POLICY BRIEF

Policy Brief #4 March 2006

Rationalisation of Industrial Sector Water Use is the Key to Sound Groundwater Management

Yatsuka KATAOKA, Gemunu HERATH, Keishiro HARA, Shinichiro OHGAKI




Authors:

Ms. Yatsuka Kataoka
Policy Researcher,
IGES Freshwater Resources Management Project
kataoka@iges.or.jp

Dr. Gemunu Herath
Former Visiting Researcher,
IGES Freshwater Resources Management Project

Dr. Keishiro Hara
Researcher,
IGES Freshwater Resources Management Project
k-hara@iges.or.jp

Prof. Shinichiro Ohgaki
Project Leader,
IGES Freshwater Resources Management Project

Institute for Global Environmental Strategies
財団法人
地球環境戦略研究機関

Many Asian cities have greatly relied on groundwater in the course of their development. Large populations and concentrations of industrial activity in urban areas intensified the stress on groundwater. Such stress has resulted in environmental problems, such as the drawdown of water tables, land subsidence and saltwater intrusion, which interfered with the sound development of the cities.

Considering that the industrial sector heavily consumes groundwater, an urgent review of the groundwater management for industrial use should be made. Current measures in some Asian countries mostly rely on the regulations of groundwater abstraction and the provision of alternative water sources to meet the existing water demand. However, these measures often place additional stress on other water resources and may increase financial problems and the environmental risk in the infrastructure development of new water sources.

In the context of sound groundwater management, we believe that government resources should be allocated to promote the rationalisation of water use in the industrial sector and recommend that:

- Economic instruments, such as tax reductions to introduce water-saving practices, groundwater usage charges and wastewater treatment charges, should be introduced to motivate water saving, reuse and recycling; and
- The enforcement of water pollution control should be strengthened to control water demand.

A missing perspective - reduction of water demands in the industrial sector is the key to sustainable groundwater management

The intensification of water stress was observed in many areas of the world since the last century. In Asia, the region that experienced rapid growth in its economy and population, water consumption more than doubled in the latter half of the twentieth century. According to United Nations' projections, Asia will see a continuous population growth, particularly in urban areas where more than half of the Asian population will live by 2025 (UN 2004[1]). It is said that population growth will be the factor that will contribute most in the increase of water demand for decades to come. Considering the concentrations of population and economic activities, water demand in urban areas will steadily

[1] United Nations. 2004. World Population Prospects: The 2004 Revision and World Urbanization Prospects. http://esa.un.org/unpp [16 February 2006].

increase and put more stress on this precious resource.

Groundwater has historically played an important role in the development of cities. Over half of the twenty-three cities with a population of more than 10 million rely on or significantly use local groundwater and most of them are located in the developing regions of Asia and Latin America (Morris et al. 2003[2]). There are not enough data related to groundwater use in Asian cities, but we can see that large cities, such as Bangkok, Beijing, Jakarta and Manila face problems caused by the intensive abstraction of resources that exceed their recharging capacities, such as water table drawdown and land subsidence. Because groundwater is highly accessible and its exploitation cost is cheaper than other water sources, the resource is often used to excess.

To tackle the excessive abstraction of groundwater and prevent related problems, Asian cities have taken certain measures to control groundwater demand. An overview of these current measures shows that the regulation of groundwater abstraction and provision of alternative water sources to meet the existing water demand are the main pillars of groundwater management. However, the weak enforcement of regulations does not bring the expected results and the development of new water sources often faces financial problems and environmental risk. Considering the sustainable utilisation of not only groundwater but also other sources of water, a more comprehensive perspective should be incorporated into the current management of groundwater. In this context, the reduction of water demand by industry, which is a large consumer of groundwater in Asian cities, could be a solution to be promoted which will subsequently reduce groundwater demand and thereby effectively minimise the stress to groundwater resources. However, little attention has been paid to the rationalisation of industrial water use so far in groundwater management policy in Asian cities.

"…little attention has been paid to the rationalisation of industrial water use so far in groundwater management policy in Asian cities."

The industrial sector is critical for the sustainability of groundwater

Groundwater has played an important role in the development of cites in the Asian region, serving as a major source of water (Figure 1). When looking at the beneficial uses, the industrial sector consumed the most groundwater in Ho Chi Minh City, Bangkok and Bandung (Figure 2).

