NINE DRAGONS, ONE RIVER:

The Role of Institutions in Developing Water Pricing Policy in Beijing, PRC.

by

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Abstract

Water prices in Beijing have experienced growth over the past few years, but remain "cheap" considering the cost of supply and lack of resources. This paper uncovers the role of institutions (defined by formal aspects such as laws, regulation and policies, government departments and hierarchies, and informal aspects such as history, personal and bureaucratic motivation) in determining and implementing water pricing policy and water price reform.

While this paper is primarily descriptive, it is formulated as a multiple criteria decision-making analysis. In determining actors and objectives for this analysis, the institutions surrounding the issue of water pricing are explored to understand and describe their function, the incentives they are influenced by, the goals they aim for, and how these goals fit in the wider context of national priorities. Various alternatives derived from water pricing theory are then tested to determine how well they achieve the goals laid out.

Through this process we come to the conclusion that the implementation of higher, market-based water prices is inevitable, given the aims of local and national government alike. Further, the rising of water prices correspond with a change in national ideology from communist, egalitarian principles, to market-based, market socialist principles.

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Preface

The title of this thesis, "Nine Dragons, One River: The Role of Institutions in Developing Water Pricing Policy in Beijing, PRC" was inspired by the Chinese *chengyu* (four character saying) "nine dragons, one river." I first heard this *chengyu* during an interview with a civil servant working in the Beijing Environmental Protection Bureau. He said that the nine dragons represent the nine ministries responsible for water resources in China (Ministry of Water Resources, National Environmental Protection Agency, and Ministry of Geology and Minerals, to name a few) fighting for control over the symbolic river of China. I chose to include this *chengyu* in the title for several reasons. First, it emphasizes the importance of institutions in water resources management. Second, it denotes agency coordination and conflict problems through the imagery of nine dragons fighting for control of a single river. And finally, it is distinctly Chinese, both in the imagery of dragons, and in the fact that it is a Chinese *chengyu*. Similarly, this paper covers many institutional issues which too are distinctly Chinese.

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For my family, wherever they may be.

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.

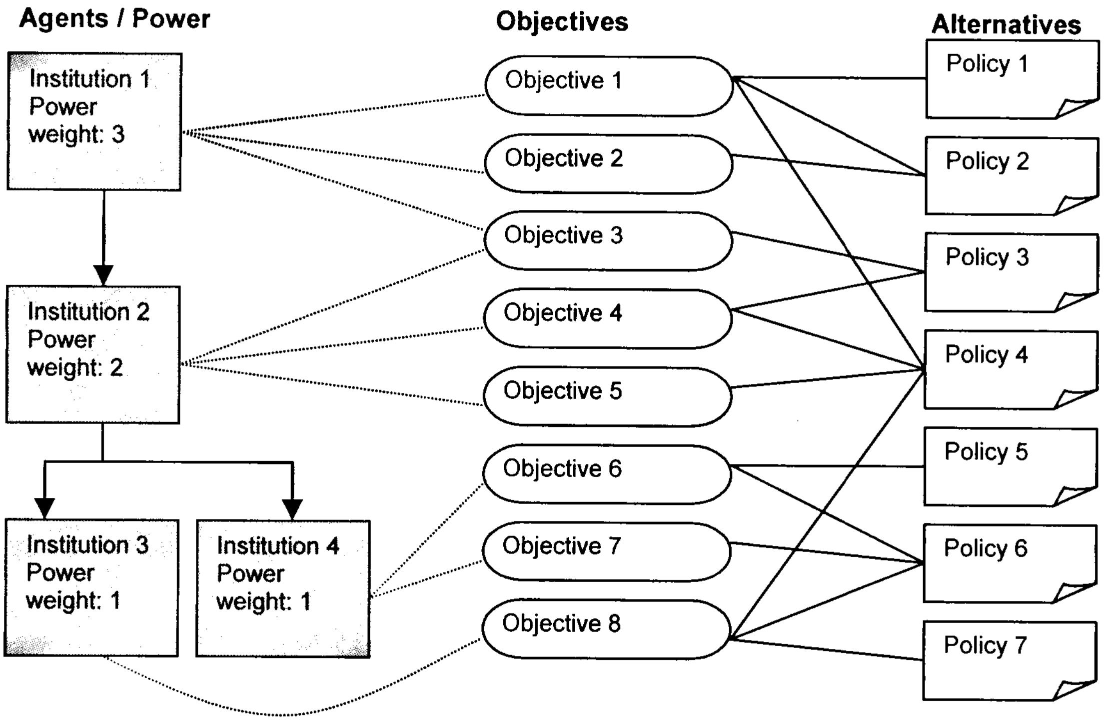


Figure 1.1. Framework diagram.

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.

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

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.

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°20' – 117°30' east, and the latitude is 39° 25'-41°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 °C, with a range from -2.8°C in winter to 42.6°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

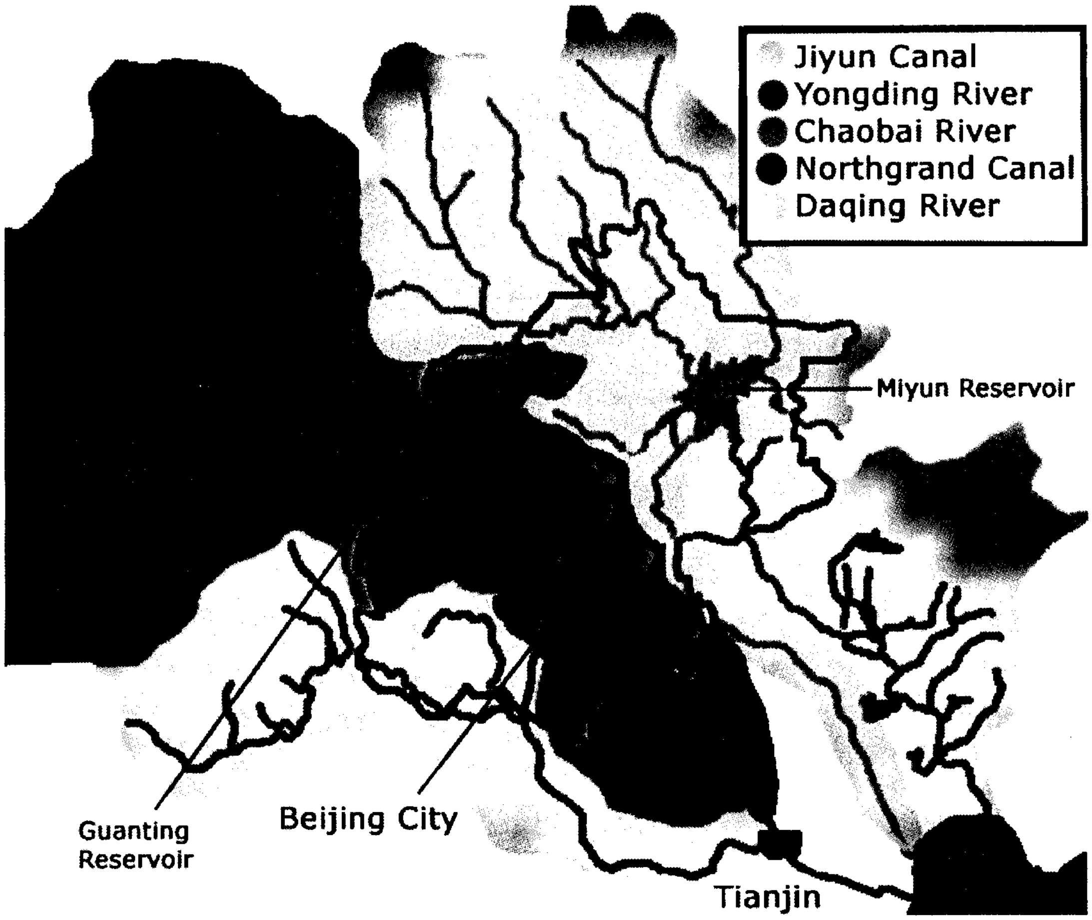


Figure 2.1. The five major river watersheds of Beijing. The black outline denotes the Beijing administrative boundary. Beijing City is denoted, also in black, within the larger boundary. Note the city of Tianjin to the southeast of Beijing.

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).

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.

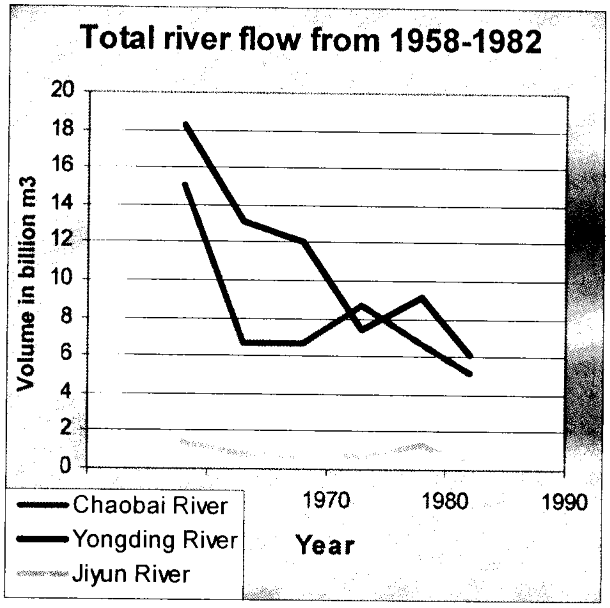


Figure 2.2. Total river flow volume of the Chaobai, Yongding, and Jiyun Rivers, 1958-1982 (from Jiang, 1998).

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**

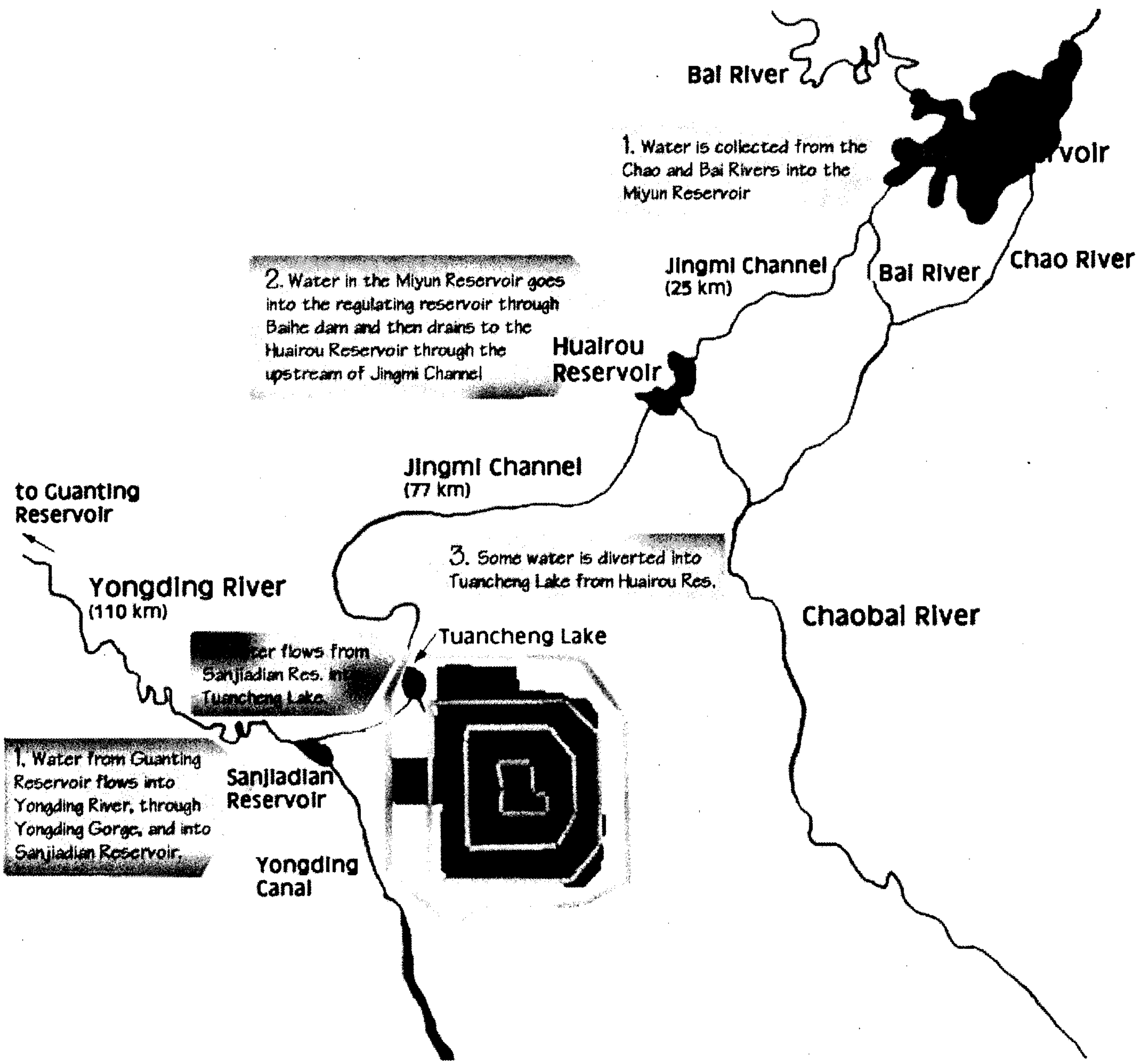


Figure 2.3. Beijing's primary surface water drinking system.

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).

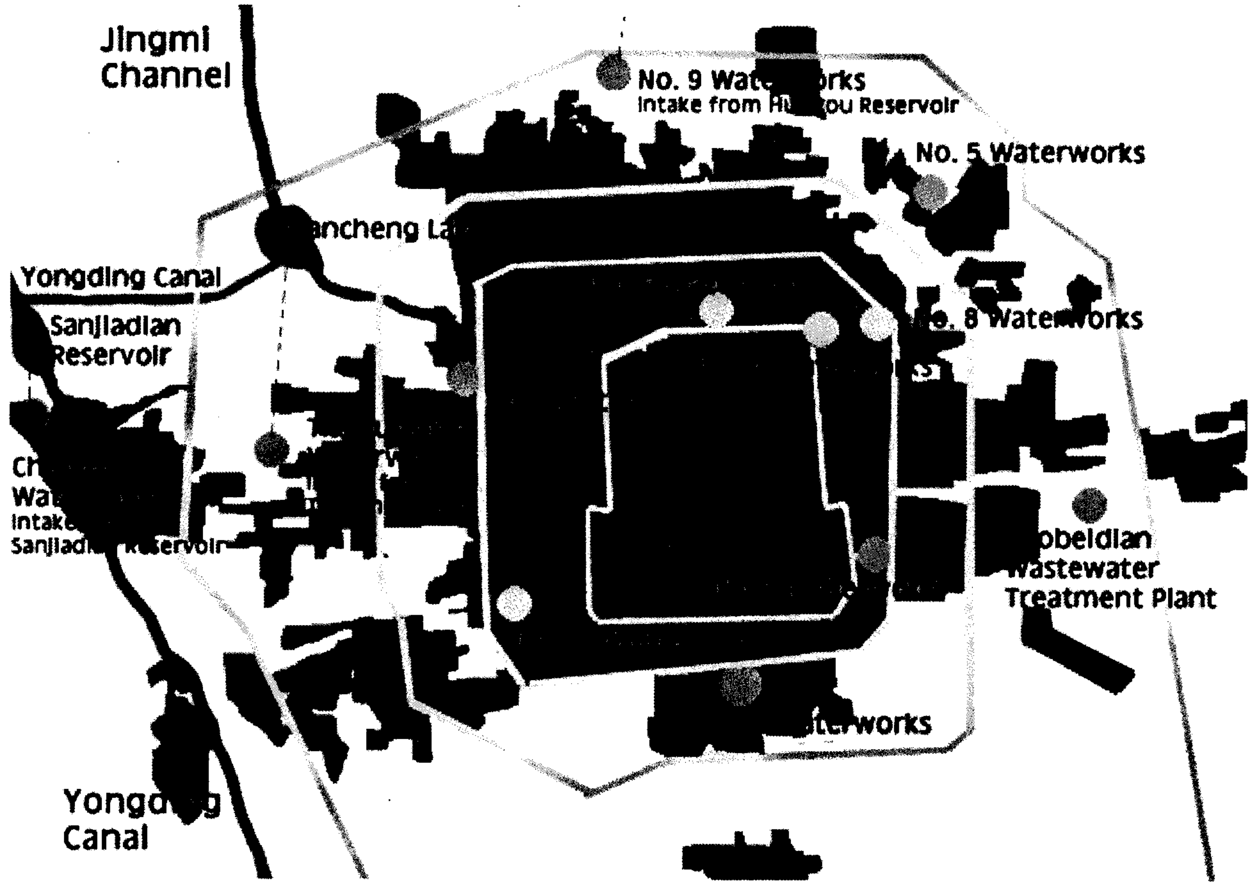


Figure 2.4. Waterworks in Beijing's urban core.

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).

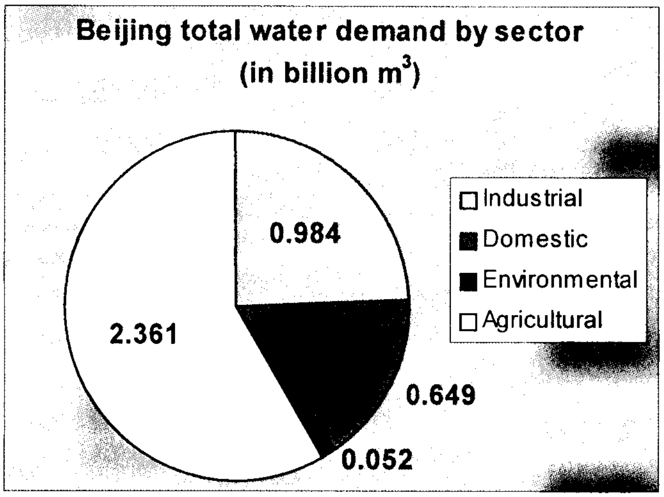
2.3. Water Demand in Beijing

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.

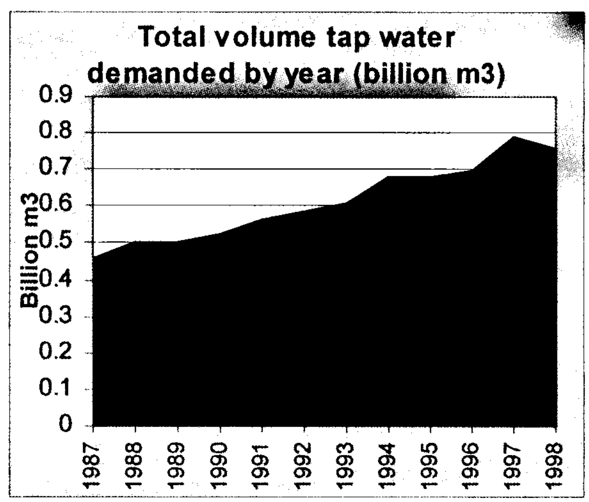


Figure 2.6. Total volume of tap water demanded in Beijing from 1987-1998 (Beijing Municipal Statistical Yearbooks, 1988-1999).

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.

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**

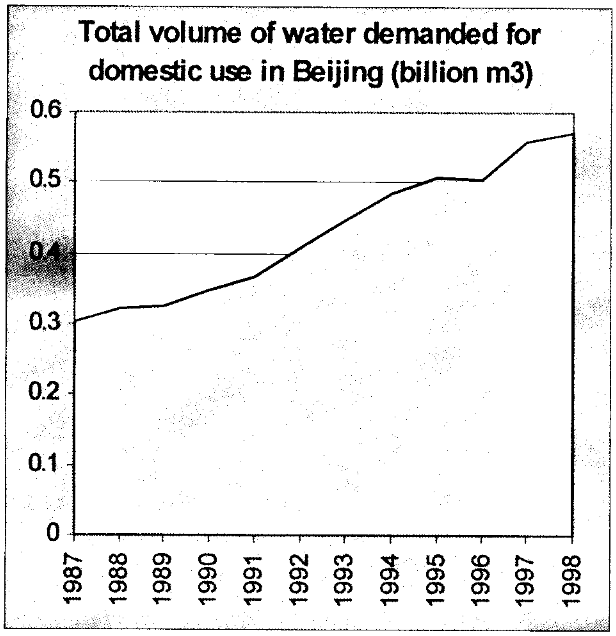


Figure 2.7. Total domestic water demand in Beijing, 1987-1998 (Beijing Municipal Statistical Agency, 1982-1999).

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).

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

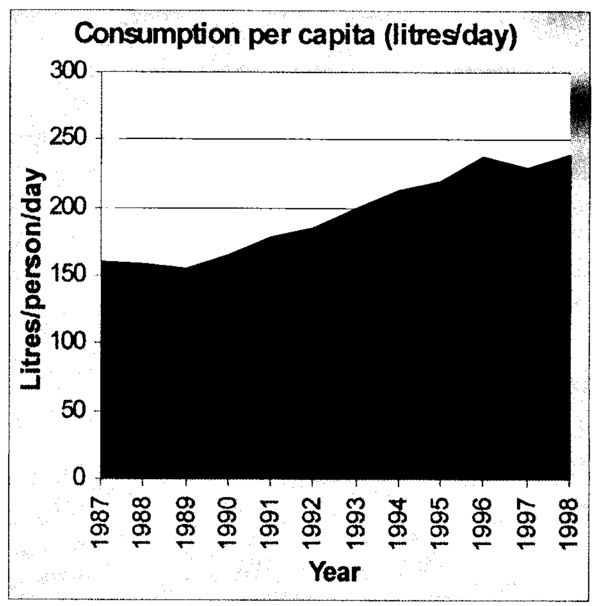


Figure 2.8. Beijing domestic water consumption per capita from 1987-1998 (litres/day) (Beijing Municipal Statistical Agency, 1988-1999).

[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.

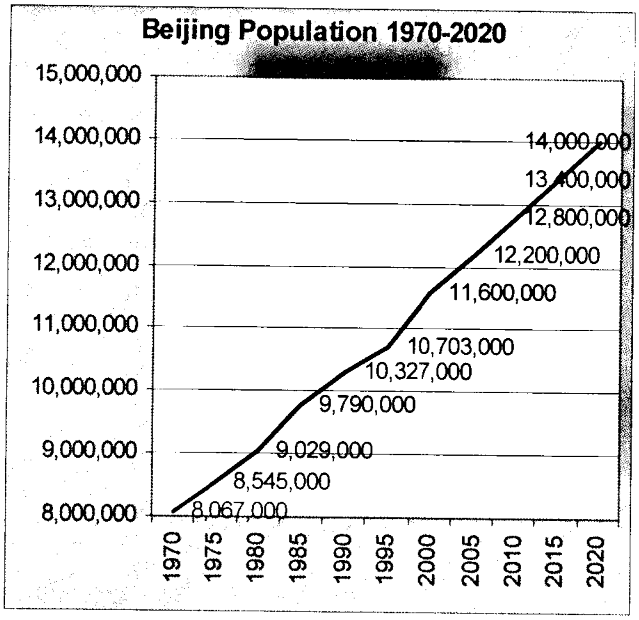


Figure 2.9. Population of Beijing Municipality, 1970-2020 (Beijing Municipal Statistical Agency, 1988-1999 and Beijing Public Utilities Bureau, 1993).

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.

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

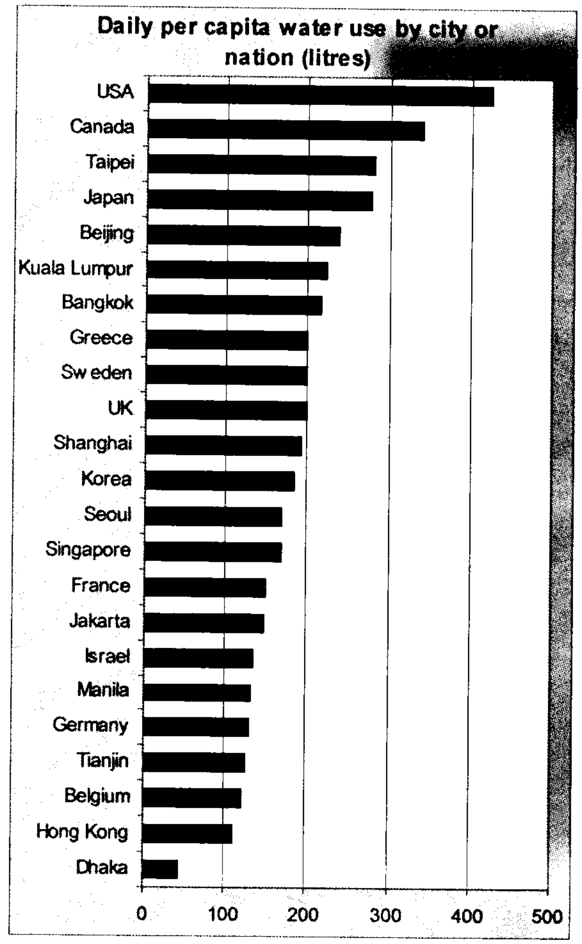


Figure 2.10. Per capita water consumption in other cities and nations from the 1990s (in litres/day) (Chreod, 1999, Borch, 1995, OECD 1999).

[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.

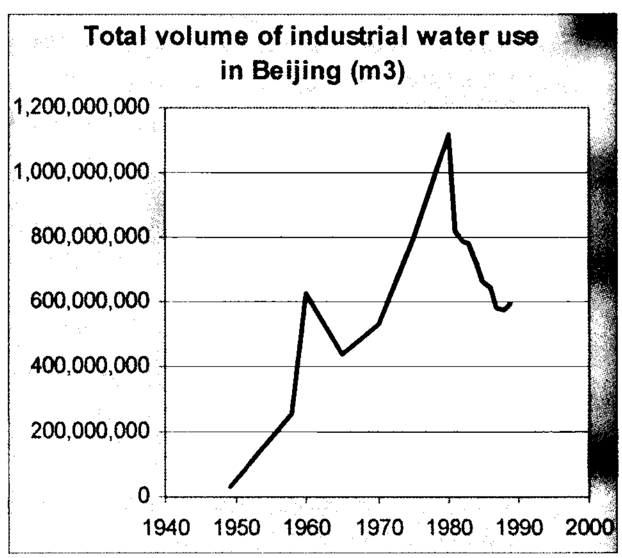


Figure 2.11. Total volume of industrial water use in Beijing, 1949-1989 (Jiang, 1998).

[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).

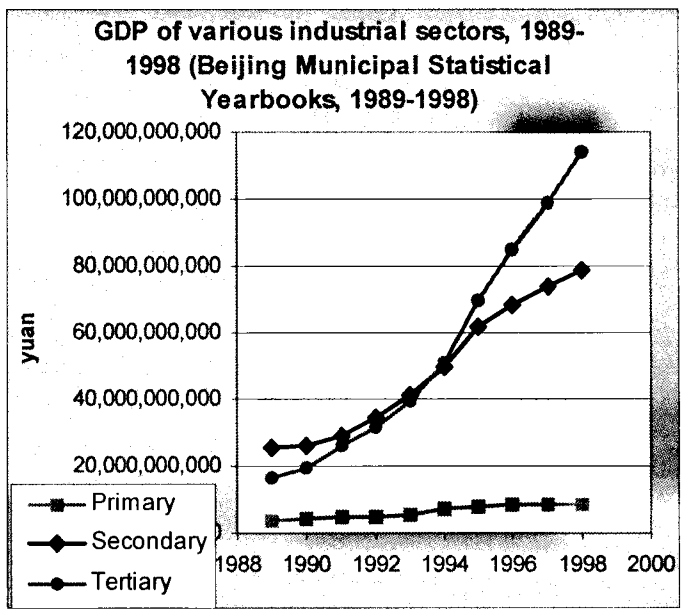


Figure 2.12. GDP of various industrial sectors in Beijing, 1989-1998 (Beijing Municipal Statistical Agency, 1989-1999).

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).

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).

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

Direct Water Consumption by Industry (m³ / 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**

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.

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.

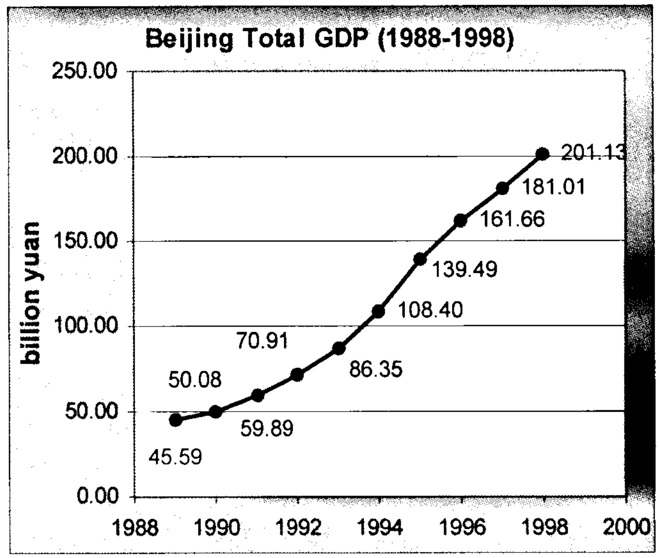


Figure 2.13. Beijing GDP, 1988-1998 (Beijing Municipal Statistical Agency, 1989-1999).

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.

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

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.

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/m³) 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/m³.

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 m³ per year, while in 1993 it was 3.43 billion m³, and in 1980, 3.581 billion m³ (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).

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

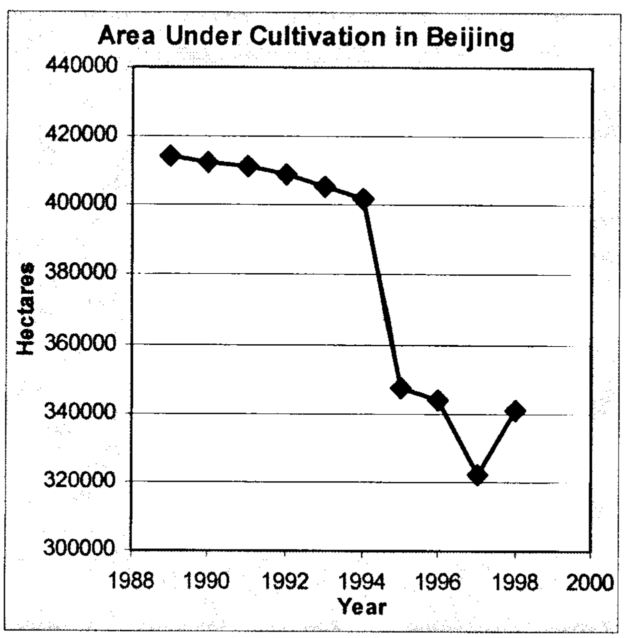


Figure 2.14. Area under cultivation in Beijing, 1989-1998 (Beijing Statistical Agency, 1990-1999).

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 drove up the real costs of new supplies by over 7 percent per year. Recognizing an imminent water crisis, some

[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).

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.

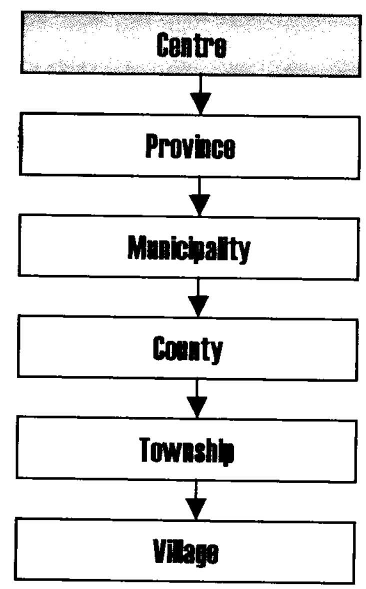


Figure 3.1. Hierarchy of territorial rank.

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.

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.

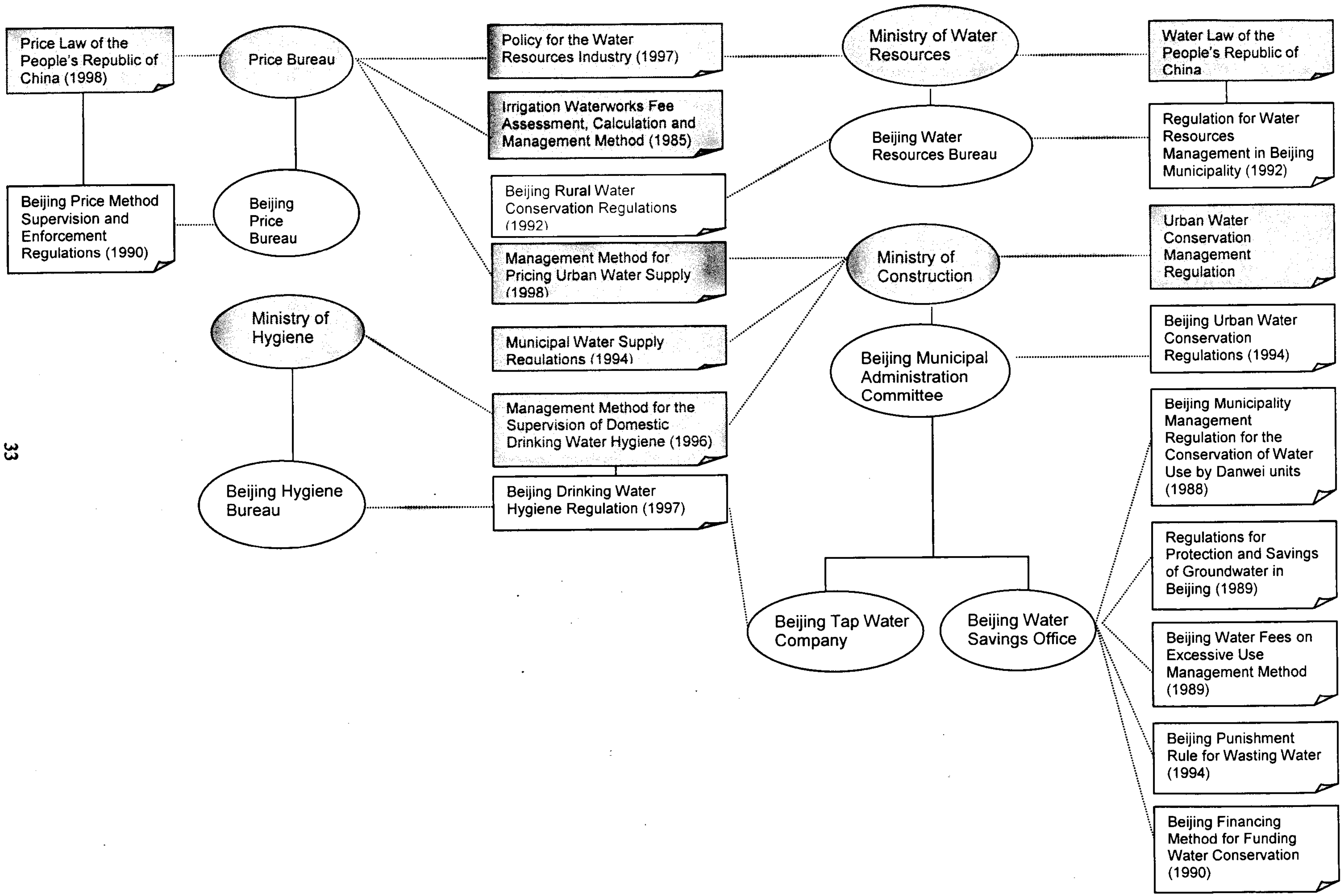


Figure 3.2. Relationship between agencies and laws.

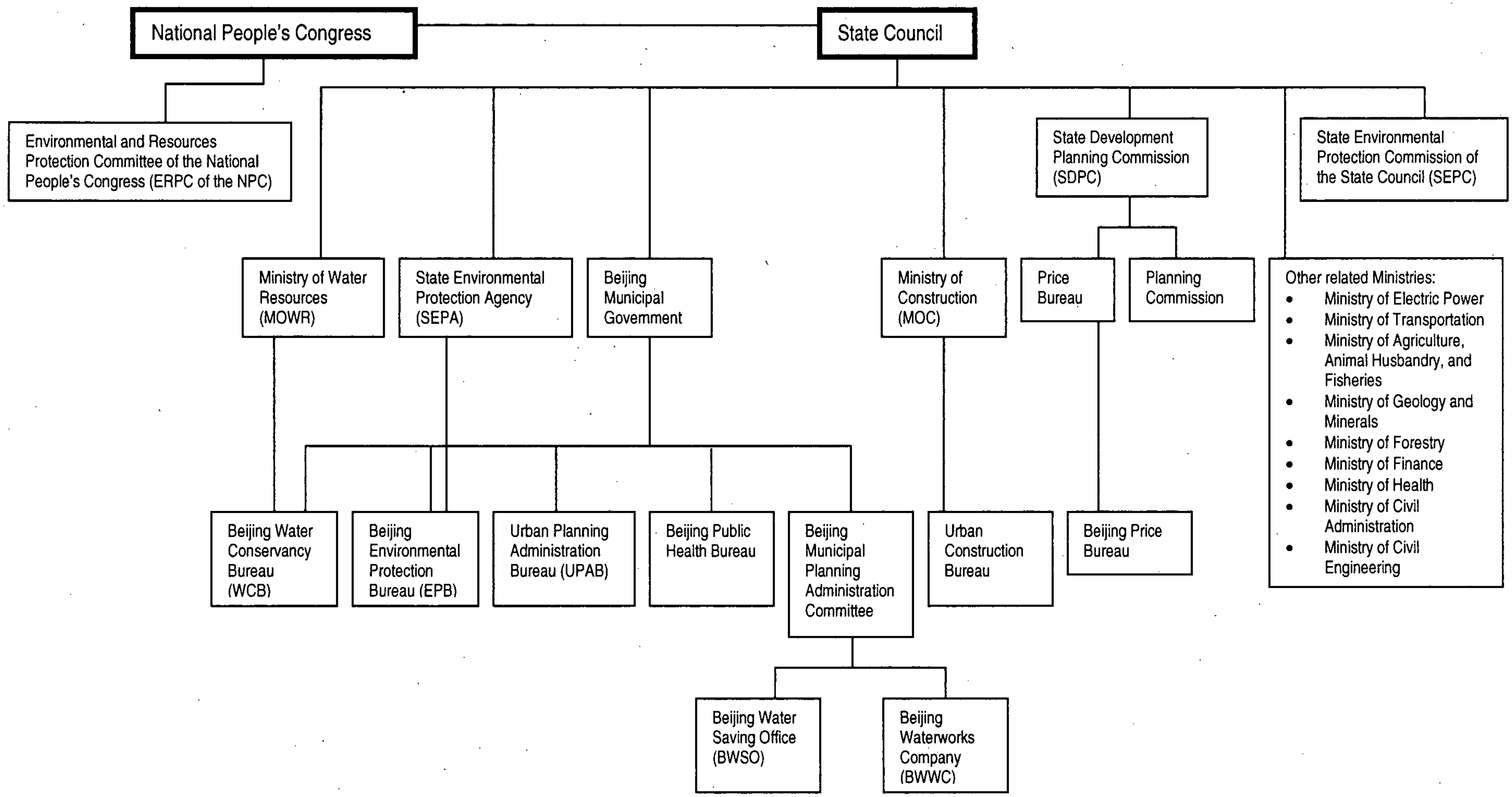


Figure 3.3: Organization of water-related governance in the People's Republic of China

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 non-economic 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.

Chapter 4: Power

In the previous section, we described and short-listed the agencies relevant to water pricing in Beijing. In a typical policy analysis, satisfied with our description of the actors involved, we would continue to examine their objectives. However, this study includes the added element of a weight into the decision equation. More specifically, it considers the implementability of policies based on the power level of the actor involved.

In examining power structures, it is important to remember that actor behavior is determined by incentives. There are formal incentives, such as those codified in regulations and laws, which establish formal power structures. And there are informal incentives, which stem from informal arrangements (such as customs and codes of behaviour) and personal objectives, which lead to informal power structures.

Power may be manifested in several ways. First, individuals may hold power. Certain actors within organizations may have more influence over matters than others. For example, a ministry with an influential minister with close ties to executive members is more likely to have stronger influence than one without. Unfortunately, lack of research on individual Chinese politicians, primarily due to difficulty in accessing information, forces us to omit this factor from our analysis.

Power is also held by agencies. This power may stem from a formal or informal setting. Formal power is granted through national constitutions, laws, legislation, policies, methods etc. In China, formal power is manifested in the hierarchical ordering of organizations within China's bureaucratic structure as introduced in Chapter 3. Additionally, the formal power of an agency is determined by "the duties and regulations governing each position and office, the relation of all positions to one another, and the formal rules and recognized practices" (Britan and Cohen, 1980).

Informal power stems from social interactions occurring outside formal roles: subculture groups that influence people through norms, sentiments, cliques and status seeking. These social interactions may lead to problems such as bureaucratic inefficiency and poor coordination, which weaken an agency, or they may lead to the use of *guanxi*, corruption, or other informal tools to empower the agency. Thus informal power can aid the fulfillment of formally defined goals, or hinder their achievement.

4.1. Formal Power Ranking

In Chapter 3, a short-list was created, which slotted actors into one of three hierarchical rankings (listed in Table 4.1).

Table 4.1. Formal hierarchical designation.

Actor	Formal Hierarchical Designation
Executive level bodies	High
Ministerial level bodies	Medium
Local level bodies	Low

In this section, we attempt to quantify these ranks and set weights based on them. It is clear that the executive level outranks the ministerial level, which outranks the local level. To estimate the weight imposed by formal hierarchical rankings, we apply an outranking method known as an *Analytical Hierarchy Process* (AHP) (see Appendix D for an explanation of how it works). This method generates the following weights (see Table 4.2) based on the formal hierarchical designations in Table 4.1.

But formal hierarchical ranking is not the only determinant of formal power level. One must also consider how relevant or concerned with the issue the various agencies are, based on their mandates. The *relevance rank* may be viewed as the "thrust" or "emphasis" on the issue. An agency may have a high power rank, but if it is not very concerned with the issue, then it will have less effect on the outcome. Reversibly, a low ranking agency which places a lot of emphasis and energy into the issue, may counter-balance its lack of hierarchical power with passion. Table 4.3 depicts and explains the relevance of various actors to this issue. In Table 4.4, the level of relevance is again quantified through AHP.

Table 4.2. AHP results for formal hierarchical ranking. The BMG is ranked slightly higher than ministries (even though technically they are the same rank) because in relative terms, the BMG holds slightly more power over local bureaus than ministries, because local bureaus are dependent upon the BMG for their budget.

Agency	Hierarchy Weight
Central Government (NPC and SC)	0.4003
Ministry of Construction	0.1108
Ministry of Water Resources	0.1108
Beijing Municipal Government	0.1548
Beijing Waterworks Company	0.0372
Beijing Agricultural Bureau	0.0372
Beijing Water Resources Bureau	0.0372
Beijing Water Savings Office	0.0372
Beijing Price Bureau	0.0372
Beijing Hygiene Bureau	0.0372

Table 4.3. Actors and their relevance to the issue of water pricing.

