Water Service Delivery Reform in China: Safeguarding the Interests of the Poor

Denis Nitikin

The World Bank, USA

Chunli Shen

University of Maryland, College Park, USA

(Janey) Qian Wang

San Francisco State University, USA

Heng-fu Zou

Central University of Finance and Economics CEMA, Wuhan University IAS, Peking University, and China Development Bank

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Abstract

China faces a water scarcity problem that is severe by international standards. Many factors, including rapid urbanization and environmental degradation etc, have been challenging the water service delivery in China. Since water scarcity and quality have impact on the poor, reforms to the water service provision can produce substantial improvements in the living standard of the economically disadvantaged groups. The objective of this study is to critically evaluate the strengths and weakness of China's current water financing and delivering system, with a focus on safeguarding the interests of the poor, and to offer insight into possible solutions.

Keywords: water administration, water pricing, water financing

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Corresponding author: (Janey) Qian Wang, Assistant Professor

Mailing address: San Francisco State University, Department of Public Administration, 835 Market Street, Suite 515, San Francisco, CA 94103, USA. Email address: jqwang@sfsu.edu.

I. Introduction

Rapidly increasing scarcity and deteriorating of quality of water resources present a serious challenge to China. These problems, to a substantial degree, are caused by demographic factors and economic growth, the processes which one cannot easily control at will. Pressing environmental problems call for radical policy measures to curb water demand and to increase environmentally sustainable water supply.

The distribution of water in China is highly diverse. While Southern China has abundant natural water resources, Northern China is naturally arid and water is scarce. In addition, the more socially and economically prosperous regions have more serious water shortage problems, which obstructs their economic development.

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Currently, urban water prices in China hare handled with a single bill, which includes the tap-water price (costs of pipe network construction and maintenance), sewage treatment fee, water resource fee (benefit areas are also subject to the South-to-North Water Transfer Project Fund) and an additional fee for urban public utilities. As of the end of 2010, the residential tap-water price in 31 capital cities was average 1.95 RMB/M^3 and the residential sewage treatment fee was 0.77 RMB/M^3. Compared to other countries, the water price as a percentage of family expenditures is still relatively low in China.

However, policy changes may jeopardize the welfare of the poor if they are not adequately protected. For instance, price increases in effort to dampen the demand for water and enlarge availability of water in the medium-long run can further limit the poor's access to water in the short run. Similarly, increasing tariffs on industrial uses of water can discourage development.

This study proceeds as follows. Section two introduces the system of water provision in China. Section three reviews government financing of water services. Section four explores issues in water administration, including urban areas and rural areas. Section five explains water demand management through price adjustments. Section six shows the access to water services for the poor and the welfare effects of increased water charges. The last section provides policy recommendations on low-cost efficiency improvements and water pricing policy.

II. The System of Water Provision in China

Water is a scarce resource in China. In 2008, the average per capita availability of water was 2,100 M^3, which was almost one-fourth of the world average (8,210 M^3 per capita) (Wu, Han, and Zhou, 2010). Water scarcity in China is a function of a growing demand for the resource due to industrialization and population growth, rapidly escalating levels of pollution, and the geographic pattern of water distribution. Population growth mounts substantial pressure on China's water resources, which – barring major climatic changes – remain constant. During 1983-2003, a twenty-three percent decline in water availability occurred parallel to a twenty-five percent increase in population over the same period.[1] At current population growth rate, it was projected that by 2010, China's water availability would fall below 2,000 M^3 per person, making China a "water-stressed"[2] country.

Regional disparities in water availability are dramatic with the northern regions severely starved. In the north, water availability rate as low as 964 M^3 per capita, falling below the water-

[1] From 1983 to 2003, the population changed 1.03 to 1.29 billion, while water availability changed from 2,849 to 2180 m^3/capita (China Statistical Yearbook, 2004 and Shalizi, 2006).
[2] According to the UNDP, UNEP, World Resource Institute classifications, a country is considered "water-stressed" if its per capita natural water availability is below 2000 M^3; countries with water availability below 1000 M^3 per capita are classified as "water-scarce."

scarcity level; in the south, water availability is 3,208 M^3 per capita – a 4.2-fold gap. Average human water use rate in the north was around 49 percent in 2000, while in the south it was around 15 percent in the same year. Within the north region, the Hai river basis is by far most intensively used at the rate of 95 percent, followed by Huai and Huang basins exploited at 64 and 53 percent respectively.

As a result of heightened water consumption, the water flow in the rivers has suffered serious reduction. For instance, in the deltas of Hai and Huang rivers have averaged 15 million M^3 less than the amount required to transport silt and to maintain estuarine and coastal environments. Over utilization of the up-stream water resources has caused reduction in the volume and quality of down-stream water supply (World Bank, 2002a).

Excessive diversion of surface water flows has been compensated at the expense of increased exploitation of underground aquifers. Mining of aquifers has been intensive, leading to substantial drops in groundwater tables of around 90 meters in the Hai river basin and 100 to 300 meters in Beijing (World Bank, 2002a). Mining of aquifers to satisfy current demands makes them unavailable as a means of insurance during periods of drought and in fact may contribute to drought. Depletion of groundwater has led to salt water intrusion around the coast and subsidence in coastal and non-coastal areas. Subsidence in turn causes damage to structures and undermines flood protection.

Deficient water supply is compounded by low water quality. Heavy pollution raises the cost of recycling water or makes it altogether impossible. In 2003, total municipal and industrial discharge reached 46 tons, three quarters of which remained untreated. In 2003, over 38 percent of river waters were polluted. In China's seven major river systems, in 70 to 80 percent of the water, pollution level too high to allow any designated beneficial use (EIA, 2003).

Urban and rural areas contribute approximately equal shares to the total water pollution. In the urban areas, municipal waste has become the leading polluter followed by industrial pollution as the second largest contributors. Due to intensive urbanization, municipal waste grew by 6.6 percent increase in 2003 while industrial pollution increased at a much slower rate of 2.4 percent in the same year. Construction of adequate sanitation infrastructure could not keep up with the pace of the mounting population pressure in the urban centers.

In the rural areas, the key sources of pollution are fertilizer and pesticide runoff as well as livestock production waste. China's (near) self-sufficiency in grain production has been achieved due to heavy pesticide use, 317 kg per hectare of cultivated land. Additionally, application of fertilizers have been unbalanced (deficient in potassium and phosphorus), often using inefficient methods; the quality of fertilizers has been low in many cases. China's consumption of pesticides and fertilizers was 1.708 million tons and 54.044 million tons respectively in 2009 (Greenpeace, 2011); a substantial share of them is highly toxic chemicals. Since most of rural water pollution comes from non-point sources, it is hard to contain and has been largely outside of government's control.

