Effective management of indispensable water resources is crucial for national and regional economic growth as well as social welfare in the long run. Furthermore, ubiquity of water resources and the effects from the accelerated climate change have emphasized the importance of sustainable water environment policy for appropriate utilization of water resources. Although at present countries’ progress towards a sustainable development path is achieved by a country or an international organization, there has been lack of policy implications as a framework for monitoring and accountability for sustainable water use.

This study is conducted in partnership with the United Nations University Institute of Water, Environment and Health (UNU-INWEH) in Hamilton, Canada, and United Nations Office for Sustainable Development (UNOSD) in Incheon, Republic of Korea. The purpose of this study is to understand current status and national aspirations for various elements essential to sustainable water resource management and implementation resources and strategies necessary to achieve these aspirational targets. The study will offer a starting point for developing implementation plans to achieve water-related goal(s) under the Sustainable Development Goals (SDGs).

I would like to express my gratitude to Dr. Jong-ho Ahn and all those who have conducted this research along the way. In addition, I would also like to extend my gratitude to advisory committee members for their participation in our consultation and their advice despite the busy schedule.

Henceforth, in the process of establishing a target for Sustainable Development Goals, I hope that Korea’s case study would become a valuable reference and an opportunity to introduce Korea’s policy outcomes.

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Abstract

Korea is located in Northeast Asia along the rim of the Pacific Ocean, where the climate is relatively warm and humid with four distinct seasons. The annual rate of precipitation is high at 1,277mm, but varies regionally, making the water resource availability also variable across the country. The seasonal variations of precipitation, on the other hand, cause a frequent flooding and drought cycle, which is one of the main challenges of water resource management in Korea. Also climate change has been emerging as a major compounding factor for this issue, thus prompting a set of response measures to be adopted immediately.

The development of water resources, which is closely linked with economic development, has always been considered as a major national agenda throughout the nation’s history. Despite the vulnerable characteristic of the main source of water supply being surface water, public water supply nearly six-folded over the last four decades (from 1965 to 2007), from 5.1 billion m³ to 25.5 billion m³. The percentage of households with access to water service has gone up from a mere 20% in the early 1960s to 98.1% in 2012. At the same time, the sewerage connection rates have also grown rapidly, from almost none to over 90%. The key to success for this dramatic progress was the strenuous efforts made by the government to develop and manage water resources, including the timely preparation and aggressive implementation of environmental policies during the late 1980s, when the environmental pollution caused by industrialization and urbanization started to surface and be perceived by the public. The proactive efforts to educate expert engineers and scientists in the field of water resource management should be counted as another key success factor.

The Ministry of Land, Infrastructure and Transport (MOLIT) is in charge of

the development of water resources such as rivers and dams in the country as a whole, while the Ministry of Environment (MOE) is in charge of investment and operations of the infrastructure that preserves water quality. The set of major laws and regulations that support the water management and utilization framework in Korea includes “River Act”, “Groundwater Act” and “Act on Dam Construction and Assistance, etc. to Neighborhood Areas”. The MOLIT is responsible for administering these laws for national water supply and flood management. On the other hand, “Water Quality and Ecosystem Conservation Act”, “Water Supply and Waterworks Installation Act”, “Drinking Water Management Act”, “Promotion of and Support for Water Reuse Act” and “Act on Water Management and Resident Support in the Four River Basins” are governed by the MOE. In addition, the Ministry of Agriculture, Food and Rural Affairs (MOAFRA) oversees “Rearrangement of Agricultural and Fishing Villages Act”. The mid- and long-term national water resources agendas are pursued by these central government bodies, while local governments are responsible for regional-level planning and implementation. Every ten years, the MOLIT establishes national long-term water resource plans and the MOE establishes a national waterworks plan. Various administrative guidelines exist for the planning, financing and completion of water projects, as well as for transparent financial operation with proper monitoring. Government’s financial aids for water projects are generally provided based on the implementation plans drafted by the local governments and followed by annual assessments that determine the levels of support for the following year.

