

SOUTH KOREA'S WATER RESOURCES POLICY TOWARD THE 21ST CENTURY: CONFLICTING VIEWS

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Abstract: Issues and problems in formulating South Korea's water resources policy are discussed in terms of water quantity and quality. South Korea needs both water conservation and water supply capability for the growing population and economic activities. The government has attempted to build more large-scale dams to store and supply water for residential, farming and industrial uses, but the environmentalists who emphasize conservation and environmental protection oppose the government. The environmentalists are popular among the general public. Water quality has been deteriorating from point- and non-point sources. Urban and farm runoffs are serious pollutants. All want to preserve water quality. There is no dispute on this matter between the government and the environmentalists. Money is hard to come by to preserve water quality. Economic and financial crises and not self-sufficient local governments' revenue structure are pessimistic. Basic survey on water resources, hydrology and hydraulic is badly needed for the future water resources planning.

Key Words: water quantity, water quality, water resources planning, farm runoff

1. INTRODUCTION

The United Nations has classified Korea as a water scarce nation in the near future. Rain is concentrated in three summer months, so that dam construction is a must, but there is no more "appropriate site" for a large-scale dam. South Korea has Indiana-size landmass with 45 million people. Naturally, South Korea is not blessed by even distribution of rain. Man-made thousands of reservoirs, including 11 multi-purpose dams, are supplying the necessary amount of water. However, what is the necessary amount of water? Environmentalists argue that the government policy-makers are planning to construct larger scale dams. Estimating the necessary wa-

ter quantity is based on two different conflicting criteria by two opposing groups. The government policy makers are forecasting the future water consumption based on the past trend analysis, whereas the environmentalists are forecasting the future water consumption based on the different scenario, for example, reduced consumption due to the higher water price mechanism, and more tree-planting projects in the mountains and valleys (Lee, 1998).

Regional disparity of precipitation is noticeable in South Korea. The Han River and the Kum River are relatively affluent, whereas the Naktong River and the Youngsan River are not. Drinking water supply is a serious problem to the Pusan residents located at the southernmost

port at the end of the Naktong River. Industrial and urban water use in the Taegu area above Pusan, and less than par wastewater treatment in the upper and middle parts of the River basin make the Naktong River situation worse (Kim, 1996; Local Autonomy Monthly, 1999; Korea Environment Institute, 1998).

Controlling flood in the summer months is becoming another serious problem. El Nino-caused floods hit the northern part of the nation in the last couple of years, and increased the number of human victims and the property loss and damage. Ultimately, human settlement in the flood-prone area should be discouraged. New land use planning and regulation are necessary. It is an irony for a small nation to confront the flooding in summer and water scarcity, drought, in spring, fall, and winter seasons.

2. WATER RESOURCES POLICY: ISSUES AND PROBLEMS

This paper discusses the conflicting water resources policy proposals from (1) water quantity and (2) water quality.

2.1 Water Quantity

Estimating the future residential water consumption depends on the future population size, future drinking water price, and future per capita

consumption. The Korean government established drinking water supply to 82.1 percent of the communities and per capita daily consumption 406 liter in 1994, and estimates 90 percent drinking water supply and per capita daily consumption 440 liter in 2001 and 95 percent and 480 liter in 2011 (Ministry of Construction and Transportation, Long Range Comprehensive Water Resources Plan, 1997-2011). See Table 1. The government estimates the industrial water use based on the industrial facilities' space times per space water use. There is an average unit consumption out of all kinds of industrial water consumption. The future industrial use is calculated by the government's plan for industrial park and industrial-agricultural park. Estimating the future agricultural water consumption is based on the same land size times the per unit water use, even though the farmland is reducing.

The government's estimates can be different among the different agencies. For example, the Industry Ministry's calculation of water use in steel is just half of the Construction Ministry. The agricultural use is about half of total water consumption under the subsidized water price.

