policies, laws and legislation provide descriptions of the duties of various agencies. Legislation therefore allows us to better understand the role of various actors. Finally, policies and laws are often drafted, and in some cases issued, by various actors. In that case, the policy or law acts as a window into the goals of that agency. Figure 3.2 depicts some important actors involved in water pricing and the relationship between the actors and the laws that bind them. It is important to note that local level agencies are subject to the laws and regulations binding their national level counterparts *in addition* to local level regulations. As an example, the Beijing Price Bureau is subject to both the local Beijing Price Method Supervision and Enforcement Regulations and the national Price Law. Additionally, some laws regulate (or are regulated by) more than one agency. For example, the Management Method for Pricing Urban Water Supply involves both the Price Bureau and the Ministry of Construction. For more information on the laws and regulations shown in Figure 3.2, please see Appendix B.

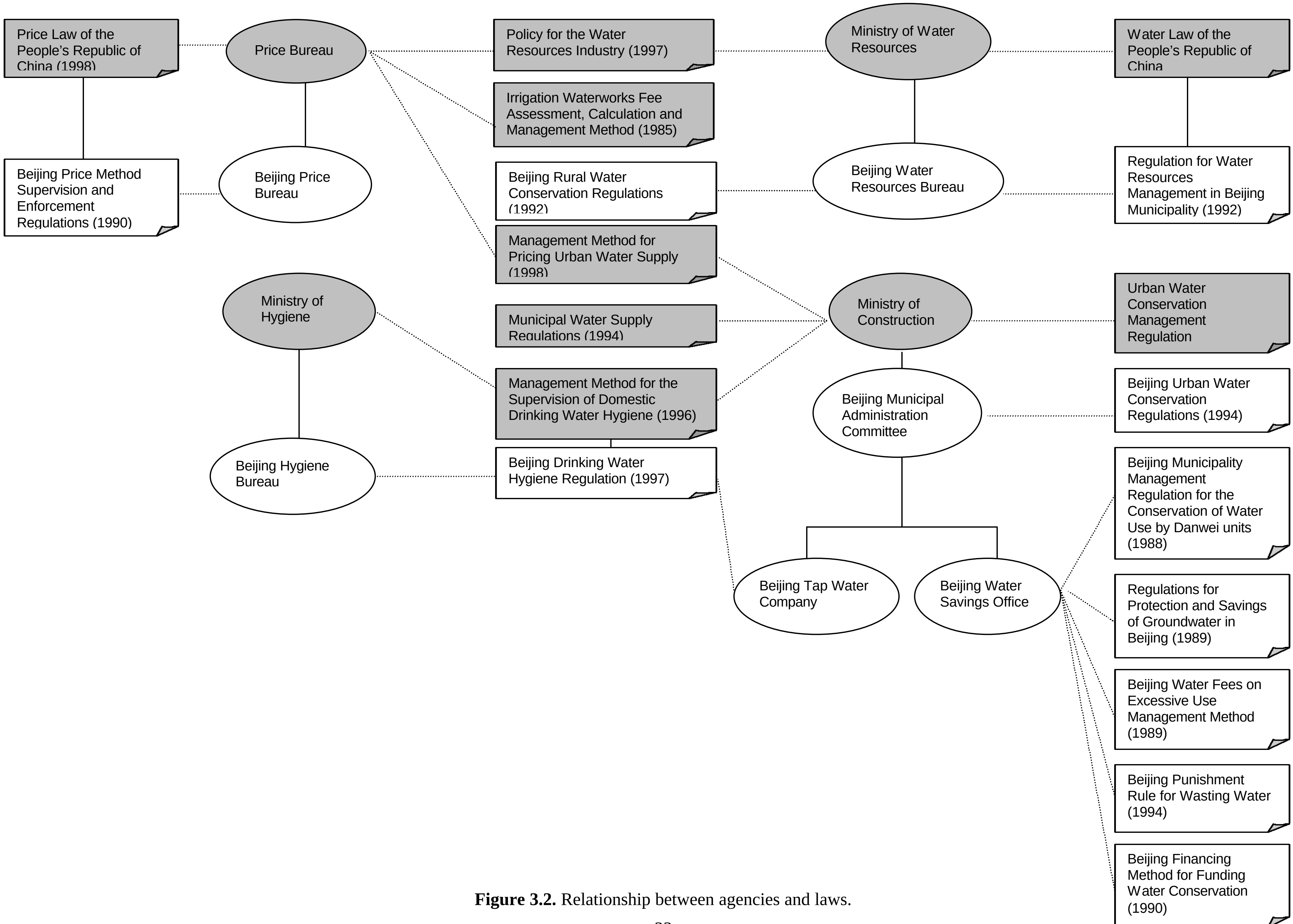


Figure 3.2. Relationship between agencies and laws.