To summarize, the system of water provision in China is facing serious challenges and requires immediate and radical modernization. The need for reforms is more evident in the north where water provision increasingly runs up against physical constraints (e.g. dropping water tables, etc.). On the basis of the discussion above, it is clear that the water reform should contain the following features: (1) It should emphasize management of demand for water rather seeking to invest in increasing the supply alone. Despite the heavy investment requirements, as a matter of coordination and policy it is easier to address the problem of water scarcity from the supply side. Yet this is not sustainable, management of water resources should be leaning heavier

toward management of demand. (2) On the demand side policy interventions should address low efficiency of water use in agriculture and industry, promote water reuse, introduction of cleaner technologies and monitor pollution. (3) Since urbanization has contributed most prominently to water scarcity, close attention to urbanization patterns should be paid, to avoid policies which encourage unsustainable rural-to-urban migration; this is consistent, however, with the recent strategic shift in China's economic policy toward rural development – from the point of efficient water resource use, rural growth is largely favorable; similarly migration toward smaller cities and town would promote water resource sustainability as well. (4) Because of non-point nature of rural polluters, achieving of efficient rural water use poses more serious coordination and enforcement costs.

The need for environmental reforms has been materialized politically in the form of environmental protest in response to environmental accidents and disputes. According to Zhou Shengxian, head of the State Environment Protection Administration (SEPA), the incidence of mass protests related to environmental concerns has been rising at the yearly rate of almost 30 percent; protests have concentrated in economically developed regions (China Daily, 2006). In 2005 alone, over 50,000 environment-related disputes occurred last year. People protested against pollution as a result of environmental mishaps in 97 percent of cases. Water contamination specifically made up 50.6 percent of the total accidents. The prospects for the future are not comforting: unless effective measures are taken the scale of environmental pollution – and unrest – will grow in proportion with economic growth.

With these objectives in mind, we further consider fiscal and administrative aspects of reforms of the water sector, subject to an additional constraint – concern for the interest of vulnerable households.

III. Government financing of the water services

In 2007, the total capital investment in fixed assets from the water sector was 102.65 billion RMB, of which the largest share, 41 percent, was dedicated to flood control, 41 percent was invested in water resource projects, and 7 percent spent on soil and water conservation and environmental management. The total investment in the on-going capital construction projects in the water sector reached 575.0 billion RMB by 2007. Out of 4,852 capital construction projects, 3,605 were funded by the central government (MWR, 2008).

Completed investment in water resource projects centered on the phase I projects of eastern and central routes of South to North Water Transfer, rural drinking water supply projects, projects for reconstruction of large-sized irrigation districts, as well as water saving irrigation projects. However, only 1.9 out of 24.09 billion RMB was allocated toward rural drinking water supply (MWR, 2005).

The central government invested 29.75 billion RMB in the water sector in 2004, roughly 37.6 percent of total public investment in the sector. Nearly ½ of central government water financing were targeted for the central region; the western region received 35.6 percent and the eastern region received 14.6 percent. Forty-six percent went to the rural areas (MWR, 2006). Most of the central government's investment - 71.1 percent – came from the special state debt fund and only 24.7 percent from budgetary appropriations (MWR, 2006).

So far China's dependence on foreign source of financing of the water sector has been considerable high. In 2002-2004, China's water sector received a total of $583 million from development assistance committee (DAC) donors. 69 percent of it was targeted to large water

sanitation and supply systems, 11 percent in river development and 6 percent in agricultural water systems development. World Bank's share in water sector aid to China amounted to over 41 percent; Japan's share exceeded 25 percent (OECD-DAC, 2006). [3]

Such substantial dependence of China's water sector on external funding is unsustainable and domestic investment in water must be developed. Privatization of water provision is underway, but has progressed slowly. Between 1998 and 2003 the public share in the total value added of the water sector declined from 96 to 86.7 percent. In terms of employment, the role of the public sector remained more prominent – it employed over 94 percent of the labor force.

As a result, private investment in water and sanitation in 1994 - 2008 was small, but in the recent years there has been a tendency toward an increased participation by domestic private investors (Figure 1) as privatization of the water sector advanced.

INSERT FIGURE 1 HERE

Sub-national share in the funding of water sector investments has been considerable, around 65 percent. The role of local governments in management of these investments has been even greater – around 82 percent of investments in water were managed by sub-national government in 2004 (MWR, 2005). By law, local governments are not allowed to borrow from markets and their access to financing has been limited. The restriction is frequently circumvented by encouraging water plants which have the status of enterprises – albeit public ones – to borrow with implicit guarantees from municipalities that the debt will be assumed by the municipal governments, even if the contracting party to loans are the water enterprises.

To summarize, with respect to government participation in financing of the water sector, the following weaknesses can be identified: (1) Overall, expenditure on water infrastructure and

[3] In 2000-2004 China's water sector received $275 million (in 2003 USD) in *bilateral* aid from DAC donors, mostly Japan ($222 million). China accounted for over 11 percent of DAC's total aid to water supply and infrastructure sector worldwide (Benn, 2006).

services has not closed the gap between supply of water and demand for it. (2) At the same time, intergovernmental fiscal arrangement do not promote efficient service delivery; specifically, the assignment of responsibility for direct infrastructure financing to counties and prefecture fails to exploit economies of scale and overburdens local government. (3) Dependence on external funding and reliance on government debt-based financing has reached unsustainable levels; it would be more effective to cultivate domestic and/or private sector provision of water services. (4) Improved to business environment – greater borrowing autonomy by enterprises and possibly by local governments – will stimulate private participation and can help resolve the chronic shortage of funds for costly water infrastructure investment.

IV. Issues in Water Administration

The responsibility for urban water supply rests with the urban construction committees; National Development and Reform Commission (formerly known as State Development Planning Commissions) at different levels of government participate in the planning of development of fixed assets and in allocation of capital investment funds. Control over wastewater discharge is exercised by the environmental protection bureaus (EPBs) at provincial and municipal levels in administration. Some overlap exists between the EPBs and urban construction committees because the former can also sometimes initiate infrastructure development. Another instance of overlapping mandates in urban water resource management appears in cases when city hydrology bureaus administer sewage treatment facilities.

All the water supply plants, the piping networks as well as municipal water treatment facilities are publicly owned[4] and operated in the vast majority of case, but since 1998 some plants and networks have been operated by private companies.[5] The transfer of operation right to private parties is however cumbersome since special authorization by the government is required.

Water supply and wastewater treatment enterprises are increasingly administered as institutionally separate entities, with wastewater treatment enterprises operating within municipal administrations. Wastewater treatment enterprises are not responsible for wastewater collection, which can be operated by a different enterprise.