Agency	Relevance	Explanation
Central Government (NPC and SC)	Medium	• Water pricing is not a primary concern for the executive level of government
Ministry of Construction	High	• Responsible for the financial sustainability of urban water provision
Ministry of Water Resources	Medium	• Responsible for water pricing in rural areas, however since thrust of water pricing emphasis is on urban areas, it is less involved than the MOC
Beijing Municipal Government	High	• Responsible for providing subsidies to BWWC • Responsible for overall socio-economic well-being of Beijing
Beijing Waterworks Company	High	• Strong emphasis on increasing water prices to ensure financial sustainability
Beijing Agricultural Bureau	Medium	• Focuses on farmer poverty which relates very directly to water pricing
Beijing Water Resources Bureau	Medium	• Emphasis on rural water provision and other water issues. Does not prioritize water pricing
Beijing Water Savings Office	Low	• Promotes water conservation and water use regulation but does not focus on water pricing specifically
Beijing Price Bureau	Low	• Ensures national pricing objectives met but is not actively involved in water pricing issues per se
Beijing Hygiene Bureau	Low	• Does not focus on water pricing exclusively

Table 4.4. AHP Results for relevance to water pricing ranking.

Agency	Relevance Weight
Central Government (NPC and SC)	0.0786
Ministry of Construction	0.2177
Ministry of Water Resources	0.0786
Beijing Municipal Government	0.1452
Beijing Waterworks Company	0.2319
Beijing Agricultural Bureau	0.0858
Beijing Water Resources Bureau	0.0762
Beijing Water Savings Office	0.0287
Beijing Price Bureau	0.0287
Beijing Hygiene Bureau	0.0287

Finally, through AHP we derive the formal power weights (shown in Table 4.5), based on a 2:1 relationship[6] between the hierarchical weight and the relevance weight.

[6] That is to say that we assume that the hierarchical rank has twice as much importance in determining overall power as relevance to the issue.

Table 4.5. AHP results for formal power weights.

Agency	Formal Power Weight
Central Government (NPC and SC)	0.2931
Ministry of Construction	0.1464
Ministry of Water Resources	0.1001
Beijing Municipal Government	0.1516
Beijing Waterworks Company	0.1021
Beijing Agricultural Bureau	0.0534
Beijing Water Resources Bureau	0.0502
Beijing Water Savings Office	0.0344
Beijing Price Bureau	0.0344
Beijing Hygiene Bureau	0.0344

Although this study only applies the formal power weight shown in Table 4.5, it is important to note that informal power also exists. Informal power has the effect of increasing as a whole the hierarchical power of the local level. Additionally, it may empower some agencies above others. The next section explains the importance of informal power but it will be omitted from the analysis because it is extremely difficult to quantify and requires intimate knowledge of the interactions between various agencies.

4.2. Informal Power Ranking

In the 1950s, China was portrayed as a well-oiled totalitarian machine even more extreme than the Soviet Union (Whyte, 1980). China had purportedly achieved *democratic centralism*[7] and was thus able to successfully implement policies from top-down, due to a high level of compliance from all levels of government. In this "ideal" authoritative state, political priorities were set by the "Communist party and the leading echelons of government, especially the State Council and the State Planning Commission. These priorities are compiled in sets of imperative commands that are then communicated downward through bureaucracies for implementation. Ideally lower echelons comply fully with the orders of their superiors, and that results in a highly uniform process of implementation in which decisions are made in accordance with the interests of the whole as defined by the central elite" (Ross, 1988).

In reality, China is not a well-oiled machine humming smoothly along its hierarchical axes, but a warzone in which local authorities struggled to empower themselves and promote their own interests, while central authorities use formal levers to maintain central control. This model of Chinese politics is known as *fragmented authoritarianism*. According to this model, authority below the very peak of the Chinese political system is fragmented and disjointed. In the words of Li (1994):

> "The fragmentation is perceived to be so serious as to have turned the Chinese political process into something like protracted guerilla warfare, the bargaining treadmill, or the rural county fair or market, a setting characterized by protracted haggling, posturing, conditional outcomes, frequent failure to reach agreement, and issues that rise and fall on the agenda, but are rarely fully resolved or discarded. It is also perceived that bureaucracies have come to gain so much defacto power that they are now often able to 'blunt the weapon of control of the top leaders' and to transform these bold initiatives into modest programs or turn them, in reality, into non-decisions. They can do so by maximizing self-sufficiency, hiding or distorting information passed upward, exercising feigned compliance, cultivating patron-client ties at higher levels, and taking advantage of extra-budgetary resources made possible by the economic reforms" (Li, 1994).

Today's China is more fragmented than it was under Mao, however this fragmentation occurred slowly over a long stretch of time. The beginnings of decentralization of power, whereby powers were devolved to lower levels of administration (such as municipal or county level governments), occurred in the early Maoist period (between 1958-1976). This devolution was not accidental, but purposely initiated by central authorities to tackle "perceived problems arising from over-centralisation in the system of economic planning and management" (White, 1991a). In this period, control undulated between decentralisation and recentralisation. At times central authorities attempted to re-seize control over local agencies by manipulating the purse strings. Thus before 1979, "bureaucracy was neither strong enough nor powerful enough to play an important role in policy making" (Huang, 1999).

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[7] *Democratic centralism* is a system in which higher level cadres issue binding orders to subordinate units, who are required to fully implement these directives. Huang (1999) summarizes *democratic centralism* as a state in which "the minority should submit to the majority, the individual should submit to the organization, the subordinate should submit to the higher authorities, and all levels of organizations and individuals of both party and the state should submit to the Party Centre" (Huang, 1999). China is a self-proclaimed *democratic centralist*.

By 1985 China had become less of a well-oiled machine as the central government lost some ground in its bid for authority. In this period, the Chinese economy transformed from a centrally-planned system to a market-based system. This transition created a great deal of overlap, during which China experienced what is known as a *dual-track economy* – a hybrid system of half-state, half market, with an awkward mix of institutional behaviours, ranging from bureaucratic to entrepreneurial.

Marketization meant that subsidies to local agencies were drastically reduced. The transfer of state-owned enterprises into private hands meant that revenue originally generated by these enterprises was no longer available to the central government. "The Chinese state has found itself facing a fiscal crisis, dwindling sources of revenue being counterpoised against escalating demands for extra resources from sectoral interests and a heavy burden of consumer subsidies to cushion urban populations from the rise in agricultural procurement prices and inflationary pressures generally" (White, 1991). National coffers thus shrunk, and with it, local budgets.

Without the availability of subsidies, local governments were both forced and encouraged to seek new sources of revenue. Acts of entrepreneurship by bureaus and ministries were sanctioned and throughout the 1980s, government agencies began to take part in market activities, which were often unrelated to their mandates, to earn revenue. Governmental agencies were given permission to sell information to other government agencies as a means of cost-recovery. Acts of illegal entrepreneurship, in the form of corruption, were allowed to take place, although not officially sanctioned[8].

Additionally, in the early 1980s, a new system of revenue-sharing between central and local authorities was introduced[9]. This was known as the system of *extra-budgetary funds*. Reforms allowed local authorities to keep extrabudgetary funds, which were funds acquired outside those allocated by the central government, which were not subject to central budgetary control, and "which they could use to pursue their own policy preferences" (Lieberthal and Lampton, 1992). The attractiveness of extrabudgetary funds led to the increased shifting of collected revenue into this category, with detrimental effects on central finances[10]. The result was local government gaining more autonomy from the central government, who could no longer rely on the threat of budget-downsizing to ensure local compliance.

Further, marketization led to changes in the structure of the economy. As section 2.3.2.1 explained, industry shifted from heavy, state-owned, and large-scale, to light, private, and small-scale enterprises. This shift served to strengthen local governments, which are mainly responsible for the latter categories.

By 1989, it was clear that the power of the central government to ensure compliance by the lower echelons was dwindling. The Chinese economy began to resemble a patchwork of "independent kingdoms", rather than an integrated, centrally-controlled "well-oiled machine." Policies were no longer simply dictated by higher level agencies to lower levels. Now they increasingly involved intense bargaining at all stages of the

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[8] The incidence of "turning a blind eye" to corruption by local authorities is discussed by Fan and Grossman (2000) in an interesting article which argues that corruption was allowed to continue because it prompted local officials to promote economic reform. The article argues that selective enforcement and threat of punishment acted as a means by which excessive corruption was prevented, while allowing "mild" economically beneficial corruption to continue.

[9] Traditionally, local tax offices collected taxes on behalf of the central government. This money was transferred through upward-sharing to central authorities who in turn pay back tax refunds and subsidies to local authorities. Local governments had no control over tax bases or rates, nor were they able to autonomously determine their budget size. The central authorities found problems with this system. Local agencies did not have the proper incentive to collect taxes to their entirety. First, revenues collected would be shared by the centre and other provinces. This meant that efforts made by Beijing to collect the taxes of Beijingers, may go into the coffer of another province. Second, collection policies were ambiguous and not based on clear-cut principles. This meant that it was possible for "the central government unilaterally to change the 'rules of the game'"(Wang, 1996), and that bargaining was key in determining revenue-sharing. Some local governments were not obligated to collect in full if a deal could be struck with the centre. Third, full collection would only result in higher requirements by the centre in the following year. This created an incentive to keep collections low. Fourth, there was no penalty on local government if it failed to collect because central authorities lacked the resources to effectively monitor collection efforts. Finally, the cost of rigorous collection to the local agent was high. Not only would it require manpower, time and money, but it would jeopardize local government's relationship with the community. As Wang (1996) notes, local tax offices are not always as loyal to central government as they are to local government. "Local tax officials are lifelong residents of the community who relied upon the local government for the provision of housing, utilities, fringe benefits, and other non-cash allowances. Local governments could make their lives very hard if they did not cooperate. Thus, while strictly speaking, local tax offices were the agents of both the central and local governments, in practice their loyalty to the latter was much stronger. Consequently, local governments had effective control over revenue collection."

[10] An attempt was made by central authorities to correct this in 1994. These reforms aimed at solving incentive issues by setting distinct categories for collected taxes: central taxes, local taxes and shared taxes. Revenue-sharing would be based on established rules (75% VAT to the centre, 25% to local) to eliminate the need for bargaining and to stabilize funds available to national authorities. However, the existence of extrabudgetary funds meant that local agents would continue to place more emphasis on collection of taxes which could be placed into these funds, rather than on those which must be remitted to higher-level authorities.

policy-making process[11]. The existence of a bargaining table means that local level departments and agencies are not simply empty vessels to be filled by the commands of higher-level authorities, but semi-autonomous entities who have power of self-determination. In the post-Mao years bargaining increased with the relative decline of hierarchical command, and the associated increase empowerment of local authorities.

From the point of view of the highest levels of government, bargaining, negotiations and protracted consensus building are problematic and undesirable. To the central government, poor compliance is symptomatic of the inefficiencies that plague China's bureaucracy. Inefficiencies and other bureaucratic problems (see Section 4.2.1) are seen as debilitating government from achieving the objectives laid out by national authorities. In an attempt to correct these problems, the national government has constantly reformed administration through the reassignment of ministries or the replacement of personnel[12].

From the vantagepoint of local authorities, the "inefficiencies" perceived by higher level authorities, are actually tools to increase local power. Bargaining, poor coordination and other "inefficiencies," result from a concerted effort on local government's part to assert local control. In the struggle for power with their superiors, informal instruments of power (such as *guanxi*, corruption etc) are used to defy central authorities, while feigning compliance. Indeed, inefficiencies make good scapegoats, by covering up defiant behavior. Section 4.2.3 describes some of these tools of informal power.

4.2.1. Problems Facing Chinese Bureaucracies

Today, China's bureaucracy is viewed as "the Achilles heal of modernization" (Ma, 1996), "a lifeless crutch that is no longer useful," and "an organization that cannot learn from its errors" (Buchanan and Huczynski, 1985). Even Deng Xiao Ping himself, in a speech in 1980, condemned bureaucracies "as authoritarianism, routinism, elitism, corruption, shrinking of responsibility, deceit, laziness, talentlessness, formalism, red tape, nepotism, and the seeking of special privilege" (Chow, 1993). A 1993 survey of bureaucrats and members of the public in China found that bureaucracies are perceived as "wasteful, apathetic to public needs, slow to react, abusive, or reactionary; others accused it of being ineffective, redundant, overstaffed, ossified, or self serving" (Chow, 1993). Chinese authorities and academics alike attribute policy failures to some of the bureaucratic problems detailed in the next few sections.

4.2.1.1. Human Resources Problems

Chinese public administration is an unstable mix of "merit bureaucracy" and "ideology bureaucracy." Traditionally, bureaucrats of the emperor were chosen by both merit and morality. On the one hand, civil servants were chosen through rigorous examinations. On the other hand, these examinations "required that the candidates write bagu essays, topics of which were selected from the Four Books and Five Classics, all of which stress the importance of moral standards and moral behavior" (Ma, 1996). The importance of ideology was reinforced by the Communists: Mao had a distrust of professional and rigid bureaucracies. "His enthusiasm for dispensing with basic governmental institutions enhanced the role of ideology in government and enabled the CCP to follow the traditional Chinese model of administration. In addition, the newly established Leninist regime in Moscow provided an example of controlling the government bureaucracy by means of ideology... The Chinese Communists saw the Soviet model as a full-blown alternative to the western ideal of bureaucracy" (Ma, 1996).

In the 1980s, Deng Xiao Ping, disgusted by the inefficiencies and incompetence that he saw in China's ideology bureaucracy, began to institute a series of bureaucratic reforms. His model for these reforms was German sociologist Max Weber's *rational bureaucracy*. Rational bureaucracy aimed at "eliminating from

[11] Typically bargaining occurred between equals in the hierarchy and entities one step above or below. It most often happened between "two or more bureaucracies of approximate equal resources, none of which can carry out an undertaking without the cooperation of the other(s), but which cannot compel the cooperation of the other(s) and cannot persuade a senior authoritative leader of institution to compel the other(s) to cooperate" (Lampton, 1992).

[12] A tactic that central authorities use to counteract local power is to take ministries and merge or divide, promote, or demote them. "When a sector or function is losing out in ministry- or provincial-level bargaining, one ploy is to transform the ministry into a commission" (Li, 1998). These changes may give more or less power to various actors and may force conflicting actors to resolve problems within a newly merged ministry. "In 1982, for instance, the Water Conservancy and Electric Power ministries were merged...the logic of the move, discussions would now be 'in the family' rather than 'between families'" (Lampton, 1992). In another example, "the elevation of Education from ministry to commission status in 1987 ... was designed to give education more clout in the competition for government resources, in addition to enhancing coordination of educational activities under different ministries... One consequence of ministerial merger is a loss of bargaining power for each component in the merger; this complaint was heard from the ministries of Water Resources and Electric Power when the two were merged first in 1980 and again in 1982" (Li, 1998).

official business love, hatred, and all purely emotional elements" (Britan and Cohen, 1980), and as such advocated the practice of choosing civil servants on the basis of their "technical qualifications and their work roles as defined by a consistent set of abstracted rules. Being a bureaucrat is a career, and promotion occurs in a regularized manner...The bureaucracy's environment – clients, policy-making, and outside constituencies – is either ignored or treated as depersonalized input" (Britan and Cohen, 1980). Thus Deng aimed at creating a politically-neutral merit bureaucracy with elements of "hierarchy, unity of command, specialization labour, employment and promotion based on merit, full-time employment, decisions based on impersonal rules, written communications, and bureaucratic employment total separate from the bureaucrat's private life" (Ma, 1996). As part of these reforms, Deng required higher technical skills for job qualifications, implemented crash programs to reeducate bureaucrats, and established open competitions for recruitment (Ma, 1996).

However, in China politics and administration are not easily separated: "the CCP leadership have never accepted the need for a politically neutral civil service. They have argued that policy is the lifeblood of administration" (Ma, 1996). While China's bureaucracy is becoming increasingly merit-based, it is only with reluctance on the part of senior officials. Additionally, merit-based bureaucracies do not eliminate the occurrence of access to power and privilege through informal means once in the civil service.

Another human resource problem faced by Chinese bureaucracies is a lack of personnel. The National Environmental Protection Agency, for example, which works with an area slightly larger than the United States, has only a fraction of the staff. In 1997 the US Environmental Protection Agency (US EPA) had a staff of 6,098 employees, while the Chinese counterpart only had 250 staff members (Zhang and Ferris, 1998b). In periods of understaffing, monitoring of policy implementation is likely to suffer.

Chinese civil service workers are also affected by low average salaries. In 1988, the average annual salary of cadres was 2.3% lower than the entire labour force, and much lower than salaries from private companies (Dong, 1993). Further, a lack of salary brackets means that civil servants very quickly reach the top of the salary ladder and thus lose incentive to work harder (Dong, 1993).

However, in wealthier, more modern Chinese cities such as Beijing, government officials tend to be more "flexible and sophisticated, ... younger and more efficient than their predecessors, better educated, and well-informed on government policies and regulations" (EAAU, 1997).

4.2.1.2. Poor Coordination

On of the most commonly cited problems with China's bureaucracy is poor coordination. Coordination problems exist between agencies of a similar level (for example, the Beijing Environmental Protection Bureau and the Beijing Water Resources Bureau), and between agencies of different levels within the same functional department (for example, the Ministry of Water Resources and the Beijing Water Resources Bureau). The former is known as horizontal coordination and the latter, vertical coordination.

Horizontal Coordination

Water pricing in Beijing is a task shared by many bureaus at the municipal level, as described in Chapter 3. Often it is difficult to coordinate the efforts of various agencies. For example, data is gathered independently. In the case of water pricing, the BWWC gathers information on urban demand, while the Beijing Water Resources Bureau separately gathers information on irrigation demand. Supply information is divided between the Beijing Water Resources Bureau (surface water) and the Beijing Geology Bureau (groundwater). Typically "there is only very limited and informal communication between ... units at the same administrative level" (ESCP, 1998a). Poor information-sharing and coordination between these actors means that "officials are usually knowledgeable only about activities within their own cellular hierarchy and are completely ignorant about parallel hierarchies"

Box 4.1. Lake Dianchi – A Case of Coordination Failure (Hamburger, 1998)

An interesting case of poor horizontal coordination leading to repetition and waste is that of Lake Dianchi in Kunming, Yunan.

Lake Dianchi served as the major source of drinking water for the city of Kunming. When it became apparent that the lake was suffering from eutrophication, World Bank assistance was sought by the Yunan Environmental Protection Bureau. The World Bank determined that the project would focus on protecting the lake as a source of drinking water and thus justified investments to control nutrients to defer the need to divert drinking water from elsewhere.

At the same time, unbeknownst to the Yunnan EPB, the Yunnan Water Conservancy and Hydropower Bureau (WCHB), who was responsible for drinking water supply had independently conducted feasibility studies on water import schemes. The local government, on the advice of the Yunnan WCHB approved a diversion project from outside Dianchi.

In sum, this case study demonstrates how "fragmented authority, lack of clear lines of authority, and conflict and lack of cooperation among institutions within the water resources management bureaucracy undermined the economic justification for the World Bank's loan" (Hamburger, 1998).

(Pye, 1982), and that policy formation and implementation tends to be slow[13].

In the case of water management, the Ministry of Water Resources, which is responsible for overall water management for the entire country, has difficulty enforcing its mandate on agencies at a similar level. Often agencies disregard the MOWR's policies, plans and directives if they are perceived to be inconsistent with their own objectives. Perhaps the most problematic form of horizontal organization is between bureaus of the same administrative rank, in different regions, provinces, or municipalities. Inter-territory communication is particularly poor as there is a lack of formal channels of communication and coordination. Water allocation, which affects water supply and thus water prices, is highly vulnerable to inter-territorial disputes. Since Beijing is situated upstream of Tianjin, Beijing holds the advantage and has access to higher quality, more abundant water resources. There was little that Tianjin could do when in 1981, the State Council decreed that Miyun Reservoir would be used exclusively by Beijing, leaving Tianjin with no compensation, and the burden of building two expensive emergency water diversions from the Yellow River (Nickum and Marcotullio, 1999). Unlike in the United States, China does not have a mechanism to establish interstate agreements which give downstream users rights water in upper reaches. The river basin commissions attempt to improve coordination by establishing a forum for inter-territorial disputes, however, their effectiveness has so far proven limited.

Vertical Coordination

Vertical coordination refers to the coordination between different level agencies within the same functional department (for example, the Ministry of Construction and the Beijing Municipal Administrative Committee). As noted earlier, functional departments operate under the dual leadership of the local people's congress and the corresponding departments at the higher level. And while local bureaus are obliged to obey the mandates of their national level ministry, in reality, vertical coordination within a functional department is weak for two reasons.

First, financing of local bureaus and departments are provided not by its functional superior, but by the local government (in this case, the BMG). The BMG provides almost the entire budget of most municipal-level bureaus. For example, the Beijing Environmental Protection Bureau's operating budget is based 20% on collected effluent fees, and 80% on local government funding.

Second, "administrative personnel at the subnational level are, as a practical matter, more dependent on state and party officials at the subnational levels for career support than on their counterparts at the national level. The positions to which such personnel might advance are also far more likely to be found at the subnational level, even if such opportunities lie outside the particular bureaucracy in which they are working. Similarly, subnational offices of national bureaucracies seeking state assistance in the enforcement of the orders they issue typically must rely on subnational authorities, rather than Beijing" (Alford and Shen, 1998).

4.2.1.3. Poor Definition of Roles

Although chapter 3 portrayed the roles of various actors as relatively well-defined, often bureaucracies are impeded by poor definition of duties and overlapping responsibilities due to poorly written laws. Some problems with Chinese laws include:

1. Overly general laws: Many laws are written without detailed explanation of the agencies responsible for certain activities. Lack of reference to implementation means that in many cases *no* actor is appropriately assigned to oversee regulations. Additionally, a lack of clear definition of legal terms also allows agencies to avoid performing their duties.
2. Overlapping laws: Laws overlap when new regulations fail to replace old regulations, creating confusion and conflict. "For example, the introduction in 1993 of a volume-based charge on industrial wastewater ... did not replace the existing noncompliance charge" (Panayotou, 1998).
3. Conflicting laws: Laws conflict when they are established by different organizations without consulting with each other. For example, some contents and articles in the Procedure for Water Use License System and Regulations of Water Quality Management for Water Use System promulgated by the MOWR directly conflict with Regulations for Urban Water Demand Management and Regulations for Urban Groundwater Exploitation Management promulgated by the MOC.

[13] This was particularly the case in the 1980s when policy implementation was impeded by intense bickering between horizontal agencies. Problems that were once solved at lower levels were being pushed up to the State Council to solve. As a result, the central government made many ministerial reshuffles in an attempt to improve horizontal coordination.

4. Poor promulgation: Poor promulgation and announcement of laws and legislation often means that responsible agencies are not made aware of them. "Often these laws are not even known to the legal profession and are even less well known to officials throughout the county who are responsible for administering them" (EAAU, 1997).

4.2.2. Informal Incentives

In the previous section we described bureaucracy as viewed from above, by national leaders and agencies. In the next two sections, we reexamine bureaucracy from the point of view of the bureaucracy itself. Section 4.2.2 describes the motivation of bureaucracies as largely informal and section 4.2.3 describes some of instruments of power applied by local level bureaucracies to raise their status.

In discussing informal bureaucratic power in China, we adopt what is known as an *open systems approach*[14]. This approach, stemming out of research from the 1970s, depicts bureaucracies as groups of individuals attempting to achieve their own goals. The incentives which motivate the bureaucracy is thus the culmination of the incentives that motivate individuals, *in addition* to incentives derived from the agency's formal role. The bureaucracy is thus a living system, which must "evolve organizational structures that can cope with internal pressures and tensions among their component parts... At the level of formal structure, relations between a bureaucracy and outside agencies and persons is generally Weberian; that is to say, governed by rules and regulations that stimulate the duties, obligations, rights and privileges of the organizations and its members. Within these rules, an organization competes with others for scarce resources, marshals support for its demands, and responds to pressures and requirements placed on it by other agencies, political groups, factions, and individuals" (Britan and Cohen, 1980).

Bureaucrats are motivated by the need to protect their own positions of power within the community. Researchers of Chinese administration increasingly emphasize the fact that "cadres can be classified as rational beings interesting in maximizing utility by increasing benefits and reducing costs" (Chow, 1993). Even Chinese "bureaucrats are people first, officials in organizational positions second" (Britan and Cohen, 1980) and thus they are conscious of their political survival and will pursue changes only if it promotes their careers. In order to achieve this, local bureaucrats must appease both their superiors and the people they serve. Local agencies aim "to conceal from the central government that a good outcome resulted from good luck rather than from extra effort or that a bad outcome resulted from poor effort rather than bad luck" (Fan and Grossman, 2000).

Higher level authorities are appeased when lower echelons obey their direct commands, or when it appears as if higher-level policy initiatives are being followed through at local levels. Creating the appearance of organisational loyalty, such as by not questioning, disobeying or defying higher authorities, ensures that the lower echelons may keep their "iron rice bowl." However, local officials have methods to create the image of obedience, while in actuality pursuing local, rather than national interests (see Section 4.2.3).

Local officials also have an incentive to please the local population.

> "Local officials are strongly motivated to pursue local interests, partly because of an underlying bureaucratic imperative towards maintaining an expanding their bailiwicks, partly because local politicians wish to minimise local discontent and expand their patronage base, partly because of a sense of local patriotism and partly because each assumes that other localities are operating along similar lines" (White, 1993).

4.2.3. Instruments of Bureaucratic Power

Goggin et al (1990) define four potential bureaucratic reactions when faced with a new policy to be implemented. These are:

- Defiance (delay with modifications that hurt the state's chances of achieving its goals)
- Delay (delay with no modifications)
- Strategic delay (delay with modifications that help the state's chances of achieving goals)
- Compliance (prompt implementation with or without modifications that help the state's chances of achieving its goals)

In China it is political suicide to outright defy one's superiors. Since China largely operates on a system of appointments, rather than democratic voting or apolitical hiring, local politicians use other instruments to delay and defy, without the appearance of doing so. This section details some of these "tools" at local disposal.

[14] This is in contrast to the pre-1970s Weberian approach which views bureaucracies as organizations whose actions and behaviors were dictated wholly by their formal structure.

4.2.3.1. Information Control

Local agencies rely on protection and control of information to gain an advantage over their superiors. Collection of data occurs from bottom-up, which allows local agencies to distort or withhold information to their advantage. "Lacking information and expertise necessary to evaluate the recommendations of lower-level units, political leaders will often permit those units to become de facto decision-makers in their own policy spheres" (Halpern, 1992).

In today's China, "policies call for agencies to charge one another for basic information. Yet, to charge for hydrologic and other data essential for water resources management is counterproductive and costly, and cripples all activities. Reliable data cannot be obtained without a long-term program having an assured budget, year in and year out" (Frederiksen, 1999). This lack of information-sharing leads to manipulation of information to provide a tactical advantage is dealings with other agencies.

4.2.3.2. Red Tape / Formalities

Formalities, or in a more negative light, *red tape*, are the rituals by which bureaucracies conduct themselves every day. While the purpose of formalities is to ensure consistent and professional conduct, they may be used as a tool by bureaucracies to exert power over higher level agencies. For example, local agencies have been known to use red tape in delaying the implementation of policies that they didn't agree with.

Chinese bureaucracy has been typified by red tape for much of its history, stemming as far back as imperial times. "Dynastic China's obsession with ritualism caused Etienne Balaz to describe Chinese regime as that of 'red tape and petty fuss – yards and yards of tape and never ending fuss.' However, this 'endless fuss' was considered the most apparent Confucian touch. A ruler, according to Confucius, 'should observe the established ceremonies, and offer all sacrifices in accordance with the rites, and then all else will go well in the world'" (Ma, 1996).

Chinese bureaucrats, past and present, understand the importance of red tape to both their careers and their departments. Bureaucrats with little professional qualifications hide behind formalities to avoid being labeled incompetent. "Penchant for formalism hides the cadres' inadequate education. Low literacy among cadres has made it difficult for them to comprehend and evaluate the technical content of their administrative assignments. It is much easier for uneducated officials to accept, emulate and develop formalities...Formalities do not require formal education to put them to use. Formalities take less time and effort to work out. Formalities are more perceptible than substance" (Ma, 1996).

4.2.3.3. Informal Connections / Guanxi

Although Figure 3.4 portrays government in China as bound by simple vertical and horizontal relationships, in reality, there exist millions of fine connections which bind individuals within various agencies in an informal manner. This web of *guanxi* can either subvert or support the initiatives of authorities at higher levels. While the study of *guanxi* relations within the Beijing water management circle is well beyond the scope of this paper, it is important to perhaps note the importance of *guanxi* in creating informal power.

According to the Oxford *Concise English-Chinese Chinese-English Dictionary* (1986), the word *guanxi* translates as "relation; relationship...ties; connections." In Chinese culture, *guanxi* plays an important role in holding together the social fabric. *Guanxi* exists between two parties for various reasons. These may range from blood relations and friendship, to sharing a hometown, or a dorm in college. Having *guanxi* with another person entitles mutual support. Clearly, the closeness of such *guanxi* differs, and as such so does the level of support and aid between the related persons. Typically, *guanxi* relations are patron-client relations (also known as mentor-protégé relationships), in which one person has more access to power (patron) than the other (client). *Guanxi* benefits are therefore usually unbalanced, with the client benefiting more from the relationship than the patron. However, it is false to assume that the client has no responsibilities. In Chinese culture, a favour is expected to be returned, unless one is willing to break the *guanxi* relationship.

Guanxi permeates Chinese society, and Chinese bureaucracy is no exception. Research by Chow (1993) shows that "Chinese cadres have a strong tendency to cultivate personal ties (*guanxi*) and that group dynamics has adversely affected the performance of cadres" (Chow, 1993). There are thousands of cases in which *guanxi* has helped, or reportedly helped, political figures rise to power. *Guanxi* in the political realm not only allows proximity to power but protection against being hurt. "A bureaucrat under the protective umbrella provided by his informal back-stage boss could be more influential than the bureaucrat's formal position suggested" (Ma, 1996). This can disrupt the normal, intended flow of policy from the drawing board to implementation by creating new incentives outside of those set formally. For example, bureaucrats may more likely comply with policy directives when they have *guanxi* connections with the higher level authorities holding the directive. Often "policy implementation was undermined because officials tended to pay more attention to informal connections than to formal superior-subordinate relationships" (Ma, 1996). In the extreme, *guanxi* leads to factionalism, in which "Chinese officials tend to turn to small, informal groups for the satisfaction of various personal needs" (Chow, 1993). Close *guanxi* with upper level decision-makers may empower certain local actors. For example, many submit that *guanxi* between the mayor of Shanghai and President Jiang Zemin is an important reason for the targeting of Shanghai as a zone for economic growth.

4.2.3.4. Corruption

The Chinese government considers pervasive corruption as one of the greatest weaknesses of the governance system today. Crackdowns, in which public officials caught being corrupt are punished with sentences as severe as the death penalty, have increased. Additionally, "the national government has adopted provisions, such as the Provisional Procedures on the Rotation of the Jobs of the State Council Servants, with the intent to deter corruption by requiring that senior officials who maintain the same job for five years or more rotate to new jobs" (Zhang and Ferris, 1999b). However, in spite of these well-publicized enforcement campaigns, corruption continues to be widespread.

The tradition of corruption is strongly rooted in China. "In ancient China, misuse of public authority and misallocation of official funds for personal gains by mandarins-the officials-were often regarded as normal, or even rational" (Chow, 1993). Over many years, corruption has developed into a social norm.

Another reason for corruption is that it allows some degree of local control and autonomy from higher level authorities. Being corrupt allows local officials the financial independence that enables them to make decisions based on local and personal conditions rather on the wishes of higher-level authorities. As such, corruption is another tool for local empowerment.

4.3. Summary of Power

This purpose of this chapter has been to introduce the concept of actor power, particularly informal power. The application of power to the analysis is difficult, however. In the case of formal power, a quantitative weight was derived based on relative hierarchical levels, and relevance to the issue of water pricing. This weight was generated through a series of educated guesses based on available literature (laws, mandates, constitution etc), manipulated through AHP. In the case of informal power, no literature was available to informally rank the agencies, and thus no guesses can be made about the relative informal power of various agencies. The only conclusion about informal power that may be drawn is that in general, informal power increases local power and decreases national power. The level of this effect is impossible to determine without more information. Thus this paper does not attempt to quantify informal effects, but will simply keep note of the fact that local bureaus likely wield more power than they appear to formally.

Chapter 5: Objectives

The following objectives are primarily derived from the mandates of actors, as well as the laws, rules and regulations that bind them (see Appendix B on laws for more details). Others are not derived from any particular source, but are general objectives that are common in developing water pricing policy.

5.1. Financial Independence for Water Providers

The plight of Chinese tap water companies prompts the goal of financial independence. Before the 1980s, China's tap water companies were able to earn modest profits from revenues collected through user fees and subsidies from the central government. In the 1980s, modest declines in profit were apparent. In 1972, tap water companies made a profit of 0.046 yuan/m^3; by 1983, this figure was down to 0.036 yuan/m^3 (Ross, 1988). In 1987, profit statements showed record losses and a trend of annual deficit began.

The trend of losses continued through the 1990s. In 1990, China's water supply companies maintained a profit of 385.8 million yuan (Song, X., 1999) but a few years later, this figure would be in the negative. In a review of 31 of China's primary tap water providers (see Table 5.1.), 12 (or 37.5%) recorded losses for 1994. Most of the companies that profited barely did so and in total they showed a cumulative net loss of 640 million yuan (Shen et al., 1999). A similar study two years later found that 35% of tap water companies failed to earn a profit, and that the "performance of losers was bad enough to offset the net earnings of WSCs that made a profit. It became even worse in 1997 with the loss of 746 million yuan for the entire water supply industry" (Wei, 1999) at an average annual profit decline of about 90 million yuan (Song, X., 1999).

In Beijing, after 1994, with the beginning of the operation of phase two of the ninth waterworks, the Beijing Waterworks Co. recorded losses as high as 100 million yuan annually (Jiang, 1998).

There were several reasons for the decline in profits: an aggressive expansion of water supply service to achieve near-universal service by the late 1990s, increasing costs, and reduction in state subsidies.

Table 5.1. China's tap water companies' profit and loss statement, 1994 (Shen et al., 1999)

City	Balance (10,000 yuan)	Supply Cost (yuan/1000 m3)	Supply Cost (yuan/m^3)	Average Water Price (yuan/m3)	Revenue (10,000 yuan)
Whole Nation	-6397.05				985,899.86
Beijing	-2416.05	496.34	0.50	0.42	21700.88
Tianjin	-1433.13	415.05	0.42	0.42	21071.58
Shijiazhuang	-1056.49	295.64	0.30		3617.00
Taiyuan	4677.10	300.50	0.30	0.74	10585.39
Shenyang	152.20	400.39	0.40	0.50	17598.70
Dalian	-8800.00	1059.87	1.06	0.92	18509.00
Changchun	-1170.00	675.54	0.68	0.60	11738.50
Hohhot	1576.00	327.00	0.33	0.58	4406.00
Harbin	384.00	697.13	0.70	0.73	13364.00
Shanghai	-33711.34	617.85	0.62		64230.67
Nanjing		355.62	0.36		13736.09
Harbin	-501.77	409.00	0.41	0.45	11687.91
Hefei	161.90	299.35	0.30	0.36	5232.00
Fuzhou	1114.28	220.11	0.22	0.32	5590.39
Nanchang	460.30	213.70	0.21	0.31	5512.00
Jinan	-2814.00	391.17	0.39	0.54	8150.00
Qingdao	-423.00	1145.72	1.15	1.32	17249.00
Zhengzhou	551.45	332.00	0.33	0.448	11907.40
Wuhan	-2266.60	247.88	0.25	0.25	17450.50
Changsha	-2146.00	212.00	0.21	0.25	7214.00
Guangzhou	11204.00	444.37	0.44	0.54	59702.00
Nanning	483.72	238.87	0.24	0.30	5741.44
Haikou	692.00	560.16	0.56	0.75	6032.00
Chengdu	78.50	213.74	0.21	0.28	7830.70
Chongqing	-1059.00	476.00	0.48	0.60	10592.00
Guiyang	4.00	298.00	0.30	0.31	3642.00
Kunming	2.57	369.79	0.37		5159.23
Xian	373.38	405.38	0.41	0.46	10435.34
Lanzhou	2465.09	165.64	0.17	0.33	10426.09
Xining	208.00	221.89	0.22	0.44	1921.00
Yinchuan	132.40	346.50	0.35	0.37	1652.00

Service expansion

Between 1986-1996, nation-wide tap water sales grew 9.8% annually, service population 7.1%, production capacity 9%, and total piping length 7.5% (Wei, 1999). Estimates place the amount of investment in water provision between 1991 and 1995 at seven times the amount invested between 1986-1990. By 1996, approximately 90% of the urban population had running water. This number ran as high as 97% in large cities. In Beijing's urban core, by 1996 100% of the population had running water (compared with about 84% in 1990) (Beijing Municipal Statistical Agency, 1988-1999). Additionally, running water is available 24 hours in Beijing.

Increasing costs

Costs of water provision have been increasing for China's water supply companies. First, basic operating costs rise as water supplies become more scarce and tap water companies are forced to transport water from further upstream (Tseng, 1997). Second, water quality deterioration increases the treatment cost of bringing the quality up to drinking water standards (Tseng, 1997).

Third, poor accounting for maintenance and depreciation, in combination with aging infrastructure, result in high costs. For years, the Chinese system consisted of managers receiving capital from the state as outright grants without being required to amortise capital investments. "Therefore it is not surprising that Chinese officials are generally insensitive to the costs of tying up capital for long periods without obtaining a return on investment. Chinese negotiators generally seem to have no guidelines for deciding how important it is that the machinery of a plant will be in full production in six months, a year, 18 months, or two years. Low price is paramount" (Pye, 1982). This improper accounting leads to investment in poor quality construction and materials and inadequate plant and system maintenance schedules.

As a result, China's water supply assets, valued at 110 billion yuan (1990s figure), require annual maintenance expenditures of 3.1 billion yuan which is more than double annually collected revenue (Yu and Jia, 1997).

Subsidy cuts

Water supply in China has historically relied heavily on subsidies from central authorities to ensure financial sustainability. Between 1991 and 1997, for example, government subsidies to tap water companies totaled 2.81 billion yuan (Song, X, 1999). Even as late as 1997, subsidies totaled 1.138 billion yuan (Song, X., 1999). Calculations show that without those subsidies, the Beijing Waterworks Company would have been recording losses in as early as 1988 (Jiang, 1998).

However, with market reforms beginning in 1978, government subsidies for water provision became increasingly scarce. In Beijing, total subsidies to the BWWC fell slightly between 1992 (34,000,000 yuan) and 1993 (30,800,000 yuan) (Jiang, 1998). As a result, tap water companies have had to rely increasingly on non-governmental sources of revenue, such as multilateral loans (i.e. through the World Bank or Asian Development Bank), private corporate investors, and bilateral loans. By the mid-1990s, more than a half of China's water supply system was built by non-governmental sectors.

In light of service expansion, rising costs, and decreasing subsidies, tap water companies are aiming for financial independence and self-sufficiency. The following goals help achieve self-sufficiency.

5.1.1. Full Cost Recovery

Ensuring full cost recovery is a common objective in water tariff design. Baumann, Boland, Hanemann (1998) in *Urban Water Demand Management and Planning* state that water rate structures should provide revenues sufficient to allow the utility to operate on a self-sustaining basis. Revenue should cover operating costs such as salaries, chemical supplies, gas and electricity, taxes, and capital costs for system expansion, upgrades, or equipment replacement.

The Management Method for Pricing Urban Water Supply and the Irrigation Waterworks Fee Assessment, Calculation and Management Method are two primary national sources that call for full cost recovery. The former requires water prices to be calculated based on supply cost (Article 7), which includes general costs, expenses, taxes paid by the supply company, a margin of profit for the supply company, costs incurred due to water loss, and wastewater treatment costs (Articles 7-9). The latter method also requires water prices to be set according to supply cost (Article 5), which includes engineering operating management expenses, overhaul fees, and depreciation as well as other investment costs (Article 4).

5.1.2. Minimize Cost of Service Provision

In order to pull themselves out of the red, tap water companies aim to reduce the cost of service provision. Water pricing policies which reduce the cost of service provision are those that support water conservation to postpone the development of new water supply infrastructure, thus lowering the annual operating budget for the tap water company. This is accomplished by reducing peak water usage to delay the need for immediate supply system expansion, and reducing idle capacity to amortize capital investments, thereby reducing the per unit cost of service provision.

5.1.3. Reasonable Return on Capital

All enterprises require a reasonable profit margin in order to be financially sustainable. According to the Management Method for Pricing Urban Water Supply, water prices should be calculated on the basis of cost and with a reasonable profit between 6-12% (average 8-10% of net asset profit rate), depending on ownership of capital (Article 7 and 11). The Irrigation Waterworks Fee Assessment, Calculation and Management Method also specifies that water prices should be set to allow for a profit (Article 5). Reasonable profit is therefore clearly supported by the Ministry of Construction and the Ministry of Water Resources, the drafters of these methods, and the Beijing Waterworks Company.

5.1.4. Stable Source of Revenue

Net revenue stability is a common goal to all tap water companies. Some pricing policies are "conducive to a stable and predictable stream of net revenue over time and as circumstances change (e.g., in a drought)... [allowing] for more accurate budgeting, better planning, and lower long-term financing costs" (Baumann, Boland, Hanemann, 1998). Other pricing policies provide unstable revenues which "increase the risk of insufficient cash flow and can raise long-term financing costs. To the extent that cost does not automatically vary in line revenue, instability in revenue can generate instability in cost" (Baumann, Boland, Hanemann, 1998). Revenue stability is enhanced by stable water demand, tariffs, and supply costs.

5.2. Water Conservation

Chapter two's description of Beijing's water "crisis" makes the need for water conservation obvious. This goal is not unique to Beijing but common in designing most water-pricing schemes, and is sought after by virtually all levels of government.

On a national level, documents such as Agenda 21 and the Water Law establish the need to conserve water through manipulating water fees. Agenda 21 requires the use of water pricing to encourage conservation and sustainable development and requires the adjustment of existing economic measures and financial incentives to meet the objectives of sustainable development (14.11c). The Water Law requires all levels of government to draw up plans for water savings through adoption of water savings technology, reduced water consumption, and increased water reuse (Article 7). At the municipal level, the Beijing Ninth Five Year Plan specifically calls for price reform to promote the reduction of waste and the reasonable use of resources.

Water conservation is achieved by reduction of water use in both the present and the future. The installation of water efficient technologies and water reuse facilities help reduce future water usage and are therefore also objectives.

5.2.1. Installation of Water Efficient Technologies

Much of China's industry today continues to apply water-inefficient technologies. In comparison with industrialized nations, China uses more water per unit output in almost all sectors (see Table 5.2).

Table 5.2. Industrial examples of water-inefficient Chinese technologies (as compared with typical western nations).

	China (m^3 water / ton produced)	Typical western nation (m^3 water / ton produced)
Synthesis of sulfuric acid	200-700 m^3	20 m^3
Crude oil refining	5-32 m^3	0.2 – 1.2 m^3
Newsprint-making	100-300 m^3	50 m^3
Steel-making	2-3 times as much water as in west	
Breweries	4 times as much water as in west	

In agriculture, poor irrigation practices lead to great water wastage. For example, currently vegetable irrigation is applied at a 50% efficiency rate in China, or 2,400 m^3/ha. Applying this water at a 75% efficiency would save 1,600 m^3/ha (Smil, 1993). Much of China's fields are irrigated by flooding which consumes more than 1,000 m^3 of water per mu (Yu and Jia, 1997). In contrast, spray methods consume only 500 m^3/mu and drip irrigation merely 300 m^3/mu (Yu and Jia, 1997). Additionally, many farmers fail to take elementary measures which lead to great savings, such as leveling their fields, irrigating in the cool of the day, and lining ditches.