Environmentalists want the underdeveloped and un-competitive agricultural sector is reduced, and its subsidized water price should be

Table 1. Per Capita Water Consumption

(Unit: liter)

| Nation | Water Consumption |
|---------------|-------------------|
| Great Britain | 267 |
| France | 211 |
| Germany | 196 |
| Netherlands | 195 |
| Italy | 293 |
| Japan | 367 |
| S. Korea | 408 |

Source: Korea Ministry of Environment, Environmental Statistics, 1996

Table 2. Comparative Productivity: Industrial vs Agricultural

| | | 1980 | 1990 |
|--|-------------------|--------------|------------|
| Total Consumption (100 million ton) | Total Consumption | 168.7(100%) | 272(100%) |
| | Residential | 23.0(13.6%) | 47(17.3%) |
| | Industrial | 7.2(4.3%) | 25(9.1%) |
| | Agricultural | 108.1(64.0%) | 150(55.1%) |
| | Maintenance | 30.5(18.1%) | 50(18.4) |
| Production Cost (100 million won) | Industrial | 162,008 | 385,906 |
| | Agricultural | 77,868 | 118,640 |
| Production Value by 1 ton(won) | Industrial | 22,595 | 15,436 |
| | Agricultural | 721 | 791 |

Source: Compiled from the 2nd and 3rd Comprehensive Water Resources Planning

abandoned. See Table 2.

Kim and Lee's estimate for metropolitan area water consumption is much less than the Korean Water Resources Corporation (KOWACO), the major government agency.

Their estimate factored in the water price actualization and income changes in their three different scenarios. Scenario 1 is based on annual growth rate as 6.6 percent, with no water rate hike; scenario 2 as 2.9 percent with no water rate hike; and scenario 3 as 2.9 percent with drinking water rate hike as 11 percent and industrial water price as 8.7 percent. Scenario 1 is a rosy picture and scenario 2 and 3 are more

realistic. The water price will play a key role in reducing the water consumption, but how influential is not very certain. Price elasticities are different from one researcher to another in the range of -0.1 to -0.7. Seasonable variable may be intervening. Many urban residents do not have flower garden and lawn to be watered as the middle-class American people. Sizable water price-hike happened in 1999 in Seoul and its vicinity and will happen in the immediate future in Taegu and its vicinity. Therefore, more empirical research works on price elasticities should be conducted in order to draw a convincing conclusion on the coefficient correlations between

Table 3. Drinking Water Price in World Cities

| City | Price (won/ton) |
|-------------|-----------------|
| France | 1,810 |
| England | 1,638 |
| Japan | 1,374 |
| Australia | 871 |
| U.S.A | 664 |
| Italia | 584 |
| South Korea | 240 |

Source: The Price of Trends in OECD countries, OECD, 1999
Korea Ministry of Environment, 1999

Table 4. Drinking Water Production Cost Vs Price

| | Urban Area | Rural Area |
|--------------------------|------------|------------|
| Production Cost(won/ton) | 117.5 | 375.7 |
| Price (won/ton) | 65.2 | 290.9 |
| Gap (%) | 55.2 | 77.4 |

Source: Korea Prime Minister's Office, Comprehensive Measures of Water Management, 1996

Table 5. Long Marginal Cost of KOWACO

(Unit: won/ton)

| Discount Rate | Scenario 1 (optimistic Scenario) | | | Scenario 2 (pessimistic Scenario) | | |
|---------------|----------------------------------|--------|--------|-----------------------------------|--------|--------|
| | Reserve rate | | | | | |
| | 10% | 15% | 20% | 25% | 30% | 35% |
| 8.5% | 224.89 | 233.33 | 240.56 | 376.51 | 398.67 | 419.46 |
| 10.0% | 239.37 | 249.04 | 257.29 | 415.34 | 440.65 | 464.39 |
| 11.0% | 249.28 | 259.80 | 268.74 | 442.31 | 469.78 | 495.54 |
| 12.0% | 259.46 | 270.84 | 280.50 | 470.10 | 499.78 | 527.62 |

