

# **Situations Surrounding Water Use and Water Saving Measures in Korea**

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## **Abstract**

Korea is one of the nations where water shortage has become a problem. With its rapid economic growth and urbanization, Korea is facing a threat of serious water shortage in the near future. This paper is concerned with the situations surrounding water and measures taken for water saving in Korea drawing on “Statistics of water works and sewage-2009” in 2010, “The national water demand management policies (2007 ~ 2016)” issued by Ministry of Environment in 2007, and “Long-term comprehensive water resource projects” issued by Ministry of Land, Transport and Maritime Affairs in 2006. Strategies for water saving in the country are beginning to shift from conventional mandatory regulations, non-compensatory maintenance, and incentive granting by the government to voluntary participation of citizens and water companies, enhanced competitiveness through restructuring of water projects, evaluation of demand management, and monitoring.

## **Keywords**

Korea, situation of water use, water resources, saving water, National water demand management policies

## **1. Introduction**

Though the mean annual precipitation in Korea (1,274mm) is 1.3 times higher than the global average, the annual mean precipitation per capita accounts for only 12.6% of the world average. On top of it, serious water shortage is expected in the near future as the rate of industrialization and urbanization in recent years has been accelerating faster than ever. In terms of actual usable water resources, the situation is far worse. According to UN PAI (Population Action International), the country is now classified as a member of the nations suffering from water shortage.

As a measure to cope with water shortage, Korea gave the highest priority to increasing water supply through development of water resources. However, water supply from dam development has reached its limit. As a result, new systems such as the national water saving target (reducing water usage volume to 790 million m<sup>3</sup> by 2006) based on “The comprehensive water saving measures’ in 2000 and ”The enforcement of Water Supply Act for water saving” were enacted to replace the President’s instructions “Multilateral study and promotion of measures for reducing water consumption” in 1999.

In 2007 the effects of the comprehensive water saving measures were reviewed. As a consequence, achievement of 105% over the national target was confirmed, the problems in promoting the measures pointed out, and the direction of development laid down. Based on these, “The national water demand management comprehensive measures” were enacted in September 2007, and the national water demand management promotion road map and water reducing targets for 2007~2016 (1021 million m<sup>3</sup>) were established.

## **2. Current Situation and Usage of Water Resources, and Need for Water Saving**

### **2.1 Characteristics of water resources and status of water usage and its prospects**

Great fluctuations in regional precipitation due to seasonal and yearly changes make the management of water resources a challenging project in Korea. Two thirds of Korea’s annual precipitation occurs in the months between June and September with heavy rainfalls concentrated in the summer. In contrast, winter and spring are frequented by dry weather. In spite of the fact that 65% of the land is occupied by mountains, Korea’s coefficient of river regime is approximately 300 ~ 400; higher than most other countries as its rivers have shallow topsoil layers and steep gradients. Within Korea itself, the highest regional figure is 1.7 times as large as the lowest, which means available water resources are highly subjected to regional deviation.

According to provision 11 of River Act (stipulated in “Long-term comprehensive water resource projects”, the minister of Ministry of Land, Transport and Maritime Affairs is required to make “Long-term comprehensive water resource projects” in 10-year intervals, review them every 5 years, and make amendments if necessary. In line with this stipulation, “Long-term comprehensive water resource projects<sup>3)</sup> (2001 ~ 2020)” and supplementary plans for 2006 fiscal year were established in July 2001. Total annual volume of water resources in Korea in 2003 was 124 billion m<sup>3</sup>. Loss of 51.7 billion m<sup>3</sup> (42%) through underground seepage and evaporation taken off, water that runs on the ground is estimated to be 72.3 billion m<sup>3</sup> (58%). 42% of it (52.2 billion m<sup>3</sup>) comes from instantaneous outflow in times of heavy rain, while normal outflow constitutes 16% (20.1 billion m<sup>3</sup>). The main sources of water usage are rivers and dams. Total amount of water used including some underground water accounts for only 27% (33.7 billion m<sup>3</sup>). Table 1 shows the total volume of water resources and water usage by year.

”Long-term comprehensive water resource projects” in 2006 was intended to enhance stability, equilibrium, and efficiency of water usage. And the prospects of water

resources in 2020 include: 1) To lower regional water shortage ratio against demand to less than 10%; 2) To reduce flood damage by 30% of the current level; 3) To restore the riverine environment; and 4) To raise the level of water resource exploration technology to 90% of that of advanced countries.