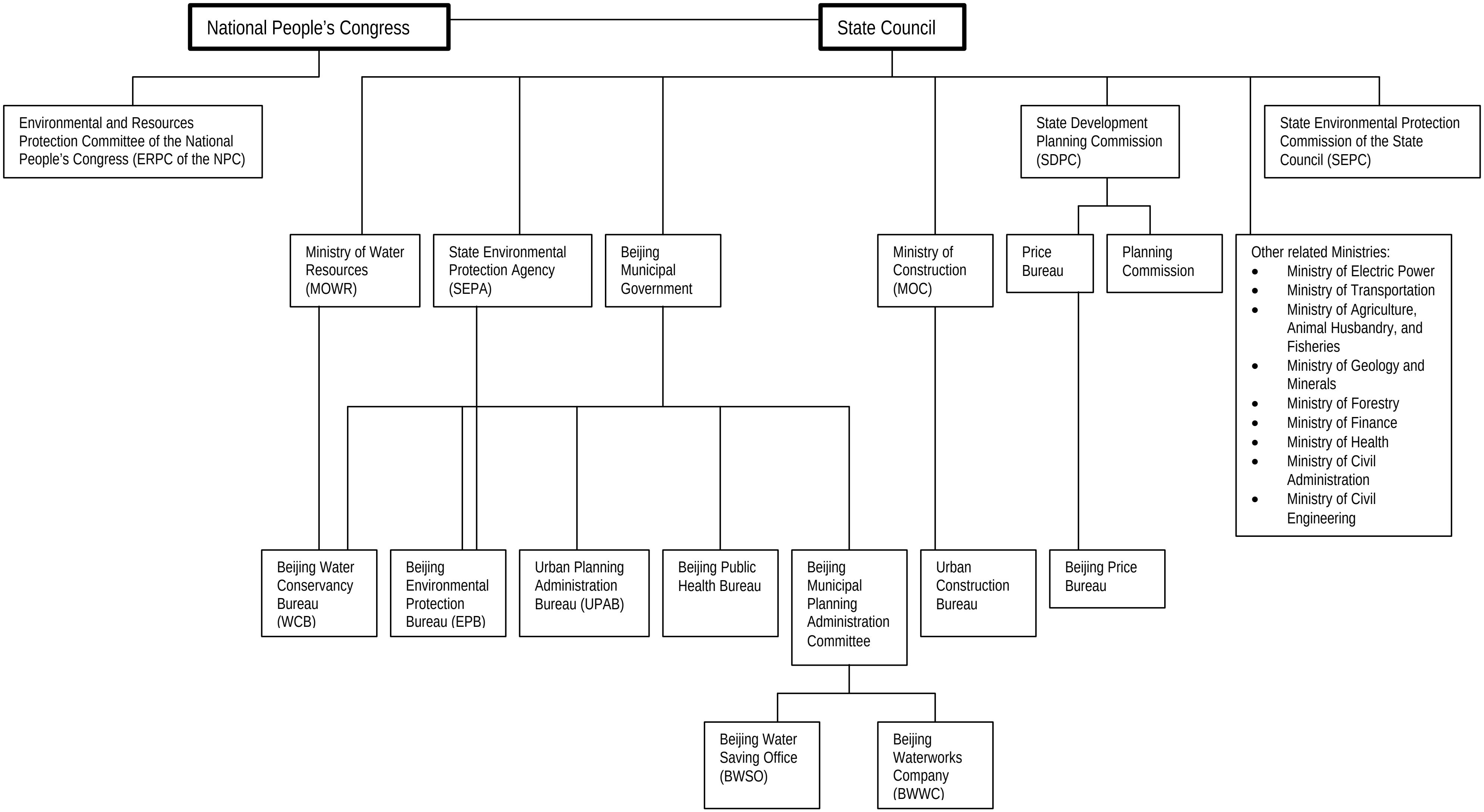


Figure 3.3. Organization chart of water-related agencies in the People's Republic of China.