The degree of administrative control over the state-owned water supply and treatment enterprises varies. Even though water utility enterprises can now set the level of charges, they inevitably succumb to the pressure from local government to keep fees well below the cost-recovery threshold, leading them to operate at a loss.[6] By contrast, wastewater enterprises do not collect their own revenues from user fees; instead they calculate their costs and submit their estimates to be included in the calculation of the wastewater tariff by the provincial governments.

Upon collection of the water fees – performed by the water supply utilities or the municipal construction department – water enterprises transfer receipts to the municipal budgets. These revenues are not earmarked and there is no link between the preparation of the operation

[4] In those industries for which water quality requirements are unmet by the municipal water supply and treatment network, industrial water supply plants and water treatment facilities are owned and operated by the enterprises themselves.

[5] Six hundred sixty cities with the aggregate population in excess of 350 million is serviced by own water supply plants. Municipal water supply piping reaches over 77 percent of urban residents (US Department of Commerce, 2005). Municipal wastewater treatment facilities had been constructed in 310 out of 660 cities. But Majority of towns – there are 1700 of them – still lack municipal water treatment facilities.

[6] The government often approves the rates, which are well below even direct business costs. For example in Luzhou, the WWTP enterprise has recently proposed full cost recovery tariff at the level of 0.95 RMB/m^3, and operational and maintenance cost-recovery tariff at 0.4 RMB/m^3. Following government-wide consultations, the rate approved by the Price Bureau was only 0.2 RMB/m^3. There was no accompanying explicit legal commitment as to who and how the resulting deficit of wastewater enterprise will be covered (OECD, 2004).

and capital budget and the revenue collection (OECD, 2004). The single-billing for water supply and treatment is a common practice in OECD countries. It is cost - efficient since it is cheaper for water treatment companies to pay water supply utilities a commission for the collection service than to establish their own billing entities. On the other hand, the bundling of the two fees on one bill improves collection rates for water treatment, since users' willingness to pay for water treatment tends to be lower than their willingness to pay for water supply.

Nevertheless, transfer of the water treatment share of the collected revenues to the corresponding enterprises via municipal budgets introduces substantial inefficiencies – the charges thus remitted tend to not reach the service providers. Municipal governments claim the revenue from wastewater treatment enterprises as their own, violating the principle of separation of municipal ownership of *shares and not of assets* in public enterprises, commonly used in OECD countries.

On the other hand, there are indications that municipalities have used the lack of transparency in the single-billing system to charge wastewater fees when they had no legal basis to do so. Municipalities which have no water treatment facilities cannot charge water treatment fees, unless they are planning to construct such a facility in three years' time. However, monitoring of compliance with this law is difficult.

In rural areas, surface water irrigation schemes are mostly state-owned and are administered largely by provincial and local government agencies. The regulatory and water supply roles are played by the provincial governments under the strategic guidance of the national river basin commission. Provincial water bureaus are involved in planning, design, monitoring, operation, and construction of irrigation infrastructure and hydropower facilities and supply of water. The primary responsibility of prefectural bureaus is construction and

maintenance of the irrigation, flood-control infrastructure and medium-sized reservoirs. Township-level bureaus share responsibility for construction and maintenance of branch canals, ancillary infrastructure and small reservoirs; township bureaus also collect water fees. Village committees and individual farmers carry out the maintenance of the field canals.

Administration of surface water irrigation remains *fragmented* across a large slew of agencies, whose responsibilities often overlap. The recently advocated integrated management approach has promoted more parsimonious distribution of irrigation administration[7], but the organization matrix still remains excessively complex, lacking cohesion and highly vulnerable to the misallocation of resources (Ma, 2000). These considerations prompted the Chinese government to aggregate the functions of enforcement and supervision over water conservation and supply and pollution prevention within a single office (MWR, 2005).

Overstaffing presents another challenge to the efficiency of the public irrigation infrastructure management. Privatization of the water sector has proceeded at a rather slow pace and there is evidence that while the economic size of the public water sector has declined faster than the number of staff it employs maintaining substantial obligations to the employees (pensions, medical insurance, and other subsidies).[8] As in other public enterprises, suboptimal staffing is motivated by considerations of political and social stability. In the water sector, political and social pressure is made more acute by the weakness of the private sector which in other branches of industry and services has absorbed a large share of the laid-off of the public enterprises.

[7] A number of provinces and municipalities – including Beijing, Shanghai, Heilongjiang, and Hainan – introduced integrated water management at provincial level. China Water Investment Company has been established (MWR, 2006).

[8] Significant efficiency improvements could be made. For instance, while the public share in the value added of the water sector is under 87 percent, public enterprises account for 94 percent of the sector's employment (OECD 2005).

The salaries of the irrigation sector employees are financed from the collected water fees. On the one hand, this gives water bureaus an incentive to increase rates and to expand water supply in order to maximize revenue. On the other hand, the overblown – due to overstaffing - wage bill of the irrigation sector takes up all or almost all the revenue, leaving little for infrastructure maintenance.

In addition to the obvious natural detrimental effect on the quality and coverage of the irrigation infrastructure, financing of salaries at the expense of infrastructure investment undermines the key linkage between water charges and benefit incidence in irrigation. Farmers simply do not see any improvement in service delivery associated with their water payments. Naturally this undermines farmers' willingness to pay for the irrigation service and induces avoidance of water charges.

Mass creation of water user associations in rural area alleviated some of these issues. World Banks' pilot projects indicate that they boosted water users' participation in irrigation management leading to a number of positive consequences in pilot projects. They took on some of the functions of the township and village water bureaus, specifically water distribution, collection of water fees and operation and maintenance of minor infrastructure installations. Serving as intermediaries between the township bureaus and the farmers, water user associations facilitated resolution of conflict between farmers over water use; they also made collection of water fees easier. Farmers' confidence that the fees they pay will benefit them (e.g. invested in maintenance of local irrigation systems) increased. By 2004 there was already a network of 5000 of these associations (MWR, 2005).

