

A water surcharge policy for river basin management in Korea: A means of resolving environmental conflict?

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Abstract

Conflict between the upstream and downstream residents of four major river basins in Korea has recently intensified. The introduction of a metric-based surcharge for piped water, coupled with environmental regulations, aims to resolve these conflicts. The water surcharge system was introduced both to collect revenue via a levy and to achieve a win-win situation for both upstream and downstream users through two major policy measures: increasing infrastructure investment in wastewater treatment and providing subsidies to upstream residents to compensate for the losses imposed by environmental regulations. A volumetric surcharge is in line with taxation policy as ordinary households are relatively price inelastic. However, the surcharge is an earmarked water consumption tariff for piped water in order to raise revenue, rather than a full-cost based pollution preventive measure. The remaining tasks include the comprehensive reform of the pricing system to promote equity, efficiency and sustainability of water use.

Key words: water charges, river basin management, Korea, Water pollution, Water demand, Water supply, Environmental conflict

1. Introduction

Water resources in river basins have traditionally been regarded as a common good. However, market failure, combined with a failure of governance, often leads to water-related

problems. The nature of water as a common resource tends to result in the excessive depletion/production and consumption of the resource, as well as social costs in terms of pollution. These problems are compounded by a failure of governance. For example, institutional failure, such as poorly established environmental law and a coordination failure between central and local governments about water pollution problems can exacerbate social conflicts.

In order to achieve efficient river basin management we need to consider two different types of users of river flows. One group is consumers such as households, industry and farmers who deplete the water from rivers through their use of the public water supply (this group is often located in the downstream of rivers). The other group is polluters, including industry, livestock and households, which are often located upstream. These two groups of river consumers are in conflict, although both create social costs. Market failure to allocate the common resource (water) efficiently is the main problem for the upstream river users. These users want to use (i.e. discharge pollutants into) water with a view to maximising their individual welfare or corporate profit, without considering the negative impact on the environment. On the other hand, the downstream users want to enjoy clean water without considering the depletion of this scarce resource and the consequent social costs.

An efficient river basin management system needs to consider both of these forms of social cost. There are two options for preventing upstream pollution. One is a command and control (C&C) type of regulatory policy and the other is a market-based system. Prohibition of business activities and the discharge of pollutants are examples of the C&C approach. Market-based measures include a Pigouvian-type tariff system and Coasian-type market creation¹. The Pigouvian model implies internalisation by placing a tariff on water, whereas

¹ We notice that price policy is not a panacea. There certainly is not a place in the world where the market can resolve tradeoff issues at the total wholesale level of the river and this set of multiple uses needs administration and politics. We appreciate Jerome Delli Priscoli and referee's comments on this issue.

the Coasian school recommends the creation of property rights over common resources as well as a market for their transfer, in order to resolve conflicts among competing users (Coase 1960). Institutional economists are also concerned to minimise transaction costs and advocate reforms in governance in areas such as water law, policy environment and management (Picciotto 1995; North 1990).

A charge/tariff on publicly supplied water is regarded as the main measure for reducing the social costs incurred by downstream river users². Such a tariff system can be divided into a fixed charge, a variable charge and a hybrid-type non-linear charge. Under a fixed charge system, consumers pay a fixed amount regardless of the quantity of water they consume. Such a scheme is simple, but it cannot control the inefficient use of water. Under a variable charge system, consumers pay a tariff based on their rate of consumption. This may promote the efficient use of water, but fluctuations in revenue may damage the security of the public water supply. Non-linear pricing measures include two-part tariff and increasing block tariff (IBT) schemes. A two-part tariff scheme is a combination of a fixed charge (i.e. an access fee) and a consumption-based variable charge (i.e. a usage payment) (Oi 1971; Cassou & House, 1999). IBT is a modified two-part tariff as it breaks down the variable component further, so that one price is charged for the first block of water, the unit price increases to the next level for the next block and so on. These non-linear pricing systems are considered more advanced than the previous two approaches as they promote the efficient use of water as well as creating a stable source of revenue if administrative costs are not high.