One of the major challenges in recent years in Korea is the institutional fragmentation and over-decentralization of the utility sector. Currently, the water and aquatic eco-system qualities are regulated by the MOE, while the water quantity management by the MOLIT. This segregation has turned out to be one of the barriers to an integrated water management system, which is strongly demanded due to climate change issues. Therefore, water resource related laws are required to be consolidated for systematic management of water quantity and quality, water rights and aquatic eco-system. The need for a consolidated legislation has been gaining support from the experts and the water industry for many years, but the central government’s stance on this
issue is still unclear. On the other hand, recently, there has been a strong push by the government toward the consolidation of the water and wastewater utility sector to improve management and economic efficiency. The average operation rate of water and wastewater treatment facilities was 80% in 1991, and later declined to 50% in 2006. The main cause of the problem was the continuing over predictions of capacity and the failure of economies of scale made at the time of investment planning stages. The government is making efforts to establish a set of investment planning guidance and also to revamp overall operations system, to better fit the actual demand by consolidating the facilities.

Another important issue is how to secure sustainable financial policies. The revenue from the public water and wastewater services is not sufficient to cover the expenses, and government subsidies have been the main source for balancing expenses, improving, and expanding the nation’s water and wastewater treatment facilities. The amount of the government subsidies is determined by considering the total amount of investment and the location of the facility as the government is working to reduce the gap between urban and rural wastewater services. However, the current subsidies-heavy financing structure has been one of the major concerns for a while. In some case, the national average water tariff (610.2 KRW/m³ in 2010) covers only 78.5% of the production cost (777.2 KRW/m³), and the remainder is being compensated by the government subsidies. Over the past several years, the government subsidies for water and wastewater services have been maintained at a level of around 10%4. The government plans to phase the subsidies out gradually, considering the balance between current macroeconomic status and public spending. For wastewater service, the ratio of expenses recovered by the revenue had gradually increased to 62.5% by 2004, dropping again to 40% in 2009 (national average sewage tariff is 240 KRW/m³, 38.3% of the total production cost of 715.6 KRW/m³)5. The government has been strongly promoting privatization of sewage services, in order to more realistically reflect the actual cost of wastewater treatment, to maximize the return on investment, and ultimately to reduce the government

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subsidies. The privatization plan is expected not only to improve the operation efficiency and quality of services and to reduce the financial burden of the local government, but also to improve the environmental quality. So far, private companies had been constructed and been operating over 100 sewage treatment facilities between 1998 and 2008, and as of 2009, about 70% of the nation’s wastewater treatment facilities were being operated by private companies\(^5\). This trend is expected to continue, especially as longer-term operations contracts will be permitted in a foreseeable future.

An array of water environment changes such as climate change and growing expectations with respect to public welfare, including water and wastewater services, has created new issues in terms of the sustainable water use. Therefore, a set of new and expanded policies for water resource management and water services is needed to tackle the climate change issues such as urban flash flooding and higher drought risks, and to suit the higher standards of living that demand better access to high quality water for leisure, tourism and exercise. As a prerequisite, the new dimensions of functions and values of water should be recognized, appreciated and framed accordingly among policy makers and decision makers.

Keyword : Sustainable Development, Water Management, WASH, Water Governance
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I. Background

Once agreed to by the World’s governments, the Sustainable Development Goals (SDGs) will provide an international framework that will enable countries to better target and monitor progress across all three dimensions of sustainable development and enable realization of green economy approaches. It is important to keep in mind that the goals will be applicable to all of their level of development, which underlines the need for understanding how their implementation will take place in a broad range of social and economic conditions. Moreover, successful implementation of sustainable development agenda in the post 2015 era requires governments to play an important role in setting national targets, addressing potential implementation challenges, and providing an enabling environment for advancing implementation. In particular, a critical key feature of the SDGs will be linking water-related SDGs to the national development strategies and reliable monitoring for informed decision-making on public.

Main objectives of this study are as follows:

- Developing narratives for water SDGs consistent with the current status and national development priorities, which include articulation of target(s);
- Analyzing potential roadmaps and governance scenarios for meeting national targets that would also advance green economy principles;
- Assessing means of implementation to achieve the national targets, including analysis of potential resource mobilization strategies; and
- Undertaking a cross-cutting review of national studies in order to

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understand core similarities and differences that can start to establish linkages between national and global goals.