In the overall water usage plan, it is clearly indicated that systematic plans be drawn up to ensure efficient supply and management of water by making prediction assessment on the balance between water demands and water supply resources in target years. The overall plan is supplemented with scenario concepts taking into account the uncertainty elements caused by changes in the future population, economy, society and environment envisioning high demand, standard demand and low demand situations. Table 2 shows demands for water grouped into 4 categories: domestic, industrial, agricultural, river maintenance; and prospects of demand by the target year up to 2020. One of the characteristics of the supplemental plan made in 2006 is its introduction of scenario concepts to indicate the prospects of high or low demand relative to the standard. The standard demand for domestic water use is estimated to grow from 7.63 billion m<sup>3</sup>/year in 2003 to 8.1 billion m<sup>3</sup>/year in 2011 and 8.2 billion m<sup>3</sup>/year in 2020. Though in some categories water use amount tended to decrease from the estimates made in 2001, fluctuations varied in each of the three scenarios.

**Table 1 Amount of Water Resource and Use of Water by “Long-term comprehensive water resource projects (2006)”**

(Unit: million m<sup>3</sup>/year)

Category	year					
	2001	2011	2016	2021	2026	2031
Total resource	1,100	1,140	1,267	1,267	1,267	1,240
Total use	51.2(100%)	153(100%)	249(100%)	301(100%)	331(100%)	337(100%)
Domestic	2.3(4%)	19(12%)	42(17%)	62(21%)	73(22%)	76(23%)
Industrial	4.1(8%)	7(5%)	24(10%)	26(8%)	29(9%)	26(8%)
Agricultural	44.8(88%)	102(67%)	147(59%)	149(50%)	158(48%)	160(47%)
For maintenance	-	25(16%)	36(14%)	64(21%)	71(21%)	75(22%)

**Table 2 Water for Domestic Use According to “Long-term comprehensive water resource projects (2006)”**(Unit: million m<sup>3</sup>/year)

Category		year				
		2006	2011	2016	2020	
2001 long- term plan	Total	351	374	378	381	
	Domestic	76	87	89	90	
	Industrial	37	40	43	46	
	Agricultural	160	162	162	162	
	For maintenance	77	84	84	84	
2006 Supplementary Plan	High demand	Total	345 (Δ5.27)	362 (Δ11.52)	371 (Δ7.13)	372 (Δ9.25)
		Domestic	80 (+3.43)	82 (Δ5.08)	83 (Δ5.72)	84 (Δ6.37)
		Industrial	28 (Δ8.61)	34 (Δ6.53)	40 (Δ3.59)	39 (Δ7.01)
		Agricultural	160 (Δ0.09)	16 (+0.09)	164 (+2.18)	166 (+4.13)
		For maintenance	77(-)	84(-)	84(-)	84(-)
	Standard	Total	344 (Δ6.95)	355 (Δ18.55)	358 (Δ19.92)	356 (Δ25.79)
		Domestic	79 (+2.33)	81 (Δ6.46)	82 (Δ7.40)	82 (Δ8.26)
		Industrial	28 (Δ9.19)	32 (Δ8.65)	36 (Δ7.49)	34 (Δ11.43)
		Agricultural	160 (Δ0.09)	16 (Δ3.44)	157 (Δ5.03)	156 (Δ6.10)
		For maintenance	77(-)	84(-)	84(-)	84(-)
	Low demand	Total	340 (Δ10.43)	345 (Δ28.49)	340 (Δ37.30)	333 (Δ48.46)
		Domestic	77 (+0.67)	79 (Δ8.53)	79 (Δ9.91)	79 (Δ11.09)
		Industrial	27 (Δ10.08)	29 (Δ11.22)	31 (Δ11.83)	29 (Δ16.65)
		Agricultural	158 (Δ10.2)	153 (Δ874)	146 (Δ15.56)	141 (Δ20.72)
		For maintenance	77(-)	84(-)	84(-)	84(-)

Δ: Deficit, +: Surplus, ( ): Comparison with 2001,  
For maintenance: Water used for maintenance of rivers

## 2.2 Water supply penetration rate

Water supply penetration rate in the 1970s was as low as 32.4%. By the end of 2009, however, 47,336 million people constituting 93% of the entire population had begun to enjoy the advantage of water supply through 164 local waterworks companies and 1 wide range supplier. Table 3 shows yearly trends of water supply penetration rates. Except for industrial use, water supply per day per capita has been declining steadily since 2004 to reach 332 L in 2009. Reduction of water usage due to application of water saving apparatuses and waterworks for miscellaneous use, reduction of leakage due to promotion of services with earnings seem to have been contributing factors. It

also seems to indicate the effectiveness of the national water saving targets and the comprehensive water saving measures established in March 2003.