South Korea (hereafter Korea) has traditionally considered water to be an unlimited natural resource. A wasteful person is described as “spending money like water”. Therefore, in a similar vein to the riparian doctrine, there was little social concern about the allocation and management of national water resources. However, the perception of water has changed

² Upstream residents and industry also use the publicly supplied water. However, major residential areas such as metropolitan cities are often located in the downstream regions of the river.

significantly recently as water-related conflicts have intensified. The main objective of this paper is to investigate changes in the management of four major river basins in Korea. The paper is particularly concerned with an assessment of the surcharge for piped water to domestic users that was introduced as part of the Comprehensive Countermeasures for Improving Water Quality in Four Major Rivers that were announced in 2002 (Ministry of Planning and Budget, 2002a). Korea has begun to introduce a surcharge for piped water since 1999 when the government announced the Han River Special Law to improve the quality of water in the river. The unique features of these surcharges are that they are levied on end users and they are earmarked tariffs.

The following section outlines the nature of the problem in terms of supply and demand and the maintenance of quality. Section 3 discusses three major water price reforms and Section 4 presents an assessment of the reforms and outlines the remaining issues relating to price reform. The conclusions are presented in Section 5.

2. The problem

2.1 Supply-side issues

Korea has to deal with the problem of decreasing water availability per capita³ and this is an issue that has concerned civil engineers in Korea (Shim *et al.*, 2002 and references therein). The total annual runoff in river basins and damming of the rivers have been the main concerns in ensuring both the supply of fresh water and flood prevention.

Table 1 shows that water availability per capita is expected to decrease sharply by 2021. This is mainly attributable to population increase, given the marginal flexibility of supply. Total water supply in 1993 included supply from river flows (53%), reservoirs/dams

³ Water can be divided into real water and paper water (California Department of Water Resources, 1993). The water availability problem is largely related to the absolute amount of wet water and the reuse of wastewater. Wet water, or real water, refers to water available for transfer between competing users without incurring costs to another legal water user. The opportunity cost of this transfer is nil. Examples include the transfer of stored water from a reservoir to other users. On the other hand, paper water refers to transfers of water that are accompanied by an opportunity cost. Diversion of river flows is an example.

(41%) and river and groundwater (6%). The table indicates that total water availability per capita in Korea increased marginally from 7.0 to 7.1 metric tonnes/capita between 1993 and 2001, but will then decline continuously, to 6.4 metric tonnes/capita by 2021. Meanwhile, the population is projected to grow from 44.2 million in 1993 to 52.4 million in 2021.

Historically, the concept of supply-side policy began from an understanding of water in terms of “shortage”, implying that access to a given quantity of water was a basic human requirement (Hoekstra, 1998). This traditional supply-side approach may still be justifiable where there is a shortage of water to meet basic human requirements such as drinking and cooking.

There are three major limitations to this approach. Policy emphasis on the supply side ignores the need for conservation of water by controlling demand. It also has the potential to damage the environment. For example, the impact of damming on the environment and the ecological system are still controversial and the impact of pumping underground water on aquifers has yet to be known. Thirdly, a supply-side policy often requires a large amount of capital-intensive investment, so its implementation tends to take time. The Korean government plans to construct 12 small and medium-sized dams by 2011. However, environmentalists and local residents oppose this plan. Politicians’ awareness of this opposition and the large amount of capital required (an average of 20×10^9 won for a small to medium-sized dam [US\$1 = 1,200 won]) are further constraints. Korea has not constructed any dams since the Tamjin dam in Changheung in 1992.

2.2 Demand-side issues

Table 2 shows the projected trends in total water demand by sector in Korea between 1993 and 2021. Total water demand including piped water is projected to increase from 29×10^9 tonnes in 1993 to 37×10^9 tonnes in 2021. Agriculture is currently the highest

consumer of water (53% of total demand), followed by sectors such as maintenance (20%), domestic users (18%) and industry (9%).

The table also indicates that domestic and industry demand will rise sharply, while demand from agriculture will decline marginally. In 1993, the level of demand from the domestic sector was 5.3×10^9 tonnes, equivalent to 18.3% of total demand. Domestic and industry demand is projected to increase by 79.3% and 61.5%, respectively between 1993 and 2021.

Data combining supply and demand factors in the table indicate that Korea will have a water scarcity problem from 2011, although these figures do not take into consideration the planned construction of dams and may therefore be overestimates⁴. The table shows that demand for water will be greater than supply by 2.5×10^9 tonnes in 2011 and by 3.3×10^9 tonnes in 2021. These figures confirm that a growing population, combined with urbanisation and expanding industrial activity, will continue to put pressure on the water supply in Korea, given the virtually fixed supply capacity of water. The water supply capacity is projected to grow by 8.7% per annum, with total demand growing by 27.6% over the same period.