3.2.2.2. Brief History of Chinese Law

China's history is one in which the power of leaders (whether an emperor or a CCP leader) supercedes the rule of law. Traditionally, laws in China were the instruments of rulers and emperors, written to establish an administrative and punitive system of governance and control, rather than a structured institution that superceded the power of individuals, which is akin to the rule of law via natural rights common to the Western liberal tradition. In essence, the role of law in China is to provide *rule by law* rather than *rule of law*. Chinese culture as a result relies on "moral precept and local custom to resolve many problems that other societies have addressed through public, positive law. Nor has public, positive law been a central means for ordering society throughout much of the history of the People's Republic of China" (Alford and Shen, 1998).

The founding of New China only further reinforced the notion of *rule by law*. In 1949, all existing laws were repealed. "Discretion remained with the political authorities. Domestic contracts were more like declarations of intent than binding commitments... The legal profession virtually disappeared during the Cultural Revolution. The courts had no independence but functioned under the direct control of the Party's legal committees. The courts had only a minimal part to play in resolving economic disputes, which were usually addressed by the industrial ministries" (EAAU, 1997). Additionally, during the 1950s, courts were suspended, the Ministry of Justice was temporarily eliminated and law schools were shut down (Alford and Shen, 1998).

It was not until the 1980s, that China would, for the first time in its history, begin to seriously develop the *rule of law*, according to western liberal traditions.

The Deng Xiao Ping era, beginning in 1978, brought great change to the Chinese legal world. Deng was committed to building a working legal system. The third session of the Eleventh Standing Committee of the CCP proclaimed that "from now on legislation should become the important agenda of the National People's Congress and its Standing Committee" (Pu, 1996). Four years later, the Constitution of the People's Republic of China was enacted, empowering "the NPC's Standing Committee to make legislation, thus putting legislating into high gear. Statistics show that from 1979 to the end of 1995, in addition to the ratification of the current Constitution and its two amendments, more than 280 laws and legal decisions have been made" (Pu, 1996).

These years saw the creation of laws that would lay the foundation of China's environmental legal system. Laws such as the Forestry Law and the Environmental Protection Law defined property rights and distinguished between legal and illegal behavior for the first time. "Prior to this period, property rights and behavioral norms had been only loosely defined and were often subject to arbitrary political redefinition" (Ross, 1988). Additionally, as of the 1980s, the duties and responsibilities of various regulatory agencies were defined through laws and the Constitution (1982).

The past decade has seen further strengthening and legitimization of China's legal system. In the six years between 1993-1998, 152 laws were scheduled for consideration by the NPC, which is astonishing considering that about this same number of laws were enacted in the 44 years between 1949 and 1992 (WB, 1997a). This momentum is fueled by marketization of the economy and the demands of foreign business in China.

Increased trade has led to frustrations for foreigners who complain that a lack of legislative authority creates an air of uncertainty for businesses. "Foreign companies, being from countries having achieved full institutionalization and legalization, will regularly abide by the law, and not by personal or political connections. They will even be resentful toward violations of the law and toward inadequate law enforcement" (Pu, 1996). To appease the business world, the NPC has generated huge volumes of laws, particularly commercial law. As a result, today business disputes may be settled in a courthouse,

Box 3.1. Hierarchical Ordering of Chinese Legislation
The classification according to legal status and force from highest to lowest is as follows (Song, L., 1999):

1. The Constitution of the PRC
2. Basic laws (jiben fa) enacted by NPC
3. Other laws (falu) from NPC Standing Committee
4. Interpretations of the Constitution and basic laws (lifa jieshi) issued by the Standing Committees
5. National administrative regulations and other documents having the force of law issued by SC (xingzheng fagui) made by the State Council
6. Ministerial regulations, national standards (guojia biaozhun) and rules (bumen guizhang) issued by national ministries and commissions
7. Regulations (difang fagui) issued by People's Congresses (and their standing committees) at the subnational level, consistent with national legal enactments
8. Resolutions released by Provincial Governments and their different departments
9. Regulations and other legal orders known as difang zhengfu guizhang issued by the executive branch of people's governments at the subnational level
10. The resolutions and determinations made by local power body and administrative body at different levels below the provincial level
11. Technicality regulations and standards with legal force

or through the central arbitration system, and the legal profession is emerging with the number of new graduates increasing yearly.

3.2.2.3. Hierarchy of Chinese Legislation

Chinese laws are arranged in a hierarchical ordering, in which laws of a higher level always supercede the laws of a lower level when there is a conflict. Lower level laws must be as or more stringent than higher level laws, but may not be less stringent. Legislation ranges from the Constitution of the People's Republic of China at the top, to local methods and technical standards, at the bottom (see Box 3.1).