Source: Kim Tai Yoo, et al, "A Study on Determining Optimal Water Price in Korean Multi-Regional Water Supply", in Vijay P. Singh, et al (eds). Water Resources Planning and Management, Highland Ranch, CO: Water Resources Publications, 1999.

water price and water consumption. Water price hike to actualize water production cost, that is 100 percent increase, may reduce at least 20 to 40 percent of consumption. However, the drinking water is a portion of much less than the agricultural use. Therefore, agricultural water price actualization is desirable. See Table 2, 3, 4. The government cannot abandon the subsidy, due to the farm household's income is conspicuously less than urban counterpart's. Farming population is still 10 percent of the total population; however, their productivity is conspicuously lower than American farmers in rice production, for example. Farmers are saying that the agricultural water returns to the river. Rice paddies, the main agricultural water use, return half of the used water to the river with fertilizer and insecticide before the harvest.

Korea's per capita daily water consumption, 408 liter, is higher than that of many Western nations; however, the water price is extremely

low. Average household's monthly water bill is equal to a cup of coffee in a city coffee house. Higher water consumption and waste water generation has been encouraged by low water price or subsidized water price so long. Tokyo is 3.3 times of Seoul's. Subsidized drinking water price is 50 percent of production cost and wastewater bill is 70 percent. The leaking from the drinking water pipeline is much serious than that of the Western nations. The 20 percent leaking is equivalent to one medium-size dam's storage.

In 1990s, Ministry of Construction & Transportation, Republic of Korea forecasted shortage of water supply by year 2006, 450 million ton/year, and by 2011 1,997 million ton/year, and expected dam building investment of 16 billion won. This kind of forecasting and investment plan will be dramatically scratched by the environmentalist's challenge. Environmentalist's power has grown, and is growing. Envi-

ronmentally conscious people are growing in number. They have already influenced President Kim Dae-jung to reconsider the last large-scale dam construction plan at the Dong River in Kangwon Province. The Korean people prioritized the environment care above the national security issue in the 1990's (Ku, 1999).

South Korea is neither a desert nor a semi-desert land. During the poverty stricken post-Korean War era, Koreans survived with very little water supply. Urban residents waited a long line with their buckets at the public water faucet. Compared to those days in the 1950s, Koreans enjoy a great economic affluence and abundant water supply. However, water surplus is not necessarily bad for the affluent society. As a matter of fact, water price hike is not enough for southern part of South Korea—the Nakdong River and the Youngsan River for dry or drought seasons. Without major dam constructions, South Koreans cannot overcome the water shortage for the dry and drought seasons. Korea has very limited choice.

2.2 Water Quality

River water quality was deteriorating in the 1990s, despite a serious monetary investment in wastewater treatment. The government has been generous to small polluting businesses and industries that could not afford to install anti-pollution devices. Pollution from the industrial parks and big businesses has been closely regulated by the Ministry of Environment. Cow, hog and chicken waste in the farm have not been regulated at all. The wastewater treatment systems were installed at 60 percent of the Korean communities. The government has a plan to set up 92 percent by 2011. Septic tanks are not effectively installed in the farm houses. The best available technology or the best practicable

technology has not been seriously discussed.

The Korean local governments are responsible to manage drinking water and wastewater treatment systems. However, they do not have enough money to create, manage modern wastewater plants. The authoritarian central government forced local governments to build the wastewater plants, but financing the plants after new local autonomous government law in 1995 made the situation worse. Paying the principal and interest for the construction loan, and financing the operation costs are not easy to many local governments (Choi, 1998). Wealth of the nation has been concentrated in Seoul and its vicinity and major cities. Many local governments simply cannot finance the wastewater plants with their own resources. How to allocate the national tax revenues to the local governments has been discussed, but nothing tangible has been achieved (Choi, 1999).