The ratio of annual water withdrawal to annual water resources in Korea was around 45% in the early 1990s (OECD, 1994). A study commissioned by the UN Commission on Sustainable Development defined water scarcity in terms of the total amount of annual withdrawal as a percentage of annual water resources. This criterion identifies a water scarce country as one in which annual withdrawal exceeds 40% of annual water resources. According to this criterion, Korea has had a water scarcity problem since the early 1990s.

2.3 Water contamination

⁴ Korea currently plans to construct 12 small and medium-sized dams by 2011. These are Hantankang Dam, Bamsumgol Dam, Soksa Dam, Sonriwon Dam, Okkye Dam, Whabook Dam, Ian Dam, Jicheon Dam, Kamcheon Dam, Ahnui Dam, Jucksung Dam and Pyungrim Dam. Internal data from the Ministry of Transportation and Construction indicate that water scarcity will be -1.8×10^9 tonnes in 2011 and -2.6×10^9 tonnes in 2020.

Table 3 shows projected wastewater emission by sector in Korea between 1988 and 2001. Total wastewater emission from the domestic sector, industry and livestock increased by 51.6%, from around 13.6×10^6 tonnes/day in 1988 to 20.6×10^6 tonnes/day in 1993. Domestic sewerage was the main source of wastewater, followed by industry. The shares of domestic sewage and industry in total discharges in 1988 and 1993 were around 70% and 25%, respectively.

The table indicates that the share of domestic emissions has been declining overall, but that the share of industry has been increasing. Wastewater discharged by households was around 10×10^6 tonnes/day in 1988, but had increased to 15×10^6 tonnes/day in 2001. The table also indicates that, despite the growing population, the proportion of domestic sewerage per capita continuously increased until 1993 before dropping somewhat in 2001. In the meantime, industrial discharge has increased from 3×10^6 tonnes/day to 7.9×10^6 tonnes/day. The share of livestock was relatively small (less than 1%) and shows an overall declining trend.

3. Conflict and reform

3.1 Water pollution and conflict

Figure 1 shows the trends in water contamination, measured by biological oxygen demand (BOD), which refers to the amount of oxygen that bacteria in water will consume in breaking down waste, in the four major river basins between 1990 and 2001. Overall, the data confirm that none of the four river basins meets the conditions for potable water supply Class 1, which requires a level of 1 BOD or less. Water quality in the upstream was better than it was downstream, where it has deteriorated particularly since 1998. Water in the upstream, except in the Nakdong River, approached potable supply Class 1 by the end of 2001. However, levels of BOD in the downstream ranged between 3–4 (Han River), 3–7 (Nakdong River), 2.5–5 (Kum River) and 4–7 (Yong San River).

The level of pollution in the Han River Basin *vis-à-vis* other areas has been relatively good⁵. Paldang Dam and Noryangjin are two major sources of piped water for Seoul, Korea's capital. The quality of water in the upstream (Paldang Dam) fell into potable supply Class 2 between 1990 and 2001. However, this figure indicates an overall deterioration in the upstream quality. While the levels of pollution fluctuate, the downstream (Noryangjin) seemed to fall into potable supply Class 3 in all years but 2000. The consistently high level of pollution in the upstream seemed to affect adversely the quality of water in the downstream.

The figure also confirms that pollution was most serious in the Nakdong River and the Yongsan River. The Nakdong River supplies water to Busan, Korea's second largest city and Daekoo, its third largest city. In particular, BOD levels in Koryong region on the Nakdong were nearly five times higher than in Paldang Dam on the Han River during the 1990s. This extreme level of pollution in the downstream was attributable to the location of cities and the large number of textile factories in the upstream. The water quality in the downstream of the Yongsan River basin failed to meet the BOD level for potable Class 3 and this was largely due to poorly installed waste treatment facilities.