In general, laws are of the highest order. Laws may be promulgated only by the National People's Congress (and its Standing Committee). They include basic laws such as the Criminal Law of the PRC (1997), and regular laws, such as the Water Law of the PRC.

Beneath laws are regulations. These are issued by the State Council and its ministries, and tend to be more technical and specific than laws. Local laws and regulations are often based on national laws and seek to implement national laws.

Rules, resolutions, standards and methods rank lower than regulations. Ministries and agencies under the State Council may formulate these. Rules tend to be more administrative and methods more technical, while standards provide numerical bases for compliance that must be used in reference to regulations, rules and methods. As of 1998, over 100 environmental rules and methods, and 350 standards have been issued, primarily by local government.

3.2.2.4. Policy-Making Process

In section 3.2.1 we learned that policy-making in China is akin to an inverted sieve. Lampton (1992) describes policy-making in China as *management by exception*. "At each level of the organisation hierarchy, agency representatives make decisions by a rule of consensus. If they all agree, the decision is automatically ratified by the higher level. If the bureaucrats cannot reach consensus, then the decision is referred to the higher levels, and if the higher levels cannot agree, then either nothing happens or the ultimate principal, the Communist Party, intervenes to impose a solution" (Lampton, 1992). But understanding the details of policy-making process in China is much like tracing the movement of a single blood cell through the entire human body; the journey is time-consuming, involves a network of organs, and the specific route depends on the situation.

In general, procedures vary depending on whether it is a policy, law, or regulation being formed. Different administrative bodies are granted the authority to create statutes of various levels. In the case of water pricing, we are interested in the formation of (a) national water laws or policies, (b) methods to determine water prices, and (c) local water prices.

The NPC and SC are responsible for adopting national laws. The highest-level national laws may only be enacted and amended by the NPC or its Standing Committee, upon the ultimate approval by the Chinese Communist Party. Fundamental laws (such as the Civil Law) and the Constitution may be enacted or amended only by the NPC. The NPC also holds the power to annul decisions which it deems in appropriate made by its Standing Committee.

Box 3.2. Making national laws and the role of the Environmental Protection Committee (EPC)

Before the founding of the EPC, the law-making process proceeded somewhat as follows: legislative drafts are first prepared by relevant government ministries (such as Ministry of Water Resources or Ministry of Construction). It may take several years for the ministry to conduct research. The draft is then reviewed by the State Council's Bureau of Legislative Affairs which consults other related ministries and agencies on the matter. Once other ministries have made changes and all ministries agree on a final draft, the State Council approves the draft. It is then submitted to the NPC for consultation and potential passage (Zhang and Ferris, 1999a). The Communist Party of China would give or withhold approval at this point. This process is long and drawn-out, often taking years before laws are adopted. For example, the water pricing-related regulation *Policies for the Water Industry* required more than ten years to pass, and the regulation for water drawing permits took more than five years.

In 1993, nine special committees on various issues (including the EPC) were founded in the National People's Congress. These committees take the place of the ministries in preparing legislative drafts or revisions for review by the Standing Committee. While there is no committee exclusively designated for water resource issues, the EPC drafts environmental laws, including those pertaining to water environments. The purpose of these committees is to save time. This is achieved by having a team of experts within the NPC who write drafts and directly submit them, thereby reducing the number of time-consuming and repetitive consultations with each and every subsidiary ministry or agency. However, the degree to which these committees speed things up is unclear as "it is still common practice to obtain comments and suggestions from relevant government ministries and agencies. Thus, while drafting responsibilities are concentrated within the committees, involvement of ministry and agency representatives is still necessary to build sufficient consensus for passage and sound implementation of the legislation in question" (Zhang and Ferris, 1999a).

National methods for water pricing are medium-level legislation. National water pricing methods are instigated by the Ministry of Construction, the Ministry of Water Resources, and/or the State Development Planning Commission, depending on the target of the method. These ministries draft the method and justify it to the State Council who decides whether or not to enact it. Again, relevant agencies would be invited to provide feedback on the proposed plan, before the State Council ratifies it.

Local laws and regulations are promulgated by local People's Congresses (such as the Beijing People's Congress) and their standing committees. Local laws that conflict with the Constitution or other higher level laws may be annulled by the Standing Committee of the NPC. Local standing committees have the power to annul decisions made by progressively lower level levels of government. However, it is rare for regulations to require annulment as "most rules and regulations formally require the consent of the Party and higher levels of government prior to enactment" (EAAU, 1997).