Controlling point sources is one thing. Controlling non-point sources is another matter. South Korea should find the means to control both point and non-point sources simultaneously. The central government's Ministry of Environment has more money than before, but the money is short to meet even urgent needs. The Ministry of Environment has attempted to create buffer zone between the river and the human settlement, and regulation based upon the river basin's total amounts of pollution. But the Ministry does not have money to purchase the buffer zone, and the residents violently protested the buffer zone concept on the ground of their property right. The Ministry finally imposed the water use fee to the affluent lower river basin residents to create the fund for the relatively poor upper river basin residents. It is a kind of cost-sharing design to transfer the money from the affluent town to the not so affluent town.

Table 6. Comparison of Korea's National and Local Tax Revenues

(Unit: bil. Won, %)

| Year | Total Amounts | National Tax | | Amount of increase | Local Tax | | Amount of increase |
|------|---------------|--------------|---------------|--------------------|-----------|---------------|--------------------|
| | | Amounts | % of increase | | Amount | % of increase | |
| '92 | 44,680 | 35,218 | 78.8 | 4,898 | 9,462 | 21.2 | 1,427 |
| '93 | 50,286 | 39,261 | 78.1 | 4,042 | 11,026 | 21.9 | 1,564 |
| '94 | 60,493 | 47,262 | 78.1 | 8,001 | 13,231 | 21.9 | 2,205 |
| '95 | 72,090 | 56,775 | 78.8 | 9,513 | 15,316 | 21.2 | 2,085 |
| '96 | 82,355 | 64,960 | 78.9 | 8,186 | 17,395 | 21.1 | 2,079 |
| '97 | 88,333 | 69,928 | 79.2 | 4,968 | 18,406 | 20.8 | 1,011 |
| '98 | 84,947 | 67,798 | 79.8 | -2,130 | 17,150 | 20.2 | -1,256 |
| '99 | 94,244 | 75,658 | 80.3 | 7,860 | 18,586 | 19.7 | 1,437 |
| '00 | 98,223 | 79,703 | 81.2 | 4,045 | 18,521 | 18.8 | -65 |

Source: Ministry of Finance and Economics, Tax Policy Department, 2001

The Han River and the Nakdong River basin have adopted the cost-sharing plan, and other river basins will adopt the cost-sharing plan sooner or later.

Development of environmental technology and environmental infrastructure need more investments from all possible sources. Korea's environmental technology development investment is 0.58 percent of GNP (1998). The Organization for Economic Cooperation and Development (OECD) nations' environmental budgets are 0.5 to 1.7 percent of their GNP, but South Korea's allocation is 0.58 percent in 1998 (Choi, 1999). South Korea's national budget has been skewed to the defense due to the confrontational situation with North Korea. Recently, South Korea's "sunshine policy" toward North Korea has gained some successes, so that converting the defense budget to the environment may be desirable and useful. South Korea should invest more money for water quality and water quantity programs than its defense from the North.

Economic development and growth prevail over the environmental quality since the so-called International Monetary Fund crisis in

1997. It should not. Incremental budget for environment may not be enough. One percent of the GNP and three percent of the government budget should be allocated to the environment. As long as the local governments manage drinking water and wastewater treatment systems, the central government should allocate its resources to the local governments dramatically. The present national and local tax system guarantees the 80 percent to 20 percent composition of revenues. See Table 6. Increased budgets should be spent for conducting environmental basic survey (for example, National Water Information System) and research and development. Replacing old leaking water pipelines (10 percent leaking goal by 2006), installing effective septic tanks in farm households, expanding buffer zone, and modernizing water technology (water resources data base, flood control / prevention technology, stream hydrology, design of hydraulic structures) must be the budget priorities. Introducing environmental tax has been seriously discussed in Korea, but has not been accepted. A comprehensive tax reform should be done. It is not an easy task. Maintaining good water quality requires money, first of all.