Figure 1: Recent Dependency on Groundwater

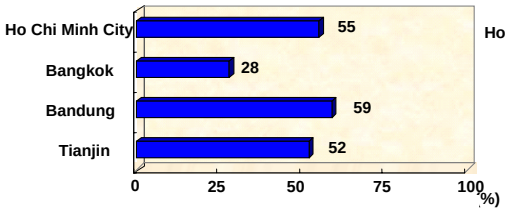
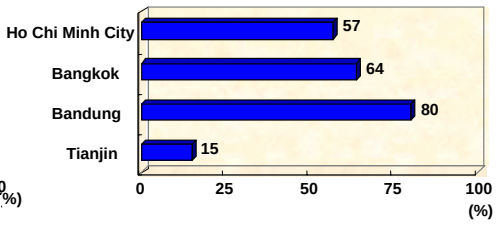


Figure 2: Recent Percentage of Industrial Use in Total Groundwater Abstraction



Source: Case study report on each city
Note: Bangkok's data is for the Chao Praya basin where the study area is located.

"…shows a strong correlation between groundwater use and regional GDP (RGDP) in Ho Chi Minh City and Bandung where industrial use of groundwater is dominant."

Figure 3 shows a strong correlation between groundwater use and regional GDP (RGDP) in Ho Chi Minh City and Bandung where industrial use of groundwater is dominant. In Bandung, the groundwater abstraction volume

[2] Morris, B. L., A. R. L. Lawrence, P. J. C. Chiltion, B. Adams, R. C. Calow, and B. A. Klinck. 2003. *Groundwater and its susceptibility to degradation: A global assessment of the problem and options for management.* Early warning and assessment report series, RS. 03,3. Nairobi: United Nations Environment Programme.

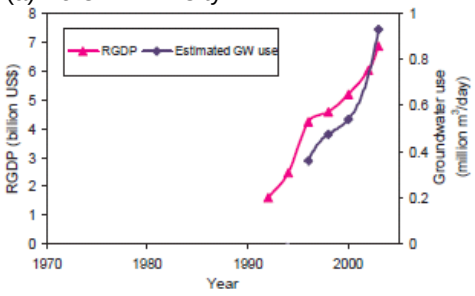
"Such a strong correlation indicates that continuous industrial development can put more stress on the resource if no effective measures to control groundwater use are taken."

dramatically decreased in 1997 because the economy of the city was affected by the Asian financial crisis, but the abstraction intensified again during the economic recovery period.

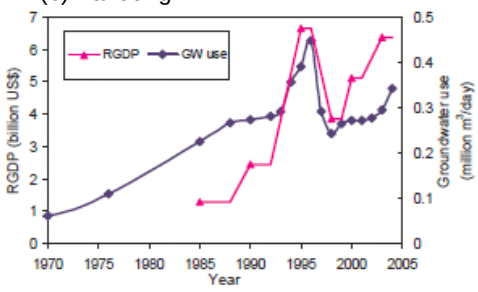
Such a strong correlation indicates that continuous industrial development can put more stress on the resource if no effective measures to control groundwater use are taken. Considering that the industrial sector is critical for the future of groundwater in Asian cities which will undergo continuous industrialisation, it is necessary to take action to change groundwater use practices in the industrial sector.

Figure 3: Correlation between RGDP and Groundwater Use

(a) Ho Chi Minh City



(b) Bandung



State of Groundwater Management in Bandung, Bangkok, Tianjin and Osaka

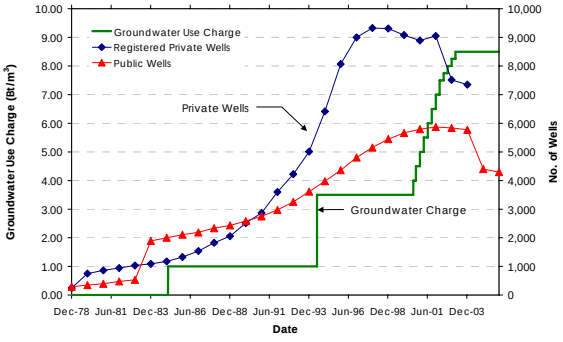
Bangkok - strengthening groundwater charges

Bangkok has suffered from the drawdown of its water table and the resultant land subsidence since the late 1960s. Records show that the groundwater level dropped by about 5 – 10 m from the late 1970s to the early 80s. The recorded land subsidence rate was up to 10 cm/year in the eastern part of Bangkok and the incident has extended to the outskirts of the city. The city has regulated groundwater abstraction with a system of charges but the effectiveness of the control measures has not been observed until recently.