In the case of water prices, the Beijing Tap Water Company, in conjunction with the Beijing Municipal Planning Administration Committee, conducts studies to justify proposed price changes. The Beijing Price Bureau and the Beijing Municipal Government then review the submission. Other agencies that may be affected by proposed changes are invited to voice their concerns and opinions. Recently, members of the general public were invited to contribute to the discussion. After any necessary adjustments are made, the Beijing Price Bureau adopt the new changes, on the approval of the Beijing People's Congress.

While this process sounds structured, in fact it is very informal and flexible. Reforms have allowed each territorial level some flexibility, which is not codified in law or constitutions. This flexibility empowers bureaucracies at various levels to negotiate and bargain their positions (see section 4.2).

3.3. Short-List of Major Actors

Figure 3.3 displays all the agencies with relevance to water pricing in Beijing. From this list, a short-list of the primary actors is generated. These actors are described in sections 3.3.1 to 3.3.10 and listed in table 3.3.

Table 3.3 ranks the actors according to their position in the hierarchical system. In the second column of this table, each actor is assigned a rank, according to the ranks listed in section 3.2.1. These were (from highest to lowest) executive, commission, ministerial (and Ministerial-level such as the Beijing Municipal Congress), and local (in our case, municipal level agencies will be considered local). For the purpose of our analysis, commissions were omitted because they oversee several ministries with varying mandates and act as intermediaries. Thus they do not hold clear objectives and goals themselves. The third column in Table 3.3 highlights the key concerns of each actor. The last column lists the sources from which these concerns were derived.

Sections 3.3.1 to 3.3.10 provide brief descriptions of each actor. For more details on these agencies, please consult Appendix C. You will notice in comparing Appendix C with the shortened list of actors in Table 3.3 that some actors (such as the NEPA) have been omitted altogether. This is because these actors have only a very weak relevance to water pricing. Other actors have been merged (such as the MOA and the Beijing Agricultural Bureau) to eliminate overlap or duplication. In these cases, the local counterpart has remained. This is because water pricing is essentially a local issue between local counterparts, and because local bureaus can more or less represent national ministerial interests. Only two national level agencies remain, the Ministry of Water Resources and the Ministry of Construction (herein designated the MOWR and MOC, respectively). These ministries are included because they provide water-related services to Beijing that are non-localized. For example, plans for water supply expansion are regional or national (e.g. the South-North Transfer project), and thus the MOWR must be considered a key player in determining Beijing's water pricing. Another reason to include these ministries is that their mandates may be in discordance with local government mandates, and thus their local counterparts have trouble implementing their policies. For example, the MOC enacted detailed water pricing methods which have yet to be adopted by their local counterparts. Finally, keeping these two ministries emphasizes their particular importance in establishing water-pricing policy, with the MOWR responsible for rural pricing, and the MOC responsible for urban.

3.3.1. Central Government (NPC and SC)

The central government is represented by the National People's Congress and the State Council, which are the highest organs of state power. The central government holds ultimate power to overturn any decisions made by lower levels of government. The goals of the central government are largely determined by the goals of powerful individuals within the executive and CCP. The goals and objectives of the executive level are evident in national Five Year Plans.

3.3.2. Ministry of Water Resources (MOWR)

As the functional department responsible for unified national water resources management under the State Council, the Ministry of Water Resources is responsible for national, regional, and inter-provincial water resources planning, irrigation, rural water supply, flood control planning, water quality planning, water savings, and large-scale water projects.

3.3.3. Ministry of Construction (MOC)

As the functional department responsible for the overall administration of the construction sector under the State Council, the Ministry of Construction is in charge of control and construction of municipal water supply and wastewater treatment facilities. The MOC administrates and controls the tap water companies and is therefore responsible for their viability. Additionally, the MOC controls the Water Savings Offices and is thus responsible for water conservation.

3.3.4. Beijing Municipal Government (BMG)

As the highest level of government at the municipal level, the Beijing Municipal Government holds the same level of power as national-level ministries. All local level bureaus must seek funding and ultimate approval for plans and policies from the BMG. The BMG is responsible for provincial duties such as planning, surveying, designing, constructing, operating, and managing irrigation, drainage, flood control works, and rural hydropower. It is also responsible for county and municipal tasks, such as constructing and maintaining canals, irrigation and flood control structures, and medium-sized reservoirs. The goals of the BMG are largely revealed in Beijing's Ninth Five Year Plan.