Increasing water use efficiency in the agricultural sector can have substantial gains. It is estimated that an increase in irrigation efficiency of only 20% would supply farmers in the Beijing region with at least as much water as would be provided by the South-North Middle Route Transfer project (see Box 6.2 on this project) (Ross, 1988).

The use of inefficient technology, even in water short areas, stems from their comparatively low cost. Today, water prices are too low to incite users to switch to more expensive, more efficient technologies. Thus water reuse and other water saving technology have trouble finding a market. Policies that increase the cost of not switching technologies, or decrease the cost of installing them will incite people to invest in water-saving technologies.

The goal of installation of water efficient technologies is evident in the Beijing Ninth Five Year Plan which requires all sectors to plan and implement water conservation and raise the efficiency of water use by adopting water-saving technologies.

Although the goal of increased installation of water efficient technologies is one which will ultimately benefit the Beijing Waterworks Company, in the short term, it is held primarily by the Beijing Water Savings Office, who holds the mandate of encouraging water demand reduction.

5.2.2. Installation of Water Reuse Facilities

The water savings to be had from water reuse are large. One estimate places the potential annual water savings in Beijing at about 0.4 billion m^3, with the use of 0.9 billion m^3 of recycled treated wastewater (Wang et al., 1999). Current water reuse situation was discussed in section 2.3.2.4. and will therefore not be repeated here. It is important to note, however, that like water efficient technologies, the installation of water reuse facilities is prompted by higher water prices.

5.3. Equity and Affordability

Equity and affordability are commonly pursued in designing water pricing policies. However, both of these goals lack universal definition.

5.3.1. Affordability

Of the two terms, *affordability* is more easily understood. For our purpose, *affordable water* is water that is purchasable by all households without placing an unreasonable financial burden, or forcing difficult trade-offs.

To determine whether affordability is an issue, one calculates either existing water tariffs as a percentage of household income, or full cost recovery as a percentage of household income. A general measure of affordability recommended by the World Bank is that "combined tariff for fresh and wastewater services should be set such that monthly payment by households should not exceed 3 per cent of average household income. Alternatively, the tariff should be set such that monthly payments do not exceed 5 per cent of the average income of the thirtieth percentile, counted up from the poorest individual, of total income distribution. The second criterion has the strength of specifically recognising the water and sanitation services should be affordable to those of relatively low incomes" (Merrett, 1997).

By this criteria, water is affordable in most nations (according to Table 5.3). The ADB found that most households in the Asia-Pacific region spend less than 1% of total household income on water (average 0.6%). This figure is low in contrast to other utilities: electricity 2.4%, telephone 3.1%, and gas 2.1% (Shepard, 1999). Table 5.3 shows the amount of average household income spent on water in various countries. In most situations neither existing tariffs nor potential full cost recovery tariffs pose affordability problems for the average household.

Table 5.3. Measures of affordability of water charges in various nations (OECD, 1999; Xu, 1999)

Country	Existing water tariffs as a proportion (%) of household income	Full cost recovery as a proportion (%) of household income
Portugal	0.5	2.8
Germany	1	1.2
France	1.1	1.5
England and Wales	1.2	1.3
Spain	0.4	1.6
Denmark	0.8	0.9
Korea	0.6	0.9
Greece	0.4	2.1
Ireland	0.3	1.9
Indonesia	2-5	
Malaysia	0.8-1.6	
Philippines	0.65-1.18	
Singapore	<1	
Sri Lanka	1.38	
Thailand	2-3	

Other researchers argue that the dramatic rise in real incomes in China make affordability an easy objective to achieve. For example, the Asian Development Bank estimates that since average household incomes in Asia are growing at 8% per year in real terms, households can be expected to afford water that is more expensive. Section 2.3.1.2. addresses the income increase in Beijing which suggests that water prices can rise to some degree without impacting affordability. One study of water prices in Shijiazhuang, Hebei finds that even fairly large increases in water prices will have negligible impacts; a 30% increase in water tariffs is likely to increase household expenditures by one thousandth. "Where incomes are increasing, as they are in China, the increase in income in 12 months is likely to be a hundred times the increase in expenditure on water supply. Where incomes are increasing, and water tariffs are low, households barely notice the financial impact of quite substantial increases in water tariff" (Elston, 1999).

In the agricultural and industrial sector, an affordable water rate is 3% of gross value of output, or 7% of net value (Ross, 1988). In China today, industries have little trouble affording water. Current industrial water fees are only 0.35% of production costs for Beijing's industry (Nickum and Marcotullio, 1999). With little or no fees on agricultural water use at present, farmers are easily able to afford water.

The need to ensure affordability for the whole of China is enshrined in the Price Law, and administered by the Price Bureau. This law states that prices must be affordable to the people and that prices should be set to promote economic and social development (Article 1). It also requires that the Price Bureau determine affordability by soliciting the opinions, concerns and recommendations of consumer and business operators (Articles 22, 23 and 25). In terms of water pricing, the Management Method for Pricing Urban Water Supply (1998) sets affordability as an important principle in designing water pricing policy. This method states that adjustment of urban water price shall give full consideration to the level bearable to the society (Article 24(3))

5.3.2. Equity

Equity is much more difficult to define. There are several possible definitions: fairness, reduction of income gap, and equality. For our purpose, we will use the second definition of equity and create separate objectives for the other definitions.

Equity requires that high-income residents bear a higher burden of the water supply costs than low-income residents regardless of whether or not they contributed to it. It also requires the elimination of policies that favor the rich in order to reduce the income gap, rather than widen it.

Closing the income gap is of concern to all levels of government. However, since regional income differences are greater than income gaps within urban cores, equity is primarily a national government concern. National level leaders grapple with the problem of a wealthy east coast and an impoverished western interior. But even so, "the gap between the haves and the have-nots is not large enough to threaten the social order or warrant remedial policies. The per capita income cutoff for the richest 5 percent of the population (3180 yuan in 1990 prices) is exactly ten times the absolute poverty line (318 yuan in 1990 prices)" (WB, 1997).

However, there are signs pointing to an increasing discrepancy between the wealthiest and poorest Chinese citizens. The number of people defined as "rich" has sky-rocketed. In "1995, there were 150 million people in China with an average annual household income above US $3000. By the year 2000, the number is expected to grow to 450 million people ... Of these, 100 million will have incomes in excess of US $9000 which will have the buying power in China equivalent to that of a US $40,000-45,000 household income in the United States" (Li, 1999). Meanwhile, the number of people below the international poverty line continues to be high in China as a whole. In the mid-1990s, an estimated 60% of China's 1 billion citizens earned less than US$1/day (WB, 1997a).

At the urban level, the gap between the rich and the poor is less dramatic. Urban poverty is negligible with poverty concentrated mainly in rural areas. For example, "in 1981 just 0.3 percent of the urban population lived in absolute poverty, while 28.0 percent of the rural population did" (WB, 1997). In 1995, "no urban residents [had] incomes below the absolute poverty line. And ... just 0.1 percent of the registered urban population lived below the higher poverty threshold, down from a peak of 1.8 percent in 1989" (WB, 1997). In urban areas, migrant workers are typically the poorest members of society. For example, "migrant workers from Anhui and Sichuan provinces earn 1.64 yuan and 1.72 yuan an hour, compared with the national average wage of 2.23 yuan an hour" (WB, 1997).

Deng Xiao Ping argued for the need to achieve an equitable China in spite of high economic growth policies at a Chinese Communist Party meeting in 1992: "We do not mean to make the rich become richer while making the poor still poorer; polarization between rich and poor is absolutely intolerable. Those who get rich first may pay more taxes to support others in their development." At the local level, the Beijing Ninth Five Year Plan contains clauses that aim at reducing the gap between urban and rural, workers and peasants, by promoting the integration of urban and rural, and quickening the industrialization and modernization of rural areas. Also on the agenda are plans for the continued development of social services, such as social welfare, and improved income tax collection as a means of controlling the widening income gap.

However, recent plans and agendas have given relatively little focus to the goal of equity. Although politicians continue to pay lip-service to this goal, most are willing to choose economic growth over equity (see section 5.5 on marketization of the economy). The number of policies aimed at reducing the income gap are far outnumbered by policies resulting in an increased gap.

5.3.2.1. Fairness

Fairness is achieved by apportioning costs of water supply according to the responsibility of costs. This definition implies that an equitable rate structure charges customers based on volume used, and impact on water supply expansion needs. A fair rate structure should apportion costs of service among different uses in a manner that is not arbitrary.

5.3.2.2. Equality

Equality is achieved by pricing water equally for all users regardless of need, income, or use. While traditionally equality was a goal of primary importance, in recent years, emphasis has switched towards efficiency.

5.4. Maximise Ease of Implementation

The ease with which pricing policies are implemented hinges on public awareness, public acceptance, policy simplicity, and administrative complexity. These goals are held primarily by the Beijing Waterworks Company which desires smooth implementation of its policy proposals.

5.4.1. Maximise Public Awareness

Pricing policies are more likely to be successfully implemented when the public is aware of the need for price reform and the nature of proposed changes. In recent years, both direct and indirect public involvement in policy-making has been increasing in China. First, the policy-making process has become more inclusive with forums for public opinion expression. "For example, the recently amended Water Pollution Prevention and Control Law provides for the consideration of public comments related to construction, reconstruction or demolition of projects that will impact water quality" (Zhang and Ferris, 1999b). Section 3.2.2.4. outlined the recent public involvement in water price reform in Beijing. Public opinion may also be indirect: "the populace responds to official policy, the leadership factions monitor mass behaviour, and then policy adjustments are made to assure a closer fit between the leadership's goals and popular predisposition" (Ross, 1988).

Increasing public involvement stems from greater public understanding of issues. Greater access to media services in China has created a more aware populace. For example, in 1996 television reached 83.4% of the total population of China (Li, 1999). A 1995 Gallup poll found that 92% of the total population watch TV, 80% listen to the radio, 70% read newspapers, and 66% read magazines (Li, 1999). Not only are media tools more accessible, but articles and news reports on environmental matters appear frequently. News programs, such as the well-known TV series Jiaodian Fangtan (Focus on Hot News) and Jingji Ban Xiaoshi (Economic Thirty Minutes), devote a sizeable chunk of airtime to environmental stories (Duan, Yan, and Gao, 2000). Many environmental government agencies use publicity funds to increase environmental awareness. For example, the "NEPA used these funds to support press conferences, sponsor environmental columns in national newspapers, and support television programs on Beijing TV. Dalian Environmental Protection Agency has used publicity funds to sponsor a half-hour radio program entitled 'Voice of Green' which aims to raise public environmental awareness in the province" (ECSP, 1998c). In 1996, China's seventy newspapers carried 17,555 environment-related articles, or about 10.1% of total news coverage for that year – double the 1995 amount (Wen, 1998).

However, as communication is still largely controlled by state-owned media groups such as the large and influential Xinhua News Agency, Chinese Central Television (CCTV), and China Central Radio Station, impartial information may be hard to come by. "From a Western point of view, almost no media group in mainland China can be considered independent. Most newspapers are sponsored by Communist Party Committees at different levels or ministries, as well as the newspaper's regional level offices" (Wen, 1998). Traditionally, the Chinese government has used the media to publicize new laws and regulations, broadcast messages from government departments, and engender public acceptance of policies. For example, "after the Three Gorges Project was approved by Chinese authorities, articles opposed to hydroelectric projects, or their negative environmental impacts, have seldom been allowed to be published in China" (Wen, 1998).

Therefore public knowledge of environmental issues in China is generally low in spite of the high percentage of airtime devoted to these issues. "A survey conducted by the China Environmental Protection Foundation in 1995 found that 60 percent of 4,000 people interviewed thought that China was rich in natural resources and had no need to worry about environmental protection. In addition, over 80 percent admitted that they knew little about environmental problems" (Wen, 1998). Water pricing appears to be poorly understood in Beijing. In a recent survey (see Table 5.4), 21% of Beijingers were not aware of water rates. However, an encouraging 100% of the sample were aware of Beijing's pressing water needs.

5.4.2. Minimise Public Unrest

Rogers (1996) argues that "politics ultimately controls water resource decisions." He cites a case study in which the "Tucson city government was recalled by the electorate because of an increase in the price of water; probably the first time such an issue has lead to the downfall of a city government anywhere in the world" (Rogers, 1996). A fundamental objective in the development of water pricing policy is therefore approval by the public.

Avoiding public unrest is of paramount importance to local officials who rely on local support to remain in power. Higher water rates may incite water-dependent companies to complain and threaten layoffs or plant closures (Prasitka, 1988). Poor public support leads to low compliance rates. We have already seen in section 2.4.2 how unrest in the agricultural sector led to defiance and vandalism. Not surprisingly most politicians will go to great lengths to avoid supporting higher rates.

One study by the UNDP-World Bank (1999) in India found that households were willing to pay up to 3.4 times more than the tariff rates proposed by the utility, but governments were unwilling to charge consumers "for these services and the result is a continuing cycle of low revenues, high costs, unsatisfactory services and financial crisis" (WB, 1999). In China, water pricing reform is largely inhibited by fear of public unrest. "The willingness of local governments in prioritizing water pricing reform is determined by complex local social, institutional and financial arrangements. Social unrest is a major concern here, and when coupled with the lack of an effective project approval and financing infrastructure, local governments have more than enough incentives to act slowly on reforms" (Yan and Stover, 1999).

In many instances, these fears are not unfounded; there is evidence of unwillingness to accept price increases in China. One study by Jiang (1998) of Beijing households found that half of residents surveyed considered existing water prices already too high (see Table 5.4).

Table 5.4. Survey results from a Beijing study on knowledge and acceptance of water price reforms (Jiang, 1998).

Question	Response
Do you know that Beijing seriously lacks water?	100% yes
Do you know about construction of the south-north water transfer project?	10% have heard of it
Do you know Beijing's domestic water fee standards?	12% do not know or haven't noticed
Last month, how much water did your family use – how much did you pay in water fees?	21% didn't take notice
Do you feel that Beijing's present water rates are too high?	40% not high, 50% high, 10% indifferent
Does your family re-use water used for washing vegetables for flushing the toilet?	87% no, but 50% additional remarks, if water price went up, will think of way to reuse
Does your family take water saving measures?	52% no
Do you think danweis are concerned with water conservation?	68% no they are not concerned with water conservation

Another survey by Ma Xiangling (1999) found that of 12 enterprises surveyed, 10 agreed to increased tariffs, 1 disagreed, and 1 did not respond. A survey of 183 households by the same researcher attained the results shown in Table 5.5.

Table 5.5. Attitude towards water price hikes by income level (Ma, X., 1999).

Attitude towards price hikes	Household income			
	>3000 yuan/month	>1500 yuan/month	<1500 yuan/month	Total
Total	10	156	17	183
Agree	10	154	12	176
Disagree		2	5	7
Afford easily	10	150	9	169
Affordable		6	6	12
Not Affordable			2	2

While these numbers do not appear significant (with only 7 families out of 183 disagreeing with price increases), there have been recent cases of public outcry over water prices. One such example is in the township of Jiazi, Guangdong (see Box 5.1). In this situation, water prices had an adverse psychological impact leading to public unrest and displeasure.

Public acceptance hinges on several factors: whether the public has a high degree of awareness (objective 5.4.1.), whether prices are affordable and equitable (objective 5.3.), and whether or not the policy is simple enough to be publicly understood (objective 5.4.3). Additionally, public opinion depends on how reactive the public is, and whether or not policy conforms with present ideology.

Public Reactiveness

Government agencies care only about public opinion that is expressed. In a tightly controlled state with no freedom of expression (such as China during Mao's reign) public opinion is not valued.

Following the death of Mao Tse Tung, China developed a *culture of reaction.* In the past decade the number of environment-related civil cases reaching Chinese courts have more than doubled (Zhang and Ferris, 1998b). More and more citizens are voicing their concerns by writing letters and making phone calls to their local government agencies. In the late 1980s and early 1990s, over 130,000 environmental complaints were filed by mail or in-person (Alford and Shen, 1998). Public demonstrations and exhibits on issues of public concern have also increased. During the drought period of the 1980s, "water conservation campaigns were prominent...Rallies to conserve water were held in Beijing on August 28, 1981, and in November after the summer rains failed to appear" (Ross, 1988).

Ideological Acceptance

In order to minimize public unrest, either the ideologies behind policies match that of the public, or the public must be made to accept the ideological values of the proposed policies.

The pricing of water was ideologically suspect up until the 1980s. According to Marx's theory of wealth, only labour produces wealth. Since natural resources embody no human labour, they have no value, thus it is fundamentally wrong to charge for them. As a result, water supply has historically been regarded as a free public service by state-owned public utilities. Chinese consumers therefore believed that it is the "fundamental right of households to have access to water without paying a price for the resource" (Merrett, 1997).

Recent acceptance of price hikes stems from both an increased acceptance of market-based policies and a decreased importance of ideology as the foundation for policies. Following the Third Plenum, the central government enacted reforms which "liberalized the scope of intellectual and personal freedom, increasing the opportunity for intellectuals to influence public policy. Economists in particular enjoyed a renewal of prestige... They vigorously advocated the wider application of economic methods in water policy as well as the rest of the economy" (Ross, 1988). Coincidently, at the same time, a drought in the early 1980s forcing factory closures and constraining water use served well to prove to the public that water pricing reform was needed to ensure the most economical use of water (Ross, 1988).

Additionally, the role of ideology as the basis for society began to diminish after 1978. By the 1990s, it was clear to the public that, ideologically, the socialism that the CCP continued to pledge conflicted with the rampant laissez faire capitalism that they saw occurring all over the country. This conflict eroded the legitimacy of ideology as a backbone for public policy-making. "The desancitification of ideology in the 1980s has allowed people to become indifferent to politics and concentrate on private/material things. In the logic of the economic reform, this was not only allowable but desirable because it removed political fetters on productivity and provided incentives for personal initiative. People were urged to consume, to become rich, to open their minds to foreign ideas, to develop themselves as 'entrepreneurs' by seizing business opportunities, to compete with each other and regard inequality as a social good rather than evil" (White, 1993).

Box 5.1. Public unrest in Jiazi, Guangdong (Excerpt from Lei, 2000)
Earlier this year, the *Guangzhou City Evening Paper* reported that the town of Jiazi, Guangdong, raised water prices to the highest in China: 2.8 yuan/m^3 for domestic, 3.5 yuan/m^3 for industrial, and 4.5 yuan/m^3 for commercial. The article documents some of the negative financial impacts this price hike has had on local residents and businesses. Households are disgruntled at not only high rates, but at the existence of fixed charges:

> Retired teacher Mr. Li holds up a thick pile of water bills, totalling 340 yuan/month. The old teacher says "my one month retirement pay is only 460 yuan, my son and daughter-in-law live with me, and they have three children who are all still in school. My whole family's income barely amounts to six or seven hundred yuan, and water fees alone will cost us 340 yuan, and you say we can swallow it up?"
> The reporter notes that Mr. Li's family have installed a dirty water system in the family toilet. Normally, water used for washing clothing is used to clean the cupboards, wipe the table, and finally flush the toilet. Mr. Li states "the tap water company has another regulation one cannot accept. Every month one must pay 6 tons of basic water fee, they call this a ' bottoming fee ', even if you do not use the water you must pay it."

The reporter provides another example of households dealing with the high cost of tap water by replacing it with well-water.

> Reporter walks out the town ruins, and arrives at the large courtyard at #98 Xinmin Road and sees a well. Originally this courtyard housed seven families. Before connection to tap water, all seven families used well water, once they were connected to tap water, 3 water meters were installed, but logically, since water fees were too high, they were never used. All the families in the courtyard were consulted later to find that quietly living upstairs were three families with two water meters, these 3 households spend half their time out of the country doing business and do not mind paying the "bottoming fee", but in fact the four families downstairs only installed one water meter, which leaves 3 families out of the "bottoming fee", but every "bottoming fee" and water fee are shared by 4 families. The middle age Mr. Huang says: "There is no other choice, it is forced upon us. It should not be done like this, who can afford such an expensive water fee." Everyone in the courtyard confirms, the 4 families only use 20 m^3 of water per month, they mainly rely on well water except when cooking rice or other cereals or to make tea. Clothes washing and showering all use well water. Some say that they had hoped to live entirely on running water long ago if tap water wasn't so expensive, because well water contains salt and clothes do not wash out white but yellowish. Therefore, while it sounds as it tap water is convenient it is not the case to some.

In another part of the county, families are coping with high water rates by buying and selling tap water from each other:

> Some households would rather buy water from another family so as not to install a water meter ... the household that sells water also benefits by selling water to spread the cost of the "bottoming fee."

Commercial enterprises are greatly impacted. At 4.5 yuan per m^3 restaurateurs spend a fair-sized chunk of their expenditures on water. Many restaurant owners complain that fees are too high.

Industry is also affected by rising water prices. An example of this is the local Lufeng ice manufacturer. This factory, a state-owned enterprise, went from earning a yearly profit before price hikes, to losing money continuously after the price hikes. Being a state-owned enterprise subject to price regulation, this company is not able to pass on the water prices by raising their prices. Instead, it too attempts to cope with cost by drawing from well-water: 70% of the ice is now made with well water.

5.4.3. Maximise Policy Simplicity

Pricing policies that are clear, transparent and easily understood by company staff, government officials and customers alike are more practical and easy to administer. Policies which are complex are more difficult for the public to comprehend. Therefore, the Beijing Waterworks Company holds the goal of simplifying policy structure in order to minimise public unrest and ease implementation.

5.4.4. Minimise Administrative Complexity

Minimising the need for administrative, informational, monitoring, enforcement, and transaction costs is a goal held by the Beijing Waterworks Company. This objective helps achieve other goals, such as increasing public understanding, reducing costs, and increasing ease of implementation.

5.5. Economic Liberalization / Marketization

After the Third Plenum in 1978, reformers led by Deng Xiao Ping strove towards an increased use of the market in all sectors of the economy. These reformers exchanged the priorities of equality and government regulation of the economy, for economic growth. As a result, China transformed rapidly from a command economy to a *market socialist economy*. Many sectors previously under state control were marketized, and China retired its protectionist policies to become one of the world's ten largest exporters (Mastel, 1997).

Although the birth of Chinese *market socialism* is officially marked by the Fourteenth Party Congress in 1992, official acceptance of marketization occurred as early at 1987, with the pronouncement of the "Decision on the Early Stage of Socialist Development" at the Thirteenth Party Congress. The development of a market economy was already well underway, when Deng Xiao Ping proclaimed in 1992 that "if an idea can help speed up development, we must not stop it but should try to make development still faster. In any case, we must set store on efficiency and quality. We must seize every opportunity to make the country develop quickly. We have a good opportunity now; if we fail to seize it, it will be gone soon. Slow development simply means to halt. We must strive really hard to upgrade the economy to a new level every few years." In 1994, the "Decision on Reform of the Economic System" was passed, which changed the doctrinal belief that socialism equals a planned economy with the notion that socialism equals a market economy. "After adoption of this resolution, the pace of economic reform dramatically quickened" (Yabuki, 1995). While the impetus to liberalize seems to have slowed in order to regain stability, pressures from both internal (reformers and Chinese businesspeople) and external (WTO partners, and foreign companies) agents to further liberalize the economy are great.

With the adoption of a market economy, the Chinese national government pursued all the objectives of a capitalist economy. Some of these include maximizing economic efficiency, maximizing the use of market-based instruments, and minimizing the use of subsidies. Clearly, these goals overlap with one another, however, they are detailed separately because they each relate specifically to water pricing policy.

5.5.1. Maximize Economic Efficiency

The main objective of a market economy is to maximize economic efficiency. This means maximizing output for any given level of input. In a world with scarce resource inputs, economic efficiency seems logical.

Water, like all commodities, is economically scarce when there is not enough available to allow users to have as much as they want without giving up something else of value in order to obtain it. When water is plentiful, there is no need to develop rules for its use and allocation (see Appendix A for an introduction to the economic foundations of water pricing theory). Maximising the economic efficiency of water use means making the most (value-wise) out of each unit of water.

5.5.2. Maximize the Use of Market-Based Instruments

According to neoclassical economics, market-based instruments are the most effective in achieving economic efficiency. Thus the goal of maximizing the use of market-based instruments is held by top leaders in China. Many national-level decrees, plans and laws, including the national Ninth Five Year Plan and Agenda 21, specify the need to apply market-based techniques.

Water allocation can be accomplished in three general ways: (1) without using market-based instruments (2) entirely using market-based instruments (3) partly using market-based instruments. Different water pricing policies differ with respect to these three methods and therefore differ in the level they achieve this objective.

5.5.3. Minimize the Use of Subsidies

There are not a lot of direct references to the reduction of subsidies, however this goal is clearly being pursued. The rationale behind this goal is multifold. First, government reforms beginning in the late 1970s reduced revenues collected by the central government. Central agencies could no longer afford large subsidies to lower level governments. Second, the adoption of market principles meant that subsidies were no longer viewed as tools to better society by fostering equity, but disruptions to a smooth market flow which "adversely affect incentives offered by water sector enterprises, and hinder efficient performance" (Shepard, 1999). Government acknowledged that subsidized water is subject to wasteful, inefficient use.

There are ample examples of subsidy cuts throughout China. For example, section 5.1. discussed the impact of subsidy reductions on tap water companies. Agenda 21 argues for the need to reduce subsidies that inhibit the achievement of environmental goals. Since water provision in Beijing is subsidized by the Beijing Municipal Government, this goal is largely held by the BMG.

5.5.4. Minimize the Role of the State

Neoclassical economists, such as Adam Smith, argue for the reduction of government control in order to achieve a smoothly functioning, economically efficient market. In an effort to marketize, Chinese leaders are taking this advice and preoccupying themselves with redefining the role of the state as regulator rather than as allocator. Reforming the role of the state involves reducing subsidies to local government (see 5.5.3), encouraging market forces to allocate goods rather than rely on government allocation (see 5.5.2.), and reforming state-owned enterprises (or SOEs) (see 5.5.4.1.).

5.5.4.1. Reform State-owned Enterprises (SOEs)

After the rise of the CCP, the central government, under various Ministries, took over industrial production in the form of state-owned enterprises. For a number of years, these enterprises employed China's industrial workforce and more or less effectively industrialized the nation. However, their inefficiencies and gross environmental neglect became apparent and acknowledged after Mao's death. His death also marked the beginning of the end of SOEs.

Following Mao's death, Deng Xiao Ping's economic reforms legalized and promoted non-state enterprises. He also aimed to make SOEs profitable and market-based, through policies that both dismantled the most inefficient SOEs and reformed others. Some reforms "include changing the makeup of governing board, privatizing competitive SOEs, and allowing the SOEs that simply are not salvageable to declare bankruptcy" (Mastel, 1997). Shutdown was avoided unless absolutely necessary because of unemployment issues. Indeed the reform of SOEs was urgent, particularly for large firms which employed thousands of workers. Many were operating in the red, and some deeply so. Profits of SOEs declined on average from 15% in 1981 to 3% by 1990 (Yabuki, 1995). The result of these reforms was a dramatic decline in the number of SOEs. In the late 1970s state owned enterprises contributed 80% of production, but by 1990 this figure was only 50% (Yabuki, 1995).

However, the work of reformers is not complete. The Ninth Five Year Plan continues to call for reforms on SOEs. Today, SOEs remain a massive force in Beijing numbering 100,000 (ranging from large manufacturing operations with thousands of employees to small local ventures with only a few) (Mastel, 1997) and accounting for 50% of total industrial production in the mid-1990s (Chreod, 1999). Many problematic enterprises have used their intimate relations with the ministries responsible for their sectors to resist reformation. Their role in employment is crucial to much of China's urban population and thus, according to one analyst, "it is unlikely that reforms will remove state-owned enterprises from the economy over the next fifteen years, provided the Communist Party remains in power. Their growth, however, is likely to be limited and there will be cases of privatization" (Edmonds, 1996).

While reform of SOEs doesn't appear directly related to water pricing, its relevance lies in the fact that water supply companies are SOEs. Although privatization of tap water supply has yet to occur in China, it may happen in the near future. Regardless, the goal of making SOEs (such as tap water companies) more profitable and less reliant on government support is wholly supported by the central government.

5.6. Economic Growth

Perhaps the most important objective for China as a whole is economic growth. Already in the past two decades, China's economic growth, at 9.5% per annum, has been deemed "the greatest economic achievement of the later half of the twentieth century" (Mastel, 1997). Figure 5.1 shows China's GDP growth from 1985-1995.

Today, nary a speech goes by in the National People's Congress without addressing economic growth. Numerous documents reinforce economic growth as national priority number one. The national Ninth Five Year Plan set GDP growth targets of 8% per year between 1996-2010, 6.4% between 2011-2020, and 5.7% between 2031-2050 (Wang et al., 1999). It aims to double 1980 per capita GNP by 2000, and double 2000 per capita GNP by 2010. The Beijing Ninth Five Year Plan sets a similar target: GDP growth rate of 9% per annum in Beijing between 1996-2000 (8% between 2000-2010), to 213 billion yuan (in 1995 prices) by 2000. Agenda 21 calls for the prioritization of economic growth over environmental objectives. In the preface, Premier Li Peng conveys not only the sense that environmental protection is less important than economic growth, but that economic growth is a prerequisite for environmental protection.

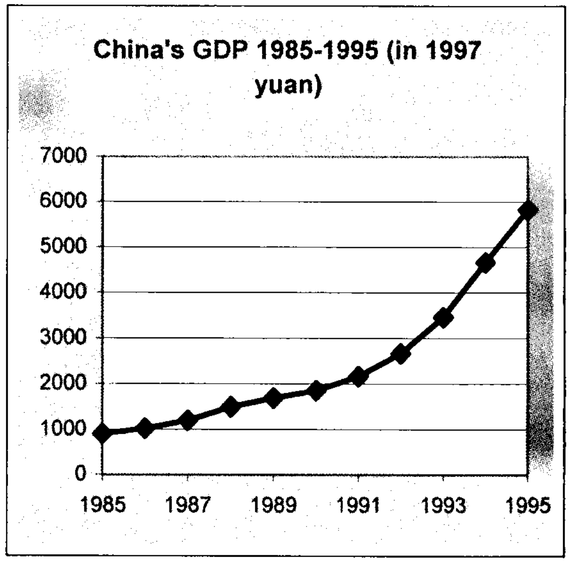

Figure 5.1. China's rising GDP (WB, 1997a).

Although all levels of government desire economic growth, for the sake of this study we will consider this objective as primarily held by the central government and the Beijing Municipal Government.

5.7. Improve Living Standards

The Ninth Five Year Plans contain statements about the improvement of living standards. For example, the Ninth Five Year Plan aims to improve access to health and education, eliminate poverty, and bring per capita GDP to US $5100 by 2025 (Wang et al., 1999). The Beijing Ninth Five Year Plan aims to increase per capita income by 3-5% annually, raise the living standards of low income residents and ruralites, improve housing conditions, and make the material lives of Beijingers well-to-do and comfortable by 2010.

The goal to improve citizen living standards is held primarily by local level governments, such as the Beijing Municipal Government.

5.8. Tertiarization

In Beijing, as in the rest of China, government has placed priority on the development of the tertiary sector. Section 2.3.2.1. describes the recent shift towards the tertiary sector. The rationale the Chinese Communist Party provides for this directive is that the "tertiary industry requires less inputs, yields quicker returns, and brings about positive social effects...[it] has a unique advantage in absorbing workers and creating jobs. It includes a large number of trades and a wide variety of jobs...Speeding up the development of the tertiary industry is a major step toward easing the increasingly serious employment pressures in our country" (CCP, 1992).

The goal of tertiarization stems from the highest ranks of Chinese government in CCP Document No. 4, June 16, 1992. This document announces the decision by the State Council and CCP to accelerate the development of the tertiary industry above that of primary and secondary industries, so that the weight of the tertiary industry in China's GNP and employment structure reaches "the average level of developing countries."

This national goal is manifested at the local level in the Beijing's Ninth Five Year Plan. This plan aims to grow the tertiary sector at 10% annually, and aims for a primary: secondary: tertiary ratio of 4.5:45.5:50 by 2000, and 2.6:42.4:55 by 2010. It calls for the enlargement and improvement of the services sector to create a multi-functional, multi-level, highly efficient tertiary sector. The focal points for development of this sector are commerce and finance, tourism, transportation, post and telecommunications, IT, and real estate.

The relationship between tertiarization and water pricing policy is not strong. Promotion of the tertiary sector will have the effect of reducing water usage (as water use per yuan output from tertiary sector is low). Further, local politicians may have the incentive to keep commercial water prices low to encourage the growth of the tertiary sector.

5.9. Price Control

Since the founding of New China, commodity prices have been regulated more or less by the central government through its Price Bureaus. Public utilities, such as water supply, fall under one of the categories for strictest government price control. Today's price control objectives focus on minimizing price inflation and normalizing prices.

5.9.1. Minimize Inflation

China experienced high inflation rates between 1979 and 1995. From 1990 to 1994, inflation reached as high as 11%. Thus one of the main concerns of the Beijing Municipal Government and the Price Bureau to minimize price inflation. This goal is described in several national documents. First, the Ninth Five Year Plan aims to control inflation by "implementing a firm finance and currency policy in order to maintain a balance with regard to society's demand and supply, and to lower the commodity prices. Above all, it is necessary to keep the prices on goods lower than the economic growth rate" (UNDP-China, 1996). Additionally, the Price Law requires prices to be set to stabilize the general price level (Article 26).

Policies which contribute to inflation are those which raise the price of goods excessively, or policies which change commodity prices too rapidly.

5.9.2. Price normalization

China aims "to raise all domestic prices of tradables to world price levels by the year 2000" (Panayotou, 1998). Although this objective is meant to help China enter international trade organizations, marketization of the economy and reduction of government subsidies requires the normalization of commodity prices.

As of 1978, price reforms began to bring commodity prices to market levels. Previously these prices were kept artificially low for social equity reasons, but with the empowerment of the reformers and the introduction of marketization in China, an impetus was felt to normalize prices. By the early 1980s, a significant proportion of transactions began to occur at market prices "and in 1985, market prices were given legal sanction for exchange of producer goods outside the plan… Gradual decontrol of consumer goods prices – initially cautious – steadily brought most consumer goods under market price regimes" (Naughton, 1995). Table 5.6 demonstrates that in 1978 only 3% of goods were at market prices. By 1990, almost half of all goods traded were at market price.

1992-94 saw the most rapid marketization of prices in China. The number of goods subject to planned prices was reduced and the number of goods allowed to oscillate either at floating, negotiated, or market prices increased (White, 1993). "The government began to dismantle price controls on those commodities where they had been most deeply entrenched. These included key producer goods such as coal, oil, and steel, as well as sensitive consumer goods, particularly grain. For the first time, the government … started to cut back the plan in order to move toward full market pricing" (Naughton, 1995).

Table 5.6. Percentage of commodities under government control (Naughton, 1995).

	1978	1985	1988	1990
Proportion of total retail sales				
Market prices	3%	34%	49%	45%
Guidance prices	Neg.	19%	22%	25%
Fixed prices	97%	47%	29%	30%
Proportion of agricultural procurement				
Market prices	6%	40%	57%	52%
Guidance prices	2%	23%	19%	23%
Fixed prices	92%	37%	24%	25%

5.10. Control Population Growth

Although population growth has slowed, it is by no means a finished battle. Population growth control is still a top priority among China's leaders. In fact, China's top objective in managing its water resources is to control population growth (Frederiksen, 1999). This objective is stipulated in the national Ninth Five Year Plan, which aims to keep population at less than 1.3 billion by 2000, and 1.4 billion by 2010, and the Beijing Ninth Five Year Plan, which aims for a maximum population of 11.25 million in 2000, and 12.1 million in 2010.

5.11. Agricultural Reform

Agricultural policy in China over the past two decades swung like a pendulum between strict controls (to ensure food security) and marketization of the agricultural sector (to ensure financial sustainability).

Government concern for food security stems from a 2,500-year history punctuated by periods of crop failures and food shortages. Millennia of problems have forced Chinese rulers, from as early as 500 BC, to manage grain supplies. As a result, China remained relatively self-sufficient in terms of food production until the famine of 1959-1961, in which 43-46 million Chinese perished. In 1961, the government initiated major food grain imports for the first time in the nation's history. That year, 4.9 million tons of wheat were imported to stave off further famine (Crook, 2000). Since then, food production slowly stabilised, but imports were never fully abandoned.

With the stabilisation of crop production and the empowerment of the reformers in the late 1970s, came the first wave of agricultural reforms. From 1979-1984, reforms focused on decollectivizing agricultural production away from communal-units, back towards household units. This culminated in the enactment of the "household responsibility system" in 1983. "Households are now responsible for both production and distribution of net revenue ... they also control means of agricultural production such as tools, draft animals and mechanical equipment. As long as the mandatory procurement system is still in operation (formally or informally), the household is still obliged to deliver a certain amount of output to the state; it must also pay state agricultural tax and a contribution to the upkeep of the village collective. After meeting these responsibilities, it is free to dispose of its extra output as it wishes (consume it, sell it on the local free market, or sell it to the state at higher-than-quota prices)" (White, 1993). This system had the effect of encouraging households to increase production and keep down costs in order to earn a small profit for themselves.

The second stage of agricultural reform began after 1984. This stage aimed at rural commercialisation. Up until the 1980s, government-run "grain bureaus purchased, transported, stored, milled and sold all grain leaving the farm" (Crook, 2000). In the decade between 1984 and the early 1990s, food conditions improved and government began "to explore the principle of comparative advantage as applied to grains. Many had become comfortable with the idea that China could import 10 to 15 percent of its annual grain consumption requirements and still be basically self-sufficient" (Crook, 2000).

In January 1985, the system of mandatory state procurement of agricultural produce was abolished in State Council document one. No longer would government place responsibilities on agricultural households to produce a quota amount of grain each year; production would be now based on a series of contractual obligations. Further, there were reforms in "pricing policy, a diversification of purchase and sales channels and the replacement of procurement quotas with voluntary contracts signed between peasant producers and state grain departments" (White, 1993). Water prices for farmers were also raised in some areas in an effort to achieve economic efficiency in the agricultural sector (see section 2.4.2). By the beginning of the 1990s, "the government was no longer the nation's sole grain purchaser. As open markets became increasingly important, many provinces began phasing out the grain ration system that allowed urban consumers to purchase grains in retail markets" (Crook, 2000). "Henceforth, the role of the state as monopolist would decline and the role of markets would increase" (White, 1993).

In spite of reforms (or perhaps because of) the agricultural sector suffered low returns, and low profitability, which strained the relationship between government and farmers. Peasants were discontent and complaints were recorded from 1986 onwards (Zhu, 1991). Increased costs, such as water fees, were unpopular with peasants who in many cases refused to comply (see section 2.4.2). They argued that the production quota system had not been abolished but still existed under the guise of contracts. They resented the emphasis the central government placed on industry over agriculture. They felt that "as the economy became more market-oriented, all sectors of the state involved in the rural economy were pursuing their own special interests at the expense of agriculture: departments in charge of capital investments or materials supply diverted resources to projects from which they could reap quick and huge profits; some commercial departments raised the prices of farm inputs arbitrarily, or sold them elsewhere for a profit or foisted sub-standard products on farmers" (White, 1993). "While these criticisms were no doubt directed at local officials who were rapidly extending their industrial base, there were probably also an implicit criticism of central reformers, such as Zhao Ziyang, who could be accused of encouraging behaviour if not actually advocating it" (White, 1993).

In 1994, Lester Brown's book *Who Will Feed China? Wake-Up Call for a Small Planet* "upset China's leaders and temporarily undermined the delicate consensus within China that was supportive of the ongoing gradual grain market liberalization" (Crook, 2000). He argued that loss of cultivatable land and increasing demand for meat products[15], would lead agricultural collapse in China. He claimed that China would "need to import 175 million tons of grain by 2025. But world grain exports, after tripling between 1960 and 1980, have leveled off and thus may not be able to satisfy this additional need" (Brown and Halweil, 1998). As a result, China will drive up world prices because unlike smaller countries such as Isreal, Jordon, or Saudi Arabia who can import 70 to 90 percent of their grain without disrupting markets, China cannot (Brown and Halweil, 1998).

The cumulated effect of peasant unrest and Lester Brown's infamous book was a reversal in agricultural policy in the mid-1990s back towards grain self-sufficiency. Imports of grain were replaced with imports of chemical fertilizers. The "governor's grain bag responsibility system" was established in early 1995 to return responsibility for grain supply and demand management to provincial governors. It "aimed to stabilize or increase the area planted to grain; raise yields; increase grain production; ensure sufficient grain stocks; and raise the level of grain self-sufficiency at both provincial and national levels" (Crook, 2000). As a result, by 1998 China achieved a 100% grain self-sufficiency level.

In the spring of 1998, the pendulum began to swing back in the other direction. The extreme cost of supporting the "grain bag responsibility system" became unbearable to the national government. The cost in bank loans to fix grain prices at a high enough rate to ensure adequate levels of production increased from 47 billion yuan in 1984 to 226 billion yuan in 1994 (Crook, 2000). Total losses to the government for the 1997/98 year amounted to over 100 billion yuan (Crook, 2000).

That year, Premier Zhu Rongji formulated the "Four Separations; One Perfection" policy which aimed at improving management of grain companies and marketization of grain markets. At the same time, China's bid for entry into the WTO created a renewed impetus to reform agriculture. Although many aspects of agriculture had been liberalized, strict controls were still placed on grains to ensure food security. These instruments, such as "tariff rate quotas, import and export licenses, state trading companies, value-added taxes, and foreign exchange controls" (Crook, 2000) were used to protect Chinese farmers and ensure self-sufficiency. Pressure from WTO members over these taxes prompted Chinese leaders to reduce agricultural tariffs and relax trade restrictions. In April 1999, China agreed to a tariff freeze, with the commencement of tariff reductions in 2000, continuing through 2004 (Crook, 2000). Again it appears as if food security has been shelved and replaced by agricultural marketization.

This study will consider three agricultural-related goals: marketization of agriculture, food security, and protection of rural livelihoods. Traditionally, the Ministry of Agriculture was mandated with the goal of agricultural security and protection of rural livelihoods. Although in the past two decades it has been assigned the task of easing in reforms, in many instances, it has sided with farmers in protesting change. Thus the Ministry of Agriculture in our study will be responsible for both food security and protection of rural livelihoods. The goal of agricultural marketization will be held by the central government since the impetus for change stems from the highest levels of authority.

5.11.1. Food Self-sufficiency

According to the World Bank (1997a) "China's concerns about food security are as perennial as the harvest." Although leaders are aware of the cost of food security, they continue to place food security at the top of the list of five priorities for 'promoting sustainable, rapid, and sound development of the national economy' in the Ninth Five Year Plan and the Fifteen-Year Perspective Plan (WB, 1997a). Chen Yun in the 1980s argued that grain production must come first because grain shortages can cause social disorder (Ross, 1988).