**Table 3 Penetration Rate of Water Supply System by Year**

Category	2003	2004	2005	2006	2007	2008	2009
Total population (in thousand)	48,824	49,053	49,268	49,599	50,034	50,394	50,644
Population with water supply (in thousand)	43,633	44,187	44,671	45,270	46,057	46,733	47,336
Penetration rate (%)	89.4	90.1	90.7	91.3	92.1	92.7	93.5
Amount supplied (L/[day/capita])	347	353	351	346	340	337	332

\* 2009 Statistics of water works, the Ministry of Environment (2010)

Table 4 shows regional water supply penetration rates including water supply per day per capita. The penetration rates for Special City / Metropolitan Cities, cities, rural areas, and farming and fishing villages are 99.4%, 98.6%, 88.8%, and 51.0% respectively. The penetration rate tends to increase as the size of a community grows, but water supply per day per capita shows the reversed trend.

**Table 4 Regional Water-supply Penetration Rate**

Category	Total population	Population with water supply (in thousand)	Penetration rate (%)	Amount supplied (thousand tons /day)	Amount supplied per day per capita (L)
National	50,644	47,336 (47,994)	93.5 (94.8)	15,696	332
Special ward Wide city	23,380	23,241 (23,268)	99.4 (99.5)	7,222	311
Cities	18,206	17,952 (17,973)	98.6 (98.7)	7,372	411
Rural	4,033	3,582 (3,657)	88.8 (90.7)	1,102	179
Farming and fishing villages	5,024	2,561 (3,096)	51.0 (61.6)		

\* Figures in ( ) include simple water supply in villages

\* 2009 Statistics of water works, the Ministry of Environment (2010)

Table 5 shows yearly analysis of water supply amounts. Korea's water production in 2009 reached 5.76 billion m<sup>3</sup>, of which 5.1 billion m<sup>3</sup> accounted for actual usable water excluding the amount lost to seepage. The amount of water supply with charge was 4.76 billion m<sup>3</sup> (earnings rate: 82.6%). The earnings rates are have been on the rise while leakage rates are gradually declining.

**Table 5 Analysis of Water Supply Amount by Year**

Category	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total supply	5,812	5,791	5,696	5,723	5,909	6,002	5,749	5,747	5,804	5,760
Supply with earnings	4,342	4,367	4,395	4,489	4,633	4,761	4,601	4,659	4,744	4,759
Earnings ratio	74.7	75.4	77.2	78.4	78.4	79.3	80.0	81.1	81.7	82.6
Amount of leakage	859	804	700	781	839	845	819	734	709	658
Leakage rate	14.8	13.9	12.3	13.6	14.2	14.1	14.2	12.8	12.2	11.4

\* Unit: million m<sup>3</sup> (Earnings ratio and Leakage ratio are in %)

Table 6 shows water supply with earnings divided by usage. Water charges are going up gradually at annual average rate of 1.3%. As seen in the table, domestic use accounts for the largest percentage: 3.040 billion m<sup>3</sup> (66.1%) in 2009, followed by business use with 926 million m<sup>3</sup> (20.1%), commercial use with 544 million m<sup>3</sup> (11.8%), and public bath use with 92 million m<sup>3</sup> (2.0%).

**Table 6 Trend of Water Supply Amount by Use**

Category		2001	2002	2003	2004	2005	2006	2007	2008	2009
Amount of water with charge (million m <sup>3</sup> )	Total	4,118	4,146	4,246	4,357	4,420	4,483	4,529	4,529	4,602
	Domestic	2,693	2,708	2,785	2,868	2,906	2,939	2,970	2,964	3,040
	Business	599	612	643	666	731	612	572	631	544
	Commercial	725	720	712	718	676	826	879	837	926
	Public bath	101	106	106	106	107	106	107	97	92
Amount per capita (L)		266	264	267	270	272	271	269	265	266

\* Water for industrial use and others are excluded.