Conflicts between residents in upstream and downstream areas have intensified owing to the scarcity of good quality water and are exemplified by the conflict between Busan and Daekoo residents. Busan residents have consistently complained about the quality of their water and asked the government to introduce special measures to assist them. Upstream residents, including those of Koomi and Andong in the Nakdong River basin, opposed the enactment of the 2001 special law. Their major concern was the economic losses that would be brought about by environmental regulations. In particular, the upstream of the Nakdong

⁵ The Han River Basin occupies a drainage area of approximately 26,200 km² in the central portion of the Korean peninsula, with annual discharges of around 18,000 million cubic metres (mm³) (Shim *et al.*, 2002). Average annual precipitation over the basin is 1,294 mm, with 65% of this total concentrated between June and September.

River has a number of industrial complexes, including one of Korea's largest textile industry complexes in Daekoo and another industrial complex in Koomi.

The local residents established a special committee to lobby the government and argued that the environmental regulations introduced by the central government could inhibit the development of the local economy (*The Chosun Daily*, 1 December 2001). The issue of developing the Wee Cheon Industrial Complex in the middle section of the Nakdong River has been unresolved for years owing to this conflict between upstream and downstream residents.

3.2 Water charges

Korea has announced three important water pricing policy reforms in order to resolve such conflicts and improve water quality along the four major river basins. The first was the Comprehensive Water Management Countermeasures policy of 1996. The 1996 countermeasures were introduced in preparation for Korea to join the OECD. While this policy did not directly target the four major river basins, it encouraged the improvement of economic instruments to prevent and/or resolve conflicts over water. As a result, 59 of 167 local governments abandoned minimum fixed charge schemes and re-introduced volume-based water charges. In particular, the basis for access fees has changed from a fixed amount to one based on the size of the water pipe⁶.

The second reform was the Han River Special Law of 1999. A volume-based water charge system for publicly supplied water along the Han River Basin was introduced in that year. The surcharge rate has remained at 110 won per tonne since its introduction. Surcharges for piped water were levied on residents in the downstream section of the river such as Seoul, whole regions of Incheon City and 22 municipalities in Kyung Ki Province. As a result, the unit water price increased from 260 won/tonne to 370 won/tonne and payments for water

⁶ The price of piped water is determined by local governments while the central government (Ministry of Environment) provides general guidelines for the pricing structure.

consumption by an average four-person family have increased by 42.3%, from 6,168 won/month to 8,775won/month (Table 4).

The third measure was the Comprehensive Countermeasures for Improving Water Quality in the Four Major Rivers, which was announced in August 2002 (Ministry of Planning and Budget, 2002a). As in the case of the Han River, a water surcharge was introduced. The surcharge rates along the Nakdong River basin, the Kum River and the Yong San River are 100 won/tonne and 120 won/tonne, respectively. As a result, the unit water price per ton will increase from 290 to 390 won/tonne in the Nakdong River region, from 275 to 395 won/tonne in the Kum River and from 323 to 443 won/tonne in the **Yong San•Sum Jin River** (Table 4). The table also indicates that the countermeasures introduced in 2002 mean a higher price for publicly supplied water (piped water) by 34.4 to 43.8% for an average four-person household.

These comprehensive measures were based on special laws for water quality management in the Nakdong River, the Yong San–Sum Jin and the Kum River, which were passed in the parliament in December 2001. While the title indicates that the measures relate to the four major rivers, they actually excluded the Han River basin where a water surcharge was introduced by the Han River Special Law in 1999. Water from the Nakdong River basin is supplied to Busan metropolitan area (downstream), Daekoo city (upstream), Ulsan city (upstream) and 27 municipalities. The funds generated by these surcharges will be pooled in the newly created Han River Water System Management Fund (created in August 1999), the Nakdong River Water System Management Fund, the Kum River Water System Management Fund and the Yong San River Water System Management Fund created in July 2002. The Ministry of Planning and Budget will control the funds.

3.3 Environmental regulation

The countermeasures based on the laws introduced in 2001 also strengthened environmental regulations. Major measures include the introduction of regulations relating to the total amount of pollutants from June 2004 for metropolitan cities, from June 2005 for other cities and from June 2006 for local municipalities in the Nakdong River region (see Appendix 1). The situation is similar (with a marginal time lag) for the Kum and Yong San Rivers but different from the Han River.