3.3.5. Beijing Water Resources Bureau

As the water administration bureau of the BMG, this local level branch of the MOWR is responsible for the unified management of the municipality's water resources. It transcribes the MOWR's responsibilities to the local level. While its role is to act as the local counterpart to the MOWR, it reports directly to the BMG.

3.3.6. Beijing Price Bureau

This local-level agency monitors prices in Beijing and gives final approval for any price changes (including water price changes). The goals of this bureau are largely determined by national and local level price laws.

3.3.7. Beijing Waterworks Co. (BWWC)

Founded in 1910, the Beijing Waterworks Company provides the city with its tap water and operates the tap water system outlined in section 2.2.6. Additionally, it is responsible for overall urban water supply planning and issuance of licenses for water extraction by major users.

3.3.8. Beijing Water Savings Office (BWSO)

The Beijing Water Savings Office holds the purpose of "improving urban water conservation, protecting and reasonably using river water sources, and promoting national social-economic development" (Art. 1, Urban Water Conservation Management Regulation, 1998). This is achieved by encouraging water savings through programs such as quotas, fees, education, and water use planning.

3.3.9. Beijing Hygiene Bureau

This bureau works closely with the Beijing Waterworks Company to ensure that Beijing's tap water meets drinking water quality standards according to national regulations. Duties of this bureau include issuing hygienic licenses to the tap water company for new water supply systems, and inspecting and approving expansion or reconstruction of existing supply systems.

3.3.10. Beijing Agricultural Bureau

As the Beijing-level counterpart of the Ministry of Agriculture, the Beijing Agricultural Bureau aims primarily at ensuring national food security and protecting local rural livelihoods. Some duties of this bureau include formulating and implementing development strategies, programs, and policies, applying economic and noneconomic measures to ensure the rational allocation of resources, and otherwise providing support to the Beijing agricultural sector.

Table 3.3. Short-list of actors.

Agency	Rank	Primary Mandates	Primary documents revealing goals
Central Government (NPC and SC)	Executive	• Overall economic and social growth and development of China	• Five Year Plans • Agenda 21 • Constitution of the PRC
Ministry of Water Resources	Ministerial	• Large-scale water supply • Water conservation • Expansion of irrigation	• Water Law • Irrigation Waterworks Fee Assessment, Calculation, and Management Method • Policies for the Water Resources Industry
Ministry of Construction	Ministerial	• Large-scale urban infrastructure, including water supply infrastructure • Cost recovery for tap water companies • Water conservation	• Urban Water Conservation Management Regulation • Management Method for the Supervision of Domestic Drinking Water Hygiene • Municipal Water Supply Regulations
Beijing Municipal Government	Ministerial-level	• Overall economic and social growth and development of Beijing	• Beijing Five Year Plans
Beijing Water Resources Bureau	Local	• Rural water supply for Beijing • Conservation and management of water use in Beijing's agricultural sector	• Regulation for Water Resources Management in Beijing Municipality • Regulations of Rural Water Conservation in Beijing
Beijing Price Bureau	Local	• Ensure prices meet national objectives • Set and enforce prices	• Price Law of the PRC • Beijing Price Method Supervision and Enforcement Regulations
Beijing Waterworks Company	Local	• Provide urban tap water • Ensure self-sufficiency and water quality	
Beijing Water Savings Office	Local	• Promote water conservation and water use regulation	• Urban Water Conservation Management Regulation • Beijing Urban Water Conservation Regulations • Regulations for Protection and Savings of Groundwater in Beijing • Beijing Municipality Management Regulation for the Conservation of Water Use by Danwei units • Beijing Water Fees on Excessive Use Management Method • Beijing Financing Method for Funding Water Conservation • Beijing Punishment Rule for Wasting Water
Beijing Hygiene Bureau	Local	• Ensure water quality meets drinkable standards	• Management Method for the Supervision of Domestic Drinking Water Hygiene • Beijing Drinking Water Hygiene Regulation
Beijing Agricultural Bureau	Local	• Develop agricultural production to meet market needs • Ensure stable food security • Prevent farmer poverty • Prevent environmental deterioration	• Agenda 21 • Five Year Plans • Beijing Five Year Plans • Agricultural Law

In the next chapter, the relations between these actors will be described and quantified. The policies, mandates and goals of these short-listed actors will act as the foundation for the goals and objectives of our policy analysis, as detailed in chapter 5.