"The recent positive results of groundwater control were attained by the introduction of a combination of the extension of the public water supply coverage and by a step-by-step but sharp increase in groundwater-related charges."

The recent positive results of groundwater control were attained by the introduction of a combination of the extension of the public water supply coverage and by a step-by-step but sharp increase in groundwater-related charges. The groundwater user charge rapidly increased from THB 3.5 (USD 0.09)/m^3 to THB 8.5 (USD 0.22)/m^3 between 2000 and 2003, and the public water supply coverage in the metropolitan Bangkok area has reached 90 per cent of its population by 2004. As a result, the number of private wells began to decrease during that period (Figure 4). In 2004, an incremental charge called the "groundwater preservation charge" was introduced to groundwater users in Bangkok and its vicinity (the critical zones), where groundwater use is controlled more than in other areas. After the introduction of the new charge, the total amount that groundwater users had to pay became almost equal to the cost of water supplied by the public water supply scheme.

Figure 4: Chronological Change in the Number of Wells and Groundwater User Charge



"Because of the comparative strength of groundwater in terms of cost and the insufficient alternative resources, industry continues to use groundwater."

Bandung - struggling to control groundwater use

In **Bandung**, significant water table drawdown was observed and then groundwater abstraction control was introduced in the 1970s. In addition to regulations for groundwater pumpage, a groundwater user tax was introduced in 1974. However, the measures observed so far do not appear to be effective. The groundwater user tax ranged from about IDR 1750 (USD 0.19) to IDR 3138 (USD 0.34)/m^3, while the charge for accessing the public water supply was about IDR 2725 (USD 0.29) to IDR 9600 (USD 1.05)/m^3 for industry. Because of the comparative strength of groundwater in terms of cost and the insufficient alternative resources, industry continues to use groundwater.

Tianjin - seeking other sources of water

Tianjin has also suffered from the drawdown of its water table and resultant land subsidence since the late 1970s. The control of groundwater abstraction was implemented strictly in the area with significant land subsidence impacts where the most industrial activities took place. As an alternative water source, water has been transferred from other basins. The desalinisation of sea water was practiced in the coastal industrial zones as an alternative to groundwater resources. A groundwater user charge was imposed to discourage groundwater use in the city. In addition to the control of groundwater use, the municipality promoted water rationalisation in the industrial sector by setting targets for water use and imposing more charges to those who exceed their groundwater-use targets. Agricultural use of groundwater is now dominant in the city but there is less control of the abstraction for agricultural use.

Osaka - What happened after the success?

"In Japanese cities, groundwater management was introduced in the late 1950s to abate land subsidence caused by the overexploitation of groundwater."

In Japanese cities, groundwater management was introduced in the late 1950s to abate land subsidence caused by the overexploitation of groundwater. In the case of **Osaka,** as with other large cities in Japan, industries were the main users of groundwater, and therefore strict controls for groundwater pumpage were introduced for the industrial users. Meanwhile, a new water supply scheme called the Industrial Water Supply Works (IWSW), provided surface water as an alternative water source exclusively for the industrial sector. The combination of the two measures was very effective in the abatement of excessive groundwater use in Osaka in the early 1960s (Figure 5).