The law also requires the designation of special monitoring areas in the upstream region to prevent pollution from business activities. It prohibits the construction of a restaurant, hotel, motel, public bath facility, factory or cattle shed within a range of between 300 m and 1km from the upstream river flows. Farming with pesticides and fertilisers is also prohibited. In particular, in order to prevent pollution from non-point polluters, the law requires the compulsory establishment of a “green belt area”, which includes the establishment of artificial damp, grassland and a green track of land when new development projects are planned in the Nakdong River region. The Nakdong River Special Law also requires the installation of infrastructure for a “buffer zone” to contain industrial wastewater from the Daekoo industrial complex until the level of water quality in the downstream improves.

4. Assessment and remaining issues

4.1 Conflict resolution

The case of water charges in Korea indicates the possibility of a cooperative solution to the conflict between upstream and downstream residents. The central government played a key role in resolving the conflict, aiming to both strengthen environmental regulations and provide a cross-subsidy for affected residents. Funds generated by the charges to domestic consumers along the river basins are intended to be used for “income compensation” for upstream residents who have suffered financial losses because of the environmental

regulations. Around 25% (129.8×10^9 won) of the funds generated will be allocated for this purpose.

The level of the water charge was determined by a special committee, but it is the responsibility of local (municipal) governments to collect the charge from households (Appendix 1). The special 2001 law that provided the foundation of the 2002 countermeasures was initiated by the Ministry of Environment in 1999. The Korean government established a Watershed Management Committee, comprising the minister of the Ministry of Environment (Chair), a vice minister of the Ministry of Transport and Construction, premiers of local communities (large local units) and the president of the Korea Water Resource Corporation. The law does not allow for the participation of local residents in the management system, but has provision for the establishment of an advisory committee to hear the views of local residents. The Ministry of Planning and Budget has the responsibility of imposing the levy and collecting the revenue.

In addition, in response to complaints from residents in the upstream region, the law allows the mayors of metropolitan cities and the governors of provinces to modify the required level of water quality determined by the Ministry of Environment.

4.2 Improving water quality

The nature of the charge for piped water is fundamentally an earmarked consumption tariff rather than a Pigouvian instrument. The government specifically aimed to raise revenue for environmental infrastructure investment and to provide a cross-subsidy. The revenue from the water charges for the four major rivers including the Han River is expected to be around 530×10^9 won (US\$1 \cong 1,200 won). These funds will be allocated to improve the quality of water in the river basins. The government plans to raise the quality of water in the four major river basins including the Han River to potable supply Class 1 or Class 2 in the upstream areas by 2005 (see Table 5). The total expected cost of this project is around 530×10^9 won

(Ministry of Planning and Budget, 2002c)⁷ and around half of these funds (273×10^9 won) will be used for the construction of environmental infrastructure such as sewerage treatment facilities. The revenue raised from the Han River basin area in 2001 was around 200×10^9 won and has been used for infrastructure investment including sewerage treatment (46.5%) and cross-subsidies (35%).

Despite the 2001 law advocating preventative policy measures, Korea still largely relies on traditional command and control to combat pollution. As outlined in Section 3.3, the special law required the restriction of business activities, particularly in the upstream areas. The target levels of water quality are determined in advance and the upper limits of the discharge load (amount of pollutant \times density of pollution) are set accordingly. In particular, the proposed introduction of environmental regulations based on the total amount of pollutant emission is expected to improve water quality.

Both excess production and consumption cause environmental problems. These problems occur when the marginal social costs incurred by private activities are not included in the agent's cost formula. In other words, individual agents simply ignore the impact of their activities on others and/or society. The discharge of wastewater into the river by upstream residents is one example. The environmental damage caused by damming and pumping aquifers is also still largely unknown and the excess use of water can create salinity problems.

One of the controversial issues in this case is that it focused more on the "treatment" of pollution than on "prevention". Investment in sewerage treatment facilities is for the treatment of wastewater. The imposition of direct charges on polluters may lead them to exploit and/or develop technology to alleviate the problem.

⁷ The estimated funds required for the project in the Han River basin were 263.4×10^9 won, for the Nakdong River basin 54.3×10^9 won and for the Yong San/Sum Jin River basin 48.5×10^9 won (*Comprehensive Countermeasures for Improving Water Quality in Four Major Rivers*, Ministry of Planning and Budget, 2002a).