This study will serve two important purposes. First, it will enhance understanding about the feasibility of various narratives and the approaches that could be used to set national targets, including assessment of resource requirements. Second, the study will offer a starting point for developing implementation plans to achieve water-related goal(s) under the SDGs.

The following themes are developed for target setting at national level: (i) improving water governance; (ii) water, sanitation and hygiene (WASH) access; (iii) water management and sustainable use/reuse; (iv) water quality. The current status of each target within the themes are compared with the aspirational targets set forth to be accomplished by 2030, leaving the differences required for these targets to be achieved. Focus on each of these statuses and their relationship to each other in order to best understand how to properly continue to assess resource requirements. The study will identify strategies for resource mobilization, including approaches for capacity development and for facilitating transfer of suitable technologies. These will be viewed in the form of a needs and implementation assessment for each of the themes.
II. Status

1. Water Resources

Korea’s annual average precipitation is 1,277mm (1978~2007), which is higher than the global average (807mm), but the total annual precipitation per capita, which is only one-sixth of the global average, is at 2,629m$^3$, mainly due to its high population density (501 capita/km$^2$)$^7$. Nearly 70% of the annual precipitation is predominantly concentrated in the wet season from June to September, posing a huge challenge in managing water resources. The total amount of available water resources is 75.3 billion m$^3$ per year excluding the losses due to evapotranspiration, and often drops during a drought year as low as to 45% of the level of normal years (approximately 33.7 billion m$^3$ per year). Total annual national water usage amounts to 33.3 billion m$^3$, 44% of the available fresh water resources, most of which are streams and rivers (29.6 billion m$^3$). Therefore, water usage is susceptible to the changes in river flows, and efficient utilization of surface water reflecting its seasonality is extremely important for sustainable water resource management. Such a high dependency of surface water makes Korea a “water stressed” country based on the Population Action International (PAI) standard.

There are 3,833 rivers and streams in South Korea with the total length of 29,839km of which 74.2%, mainly based on medium to large sized rivers and streams, is controlled in accordance with the “Long Term Water Resource Management Master Plan”, a national plan revised every ten years$^8$. The total capacity of dams and reservoirs is 18,771 million m$^3$ (10,883 million m$^3$ from multi-purpose dams, 1,335 million m$^3$ from hydro-electric dams, and 6,553 million m$^3$ from miscellaneous dams). Capacity addition of 314 million m$^3$ (multi-purpose dams) and 994 million m$^3$ (miscellaneous dams) is planned to

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be completed by 2020, and the resulting total capacity will be 20,079 million m$^3$/year$^9$. On the other hand, the rechargeable capacity of groundwater aquifers (i.e., the volume extractable keeping the steady-state groundwater level unchanged) is estimated at 10,852 million m$^3$/year, approximately 66% of the total estimated volume of the nation’s groundwater aquifers. The annual groundwater use was tolled at 3,725 million m$^3$ in 2007, having been more or less stabilized since 2003. The projected use of groundwater in 2016 is 4,044 million m$^3$, about 10% higher than that of 2007. Other sources of fresh water, however minor, include desalination of sea water, rainwater harvesting and reuse of treated wastewater, which is expected to grow as is being encouraged by the government$^{10}$.

The total flood control storage capacity of the dams is 5.14 billion m$^3$/year, including 2,198 million m$^3$/year by multi-purpose dams and 266 million m$^3$/year by hydro-electric dams. The total capacity of flood control is expected to grow by 8.5% to 5.58 billion m$^3$/year by 2020, based on the current plan for additions$^{10}$. The recent floods show that the extent of flooding is decreasing whereas the amount of flood-related property damages is sharply increasing. The total property damage from a recent five-year period (2002~2006) was estimated at USD 22,262 million. Water supply shortage issues in most areas have been resolved, however, a deficiency of up to 160 million tons (based on the five-year-frequency drought scenario) ~ 430 million tons (based on the worst-case drought scenario), most of which will be suffered by islands, coastal and remote mountain areas (as of 2020)$^{10}$, still exists. In the meantime, according to the A2 global warming scenario$^{10}$, the average temperature is projected to increase by 2.03 °C from 12.5°C (1971~2000) to 14.53°C (2031~2060), the average annual precipitation by 6% from 1,230mm (1971~2000) to 1,299mm (2031~2060), and the drought period from 0.5 months to 1.7 months$^4$. These predictions, alarming as they are, stress the importance and urgency of a more sustainable water resource management framework for the nation.