Table 7 shows fluctuations of water charges from 2001 to 2009. Although water charges are set lower than production cost, the annual average increase of water charges is 2.74% while that of production cost is 3.76%. The realization rate that indicates the ratio of water charge against production cost remains in the range of 75% ~ 89%. The national average water charge in 2009 was 609.9 Won/m<sup>3</sup> and the realization rate 80.1%.

**Table 7 Trend of Water Charge by Year**

Category	2001	2002	2003	2004	2005	2006	2007	2008	2009
Charge	489.1	514.0	532.9	550.7	563.2	577.3	603.9	613.2	609.9
Production cost	569.1	593.9	596.6	638.9	680	704.4	715.4	730.7	761.6
Realization rate	85.9%	86.5%	89.3%	86.2%	82.8%	82.0%	84.4%	83.9%	80.1%

\* Unit: Won/m<sup>3</sup>

### **3. The National Water Demand Management Comprehensive Policies**

#### **3.1 Purpose and function**

Demands for water have been growing in Korea as a result of the recent rapid industrialization and urbanization. However, a threat of serious water shortage is lurking in the near future as the development of water resources has reached its limit. Therefore it seems more feasible to adopt multi-faceted policies in addition to promoting demand management strategy such as water saving than to depend on the approach that focuses on increasing supply by making more dams. The government enacted “The national water demand management comprehensive policies” in September 2007 to establish an organic demand management system that runs through all stages of water supply, use and recycle, to improve factors contributing to water waste, to expand infrastructure for water saving, and to efficiently promote water demand management systems on community level through popularization of water saving apparatuses. At the heart of the policies lie two main themes: setting up water saving target (1.21 billion m<sup>3</sup> in total in 10 years between 2007 and 2016) and establishing step-by-step strategic systems. They aim at consolidating business structures to improve earnings rate and building systematic management systems on the supply level; popularizing water saving apparatuses for consumers, and improving water charges on the use level; and improving system management of rainwater utilizing facilities and expanding recycle of sewage and waste water on the recycle level.

#### **3.2 Establishment of water demand management targets**

The comprehensive water saving measures(2000 ~ 2006) had been in place before the implementation of “the national water demand management comprehensive policies(2007~2016)” in September 2007. Table 8 shows the targets of the measures for 2007 ~ 2016 which include the targets and results of the measures for 2000 ~ 2006, and the combined figures of the two time periods are indicated according to the method of promotion. The major means of water saving in descending order include installation and penetration of water saving apparatuses (36.8%), improvement of decrepit water pipes (30.2%), recycling of sewage water (23.8%), and water saving based on realization of water charges (9.2%).

The target figures of water demand management for 2007 ~ 2016 were obtained based on the following rationale for each means of water saving. The water saving target of

the projects to enhance earnings rate such as improvement of decrepit water pipes: the plans to reduce leakage rate from 14.1% in 2005 to 7% in 2016; that of the use of water saving facilities and apparatuses: obligation of recycling in newly constructed buildings and future penetration rates of water-saving washing machines and dish washers, and rates of domestic water use (Table 9).

The use of recycled sewage water in addition to water supplied through waterworks would contribute to water saving with reduced overall amount of tap water. The amount of recycled sewage water that used in 2016 based on “Basic Plan for Water Recycling” is calculated to be 410 million m<sup>3</sup> recycled for domestic use (50%) and 440 million m<sup>3</sup> recycled for industrial use (43.7%). The target for water saving through realization of water charge, on the other hand, was deleted as having no correlation.

**Table 8 Water Saving Targets and Results by Method of Demand Management**

Category		2000~2006		2007 ~2016	2000 ~2016	Ratio (%)
		Target	Result			
Total		790	831.2	1,021	1,852	100
Improvement of old water pipes		240	185.5	374	559.5	30.2
Realization of water charges		200	169.6	—	169.6	9.2
Installation/addition of water-saving apparatuses		290	432.0	250	682.0	36.8
(Installation of water-saving facilities)	Home	(250)	(142.2)	—	(142.2)	(7.7)
	Business	(40)	(289.8)	—	(289.8)	(15.6)
	New buildings obligation			(112)	(112)	(6.0)
(Addition of water-saving apparatuses)	Water-saving washing machines			(109)	(109)	(5.9)
	Dish washers			(29)	(29)	(1.6)
Recycling (Sewage water processing)	Installation of waterworks for miscellaneous use	30	44.1	205	249.1	13.4
	Use of domestic water					
	Use of industrial water	30		192	192	10.4

\* ”the comprehensive water saving measures” 2000 ~ 2006

\* Does not reflect the results from installation of water-saving apparatuses in existing buildings from 2007 ~ 2016

\* The figures in 2000 ~ 2016 are the totals of both time periods.