In summary, a number of key issues figure prominently in water administration. (1) Fragmented institutional framework and overlapping of functions of different agencies introduce

inefficiency both in urban and rural water service delivery, leading to misallocation of resources and, ultimately, higher cost of water service and lower returns on investment in water infrastructure; in this regard introduction of the integrated management framework is a welcomed development. (2) Despite the increased autonomy of the municipal water companies to set water prices, cost-recovery of water services in rural areas has been low due to substantial pressure from the governments to keep water charges low. (3) Efficient operation of wastewater enterprises has been hampered by the poor definition of their ownership over the revenue they generate. (4) Excessive involvement of the municipal government in the allocation of collected wastewater charges remain a problem. Municipalities clearly benefit from this control since it generates extra revenue. (5) In irrigation, we observe a very similar problem: water bureaus are dependent on water revenue for financing of their overblown staff, always to the detriment of infrastructure O&M. (6) Such gaps in governance undermine users' trust in the fairness of water fees and de-link charge from any perceived benefit, undermining willingness to pay and encouraging avoidance. (7) Lack of transparency in water charges has given an opportunity to municipal governments to charge for services they do not provide. (8) Overstaffing in the public water sector raises the issue of downsizing which has not affected this sector all that much; this problem will have serious welfare implications for the laid-off, but the excess labor force can be in part absorbed by the expanding investment in infrastructure and the growth of the public sector. Positive practices are also present in water administration: (9) Single-billing for municipal water supply and wastewater treatment is a cost effective practice. (10) Water users' associations promote participatory approach, increases transparency, and ensures – albeit on a small scale – reinvestment of water fees into local irrigation infrastructure. (11) Water markets

in prepaid quantities of water have been a success, but remain severely constrained by fragmented at the level of irrigation district irrigation infrastructure.

V. Water Demand Management and Water Pricing

Water demand management is implemented using a number of instruments. On the one hand, in 17 provinces, quotas on water use are in effect, replacing uniform water fees with tariffs structures which vary according to districts and projects. Adequate water pricing can (i) improve cost recovery for the water services and, most importantly, (ii) curb the demand for water, (iii) induce application of water-saving technologies in industrial water use and in irrigation, and (iv) increase the wastewater reuse potential.

Chu et al. (2004) demonstrates non-linearity in the price elasticity of water demand. This suggests that price that small price increases will not produce the desired effect on water consumption. Price increases should be considerable to encourage wastewater reuse. Specifically any price change on irrigation water below 0.162 RMB per cubic meter produces no noticeable effect on reuse potential; price increase in the 0.162-0.237 RMB range, on the other hand, cause non-linear jumps in reuse rates (fourteen-fold). Industrial thermal power water reuse rates respond to price increases in a non-linear fashion as well – at the level of 0.95 RMB per cubic meter, reuse rates increase six-fold.

A water pricing reform was introduced in 2000, despite a considerable resistance at various levels of government to raising the water fees, a move which is considered political dangerous and unaffordable.

Prior to the reform, in 1999, in 36 large and medium-sized cities, water cost 0.14 USD. Water fees accounted for only .5 percent of household income, well below the commonly used 4% affordability benchmark and even substantially lower than the rates charge in other developing and transition economies (Figure 2).

INSERT FIGURE 2 HERE.

After the reform prices increased, their levels reflected availability of demand for water. The prices on December 2010 in all capital cities are reported in Table 2 and 3.

INSERT Table 2 and 3 HERE.

The level of the water supply tariff is set by prefectures. Wastewater treatment fees are levied by the provinces. The current levels of the wastewater treatment fees – ranging USD 0.02 to .07 in the select cities in table 1 – fall below the actual cost of a secondary wastewater treatment plant (US Department of Commerce, 2005).

Twelve cities have introduced a three-tier progressive volumetric pricing scheme, which affects municipal and industrial users. Shanghai is expected to transition to volumetric water pricing in the second half of 2006 as well. Differential rates are applied to three classes of residential users according to the volume of water consumption: below 180, 180 to 300 and over 300 cubic meters per month. Eighty percent of households fall below the180 threshold (*Shanghai Daily*, June 23, 2006).

In rural areas, low water prices undoubtedly contribute to inefficiencies in irrigation water use. At low cost of irrigation, farmers' incentive to conserve water are weak. At the same time, low prices have interfered with cost recovery and have not been able to support infrastructure maintenance and rehabilitation. Farmers' irrigation costs consist of a combination of two or three of the following four components: payment to water authorities for water supply;

payment to collectives for the construction and maintenance of local water irrigation infrastructure; cost of water pumping equipment and power; and the water resource levy (Yang, 2003).

Irrigation takes two forms according to the source of water: surface irrigation and ground water irrigation. Provincial governments levy flat area-based charges on surface water irrigation. The charge for groundwater irrigation consists of a fixed fee farmers have to pay in order to dig a well. These irrigation fees have been steadily increasing, but have not been able to dampen the demand for water; instead these fees give water administration as well as the farmers the reason to increase consumption of water.

Recall that water bureaus finance administrative expenditure – most importantly the payment of staff salaries - from water fee revenues. Consequently, water bureaus have a strong incentive to increase rates and to expand water supply in order to maximize revenue.

From the farmers' point of view, the current system of water charges fails to give an incentive to conserve water. The flat fee on irrigation taxation – based on the size of the irrigated plots – severs the link between the payment for water and the amount of water consumed. This is why increased irrigation tariffs have failed to induce farmers to switch to more efficient irrigation technologies. In fact, Yang et al. (2003, p. 155) argues that the effect of the increasing flat irrigation charges has been to (a) lower the profit margins of the agricultural producers, for which they sought to compensate by (b) increasing water consumption instead of reducing it. On these grounds, it is absolutely necessary to combine increased water pricing with volumetric calculation of irrigation charges. Emphasis on more effective collection of water fees can raise the water revenue, but will fail to improve water conservation.

Levies on groundwater use are one-time charges on the drilling of the wells and do not establish any correspondence between the cost of water and the volume used. However, by contrast with surface water irrigation, the farmers using groundwater irrigation (a) have more control over the volume of water use and the choice of water withdrawal technologies; and (b) have de fact control over the water resource with a much clearer sense that efficient water use will allow longer use of the resource. In groundwater irrigation, excessive water use is more due to the lack of monitoring over well-digging and restrictions on the volume of groundwater use must be integral to any fiscal policies. However, the enforcement of the well fees has been weak and the groundwater use has been determined solely by farmers' financial constraints and the availability of water. As a result, groundwater irrigation remains poorly regulated and generates little public revenue.

Recently, in a number of irrigation districts water markets have been introduced, when farmers can prepay for given volume of water (minimum 10 cubic meters). Farmers then can sell their water use rights for that amount to other farmers. Water markets then contain a mechanism which can encourage more sustainable water use. However, in most cases the extent of the market is limited by the size of the irrigation district, due to the physical limitations of the irrigation infrastructure. Local governments in the Heihe river basin have introduced subsidies on water-saving irrigation methods in the amount of $632/ha for pipe irrigation and $1,807/ha to encourage sprinkle and drop irrigation (Chen et al., 2005). These subsidies should be better targeted to poor farmers.