The Pigouvian model emphasises the internalisation of social costs in the private cost function by a government-initiated tariff system. It supports the Polluter Pays Principle for the polluter and a volumetric tariff for the consumer. The **Dublin** Statement on Water and Sustainable Development encourages the exploitation of the price mechanism to resolve water problems (ICWE, 1992). The limitations of the tariff system include government policy failure owing to poor information on the marginal costs and benefits of abatement. The Coasian approach implies a voluntary contract between agents relating to market transactions involving the created property rights over the common resources. The Coasian model also implies that the allocation of rights to either polluter or pollutee has no effect on market outcomes, given zero transaction costs. Thus, the allocation of property rights and ownership of water usage rights are subject to culturally based legal institutions. The application of economic instruments is expected to bring a reduction in the emission of pollutants and promote research and development (R&D) investment in environmental technology.

4. 3 Water conservation and volumetric charges

The rapid increase in demand for water, given its limited supply capacity, implies the importance of demand management policies. In the past, the absence of proper instruments for managing demand has resulted in poor water conservation⁸. The daily amount of piped water supplied per capita increased continuously between 1975 and 1994 from 216 l to 408 l, followed by a marginal drop to 398 l in 1995 (National Statistical Office, 1996). The supply rate of public water services increased from 42.4 to 82.9% over the same period. The amount of water supplied daily per capita in major cities was much higher than the national average and the supply rates of Seoul, Busan and Daekoo in 1995 were 469 l, 391 l and 439 l, respectively. A demand-side solution interprets the problem of water scarcity in terms of minimising wastewater. Korea targeted domestic users, the largest users of piped water, for

⁸ In this paper, water conservation refers mainly to a reduction in demand rather than to conservation of seasonally available resources via dams and reservoirs.

increased charges. Domestic water use is largely dominated by drinking, cooking, washing and (public) bathing by urban households.

The charge for piped water is based on weight (volume) of consumption and is thus expected to curb the wastage of water. With the introduction of a water charge in 2002 the unit water price per ton has increased from a range of 275 Won (Kum River Basin) to 323 Won (Yong San-Sum Jin), to a range from 390 Won (Nakdong River) to 443 Won (Yong San-Sum Jin Rivers). As a result, the larger consumers are expected to face a higher financial burden. The data in Table 6 indicate that the effectiveness of water pricing policies on water conservation in urban areas ranged between 16.9 and 29%, depending on the specific conservation measures taken.

However, a pricing policy that targets domestic users needs to be accompanied by more comprehensive policy measures to promote water conservation. The current surcharges only relate to piped water, whereas agriculture is the sector with the highest demand for water, implying that most water conservation projects should focus on irrigation systems. In order to promote efficient water transfer between sectors, a comprehensive water management system is required. The objectives of river management therefore need to be geared to resolving problems arising from water scarcity and conflicts that arise between competing users.

More importantly, the surcharges are uniformly levied on end users instead of having an increasing block structure⁹. Consequently, they cause a social equity problem because the relatively poor groups tend to have proportionately higher tariff burden than the richer groups under a uniform surcharge scheme.

4. 4 Full cost recovery

⁹ Water prices (not the surcharge) are based on an increasing block tariff structure in Korea, while the interval between blocks and corresponding tariff rates have changed a number of times.

The concept of full cost recovery is important, particularly for privatising water-related infrastructure and encouraging investment in/operation of environmental infrastructure¹⁰. An undervalued price for water discourages the participation of private capital because of expected losses. The participation of private capital in developing countries is justified both in terms of improving productivity and freeing up public expenditure for other social welfare needs such as health and education.

The literature shows that the cost of water production and the water price to urban households in the Middle East region in the mid-1990s ranged between 0.3 (Cairo) and 2.02 US\$/m³ (Abu Dhabi) and between 0.03 (Cairo) and 0.9 US\$/m³ (Sharjah), respectively (Abu Qdais & Al Nassay, 2001). There is no literature available on the cost function of piped water production in Korea. The water price charged in water scarce regions of the USA such as the west, south, midwest and northwest in 1994 was around US\$13.5 per 1,000 ft³ (US\$0.0038/m³) (Dinar & Subramanian, 1998). This is equivalent to around 565 won/ton at the end of 2001, indicating that the water tariff in Korea is still heavily undervalued¹¹. For example, the water price in the Nakdong River is 390won/ton, or 69% of the USA water price and less than 7% of production costs in the Middle East region.