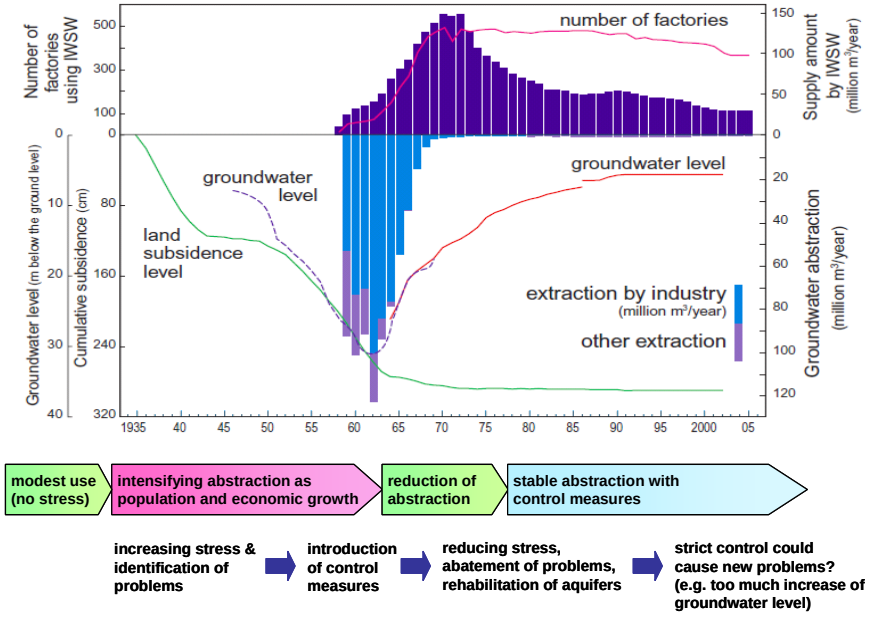


Figure 5: Groundwater problems and water supply by the IWSW in Osaka, Japan

"As a response to the emergent problems, the new infrastructure development to provide alternative water resources was useful and contributed to the industrial development at that time, but the financial difficulties and unsold water has become a social problem now."

However, since the 1970s water demand in the industrial sector has dropped and therefore the IWSW began to supply less water to the industries which resulted in less revenue than expected (Figure 5). Factors behind the decrease in water demand include the increase of water recycling rates and the structural charge for industries consuming less water. As a response to the emergent problems, the new infrastructure development to provide alternative water resources was useful and contributed to the industrial development at that time, but the financial difficulties and unsold water has become a social problem now.

Reliance on regulations and provision of alternative water resources may not promise sustainable water resources

The review of groundwater management in four Asian cities indicates four major elements in groundwater management: (a) regulations governing groundwater usage, (b) provision of alternative water resources, (c) economic incentives/disincentives to reduce groundwater usage (e.g., charges for groundwater usage and wastewater discharge), and (d) support for water saving activities of the major groundwater users. Table 1 summarised the current measures taken in each city[3].

Table 1: Measures Taken in Selected Cities

	Main components of groundwater management			
	(a) Regulations governing groundwater usage	**(b) Provision of alternative water resources**	**(c) Economic incentives/ disincentives to reduce groundwater usage**	**(d) Support for water saving activities**
Advantages/ disadvantages	Direct control is effective with strong enforcement, but it is often difficult to successfully monitor all groundwater users.	By providing alternative sources, groundwater use can be regulated but there is financial burden and potential environmental risks to be considered when new infrastructural development is necessary.	Economic instruments are effective when they are properly introduced, but equity issues (equal burden of all groundwater users, concerns of the marginalised people) should be considered.	Water-saving activities can rationalise water use itself and contribute to sustainable use of water.
Bandung	Control of abstraction volume through permission system	Expansion to include surface water usage being considered	User tax	No specific measures
Bangkok	Control of abstraction volume through permission system	Surface water (by public water supply scheme)	User charge and groundwater preservation charge	No specific measures
Tianjin	Control of abstraction volume through permission system	Surface water transfer from other basins	User charge	Mandate of water recycling in building codes etc.
Osaka	Permission for abstraction (ban of the use and construction of wells designated by the law)	Surface water to the industrial sector (by new water supply scheme for industries)	No user charge, but wastewater treatment charge applies.	Financial support for the introduction of water-saving technologies (in the1960s)

"Such reliance on alternative resources without a change in the water- use patterns may bring other environmental risks."

Except for Tianjin, current groundwater management policies do not sufficiently incorporate the supporting measures for water saving activities as the main management element of groundwater. Rather than the promotion of water rationalisation, the provision of alternative water resources with groundwater abstraction control with regulations often has come first as a countermeasure. However, such reliance on alternative resources without a change in the water-use patterns may bring other environmental risks. It may also bring the financial problems and the environmental risk in the infrastructure development of new water sources. On the other hand, as the experience of Osaka shows, promotion of water rationalisation through the reuse and recycling in groundwater management could be an effective tool to reduce groundwater demand.

[3] Based on the IGES case studies conducted in 2004 – 2005.

Allocate government resources to change water use practice in industry for sound groundwater management

Rational use of water in the industrial sector should be promoted first

Optimally integrating the different policy measures from regulatory to economic instruments, according to local situations, is the key to successful groundwater control. Among the measures, the promotion of water rationalisation should be given priority, considering the benefits of groundwater conservation as well as the conservation of water resources as a whole, and its long-term cost-effectiveness. Therefore, we recommend that government resources should be allocated for the promotion of water rationalisation with the following measures:

"Governments should prioritise their use of financial and human resources in order to encourage the rationalisation of water-use practices, in particular water reuse and recycling by industries."