Non-linearity in the price elasticity of water demand indicates that beyond a certain threshold price increases can lead to disproportionately large rise in water reuse. This suggests that price increases should be sizable to stimulate water reuse; however, in order to protect the

welfare of the poor households, a safety net should be designed, centered on targeted transfers/subsidies. Transfers should be calculated on the basis of household (or per capita) income or consumption and not on the basis of water user.

To summarize, (1) prices on water have been steadily increasing from the very low levels which could not sustain any meaningful level of expansion, or even maintenance, of infrastructure. (2) Price increases on irrigation water did not reduce consumption because the charge was related to area irrigated and not the volume of water; consequently, introduction of volumetric pricing in irrigation is necessary. (3) In urban areas progressive volumetric pricing in being introduced. (4) In agriculture, increasing water fees without an opportunity to modify consumption is likely to seriously undermine the profitability of agricultural production and lower the living standards in the countryside. (5) Introduction of subsidies for efficient irrigation methods is also an effective mechanism. (6) In groundwater irrigation, there are substantial efficiency gains to improved monitoring and enforcement of licensing.

VI. Provision of Water Services and its Impact on the Poor

Reforms in the water sector have been underway to resolve shortages in water supply and inadequate water quality. Reforms involve multiple dimensions, numerous institutional actors and stakeholders. They have direct and indirect effects on the poor. On the one hand they can directly improve (or worsen) their access to water services; and on the other, the manner in which the reforms are implemented – the costing of water services, subsidies (or lack thereof) to poor households, etc. – will affect the cost of living and the welfare; yet thirdly, reforms in the water sector will have economy-wide repercussion, especially for the growth in agriculture.

Increased pricing of water can raise the supply and quality of water, if tariff increases are introduced wisely. To the extent that improved cost recovery will increase construction of new water delivery infrastructure and improve operation and maintenance (O&M) of the existing facilities, increasing water fees – especially if the pricing is progressive volumetric – can improve equity in the access to water services. As Hussein (2004) points out, low uniform water charges lead to underinvestment in the irrigation infrastructure leading to overall deterioration of water supply, which becomes particularly inadequate at the tail ends, i.e. in underdeveloped remote locations, those where poverty is particularly pervasive (World Bank, 2001, World Bank, 2003).

However, they can directly worsen the condition of the poor as they raise cost of living. Water price increases can also slow down the growth in those sectors of economy which heavily rely on water, most importantly in agriculture, where the profit margins are narrow (Ministry of Agriculture, 2000) to begin with, and where the poor are predominantly employed. Therefore, while price reform is necessary it should be complimented with (a) public transfers toward the poor and (b) commitment to ensure equitable access to improved water supply by the poor.

Not surprisingly, the poor are disproportionately affected by water scarcity and lack of sanitation. Between 1990 and 2002, the access to improved water source had grown 10 percent for the country as a whole; by 2002, 77 percent of Chinese had access to an improved water source and the sanitation coverage rate reached 44 percent (up from 24 in 1990). Nevertheless, there is a sizable urban-rural gap in access to these services.

In the rural areas the problems of inadequate access to drinking water and sanitation are more acute than in the urban areas. In 2002 in the urban areas, the rate of access reached 92 percent, while in the rural area it was around 68 percent; sanitation coverage rate in the rural

areas was less than ½ of the urban rate in 2002, 29 versus 69 percent, respectively (WHO-UNICEF, 2006). To the extent that poverty is concentrated in rural area, the urban – rural differential in access to water and sanitation disadvantages the poor.

Among rural residents the poor are still more disadvantaged - according to the 2000 China's National Bureau of Statistics (NBS) rural household survey, 65 percent of rural households had access to safe drinking water, while among the rural poor[9] the rate of access was 58 percent (ADB 2004). [10] The same survey reveals dramatic regional variation in the access of the rural poor to water resources. While in Tianjin, Beijing and Liaoning over 90 percent had access to safe drinking water, in Tibet, Guizhou and Chongqing, the access rates were 5, 21, and 26 percent respectively. Van der Tak (2002) estimated that in the aggregate water scarcity and pollution disproportionately affect the poor with 30 percent of the impact of water pollution and scarcity concentrating on the poor,11 affecting 260 million of China's poor.

In the urban areas the problem of access is less severe. Nevertheless, despite a nationwide increase in access to water, in the urban areas access rates dropped 9 percent between 1990 and 2002. Urbanization has outpaced provision of adequate water service. Among urban residents, migrants from the rural area are most heavily affected by the lack of access to water. They settle in areas with poor housing which often remain disconnected from the city water grids. This has been largely recognized in China's national poverty reduction strategy. From the outset, the 8-7 Poverty Reduction Program[12] included provision of drinking water for people and

[9] The poor are defined as people living in households with per capita consumption expenditure below 860 yuan.
[10] By contrast, the rates of access to electricity among the rural poor and non-poor were not significantly different, 97 and 98 percent respectively (ADB 2004), reflecting the fact that provision public services which required substantial infrastructure investment expanded at a slower pace. Public infrastructure construction relied heavily on sub-national governments' budgets which lacked scale to undertake substantial lumpy investments.
[11] Van der Tak (2002) defined households as poor if their expenditure fell under $1.25 per day
[12] In 1994, the government introduced the "8-7 Plan" (National Plan for Poverty Reduction), aspiring to lift the majority of the remaining 80 million poor above the government's poverty line during the seven-year period 1994–2000.

livestock in the officially designated poor counties as one of its objectives Sangui et al. (2004) reported that during the years of the 8-7 Program, drinking water for 53.5 million persons and 48.4 million animals in the officially designated poor counties.

Most of the investment in rural water infrastructure under the 8-7 Program was carried out through the food-for-work initiative. 10 billion RMB in central government funds was invested into the expansion of cultivable land and small scale irrigation systems; and 3.5 billion RMB were invested in digging wells, building pipelines, collecting rain water and building dams or small ponds for drinking water; additional 1.5 billion RMB were spent on controlling soil and water erosion along small rivers; and 9 billion RMB went into road construction, which also improved access to water.[13]

Although the impact of the food for work (FFW) programs is undeniably important, these programs suffered from under-financing due to the lack of counterpart funds. Undoubtedly, the contribution of the food for work program to rural infrastructure development and maintenance has been significant. Nevertheless the program has suffered from excessive devolution of financing responsibilities to sub-national governments. While the central government financed inputs to infrastructure development, provincial and county government have to provide matching funds for the labor contribution. Frequently budget constraints limit their ability to fund the labor costs and have tried to compensate for the lack of finances by recruiting voluntary workers, counting the time worked on FFW projects toward the work day contribution requirement.