Rivers deny the man-made government jurisdiction. Four major rivers flow territories of many provinces and local governments into the ocean. The 1995 local autonomy act strengthened the separation of local government from neighboring local governments. Cooperation and coordination in the same river basin is difficult than before. Prior to 1995, South Korea was dominated by the central government. Water and sewer systems should be regionalized for the economic and efficient management as advocated by the Clean Water Act. River-basin approach or regional approach will bring up cooperation of local governments. Local governments will soon realize the necessity of cooperation in order to gain the common benefits from the river and regional water and sewer systems. South Korea's BOD is 52 times bigger than the US's due to limited nature with over-population (Park, 2000). Fertilizers, insecticides, and pesticides in the Korean farmland have been excessively used compared to the OECD nations. Korea's river is excessively polluted by non-point source such as fertilizers, insecticides and pesticides from farmland. See Table 7.

The decentralization of government functions or balanced approach to regional developments will help mitigate the nature's burden in Korea. Seoul and its vicinity have overdrawn population and growth, and as a consequence see the negative results: dysentery in Yongin City, Kyunggi province in March 2000. There is no sufficient water and sewer systems to support the new community in Yongin City. The Han River cannot accommodate any more population and industrial growth in Seoul and its surrounding Kyunggi Provide. The same will be true in the Naktong River basin. Nature's limited environmental and ecological capacity will decen-

tralize population and industrial growth in the future.

3. CONCLUSION

The scarcity of fresh water is becoming a global problem. The difficulty of securing a sufficient supply of fresh water is becoming more serious in a growing number of countries. It is appalling to hear that nearly a quarter of the world's 6 billion people have no access to safe drinking water, while almost half lack adequate sanitation. A more chilling prediction has it that more than 3 billion people will suffer from water shortages by around 2025.

The United Nations (UN) has already said a water crisis is looming and predicted that by 2010 the crisis could develop into conflicts and wars. It is urged that dramatic improvements in providing, managing and saving water be made immediately. There are already 80 countries with inadequate water supplies, and almost 40 percent of the world's population must struggle daily to try to meet their water needs, according to statistics released by the UN.

In an effort to address the global water crisis, the Global Water Forum was held in The Hague under the theme of "Water for the 21st Century," in March 2000. The conference, also aimed at enhancing public awareness of the seriousness of the situation, was attended by thousands of famous, politicians and representatives of non-governmental organizations.

What makes matters worse is that while a growing world population must meet its needs with a finite amount of water, usable supplies are being reduced by pollution from industries and sewage, waste through leaking pipes and human greed. The World Bank estimates that as much as \$600 billion needs to be invested in water delivery systems.