■Introduce economic instruments to motivate water reuse/recycle

Governments should prioritise their use of financial and human resources in order to encourage the rationalisation of water-use practices, in particular water reuse and recycling by industries. The possible support given by governments can include:

- provision of incentives, such as tax reductions to introduce water-saving practices, or subsidies for the introduction of water-saving or recycling technologies;
- provision of disincentive for the use of water, such as an increase in the water-use charges, additional charges for targeted water use volume; and
- provision of technical guidelines and training for those who are in charge of the operations.

Among the possible measures to motivate industries to save, reuse and recycle, charging for groundwater abstraction is the most effective tool to decrease groundwater demand when properly applied, as Bangkok's case shows. Especially for the industrial sector, the system of charges works well because industries are more sensitive to increases in their production costs.

In promoting water use and recycling, it is necessary to consider all types of industry in order to determine the types that should be given priority. The purpose and amount of groundwater usage differs according to the type of industry. Therefore, for example, strict regulations governing groundwater usage can be introduced in combination with measures to promote the introduction of water-saving technologies to an industry, such as the steel industry, which uses a lot of water but can recycle wastewater within its production process. But for an industry that requires good quality water and cannot recycle or reuse it in its production process, such as in the food industry, the same combination of policy measures as those that apply to the steel industry cannot work well.

"In addition to direct charges for groundwater users, water pollution control measures, such as enforcing quality standards for effluence discharge from factories and wastewater treatment charges should be applied or strengthened."

■Strengthen pollution control and its enforcement as a tool for reduction of water demands

In addition to direct charges for groundwater users, water pollution control measures, such as enforcing quality standards for effluence discharge from factories and wastewater treatment charges should be applied or strengthened. For example, to save the cost of wastewater treatment, industries try to minimise wastewater volume. The introduction of a progressive charge according to the treated wastewater quality and the volume of effluence could lead industries to minimise wastewater volume through the reduction of water input and to promote water reuse and recycling in the production process.

Indirect charges, especially wastewater discharge/treatment charges, can contribute to the reduction in groundwater abstraction as well. Hiratsuka City in Japan managed to halve the volume of industrial groundwater pumping from

1972 to 1976 by rationalising water usage. An analysis concluded that the introduction of a wastewater treatment charge motivated industry further to rationalise its water usage. It was estimated that the wastewater treatment charge was JPY 28 (USD 0.23) — 56 (USD 0.45)/m^3, which was above the investment for water-saving technology, estimated to be about JPY 19.5 (USD 0.16)/m^3. (Sibazaki 1981[4]).

Pollution control can contribute not only to the mitigation of water pollution but also to the rationalisation of water use in industries. Asian cities have already taken some measures against water pollution and they should be strengthened from the perspective of groundwater management too.

■ ■ ■

Acknowledgements

The authors wish to thank their research partners involved in the research on sustainable water management policy (SWMP) — a sub-component of the Freshwater Resources Management Project, the Institute for Global Environmental Strategies (IGES), including the Asian Institute of Technology, Thailand; Ho Chi Minh University of Technology, Viet Nam; West Java Environment Protection Agency, Indonesia; Nankai University, China; and the University of Peradeniya, Sri Lanka. These research partners contributed the data for each city examined in this paper.

For more information related to this article or groundwater management, please refer the following our publication:
- Sustainable Groundwater Management in Asian Cities - a summary report of research on sustainable water resource management -
- International Review for Environmental Strategies (IRES) Vol.6, No.2. Special Feature on Groundwater Management and Policy

[4] Shibazaki, T. 1981. Chikasui riyo hozen no shinkyokumen, sono chiho bunsanka to tayo-ka ni taioshite [New dimension of groundwater conservation — corresponding to localization and diversification]. In Gendai no Mizu Mondai (Julist Zokan Sogo Tokusyu 23), 57–64. Tokyo: Yuhikaku.

Institute for Global Environmental Strategies
2108-11 Kamiyamaguchi, Hayama,
Kanagawa, 240-0115 Japan
TEL: +81-(0)46-855-3700
FAX : +81-(0)46-855-3709
E-mail: iges@iges.or.jp
http://www.iges.or.jp