There are numerous reasons for promoting a policy of food self-sufficiency. First, with a swelling population, China is at risk of famines. Food security aims at avoiding catastrophes such as the famine of the Great Leap Forward, which claimed 43-46 million lives (Crook, 2000). Second, self-sufficiency in feeding one's population is politically advantageous and brings about order and stability. This is because China is determined to avoid dependence on imported grain for fear of volatility in world markets and vulnerability to

[15] "A meat-based diet is a more water intensive diet given that producing one pound of nutrients in the form of meat requirements requires more water based inputs, chiefly more grain, than is required to produce the same amount of grain-based nutrients" (Chreod, 1999).

boycotts by large grain exporters such as the US, on political grounds. Finally, as a primarily agricultural nation, farming acts as the mainstay of China's economy. Other sectors, such as industry, depend on the primary sector. Researchers found that events affecting agriculture would affect industry a year later. "For example, the decline in agricultural growth in 1952 and 1953 was mirrored by decline in industrial growth in 1953 and 1954. This clearly suggests that industrial growth was constrained by the growth of agricultural because of, inter alia, the reliance of industry, especially light industry, on agriculture for raw materials and the constraint that lagging food production exercised in growth in the industrial worker population" (Yabuki, 1995). Thus food security helps ensure a solid foundation for the rest of the economy.

Several sources establish the goal of food security. First, the Ninth Five Year Plan places "high priority on developing agriculture in general and grain production in particular" (WB, 1997a). The Plan commits to boosting agricultural production to 500 million tons per year by 2000, or 400 kg/person (Yabuki, 1995). The Beijing Ninth Five Year Plan targets an agricultural output value of 9.5 billion yuan (in 1995 prices) by 2000. Second, the Agricultural Law contains clauses pertaining to protective pricing, risk funds, and county-level crop purchase at state established prices for important crops such as grain and cotton (Articles 22, 36, and 41). The Agricultural Law also places controls on availability and price of agricultural inputs (Articles 33 and 8), and regulates the movement and production of key agricultural products[16] (Articles 35 and 36).

5.11.2. Agricultural Marketization

The demotion of agriculture from China's top priority to a market-based sector is the aim of many of China's top leaders. Bent on reform, these leaders aim to "diversify the rural economy and make it more market responsive" (Ross, 1988). Since the market economy promotes economic efficiency and maximising the use of market-based instruments (see 5.5.1), agricultural marketization requires the efficient allocation of resources across sectors[17], and within the agricultural sector[18].

Although the Ninth Five Year Plans and the Agricultural Law emphasize the need to protect the agricultural sector, these same documents also call for marketization of agriculture. First, the Ninth Five Year Plan de-emphasizes the importance of agriculture to the overall economy by focusing attention on industrial rather than agricultural development. The desanctification of agriculture makes it simply a sector like any other and thus erodes the legitimacy of protectionist policies. The Beijing Ninth Five Year Plan argues for market-based policies for Beijing's agricultural sector, such as "toward a market, service capital and prosper farmer," and development of "high yield, high quality, high efficiency" agriculture. According to this Plan, emphasis in agriculture should switch from grain production towards development of poultry, beef, and lamb, agricultural by-products, and high quality non-staple foods. Finally, the Agricultural Law contains clauses that call for marketization. It states that the primary purpose of agricultural development is to develop the socialist market economy in rural areas (Article 1). It also calls for adjustment of agricultural production according to market demands (Article 22) and gradual introduction of the market in purchasing and selling agricultural products (Article 35).

5.11.3. Protection of Rural Livelihoods

A goal related to food security is *farmer security*. The Agricultural Law specifically addresses the need to consider rural livelihoods in several places. In Article 1, it specifies that agricultural development must be done while "safeguarding the lawful rights and interests of agricultural production and operation organizations and agricultural labourers" (Article 1). The purpose of agricultural development, according to this law, is to "emancipate and develop rural productive forces, develop and utilize the rural labour force, and increase the income of agricultural labourers, raise their living standards, build a new countryside of common prosperity and

[16] These are products, such as grains, which impact on the national economy and on people's livelihoods

[17] The shifting of water resources away from agriculture towards industry increases efficiency. For example, a thousand tons of water can either produce one ton of wheat which fetches a market value of $200, or $14,000 worth of industrial of output (Brown and Halweil, 1998). In Beijing, reallocation of water out of agriculture occurred first in the 1980s, and again in 1994. In 1984, the State Council authorized the transfer of water from the Miyun reservoir from agricultural to urban use. Fortunately for farmers, government support was available in the form of subsidies to help farmers convert to water-saving irrigation techniques such as sprinklers (Nickum and Marcotullio, 1999). In 1994, however, farmers were not so lucky. That spring, they were denied access to irrigation water because it was needed to satisfy the thirsty urban core. Currently, Beijing's policy dictates that agriculture has the lowest priority: "local water resources will be used to ensure supply to the city centre. During serious drought, water resources allocation will give first priority to domestic use, second to industry use and third to agriculture" (Beijing Public Utilities Bureau, 1993).

[18] Market economists encourage Beijing to grow crops that minimize on the use of scarce resources such as water and land, and generates more revenue per unit input. Thus higher value crops (such as vegetables) and low-water intensity crops are being encouraged as part of agricultural marketization (in section 2.3.3 we discussed how this process is already occurring).

civilization and gradually realize agricultural modernization" (Article 2). Additionally, the Agricultural Law promotes the development of non-agricultural markets, such as town and village enterprises, to absorb excess agricultural labour (Article 24).

5.12. Ensure Adequate Water Supply

China's system of water management splits responsibility for various aspects of water supply into many organizations. Overall water availability on a regional or national scale is under the mandate of the Ministry of Water Resources. The MOWR approves and funds major water projects, such as the South-North Middle Route Transfer Project (see Box 6.2), which supply the Beijing region with water resources. Within Beijing Municipality, rural water supply and delivery is the responsibility of the Beijing Water Bureau, while urban water supply is taken care of by the Beijing Waterworks Company. Since urban water needs to be potable, the Beijing Hygiene Bureau is charged with the responsibility of ensuring adequate water quality in the urban area. Although objectives 5.12.1 to 5.12.4 are straightforward, they will be separated because they fall under the mandates of different actors.

5.12.1. Ensure Adequate Overall Water Supply

This goal is to ensure that Beijing has enough water to satisfy urban (domestic and industrial) and rural needs.

5.12.2. Ensure Adequate Water Supply for Agricultural Use

This goal is to ensure that enough water of an acceptable quality is available to farmers for agricultural uses.

5.12.3. Ensure Adequate Water Supply for Urban Use

This goal is to ensure enough water to meet urban (domestic and industrial) requirements.

5.12.4. Ensure Adequate Water Quality

This goal is to ensure that urban water for potable purposes meets both national and municipal drinking water standards.

5.13. Summary of Objectives

The objectives described in this chapter are summarized in Table 5.7. The first column simply lists the objectives described, while the second column lists the primary actor(s) that hold the particular objective. The last three columns attempt to prioritise the objectives. Column three describes how important this objective is to the particular actor(s) who hold it. This is based on the assumption that agencies prioritise their goals and give some goals greater weight than others. In this table, the level of prioritisation ranges from very low to very high. The fourth table is similar to the third, only this time the priority of the goal to the nation in general is provided. While some goals are deemed national priorities, such as economic growth, others are not worthy of national attention, such as providing tap water companies a stable source of revenue. And finally, the last column describes how relevant each goal is to water pricing policy. While some goals, such as full cost recovery for tap water companies, are directly related to water pricing policy, others, such as population growth, have little relevance to the issue. Only very few goals are listed as having very low relevance because completely irrelevant goals did not enter the study altogether.

Table 5.7. Summary table of objectives.

Objective	Primary goal holder(s)	Priority for actor involved	National Priority	Relevance to Water Pricing Policy
5.1. Financial Independence for Water Supply Providers	• Ministry of Construction • Beijing Waterworks Co.	Very High	Low	Very High
5.1.1. Full Cost Recovery	• Ministry of Construction • Beijing Waterworks Co.	Very High	Low	Very High
5.1.2. Minimize Cost of Service Provision	• Beijing Waterworks Co.	High	Low	Very High
5.1.3. Reasonable Return on Capital	• Ministry of Construction • Ministry of Water Resources • Beijing Waterworks Co.	High	Low	Very High

5.1.4. Stable Source of Revenue	• Beijing Waterworks Co.	High	Very Low	Very High
5.2. Water Conservation	• Beijing Municipal Government • Beijing Water Savings Office	Very High	High	High
5.2.1. Installation of Water Efficient Technologies	• Beijing Water Savings Office	Medium	Low	Medium
5.2.2. Installation of Water Reuse Facilities	• Beijing Water Savings Office	Medium	Low	Medium
5.3. Equity and Affordability				
5.3.1. Affordability	• Beijing Price Bureau	High	Medium	High
5.3.2. Equity	• SC and NPC	Low	Low	Low
5.3.2.1. Fairness	• Beijing Municipal Government	Low	Low	Low
5.3.2.2. Equality	• NPC and SC	Very Low	Very Low	Very Low
5.4. Maximize Ease of Implementation	• Beijing Waterworks Company	Very High	Low	High
5.4.1. Maximize Public Awareness	• Beijing Waterworks Company	Medium	Low	Low
5.4.2. Minimize Public Unrest	• Beijing Waterworks Company	Very High	Medium	High
5.4.3. Maximize Simplicity of Policy	• Beijing Waterworks Company	Low	Very Low	Medium
5.4.4. Minimize Administrative Complexity	• Beijing Waterworks Company	Low	Very Low	Medium
5.5. Economic Liberalization / Marketization	• NPC and SC	High	High	Medium
5.5.1. Maximize Economic Efficiency	• NPC and SC	High	High	High
5.5.2. Maximize the Use of Market-based Instruments	• NPC and SC	High	High	Very High
5.5.3. Minimize the Use of Subsidies	• Beijing Municipal Government	High	Medium	High
5.5.4. Minimize the Role of the State	• NPC and SC	High	High	Medium
5.5.4.1. Reform SOEs	• Beijing Municipal Government	Very High	High	Medium
5.6. Economic Growth	• NPC and SC • Beijing Municipal Government	Very High	Very High	Low
5.7. Improve Living Standards	• Beijing Municipal Government	Medium	Medium	Low
5.8. Tertiarization	• NPC and SC • Beijing Municipal Government	High	High	Very Low
5.9. Price Control	• Price Bureau	High	Medium	High
5.9.1. Minimize Price Inflation	• Price Bureau • Beijing Municipal Government	High	Medium	Medium
5.9.2. Normalize Prices	• Price Bureau	Medium	Medium	Very High
5.10. Control Population Growth	• NPC and SC	High	High	Very Low
5.11. Agricultural Reform				
5.11.1. Food Self-sufficiency	• Beijing Agricultural Bureau	Low	Low	Medium
5.11.2. Agricultural Marketization	• NPC and SC	Medium	Medium	Medium
5.11.3. Protection of Rural Livelihoods	• Beijing Agricultural Bureau	High	Low	High
5.12. Ensure Adequate Water Supply	• Ministry of Water Resources • Beijing Municipal Government	High	High	Low
5.12.1. Ensure Adequate Overall Water Supply	• Ministry of Water Resources	High	High	Low

5.12.2. Ensure Adequate Water Supply for Agricultural Use	• Beijing Water Bureau	Medium	Medium	Medium
5.12.3. Ensure Adequate Water Supply for Urban Use	• Beijing Waterworks Co.	Very High	High	High
5.12.4. Ensure Adequate Water Quality	• Beijing Hygiene Bureau	Very High	Low	Low

Chapter 6: Alternatives

This chapter lists water pricing alternatives. These options were derived from water pricing theory literature. For more information on the economics behind these alternatives, please see Appendix A.

6.1. Sectoral Allocation

When setting a pricing policy, the government can either set prices intersectorally (allocating water between sectors) or intrasectorally (allocating water within one sector).

6.1.1. Intersectoral Pricing

Intersectoral pricing sets equal prices for a specific quality and quantity of water *across sectors*. In other words, all sectors face the same prices because demand is taken as a lump sum regional demand rather than demand divided by sector. Intersectoral pricing has the effect of reallocating water from less efficient water users to more efficient water users.

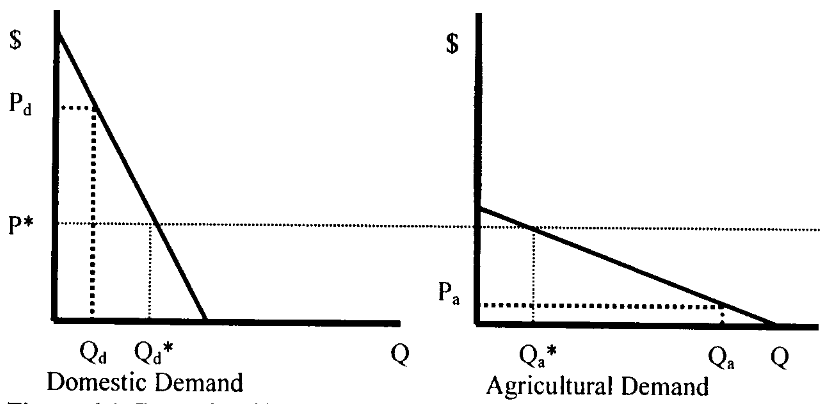

Figure 6.1. Example of intersectoral pricing between domestic and agricultural users.

> **Box 6.1: Beijing – a maturing water economy**
> In many ways, Beijing is exhibiting the typical signs of a "maturing water economy" according to Nickum (1994). This movement from a "developing," or "expanding" water economy to a "maturing" one has been observed in other cities. During the expansionary phase, the incremental cost of new water supplies remains relatively constant, in real terms. Ample underdeveloped water resources are available to meet expanding demands. Extensive development of water-intensive industries, particularly irrigated agriculture, takes place. Economic growth is reflected in expanding water supplies.
> The mature phase, characterized by full development of inexpensive water sources and by growth and shifts in the economy away from primary industries such as agriculture, results in rapidly rising water costs and greatly increased interdependencies among water users" (Saliba and Bush, 1987). In the mature water phase, transfers of water occur from lower-value to higher-value and stagnant to

Figure 6.1 demonstrates the reallocation of water from irrigation to domestic use through the equalisation of prices across sectors. Initially, farmers and households face different water prices. As in the case of most cities domestic users face a higher water price (P_d) while agricultural users face a lower (likely subsidized) price (P_a). At these prices, total domestic water-users demand Q_d units of water, while agricultural users demand Q_a units. The water utility then decides to equalise prices by charging both domestic and agricultural users the same water rate (P*). Since the price has dropped for domestic users, they now demand a greater quantity of water (Q_d*). That additional supply of water is coming directly out of the allocation originally intended for irrigation. This is because P* is higher than the price farmers were initially paying and thus their water demand drops to (Q_a*). Many units of water have thus shifted from agricultural users to domestic users. This movement of water from lower-value to higher-value sectors is indicative of a maturing water economy (see Box 6.1).

Intersectoral pricing can also be a useful way to deal with demand increases, without increasing supply (see Figure 6.2). In the case where urban demand for water (D_u) increases (to D_u') while total water supply remains fixed, total regional water demand also increases from D_t to D_t'. This increased total demand drives the price of water up to P' (from P). At this new price, farmers can only afford Q_a' of water (instead of Q_a). The city, however, will now purchase Q_u' units of water (up from Q_u). The shaded area shows the increase in benefits to the urban area and the decrease in benefits to agriculture. As you can see, in this situation, there is clearly a net loss as a result of redistribution. In some cases there can be clear net gains.

Although intersectoral pricing may improve efficiency, there are problems with its application in Beijing. It is estimated that the economic rate of return to a unit of water for agriculture is less than 10% the return to municipal and industrial users (Lee, 1998). Clearly, agriculture cannot compete. Thus the application of intersectoral pricing may jeopardise other objectives such as food security (see 5.11.1), low cost food, and adequate rural incomes (see 5.11.3).

The application of intersectoral pricing is known as *opportunity cost pricing* (see section 6.2.4 for more information).

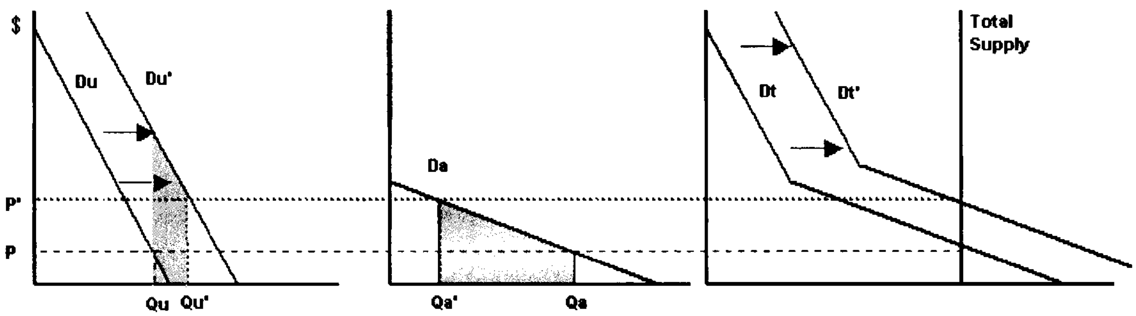

Figure 6.2. Intersectoral pricing in the case of fixed total available supply.

6.1.2. Intrasectoral Pricing

The effect of charging an equal price to all users within a sector is that water is reallocated within that sector from low-value uses to high-value uses. In the agricultural sector, shifts would occur from low-value, water intensive crops to high-value water-conserving crops. There is empirical evidence that this is occurring in the United States. "In Arizona for instance, the proportion of the state's irrigated acreage planted in alfalfa and small grains has declined by nearly 50 percent since 1970 and acreage in crops with higher returns to water (fruit and nut crops, vegetables and cotton) has increased proportionally" (Saliba and Bush, 1987). For industry, a similar shift occurs - low-water consuming, high-value industries are fostered, while highly consumptive, low-value, water-inefficient industries are either forced to change technologies or are slowly phased out. In the domestic realm, water use shifts from low-value water use (such as lawn watering) to high value water uses (such as drinking and washing), when prices are raised.

In the case of Beijing, intrasectoral pricing in the agricultural sector would shift production away from low value staple crops to higher value vegetables, by-products, and meats. While such a move erodes food security to some degree, it achieves goals such as agricultural marketization. In the industrial sector, intrasectoral pricing would promote the tertiary sector over heavy industry.

6.2. Pricing Methods

Pricing methods are the way in which we charge for water, based on either quantity used or time of use. The price level is the actual price charged for a given volume of water.

6.2.1. Public Allocation

Public allocation does not involve water pricing but relies entirely on general tax revenues, with allocation determined by public authorities. Some countries, such as Ireland, find it more efficient to consolidate household water charges into general taxation systems rather than issue separate water bills (OECD, 1999). While this may appear to be a step backwards, it is wholly justifiable when the cost of administrating a pricing structure is greater than the benefits.

Advantages:

- Equitable: since water is funded by general tax revenues which, presumably, are founded on progressive taxes such as income taxes, low income households are not adversely affected by high water prices.
- Simple: there is no need to understand a pricing system; time and money is saved by not needing to meter, bill, or collect.

Disadvantages:

- Poor conservation: perceived "free" water is likely to be wasted, no incentives for efficient use or reuse.
- Political pressure: allocation of water to various sectors and users may be influenced more by political lobbying than actual need.

- High informational needs: all information on the trade-offs between costs and benefits of various water allocation schemes is needed in order for public authorities to make the best decision. The computations required to accurately compare costs and benefits, in order to allocate goods and services to those who value them more, are too complex to be effectively performed centrally.
- Perceived as unfair: users who place more strain on supply systems are not forced to pay more for the service.

In the case of Beijing:
The pressing need for careful water allocation in the light of severe water shortage, makes this option particularly prone to political mishandling. Additionally, with a fairly sophisticated system of water pricing already in place (at least for domestic and industrial water use) the cost of administering a water pricing system is likely to be outweighed by the benefits.

6.2.2. Marginal Cost Pricing

Marginal cost pricing sets the price rate equal to the cost of producing the last unit of water supplied (or in other words, the price rate is equal to the marginal cost curve). This pricing scheme generates the optimal price and quantity, which maximises total benefits to society; that is, maximises consumers' surplus plus producer's surplus. This efficient point occurs when the marginal cost of supplying an additional increment of water equals exactly the marginal benefit (MB) of that additional increment. In other words, where the demand curve (MB) and the marginal cost curve (MC) intersect. This point is (P*,Q*) in Figure 6.3. At a quantity less than Q*, the consumer is willing to pay more than the cost of providing an additional unit of water, therefore the utility has an incentive to provide more units of water. At any quantity greater than Q* the cost of providing that water is greater than the amount consumers are willing to pay. Another way to conceive of this optimal point is to look at the losses in consumers and producers surplus when we move away from the efficient price and quantity. For example, if we were to move from supplying at the optimal Q* amount to Q', we would experience a loss in consumer surplus of B and a gain of A (as price would have to move from P* to P'). Producers' surplus will decrease by areas A and D. The net equation is -B+A-A-D = -B-D. Society is therefore worse off as a whole due to the loss of the shaded triangle BD. This is known as a dead-weight loss, which occurs due to movement away from the most efficient point.

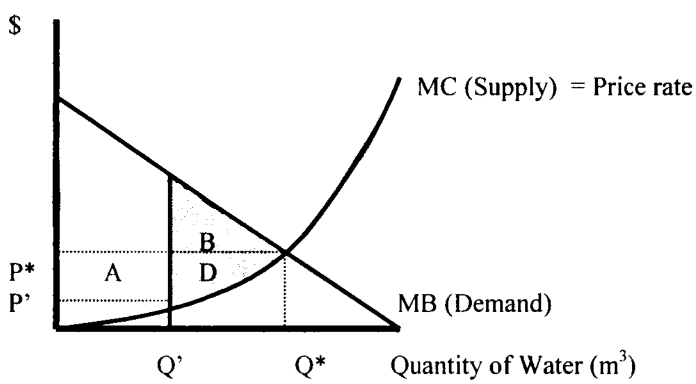

Figure 6.3. Example of marginal cost pricing.

While marginal cost pricing is still relatively rare, some countries have made attempts at implementation. Portugal, for example, in 1994 enacted legislation that requires new privatised water services to be provided at a charge equivalent to long run MC (OECD, 1999).

Because marginal costs are by definition "the cost of the next unit," calculation of long run marginal cost (LRMC) involves looking at the cost of the next major supply project. Typical LRMC curves are not smooth lines, but rising step-like curves, with each step indicating the cost of the next major project. In the case of Beijing, the next supply expansion project currently being proposed is the south-north transfer project (see Box 6.2).

6.2.2.1. Quantity Constraints

A special case in water pricing occurs when to the total amount of water available to the city is finite and thus expansion is constrained. In this case, pricing as a means of reducing demand and encouraging conservation is crucial. Figure 6.4 illustrates this scenario. The absolute maximum amount of water available to the city is denoted by Q_{max}, beyond which there is no possible expansion. Figure 6.4 also shows two possible marginal cost curves (MC_1 and MC_2) and the price at which water quantity is maximised (quantity equals demand at P*). In such a situation, setting price = MC only makes sense if $MC \geq P^*$ (such as if MC looked like MC_2). If MC < P*, demand for water would be greater than total available supply.

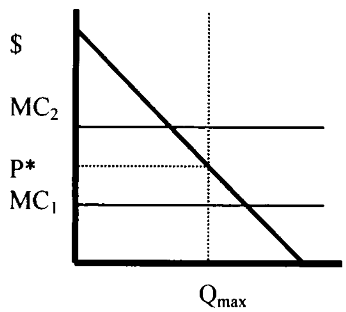

Figure 6.4. Example of MC pricing in a situation with constrained supply quantity.

Box 6.2: South-North Middle Route Transfer Project – Implications for MC pricing

With Beijing's hydrological crisis on the lips of bureaucrats and party officials in Beijing, a water supply scheme stemming from the mind of Mao Tze Tung began to take reality. The concept behind this project, tentatively entitled the South-North Middle Route Water Transfer Project, is simple: a gravity-based canal will transport water from the Yangtze River, northwards to Jiangsu, Anhui, Shandong, Tianjin and Beijing. The impacts and politics behind this endeavour, however, are extemely delicate. To better understand why this South-North transfer has been described as "more politically complicated than the Three Gorges Dam" we must first examine the project in some depth.

According to present plans, water will be diverted from the Danjiangkou reservoir in Hubei along a 1,240 km canal to Henan, Hebei, Beijing and Tianjin. Since the canal source is 300 feet higher than Beijing, the aqueduct would be downhill and use gravity to move the water. Along the way, the aqueduct will cross 4 river basins (Yangtze, Huaihe, Yellow and Hai), and 219 rivers and streams (including the Yellow River).

This project is divided into two stages. The first construction period would last four years and would create a pumping capacity of 600 m^3/s at Jiangdu, with an average annual pumpage of 9.14 billion m^3 at Jiangdu. The second period would take seven years, and would allow for a pumping capacity 1000 m^3/s and a average annual pumpage of 19.15 billion m^3 at Jiangdu station.

Clearly, any project of this scale (the second largest national construction project) will have huge environmental impacts. Some of these include a reduction of flow in the Yangtze River, which could lead to seawater intrusion, significant disturbance of aquatic ecology along the canals, and pollution of water by urban or industrial areas along the route. Additionally, social impacts will occur around the Danjiangkou reservoir, which must be expanded displacing 225,000 people, mostly farmers, in Hubei and Henan provinces (Tyler, 1994).

Additionally, financial costs are high. The initial estimate of USD $5 billion is expected to grow by up to ten-fold because this number "appears to include just construction costs and omits other considerations" (Lee, 1998). A complete cost estimation of the project would include environmental costs (e.g. reforestation, water treatment facilities, compensation for crops lost), and resettlement and development costs, in addition to construction, operation and maintenance costs.

One would require great benefits to offset these costs. However, "the amount of water (the benefit of the project) from Yangtze River is very uncertain and quite limited" (Luo, 1994). The anticipated mean annual transferable amount of water is 14.5 billion m^3, which will provide mean annual benefits of 18.5 billion yuan (15.88 billion yuan in urban industrial and domestic supply, 2.38 billion yuan in irrigation, and 0.25 billion yuan in flood control). For Beijing, this would translate to 70 m^3/s of in-flowing water. However, only less than 10% of the population benefit from this project – provinces along the way who are negatively impacted will be reluctant to contribute funds and manpower to this project, potentially leading to regional confrontation.

Advantages:

- Economically efficient: marginal cost pricing is currently being pushed by organisations such as the World Bank because it maximises gains to society.
- Conservation: MC pricing minimises waste (where waste is defined as use in which the benefits do not outweigh the cost of water provision).
- Fair: since heavy users pay more, MC pricing places the burden of increased demand (cost of extending system) on those that cause the increase.
- Flexible: easy to adjust to varying water supply quantities.
- Delays capital expenditures: pricing at marginal cost allows the utility to determine when users are willing to pay for additional capital (pricing at marginal cost can allow the utility to find the demand curve of users).

Disadvantages:

- Equity: neglects equity issues, tendency for those with ability to pay to be allocated more water, likely to negatively affect lower income groups and may incite undesirable changes in income distribution.
- Time-span sensitive: MC depends on the time horizon (whether we are considering the long run or short run).
- No guarantee of cost recovery: if fixed costs exist (and therefore AC greater than MC), pricing at MC results in financial loss to the utility.
- High information requirements: requires forecasts of costs and demand, and full social and environmental costs of water supply.

- Unstable: causes fluctuations in price, capacity utilisation and revenue (uncertainties compounded by effect of weather on water demand), heavily dependent on nature of demand.
- High tariffs: many water officials consider marginal cost pricing as leading to unrealistically high tariffs. "In fact, there are many different tariffs structures that would allow full cost recovery without strict marginal cost pricing" (Rogers, 1996). The high rates of marginal cost pricing make it a difficult pricing structure to implement. Often, only full average costs are recovered (Asad et al, 1998).
- Difficult to accurately calculate: very difficult to calculate LRMC due to indivisibility associated with large and long term additions to capacity which generally occur in the industry (Shepard, 1999).

In the case of Beijing:
Marginal cost pricing would primarily pose difficulties with regard to affordability. Based on the cost of the next long run supply projects, estimates place MC prices for domestic water use at 5 yuan/m^3 (taking the middle route transfer project into account) for the 15 year loan term, and 2.5 yuan/m^3 thereafter (US Embassy in Beijing, 1997). Industrial marginal costs are 3.10 yuan/m^3 (in 2000), 4.08 yuan/m^3 (in 2010), 5.14 yuan/m^3 (in 2020) (UNDP, 1994). Agricultural MC prices in Beijing are estimated at 1.72 yuan/m^3 (in 2000), 1.85 yuan/m^3 (in 2010), 1.58 yuan/m^3 (in 2020) (UNDP, 1994)[19]. These figures are significantly higher than current rates and higher than 3% of average household income (which is the measure of affordability according to the World Bank – see section 5.3.1 and Table 6.10). This would pose particular problems for poorer urban households and ruralites. These prices surpass those set by Jiazi in Guangdong, which incited public unrest (see Box 5.1), and are therefore also likely to trigger public outcry. However, given the water shortage situation in Beijing, such a pricing scheme would go far in encouraging water conservation and efficient water usage.

6.2.3. Transferable Water Rights

There is increasing interest in the United States in the use of transferable water rights as a means of water allocation. With this method, water is not priced by a regulating body but set by a water market. Users are given "rights" to extract water from various bodies of water. In the U.S., many of these rights are owned by irrigators and determined through prior appropriation and riparian rights. These rights are sellable to other users. This open market theoretically achieves efficient water allocation and pricing as rights holders sell to the highest bidders thus shifting water from low-value to high-value uses.

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[19] Long run marginal cost curves are more difficult to calculate because they require estimations of the marginal cost of expansion of the supply capacity. My research has revealed several very different estimations of marginal cost of water in Beijing:

- 5 yuan/m^3 as the true cost of water in the north (China Environment, 1998).
- 5 yuan/m^3 (taking the middle route transfer project into account) for the 15 year loan term, and 2.5 yuan/m^3 thereafter (US Embassy in Beijing, 1997).
- 0.6 yuan/m^3 in Beijing in 1988 (Ross, 1988)
- 1.4 yuan/m^3 in Beijing (Yu and Jia, 1997)
- US $0.11/m^3 in 1987 (Hufschmidt, M.M. et al., 1987).
- 1.32 yuan/m^3 (including both expansion and variable marginal costs) with an expected increase to above 3.0 yuan/m^3 by 2006 for Beijing (Yan and Stover, 1999)

These estimations likely vary for several reasons. First, the year of estimation varies. Some estimates are for the marginal cost of water supply in Beijing in the 1980s. Inflation has changed the value of the yuan and thus an un-indexed price is likely to be much lower. Second, the volume of water referred to by various analysts are different. In the 1980s, the volume of water produced was lower than in the present, and cost of the next unit of additional water would also be lower (this is based on the premise that marginal cost increases as total volume supplied increases). Third, while we can presume these analysts are estimating the marginal cost of tap water for domestic use, it typically not noted and thus uncertain. Some estimates may be estimating the marginal cost of irrigation water, while others may be estimating the cost of domestic tap water. Clearly, the marginal costs differ greatly between sectors.

Finally, what the cost estimator chooses to include or exclude in the estimation of marginal cost differs. While ideally, all costs, both external and internal, should be included, oftentimes difficulties in doing so prevent certain costs from being included in the estimation. For example, the construction of the Miyun reservoir in 1958 required 409,000 mu of land, which was 35.4% of cultivated land in Miyun county, and 10.1% of all the land in Miyun county. As a result, the county experienced a land shortage for cultivation. However, people in this county who experienced a direct economic loss were not compensated by the water users in the city. Evidence of this lies in their continued impoverishment; in 1991 the average monthly income in the Beijing suburbs was 1,456 yuan while the average income in Miyun county was a mere 929 yuan. Additionally, the Miyun reservoir periphery district is one of the most impoverished districts in Miyun county. Further, recent attempts to protect drinking water quality have created a buffer zone around the reservoir in which anything not related to water conservation is prohibited from being constructed. As a result, Miyun industrial development is stunted, and citizens do not receive compensation (Jiang, 1998).

The MC figures which I have chosen to represent are based on the building of the South-North Middle Route Project (see Box 6.2 for a summary of this project).

Advantages:

- Efficient: maximises overall social benefits, allows internalisation of externalities. .
- Equitable: proper allocation may allow for equitable compensation. For example, in the case of marginal cost pricing, those in low-value water-intense industries (such as agriculture) lose out when prices are set to marginal cost. However, if those users are allocated the rights to that water initially, as prices are driven up, they can gain by selling off their rights.
- Flexible: flexible in responding to changing market conditions.

Disadvantages:

- Legal issues: sensitive to existing physical, legal and institutional framework. In China water is state-owned and private water rights are thus non-existent.
- High information requirements: for an efficient market, full information must be available to all users.
- Transaction costs: costs of negotiating water sales may be high and may prevent a functioning water market.
- Difficult to implement: empirically, "virtually no other countries have developed functioning water markets, and even in the United States and Chile, government intervention and involvement remain significant" (Asad et al., 1999).

In the case of Beijing:
Transferable water rights can be ruled out as an option, at least for the foreseeable future. This is because the legislative framework of China vests water rights solely in the state thus making such a system unimplementable.

6.2.4. Opportunity Cost Pricing

Another theoretically optimal price structure is *opportunity cost pricing*. This structure involves setting price equal to the "the value to society that could be achieved if the same investment were made elsewhere" (Teerink and Nakashima, 1993). This ensures that water is used for maximum gain.

Advantages:

- Economically efficient: maximises net social benefits. "By pricing water at rates to receiver opportunity costs, the real value to the consumer is tested in his willingness to pay and the quantity consumed" (Teerink and Nakashima, 1993).

Disadvantages:

- High Informational Requirements: information requirements are onerous and vary dramatically by season and place. This method also requires full knowledge of all opportunity costs including costs and benefits that are not easily quantified.
- Over-pricing: poor estimation of the demand curves of various users may lead to an over-estimation of the willingness to pay for water. For example, if water sold to farmers is priced at the opportunity cost, which would be the amount industry or municipal users are willing to pay, prices will rise significantly. However, one must take into account the quantity involved – industrial and domestic users only use small quantities of water relative to agriculture and thus the opportunity cost of that water for irrigation is actually near zero. However, if the analyst uses long run demand of industry and urban users as a basis for willingness to pay, over-estimation of the opportunity cost of that water will likely occur.
- Not perceived as fair: the concept behind opportunity cost pricing is difficult for users to grasp and thus there will be stronger resistance to its implementation. Asad et al (1998) argue that opportunity cost pricing defies common sense. "It would mean that farmers in, for example, Chile, Australia, and California would be asked to pay more than 10 times the cost of providing the services they receive!" (Asad et al, 1998)
- Dependent on definition of "opportunity": the pricing structure varies significantly depending on how broadly defined the term "opportunity" is. For example, if the analyst considers inter-sectoral re-allocation a possibility, then opportunity costs are likely to higher than if the analyst only considers intra-sectoral localised reallocation. Asad et al (1999) define four levels of opportunity cost (ranging from narrowest to broadest):
    1. Water can be used only by an individual user

2. Water can be leased or sold to neighbours
3. Water can be leased or sold within a limited district
4. Water can be leased or sold to any urban or agricultural user

In the case of Beijing:
Opportunity cost pricing in Beijing would result in a price of 1.34 yuan/m^3 across all sectors[20]. This would have the effect of shifting water use out of the agricultural sector into industrial and domestic uses. While this could harm food security and rural living standards, it would benefit urban users and lead to economic efficiency gains.

6.2.5. Full Cost Recovery Pricing

This pricing system is also known as *average cost pricing* because prices are set equal to average cost of supplying water (instead of marginal cost). Average cost is the total cost of production of a particular quantity of water (fixed and variable) divided by the number of units of water produced. Figure 6.5 exhibits a typical average cost curve for water supply. As you can see, average costs are high for initial units because of high fixed costs. Once those fixed costs are spread over a large volume of water, average cost declines. After a minimum point, variable costs (assuming that they are rising as volume increases) increase faster than fixed costs are spread and the average cost curve rises again. If variable costs are constant on the other hand then average costs would be declining as volume increases. "In the case of water utilities, there is not much empirical evidence to assess whether average costs are declining in the long run" (McNeill, 1989). I submit, however, that if environmental externalities are included into the cost calculation, as volume increases, average cost must eventually increase rather than decline indefinitely.

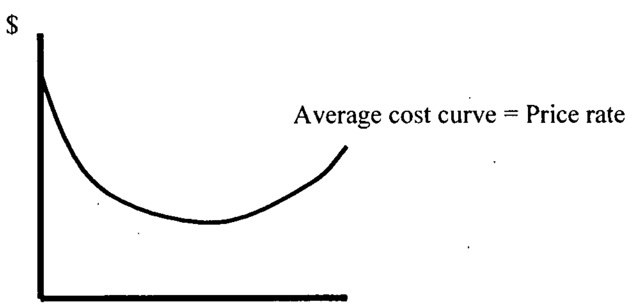

Figure 6.5. Example of an average cost curve.

The primary purpose of full cost recovery pricing is to generate sufficient revenue to achieve financial sustainability (cover the full cost of the system at any level of water delivery without making excessive profits). However, there are varying degrees of effectiveness depending on the calculation of supply costs. An incomplete cost calculation might include costs such as operations and management while omitting externalities, maintenance, and depreciation. All in all, average cost pricing is more commonly used than marginal cost pricing. "For urban and agricultural use, most developing countries and some industrial countries set charges on the basis of average rather than marginal costs of supply" (Asad et al., 1998).

Advantages:

- Funds available for regular O&M: funds available for regular maintenance to ensure high-quality, reliable supply, thereby reducing water loss and prolonging the life of water system's fixed assets.
- Funds available to mitigate other costs: funds available to protect sources and watersheds.
- Conservation: wasteful use discouraged; may eliminate or reduce need for new supply or wastewater treatment facilities; consumers develop awareness of true cost and value of water.
- Encourage Best Management Practices: introduces incentives for sound financial practices and efficient management.

[20] This figure was based on an estimate by Jiang (1998) that calculated that the raising of water fees across all sectors to 1.341 yuan / m^3 could save 946 million m^3 or water, or 75% of the transfer project. Thus the long run opportunity cost of using water in any sector may be estimated as 1.341 yuan / m^3.

Disadvantages

- Hard to implement: implementation is complex and often extremely difficult. This is because *full cost recovery pricing* is hard to justify politically, especially when difficult-to-quantify external costs are included into the equation, because rates would have to increase significantly. Not surprisingly, "few countries… attempt to recover capital costs from users. Where attempts are made, even in industrial countries, investment costs are almost always subsidised in the form of favourable borrowing arrangements" (Asad et al., 1998). Brazilian cities, for example, were only able to achieve full cost recovery for O&M and partial cost recovery on investment in the medium term.
- Equity: The first few blocks of water are significantly more expensive than later blocks when fixed costs are spread over larger volumes. Therefore, average cost pricing tends to be in the form of decreasing block rates (see section 6.3.2.3). Water for basic needs tends to be priced higher than water for luxury needs with such a price structure, thereby adversely affecting the poor, who only purchase water for basic needs.
- Poor conservation: in order to amortise the cost of supply, average cost pricing tends to encourage increased water use. While this may be.desirable in places with abundant resources, it water-scarce cities such as Beijing, such expansion is unsustainable.

In the case of Beijing:
One analyst (Elston, 1999) places full cost recovery prices in Beijing at 2.5 yuan/m^3 for urban water use (including wastewater treatment costs). Although this price is higher than current rates (and will thus promote conservation and more efficient use of water resources), as we have seen in Chapter 2, economic growth trends point to inevitable increase in water demand. Thus while in the short run average cost pricing meets objectives, eventually demand will overshoot supply at this price. Additionally, as is the case with most cities, average cost prices in Beijing are unlikely to include the environmental costs associated with water supply. This is largely due to the fact that the agencies responsible for water pricing (BWWC, MOC) are not the same as the one responsible for mitigating environmental damage and funding environmental reconstruction projects (NEPA). Hence it is outside the jurisdiction of the water pricing agency to consider environmental costs. Finally, the initial capital costs of much of Beijing's water supply fails to enter price calculations properly. The majority of irrigation works in China were built between 1950s and 1970s, thus the value of these fixed assets is underestimated at present. The cost to build the engineering is much higher today than it was for these old irrigation works (Wang and Huang, 2000).

6.2.6. Ability to Pay Pricing

Like most necessities in life, water has an income elasticity of less than –1 (see Box 2.2. on income elasticities). This essentially means that low income groups spend proportionally more on this necessity than high income groups. "Since water is the most basic of all needs, a move to water pricing may have a sharper effect on the poor" (Merrett, 1997).

One way to ensure that the poor are not adversely affected by water prices is to set prices according to income, or ability to pay. There are several ways to calculate *ability to pay prices*. One may under-price water for particular classes of users with resulting shortfalls to be covered by other users. This involves a series of inter- or intrasectoral cross-subsidies. In Ceara, Brazil, for example, intersectoral cross subsidies are used: industrial users pay 60 times higher prices than municipal users, who in turn pay 10 times more than rural users. Proposed prices per 1000/m^3 of water for various uses are: industrial USD$663.60, municipal USD$11.10, and irrigation and aquaculture USD$1.10 (Asad et al, 1998). Another method to set prices according to ability to pay is to cap water tariffs at an affordable level for the average person. As discussed in 5.3.1, the definition of "affordable" is around 3% of gross income.

Advantages:

- Equitable: income redistributed from high-income users to low-income users, low-income users not disproportionately impacted by water tariffs.
- Politically acceptable: appears equitable.
- Flexible: adjustable to local conditions, adjustable to varying water supply quantities.

Disadvantages

- Inefficient: in the United States, there is a longstanding policy of subsidising irrigators. "Providing water to irrigators at less than the marginal cost of supplying that water prevents farmers from accounting for the full opportunity cost of irrigation water use. As a result, marginal values of water in irrigation may be less than the marginal costs of providing irrigation water and may also be less than water's marginal value in alternative uses" (Saliba and Bush, 1987).
- Heavily dependent on local capacity.
- Poor conservation: over-subsidisation leads to distorted incentives, misallocation, and waste of water.
- Difficult to determine ability to pay.

In the case of Beijing:
Administratively, setting differentiated prices based on income is very difficult for several reasons. First, some of the poorest urban citizens are illegal migrants whose incomes are not reported, and who therefore cannot benefit from ability to pay pricing. Second, a large informal sector creates great difficulty in determining incomes. Most likely, incomes will be undervalued since official statistics fail to take informal activity into account. Finally, the existence of tap-sharing in apartments and old courtyard houses makes differentiated income-based pricing extremely impractical. The second method (non-differentiated ability to pay pricing) would result in a maximum domestic water price of 4.46 yuan/m^3 [21]. This implies that there is much room to increase current tariffs while still ensuring affordability.

6.2.6.1. Ramsey Pricing

Ramsey prices attempt to maximise total benefits by setting prices inversely proportional to the income elasticities of the different consumer groups. In other words, higher prices are charged for groups with elastic demands and lower prices for consumers with inelastic demands. An inverse elasticity rule is used to generate the price structure. This rule states that the optimum mark-up is:

$P_i - C_i / P_i = \lambda / \varepsilon_i$ where: P_i = price charged in each user category; C_i = MC for each user category; λ = constant (found by trying different values until the total supply cost of water is covered); ε_i = elasticity of demand for each user group

Advantages:

- Conservation: since highly elastic groups are charged more, prices will have a greater effect in reducing consumption.
- Equitable: groups relying on water for basic needs have inelastic demands and will therefore be charged less than groups using water for luxury purposes.