[13] As a result, 30 million mu of improved land and 40 million mu of land with new or improved irrigation were added, solving the drinking water problem for 30 million persons and 40 million animals; the soil and water erosion of 30 thousand sq. km of land was treated, and 100,000 km of roads were constructed or received maintenance (NBS, 2001).

Welfare effects of increased water charges

OECD's (2004) affordability analysis of increased municipal water charges in connection with prospective wastewater treatment construction in Sichuan province indicates that affordability was not a real concern (see table 4). In the 14 towns and cities they studied the current water charges in 2000 accounted for .6 to 3.1 percent of household income and in most towns the share was below 2 percent. The share of water fees in the income of the bottom decile was above the 4 percent affordability threshold in the majority of the location. In two locations 40 percent of the population fell below the affordability threshold. Clearly increase in the price of municipal and residential water will disproportionately affect the bottom deciles of the population.

INSERT TABLE 4 HERE

According to the World Bank's survey conducted in Sichuan province residents in connection with the Sichuan Urban Environment Project, revealed reasonable willingness to pay for water charge increases (World Bank, 1999). Conceivably willingness to pay will increase as household incomes grow and if users notice improvements in service delivery as result of increased water fees.

Irrigation taxation in its current form negatively affects the average growth in the agricultural sector and also has an unfavorable effect on agriculture. We have already noted that price elasticity of irrigation water demand is very low, leading to increased consumption of water by the farmers in response to the flat water fee increases. Unable to lower their water costs by reducing water use, the farmers have to seek to offset the negative effect of the fee increase on their agricultural incomes through more intensive irrigation. The farmer faces a choice between a more intensive water use and lower profitability and decline in welfare. Therefore, the flat

irrigation fee can potentially reduce the welfare levels in the rural sector, contributing to rural poverty.

As a result of inadequate fiscal structure of the water administration which does not deliver the benefits to those who bear the cost of irrigation, there are serious equity concerns. Not only do the water charges cut into farmers' incomes, they do not deliver the public good they purport to finance and consequently amount to income redistribute away from the rural population (farmers and farm employees) who are already economically significantly more disadvantaged than their urban counter parts. This is yet another[14] instance of regressive distribution of public benefits.

Overall, in terms of water service delivery, we observe the following regularities: (1) Rural areas have lower access to improved water supply and sanitation than the urban ones. (2) At the same time the coverage rate in the urban areas has dropped considerably since 1990, indicating that cities have grown faster than their water supply systems. (3) Deficiencies in the urban water supply likely affect the migrant population disproportionately. Migration to large urban centers (Beijing, Shanghai, and Tianjin) has been increasingly unsustainable and measures should be taken either to discourage it or to direct the rural migrants to smaller cities. (4) Poverty Reduction Strategy has been successful in improving water service infrastructure in the designated poor counties, but its contribution is confined to small-scale interventions which could be accomplished by the efforts of the unskilled village or township population labor force; constraint of local budgets could not accommodate sizable investment requirements of large water infrastructure which could exploit economies of scale.

[14] Historically, the below-market mandatory pricing of agricultural products amounted to a regressive net tax on the rural population and a subsidy for the urban residents, who benefited from low cost of food.

VII. Policy Recommendations

The central concern of the water public administration strategy is to address water scarcity. For environmental reasons, measures which purport to manage demand for water should be emphasized. Alleviation of water scarcity will benefit the poor, but the current distribution of access to water supply and sanitation warrants concerted efforts – like the one undertakes within the Poverty Reduction Strategy framework – to target poor areas. However, efforts should be made to provide sufficient funding for targeted infrastructure construction in poor areas to enable construction of facilities capable of exploiting economies of scale.

Additionally, water management should account for a number of vulnerabilities in provision of water service: lower access to water supply and sanitation in rural areas than in urban ones; declining coverage rate in the urban areas which suggests that cities have grown faster than their water supply systems; and deficiencies in the urban water supply which are likely to affect the migrant population disproportionately. Migration to large urban centers has been increasingly unsustainable and measures should be taken either to discourage it or to direct the rural migrants to smaller cities.

Management of demand for water should be carried out within a comprehensive framework which eliminates technological, organizational and institutional inefficiencies through a series of reform, without over-reliance on price mechanisms alone. The direct costs of eliminating inefficiencies – especially institutional and organizational ones – are likely to have lower direct cost for the poor.

Low-cost Efficiency Improvements

Apart from concerns about affordability and equity of the effect of price increases, the analysis in the previous sections point to several reasons why price increases may not promote water conservation. Specifically, relatively low-cost efficiency improvements suggested by the analysis above should include the following measures:

First, with regard to agricultural technologies, use of more environmentally friendly pesticides and fertilizers could be subsidized. Second, in terms of financing, improve expenditure assignments between levels of government to correct incentives and to enable scale-appropriate investment. Further define property/use rights to water in ways which enable profitable operation of water facilities. Third, a series of steps are necessary to enhance governance in the public sector: (a) limit the control of municipal governments over the revenue flows of wastewater treatment enterprises; limit the ability of local water bureaus to finance its operating costs directly from water charges (even though a certain relationship between the amount of revenue collected and the amount of revenue appropriated could be necessary to stimulate collection rates – a tax farming arrangement of a sort) at the expense of financing infrastructure. (b) Eliminate overlapping mandates of different government agencies. (c) Further support water user associations, giving them specific mandates, especially with regard to collection of water fees. (d) Expand the practice of water markets in pre-paid water-tender. (e) Further explore the option of allowing farmers to trade or exchange their water rights across irrigation districts. (f) Increase monitoring and enforcement of licensing in groundwater irrigation. (e) Overstaffing in the public water sector raises the issue of downsizing which has not affected this sector all that much; this problem will have serious welfare implications for he laid-off, but the excess labor

force can be in part absorbed by the expanding investment in infrastructure and the growth of the public sector.

Finally, as for business environment, create a possibility for private domestic and foreign participation. Participation of foreign partners in Build-Operate-Transfer (BOT) deals could be particularly advantageous, given that the user-pays financing options are not affordable or look problematic on equity grounds, and the option of "creditor-pays" seems more feasible. Anecdotal evidence suggests that user-pays-like schemes which include the cost of prospective water infrastructure construction in current water bill requires better governance practices at the municipal level.