Attracting private capital and reforming water utilities is a difficult task. Slow asset turnover that requires long-term debt finance is yet another barrier to private participation. Putting a tariff on water is politically sensitive and competition (and therefore productivity) could be limited. Full cost recovery-based water pricing is a first step towards encouraging private capital and company participation.

4. 5 The market for water transfer

¹⁰ There is some controversy about the definition of full-cost pricing. This paper follows the definition by Rogers *et al.* which comprises full supply cost (capital charges and overhead and material costs) plus opportunity cost and economic externalities plus environmental externalities (Rogers *et al.*, 1998).

¹¹ The conversion rate used is 40 cubic feet = 1 ton. The average exchange rate (basic rate) at the end of 1994 was US\$ = 788.7 won. The CPI index (2000 = 100) was 78.43 in 1994 and 104.1 in 2001.

In contrast to the Pigouvian model, the Coasian school recommends the creation of a market for water transfer. This instrument provides for both efficient resource allocation and pollution prevention. First, a voluntary contract between competing users reduces conflict and leads to the efficient allocation of resources. The demand for water by agriculture in Korea is around 53% of total demand. This figure is relatively small compared to other countries such as China (around 70–80%). The declining rate of water use by agriculture in Korea implies that the transfer of water from supporting rice farming to domestic users and to industry will be required in the future. This expectation is based on the theory of the price elasticity of demand. Agriculture is water intensive and thus by definition highly price-elastic compared to, for example, drinking water. Empirical studies show that the price elasticity for irrigated agriculture ranged from -1.0 to -3.0 (Herrington, 1987), whereas the long-run elasticity of residential water demand in the USA ranged from -0.3 to -0.7 (Shneider & Whitlach, 1991).

The Coasian model indicates that the market mechanism can also be employed to cope with water crises. The Coasian approach can be applied from different perspectives. One is through the creation of ownership for water use and the other is through pollution rights. These rights are exchangeable in the market. The Coasian option is expected to facilitate the development of environmental technology, as technology holders will be able to sell their pollution rights in the market. In a similar vein, the exchange of rights for water use is expected to promote the efficient allocation of water resources among competing sectors. It is also a prerequisite for the encouragement of private capital participation in diverting river flows. Such exchanges in the marketplace may be the long-term solution to water problems if Korea can surmount existing problems, such as comprehensive reforms, to introduce this Coasian exchange concept, in terms of both legal institutions and organisational framework. Furthermore, these market-based approaches to resolving water conflicts presume cases of pure large scale markets. Compared to the case in the USA, Korea has a lack of pure large

scale markets, which may constrain the introduction of policy opening markets for allocation of whole rivers.

5. Conclusions

In order to resolve growing conflicts over water, the Korean government introduced a series of countermeasures that culminated in the Comprehensive Countermeasures for Improving Water Quality in Four Major Rivers in 2002 (Ministry of Planning and Budget, 2002a). These measures increased the user cost of piped water significantly by introducing a surcharge with a view to resolving conflict between upstream and downstream residents. One major aim of the price reform is to improve water quality through infrastructure investment. Water surcharges are thus used to raise revenue. The second goal of the policy is to provide subsidies to residents in the upstream areas in order to compensate them for economic losses incurred because of strengthened environmental regulations.

The water surcharge is an earmarked tariff, which is levied on all households along the rivers, except in the case of the Han River where the charge only applies to residents in the downstream. This levy on the price-inelastic household sector is justifiable for tariff purposes. Households have also been the major source of wastewater. However, the nature of the water charge in the nexus of environmental protection is unclear. This water charge is similar to a consumption tax, as the levy is imposed on both upstream and downstream residents. While a large portion of the earmarked tariff is used to improve water quality, the purpose of the surcharge *per se* is different from the full-cost-based Pigouvian concept.

The effects of this price reform on resolving conflict through improving the quality of water have yet to be determined. Both domestic and international experience indicate that a policy that targets ex post “treatment” of pollution has limitations in curbing the emission of pollutants. The introduction of the full-cost based Pigouvian instrument and/or the creation of a market for pollution rights would motivate polluters to “prevent” pollution. The introduction

of a more refined version of the two-part tariff system, or an increasing block tariff structure for the surcharge, could also be expected to improve water equity for poorer households.

Furthermore, an integrated water resource pricing system that includes groundwater extraction charges is an issue still to be investigated.

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Appendix 1. Pollution control in accordance with total amount of pollutant emission in Korea.