Disadvantages:

- High information needs: elasticity of demand for each sector and various user groups must be known.
- Effect depends highly on how sectors and user groups are grouped.
- Not particularly efficient: only 3% more efficient than tariffs based on traditional cost recovery methods (Rogers, 1996).

In the case of Beijing:
Similar to the case of ability to pay pricing, Ramsey prices are problematic because they depend on knowledge of the income elasticities of various groups.

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[21] This figure defines affordable as 3% of gross income, and it was calculated as follows:
13033.15 yuan / year (approximate average income in Beijing in 2000)
÷ 365 days year
= 35.70 yuan / day
x 3% (amount within affordable range)
=1.07 yuan / day (the average Beijinger can afford to spend 1.07 yuan / day on water)
÷240 litres / person / day (current consumption)
=4.458 yuan / m^3

6.2.7. Willingness to Pay Pricing

Willingness to pay pricing sets the price rate equal to the demand curve. This practice is mostly used in municipal contexts. Prices are set through a series of detailed studies, often in the form of household surveys, carried out by government.

Advantages:

- Equitable: charges the amount people are willing to pay, which presumably indicates what they are able to pay.

Disadvantages:

- High informational requirements: requires fairly accurate assessment of user willingness to pay; also requires constant re-assessment of willingness to pay when users' incomes increase.
- Conservation: lacks incentives to use water more efficiently.
- May not lead to full cost recovery.

In the case of Beijing:
Setting price equal to willingness to pay yields an industrial rate of 3.92 yuan/m^3 (Wang and Lall, 1999) and a domestic rate if 1.8-4.3 yuan/m^3 (WB, 1998). Willingness to pay pricing in the Beijing context works fairly well in achieving goals such as conservation, full cost recovery, and efficient water use, given constrained supply. It is conceivable that in the short run, willingness to pay pricing in Beijing will lead to some reallocation of water use both within and between sectors (which puts low income groups and food security at risk), while in the long run it would bid water prices to as high as marginal cost pricing. At this point new supply installations could be built.

6.3. Tariff Structures

The previous section examined the various pricing methods – this section examines the possible structures of the tariff itself. While some pricing structures require specific tariff structures others are flexible in their tariff design. Tariffs are either non-volumetric (not based on quantity consumed) or volumetric (based on quantity consumed).

6.3.1. Non-Volumetric: Flat / Uniform Rate

The non-volumetric water rate is one of the most commonly used around the world. In Ontario, for instance, 35% of municipal water customers are charged uniform rates (Eaton, 1996). Uniform rates are essentially equalized prices for each customer.

Figure 6.6 demonstrates the effect of a flat rate price of P*. The user is charge P* regardless of whether he consumes one or a million units of water. This is essentially like charging a flat rate of P* and a variable rate of P' (or zero). The consumer will react by attempting to maximise consumer benefit by consuming the maximum quantity desirable (Q'). Overshooting the efficient point (Q*) results in a dead-weight loss equal to the shaded triangle.

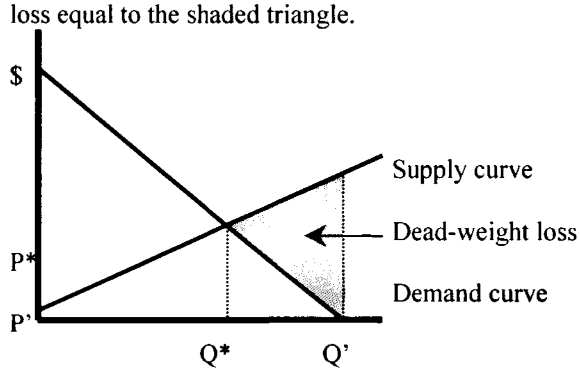


Figure 6.6. A demonstration of the effect of flat rate pricing.

Often these rates are linked to some customer characteristic, such as geographic location, size of supply pipe or meter flow capacity, property value, number of water consuming appliances, lot size etc. Table 6.1 provides some determinants of flat fees from several countries.

Table 6.1. Determinants of flat fees or fixed elements (OECD, 1999).

Country	Determinant of flat fee or fixed element
Australia	Equal for all, property value, meter size
Belgium	Equal for each house
Canada	Equal, property value, property front, lot size
Denmark	Property value, no. of taps, estimated volume, meter size
Finland	Equal, meter size
Iceland	Square meters in house
Korea	Pipe diameter
Netherlands	Size of house, number of rooms, garden size

Advantages:

- Easy to design and administer: the importance of simple, transparent pricing may override efficiency. In Denmark for example the water utility chose to make water charges clear to each household even if these charges are non-volumetric (OECD, 1999).
- Equality: most equal "because all consumers are charged the same rate per unit" (Prasitka, 1988).
- Ensures certain amount of revenue to utility regardless of consumption.

Disadvantages

- Inefficient: leads to inefficient allocation of water; net social benefits are not maximised.
- Poor conservation: no incentive to conserve water; leads to water wastage.
- Does not ensure full cost recovery.

In the case of Beijing:
Given the seriousness of the water crisis in Beijing, such a system, which not only fails to encourage conservation but creates perverse incentives to waste water, is unlikely to be popular with most agencies. Further, the existence of a fairly universal metering system in Beijing's urban core combined with an established system for volumetric pricing means that efficiency gains from volumetric pricing will almost certainly outweigh administrative costs.

6.3.2. Volumetric Pricing

6.3.2.1. Metering

Unlike flat-rate non-volumetric pricing, volumetric pricing requires metering of some sort because amount paid in water tariffs depends on quantity consumed. Today, even in the developed world, very few countries or cities have mandatory universal water metering. Denmark in one of the few countries that requires all properties connected to the public water supply system to have a meter installed. Meters are installed by the water utility but paid for by the individual owner (OECD, 1999). However, Canada, with 40% of water customers lacking water metering, typifies most countries (Eaton, 1996). In the UK (1993) a stunning "98% of households lived in accommodation where their water consumption was unmetered and where the costs of water were met not by a price for its use but by a property-based fixed charge levied by the private water-service companies" (Merrett, 1997). Universal metering is controversial in many Canadian municipalities, partly due to the cost of implementation. It is estimated that universal metering in Canada would cost $700 million for equipment and installation alone[22] (McNeill and Tate, 1991). In the UK, two water companies had to withdraw compulsory metering programs due to public opposition. Often regulators oppose universal domestic metering but encourage selective metering where resources are scarce, where household are consuming significant amounts of water for luxury purposes, and for new homes where installation costs are relatively low.

However, there is ample evidence to show the usefulness of metering in preventing the problems associated with flat-rate tariff structures (see section 6.3.1). Some examples include Peterborough, Ontario, where the water utility found that metering led to a 10% decline in water use (McNeill and Tate, 1991). In Calgary, unmetered water use was 46% greater than use in metered residences in 1984 (McNeill and Tate, 1991) and in Dallas, Texas, a 43% drop in water demand was recorded following meter installation in 1978 (McNeill and Tate, 1991). Table 6.2 provides a few more examples of savings due to metering from around the world. In general, findings suggest that "water use declines, often by as much as 30%, following the installation of water meters and the implementation of volume-based pricing" (McNeill and Tate, 1991).

[22] Costs such as administration and meter maintenance are in addition to this cost.

Table 6.2. Examples of savings due to water metering.

Place	Period	Savings due to metering
Collingwood, ONT, Canada	1986-1990	Summer peak: 37%
Leavenworth, Washington, USA	1988-1991	Summer peak: 61%
Isle of Wight, England	1988-1992	Annual: 21.3%
Metering trial sites, England	1988-1992	Hot, dry summers: 27% Wet summers: 15%
Mataro, Spain	1983-1993	Annual: 35%
Terrassa, Spain	1994-1995	Annual: 12.7%
East Anglia, UK	1990s	Annual: 15-20% Summer peak: 25-35%
Portland, USA	1993-1994	Annual: 10-12%
New York City, USA	1991-1995	Annual: 7.4%

"The feasibility of charging for water by volume used depends on the practicality of monitoring meters" (Asad et al, 1998). Thus is it crucial that the analyst calculate whether not it is worthwhile to install universal metering before recommending volumetric pricing. This net benefit is determined by subtracting the cost of foregone water usage on consumers surplus plus the cost of the purchase, installation and operations cost of the meters from the benefit gained from metering to the producer's surplus. If this result, the net present value of metering, is positive then metering is economically justified. A California study in 1988 found that meters were cost effective if water cost more than 21 cents per m^3 and meters could be installed for under $500 (at the time, the cost of an average meter in California was only $80) (McNeill and Tate, 1991).

As we have described in section 2.2.6.1, universal metering is available in Beijing. However, an issue of particular relevance to Beijing is the problem of shared meters in both apartment complexes and multifamily courtyard houses. Table 6.3 demonstrates the prevalence of metering single-family homes versus metering apartment buildings. While apartment buildings are metered in nearly ever OECD country (with the owner receiving cumulative volumetrically-based water bill), there are no cases of apartment units being metered individually. The water bill is recovered from tenants through a flat rate charge based on some criteria (such as floor space, number of rooms, appliance ownership etc.). Without volumetric pricing on each individual apartment unit, high volume users will be subsidised by low volume users. Also, single master-meters have no effect on total demand (the owner allocates the increase in the aggregate bills, and each resident decides that the increase is not his/her fault, but pays the bill anyway). However, switching to individual metering for each apartment unit, such as currently proposed in Denmark, "may lead to relatively complicated billing systems, and thus prove difficult to administer" (OECD, 1999).

Table 6.3. Comparison between percentage of buildings metered in single-family homes and apartment complexes (OECD, 1999). Data derived from 1997-1998 data.

	Single-family homes	Apartments
Australia	95-100%	Insignificant
Belgium	90%	Many cases
Canada	55%	Few
Denmark	64%	1% in Copenhagen
France	100%	>50%
Germany	100%	10-20%
Greece	100%	100%
Japan	100%	94%
Korea	100%	100%
Sweden	100%	0%
Switzerland	100%	0%

6.3.2.2. Constant Rate

A constant tariff rate means that regardless of the volume consumed, water is charged at $X per unit. Many cities currently use constant rates. For example, 28% of Ontario's water customers face constant water rates (Eaton, 1996).

Figure 6.7 illustrates three possible constant rate structures (P_1, P_2, and P^*) as well as the corresponding water demand quantities (Q_1, Q_2, and Q^*, respectively). When tariffs are flat rate, consumers will purchase water so long as the benefits outweigh the price charged. The last unit purchased will be where the price equals the marginal benefit (or where the price = demand curve). Efficient allocation occurs only at

MC=MB. At the price rate P_1, prices are too high and water is under-supplied. At P_2, prices are too low and water is over-consumed. Both price rates P_1 and P_2 result in dead-weight losses.

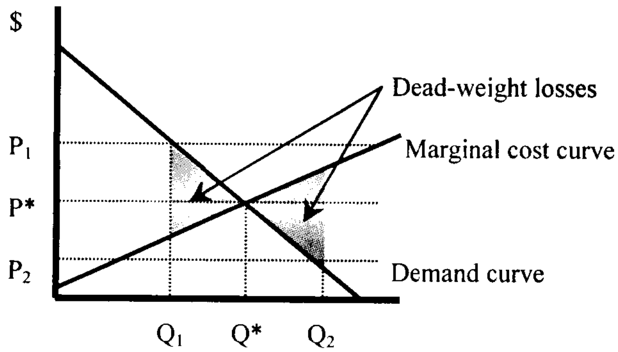


Figure 6.7. Example of constant rates.

Advantages:

- Fairness: perceived as fair to both small and large water consumers because amount paid varies in direct proportion to use.
- Some conservation: since this structure is volume-based it provides some incentive to reduce water consumption.
- Potentially efficient: if the price is set at MC=MB (such as P* in Figure 6.7) then efficient pricing is achieved.
- Simple to understand and administer.

Disadvantages:

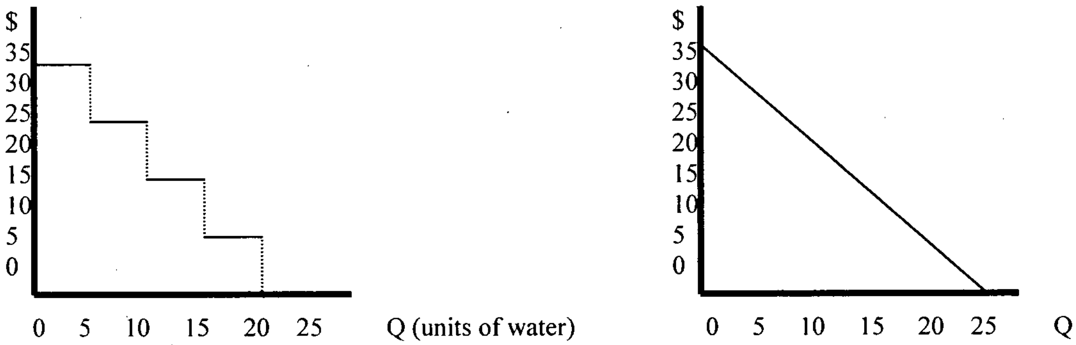
- High informational need: the price-setter needs to know the efficient price in order to set the price to the most efficient rate, if this information is inaccurate or unavailable, there is likely to be dead-weight efficiency losses.
- Likely inefficient: the likelihood of gathering enough information to set P* is small and therefore the likelihood of inefficient pricing is large.
- Might fail to cover costs: use of long run marginal/average cost may result in deficit; must be based on total costs otherwise insufficient revenue generated.

In the case of Beijing:
Constant rates are currently applied and at prices below the economically efficient rate. The advantage of this rate structure in Beijing is that it is simple and has been traditionally used. While in the short run, constant rates may suffice in achieving most goals, as incomes increase and excessive, luxury water use by a small percentage of the population develops, increasing rates will be increasingly required to reduce inequity and inefficiency.

6.3.2.3. Declining Rates

Declining rates have typified water pricing world-wide until only very recently. Many municipalities still apply declining rates. For instance, in Ontario about 36% of the serviced population pays declining block rates (Eaton, 1996). Canadian cities such as Pickering and St. Catherines also continue to use such a structure.

A declining block rate is one in which the price charged per unit of water consumed decreases as consumption increases. Figure 6.8a shows the first 5 units of water to cost $35/unit. The second 5 units of water cost only $25/unit and so on. A declining tariff structure can either be in the form of block-rates, such as in Figure 6.8a, with discreet blocks in which a particular price is set, or it may be continuous, such as in Figure 6.8b.



Figures 6.8a and 6.8b. Examples of (a) declining block rates, and (b) continuous declining rates.

The rationale for implementing a declining tariff rate is that expansion of water supplies lowers average cost (per unit) of supply to all customers (see section 6.2.5 on *average cost pricing*). Other reasons for declining tariff rates may include encouraging water use for health and sanitation reasons, attracting industry, maintaining food security by provided cheap water supplies for agriculture, improving fire-fighting capabilities, and increasing water use to prevent idle capacity (particularly after new supply infrastructure is built). Another rationale often used by high-volume water users is that it is small-volume customers who concentrate in peak hours who cause increase in cost of water supply (see section 6.3.2.6 on *peak-load pricing*). "Large-volume users, particularly industrial users, argue that the flat rate is inequitable to them because they tend to equalise their water use over the course of the day or year and so use a smaller proportion of their water during times of peak demand. Since the investments in additional supplies and storage capacity needed to meet peak demand add substantially to the cost of service, large-volume users argue that they are less responsible for these costs and should not be required to pay for them" (Prasitka, 1988).

Advantages:

- Lowers average cost: spreads cost of supply over large volumes.
- Reduces idle capacity.

Disadvantages:

- Inefficient: does not equate MC with MB, likely to lead to inefficient use of water.
- Requires subsidies: typically subsidised by general tax revues to cover cost of provision but rarely enough subsidy to cover cost of maintenance and capital improvement projects – therefore deterioration of system occurs. This problem is compounded by the fact that "unlike other municipal services, a poorly maintained water-supply or sewer system can go unnoticed by the public for decades" (Prasitka, 1988).
- Poor conservation: may encourage wastefulness.
- Inequitable: "in many cases it may be that the largest users dictate the system design capacity which is one of the most important and costly design parameters for water and wastewater systems" (Eaton, 1996). In such a case, low volume users end up paying more per unit than high volume, infrastructure-straining users.

In the case of Beijing:
As discussed in Box 6.1 and Chapter 2, Beijing has surpassed the "expansionary" phase of water development and is clearly in the "maturing" phase. Given the enormous strain on the supply system stemming from natural demand increase, there is little justification for decreasing rates.

6.3.2.4. Increasing Rates

Increasing rates begin at low per unit prices for initial quantities of water with higher prices for additional units. This tariff structure is designed to allow for essential domestic use at lower rates while discouraging water wastage. Figure 6.9 is an example of an increasing block rate structure. The first five units of water are provided at a price of $2.50/unit. The next five units are more expensive at $7.50/unit and so on.

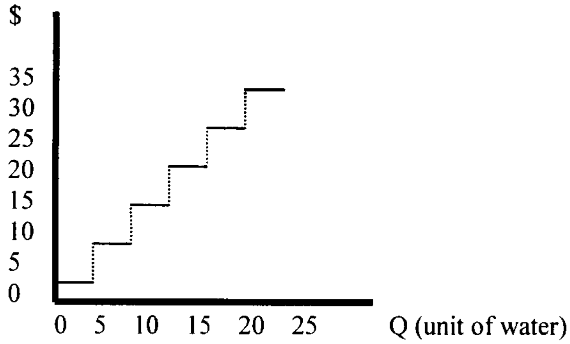


Figure 6.9. Example of an increasing tariff structure.

While increasing block rates are still underused, there are some examples of their application around the world. In Japan, for example, 57% of water utilities applied increasing-block tariffs in 1998 (OCED, 1999). Athens, Greece also provides an example of increasing block rates (see Table 6.4). In 1995, Athenian water users faced five water rate brackets. When volumes surpass 20 m^3 per month per household (667 litres/day), water ceases to be cheap and prices increase by almost triple (OECD, 1999). Households which use an irrationally large volume of water are thus penalised. It is noteworthy to show that in addition to strict increasing block-rate prices, Athens has also increased overall water prices significantly between 1991 and 1995.

Table 6.4. Domestic water tariffs in Athens, Greece (GRD/m^3).

Monthly consumption band (m^3)	1991	1995
≤5	48	117
6-20	72 (+50%)	178 (+52%)
21-27	200 (+177%)	514 (+189%)
28-35	280 (+40%)	720 (+40%)
>36	350 (+25%)	900 (+25%)

Another case study of successful implementation of an increasing two-block rate is Zurich, Switzerland, where in the 1970s the pricing system was radically altered to introduce an excess charge. This excess charge was applied only if a consumer had exceeded during the billing period a daily allocation geared to the size of the meter. The utility allowed the household to consume up to 1000 litres/day at the basic price (other consumer classes were given higher specified allowances). At volumes above this base amount a significantly higher volumetric rate (approx. 40% higher) was charged. As a result of this tariff, an overall reduction in water consumption was experienced in both normal and high-volume water user classes. Total water consumption fell from 50.7 million m^3 in 1970 to 39.2 million m^3 in 1997 (OECD, 1999).

Advantages:

- Conservation: this pricing system encourages users to adopt methods of water conservation particularly at higher volumes of water. Empirical evidence has shown that increasing block rates work to reduce summer sprinkling and "motivates customers to install water-saving devices or drought-resistant landscaping and to practice conservation year-round" (Prasitka, 1988).
- Used to discourage certain developments: best used for residential areas or for communities trying to discourage industrial development.
- Potentially equitable: with individual metering, can assist low volume consumers.

Disadvantages:

- Large-volume industrial customers pay more even when their use is not concentrated in peak periods. This problem can be avoided by separate rate schedules for industrial customers, or by having a humpback rate schedule in which price of water falls again at some level that exceeds monthly use by most residential customers.
- Unstable revenue stream: financially risky for water utility because stream of revenue is unstable since reductions in water use occur at the highest rate block.

- Complicated to implement: implementation requires extensive planning, and complex pricing structures give distorted signals to consumers "who tend to focus on the average usage price rather than the marginal usage price, and therefore perceive that there are few benefits from saving water" (Shepard, 1999).
- Metering costs: requires individual metering.
- Equity issues: poor block designs may negatively affect low volume consumers. If the first block is too small low volume customers may face higher rates. Additionally, increasing block rates may penalize low-income large households.
- Questionable conservation effects: increasing prices are only effective in reducing consumption where high volume consumers with elastic demands account for a large percentage of total consumption.

In the case of Beijing:
Although there are many advantages to using increasing block rates in Beijing, the primary reason to take caution is that increasing block rates may negatively affect low income customers who share a meter, or low income large families. To demonstrate the first case, a case study of Shijiazhuang found that increasing block rates negatively impacted low income, low volume customers who shared one main bulk meter. "The main meter would be charged at the high blocks or steps (due to the large number of consumers) where the highest marginal tariffs operate. The most likely outcome is that the individual household faces an average tariff which is higher than if it had been charged directly by the water enterprise on the basis of an individual household meter" (Shepard, 1999). Many Chinese households contain many family members and thus increasing block rates may negatively affect large families who must go beyond the first few blocks just to satisfy basic needs.

6.3.2.5. Combined Rates / Dual Tariff Schemes

For urban water supply, many countries are replacing flat fees with combined tariff structures that have both a fixed and a volumetric component. The fixed fee component may be in the form of:

- Connection charge: a one-time, up-front charge for connecting the customer to the public water supply system. The Coase Two-Part Tariff combines a fixed connection charge that is the same for all consumers (which equals fixed costs divided by number of connections) and a single price on consumption equal to MC. This connection charge typically recovers capital and other fixed costs.
- Fixed charges: these are reoccurring charges that cover per-period use by the consumer. A commonly used form of fixed charge are "life-line" charges which allow the user a specified initial volume of water at the fixed cost. Additional volumes above this minimal amount must be purchased at the marginal cost of supply. An increasingly common fixed charge system are fixed service charges. These cover the cost of administration and but, unlike minimum charges, do not penalise low-volume consumers by charging them for unused water.

There are some examples of combined rates in use around the world. Two examples are Japan and Korea which have 'basic rates' which include up to 10 m^3/month for each household and is applied as a fixed charge (OECD, 1999). Additional units are purchased at higher variable charges.

Advantages:

- Secure source of revenue: fixed component ensures the service provider a reliable stream of revenue to cover overhead expenses.
- Conservation: variable charges provide incentives to use water efficiently.
- Efficient: if the variable cost is based on marginal cost pricing, consumption will remain at the optimum level where the marginal willingness to pay equals marginal cost.
- Cost recovery: addresses the deficit associated with servicing past investments and recovers capital costs.

Disadvantages:

- May overprice: some analysts argue that in most Asian cities current connection costs are too high. High connection costs serve to discourage new customers and encourage excessive use of private wells
- Inequitable: fixed charges are inequitable because people who use less pay the same as those who use the block fully. One way to solve this problem is to calculate connection charges by dividing customers into different classes based on volume of water use and then calculate a fixed connection charge for each class (McNeill and Tate, 1991).
- Discourages water conservation if fixed component too high

In the case of Beijing:
While this option works well in achieving objectives such as financial stability and sustainability for the BWWC, fixed charges have the effect of a psychological impact on consumers, particularly low volume consumers. For example, in the case of Jiazi (see Box 5.1) the existence of a fixed charge that was in the opinion of many set too high led to public unrest, overuse of private wells, and meter sharing. This could likely occur in Beijing also.

6.3.2.6. Peak-load Pricing

The nature of water entails supply infrastructure to be built to accommodate maximum "peak" usage. Peak periods occur both seasonally (with summer water usage higher than winter) and hourly (with before-work morning usage and before-bed evening usage higher than other times). Capacity expansion usually stems from increased need for water during these peak times, while during non-peak times excess capacity sits idle. Thus the cost of enlarging the supply system is mainly based on providing for peak-loads. As a result, more and more municipalities are implementing peak-load pricing for seasonal and daily peaks because charging the same price for water all year tends to underprice in peak periods and overprice in non-peak. This creates inefficient benefits for peak users at the expense of non-peak users, resulting in dead-weight losses.

Peak pricing typically consists of either a surcharge on water use during high-demand periods (uniform or varying rates are charged for a base amount of water and higher rates are charged for anything exceeding that base amount) or higher seasonal rates (higher per-unit charges in summer). The former may be in effect just during summer or year-round allowing for hourly peaks to also be charged higher rates. The latter however is often preferable because it is simpler and easier to explain than surcharges.

Peak period rates are typically designed to reflect marginal costs of expansion in storage and other supply facilities to meet peak use. One way to conceptualise this distinction is to think of off-peak rates as equivalent to short-run MC (which does not account of expansion), while peak-rates are long-run MC (which accounts for expansion). A typical basis for peak rates is *marginal cost of capacity expansion*. This is typically calculated in either of the following ways:

1. [(present worth of system costs with one planned expansion) -- (present worth of system costs with a different planned expansion)] / present worth of difference in quantity of water delivered under the different capacities
2. cost of next planned expansion averaged over the expected increase in water delivered above current levels

While peak pricing promotes efficient water use, very few utilities implement such tariffs. A survey in 1982 of nearly 100 US utilities showed only one example of a seasonal component in water pricing (OECD, 1999). But there is also evidence of increasing use of seasonally-based pricing: by 1997, 10 utilities out of 121 (or 6.6%) had seasonal components. The complexity of seasonal rates inhibits their proper implementation. In the UK, for example, the Lee Valley Water Co. implemented time-of-day tariffs for water supply. For three hours in the morning and three hours in the evening, water rates were 95% higher in the summer and 66% higher in the winter. This tariff however proved to be short-lived and was abandoned after one year in favour of a constant volumetric rate (OECD, 1999).

Advantages:

- Reduces peak demand.
- Extends available supplies: postpones or eliminates the need for a major expansion of the system.
- Conservation: encourages better use of water.
- Easily understood: customers understand the rationale behind raising rates in the summer.

Disadvantages:

- Potentially perceived as unfair: "Seasonal variations in water rates could be likened to the situation that would exist if the Postal Service boosted the price of postage required to mail a letter during the busy Christmas season, in order to curtail the mailing of Christmas cards" (Prasitka, 1988).
- Metering costs: cost of more sophisticated meters and/or more frequent meter-reading often outweighs efficiency gains which derive from their use. Temporal tariffs (hourly peak pricing) are the most cumbersome to implement because they require multi-rate tariff units (MTUs) which are meters that accumulate consumption totals for different time periods. An alternative to MTUs may be more frequent readings of orthodox meters – a labour-intensive process. "In such cases, it may be appropriate to look for

proxies for the contribution a user should make to peak costs, and one such proxy may be the maximum flow of the consumer's supply pipe per unit of time" (OECD, 1999).

In the case of Beijing:
Peak pricing in Beijing is inhibited largely by the need to install time-based meters. This cost is prohibitive at this time. Seasonal rates are set to deter summer lawn watering in western contexts, however, there is not enough evidence to show this to be a factor in Beijing. However, given trends towards luxury purchases, excessive summer use will likely be more of an issue in the future.

6.3.2.7. Equity Pricing

While some municipalities have dealt with the problem of affordable water through the use of direct subsidies and rebates, others have incorporated income and/or family needs into pricing structures.

6.3.2.7.1. Subsidies and Rebates

Subsidies and rebates aim to assist low-income customers. Some examples of these from the United States include "rebates based on income, percentage discounts on water bills for certain groups, waivers of fixed charge, and fixed allowances (or credits) for each bill" (OECD, 1999). In Sydney, Australia pensioners received a rebate of 50% on the fixed portion of the water bill and people who need water for kidney dialysis are allowed free water allowances (OECD, 1999). Sydney also offers a Payments Assistance scheme whereby customers experiencing genuine hardship may apply for a rebate on their water bills.

Advantages:

- Equity: assists low income users in affording basic needs.

Disadvantages:

- Economically inefficient: subsidies through taxes and income transfers cause distortions that result in loss of benefits in other areas of economy and potentially create dead-weight losses (McNeill, 1989).
- Conservation: subsidies may lead to wasteful water consumption. Consumers receiving subsidised water may lack an understanding of the true cost of water. It is generally recommended that subsidised customers are shown the full cost of their water use in their bills in order to correct this problem, and to provide a platform to phase out of subsidies over time.
- Difficult to administer: requires a somewhat sophisticated administrative structure to function.

In the case of Beijing:
While a subsidy system helps achieve equity goals, the difficulty lies in accurately assessing need due to poorly reported incomes, as noted earlier.

6.3.2.7.2. Cross-Subsidized Price Structures

Under this pricing structure, the first-block of water is provided at nominal or no charge. This block includes enough water for the average-sized household to fulfil its basic needs of washing, cleaning, cooking and sanitation modestly (approximately 20-40 litres per capita per day; Rogers, 1996). Additional blocks after this initial block are more expensive.

While these tariffs go far in recognising the significance of one- and two-pensioner households among the emerging poor, there are problems in terms of equity. Blocks are often so small that many average sized families are forced into higher blocks. Large poor families are disproportionately affected and could pay significantly higher average volumetric rates than smaller but wealthier households.

Countries have dealt with this problem in several ways. In Korea's Taegu City, the first block was widened to 15 m^3/month per household in 1974. At an average consumption of 62 litres/person/day, only households with nine or more people were likely to face higher block rates for water (OECD, 1999). Belgium dealt with this problem by gearing water tariffs towards number of people resident rather than towards a household. In the Region of Flanders "the organisation of the tariffs, which is managed by the local utility, is facilitated through the use of an annual register of the inhabitants of each household. Among the drawbacks of the scheme is the fact that the local water companies now have complex bills to administer (and more questions and complaints as a result). They have also had to find new revenues to replace those lost as a result of the free allowance. On the other hand, equity has clearly been enhanced" (OECD, 1999). In Athens, Greece the water utility sets an upper bound on tariff charges for families with three or more children (OECD, 1999).

Luxembourg has attempted to deal with this issue by (a) setting tariffs rates based on household size (Table 6.5) (b) making the block-sizes of volumetric rates dependent on the number of children in the household (Table 6.6).

Table 6.5. Volumetric rate dependent on number of children, Luxembourg (OECD, 1999).

Standard household tariffs	38.0 Flux/m^3
Family with 3 children	22.6 Flux/m^3
Family with 4 children	22.8 Flux/m^3
Family with 5+ children	19.0 Flux/m^3

Table 6.6. Variation in block sizes dependent on number of children, Luxembourg (OECD, 1999).

Water price in Flux/m^3	**Consumption in m^3 per year in households consisting of:**						
	1 person	2 people	3 people	4 people	5 people	6 people	7 people
40	≤60	≤100	≤140	≤180	≤220	≤260	≤300
50	61-70	101-120	141-170	181-220	221-270	261-320	301-370
70	>71	>121	>171	>221	>271	>321	>371

Another example of cross-subsidized water pricing with varying block sizes is Barcelona, Spain. In 1983, Barcelona adopted a combined/dual tariff system, with a fixed component and three blocks (see Table 6.7). Since conservation was an important goal, this tariff concentrated on reducing the amount consumed by heavy water users. The amount charged for the highest water bracket is about three times the price of water charged in the lowest bracket. Affordability was also a concern to the authorities and thus they made the middle bracket a "sliding" block with the size of the block dependent on the number of people in the household (see Table 6.8). For families with more than four people, the second block is calculated by multiplying the number of people in the household by 11 m^3. Additionally, a fixed charge which was dependent on house type was imposed to recover capital costs for water distribution and metering (see Table 6.9).

Table 6.7. Combined / dual tariff system in Barcelona, Spain, 1983 (OCED, 1999).

Band	**Charge (ptas./m^3)**
0-18 m^3/quarter	44.10
18-48 m^3/quarter (this middle section varies)	89.30
>48 m^3/quarter	121.80

Table 6.8. Example of variable block sizes from Barcelona, Spain (OECD, 1999).

Size of household	**Second block (m^3/quarter)**
1-4	18-48
5	18-55
6	18-66
7	18-77

Table 6.9. Fixed charges in Barcelona, Spain (OECD, 1999).

Fixed charge per month	**Ptas.**
House type A	208
House types B and C	547
House types D and E	842
House type F	1145

Advantages:

- Equitable: if well formulated, may assist the poorest households in paying for water.
- Conservation: if later blocks are relatively high, or increasing, water conservation above the first block will be encouraged.

Disadvantages:

- Administratively complex.
- May lead to inequity.

In the case of Beijing:
Although this pricing structure helps in dealing with equity issues associated with large families in Beijing, administratively family size-dependent rates are difficult to implement due to the presence of illegal migrants. Families are likely to appear smaller than in actuality and thus large poor families with many migrants fail to benefit from cross-subsidies.

6.4. Summary of Alternatives

Table 6.10 summarizes the alternatives presented in this chapter. The first column presents these alternatives, and the second column displays the potential prices associated with them. As you can see, prices are only available for pricing methods. This is because price structures serve only as the frame of a pricing system, and not the content. Pricing methods, on the other hand, are based upon other variables and are thus calculable. The last two columns display the major constraints and opportunities in applying these alternatives in Beijing.

Table 6.10. Summary table of alternatives.

Alternatives	Approximate price	Constraints in application	Opportunities in application
6.1. Sectoral Allocation			
6.1.1. Intersectoral Pricing	Depends	Difficulties for agricultural sector	
6.1.2. Intrasectoral Pricing	Depends	Food security issues	Corresponds with tertiarization and agricultural marketization policies
6.2. Pricing Methods			
6.2.1. Public Allocation	Domestic: 1.30 Industrial: 0.40 Irrigation: 0.06 (current figures but depends)	Water shortage issues Possible political mishandling	
6.2.2. Marginal Cost Pricing	Domestic: 5 yuan/m^3 Industrial: 3.10 yuan/m^3 Agricultural: 1.72 yuan/m^3	Prohibitive costs Public unrest	Delays infrastructure needs
6.2.3. Transferable Water Rights	Not applicable	Legal issues	
6.2.4. Opportunity Cost Pricing	All sectors: 1.341 yuan/m^3	Difficulties for agricultural sector	Benefits for urban users
6.2.5. Full Cost Recovery Pricing	Domestic/ Industrial: 2.5 yuan/m^3	Likely to be improperly calculated for long run sustainable water use	In the short run, fulfils many goals
6.2.6. Ability to Pay Pricing	Domestic: 4.46 yuan / m^3	Administratively complex Difficult to calculate incomes Fails to solve equity issues for illegal migrants	
6.2.6.1. Ramsey Pricing		Administratively complex Difficult to calculate incomes Fails to solve equity issues for illegal migrants	
6.2.7. Willingness to Pay Pricing	Industrial: 3.92 yuan/m^2 Domestic: 1.8 – 4.3 yuan/m^3	Reallocation may prove difficult for agricultural sector	In the short run, fulfills many goals
6.3. Tariff Structures			
6.3.1. Non-Volumetric: Flat / Uniform Rate	na	Not necessary given existence of system to meter and administer	
6.3.2. Volumetric Pricing	na		
6.3.2.1. Metering	na	Issue with metering multifamily apartments and courtyard houses	Metering and administrative system already in place
6.3.2.2. Constant Rate	na	Does not deal with increasing luxury users in the future	Sufficient in the short run
6.3.2.3. Declining Rates	na	Not justifiable given Beijing's water scarcity	
6.3.2.4. Increasing Rates	na	Issue of tap-sharing and large families	Prevents excessive luxury uses
6.3.2.5. Combined Rates / Dual Tariff Schemes	na	Psychological effect on low volume, low income users	Improves financial sustainability for BWWC
6.3.2.6. Peak-Load pricing	na	Possibly prohibitive meter installation costs	
6.3.2.7. Equity Pricing	na		
6.3.2.7.1. Subsidies and Rebates	na	Difficult to identify most needy	
6.3.2.7.2. Cross-subsidised Price Structures	na	Difficult to identify most needy	

Chapter 7: Results and Conclusion

This chapter begins by presenting the results derived from analyzing the data, then draws general conclusions.

7.1. Objectives-by-Alternatives Matrix

The objectives-by-alternatives matrix depicts the degree of fulfillment of each objective by various alternatives. Table 7.1 organizes the objectives from chapter 5 and alternatives from chapter 6 into such a matrix

Table 7.1. Objectives-by-alternatives matrix.

	Intersectoral Pricing	Intrasectoral Pricing	Public Allocation	Marginal Cost Pricing	Transferable Water Rights	Opportunity Cost Pricing (same as Intersectoral)	Full Cost Recovery Pricing	Ability to Pay Pricing	Ramsey Pricing	Willingness to Pay Pricing
Financial Independence for Water Supply Providers	2	2	1	6	2	2	9	3	2	3
Full Cost Recovery	3	3	1	4	1	3	9	2	2	3
Minimize Cost of Service Provision	3	4	1	8	2	3	7	2	2	3
Reasonable Return on Capital	6	7	1	4	1	6	8	3	2	3
Stable Source of Revenue	5	7	3	3	1	5	7	3	2	2
Water Conservation	6	3	2	9	3	6	6	3	8	1
Installation of Water Efficient Technologies	8	5	2	8	2	8	6	2	6	2
Installation of Water Reuse Facilities	5	5	2	8	2	5	3	1	4	1
Affordability	1	3	9	2	5	1	3	9	9	8
Equity	1	3	9	2	8	1	3	9	9	8
Fairness	5	4	2	7	2	5	5	2	4	2
Equality	9	5	9	2	2	9	2	1	1	2
Maximize Ease of Implementation	2	5	5	2	1	2	2	6	5	6
Maximize Public Awareness	4	3	1	5	4	4	5	2	5	1
Minimize Public Unrest	1	5	3	2	3	1	2	7	5	8
Maximize Simplicity of Policy	6	5	8	1	1	6	5	2	2	3
Minimize Administrative Complexity	5	5	5	2	2	5	4	2	1	2
Economic Liberalization / Marketization	8	5	1	8	8	8	5	2	4	2
Maximize Economic Efficiency	8	5	1	9	8	8	5	1	3	2
Maximize the Use of Market-based Instruments	7	5	1	7	9	7	5	1	4	3
Minimize the Use of Subsidies	7	2	1	7	6	7	9	1	3	2
Minimize the Role of the State	7	2	1	7	5	7	9	2	5	2
Reform SOEs	3	3	1	5	2	3	7	2	4	2
Economic Growth	1	2	1	2	2	1	3	2	2	1
Improve Living Standards	2	3	2	2	5	2	2	7	7	6
Tertiarization	8	5	2	5	3	8	2	4	4	4
Minimize Price Inflation	1	3	8	2	1	1	3	7	5	4
Normalize Prices	8	4	1	7	5	8	5	2	2	3
Control Population Growth	1	1	1	1	1	1	1	1	1	1
Food Self-sufficiency	1	3	8	1	3	1	1	8	7	5
Agricultural Marketization	8	5	1	7	5	8	4	2	2	4
Protection of Rural Livelihoods	1	5	8	2	7	1	2	9	8	5
Ensure Adequate Overall Water Supply	3	5	2	8	3	3	9	3	2	1
Ensure Adequate Water Supply for Agricultural Use	1	5	2	5	3	1	7	6	5	2
Ensure Adequate Water Supply for Urban Use	8	5	2	9	4	8	9	5	5	2
Ensure Adequate Water Quality	2	2	2	5	2	2	5	3	3	2
Average	**4.31**	**4**	**3.05**	**4.83**	**3.44**	**4.36**	**4.97**	**3.53**	**4.03**	**3.08**

Flat / Uniform Rate	Constant Rate	Declining Rates	Increasing Rates	Combined Rates / Dual Tariff	Peak-Load Pricing	Subsidies and Rebates	Cross-subsidised Price Structures	
3	3	3	5	8	5	2	5	Financial Independence for Water Supply Providers
2	4	3	3	6	5	2	4	Full Cost Recovery
2	4	2	8	6	8	3	6	Minimize Cost of Service Provision
2	4	4	5	6	6	2	5	Reasonable Return on Capital
6	5	3	2	9	7	5	6	Stable Source of Revenue
1	5	1	9	9	9	2	8	Water Conservation
1	4	1	9	9	7	1	8	Installation of Water Efficient Technologies
1	3	1	6	6	5	1	5	Installation of Water Reuse Facilities
8	5	5	5	3	2	8	7	Affordability
7	6	2	4	3	2	8	9	Equity
2	5	2	7	8	1	5	6	Fairness
9	7	2	2	3	2	1	1	Equality
7	7	5	2	2	1	5	5	Maximize Ease of Implementation
1	3	2	6	7	6	1	6	Maximize Public Awareness
9	4	4	2	1	1	8	7	Minimize Public Unrest
9	6	4	2	1	1	2	2	Maximize Simplicity of Policy
7	6	4	2	1	1	1	1	Minimize Administrative Complexity
3	5	4	8	8	8	1	6	Economic Liberalization / Marketization
1	3	5	8	7	8	2	5	Maximize Economic Efficiency
2	4	4	8	7	7	2	6	Maximize the Use of Market-based Instruments
1	4	2	6	6	5	1	2	Minimize the Use of Subsidies
2	3	2	5	5	5	1	2	Minimize the Role of the State
2	4	2	6	6	6	1	2	Reform SOEs
2	2	4	3	3	3	2	3	Economic Growth
5	5	1	3	2	2	8	8	Improve Living Standards
2	3	5	6	6	5	2	2	Tertiarization
7	7	5	3	3	3	4	5	Minimize Price Inflation
3	4	3	4	4	4	3	5	Normalize Prices
1	1	1	1	1	1	1	1	Control Population Growth
9	5	8	3	3	3	1	1	Food Self-sufficiency
2	6	5	8	8	5	1	1	Agricultural Marketization
8	4	5	2	2	2	7	7	Protection of Rural Livelihoods
4	6	1	7	8	7	1	6	Ensure Adequate Overall Water Supply
3	6	2	7	8	8	3	6	Ensure Adequate Water Supply for Agricultural Use
4	6	2	8	9	8	3	6	Ensure Adequate Water Supply for Urban Use
3	5	2	6	6	6	3	5	Ensure Adequate Water Quality
3.92	**4.56**	**3.08**	**5.03**	**5.28**	**4.58**	**2.89**	**4.79**	**Average**

The numbers in this table are determined by the author as a quantitative description of how well each alternative meets each objective. The values range from 1 to 9, as follows:

1 = Does not achieve objective, negatively impacts achievement of objective, or has no relation with objective
2 = Barely achieves objective
3 = Slightly achieves objective
5 = Adequately achieves objective
7 = Achieves objective very well
9 = Achieves objective extremely well

For example, intersectoral pricing does not necessarily help tap water companies achieve their goal of financial self-sufficiency, thus in the corresponding square of the matrix there is the number 2, which indicates that intersectoral pricing *barely achieves the objective* of financial independence for water supply companies. Clearly, this matrix involves educated guesses, based the information researched by the author. However, accuracy is only required to a certain degree. In many cases, it is enough to get a general sense of how well each alternative fulfills each objective. In essence, this matrix is qualitative, with numbers acting simply as convenient representations of qualitative statements.