Table 7. OECD Nations' Fertilizer Use

| | Intensity of Commercial Nitrogen and Phosphate Fertilizer (apparent consumption per km ² of agricultural land) | | | | Agricultural Production | | Agricultural Value added |
|-------------|---|--------------------|----------------------------|---------------------|-------------------------|---------------------|--------------------------|
| | Nitrogen | | Phosphate | | Crops | Total | |
| | Tones/km ² 1995 | %Change since 1980 | Tones/km ² 1995 | % Change since 1980 | % Change since 1980 | % Change since 1980 | % GDP 1995 |
| Canada | 2.2 | 63 | 0.9 | -1 | 50.5 | 39.2 | 2.1 |
| Mexico | 0.9 | -1 | 0.2 | -14 | 16.9 | 34.7 | 5.0 |
| USA | 2.6 | 3 | 1.0 | -17 | 14.4 | 20.9 | 1.6 |
| Japan | 10.4 | -8 | 12.4 | -2 | -9.0 | 3.6 | 1.9 |
| Korea | 22.3 | 12 | 10.6 | 38 | 31.8 | 55.0 | 6.5 |
| Australia | 0.1 | - | 0.2 | 17 | 84.9 | 36.0 | 3.4 |
| N. Zealand | 1.0 | - | 2.7 | 18 | 65.3 | 17.6 | 8.3 |
| Austria | 3.2 | -26 | 1.7 | -38 | -3.5 | 7.7 | 1.5 |
| Belgium | 10.0 | -13 | 3.2 | -50 | 46.1 | 30.7 | 1.3 |
| Czech Rep | 5.9 | -40 | 1.6 | -78 | -6.5 | -13.0 | 4.1 |
| Denmark | 10.3 | -20 | 1.7 | -56 | 43.4 | 22.0 | 3.6 |
| Finland | 7.0 | -3 | 2.8 | -48 | 9.0 | -4.3 | 3.7 |
| France | 8.0 | 18 | 3.4 | -39 | 10.5 | 6.0 | 2.4 |
| Germany | 10.3 | -17 | 2.3 | -65 | 13.2 | -2.0 | 1.0 |
| Greece | 3.9 | 7 | 1.7 | | 15.7 | 13.6 | 12.0 |
| Hungary | 4.2 | 7 | 1.7 | -91 | -25.2 | -25.8 | 7.2 |
| Iceland | 0.6 | -48 | 0.5 | -42 | -41.1 | 17.9 | 8.9 |
| Ireland | 7.6 | -29 | 0.3 | 1 | 7.6 | 16.6 | 5.7 |
| Italy | 5.7 | | 3.4 | -20 | -10.9 | -4.3 | 2.9 |
| Netherlands | 18.1 | -23 | 2.9 | -20 | 36.8 | 18.9 | 3.1 |
| Norway | 11.0 | -5 | 3.1 | -52 | -1.8 | 6.7 | 2.5 |
| Poland | 4.5 | -34 | 1.6 | -65 | 34.0 | 0.1 | 7.6 |
| Portugal | 3.5 | 1 | 1.6 | -10 | 8.6 | 36.6 | 3.7 |
| Spain | 2.9 | 1 | 1.6 | 5 | -14.3 | 0.5 | 2.9 |
| Sweden | 6.0 | -13 | 1.4 | -59 | -3.3 | -3.8 | 2.0 |
| Switzerland | 3.6 | -3 | 2.0 | -26 | 2.7 | 1.2 | 3.0 |
| Turkey | 2.7 | 27 | 1.5 | -9 | 37.3 | 36.2 | 15.7 |
| UK | 8.1 | 16 | 2.2 | -2 | 18.7 | 10.0 | 1.7 |
| OECD mean | 2.1 | 4 | 0.9 | -24 | | | 2.6 |

Source: Compiled Data from OECD Publications, 1998

The situation in Korea is no exception. Suffering caused by difficulties in securing sufficient water is increasing. Korea has annual pre-

cipitation of 1,274mm, 1.3 times higher than the world average of 973mm. But per capita rainfall stands only at 2,755 tons, far lower than world

average of 20,296 tons due to its population density.

The U.N. Population Action Institute (PAI) classified South Korea as a nation in a group of countries lacking in water supply, having a per capita supply of less than 2,000 cubic meters per year. Moreover, the situation is getting worse. Korea's per capita water supply, which stood at 1,470 cubic meters in 1993, is forecast to drop to 1,199 cubic meter in 2025. Other nations on the PAI list include Cyprus, South Africa, Morocco, Egypt and Poland.

According to statistics from the Construction and Transportation Ministry, Korea will see a shortage of 400 million tons of water in 2006 and two billion tons in 2011. However, few Koreans seem to regard water shortages seriously. They have long considered abundant water for granted (Ministry of Construction and Transportation, 2000).

Despite the dwindling resources, Korea's per capita daily water consumption of 395 liters is the highest among the 29 member nations of the OECD. The amount stands at 296 liters in France, 132 liters in Germany, 246 liters in Denmark and 393 liters in Japan.

Water Scarcity will deteriorate water quality. Dam construction is opposed by environmentalists who advocate water conservation and water price hike. South Korea needs ironically both dam construction, water conservation and water price hike at the sametime.

Agricultural water consumption is almost half of all water consumption, so that agricultural water conservation and price hike are necessary, but they are extremely sensitive policy suggestions, because farmers income is just about half of urban dwellers. Waters price actualization is nevertheless badly needed in all sectors.

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