Water Pricing Policy

Even with all the efficiency improvements, demand management using price adjustments is a necessary option. Water pricing policy should have the following features. (a) Pricing of water in irrigation should be volumetric to give an incentive to farmers to conserve water (current price is base on irrigated area) and to avoid squeezing farm profit margins too tight lest to discourage rural growth. Apart from the obvious welfare effect rural growth slows down rural-to-urban migration. (b) The practice of volumetric pricing in urban area should be extended and variable block tariffs used. (c) Subsidies to low-volume users – specifically progressive block charges – are effective from the point of view of reducing water demand, but are not necessarily sensitive to welfare levels. Poor households already consume water at the subsistence levels and cannot save by further reducing consumption. This is also problematic on the grounds of fairness: is it not unfair to demand that those who are already disadvantaged reduce consumption of such basic goods as water? Additionally, the results of the water cost

affordability study indicate that even with a reasonable block tariff structure, bottom deciles are disproportionately affected by the price increase. We also know that income inequalities have been steadily growing in China over the last few years, to promote equitably affordable water use the structure of block tariffs would have to be revised to account for such distributional changes, which will likely be politically difficult and organizationally cumbersome. All of this suggests that subsidies based on the volume of consumption should be complimented by targeted welfare-based subsidies.

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Appendix

Table 1. Water resource and economic development in China provinces in 2008

	Water resources per year per capita /cube meter	GDP per capita / USD
Tianjin	127	4332
Shanghai	140	5710
Ningxia	186	1397
Beijing	207	4922
Hebei	276	1815
Shandong	323	2583
Shanxi	349	1593
Jiangsu	430	3094
Henan	432	1530
Liaoning	763	2441
Gansu	1053	946
Shaanxi	1146	1425
Anhui	1163	1131
Jilin	1441	1836
Hubei	1789	1551
Zhejiang	1845	3296
Guangdong	1915	2935
Chongqing	1974	1408
Heilongjiang	2052	1697
Inner Mongolia	2168	2516
Hunan	2665	1368
Guizhou	2768	689
Sichuan	3175	1201
Fujian	3261	2352
Jiangxi	3514	1154
Hainan	3607	1341
Guangxi	3947	1169
Xinjiang	3977	1553
Yunnan	4828	983
Qinghai	11391	1358
Tibet	155924	1082

Source: Wu Peilin, Han Xue, Zhou Jinghua (2010), Regional Difference of Water Resource Stress in China: An Analysis Based on the Overall Well-Off Society Development Objective.

Table 2. Tap Water Price (RMB/ M^3)

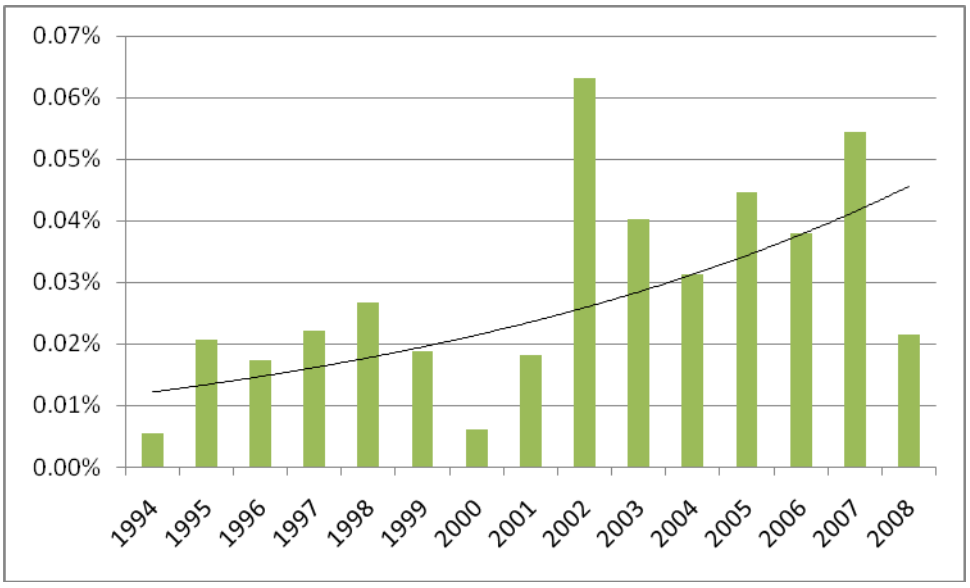
Capital City	Province	Residents	Secondary Industry	Administrative Units	Tertiary Industry	Special Industry
Hefei	Anhui	1.55	1.8	1.8	1.81	7.24
Beijing		2.96	4.44	4.12	4.66	60
Chongqing		2.7	3.25	2.7	3.25	3.25
Fuzhou	Fujian	1.7	1.9	1.9	1.9	3
Guangzhou	Guangdong	1.32	1.83	1.61	2.71	3.38
Nanning	Guangxi	1.48	2.23	2.23	2.23	5
Guiyang	Guizhou	2	2.5	2.5	3.3	10
Haikou	Hainan	1.6	2.5	1.8	2.5	2.5
Shijiazhuang	Hebei	2.5	3	2.8	3.5	24
Harbin	Heilongjiang	2.4	4.3	4.3	4.3	16.4
Zhengzhou	Henan	1.6	2	2	3	9.2
Wuhan	Hubei	1.1	1.65	1.5	2.35	4.8
Changsha	Hunan	1.21	1.38	1.21	2.2	4.2
Huhhot	Inner Mongolia	2.35	3.5	3.5	4	20
Nanjing	Jiangsu	1.5	1.85	1.7	1.85	2.95
Nanchang	Jiangxi	1.18	1.45	1.45	1.65	6
Changchun	Jilin	2.5	4.6	4.6	8	16
Shenyang	Liaoning	1.8	2.5	2.6	3	10.2
Yinchuan	Ningxia	1.6	2.28	1.75	2.28	18.08
Xining	Qinghai	1.3	1.38	1.65	2	4.5
Xian	Shaanxi	2.25	2.55	2.95	3.4	16.1
Jinan	Shandong	2.6	2.9	2.6	4.3	16
Shanghai		1.63	2	2	2	10.6
Taiyuan	Shanxi	2.4	2.7	2.7	3.5	14
Chengdu	Sichuan	1.7	2.9	2.9	2.9	10.5
Tianjin		3.5	6.3	6.3	6.3	20.7
Lhasa	Tibet	0.6	1.4	1	1.2	1.5
Urumqi	Xinjiang	1.36	1.48	1.48	2.44	8.7
Kunming	Yunnan	2.45	4.35	3.6	4.35	14.1
Hangzhou	Zhejiang	1.35	2.1	2.1	5.15	2.1
HongKong		4.16	4.16	4.16	4.16	4.16
Macao		n/a	n/a	n/a	n/a	n/a
Taibei	Taiwan	n/a	n/a	n/a	n/a	n/a

Table 3. Waste Water Treatment Price (RMB/ M^3)