Alone this matrix provides some information but not much. First, we discover that the objective of controlling population growth has little relevance to water pricing policies. Regardless of how one designs water tariffs, it will not have an effect on the growth of population. Another observation is that it is not immediately apparent which are the superior choices. Options that achieve some objectives extremely well, achieve other objectives very poorly. Finally, the non-weighted average provides an indication of which alternatives may potentially be the most desirable, and which may be the least. The top three options according to this matrix appears to be *combined/dual tariffs*, *increasing rates*, and *full-cost recovery pricing*. The two worst options are *subsidies and rebates*, and *public allocation*. However, without weighting these objectives, we do not know which have greater importance to policy-makers and which are backed by more powerful actors. In the next section we correct this problem.

7.2. Weighted Trial

Weighted average method involves the addition of a coefficient before each objective in order to give it either a greater or a lesser weight. There are essentially two sets of weights for each objective: (1) the *formal power weight* of the primary actor pursuing the particular objective, and (2) the priority which the actor places on this objective.

The first set of weights was determined in section 4.1 on formal power ranking. At the conclusion of this section, we generated a formal power ranking, based on the hierarchical ranking and the relevance to the issue of each actor. These weights are shown in column c of Table 7.2. However, certain objectives are more important than others, even to the actor in charge of pursuing them. In column d, we assign a priority ranking for each objective, and in column e we assign each priority a corresponding numeric value (from 1 to 5). The final weight (shown in column f) combines columns c and e by simple multiplication. This column will be transposed into the objectives by alternatives matrix in order to calculate the weighted average. Table 7.3 summarizes the results of the calculations.

Table 7.2. Formal power weight and priority weight.

Objective (a)	**Primary goal holder (b)**	**Formal power weight (c)**	**Priority for actor involved (d)**	**Numeric value of priority (from 1-5) (e)**	**Final weight = c x e (f)**
5.1. Financial Independence for Water Supply Providers	Ministry of Construction	0.1464	Very High	5	0.88
5.1.1. Full Cost Recovery	Ministry of Construction	0.1464	Very High	5	0.88
5.1.2. Minimize Cost of Service Provision	Beijing Waterworks Co.	0.1021	High	4	0.51
5.1.3. Reasonable Return on Capital	Ministry of Construction	0.1464	High	4	0.73
5.1.4. Stable Source of Revenue	Beijing Waterworks Co.	0.1021	High	4	0.51
5.2. Water Conservation	Beijing Municipal Government	0.1516	Very High	5	0.91
5.2.1. Installation of Water Efficient Technologies	Beijing Water Savings Office	0.0344	Medium	3	0.14
5.2.2. Installation of Water Reuse Facilities	Beijing Water Savings Office	0.0344	Medium	3	0.14
5.3.1. Affordability	Beijing Price Bureau	0.0344	High	4	0.17
5.3.2. Equity	NPC and SC	0.2931	Low	2	0.88
5.3.2.1. Fairness	Beijing Municipal Government	0.1516	Low	2	0.45
5.3.2.2. Equality	NPC and SC	0.2931	Very Low	1	0.58
5.4. Maximize Ease of Implementation	Beijing Waterworks Company	0.1021	Very High	5	0.61
5.4.1. Maximize Public Awareness	Beijing Waterworks Company	0.1021	Medium	3	0.41
5.4.2. Minimize Public Unrest	Beijing Waterworks Company	0.1021	Very High	5	0.61
5.4.3. Maximize Simplicity of Policy	Beijing Waterworks Company	0.1021	Low	2	0.31
5.4.4. Minimize Administrative Complexity	Beijing Waterworks Company	0.1021	Low	2	0.31
5.5. Economic Liberalization / Marketization	NPC and SC	0.2931	High	4	1.47
5.5.1. Maximize Economic Efficiency	NPC and SC	0.2931	High	4	1.47

5.5.2. Maximize the Use of Market-based Instruments	NPC and SC	0.2931	High	4	1.47
5.5.3. Minimize the Use of Subsidies	Beijing Municipal Government	0.1516	High	4	0.76
5.5.4. Minimize the Role of the State	NPC and SC	0.2931	High	4	1.47
5.5.4.1. Reform SOEs	Beijing Municipal Government	0.1516	Very High	5	0.91
5.6. Economic Growth	NPC and SC Beijing Municipal Government	0.2931	Very High	5	1.76
5.7. Improve Living Standards	Beijing Municipal Government	0.1516	Medium	3	0.61
5.8. Tertiarization	NPC and SC	0.2931	High	4	1.47
5.9.1. Minimize Price Inflation	Beijing Price Bureau	0.0344	High	4	0.17
5.9.2. Normalize Prices	Beijing Price Bureau	0.0344	Medium	3	0.14
5.10. Control Population Growth	NPC and SC	0.2931	High	4	1.47
5.11.1. Food Self-sufficiency	Beijing Agricultural Bureau	0.0534	Low	2	0.16
5.11.2. Agricultural Marketization	NPC and SC	0.2931	Medium	3	1.17
5.11.3. Protection of Rural Livelihoods	Beijing Agricultural Bureau	0.0534	High	4	0.27
5.12.1. Ensure Adequate Overall Water Supply	Ministry of Water Resources	0.1001	High	4	0.50
5.12.2. Ensure Adequate Water Supply for Agricultural Use	Beijing Water Bureau	0.0502	Medium	3	0.20
5.12.3. Ensure Adequate Water Supply for Urban Use	Beijing Waterworks Co.	0.1021	Very High	5	0.61
5.12.4. Ensure Adequate Water Quality	Beijing Hygiene Bureau	0.0344	Very High	5	0.21

Table 7.3. Summary of results.

	Weighted Average	Average
Intersectoral Pricing	4.82	4.31
Intrasectoral Pricing	3.82	4
Public Allocation	2.21	3.05
Marginal Cost Pricing	5.15	4.83
Transferable Water Rights	3.95	3.44
Opportunity Cost Pricing	4.82	4.36
Full Cost Recovery Pricing	5.05	4.97
Ability to Pay Pricing	2.91	3.53
Ramsey Pricing	3.70	4.03
Willingness to Pay Pricing	2.85	3.08
Flat / Uniform Rate	3.10	3.92
Constant Rate	4.11	4.56
Declining Rates	3.14	3.08
Increasing Rates	5.27	5.03
Combine Rates / Dual Tariff	5.48	5.28
Peak-Load Pricing	4.88	4.58
Subsidies and Rebates	2.48	2.89
Cross-subsidized Price Structures	4.32	4.79

From Table 7.3 we draw several conclusions. First, according to the weighted average method, the three best options are *combined/dual tariffs*, *increasing rates*, and *full cost recovery*. The three worst options are *public allocation*, *subsidies and rebates*, and *willingness to pay pricing*. The second observation is that *intersectoral pricing* ranks slightly higher than *intrasectoral pricing*. The third observation is that the best-worst lists are virtually identical for weighted and non-weighted averages (the only difference is that with the addition of weights, *public allocation* ranks lower than *subsidies and rebates*).

There are several hypotheses for why the weights do not significantly change results. First, perhaps in calculating weights, high-level agencies were assigned too low a power weighting, or low-level agencies were given too high a power rank. If this is the case, the values of the formal power ranking may not have wide enough range. However, this does not appear to be the case. Table 2.2 column c shows numbers as low as 0.0344 and as high as 0.2931 (almost a ten-fold difference). Additionally, if we took informal power into account, most likely power levels between high- and low-ranking agencies will converge rather than diverge. Another explanation may be that the analytical hierarchy process did not produce weights that were divergent enough. However, this is also unlikely as this method simply reproduces the inputted numbers and eliminates

6.4. Summary of Alternatives

Table 6.10 summarizes the alternatives presented in this chapter. The first column presents these alternatives, and the second column displays the potential prices associated with them. As you can see, prices are only available for pricing methods. This is because price structures serve only as the frame of a pricing system, and not the content. Pricing methods, on the other hand, are based upon other variables and are thus calculable. The last two columns display the major constraints and opportunities in applying these alternatives in Beijing.

Table 6.10. Summary table of alternatives.

Alternatives	Approximate price	Constraints in application	Opportunities in application
6.1. Sectoral Allocation			
6.1.1. Intersectoral Pricing	Depends	Difficulties for agricultural sector	
6.1.2. Intrasectoral Pricing	Depends	Food security issues	Corresponds with tertiarization and agricultural marketization policies
6.2. Pricing Methods			
6.2.1. Public Allocation	Domestic: 1.30 Industrial: 0.40 Irrigation: 0.06 (current figures but depends)	Water shortage issues Possible political mishandling	
6.2.2. Marginal Cost Pricing	Domestic: 5 yuan/m^3 Industrial: 3.10 yuan/m^3 Agricultural: 1.72 yuan/m^3	Prohibitive costs Public unrest	Delays infrastructure needs
6.2.3. Transferable Water Rights	Not applicable	Legal issues	
6.2.4. Opportunity Cost Pricing	All sectors: 1.341 yuan/m^3	Difficulties for agricultural sector	Benefits for urban users
6.2.5. Full Cost Recovery Pricing	Domestic/ Industrial: 2.5 yuan/m^3	Likely to be improperly calculated for long run sustainable water use	In the short run, fulfils many goals
6.2.6. Ability to Pay Pricing	Domestic: 4.46 yuan / m^3	Administratively complex Difficult to calculate incomes Fails to solve equity issues for illegal migrants	
6.2.6.1. Ramsey Pricing		Administratively complex Difficult to calculate incomes Fails to solve equity issues for illegal migrants	
6.2.7. Willingness to Pay Pricing	Industrial: 3.92 yuan/m^2 Domestic: 1.8 – 4.3 yuan/m^3	Reallocation may prove difficult for agricultural sector	In the short run, fulfills many goals
6.3. Tariff Structures			
6.3.1. Non-Volumetric: Flat / Uniform Rate	na	Not necessary given existence of system to meter and administer	
6.3.2. Volumetric Pricing	na		
6.3.2.1. Metering	na	Issue with metering multifamily apartments and courtyard houses	Metering and administrative system already in place
6.3.2.2. Constant Rate	na	Does not deal with increasing luxury users in the future	Sufficient in the short run
6.3.2.3. Declining Rates	na	Not justifiable given Beijing's water scarcity	
6.3.2.4. Increasing Rates	na	Issue of tap-sharing and large families	Prevents excessive luxury uses
6.3.2.5. Combined Rates / Dual Tariff Schemes	na	Psychological effect on low volume, low income users	Improves financial sustainability for BWWC
6.3.2.6. Peak-Load pricing	na	Possibly prohibitive meter installation costs	
6.3.2.7. Equity Pricing	na		
6.3.2.7.1. Subsidies and Rebates	na	Difficult to identify most needy	
6.3.2.7.2. Cross-subsidised Price Structures	na	Difficult to identify most needy	

Chapter 7: Results and Conclusion

This chapter begins by presenting the results derived from analyzing the data, then draws general conclusions.

7.1. Objectives-by-Alternatives Matrix

The objectives-by-alternatives matrix depicts the degree of fulfillment of each objective by various alternatives. Table 7.1 organizes the objectives from chapter 5 and alternatives from chapter 6 into such a matrix

Table 7.1. Objectives-by-alternatives matrix.

	Intersectoral Pricing	Intrasectoral Pricing	Public Allocation	Marginal Cost Pricing	Transferable Water Rights	Opportunity Cost Pricing (same as Intersectoral)	Full Cost Recovery Pricing	Ability to Pay Pricing	Ramsey Pricing	Willingness to Pay Pricing
Financial Independence for Water Supply Providers	2	2	1	6	2	2	9	3	2	3
Full Cost Recovery	3	3	1	4	1	3	9	2	2	3
Minimize Cost of Service Provision	3	4	1	8	2	3	7	2	2	3
Reasonable Return on Capital	6	7	1	4	1	6	8	3	2	3
Stable Source of Revenue	5	7	3	3	1	5	7	3	2	2
Water Conservation	6	3	2	9	3	6	6	3	8	1
Installation of Water Efficient Technologies	8	5	2	8	2	8	6	2	6	2
Installation of Water Reuse Facilities	5	5	2	8	2	5	3	1	4	1
Affordability	1	3	9	2	5	1	3	9	9	8
Equity	1	3	9	2	8	1	3	9	9	8
Fairness	5	4	2	7	2	5	5	2	4	2
Equality	9	5	9	2	2	9	2	1	1	2
Maximize Ease of Implementation	2	5	5	2	1	2	2	6	5	6
Maximize Public Awareness	4	3	1	5	4	4	5	2	5	1
Minimize Public Unrest	1	5	3	2	3	1	2	7	5	8
Maximize Simplicity of Policy	6	5	8	1	1	6	5	2	2	3
Minimize Administrative Complexity	5	5	5	2	2	5	4	2	1	2
Economic Liberalization / Marketization	8	5	1	8	8	8	5	2	4	2
Maximize Economic Efficiency	8	5	1	9	8	8	5	1	3	2
Maximize the Use of Market-based Instruments	7	5	1	7	9	7	5	1	4	3
Minimize the Use of Subsidies	7	2	1	7	6	7	9	1	3	2
Minimize the Role of the State	7	2	1	7	5	7	9	2	5	2
Reform SOEs	3	3	1	5	2	3	7	2	4	2
Economic Growth	1	2	1	2	2	1	3	2	2	1
Improve Living Standards	2	3	2	2	5	2	2	7	7	6
Tertiarization	8	5	2	5	3	8	2	4	4	4
Minimize Price Inflation	1	3	8	2	1	1	3	7	5	4
Normalize Prices	8	4	1	7	5	8	5	2	2	3
Control Population Growth	1	1	1	1	1	1	1	1	1	1
Food Self-sufficiency	1	3	8	1	3	1	1	8	7	5
Agricultural Marketization	8	5	1	7	5	8	4	2	2	4
Protection of Rural Livelihoods	1	5	8	2	7	1	2	9	8	5
Ensure Adequate Overall Water Supply	3	5	2	8	3	3	9	3	2	1
Ensure Adequate Water Supply for Agricultural Use	1	5	2	5	3	1	7	6	5	2
Ensure Adequate Water Supply for Urban Use	8	5	2	9	4	8	9	5	5	2
Ensure Adequate Water Quality	2	2	2	5	2	2	5	3	3	2
Average	**4.31**	**4**	**3.05**	**4.83**	**3.44**	**4.36**	**4.97**	**3.53**	**4.03**	**3.08**

Flat / Uniform Rate	Constant Rate	Declining Rates	Increasing Rates	Combined Rates / Dual Tariff	Peak-Load Pricing	Subsidies and Rebates	Cross-subsidised Price Structures	
3	3	3	5	8	5	2	5	Financial Independence for Water Supply Providers
2	4	3	3	6	5	2	4	Full Cost Recovery
2	4	2	8	6	8	3	6	Minimize Cost of Service Provision
2	4	4	5	6	6	2	5	Reasonable Return on Capital
6	5	3	2	9	7	5	6	Stable Source of Revenue
1	5	1	9	9	9	2	8	Water Conservation
1	4	1	9	9	7	1	8	Installation of Water Efficient Technologies
1	3	1	6	6	5	1	5	Installation of Water Reuse Facilities
8	5	5	5	3	2	8	7	Affordability
7	6	2	4	3	2	8	9	Equity
2	5	2	7	8	1	5	6	Fairness
9	7	2	2	3	2	1	1	Equality
7	7	5	2	2	1	5	5	Maximize Ease of Implementation
1	3	2	6	7	6	1	6	Maximize Public Awareness
9	4	4	2	1	1	8	7	Minimize Public Unrest
9	6	4	2	1	1	2	2	Maximize Simplicity of Policy
7	6	4	2	1	1	1	1	Minimize Administrative Complexity
3	5	4	8	8	8	1	6	Economic Liberalization / Marketization
1	3	5	8	7	8	2	5	Maximize Economic Efficiency
2	4	4	8	7	7	2	6	Maximize the Use of Market-based Instruments
1	4	2	6	6	5	1	2	Minimize the Use of Subsidies
2	3	2	5	5	5	1	2	Minimize the Role of the State
2	4	2	6	6	6	1	2	Reform SOEs
2	2	4	3	3	3	2	3	Economic Growth
5	5	1	3	2	2	8	8	Improve Living Standards
2	3	5	6	6	5	2	2	Tertiarization
7	7	5	3	3	3	4	5	Minimize Price Inflation
3	4	3	4	4	4	3	5	Normalize Prices
1	1	1	1	1	1	1	1	Control Population Growth
9	5	8	3	3	3	1	1	Food Self-sufficiency
2	6	5	8	8	5	1	1	Agricultural Marketization
8	4	5	2	2	2	7	7	Protection of Rural Livelihoods
4	6	1	7	8	7	1	6	Ensure Adequate Overall Water Supply
3	6	2	7	8	8	3	6	Ensure Adequate Water Supply for Agricultural Use
4	6	2	8	9	8	3	6	Ensure Adequate Water Supply for Urban Use
3	5	2	6	6	6	3	5	Ensure Adequate Water Quality
3.92	**4.56**	**3.08**	**5.03**	**5.28**	**4.58**	**2.89**	**4.79**	**Average**

The numbers in this table are determined by the author as a quantitative description of how well each alternative meets each objective. The values range from 1 to 9, as follows:

1 = Does not achieve objective, negatively impacts achievement of objective, or has no relation with objective
2 = Barely achieves objective
3 = Slightly achieves objective
5 = Adequately achieves objective
7 = Achieves objective very well
9 = Achieves objective extremely well

For example, intersectoral pricing does not necessarily help tap water companies achieve their goal of financial self-sufficiency, thus in the corresponding square of the matrix there is the number 2, which indicates that intersectoral pricing *barely achieves the objective* of financial independence for water supply companies. Clearly, this matrix involves educated guesses, based the information researched by the author. However, accuracy is only required to a certain degree. In many cases, it is enough to get a general sense of how well each alternative fulfills each objective. In essence, this matrix is qualitative, with numbers acting simply as convenient representations of qualitative statements.

Alone this matrix provides some information but not much. First, we discover that the objective of controlling population growth has little relevance to water pricing policies. Regardless of how one designs water tariffs, it will not have an effect on the growth of population. Another observation is that it is not immediately apparent which are the superior choices. Options that achieve some objectives extremely well, achieve other objectives very poorly. Finally, the non-weighted average provides an indication of which alternatives may potentially be the most desirable, and which may be the least. The top three options according to this matrix appears to be *combined/dual tariffs*, *increasing rates*, and *full-cost recovery pricing*. The two worst options are *subsidies and rebates*, and *public allocation*. However, without weighting these objectives, we do not know which have greater importance to policy-makers and which are backed by more powerful actors. In the next section we correct this problem.

7.2. Weighted Trial

Weighted average method involves the addition of a coefficient before each objective in order to give it either a greater or a lesser weight. There are essentially two sets of weights for each objective: (1) the *formal power weight* of the primary actor pursuing the particular objective, and (2) the priority which the actor places on this objective.

The first set of weights was determined in section 4.1 on formal power ranking. At the conclusion of this section, we generated a formal power ranking, based on the hierarchical ranking and the relevance to the issue of each actor. These weights are shown in column c of Table 7.2. However, certain objectives are more important than others, even to the actor in charge of pursuing them. In column d, we assign a priority ranking for each objective, and in column e we assign each priority a corresponding numeric value (from 1 to 5). The final weight (shown in column f) combines columns c and e by simple multiplication. This column will be transposed into the objectives by alternatives matrix in order to calculate the weighted average. Table 7.3 summarizes the results of the calculations.

Table 7.2. Formal power weight and priority weight.

Objective (a)	**Primary goal holder (b)**	**Formal power weight (c)**	**Priority for actor involved (d)**	**Numeric value of priority (from 1-5) (e)**	**Final weight = c x e (f)**
5.1. Financial Independence for Water Supply Providers	Ministry of Construction	0.1464	Very High	5	0.88
5.1.1. Full Cost Recovery	Ministry of Construction	0.1464	Very High	5	0.88
5.1.2. Minimize Cost of Service Provision	Beijing Waterworks Co.	0.1021	High	4	0.51
5.1.3. Reasonable Return on Capital	Ministry of Construction	0.1464	High	4	0.73
5.1.4. Stable Source of Revenue	Beijing Waterworks Co.	0.1021	High	4	0.51
5.2. Water Conservation	Beijing Municipal Government	0.1516	Very High	5	0.91
5.2.1. Installation of Water Efficient Technologies	Beijing Water Savings Office	0.0344	Medium	3	0.14
5.2.2. Installation of Water Reuse Facilities	Beijing Water Savings Office	0.0344	Medium	3	0.14
5.3.1. Affordability	Beijing Price Bureau	0.0344	High	4	0.17
5.3.2. Equity	NPC and SC	0.2931	Low	2	0.88
5.3.2.1. Fairness	Beijing Municipal Government	0.1516	Low	2	0.45
5.3.2.2. Equality	NPC and SC	0.2931	Very Low	1	0.58
5.4. Maximize Ease of Implementation	Beijing Waterworks Company	0.1021	Very High	5	0.61
5.4.1. Maximize Public Awareness	Beijing Waterworks Company	0.1021	Medium	3	0.41
5.4.2. Minimize Public Unrest	Beijing Waterworks Company	0.1021	Very High	5	0.61
5.4.3. Maximize Simplicity of Policy	Beijing Waterworks Company	0.1021	Low	2	0.31
5.4.4. Minimize Administrative Complexity	Beijing Waterworks Company	0.1021	Low	2	0.31
5.5. Economic Liberalization / Marketization	NPC and SC	0.2931	High	4	1.47
5.5.1. Maximize Economic Efficiency	NPC and SC	0.2931	High	4	1.47

5.5.2. Maximize the Use of Market-based Instruments	NPC and SC	0.2931	High	4	1.47
5.5.3. Minimize the Use of Subsidies	Beijing Municipal Government	0.1516	High	4	0.76
5.5.4. Minimize the Role of the State	NPC and SC	0.2931	High	4	1.47
5.5.4.1. Reform SOEs	Beijing Municipal Government	0.1516	Very High	5	0.91
5.6. Economic Growth	NPC and SC Beijing Municipal Government	0.2931	Very High	5	1.76
5.7. Improve Living Standards	Beijing Municipal Government	0.1516	Medium	3	0.61
5.8. Tertiarization	NPC and SC	0.2931	High	4	1.47
5.9.1. Minimize Price Inflation	Beijing Price Bureau	0.0344	High	4	0.17
5.9.2. Normalize Prices	Beijing Price Bureau	0.0344	Medium	3	0.14
5.10. Control Population Growth	NPC and SC	0.2931	High	4	1.47
5.11.1. Food Self-sufficiency	Beijing Agricultural Bureau	0.0534	Low	2	0.16
5.11.2. Agricultural Marketization	NPC and SC	0.2931	Medium	3	1.17
5.11.3. Protection of Rural Livelihoods	Beijing Agricultural Bureau	0.0534	High	4	0.27
5.12.1. Ensure Adequate Overall Water Supply	Ministry of Water Resources	0.1001	High	4	0.50
5.12.2. Ensure Adequate Water Supply for Agricultural Use	Beijing Water Bureau	0.0502	Medium	3	0.20
5.12.3. Ensure Adequate Water Supply for Urban Use	Beijing Waterworks Co.	0.1021	Very High	5	0.61
5.12.4. Ensure Adequate Water Quality	Beijing Hygiene Bureau	0.0344	Very High	5	0.21

Table 7.3. Summary of results.

	Weighted Average	Average
Intersectoral Pricing	4.82	4.31
Intrasectoral Pricing	3.82	4
Public Allocation	2.21	3.05
Marginal Cost Pricing	5.15	4.83
Transferable Water Rights	3.95	3.44
Opportunity Cost Pricing	4.82	4.36
Full Cost Recovery Pricing	5.05	4.97
Ability to Pay Pricing	2.91	3.53
Ramsey Pricing	3.70	4.03
Willingness to Pay Pricing	2.85	3.08
Flat / Uniform Rate	3.10	3.92
Constant Rate	4.11	4.56
Declining Rates	3.14	3.08
Increasing Rates	5.27	5.03
Combine Rates / Dual Tariff	5.48	5.28
Peak-Load Pricing	4.88	4.58
Subsidies and Rebates	2.48	2.89
Cross-subsidized Price Structures	4.32	4.79

From Table 7.3 we draw several conclusions. First, according to the weighted average method, the three best options are *combined/dual tariffs*, *increasing rates*, and *full cost recovery*. The three worst options are *public allocation*, *subsidies and rebates*, and *willingness to pay pricing*. The second observation is that *intersectoral pricing* ranks slightly higher than *intrasectoral pricing*. The third observation is that the best-worst lists are virtually identical for weighted and non-weighted averages (the only difference is that with the addition of weights, *public allocation* ranks lower than *subsidies and rebates*).

There are several hypotheses for why the weights do not significantly change results. First, perhaps in calculating weights, high-level agencies were assigned too low a power weighting, or low-level agencies were given too high a power rank. If this is the case, the values of the formal power ranking may not have wide enough range. However, this does not appear to be the case. Table 2.2 column c shows numbers as low as 0.0344 and as high as 0.2931 (almost a ten-fold difference). Additionally, if we took informal power into account, most likely power levels between high- and low-ranking agencies will converge rather than diverge. Another explanation may be that the analytical hierarchy process did not produce weights that were divergent enough. However, this is also unlikely as this method simply reproduces the inputted numbers and eliminates errors. The most likely explanation for why the weights failed to produce an effect is simply because these objectives are all relatively equal in importance (with the exception of goals such as control population growth, which is clearly less important, and economic growth, which is clearly more important). Irrelevant goals and actors have already been more or less screened out in earlier stages. Thus the weight of these remaining objectives are relatively equal.

7.3. Summary of Major Trade-offs

Given the seemingly unquenchable thirst for economic growth by all levels of China's government, it is not surprisingly that policies that are market-based, economically efficient, and self-supporting rank the highest. Indeed, there is much evidence to support the claim that China has shed its earlier preoccupation with equality and equity in the pursuit of the golden yuan. As such, water-pricing policies that involve public allocation or subsidies and rebates are given low priority. Financial unsustainability is not longer acceptable to government agencies that since 1978 have slowly had their financial umbilical cords cut from the central government. With institutions ranging from the army to the postal service corporatizing in order to sustain themselves, it is not surprising that waterworks companies feel the impetus to do the same.

Pricing policies leading to high prices rank high in this analysis. *Increasing rates*, *full cost recovery*, and *peak load pricing* all rank high, and all involve bringing water prices to much higher than current levels. Interestingly enough, the most heavily pushed pricing policy – *marginal cost pricing* – ranks lower than *full cost pricing* in spite of its economic efficiency. The complexity of marginal cost pricing, along with its extremely high rates are no doubt part of the reason for this.

High prices also serve to encourage water conservation. Chapter two emphasized the precariousness of the water shortage situation in Beijing. With the threat of industrial, commercial and agricultural losses due to water shortage, it is obvious why the Beijing government wishes to encourage water conservation now, and promote water conservation technologies in order to avoid economic loss and hardship in the future.

7.4. Conclusion

The purpose of this paper has not been simply to determine the best water pricing policy, but to demonstrate the importance of thorough investigation into the institutions surrounding the issue when conducting such an analysis. Although our analysis allows us to draw some conclusions about optimal pricing policies for Beijing, the lack of information clearly limits us in our assessment. Our first conclusion is therefore that further research must be conducted. Given the time and information limitations, as well as the broad scope of this paper, several issues were not researched to the extent that they deserved. Some areas for further investigation include:

- Informal power structure: While there is a fair base of literature on Chinese informal power, there is a paucity of case studies, and none concerning the informal relationships between the agencies involved in water pricing. The importance of informal power in determining policy decisions should not be underestimated, in spite of its omission from this study due to lack of available research. For example, a particular agency, such as the agricultural bureau, may have informal reasons to oppose increases in agricultural water tariffs (perhaps due to relations with local rural leaders). This informal incentive is not apparent in the agency's mandates or legal documents, however, it may be strong enough to cause the agency to apply informal tools (such as red tape, bureaucratic inefficiencies, or guanxi) in order to impede implementation of price hikes. Knowledge of these informal incentives would contribute greatly to our understanding of the development of particular pricing policies. An interesting study would involve interviewing bureaucrats within these agencies to derive their more knowledgeable estimations of power structures, both formal and informal. Only an insider would be able to reveal the informal relations between agencies, which would likely form a web on the formal organization chart depicted in Figure 3.3. However, a thorough investigation would be difficult as bureaucrats may be reluctant to divulge information about inter- and intra-ministerial conflicts and relations.
- Powerful individuals: Chapter 4 mentioned the lack of research on powerful individuals within various ministries. No research was uncovered on particular individuals (such as mayors, ministers, department heads etc) involved in water pricing in Beijing. Indeed a staunch supporter of price reform in the Beijing Price Bureau, or a reluctant mayor, may hold enough power to affect policy changes. Although insider information is extremely difficult to attain, such information would greatly illuminate the decision-making process.

- Formal power structure: While this study has attempted to provide an updated formal power structure, reforms are on-going. Ministries are created and destroyed, and mandates are re-assigned and re-written. While this paper was being written, the Beijing Municipal Government was undergoing massive restructuring and reform. It will likely be a few years before new agencies and new roles are established in Beijing.
- Laws, legislation, mandates: While some official documentation is available, there is little information on the extent to which various laws, legislation and mandates are carried out. Primary research would be required in order to determine the priorities of various ministries on a more informal level. As well, at the time of research, information on the Tenth Five Year Plan (spanning from 2001-2005) was not yet available. In order to attain an up-to-date account of government policy trends, it is important to have access to the most recent policies, laws, and legislation.
- Calculated options: Although there have been attempts to calculate the actual price of water under the different tariff structures by other analysts, many of these attempts are out of date and only limited to marginal cost and full cost recovery schemes. A lack of publicly available information from the Beijing Waterworks Company on costs of supply make even estimating full cost recovery difficult. Marginal costs are virtually impossible to determine without some basic information. However, if information is available, calculation of potential prices would greatly illuminate the discussion.

Our second conclusion pertains to water prices in Beijing. Based on the findings presented in this chapter we conclude that water prices in Beijing need to become more efficient, encourage more conservation, and bring in more revenue. This means that water-pricing policies that are market-based and achieve goals such as economic efficiency and water conservation are the "best" options. Specifically, water pricing policies that that are more economically efficient and encourage efficient water use, such as *increasing rates*, or *peak-load pricing*, are good options. Pricing options, such as *full cost recovery pricing*, that enable full cost recovery are also preferred in an environment of shrinking subsidies. And indeed it appears as if Chinese government is arriving at the same conclusion. Section 2.3.4 discussed how Shenzhen's tap water company is implementing an increasing rate structure, and section 2.4.4 outlines Beijing's efforts at establishing increasing rates since 1994. Further, government regulations (such as the Management Method for Pricing Urban Water Supply (1998) and the Irrigation Waterworks Fee Assessment, Calculation and Management Method (1985)) establish rules to ensure full cost recovery.

The third conclusion relates back to our original problem statement: *How do institutional goals and directives impact on water pricing policy in Beijing?* Although the final analysis showed that the weight was not of great importance (which means that power differences between agencies are not important or that all the goals in this analysis hold equal esteem), Chinese institutions, and their goals and behaviors, indeed have great impact on water pricing policy design and implementation. One could even argue that examining water prices carefully allows one to determine the goals of the institutions surrounding it, because they are so intricately linked. Or in reverse, by examining the goals of the institutions involved in water pricing carefully, one can determine water prices. For example, although food security was a national priority during the early stages of the nation, it reappeared as a priority in 1994 (see section 5.11.1). As a result, moves to raise agricultural water rates have been cautious, even within the past decade. Figure 7.1 illustrates the relationship between the progression of water prices and the evolution of government policies and priorities from the founding of New China. As you can see, water price increases correspond with changes in government leaders, ideology, and policies, adoption of new national objectives, and enactment of associated legislation.

In the pre-Deng Xiao Ping period, when power was concentrated in the hands of central leadership and goals included equality, food security, and industrial expansion, water pricing was not a priority. Abundant water resources, and the goals of various actors and institutions, combined to ensure that prices remained effectively zero.

The beginning of water pricing in Beijing coincidences with changes in institutional goals. After the drought of 1972, the Ministry of Water Resources began to experience institutional changes and its mandate was re-written to achieve water conservation, rather than irrigation expansion. As well, water shortage throughout northern China prompted national leaders to reorient policies towards conservation beginning in the late 1970s. At this time, a change of government brought with it a change in ideology. National priorities switched from equity to economic growth and marketization. Market-based policies were increasingly accepted during this transitionary period. Water prices were introduced and experienced some tentative steps towards increase. Change at this time was slow for numerous institutional reasons. First, hard-liners within the CCP were reluctant to accept marketization and still promoted China's earlier goals. Second, much of the population, particularly in the countryside, were resistant to changes that would bring them economic hardship. In some cases, the benefits of economic liberalization were not yet felt in rural areas, and thus additional costs brought public unrest.

However, by the 14th Party Congress in 1992, the transition was clearly over. The economy became decidedly *market socialist*, old ambitions were shelved, and the objectives of all levels of government became increasingly market-oriented. As a result, water prices in Beijing experienced great leaps and revisions every few years.

But one may question the closeness of the link between institutional objectives and water pricing policy because even today Beijing lacks efficient pricing. I submit that the link is indeed strong and that implementation lag fits within the Chinese practice of implementing reforms incrementally, or according to Deng Xiao Ping, by "groping pebbles to cross the stream" (Deng, 1992). When prices appear to be rising rapidly to extremely high levels, such as in Jiazi (see Box 5.1), public unrest may follow. China is currently in a testing phase, in which select cities, such as Shijiazhuang act as test sites for efficient water pricing policies. These pilot projects aim to determine the effectiveness of certain policies. The Chinese recognize that the optimal solution on paper may not have taken into account all variables and may thus fail in actuality. Additionally change is slow, and reactions delayed. After a tariff adjustment, one does not record complaints or see a reduction in water demand immediately. Typically, frequent revisions will be called for, in order to "grope" for the optimal solution.

Although one cannot predict the future direction of the Chinese government, China appears to be heading in the direction of further economic liberalization. Thus we can conclude that institutional openness to economically efficient pricing will increase and that the optimal pricing policies in this report will be implemented in a matter of time.

Another conclusion which supports the future movement of water prices to efficient levels is that both local and national institutions share similar goals and both have incentives to see the marketization of the economy, including the water supply sector. Power is decentralizing and the command of national authorities is no longer absolute. Power sharing means that implementation of national policies will therefore likely be inconsistent across provinces, cities, and counties.

But perhaps the brightest light in Beijing's dire water situation is the fact that officials are recognizing the link between price and demand, and actively increasing prices to correct for wastage. In a situation where water is increasingly scarce, the worst policy would be no policy. Even minor price increases or pilot projects are a positive sign that the issue is being addressed. Perhaps Deng Xiao Ping summarized the future direction of water pricing best when he stated in 1992: "It seems that some capitalist practices can be applied to the socialism system. It is nothing serious even if a pilot project fails! If something goes wrong, let us close down the stock exchange and reopen it some days later. After all, there is nothing 100 percent correct in this world."

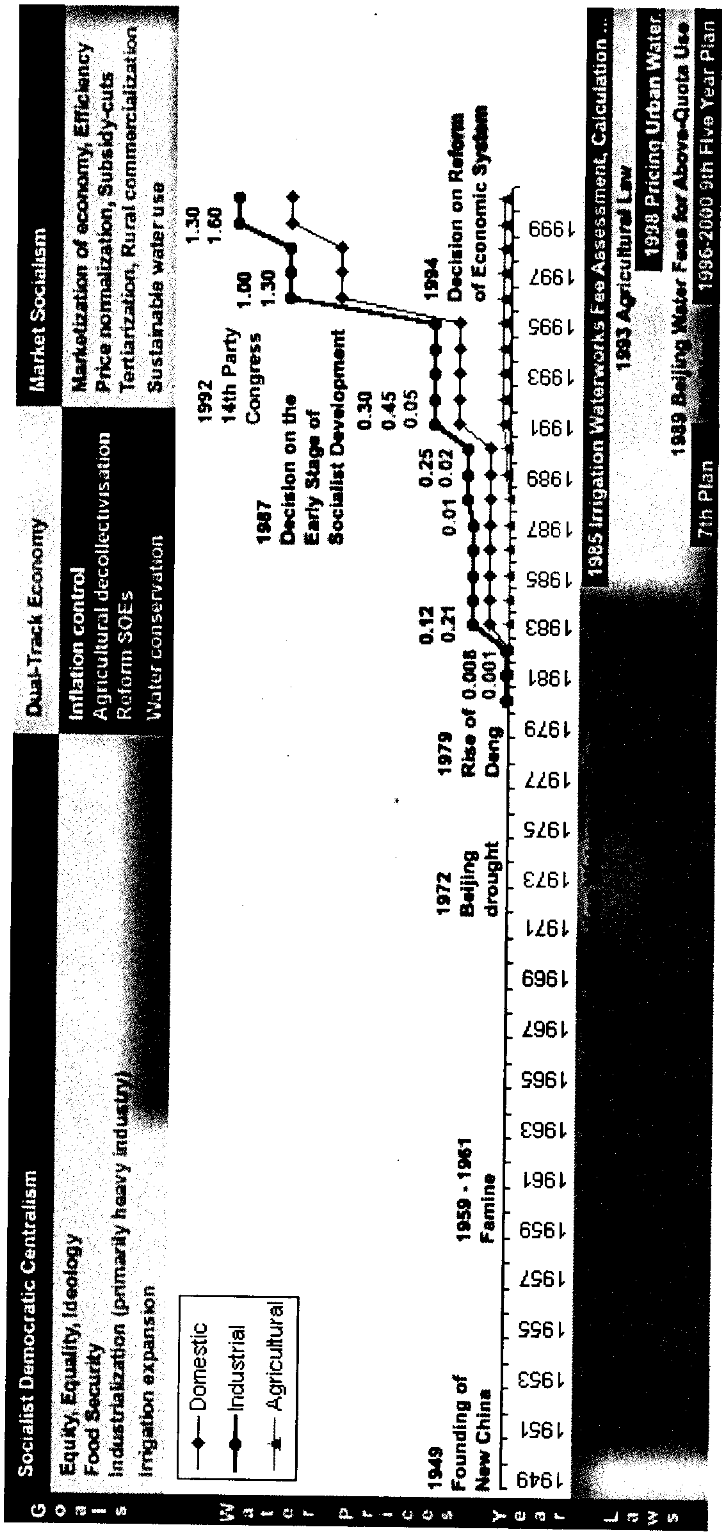


Figure 7.1. Timeline summary of (from top to bottom) governing system, primary goals, water prices in Beijing and major events, and laws and regulations.

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Beijing Water Resource Management Regulation (1992) [Chinese]
Beijing Punishment Rule for Wasting Water (1994) [Chinese]
Beijing TVE Water Saving Method (1986) [Chinese]
Beijing Water Price Management Method (1989) [Chinese]
Beijing Water Saving Technology Regulation (1988) [Chinese]
Beijing Municipality Ninth Five-Year Plan (1996-2000) [Chinese]

Appendix A: Economic Foundations of Water Pricing

A.1. Market Failures

Water, like all commodities, is economically scarce when there is not enough available for users to have as much as they want without giving up something else of value in order to obtain it. Today's governments, faced with the challenge of increasingly thirsty cities are turning to market mechanisms as a solution to problems of allocation of this increasingly scarce resource. When water is plentiful, there is no need to develop rules for its use and allocation. Allocation of most goods in capitalist economies is determined by the market: distribution is the cumulative effect of many individuals making their own decisions about how much they wish to purchase based on price and personal preference. "Markets allocate economically scarce water resources by compelling buyers to evaluate the benefits of acquiring additional quantities of water at the expense of foregoing something else of value. Reliance on market processes is consistent with the belief that individuals are the best judge of their own well-being and have the right to make economic decisions in pursuit of their own self-interest" (Saliba and Bush, 1987). This effect is known as Adam Smith's "invisible hand."

But water has qualities that make it distinct from regular goods and prone to market failures[23]. First, water can be a pure *public good*[24] (when water is used for non-consumptive purposes, such as a scenic river) or a *private good* (such as in the case of tap water). In the case of water as a *public good*, it is nearly impossible to use the market to allocate and place value on the good.

Second, the valuation of water also involves market failure in the form of *externalities*. The *public good* nature of water creates *externalities* (or side effects) which have positive or negative values to third parties but which are not noted in the cost / benefit calculation. *Externalities* (such as environmental effects due to water intake construction, impacts on fish due to changes in water levels etc) are involved in water supply but typically not accounted for.

Third, the fluid nature of water makes it difficult to ascribe to specific individuals. User conflicts arise over water when rights are not regulated.

Finally, there are significant economies of scale involved; larger projects are more cost effective than smaller projects. This means that water provision creates *natural monopolies*, which have to be regulated.

A.2. Water Demand Curves

The fundamental reasoning behind water pricing as an allocative tool is that users respond to price changes: when price rises, consumption falls. This phenomenon is observed in almost all goods (with some exceptions, such as rare collectibles) and water is no exception. The demand function, which graphically depicts the relationship between water use and price, is therefore necessarily downward sloping. There are two ways to conceptualise this relationship. One can think of it in terms of price and quantity: when the price is set very high, users only consumer small quantities of water (and vice versa). Alternatively one can conceive of demand as willingness to pay. The first few units of water are crucial for survival and thus users will pay almost any price for them. However, after basic needs are satisfied, users are less and less willing to pay for each additional increment (or marginal increment) of water, and thus the demand curve slopes downward (see Figure A.1). Because the demand curve tracks the willingness to pay for additional units of water, it is also known as a marginal value or benefit function (in other words, it notes the marginal or additional value of the next unit of water). The rate at which willingness to pay for extra units drops (depicted by the shape of the curve) depends on the individual consumer and product. Additionally, the shape and positioning of these curves is affected by need variables (such as population) and intensity-of-use variables (such as income or ability to pay, conservation practices or willingness to substitute, and willingness to pay for water). Finally, the area under the demand curve is the total willingness to pay, which is a gross measure of the value of various quantities of water to the consumers. To cost-benefit analysts, this area is the *total* or *gross benefit* derived from the particular quantity of water for the consumer. The area (shaded in grey) above the price and below the demand curve is the *net benefit* of the water to the consumer, or the *consumers' surplus*.

[23] A good subject to market failure is one which does not function efficiently in free a market situation.
[24] Public goods are those that are *nonrivalrous* (can provide benefits to more than one individual simultaneously) and *nonexcludable* (cannot limit the benefits to one individual).

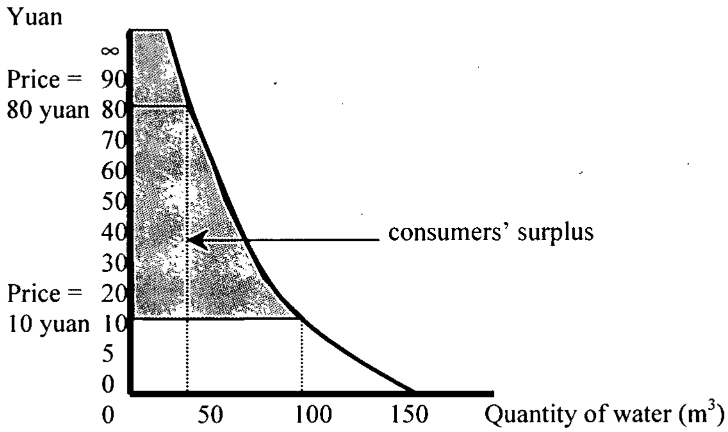

Figure A.1. Sample water demand curve.