**Table 9 Ratio of Nationwide Water Use with Earnings and Estimated Water Use in Home**

Category	Ratio	2005	2010	2015	2016
Water with earnings	(100%)	4759.6	5568.8	5905.7	5949.0
Domestic	100%(63.9)	3042.3	3559.6	3774.9	3802.6
Bath / Shower / Washing hands	32.7%	994.8	1164.0	1234.4	1234.4
Laundry	19.9%	605.4	708.4	751.2	756.7
Toilet	24.4%	742.3	868.5	921.1	927.8
Drinking and cooking	16.6%	505.0	590.9	626.6	631.2
Others	6.4%	194.7	227.8	241.6	243.4

\*"National Waterworks Plans" (July 2007)

### 3.3 Demand management measures across the entire stages

The demand management measures in the water supply stage lie mainly in integration of projects that enhance earnings rate supported by related concrete steps such as improvement of decrepit water pipes, reinforcement of measuring instruments, development and dissemination of water pipe network technical diagnosis manuals and enforcement of performance management. Additionally, systematization of pipe network information management, leakage management, and construction of a well-structured water pipe network management system based on the adoption of the overall information system is scheduled. More detailed measures for improving the water supply system such as thorough mapping of water pipe network, construction of water pipe network information DB closely connected to the national GIS, advancement of leakage prevention through activation of monitoring functions are also being planned. Furthermore, attracting private capital and expansion of model business to raise earnings rates, and standardization of service to enhance competitiveness of water utility are under consideration. The application of a management system that covers both areas where river water is supplied for tap water and its surrounding areas may also be necessary.

The demand management measures in the water use stage consist in 112 million m<sup>3</sup> water saving effects derived from installation of water saving toilets and faucets in newly constructed buildings (6,026 households), and 138 million m<sup>3</sup> saving from expanded use of water saving home appliances such as washing machines and dish washers. Together they are expected to reduce water use by 250 million m<sup>3</sup>. The measures also include development of water saving apparatuses through consumer initiatives, introduction of a grading system for the amount of water used and saved, offering incentives to consumers, and addition of production cost to water charges.

The demand management measures are broken down into two plans: an introduction of a unified rainwater control system that draws rainwater from the centralized public sewage management system and diffuse it into the on-site circulated management system for processing; and recycling of sewage water through advanced processing, by which 397 million m<sup>3</sup> water saving is expected with recycling rate going up from 7.7%

in 2006 to 19% in 2016. By utilizing rainwater, it is expected that urban environment be improved, flooding prevented and quality of public water refined through installation of pooling and filtration facilities. Its overall aim is to enhance the effects of sewage water recycling with both private and public sectors working in parallel by legalizing recycling and preparing a workable system for recycling related projects.

In order for the step-by-step approach to the demand management described above to work effectively, it is necessary to promote participation of citizens and raise their awareness by utilizing various public relations media and developing educational programs. It would also be necessary to prompt early penetration of a demand management target system by activating a performance evaluation regime through organization of evaluation systems for demand management performance and by creating incentives such as awarding communities that have achieved their targets.

#### **4. Conclusion**

Being among the nations suffering from water shortage and as a consequence of rapid economic growth and urbanization, Korea is facing a threat of serious water shortage in the near future. This paper is concerned with the situations surrounding water use and water saving measures in Korea drawing on public documents such as “Statistics of water works” issued by the Ministry of Environment, ” the national water demand management policies” in 2007 and “Long-term comprehensive water resource projects” issued by Ministry of Land, Transport and Maritime Affairs in 2006. Water saving measures promotion strategies in Korea are shifting from conventional straight-forward regulation by public administrations, legalization, non-compensatory maintenance, and incentive granting to voluntary participation of citizens and water companies, enhanced competitiveness through restructuring of water projects, evaluation of demand management, and monitoring.

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## 6. Presentation of Author

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