Capital City	Province	Residents	Secondary Industry	Administrative Units	Tertiary Industry	Special Industry
Hefei	Anhui	0.51	0.59	0.59	0.77	0.77
Beijing		1.04	1.77	1.68	1.55	1.68
Chongqing		1	1.3	1	1.3	1.3
Fuzhou	Fujian	0.85	1.1	0.85	1.5	1.1
Guangzhou	Guangdong	0.9	1.4	1.2	1.4	2
Nanning	Guangxi	0.8	0.8	0.8	0.8	0.8
Guiyang	Guizhou	0.7	0.8	0.8	0.8	0.8
Haikou	Hainan	0.8	1.1	1.1	1.1	1.1
Shijiazhuang	Hebei	0.8	1	1	1	1
Harbin	Heilongjiang	0.8	1.1	1.1	1.1	1.1
Zhengzhou	Henan	0.65	0.8	0.8	0.8	1
Wuhan	Hubei	0.8	0.8	0.8	0.8	0.8
Changsha	Hunan	0.65	0.8	0.7	1.28	1.18
Huhhot	Inner Mongolia	0.65	0.95	0.95	0.95	0.95
Nanjing	Jiangsu	1.3	1.55	1.5	1.55	1.65
Nanchang	Jiangxi	0.8	0.8	0.8	0.8	1
Changchun	Jilin	0.4	0.8	0.8	0.8	2
Shenyang	Liaoning	0.6	1	1	1	1
Yinchuan	Ningxia	0.7	1	1	1	2
Xining	Qinghai	0.52	0.63	0.57	0.95	1.15
Xian	Shaanxi	0.65	0.9	0.9	0.9	0.9
Jinan	Shandong	0.9	1.1	1.1	1.1	1.1
Shanghai		1.3	1.7	1.7	1.7	1.7
Taiyuan	Shanxi	0.5	0.8	0.5	1	1
Chengdu	Sichuan	0.8	1.4	1.4	1.4	4.5
Tianjin		0.9	1.2	1.2	1.2	1.2
Lhasa	Tibet	n/a	n/a	n/a	n/a	n/a
Urumqi	Xinjiang	0.7	0.7	0.7	0.7	0.7
Kunming	Yunnan	1	1.25	1.25	1.25	1.25
Hangzhou	Zhejiang	0.5	1.8	1.5	1.5	1.5
HongKong		n/a	n/a	n/a	n/a	n/a
Macao		n/a	n/a	n/a	n/a	n/a
Taibei	Taiwan	n/a	n/a	n/a	n/a	n/a

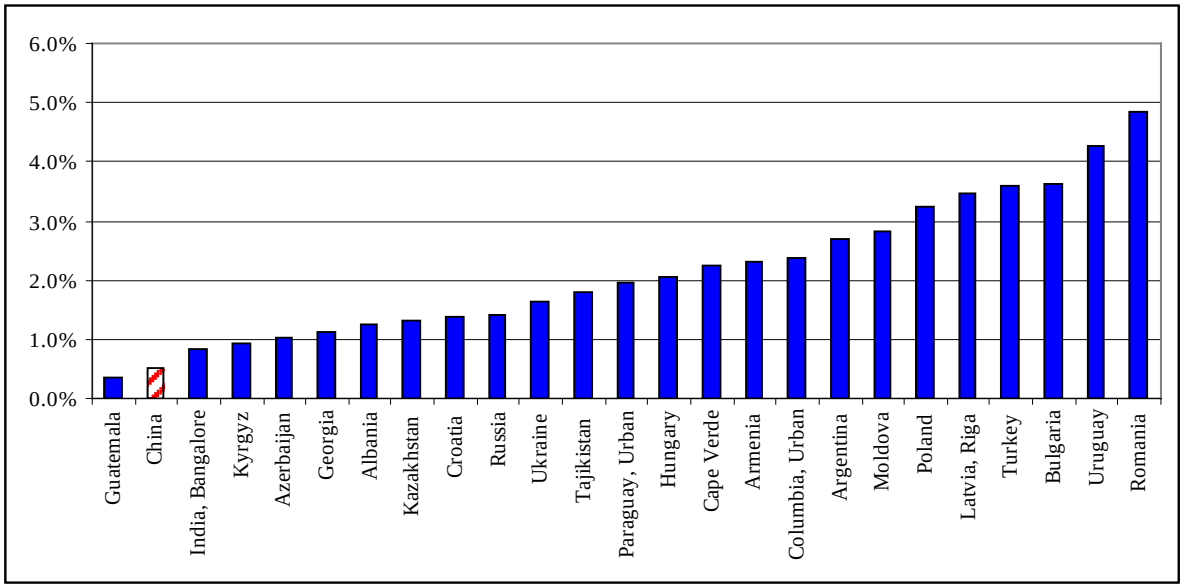
Source: www.price.h2o-china.com.

Figure 1. Private investment in water and sanitation, % GDP



Source: Authors, based on data from World Development Indicators.

Figure 2. Monthly expenditure on water as a percent (%) of household income (1997-2003)



Source: Authors, based on data from World Bank (2005) and OECD (2005).

Table 4. Affordability of combined water and wastewater bills to different income groups in selected cities in Sichuan Province in 2000

		Decile				
	Share of average household income	1	2	3	4	5
Luzhou City	*0.9%*	2%	2%	1%	1%	1%
Leshan City	*1.2%*	4%	3%	3%	2%	1%
Meishan City	*1.6%*	6%	5%	4%	2%	2%
Yibin City	*1.0%*	4%	3%	2%	1%	1%
Changning County	*1.8%*	5%	4%	3%	3%	2%
Gao County	*3.1%*	9%	7%	6%	4%	3%
Zigong City	*2.1%*	6%	4%	4%	3%	2%
Fushun County	*1.5%*	4%	3%	3%	2%	2%
Neijiang City	*3.0%*	9%	7%	6%	4%	3%
Weiyuan County	*0.6%*	2%	2%	1%	1%	1%
Zizhong County	*2.0%*	5%	4%	3%	2%	2%
Ziyang City	*0.8%*	3%	2%	2%	1%	1%
Jianyang City	*1.9%*	5%	4%	3%	3%	2%
Linshui County	*0.8%*	2%	2%	1%	1%	1%

Note: (1) Cell shaded green (orange) indicates the household income deciles, where water and wastewater bills exceeded five (four) percent of disposable household's income. Four percent benchmark is commonly used in OECD countries as the threshold of affordability; the five percent affordability benchmark was recommended by consultants to the Asian Development Bank for China. (2) The share of water charges in the household income of the top 50 percent - not presented here - is less or equal to 3 percent.
Source: Adapted from OECD (2004); simulations by project team.