Based on this demand curve, to promote conservation of water resources, one need only raise the price of water. For example, if the price was raised from 10 yuan/m^3 in our example to 80 yuan/m^3, water consumption would drop from 100 m^3 to 40 m^3. Figure A.1 only depicts the demand curve for a single individual. In order to get an aggregate demand curve for a municipality, region, or sector, simply add together the demand curves of all individuals.

It is useful to consider water demand patterns by sector (typically domestic, industrial, and agricultural) because they vary greatly in their pattern of demand. For example, domestic water users will pay very high rates for the initial life-sustaining units of water, while agriculture, on the other hand, will only pay the value of the crops. Adding together the demand curves of all sectors will reveal the total regional water demand (see Figure A.2).

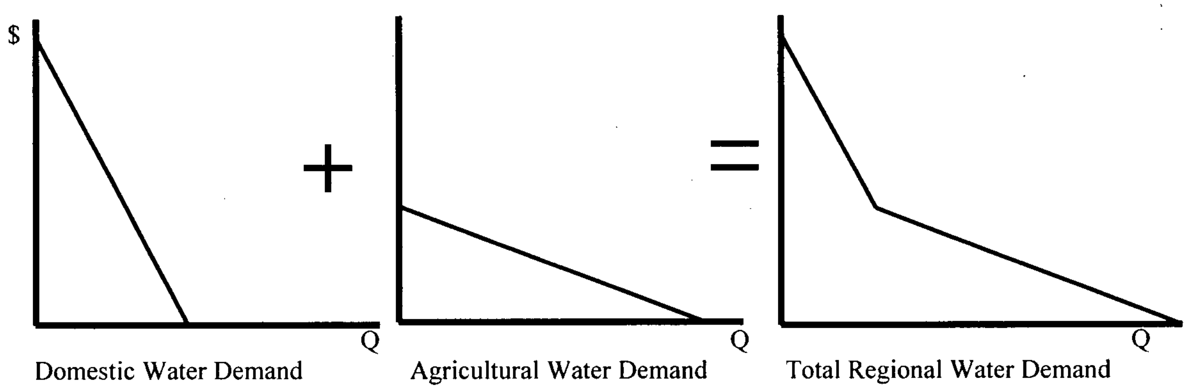

Figure A.2. Sample regional water demand curve.

A.2.1. Price Elasticity

Typically one does not need to know the entire demand curve, just the price elasticity of water. This is the percentage change in quantity of water demanded in response to a 1% change in price or, in other words, the slope of the demand curve. This is depicted in the following equation:

$$\text{Price elasticity} = [(Q_2 - Q_1)/Q^*]/[(P_2 - P_1)/P^*]$$
$$\text{where: } Q^* = (Q_2 + Q_1)/2 \text{ and } P^* = (P_2 + P_1)/2$$

Knowledge of price elasticities allows economists to estimate the change in consumption due to a change in price. Demand is:

- *inelastic* when price elasticity is between 0 and –1. This means that quantity demanded does not decrease proportionally in response to a price increase. For example, an increase in price by 10% will result in *less* than a 10% reduction in quantity. An inelastic demand curve is steep.
- *elastic* when price elasticity is below –1. This means that the proportional decline in quantity demanded will be greater than the proportion of the price increase. For example, an increase in price by 10% will result in *greater* than a 10% reduction in quantity demanded. An elastic demand curve is flat.
- *uniform* when price elasticity is exactly –1. This means that quantity demanded is exactly proportional to the price. In this case, a 10% increase in price will lead to a reduction in water quantity demanded of exactly 10%.

Price elasticity is depends on several factors including sector (domestic, industrial or agricultural), season, changes in explanatory variables (price is collinear with other variables and the omission of those variables may produced a biased coefficient), user response (users' ability to make cost-effective adjustments in utilising related goods and in water-using habits, changes in stock of water-using appliances, changes in landscaping, changes in irrigation practices or in domestic water-use habits). Long-run water demand is more elastic than short-run demand because it allows adequate time for the user to respond and adjust to changes in price.

It is useful in some cases to note the differences in price elasticities and to divide water demand in to sub-groupings. For example, in the United States where luxury water use such as lawn sprinkling is common in the summer, price elasticities vary by season. One study found water demand much more elastic in the summer than in the winter. This American study showed that in winter, residential water demand was extremely inelastic at 0.0 to –0.1. In the summer on the other hand, prices had an elasticity of -0.5 to –0.6 (Prasitka, 1988). When considering the specific nature of the water use, the study found an elastic demand when looking at lawn sprinkling alone (-0.7 to –1.6). Another study of the Eastern US compared the elasticities of residential indoor use (drinking, washing, cooking) and outdoor use (watering) and found an elasticity of –1.57 for outdoor use and –0.23 for in-door use (Rogers, 1996). Price elasticities differ by sector. Residential use tends to be the most inelastic, agricultural use tends to be the most elastic, and industrial use is so highly variable that analysts need to further breakdown the sector in order to make any sense of it. An American study found an average residential price elasticity of -0.2 to –0.4 and an industrial price elasticity of -0.3 to –6.71 (Prasitka, 1988).

There are several major problems with relying on price elasticities. First, the price elasticity is unlikely to remain constant for all quantities (in other words, demand curves are unlikely to be straight lines). At low quantities demand tends to be highly inelastic and at high quantities demand is much more elastic. This is because in order to attain those first few life-sustaining units one is willing to absorb high price increases with little reduction in water use. After basic needs are taken care of, consumers are much more sensitive to price changes and will reduce their water use quite significantly if prices rise. It is therefore important to note where on the demand curve your elasticity readings are derived from.

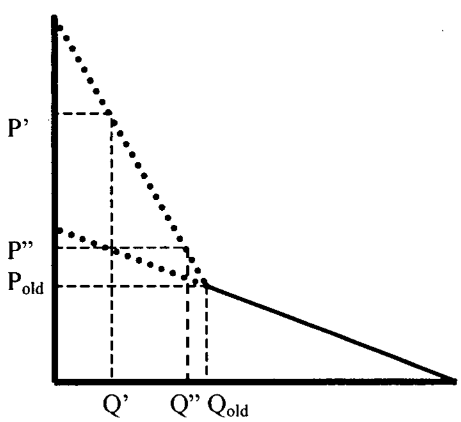

Figure A.3. Illustration of price elasticity.

Not knowing the shape of the demand curve (and the varying elasticities at different quantities) can result in problems in a situation were the utility raises water prices in an attempt to promote water conservation (see Figure A.3). For example, assume the existing price and quantity is at Q_{old} and P_{old}. At this amount of water, demand is elastic (let's just assume an elasticity of –1.5). Suppose now that the goal of the water utility is to decrease water demand from Q_{old} to Q' by raising water prices. If the analyst assumes the entire demand curve has an elasticity of –1.5 then he will advise the water bureau to increase price to P" in order to reduce demand to Q'. However, the true upper portion of the demand curve is actually less elastic. Raising the price to P" therefore does not create the desired conservation effect but only manages to reduce water demand to Q". In order to achieve a quantity reduction of Q', the utility will have to raise prices to P'.

Since elasticity does not necessarily remain consistent along the entire demand curve, elasticities provide little information on willingness to pay for more supply. In other words, the right-hand side of the demand curve (where quantities are greater than currently available) is typically unknown. For example, in Figure A.4, the tap water company wishes to increase total water supplied from the original quantity (Q_{old}) to a new, higher quantity (Q_{new}). However, it is unclear what willingness to pay for higher quantities of water is – it could range from curve A to D (and anywhere in-between). With uncertainty about the shape of the demand curve, the tap water company may wrongly assume that the curve resembles curve D, which would allow the utility to collect a price of P_{upper}, which would help defray the cost of the new supply infrastructure. However, if the true curve is curve A, then at the new quantity (Q_{new}) price is P_{lower} (or, effectively zero). This case was illustrated by the Tucson Water Department when it estimated that prices would have to increase by 17.6% to pay for increasing cost of city supply. However, with changes in elasticity taken into account, economists found that the cost would actually have to increase by 59% in order to increase total revenue by 17.6% (Rogers, 1996).

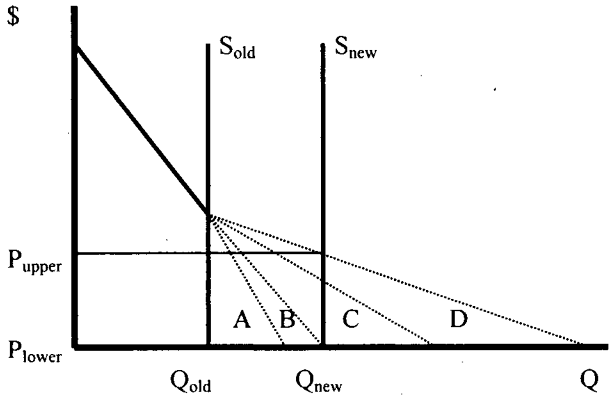

Figure A.4. Example of price elasticity uncertainty.

A.2.2. Demand Curve Dynamics

Changes in need and intensity-of-use variables will cause changes in the shape and positioning of demand curves. While shape changes are difficult to predict, positioning changes are more predictable. Income effects (changes in household incomes) will shift the demand curve to the right (if income is rising) or to the left (if income is falling). In other words, as people earn higher incomes, they demand larger quantities of water at each price. An increase in conservation (for example, through improved water-efficient taps or public awareness of) will shift the demand curve to the left (less water is demanded at each price). Finally, an increase in any of the need variables mentioned above will shift demand to the right and vice versa.

A.2.3. Determining Demand Curves

Determining these demand curves is not an easy task: how exactly do we find out how consumers value various quantities of water? Economists, in an effort to find these curves, have developed several methods. For agricultural demand curves, all non-water production costs are subtracted from total revenues to get a residual. This residual is the maximum amount farmers are willing to pay for water (typically in acre-feet per year). Industrial water demand curves are perhaps the most difficult to estimate since water requirements can vary greatly depending on the specific nature of the industry. One method of calculating industrial water demand is to examine the cost of in-plant water recycling systems as a measure of marginal cost. Domestic demand curves are typically derived through econometric analysis of price/quantity data collected directly through meter readings, or through secondary sources such as billing or surveys.

A.3. Water Supply Curves

The supply curve depicts the cost of providing various quantities of water. This curve is essentially derived from engineering studies. A complete supply curve considers both fixed costs (such as capital and labour costs for constructing reservoirs, wells, pumping stations, water mains, treatment plants, storage tanks, land acquisition), variable costs (such as operation, maintenance, labour), depreciation, provision for further expansion, cost of services provided to the water system by other municipal departments, and cost of water if purchased from wholesaler or other suppliers. These costs are affected by age of system, type of treatment needed, cost of pumping, size of service area, and average and peak water demands. An ideal supply curve would internalise externalities such as environmental and social costs as a result of water diversion, collection, transport, and treatment into supply costs.

The supply curve is also known as the marginal cost curve because it depicts the cost of each additional (or marginal) increment of water. Calculating the total area under the curve provides the total cost of supply. The area above the supply curve and beneath the price level is the producers' surplus – or profit. Water supply curves tend to be upward sloping because the least costly water supply sources are exploited first, leaving more costly projects for later quantities. In the short run, the supply curve will not likely start at zero. This is because the first block of water usually requires an investment of a fixed capital cost (in Figure A5, this amount is $20).

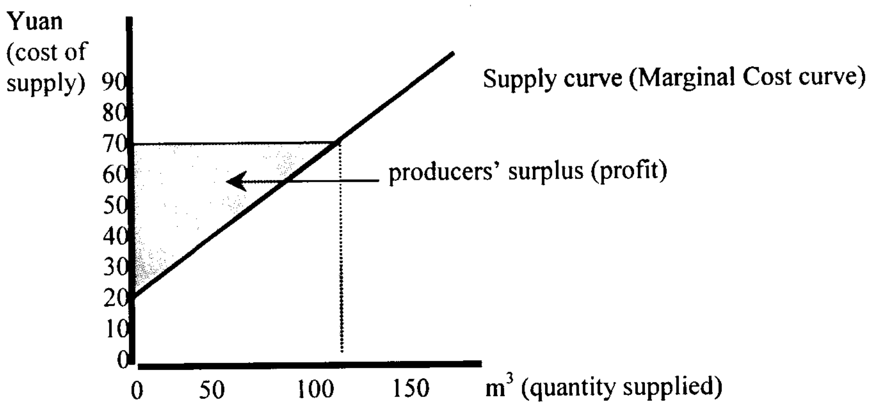

Figure A.5. Sample supply curve.

There are two ways to calculate the supply curve. First, it may be calculated historically. With this method, the incremental cost of providing various quantities of water in the past is projected into the future. The second method involves examining the cost of replacing infrastructure, or the cost of expanding infrastructure to produce another cubic meter of water.

Since demand is not stable and will rise in the future, expansion costs are a concern. Expansion, however, can only occur in the long run and therefore it is important to distinguish between long and short run cost curves (see Figure A.6).

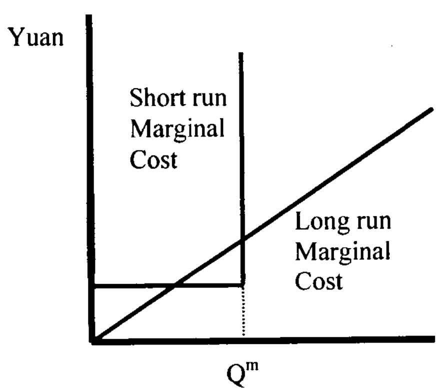

Figure A.6. Sample of long- and short-run marginal cost curves.

In the short run, total supply capacity is fixed by physical restraints, such as the diameter of the intake pipe. The short-run marginal cost in Figure A.6 will simply be the additional costs of energy for pumping, which are likely to be constant (McNeill, 1989). Above this maximum quantity (Q^m) additional costs are long run costs because they involve increasing capacity. The long run marginal cost considers the possibility of creating more capacity (ie enlarging the pipe diameter). Water utilities typically consider the long run marginal cost when setting prices. Note that the long run MC curve begins at zero – this is because all costs are considered variable when viewed from a long time horizon. The optimal price in the short run is therefore the price at which short run demand intersects short run MC. In the long run, optimal price should be set at the intersection between long run MC and long run demand.

Appendix B: Relevant Laws

This appendix provides some descriptions of important pieces of legislation mentioned throughout this paper. These laws and regulations act as the basis from which the actors (Chapter 3) and objectives (Chapter 5) were drawn.

B.1. Constitution (1954) (1982)

The Constitution of the PRC (1982) is the pillar upon which all Chinese law and governance is based. It establishes the structure of the state, and describes the roles, responsibilities, and relations of the various levels of power. Both the original 1954 version of the Constitution and its revised form (1982), provide a general concept about the fundamental ownership of water resources in China and the roles government plays its management. As early as 1954, the Constitution designated the natural environment as belonging to the public. The most important articles states that:

> All mineral resources, waters, forests, mountains, grasslands, unreclaimed land, beaches and other natural resources are owned by the state, that is, by the whole people, with the exception of the forests, mountains, grasslands, unreclaimed land and beaches that are owned by collectives in accordance with the law.
>
> The state ensures the rational use of natural resources and protects rare animals and plants. Appropriation or damaging of natural resources by any organization or individual by whatever means is prohibited. (Article 9).

In other words, water resources are state-owned and the state holds the responsibility of managing and protecting its use. Article 26 extends the role of the state as the protector of water environments from pollution and other hazards:

> The state protects and improves the environment in which people live and the ecological environment. It prevents and controls pollution and other public hazards.
> The state organizes and encourages afforestation and the protection of forests (Article 26).

B.2. China's Agenda 21 – White paper on China's population, environment, and development in the 21st century (1994)

In 1992, at the 23rd session of the Environmental Protection Committee of the State Council, it was decided that the State Development Planning Commission and State Science and Technology Commission should take lead in organizing all appropriate ministries, departments, and non-governmental organizations to work together to formulate China's Agenda 21. This document aimed at implementing China's commitment to the United Nations Rio Conference on Environment and Development in 1992. It is also a guiding document for formulating the Ninth Five-Year Plan and the Plan for 2010. In it, directives regarding the path China will take to achieve sustainable development are stated. Although this document is almost 250 pages long and contains points on many of the most pressing environmental issues facing China, the following points are most relevant to water pricing.

Economic Development over Environmental Issues

China's Agenda 21 emphasizes the *development* aspect of *sustainable development.* In fact, much of this document discusses sustainable economic growth with the premise that in order for sustainable development to occur, developing nations much first achieve some level of economic development. Passage 2.1 provides a good example of a statement that places economic growth as a prerequisite for environmental protection:

> Sustainable development is a strategic choice that must be made by both developing and developed countries. For a developing country like China, however, the precondition for sustainable development is development. The path of relatively rapid economic growth and gradual improvements in the quality of development must be taken in order to meet the Chinese people's current and future needs for basic necessities and their desires for higher living standards, and in order to consolidate the nation's strength. Only when the economic growth rate reaches and is sustained at a certain level, can poverty be eradicated, people's livelihoods improved and the necessary forces and conditions for supporting sustainable development be provided... (2.1).

In the preface, Premier Li Peng not only implies that economic growth is more important than environmental protection, but he also claims that economic growth is the foundation of environmental protection, and that environmental protection cannot occur without economic growth. Further, he submits that as such, countries that are already developed have a greater burden to protect the environment than does China.

> Economic development should be pursued in parallel with environmental protection. Economic development is essential for the very survival and progress of mankind. Furthermore, it provides a material guarantee for the protection and improvement of the global environment. For many developing countries, their primary task is to develop economy and eliminate poverty. Their reasonable and urgent needs should be taken into full consideration when we try to tackle the question of global environment. The international community should take practical steps to improve the position of developing countries with regard to debt, trade, finance, etc. and help them with their economic development. On the other hand, no country can afford to develop its economy in disregard of its pressure on environment. It is, therefore, imperative to work out a development strategy that will ensure a virtuous cycle of the ecosystem so as to attain a balance between economic growth and environmental protection.
>
> To protect the environment is a common task of mankind as a whole. However, economically developed countries bear a greater responsibility. As mankind share one earth and environmental problems sometimes transcend national and regional boundaries, a global approach is in the common interest of all countries and regions. Historically, environmental problems stemmed mainly from the excessive consumption of natural resources and massive discharge of pollutants by developed countries in the course of their industrialization. Even today, their consumption of natural resources and discharge of pollutants, whether in terms of total volume or per capita share, far exceed developing countries. Therefore, they should assume major responsibility for the deterioration of the global environment. Furthermore, they have greater economic strength and more sophisticated technologies for environmental protection. It is only natural for them to undertake a greater obligation for its solution. They should provide developing countries with new and additional funds and transfer technologies of environmental protection under concessional terms to help the latter improve their own environment and participate in the protection of the global environment. This is only wise for developed countries to do, for it serves their own interests as well as those of developing countries.

Agenda 21 aims for an economic growth rate of 8-9% per annum:

> ...And while it is necessary for China to embark on a gradual path to sustainable development, it must do this at the same time as it is improving economic conditions and structures, enhancing their effectiveness and maintaining and annual average GNP growth rate of between 8 and 9%... (2.1).

Market-Based Solutions to Environmental Problems

Many articles in Agenda 21 specify the need to "make effective use of economic and other market-oriented measures to promote sustainable development" (4.34). For example:

> To implement the required sustainable development, the government which is likely to reinforce and amend existing regulations, will take advantage of the economic policy including market incentive means to make the market mechanism play a prominent role in the transformation of ideas and methods for utilization of natural resources (14.8)

Some specific market-based objectives, measures, or activities include:

- Eliminating the notion of natural resources as "free goods"
  - Consider environmental costs when making decisions and conducting analyses of the economy, thereby reversing the tendency to treat the environment as a source of "free goods" and passing environmental costs on to the general society (4.33).
  - Reform irrational pricing system and establish a system of compensation for the use of resources, thereby gradually changing the current situation of low costs for raw materials and free use of resources (4.37).
- Levying fees for water (and other natural resource) usage:
  - In accord with the principle of compensating for the use of natural resources, gradually levy fees for the use of resources and, after conducting studies of environmental taxation, gradually introduce environmental taxes (2.16 a)
  - Introduce a market mechanism for the use and allocation of natural resources which would follow the economic principle "the user pays" to facilitate the effective exploitation of resources in favour of the environment (14.10b)
- Ensuring equity in access to resources
  - Carry out market economy incentives for more efficient control over the natural resources along with measures assuring an equitable distribution of resources for the whole society (14.11f)
- Removing subsidies:
  - Removing or reducing those subsidies that do not conform with the objectives of sustainable development (4.35a)
  - Gradually abolish those pricing policies which are unfavourable to the sustainable utilization of natural resources and rational use of environmental resources, such as the policy which provides subsidies for deforestation, which are at a level much lower than their production costs, non-repayable exploitation of mineral resources and subsidies to the prices for water and energy (14.12e)
- Using water prices to encourage conservation and sustainable development
  - Establishing a pricing system consistent with the objectives of sustainable development (4.35d).
  - The overall goal for the development and protection of water resources is to combine the development and utilization of water resources with a full-scale saving of water to alleviate water supply crisis in cities and countryside to maximize the economic, social and environmental benefits to be obtained from utilization of water resources. Furthermore, to satisfy the increasing demand for a greater quantity and quality of water which results from socioeconomic development of the society (14.32)
  - To adjust the existing economic measures and financial incentives including the resource taxes and subsidies for compensation to ecological environment to meet the objectives of sustainable development (14.11c)

B.3. Ninth Five Year Plan (1996-2000)

The Five Year Plans reveal a lot about the direction China is heading towards. Developed by the State Council, these plans are submitted to the National People's Congress for review and approval and thus contain the objectives of the highest level. These plans are essentially broad outlines of government economic and social policy, which indicate the direction of policy changes in the next five years. While they identify tasks in all areas concerning national economic and social development, they only provide general direction rather than list specific projects.

The Ninth Five Year Plan, which was passed at the Communist Party's Central Committee meeting in 1995, constitutes the basic framework of China's development for the years 1996 to 2000. "To some degree, the Plan overlaps with the Ten Year Program for National Economic and Social Development between 1991 and 2000, and is extended by the Long Term Target of the Year 2010. Some of the environmental proposals were also formulated within China's Agenda 21 program published in 1994 which was supposed to lay the basis for environmental planning in the Ninth Five Year Plan and the Long Term Target of the year 2010" (Edmonds, 1996).

The key to development according to the Ninth Five Year Plan, is rapid and balanced economic growth resulting from a transition "from a traditional, planned economy to a socialist market economy and from extensive growth (based on increases in input) to intensive growth (driven from improvements in efficiency)" (WB, 1997a).

This emphasis on changing to a socialist market economy is new. Previous Five Year Plans emphasized macroeconomic government strategic policies; this plan emphasizes the need for a controlled free-market. According to the Ninth Five Year Plan, the initial creation of a socialist market economy should be realised by 2000, and a complete socialist market economic system should be formed by 2010. To achieve this goal, the Ninth Five Year Plan lays out several important aims:

- GDP: Maintain a real GDP growth rate of 8%. Additionally, "China had originally developed a three phase strategy for doubling and then quadrupling its GNP. In 1995, doubling the 1980 GNP, a strategic goal of the second phase, was realized five years in advance of the planned phase. The Outline stresses that as the overall goals of the second phase are being realized by the year 2000, at the same time it is necessary to make plans for initiating the third step in the strategy. The goals now are to double the 1980 per capita GNP by 2000, and to double the 2000 per capita GNP by 2010" (China Online, 1998).
- Reform state-owned enterprises.
- Control inflation: During the Eighth Five Year Planning period, inflation reached as high as 11%, thus one of the major tasks of this planning period is to control inflation by "implementing a firm finance and currency policy in order to maintain a balance with regard to society's demand and supply, and to lower the commodity prices. Above all, it is necessary to keep the prices on goods lower than the economic growth rate" (UNDP-China, 1996).
- Develop five pillar industries: These industries are machine building, electronics, petrochemicals, automobiles, and construction/materials.
- Capital investment: Maintain fixed capital investment rates at about 30%.
- Financial regulation: Make efforts to increase income and cut down on expenses; regulate the distribution structure; gradually reduce financial deficits; achieve balance between financial revenue and expenditure to keep the size of the national debt to within reasonable limits.
- Increase currency supply.
- International revenue and expenses/balance: Maintain an appropriate exchange surplus, partly by increasing the foreign exchange .

In order to change the pattern of economic growth from extensive to intensive, the Plan proposes several measures, to be implemented by each government organization and in each region (China Online, 1998):

- Further develop the function of market-oriented distribution of resources, expand the scope of market regulation, and introduce competitive mechanisms in non-competitive industries and other fields.
- Improve technology of enterprises, raise the quality of products, reduce consumption and waste, expand the range of regulation by market forces, and strengthen the competitiveness of markets.
- Speed up the development of science and technology.
- Strengthen conservation and comprehensive usage of natural resources.
- Accomplish capital regulation and reorganization.

- Establish an open, impartial market and business environment, and form a circulation system of unitary opening up, with orderly competition, in order to abolish obstructions and monopolies in the market.
- Regulate the structure of production and products through planning and industrial policy.

The Ninth Five Year Plan also acknowledges that other non-economic factors are crucial to the growth of the economic and social development of the nation. These issues include:

- Eliminating poverty by 2000, and improving access to health and education.
- Strengthening agriculture.
- Protecting the environment.
- Reducing regional differences.
- Controlling population to 1.3 billion in 2000, and 1.4 billion in 2010.

B.4. Water Law of the People's Republic of China (1988) (1998)

The fundamental umbrella law for water resources management in China is the Water Law of the People's Republic of China. This law, first promulgated by the Standing Committee of the NPC in 1988 and revised ten years later, holds the primary purpose of ensuring rational development, protection, and management of water resources, especially comprehensive planning that includes other jurisdictions and water uses. Some articles that stress comprehensive planning are:

> This Law is formulated for the rational development and utilization of water resources and the protection of such resources, for the prevention and control of water disasters, and for the full derivation of comprehensive benefits from water resources in order to meet the needs in national economic development and in the livelihood of the people (Article 1).
>
> The state shall use water in a planned and economical way. People's governments at all levels should strengthen their management in conserving water (Article 7).
>
> Unified plans shall be made for the exploitation and utilisation of water resources, and for the prevention and control of floods in various river basins and regions (Article 11).
>
> The state shall encourage the development and utilisation of water resources. Efforts shall be made to carry out planned, multi-purpose, and stage-by-stage development of rivers with abundant water resources (Article 16).

The Water Law reaffirms the ownership of water resources by the state, as stated in the Constitution. This reaffirmation is found in Article 3:

> Water resources are owned by the state, that is, by the whole people (Article 3).

In order to fulfill the objectives of rational water management laid out in Article 1, the Water Law calls for economization on water usage:

> The state shall carry out planning and require strict economy in the use of water.
> People's governments at various levels shall strengthen the management of the economical use of water. All units shall adopt advanced technology for the economical use of water, reduce water consumption and raise the frequency of the reuse of water (Article 7).
>
> All areas shall, according to their respective water and soil resources, develop irrigation, drainage and water and soil conservation to bring in stable and high agricultural yields.
> In areas where the water sources are insufficient, any irrigation method which makes for an economical use of water shall be adopted (Article 15).

The Water Law makes direct reference to water pricing. It requires water fees for both self-extracted and delivered water. The Water Law specifies that the water pricing method is to be determined by the State Council and collection procedures are determined by the provincial government:

> Anyone who uses water provided by a water-supply project shall pay a water fee to the supplying unit in accordance with the relevant provisions.
> Any unit which directly draws groundwater in an urban area shall be charged a water resources fee. The collection of such fees from other units or individuals drawing water directly from subterranean streams, rivers or lakes shall be decided by the people's governments of provinces, autonomous regions or municipalities directly under the Central Government. Measures for the collection of water fees and water resources fees shall be stipulated by the State Council (Article 34).

Thus the Water Law is the fundamental basis for allowing water pricing. While this may appear insignificant, it represents a change in ideology towards an acceptance of the marketization of what was formerly considered non-marketable.

This law goes one step further by requiring that water supply costs include social costs, in particular the resettlement of inhabitants.

> Where a water project to be built by the state requires the resettlement of inhabitants, the local people's government shall be responsible for making proper arrangements for the livelihood and production of the inhabitants to be resettled. The funds needed for the resettlement of inhabitants shall be included in the investment plan for the project, and the resettlement shall be completed within the construction stage on schedule (Article 23).

Although the Water Law establishes some important, progressive tenets, in the opinion of some analysts, it is already dated. Water conditions have changed, river basin management is ineffectual, regulations on water demand management are not practical, and the law itself is too general and leaves too much room for interpretation and misinterpretation by lower level governments.

B.5. Price Law of the People's Republic of China (1997)

Issued in 1997 and effective as of 1998, the Price Law of the People's Republic of China (herein known as the Price Law) aims at

> ...standardizing price behavior so as to strengthen their role in rational disposition of resources, stabilize the general price level of the market, protect the lawful rights and interests of consumers and business operators and then promote the healthy development of the socialist market economy (Art. 1).

Article 8 of the Price Law stipulates that there will be several categories of prices.

1. Market regulated prices: prices set by market forces, uncontrolled by government. Most products and services fall under this category.
2. Government-guided prices: prices fixed by business operators according to benchmark prices set by the price bureau.
3. Government-set prices: prices fixed by the pricing bureau or related departments within their term of reference according to the provisions of this law.

Prices shall be set or guided by the government if they fall under the following categories:

> 1. The few merchandises that are of great importance in the development of the national economy and people's livelihood;
> 2. The few merchandises that are in shortage of resources;
> 3. Merchandises of monopoly in nature;
> 4. Important public utilities;
> 5. Important services of public welfare in nature (Art. 18).

According to the Price Law, the Price Bureau is responsible for:

- The administration of price for the whole nation. Price Bureaus at or above the county level are responsible for prices within their regions of jurisdiction and their terms of references (Art. 5).
- Price Bureaus issue price catalogues for government-set or guided prices. These catalogues are set by the national Price Bureau and published with the approval of the State Council. In the case of Beijing, the Beijing Price Bureau can set price catalogues with the approval on the Beijing Municipal Government, however governments below this level cannot make their own price catalogues (Art. 19).

The objectives for setting prices according to this law are:

- Prices should be set according to average cost and market supply and demand of related merchandises or services (Art. 21)
- Prices must be affordable to people (Art. 21)
- Prices should take public opinion into account:

> In fixing government-set and guided prices, price departments and other related departments shall carry out investigations into prices and costs and hear views from consumers, business operators and other quarters (Art. 22).
>
> In fixing government-set and guided prices for public utilities services of public welfare in nature and the prices for merchandises of monopoly in nature that are important to immediate interest of people public hearings presided over by government price department should be conveyed to solicit views from consumers, business operators and other quarters to explore the necessity and feasibility (Art. 23).

Consumers and business operators may put forward their recommendations with regard to the adjustment of the government-set and guided prices (Art. 25).

- Prices should promote the economic and social development of the people (Art. 21)
- Prices should allow rational price differentials between buying and selling, between wholesale and retail sale, among different regions and different seasons (Art. 21).
- Price should be properly adjusted in the light of the operation of the national economy (Art. 25).
- Prices should be set to stabilize the general price level

To stabilize the general price level is one of the major objectives of macro-economic policy. The State shall set targets for the monitoring and adjustment of general price level in the light of the requirements of the development of the national economy and the endurance of the people, list them into the national economic and social development programs and help their realization through means of monetary, fiscal, investment and import and export policies and measures (Art. 26).

- Prices should be set to protect agricultural products

Whereas the selling prices of grain and other major farm produce are too low on the market, the government shall introduce protective prices and adopt corresponding measures to ensure the protective prices be put into effect (Art. 29).

B.6. Agricultural Law of the People's Republic of China (1993)

According to the Agricultural Law enacted in 1993, agriculture is the foundation for developing the nation's economy (Art. 2). This law develops agriculture by

"ensuring the fundamental position of agriculture in the national economy, developing the socialist market economy in rural areas, safeguarding the lawful rights and interests of agricultural production and operation organizations and agricultural labourers, and promoting the continuous, steady and coordinated growth of agriculture" (Art. 1).

The primary purpose of agricultural development, as noted in Article 2 of this law, is to:

"actively develop the socialist market economy in rural areas, further emancipate and develop the rural productive forces, develop and utilize the rural labour force, land and various resources, increase effective supplies of agricultural products, and satisfy the demands of the people's life and the development of social economy; and on the basis of the development of production, to increase the income of agricultural labourers, raise their living standards, build a new countryside of common prosperity and civilization and gradually realize agricultural modernization" (Art. 2).

This law stresses the need to make the agricultural sector a part of the socialist market economy. Many articles encourage the application of market mechanisms instead of state planning to regulate the agricultural sector. For example, Articles 22 and 35 talk about adjusting the structure of agricultural production to meet market demands:

The State shall guide agricultural production and operation organizations or agricultural labourers to adjust the structure of agricultural production according to market demands, ensure steady growth of cotton and grain production, achieve all-round development of crop-plantation, forestry, animal husbandry and fishery, and develop an agriculture with high yield, good quality and high benefits (Art. 22).

Market regulation shall be gradually practised in the purchasing or selling of agricultural products (Art. 35).

The role of non-agricultural markets is also mentioned in the Agricultural Law. Article 24 suggests that town and village enterprises should be developed for their potential to absorb excess agricultural labour:

People's governments at various levels and agricultural economic collectives shall take measures to develop township and town enterprises and tertiary industries so as to support the development of agriculture, and to transfer surplus agricultural labour force (Art. 24).

Planned agriculture and protective pricing, however, is not a thing of the past. In spite of the emphasis on markets, many articles ensure that products will continue to be protected. For example, Article 22 makes it clear that the production of important crops such as grain and cotton will be planned. Article 33 stipulates that controls on agricultural inputs will be maintained:

The State shall take measures of macro-regulation and control to maintain a reasonable price ratio between agricultural products and the principal means of agricultural production such as chemical fertilizers, pesticides, agricultural plastic films, agricultural machinery and diesel oil for agricultural use (Art. 33).

Article 35 also notes that the government will continue to regulate the movement of agricultural products that are integral to the nation's economy and people's livelihoods.

> The State shall carry out necessary macro-regulation and control in the purchasing or selling activities of major agricultural products relating to the national economy and the people's livelihood.
> The State Council or the people's governments of provinces, autonomous regions or municipalities directly under the Central Government empowered by the State Council may entrust relevant management organizations with the purchase of the major agricultural products relating to the national economy and the people's livelihood. The variety and quantity of agricultural products, the purchase of which is so entrusted, shall be prescribed by the State Council or by the people's governments of provinces, autonomous regions or municipalities directly under the Central Government empowered by the State Council.
> The State Council may, when necessary, set the entrustment purchase prices of the specially designated agricultural products (Art. 35).

The need to regulate agricultural production of key products in order to stabilize the market and ensure food security is stipulated in Article 36, which states:

> The State shall practise the protective purchasing price system and establish risk fund for the major agricultural products such as grains relating to the national economy and the people's livelihood.
> The State shall practise a central and local multi-leveled storage and regulation system for the major agricultural products such as grains relating to the national economy and the people's livelihood, and set up reserve funds, establish and perfect the storage and transportation system so as to guarantee the supply and stabilize the market (Art. 36).

For these controlled products, governments at or above the county level purchase crops from farmers at a state established price. The method for this is detailed in Article 41.

> People's governments at or above the county level shall organize the relevant departments and units such as those of finance, banking, grain, supply and marketing to raise in time enough funds for purchasing agricultural products. No unit or individual may intercept or misappropriate such funds.
> Units purchasing agricultural products must, at the time of purchasing, pay off the money to the agricultural production and operation organizations or peasants who sell their agricultural products.
> No units purchasing agricultural products may, at the time of purchasing, beat down the grade or price of agricultural products or deduct any costs from the payment. Any withholding of taxes to be made under laws or administrative rules and regulations shall be handled in accordance with the provisions of relevant laws or administrative rules and regulations (Art. 41).

This law makes it clear that agriculture will continue to develop. This has implications for water resources requirements because agricultural development involves the expansion of irrigated agriculture:

> The State shall develop water conservancy undertakings and industries of means of agricultural production so as to ensure the material supplies for the steady growth of agricultural production (Art. 8).

> People's governments at various levels and agricultural production and operation organizations shall map out plans and take measures to organize the construction of irrigation and water conservancy works and shelter forests so as to ensure the steady expansion of farmland with stable yields despite of drought or waterlogging (Art. 25).

Finally, the Agricultural Law is concerned with the effects of agriculture on the environment. Several articles dictate the need to make the agricultural sector more sustainable. Water conservation is specifically mentioned in Article 26:

> In the development of agriculture, resources must be utilized in a rational way and the ecological environment must be protected and improved (Art. 54).

> People's governments at various levels and agricultural production and operation organizations shall establish and perfect the management system of irrigation and water conservancy works, develop water-saving irrigation facilities, strictly control the appropriation of water resources for irrigation by non-agricultural construction projects and forbid any organizations or individuals to unlawfully appropriate or destruct irrigation and water conservancy facilities (Art. 26).

B.7. Urban Water Supply Regulation (1994)

The primary purpose of this national urban water supply regulation is to "improve city water supply management and operation, develop city water supply, improve construction of water facilities, and guarantee water use for domestic and productive purposes…" (Art. 1). This regulation also addresses water pricing issues. Article 24 states that water fees should be paid to the water supply unit according to standard.

B.8. Policies for the Water Resources Industry (1997)

Implemented in 1997, this policy aims at regulating the water resources industry (those sectors involved in supplying water resources). It deals with implementation issues related to pricing, charging and management, water savings and protection. The objectives of this policy are specified in article 1:

> The objective of this policy is: Clarify the nature of the item (water), and balance out investment in irrigation ditches, and availability of funds for such purpose; Reasonably define the price, the standard for collecting fees, and push for industrialization of the water sector; Promote water saving and protection of water resources, and achieve sustainable development (Art. 1).

This policy sets rules on how water pricing should be conducted. It calls for national implementation of payment schemes for water resources usage of all water types (surface and groundwater). It establishes the water supplying danwei as the recipient of water fees (Art. 17). It establishes the role of the Ministry of Water Resources as the organizer, implementer and supervisor of the national water withdrawal approval system in accordance with the Regulations for the Implementation of the Water-drawing Permit System (Art. 18). It requires the establishment of reasonable water prices to cover operation costs and expenses, taxes, loans, and allow a reasonable profit margin according to the cost of construction (Art. 20). It also requires prices to be adjusted every three years until the price reaches the level where costs are covered, and from then on adjustments are to be made on the basis of changes to water supply cost at the moment (Art. 20). In the case of Beijing, the municipal Price Bureau will set water prices jointly with the Beijing Water Resources Bureau (Art. 20).

B.9. Management Method for Pricing Urban Water Supply (1998)

Also known as the National Guidelines on Water Tariffs (NGOWT), this national method deals specifically with water tariffs. Developed by the State Development Planning Commission and the Ministry of Construction in September 1998, this method lays the foundation for water price readjustment and is the most current national water pricing method to date. Its primary aim is to provide a set of unified guidelines for water pricing to be followed by all tap water companies in China, to standardize and improve what has in the past been subject to varying local government decisions.

This method provides detailed information about (i) the roles and responsibilities of various agencies, (ii) the classification of water prices (iii) the foundations upon which water prices are set.

It establishes the Beijing Pricing Bureau as the primary authority in charge of urban water prices.

> The department in charge of price under the people's government above county level is the authority for pricing of urban water supply. The administrative authorities of urban water supply above the county level shall divide their work according to the duties and responsibilities, and assist the government's pricing department to do well the water price administration (Art. 4).

However, adjustment of water prices involves more actors than simply the Beijing Price Bureau. Price change procedures are detailed in this method. This process essentially involves a submission for price change by the tap water company. The local Price Bureau upon receipt of the water price increase request will hold a hearing with all relevant parties, and then solicit approval from the Beijing Municipal Government and the national Price Bureau. After approval, new prices will be made known to the public before they are instituted. Articles 21 to 23 explain this procedure:

> Adjustment of urban water price shall be examined by the local government department in charge of price and be executed after getting approval from the people's government. It shall also report to the government departments in charge of price and water supply at higher level for file. If necessary, the higher-level government department in charge of price may give control to the urban water price. The control measures shall be defined by the State Council department in charge of price (Art. 21).
>
> Having received the application for adjustment of water price, the local government department in charge of price shall hold a hearing, inviting all departments concerned of the People's Congress, Political Consultation Committee and the People's Government and representatives of consumers to take part in the hearing. The specification on the hearing will be issued separately by the State Council department in charge of price (Art. 22).
>
> The urban water price adjustment program shall be made public by the local government before it is implemented (Art. 23).

Water prices are to be categorized by use:

> Classified water price shall be executed for urban water supply. It may be classified characteristically into residential water, industrial water, institutional water, business water and special use of water. The relative price between all classes of water price

shall be determined by the local governmental department in charge of price together with the administrative authorities of water supply, as the case may be (Art. 8).

This management method sets several criteria for determining water prices. The goals of water pricing, according to this method are: cost recovery for the tap water company, reasonable profit levels, conservation of water, and equity. The most important element is water supply cost. Costs includes general costs, expenses, taxes paid by the supply company, a margin of profit for the supply company, costs incurred due to water loss, and wastewater treatment costs. This is detailed in articles 7 to 9.

Urban water price is composed of water supply cost expenses, taxes, and profits. Both the cost and expenses shall be approved in the light of <<Financial Rule of Enterprise>> and <<Accounting Standard of Enterprise>> promulgated by the state financial authorities.

(1) Urban water supply cost includes raw water expense, electricity expense, raw material expense, asset depreciation charges, repairing expense, direct wages, water quality detection and monitoring expenses, and other direct expenses charged to cost, which are incurred in the production of water supplied.
(2) Expense includes sales expense, managerial expense, and financial expense incurred in organization and management of water production and operation.
(3) Tax represents the expenses of taxation to be paid by water utilities.
(4) The profit in the urban water price shall be approved based on the profit rate of net asset (Art. 7).

The water loss in the course of water transmission and distribution may be figured reasonably in the cost (Art. 8).

Independent accounting shall be carried out for wastewater treatment cost based on management system (Art. 9).

This method goes on to define *reasonable profit* as between 6-12% depending on ownership of capital, with an average rate of 8-10% of net asset profit rate. This is detailed in article 11.

Water utilities' reasonable earnings shall be averaged at 8-10% of net asset profit rate. The level of profit shall be determined based on the different capital source after the local department in charge of price consults with the local administrative authorities for urban water supply.

(1) For the water utilities invested mainly by government, the net asset profit rate shall be no more than 6%.
(2) For the water utilities whose water supply facilities are constructed by use of loan, introduction of foreign fund, and issuance of bonds and stocks, their net asset profit rate shall not be more than 12% during loan repayment period. After the end of loan repayment period, water price shall be approved based on the average profit rate of net asset specified in this clause.

In order to promote water conservation, this method proposes a volumetric pricing system, based upon a two-part increasing block rate. This pricing structure includes a fixed cost (known as a capacity-based price) and a variable, volumetric cost (known as a volume-based water price). The fixed cost aims at cost recovery for capital costs, and is calculated as follows:

Fixed cost = [(the yearly fixed asset depreciation amount + interest on yearly fixed asset investment) / yearly water production] x [(average population of each household) x (average monthly consumption per capita)]

The variable cost aims as recovery of operation and maintenance costs. This is calculated as follows:

Variable cost = [(costs + profit – (yearly fixed asset depreciation amount + interest on yearly fixed asset investment))/annual water sales] x quantity water consumed

The method recommends three increasing blocks for domestic water pricing, with a ratio of 1:1.5:2 (see Art. 14) with the first block allowing enough water to meet the water needs of the average person.

Equity is an important principle in designing water-pricing policy according to Article 24:

Adjustment of urban water price shall be examined and approved on the following principles:
(1) In the interest of the development of water supply industry, and meeting the requirement for economic development and the people's living.
(3) Giving full consideration to the level bearable to the society. Reasonable adjustment of water price shall be implemented in steps. When two-part water price is worked out firstly, the capacity-based water price shall not exceed one third of water price borne by inhabitants in average.

The Ministry of Construction, upon issuance of this regulation, required all cities to formulate their own implementation guidelines by the end of 1999. However, few cities met this deadline and no major progress has been made to implement this regulation. In June 1999, the Ministry of Construction and the State Development Planning Commission finalized a group of pilot cities to test this method.

B.10. Irrigation Waterworks Fee Assessment, Calculation and Management Method (1985)

Much of today's current pricing framework is born from this method passed over fifteen years ago. Replacing a trial implementation entitled Trial Practice Method for Irrigation Waterworks Fee Assessment, Calculation and Management, enacted in 1965, this 1985 version aimed at the rational utilization of water resources, the promotion of water conservation, and the guarantee of sufficient funds for water conservancy projects (also known as irrigation waterworks). Article 1 states this purpose:

> For the purpose of the rational utilization of water resources and promotion of water conservation, the guarantee of essential operation of water conservancy projects, overhaul and renewal of water usage fees, in order to fully give play to the economic performance, the water conservancy projects should implement a system of compensation for water supply. Industry, agriculture and others water users are all required to pay water fees to the water conservancy project management danwei (Art. 1).

As one of the earliest pieces of legislation concerning water pricing, this method established many principles which would be the basis upon which later water pricing methods would be set. Perhaps the most important principle is water cost as the foundation for water pricing. Article 4 elaborates on what supply cost is composed of:

> Water fee standards should be based on water supply cost, according to national economic policy and local water resources conditions, checked and ratified by each category of water use.
> The water supply cost includes the engineering operating management expenses, overhaul fee and depreciation as well as others investment costs that should enter the cost calculation. Rate of depreciation and overhaul fees, as well as other fees that should be counted into the cost, are stipulate separately by the Ministry of Water Conservancy and Hydropower and the Ministry of Finance and Trade.

This method establishes the principle of sectorally-based water price standards. Article 5 divides water users into six categories (agricultural, industrial, municipal and domestic, hydropower, environmental, and other water supply uses) and establishes different pricing methods for each.

- Agricultural and environmental-use water prices are set according to cost of supply, with allowance for profit for the water supplied, for irrigation of cash crops. A floating price system can also be used according to the conditions of national water inflow in different seasons
- Industrial water fees are calculated on the cost of water supply, plus an additional 4-6% profit for the water supply unit. This fee may be slightly higher in districts short of water resources.
- Domestic urban water fees set according to water supply plus a small margin of profit.
- Hydropower water price is based on 8-12% of the selling price of electricity.

Article 6 requires water pricing by volume:

> Water conservancy management danweis will strengthen water use management, implement water use plans, and calculate water fees according to volume of water consumed (hydropower generation is counted according to the amount of generated energy). Agricultural water use may be implement basic water fee plus a volume based water fee system, and can implement a seasonal floating water fee.

Article 6 further specifies the need to install water meters to allow for volume-based pricing:

> The danwei using the water is responsible for installing a water meter. If there is no water meter at present, the water conservancy project management should calculate water use based on hydrological measurements and standard capacity measuring.

Other details concerning the method of collection are stated in Article 7. Some of these details include:

> Industrial, municipal, and hydropower water use fees will be collected and measured on a monthly basis
> Agricultural water use fees will be measured according to use and collected according to season.
> The water unit must pay the water fee on the date according to the regulation. Late payments should be fined extra.

The Irrigation Waterworks Fee Assessment, Calculation and Management Method also specifies that the management of irrigation works is directly under the MOWR and River Basin Commissions. The price is examined by the Ministry of Water Resources until 1991, when they will be examined by the National Price Bureau.

Water conservancy projects pricing schemes are the joint responsibility of province-level Water Resource Bureaus and price, public finance, and other concerned departments. Province-level People's Congresses are responsible for examining these schemes.

After 1985, various province-level governments began to implement this method. By 1991, most provinces had issued new local water fee management methods. In a few provinces, water prices were raised by a wide margin. However, this method was never fully implemented and agricultural water fees remained far below the cost of provision everywhere in China, including Beijing.

B.11. Irrigation Waterworks Supply Price Management Method (2000)

In June 2000, the State Planning Development Commission in conjunction with the Ministry of Water Resources revised the 1985 Irrigation Waterworks Fee Assessment, Calculation and Management Method. This revision aims at correcting the failure of the 1985 method to generate results. The principle of this new method is essentially the same as the old one, with the primary aim of ensuring that cost recovery is the foundation for water prices. Since this method is not yet approved, it is mentioned only in passing and will be omitted from the analysis of this paper.

B.12. Beijing's Ninth Five Year Plan and Long-term Objectives until 2010

Approved in 1996 by the Beijing People's Congress, this social and economic development plan is a reformation of the national Ninth Five Year Plan for Beijing.

Like the national Ninth Five Year Plan, the Beijing Ninth Five Year Plan first reviews the Eighth Five Year Plan. During the Eighth Five Year planning period, the national economy experienced quick growth. Agriculture was strengthened and the tertiary sector developed quickly to occupy 47.6% of municipal GDP, surpassing the secondary industry. Industries that showed steady growth in this period include agriculture by-products, automobiles, electronics, high-tech sectors, and construction. Living standards also improved dramatically with incomes and per capita floor space increasing rapidly.

The emphasis of this plan is to strengthen the role of Beijing by 2010 as the political centre of the nation and a modern world class international city. It strives to develop Beijing's historical culture, education, science and technology, and legal system. The economy will be developed through the high-tech and tertiary sectors, to improve the lives of citizens to a comfortable, well-to-do standard of living. In order to achieve these goals, the plan sets out several concrete targets to be achieved by 2010.

Economic Growth

Average annual GDP in Beijing will increase progressively by about 9%, to a total of about 213 billion yuan (in 1995 prices) by 2000. Between 2000 – 2010, GDP will grow at about 8%.

Industrial Development

During the Ninth Five Year Planning period, the primary sector will increase an average of 3% annually, secondary 8%, and tertiary 10%. By 2000, the ratio of these industries will be 4.5:45.5:50, and by 2001, 2.6:42.4:55. The plan aims to consolidate and strengthen the primary sector, optimize and increase the secondary sector, and quicken the development of the tertiary sector.

The focal point of the secondary industry will be the development of electronics, machine equipment, and construction industries.

The tertiary sector will enlarge the services sector, and raise service standards, and economic performance to create a multi-functional, multi-level, highly efficient tertiary sector. The focal points of development for this sector are commercial and financial services, tourism, transportation, post and telecommunications, IT, and real estate.

Agriculture

During the Ninth Five Year planning period, Beijing will continue to carry out the Agricultural Law, strengthen the role of agriculture as the foundation of the economy, and persist in the policies of "toward a market, service capital and prosper farmer," and "high yield, high quality, high efficiency." Beijing will rely on science and technology to modernize agriculture and adapt it to modern urban needs. Standards will be raised on non-staple foods and development of poultry, beef, and lamb will continue. Focus will be placed on developing agricultural by-products while continuing to increase the area under irrigation by 1,100,000 mu in 5 years. By 2000, agricultural value will reach 9.5 billion yuan (in 1995 prices).

Population
Population in the city will be effectively controlled to 11.25 million in 2000, and 12.1 million in 2010.

Living Standards
Average per capita income will increase by 3-5% annually during the Ninth Five Year Planning period. Efforts will be made to raise the living standards of low income residents and ruralites. Housing conditions will improve, with per capita usable floor area to rise to 15 m^2 by 2000. By 2010, people's material life in urban and rural areas will be well-to-do and comfortable, with a rich cultural life, and use of consumer goods (such as stereos, air-conditioners, video cameras, computers etc).

Environmental Protection
Efforts will be made during the Ninth Five Year Planning period to improve environmental quality. The plan recognizes that "in the future course of development, Beijing will suffer from restrictions in resources, primarily the lack of water resources, and a great supply deficit." As such, it promotes the rational development, use and protection of various resources and the raising of resource-utilization efficiency. As part of this effort, the plan stipulates that "industry must make efforts to adopt water saving technologies. By the year 2000, industry must have an 85% water reuse rate, and must increase wastewater facilities. Municipal sewage treatment by 2000 will be 0.48 billion m^3...Price should be reformed to promote the reasonable use of resources and to reduce waste. All sectors will conscientiously plan and implement water thrift and comprehensive utilization of resources." As well, heavy industries will be restricted from developing in Beijing, particularly those that are heavy resource consumers and polluters. Finally, the plan states that water supply increases should be done in coordination with water conservation efforts.

Equity
The Plan makes some mention of efforts to ensure equity. One clause states that Beijing aims to "reduce the urban and rural gap. Promote the integration of urban and rural...step by step reduce the gap between workers and peasants, urban and rural, quicken the industrialization and modernization of the rural areas, so that people in urban and rural areas prosper jointly." Another clause makes mention of the continued development of social public goods, such as social welfare. Improved income tax collection will allow for the utilization of tax revenues as a means of controlling the widening income gap.

B.13. Regulation for Water Resources Management in Beijing Municipality (1992)

This regulation sets out the management responsibilities of various water-related agencies in Beijing. These responsibilities are detailed in section 3.3.2 and will therefore not be discussed here. What is noteworthy, however, is that this regulation stipulates that domestic water has priority in Beijing over other uses (Article 7).

B.14. Beijing Rural Water Conservation Regulations (1992)

This regulation states that all rural water use (both surface and ground) must be subject to a water resources fee, which is set by the municipal public finance bureau, price bureau, and water resources bureau. Article 10 of this regulation stipulates that water use in excess of quota should be charged at a higher rate.

Appendix C: List of Actors

This appendix provides some details about the actors involved in water resources management in Beijing as depicted in Figure 3.3.

C.1. National Level Agencies

C.1.1. National People's Congress and State Council

The National People's Congress is the highest organ of state power in the People's Republic of China. It exercises the state power of legislation, makes decisions on important national issues, and elects and chooses the leading personnel of the highest state organs of the People's Republic of China (Consulate General of the People's Republic of China in New York, 1999).

Established under the NPC, the State Council serves as the chief executive branch of the State. It is directly in charge of all commissions and ministries, and as such coordinates, oversees, and arbitrates them.

The State Council also oversees the five working organs that assist the prime minister in managing ministries and commissions (e.g. Office of Overseas Chinese Affairs, Office of Foreign Affairs), the 20 administrative agencies responsible for various special business under the integrated leadership of the State Council (e.g. State Statistical Bureau, State Bureau of Commodity Prices, State Bureau of Environmental Protection), the 7 bureaus at the vice ministry level under the guidance of relevant ministries and commissions of the State Council (e.g. State property Administration Bureau, Patent Office etc), and the four institutions under the State Council in charge of special undertakings (e.g. Chinese Academy of Sciences, Xinhua News).

With regard to water resources management, the State Council is responsible for the nation's water to some extent. Its role is to manage basic data, provide a national framework water resources planning, resolve water allocation issues among provinces, undertake major interprovincial service schemes, and direct the seven river basin commissions (Frederiksen, 1999).

C.1.2. Environmental Protection and Natural Resources Conservation Committee of the NPC (EPC)

This high-level committee researches and drafts environmental legislation and advises on environmental laws to the NPC. It was formed in 1993 in an attempt to speed up the rate at which national laws were promulgated (see Box 3.2). The primary purpose of the EPC is to prepare draft revisions of existing environmental laws for the NPC, review legislative proposals from the SC and regulations from local congresses, provide comments to other special committees of the NPC on related matters, and submit legislative proposals to the Standing Committee of NPC for examination and approval (Zhang and Ferris, 1998a). The EPC is the prime authority responsible for generating legislation on the environment and resources, and supervising the implementation of these laws.

C.1.3. State Environmental Protection Commission (SEPC)

There are two commissions under the SC that are most directly related to water resource usage: the State Environmental Protection Commission and the State Development and Planning Commission.

The SEPC is the chief non-standing institute under the State Council responsible for interagency coordination to set broad guidelines on environmental policy in view of other national priorities. Its membership is composed of 48 ministries and commissions, and its emphasis with regard to water resources is on water quality and pollution. Therefore, the SEPC has less relevance for water pricing policy than the State Development Planning Commission.

C.1.4. State Development Planning Commission (SDPC)

This functional department under the State Council has relevance to water pricing policy in several ways.

First, it is responsible for all infrastructure project approvals and investment planning for infrastructure construction. This means that all large-scale water treatment plants, diversion projects, reservoir construction projects, and other water supply infrastructure must be approved by the SDPC. Logically, the SDPC works closely with the Ministry of Construction.

The SDPC is also the central organization for economic planning in China. "It has ultimate responsibility for drafting both the five-year economic plans and the industry-specific plans, but these tasks are carried out in coordination with the relevant ministries" (Mastel, 1997). Thus it is largely responsible for taking the national objectives determined by the highest levels and putting them into policies, plans and agendas.

Third, the SDPC overseas the Price Bureau, which will be discussed in more detail in section 3.3.2.3. Any changes in water pricing needs the approval of the Price Bureau, which needs approval from the SDPC. Thus, any changes in price must correspond with the plans and mandates of the SDPC. However, changes are slow and cautious as the SDPC is the agency "most fearful of social unrest as a result of reforms" (Yan and Stover, 1999).

Some legal documents pertaining to water pricing and management issued by the SDPC include:

- Management Method for Pricing Urban Water Supply (1998) – issued in conjunction with Ministry of Construction
- Irrigation Waterworks Supply Price Management Method (2000) – issued in conjunction with the Ministry of Water Resources
- Agenda 21 – White paper on China's population, environment, and development in the 21st century (1994) – issued in conjunction with the State Science and Technology Commission and relevant ministries

C.1.5. Ministry of Water Resources (MOWR)

Originally responsible for hydroelectric power and flood control, the MOWR has been undergoing rebirth for the past few years. In the 1950s and 1960s, the MOWR set out to build irrigation systems, reservoirs, and dams throughout China's countryside. The goal was to expand water availability, control flooding and develop hydropower. In fact, the purpose of the MOWR up until the 1980s was to deal with water abundance. Its mandate changed in the 1980s with the arrival of several droughts. As cities such as Beijing moved from expanding water economies into maturation, the MOWR would have to review its *raison d'etre.* In the 1980s, reformers in the State Council began to place more emphasis on efficient use of water and therefore cut subsidies to the MOWR and its counterparts. Beijing's Water Resources Bureau laid off 20% of its management personnel when the mandate of the State Council shifted away from irrigation expansion (Nickum, 1994). The State Council now turned its attention to water pricing and demand management as means of solving water problems. However, the MOWR was slow to change and continued to hold a "bias toward engineering or hard solutions involving new construction projects" (Ross, 1988).

Over time and after many changes and reforms, the MOWR settled into its current role as the functional department responsible for unified national water resources management. Its primary purpose is to provide unified management of both ground and surface water resources, at the regional, inter-provincial and national level. Following recent reforms, the MOWR is responsible for:

National, regional, inter-provincial water resources planning

- developing national or inter-provincial water supply plans and water allocation plans
- formulating long-term development strategies of major water bodies in China, drafting out related principles, policies, statutes and laws and monitoring their implementation
- issuing a national water resource communiqué
- overseeing the seven river basin commissions (which coordinate regional water resource management activities) and the National Coordination Group on Water Resources (which unifies the management of water resources, enhances information exchange, and facilitates coordination among agencies)
- groundwater administration
- planning water resources for urban water supplies administering and monitoring the Water Law of PRC and Soil and the Water Conservation Law of PRC

Irrigation, rural water supply and flood control planning

- constructing basic rural irrigation facilities
- building and managing medium-sized and large reservoirs for flood control, irrigation, water supply and rural hydropower

Water quality planning

- planning the use of various water zones, controlling contamination of drinking water areas, monitoring water quantity and quality in lakes and rivers, supervising sewage carrying capacity (formerly carried out by the Ministry of Construction and NEPA), and developing principles, policies, and regulations for waterworks

Water savings

- developing water savings policies and plans, establishing related standards, and organizing the implementation and monitoring of these policies
- collaborating with other economic management agencies to formulate water-related financial policies, pricing systems, taxation and other economic measures
- managing the new water-use permit system and the implementation of the water fee collection systems

Only recently have water pricing-related responsibilities been established for the MOWR. While in the past, the MOWR dealt with pricing for irrigation, it is gaining more responsibilities for pricing in general. Since many of these responsibilities are still very new, time must pass before we can understand the role of the MOWR in water pricing. Today, it remains primarily in the hands of other ministries and commissions. The MOWR have drafted and are bound by several pieces of water-pricing relevant legislation:

- Water Law of the PRC (1988)
- Irrigation Waterworks Fee Assessment, Calculation and Management Method (1985)
- Policies for the Water Resources Industry (1997)

While the MOWR accepts its new-found role as a provider of national and regional water resources planning and management, it has not entirely abandoned its traditional role as water supply provider. Its hardware bias is evident in its two most recent large-scale solutions to water problems: the Three Gorges Dam and the South North Middle Route Transfer Project (see Box 6.2).

C.1.5.1. River Basin Commissions (RBCs)

There are seven river basin commissions under the Ministry of Water Resources. These RBCs were created by the State Council under the direct administration of the MOWR and aim at comprehensive watershed management for the seven major basins in China. Some of the specific tasks of these commissions are (Wang et al., 1999):

- organizing and supervising implementation of relevant laws and regulations, notably the Water Law, and formulating basin-wide policies and regulations
- formulating a development strategy for the basin, including comprehensive and technical plans in cooperation with other departments and provincial governments
- organizing the monitoring, surveying and evaluation of water resources, formulating long-term water supply and distribution plans, and supervising their implementation, managing the water use licensing system, and monitoring protection of water resources
- carrying out unified management of rivers, lakes, etc., and managing parts of important rivers
- formulating a flood prevention plan for the basin, guiding provincial flood control plans and programs, coordinating daily work in flood prevention and drought resistance, and providing guidance to the safety and construction of the flood detention areas within the basin
- resolving water disputes between provinces
- organizing efforts for prevention, supervision and treatment of soil erosion within the basin, and guiding local efforts in water and soil conservation
- reviewing project proposals, feasibility studies and preliminary designs concerning the basin by central government
- constructing and managing important water engineering projects that involve more than one province
- planning, surveying, designing, researching and supervision of important projects on the river and its major branches
- guiding work in rural and urban water structure management, hydro-power and rural electricity development

While these commissions are well-intentioned, they lack true authority. They are commissions only by name since they lack a separate governing board or corporate status. In essence they are departments of MOWR and perform functions delegated to them by the MOWR. The RBCs find it difficult to enforce provisions of basin plans on other sector ministries and provincial governments, and the functions that they perform overlap with activities undertaken at provincial and local levels. One of the primary reasons for this weakness is the absence of representation of basin provinces in the governance RBCs (Wang et al., 1999). Additionally, RBCs neglect issues such as groundwater exploitation, water quality, and water demand management. As such, while it is important to note its existence and role, the Haihe River Basin commission will be omitted from the list of actors for the purpose of this study.

C.1.6. Ministry of Construction (MOC)

This functional department is responsible for the overall administration of the construction sector. Its involvement in water issues stems from control and construction of municipal water supply systems, as well as construction of municipal wastewater treatment facilities. Additionally, the MOC administrates and controls (but does not fund) the Municipal Public Utilities Companies (tap water companies). This ministry is highly involved in water pricing issues. Recently, it issued in collaboration with the SDPC the Management Method for Pricing Urban Water Supply. It also controls water prices indirectly, through the Beijing Public Utilities Bureau.

The Ministry of Construction is also involved in the activities of the local Water Savings Offices, which are under the Beijing Municipal Administration Committee. As such, the Ministry of Construction is responsible for drafting and implementing regulations related to water conservation, such as the Urban Water Conservation Management Regulation. Additionally, the Ministry of Construction works with the Ministry of Hygiene to develop policies such as the Management Method for the Supervision of Domestic Drinking Water Hygiene. Some legal documents that involve the MOC include:

- Management Method for Pricing Urban Water Supply (1998)
- Urban Water Conservation Management Regulation (1998)
- Management Method for the Supervision of Domestic Drinking Water Hygiene (1996)
- Municipal Water Supply Regulations (1994)

C.1.7. Ministry of National Resources

This newly founded ministry was formed in 1998 with amalgamation of the former Ministry of Geology and Mineral, National Land Administration Bureau, National Ocean Bureau, and National Mapping Bureau. The duty of this new ministry is:

- to plan, manage, protect and make reasonable use of ocean resources
- to establish a series of laws and statutes in ocean resource management
- to explore and document groundwater resources

Since this ministry is newly created, its role is not yet well established or documented. While it is responsible in part for groundwater, it has yet to demonstrate responsibility for groundwater pricing and conservation. Most likely it will take on the former Ministry of Geology role of groundwater surveying and monitoring, rather than planning and utilization, which is under the authority of the MOWR. As such, we can safely omit this new ministry from our list of actors.

C.1.8. National Environmental Protection Agency (NEPA)

This organization, formerly known as the State Environmental Protection Agency (SEPA) reports directly to the State Council and serves as the centralized supervision and administration authority for environmental protection. Its goal is the "protection and improvement of the nation's living environment and ecological system to achieve a sustainable, integrated and sound development of the economy and society" (McElroy et al, 1998). With regard to water resources, NEPA is in charge of water quality. Some of its specific tasks include:

- establishing national water protection standards, administrative regulations, strategies and policies
- drafting national laws and regulations on environmental protection
- presiding over environmental impact assessments of crucial economic and technical policies
- supervising the implementation of water pollution prevention and control laws and regulations
- resolving transboundary and transdrainage area water pollution disputes, investigating and handling environmental pollution accidents and ecological destruction incidents
- coordinating with other agencies on water pollution prevention and control
- managing national environmental monitoring systems

NEPA's primary task is to administer and supervise the enforcement of environmental laws and regulations issued by NPC and State Council. Enforcement is carried out primarily by local level EPBs (Environmental Protection Bureaus). This agency has risen from a mere office in the mid-1970s to its current ministerial rank. Previously, it reported through the State Science and Technology Commission, now it reports directly to the Vice Premier in charge of environmental protection.

Since NEPA deals exclusively with water quality and does not consider water supply, we can safely omit it as a stakeholder in our water-pricing context.

C.1.9. Ministry of Agriculture

Formed in 1949, the Ministry of Agriculture (herein known as MOA) was assigned the responsible of ensuring national food security. While its role has evolved over the years, this continues to be a priority. Today, however, the changing needs of the market (see sections 2.3.3 and 5.11) and the changing realities of the environment require that the MOA adopt new goals. Some of these include:

- Establishment of national crop production and provision of aid to farmers in achieving production targets and quotas
- Protection of arable land: In May 1999, the MOA and the Ministry of Land and Resources issued a notice to protect 80% of basic farmland (China Online, 2000).
- Control of environmental pollution resulting from agricultural practices: Programs included a ban on burning crop residues and education for farmers on how to properly fertilizer. Additionally, in March 1999, the Chinese government, on the advice of the MOA, "unveiled an Agriculture Action Plan based on China's Agenda 21 to guarantee the sustainable development of the rural economy, ensure sufficient food and achieve a balance in rural resources. Projects included the creation of a food security warning system, water and soil conservation, and animal and plant protection" (China Online, 2000).
- Poverty alleviation for farmers: In the late 1990s, it became apparent that poverty among Chinese farmers was worsening. Income growth rates began slowing in 1997. That year, incomes grew 4.6%, in 1998 it grew 4.3%, and in 1999 4%. This rate was "well below the growth rate of the national economy as a whole, ... 1999 was the first year that farmers' net income from agriculture had decreased since 1979. The growth rate for 2000 was expected to dip below 4 percent. In addition, 40 percent of rural residents rescued from abject poverty since 1979 had fallen below the poverty line again" (China Online, 2000). In order to deal with poverty among the farming population, the Ministry of Agriculture instituted various reforms under the Poverty Alleviation Plan, to raise 80 million poor above the poverty line. Some reforms included:
    - Elimination of fees and taxes: In 1998, the MOA lightened farmers' financial burden by removing 9,000 fees deemed "excessive." In May 1999, a regulation drafted by the MOA was issued, which stipulated that financial levies could not exceed 5% of the farmers net income during the previous year. "Furthermore, the amount of these fees could not surpass levies imposed in 1997, and could not increase for three years" (China Online, 2000).
    - Encouragement of town and village enterprises (TVEs) as alternative income providers in rural communities.
    - Optimization of crop mix through elimination of protective prices: In 1999, the MOA introduced reforms to "promote grain mix optimization, phase out protective prices for inferior strains, and limit the amount of financial aid provided to state-owned grain enterprises" (China Online, 2000).

To achieve these objectives and goals, the MOA is mandated with the following responsibilities (China Online, 2000):

- Formulating and implementing agricultural and rural economic development strategies, programs, and policies.
- Ensuring the rational allocation of resources by recommending policies for agricultural prices, tariffs, rural credit, taxation, fiscal support and the distribution of bulk agricultural products.
- Commercializing agricultural production by developing markets for bulk agricultural goods and production inputs; forecasting supply and demand and releasing economic information.

For the sake of this study, the goals and objectives of the MOA will be derived from the following documents:

- Agenda 21
- Ninth Five Year Plan
- Agricultural Law (1993)

C.2. Municipal Level Agencies

C.2.1. Beijing Municipal Government (BMG)

At the same level as ministries is the Beijing Municipal Government (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. According to the Municipal Water Supply Regulations, the BMG is responsible for organizing the Beijing Municipal Planning Administration Committee, the Beijing Water Resources Bureau, the Beijing Urban Planning Administration Bureau, and the Beijing Geology Bureau to jointly design a water supply plan, as part of the city's overall plans.

Since the first environmental protection conference held in Beijing in 1973, the BMG has been drawing up strategies for protecting water resources. Some of the measures it has taken to promote water conservation include:

- Tightening administrative management.
- Working with various Beijing-level bureaus to establish a water savings plan which is incorporated into the general city plan.
- Publishing water-saving techniques and raising people's awareness of the water shortage problem.
- Regulating the use of private wells.
- Planning consumption and charging more to consumers using more water than planned.
- Improving the technical capacity of the Beijing Waterworks Company to save water through the use of advanced processes, equipment and technologies
- Issuing regulations and setting up a legal system to support water-saving measures

The BMG plays a crucial role in water pricing. As the highest body on the municipal scale, the Beijing People's Congress has the power to pass or reject legislation presented by local-level bureaus concerning water-pricing policy. Any changes to water prices, or local water pricing policies, must have the final approval of the BMG in order to proceed. In essence, the BMG holds ultimate power to determine water prices.

The BMG also funds departments and bureaus at the municipal level. For example, the Beijing Water Resources Bureau, is funded not by the MOWR, but by the BMG. The Beijing Waterworks Company (BWWC) is primarily subsidized by the Beijing Municipal Government, and thus the BMG has an incentive to see the BWWC achieve full cost recovery.

Additionally, it holds responsibility for other aspects of Beijing's development. The BMG must take into account national as well as local goals for economic development, equity enhancement and poverty alleviation; goals that sometimes conflict with water conservation goals.

The main reference for determining the goals of the BMG in this study is the Beijing Ninth Five Year Plan.

C.2.2. Beijing Water Resources Bureau (WCB)

As the water administration bureau of 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. Its major duties include:

- Drawing up strategic long term water supply plans and integrating them into the Municipal Economic and Social Development Plan.
- Unified monitoring, evaluation and management of water resources within the municipality.
- Managing municipal riverways, reservoirs and lakes.
- Managing municipal water engineering works including ensuring quality control and inspection.
- Drafting, implementing and monitoring local level regulations and rules related to water resources.
- Taking measures against floods or droughts affecting the municipality.
- Working with other departments to draft and implement water pricing policies and other financial affairs.
- Overseeing compliance with national water statutes, regulations, rules, methods, and standards, as well as local counterparts enacted by the BMG.

While its role is to act as the local counterpart to the MOWR, it reports directly to the BMG. Historically, however, the Beijing Water Resources Bureau has strong links with the MOWR, which exercises considerable direct authority over it.

Water pricing-related documents drafted by the Beijing Water Resources Bureau include:

- Regulation for Water Resources Management in Beijing Municipality (1992)
- Regulations of Rural Water Conservation in Beijing (1992)

C.2.3. Beijing Price Bureau

This agency monitors prices in Beijing and is in charge of final approval to any water price changes. According to the Beijing Price Method Supervision and Enforcement Regulations, the Beijing Price Bureau is responsible for carrying out national price regulations, and supervising and checking enterprises and industries at the municipal level or lower to ensure that they are following government set prices. Laws relevant to the Beijing Price Bureau include:

- Price Law of the People's Republic of China (1997)
- Beijing Price Method Supervision and Enforcement Regulations (1990)

C.2.4. Beijing Municipal Planning Administration Committee

The responsibility of this committee is primarily to guide, coordinate, supervise and inspect water supply and other infrastructure within the city. Its goal is to ensure the safe, stable supply of the municipality's water and gas, just as in the past, to contribute to development of the economy, urban construction, and improved living standards. Before recent reformation and changes, this committee supervised the Beijing Public Utilities Bureau. Since reformation, the Beijing PUB has been disbanded and the Beijing Municipal Planning Administration Committee has adopted the PUB's responsibilities. These include:

- overseeing the urban water supply system, the district/county water supply system, and the private water supply system;
- working with the bureaus responsible for various industries to determine a feasible and sound water quota level;
- drawing up plans to fine units that surpass water quotas;
- supervising the Beijing Municipal Waterworks Co. and Beijing Water Savings Office;
- managing the 14 water supply plants;
- overseeing a total of 20 enterprises and institutions related to the municipality's public utilities, such as the heating power company, coal gas company, natural gas company, and liquefied petroleum gas company.

The Beijing Municipal Planning Administration Committee is directly subordinate to, and funded by, the BMG. Its involvement in water pricing policy stems from its supervision of the Beijing Waterworks Company. As such, to simplify matters, only the Beijing Waterworks Company will be considered an actor in this analysis.

C.2.5. Beijing Waterworks Co. (BWWC)

Founded in 1910, the Beijing Waterworks Company provides the city with its tap water. Its duties are to "safely supply water to the city construction, industrial and domestic customers; to provide good service; and to manage water conservation tasks" (Beijing Public Utilities Bureau, 1993). It operates the tap water system outlined in section 2.2.6. Additionally, it is responsible for overall water supply planning and issuance of licenses for water extraction by major users.

C.2.6. Beijing Water Savings Office (WSO)

Previously under the Beijing Public Utilities Bureau and now under the Beijing Municipal Planning Administration Committee, 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). Some tasks include:

- implementing national laws, principles and policies on water conservation;
- reviewing and approving water use plans and allocating water quotas to users;
- supervising and managing development and metering of self-dug wells;
- inspecting water leakage;
- organizing, researching, promoting and developing new water saving technologies;
- educating the public on water conservation;

- ensuring that domestic water fees are measured and collected by family and that every residential building has a meter;
- setting water quotas;
- drafting and establishing policies for groundwater drawing;
- collecting groundwater resources fee (primary based on Regulations for Protection and Savings of Groundwater in Beijing, 1989);
- collecting progressive rate surcharges of over-use of water above allocated levels (such as the Beijing Water Fees on Excessive Use Management Method, 1989);
- collecting punishment fines and fees for wasted water (such as in Beijing Punishment Rule for Wasting Water, 1994).

Laws and policies affecting the Beijing WSO include:

- Urban Water Conservation Management Regulation (1998)
- Beijing Urban Water Conservation Regulations (1994)
- Regulations for Protection and Savings of Groundwater in Beijing (1989)
- Beijing Municipality Management Regulation for the Conservation of Water Use by Danwei Units (1988)
- Beijing Water Fees on Excessive Use Management Method (1989)
- Beijing Financing Method for Funding Water Conservation (1990)
- Beijing Punishment Rule for Wasting Water (1994)

C.2.7. Beijing Hygiene Bureau

This bureau works closely with the Beijing Planning Administration Committee, and the Beijing Waterworks Company to ensure that Beijing's tap water meets drinking water quality standards according to national regulations. The primary purpose of the Beijing Hygiene Bureau is to ensure hygienic drinking water to protect human health. 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. The goals of the Beijing Hygiene Bureau are detailed in:

- Management Method for the Supervision of Domestic Drinking Water Hygiene (1996)
- Beijing Drinking Water Hygiene Regulation (1997)

C.2.8. Beijing Agricultural Bureau

As the Beijing-level counterpart of the Ministry of Agriculture, the Beijing Agricultural Bureau performs similar tasks at the local level. In addition to the regulations which the MOA is bound to, the Beijing Bureau is bound by local agricultural goals stipulated in the Beijing Ninth Five Year Plan. To simplify our analysis, only the Beijing Agricultural Bureau will be included as an actor in this study.

Appendix D: AHP Explained

Developed by Saaty in 1971, Analytical Hierarchy Process (herein known as AHP) allows the ranking of various alternatives (in this case agencies), based on their relative importance to each other.

AHP works by taking a series of relationships between various alternatives (generated by educated guesses) and compensating for errors made in their estimation.

The first step in the AHP process is to make a paired comparison with respect to common criteria (for example, in our case, we first compare the hierarchical rank of all the agencies with respect to the NPC and SC, then with respect to the MOC, then to the MOWR, as so on). This information is filled into a matrix based on the values provided in Table D.1.

Table D.1. Saaty's AHP Measurement Scale

Numerical Values	Definition
1	Equally important or preferred
3	Slightly more important or preferred
5	Strongly more important or preferred
7	Very strongly more important or preferred
9	Extremely more important or preferred
2,4,6,8	Intermediate values to reflect compromise
Reciprocals	Used to reflect dominance of the second alternatives as compared with the first

These estimated/guessed relationships are shown in Tables D.2, D.3, and D.4, which depict the positions of each criteria with respect to each other. Table D.2 displays the relative importance of each agency based on the formal hierarchy. The numbers within this matrix depict the relation of the actor/alternative on the x axis to the actor/alternative on the y axis. For example, the agencies hold a relation of 1 to themselves, the NPC and SC are strongly more important than the MOC (value 5), and the MOWR is slightly more important than the Beijing Pricing Bureau (value 3), etc. A similar procedure is repeated for each criteria (see Table D.3 and D.4). Note that Table D.4 merges the two criteria in a 2:1 ratio. To merge these two criteria to create a single weight, all one does is repeat the process using the criteria from the first two sets as alternatives (see Table D.4).

Table D.2. Relative weight matrix for formal hierarchy criteria

	NPC and SC	MOC	MOWR	BMG	BWWC	BAB	BWCB	BWSO	BPB	BHB
Central Government (NPC and SC)	1.000	5.000	5.000	5.000	8.000	8.000	8.000	8.000	8.000	8.000
Ministry of Construction	0.200	1.000	1.000	1.000	3.000	3.000	3.000	3.000	3.000	3.000
Ministry of Water Resources	0.200	1.000	1.000	1.000	3.000	3.000	3.000	3.000	3.000	3.000
Beijing Municipal Government	0.200	1.000	1.000	1.000	5.000	5.000	5.000	5.000	5.000	5.000
Beijing Waterworks Company	0.125	0.333	0.333	0.200	1.000	1.000	1.000	1.000	1.000	1.000
Beijing Agricultural Bureau	0.125	0.333	0.333	0.200	1.000	1.000	1.000	1.000	1.000	1.000
Beijing Water Resources Bureau	0.125	0.333	0.333	0.200	1.000	1.000	1.000	1.000	1.000	1.000
Beijing Water Savings Office	0.125	0.333	0.333	0.200	1.000	1.000	1.000	1.000	1.000	1.000
Beijing Price Bureau	0.125	0.333	0.333	0.200	1.000	1.000	1.000	1.000	1.000	1.000
Beijing Hygiene Bureau	0.125	0.333	0.333	0.200	1.000	1.000	1.000	1.000	1.000	1.000

Table D.3. Relative weight matrix for relevance criteria

	NPC and SC	MOC	MOWR	BMG	BWWC	BAB	BWCB	BWSO	BPB	BHB
Central Government (NPC and SC)	1,000	0,333	1,000	0,500	0,333	1,000	1,000	3,000	3,000	3,000
Ministry of Construction	3,000	1,000	3,000	2,000	1,000	3,000	3,000	6,000	6,000	6,000
Ministry of Water Resources	1,000	0,333	1,000	0,500	0,333	1,000	1,000	3,000	3,000	3,000
Beijing Municipal Government	2,000	0,500	2,000	1,000	0,333	1,000	3,000	6,000	6,000	6,000
Beijing Waterworks Company	3,000	1,000	3,000	3,000	1,000	3,000	3,000	6,000	6,000	6,000
Beijing Agricultural Bureau	1,000	0,333	1,000	1,000	0,333	1,000	1,000	3,000	3,000	3,000
Beijing Water Resources Bureau	1,000	0,333	1,000	0,333	0,333	1,000	1,000	3,000	3,000	3,000
Beijing Water Savings Office	0,333	0,167	0,333	0,167	0,167	0,333	0,333	1,000	1,000	1,000
Beijing Price Bureau	0,333	0,167	0,333	0,167	0,167	0,333	0,333	1,000	1,000	1,000
Beijing Hygiene Bureau	0,333	0,167	0,333	0,167	0,167	0,333	0,333	1,000	1,000	1,000

Table D.4. Relative Weight Matrix for the formal power criteria.

	hierarchy criteria	relevance criteria
"hierarchy" criteria	1.000	2.000
"relevance" criteria	0.500	1.000

The next step involves mathematically manipulating the numbers in the matrices to produce a final weight. This is accomplished by equalizing numbers to eliminate errors in judgement when initially estimating the values in the matrices, as follows. Using Table D.4 as an example (because it is the smallest and simplest), we normalized the values in each column to attain:

1 / (1+0.5) = 0.67   2 / (1+2) = 0.67
0.5 / (1+0.5) = 0.33   1 / (1+2) = 0.33

Notice the values obtained in each row are the same, which means we have accurately determined that the weight for the "hierarchy" criteria is 0.67 and the weight for the "relevance" criteria is 0.33 without error. This is because in a 2x2 matrix, errors are unlikely to occur. However, in a larger matrix, such as in Table D.2, errors in judgement are likely to have occurred in estimating the relative importance of various agencies to each other. Normalizing the information for the MOWR and the BWCB in Table D.2 generates the following:

5 / (5+1+1+1+0.33+...) = 0.5	8 / (8+3+3+5+1+...) = 0.32
1 / (5+1+1+1+0.33+...) = 0.1	3 / (8+3+3+5+1+...) = 0.12
1 / (5+1+1+1+0.33+...) = 0.1	3 / (8+3+3+5+1+...) = 0.12
1 / (5+1+1+1+0.33+...) = 0.1	5 / (8+3+3+5+1+...) = 0.20
0.333 / (5+1+1+1+0.33+...) = 0.03	1 / (8+3+3+5+1+...) = 0.04
0.333 / (5+1+1+1+0.33+...) = 0.03	1 / (8+3+3+5+1+...) = 0.04
0.333 / (5+1+1+1+0.33+...) = 0.03	1 / (8+3+3+5+1+...) = 0.04
0.333 / (5+1+1+1+0.33+...) = 0.03	1 / (8+3+3+5+1+...) = 0.04
0.333 / (5+1+1+1+0.33+...) = 0.03	1 / (8+3+3+5+1+...) = 0.04
0.333 / (5+1+1+1+0.33+...) = 0.03	1 / (8+3+3+5+1+...) = 0.04

As you can see, the values across rows not the same this time. The differences are the inconsistencies we have introduced when estimating our relations.

With the assumption that errors in judgement exist, AHP works to overcome them by estimating overall weights using all information. It applies the following theorem, known as Saaty's eigen value method (equation on left). This theorem computes $\underline{w}$ (or the final weight) based on the matrix (A), a unit vector ($\underline{e}$), and its transpose ($\underline{e}^T$). A simplified, more workable version of this equation is also provided (right). This simplified equation may be used provided that the user takes the extra precaution of checking for errors using Saaty's methods.

$$\underline{w} = \lim_{k\to\infty} \frac{[A]^k \cdot \underline{e}}{\underline{e}^T [A]^k \underline{e}} \qquad \underline{w} = \frac{[A]^5 \cdot \underline{e}}{\underline{e}^T [A]^5 \underline{e}}$$

Completing the calculations based on the equation to the right for Tables D.2, D.3 and D.4, gives us the end results shown in Tables 4.2, 4.4, and 4.5. The following is a sample calculation for Table D.2, based on the simplified equation, shown on the right. As you can see, the results are identical to those shown in Table 4.2. A similar process is repeated for each matrix of relationships.

$\underline{w}$ =

$[A]^5$ =

11692	38802	38802	29815	114203	114203	114203	114203	114203	114203
3237	10740	10740	8252	31616	31616	31616	31616	31616	31616
3237	10740	10740	8252	31616	31616	31616	31616	31616	31616
4520	14997	14997	11522	44153	44153	44153	44153	44153	44153
1087	3606	3606	2770	10615	10615	10615	10615	10615	10615
1087	3606	3606	2770	10615	10615	10615	10615	10615	10615
1087	3606	3606	2770	10615	10615	10615	10615	10615	10615
1087	3606	3606	2770	10615	10615	10615	10615	10615	10615
1087	3606	3606	2770	10615	10615	10615	10615	10615	10615
1087	3606	3606	2770	10615	10615	10615	10615	10615	10615

[e] =

1.00
1.00
1.00
1.00
1.00
1.00
1.00
1.00
1.00
1.00

$[e^T]$ = | 1 1 1 1 1 1 1 1 1 1 |

$[A]^5$ =

11692	38802	38802	29815	114203	114203	114203	114203	114203	114203
3237	10740	10740	8252	31616	31616	31616	31616	31616	31616
3237	10740	10740	8252	31616	31616	31616	31616	31616	31616
4520	14997	14997	11522	44153	44153	44153	44153	44153	44153
1087	3606	3606	2770	10615	10615	10615	10615	10615	10615
1087	3606	3606	2770	10615	10615	10615	10615	10615	10615
1087	3606	3606	2770	10615	10615	10615	10615	10615	10615
1087	3606	3606	2770	10615	10615	10615	10615	10615	10615
1087	3606	3606	2770	10615	10615	10615	10615	10615	10615
1087	3606	3606	2770	10615	10615	10615	10615	10615	10615

[e] =

1.00
1.00
1.00
1.00
1.00
1.00
1.00
1.00
1.00
1.00

$\underline{w}$ =

0.400
0.111
0.111
0.155
0.037
0.037
0.037
0.037
0.037
0.037