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$^{10}$ The A2 scenarios are of a mare divide world. The A2 family of scenarios is characterized by : (1) A world of independently operating, self-reliant nations, (2) Continuously increasing population, (3) Regionally oriented economic development
2. Water, Sanitation and Hygiene (WASH) Access

The nationwide public water supply coverage was 98.1% as of 2012, or 95.1%, even though the populations who get their services through small and/or community-based water supply system\textsuperscript{11} are excluded. This coverage is considered very high even among high-income countries, but the supply gap between urban and rural areas still exists and is widely considered as an important social issue. Therefore, the need for additional investment to accommodate rural areas with better public water services is widely shared. The average service coverage exclusively within rural areas was 62.2% as of 2012, which is significantly lower than the national average (95.1%). In a recent publication, the MOE announced a plan to increase the access to services in rural areas to 90.2% by 2030\textsuperscript{12}. The service coverage in urban areas, 98.9%, indicates practical service saturation\textsuperscript{12}, and the main focus of water service in urban areas should be water quality. Thus, the MOE is planning to increase the implementation ratio of advanced treatment facilities, from 19% in 2012 to 77% in 2030\textsuperscript{13}.

The total amount of water demand in 2010 was 17,426,000 m\textsuperscript{3}/day, and the growth trend is expected to stabilize by 2030. However, the interregional variation in water demand is expected to keep increasing with continuing urbanization. The projected water demand by 2030 is 18,928,000 tons/day, and is expected to go down to 17,847,000 tons/day by 2050 due to the predicted decrease in the population. Based on the existing water supply capacity, the estimated shortage in water supply is 3,262,000 tons/day (or 6,071,000 tons/day if a development plan is considered), which is 17% of the total projected demand of water (or 28% if a development plan is considered) in 2030, when the water demand is expected to peak\textsuperscript{13}.

Among 528 wastewater treatment plants with capacities over 500 m\textsuperscript{3}/day located in 164 different local government jurisdictions, 153 (30%) were directly managed by the local governments to which they belong, 89 (12%) by

government-owned corporations, and 286 (58%) by private companies according to a 2010 review\textsuperscript{13}. The same review records 400,000 small-scale on-site treatment facilities scattered in the rural areas to avoid costly long collection lines. One of the most urgent issues in wastewater services is also reducing the service accessibility gap between urban and rural areas and/or between different local governments. The national average percentage of access to wastewater service reached 92% in 2012 as an outcome of the continuous past efforts to improve the service accessibility, but at the same time, the rate recorded in rural areas was mere 56%. The government is trying to increase this rate to 75% by 2015\textsuperscript{14}. On the other hand, there are some rising issues including the institutional consolidation for the over-decentralized utilities, stormwater management, and enhancing sustainable water cycle through reuse of treated wastewater.

Open defecation no longer prevails in Korea, as the ratio of flushing toilets in rural areas was reported at 84.8% in 2012\textsuperscript{15}. The contents of unconnected septic tanks or other on-site sewage treatment facilities are typically transported to night-soil treatment plants (195 in operation at the end of 2010). Only 64.6% of public schools in Korea are provided with school nurse services as of 2009, and the Ministry of Education has already published a plan to increase the coverage to 100% by 2030\textsuperscript{16}.

3. Water Management and Sustainable Use/Reuse

3.1 Industry & Agriculture

According to the statistical data published by the Bank of Korea, the contribution of the service industry to GDP is 59.1%, highest among all industries in 2013, followed by 31.1% from the manufacturing industry, 5.0%
from the construction industry and 2.3% from the agriculture/fisheries industry. The contribution of the manufacturing industry has grown by 4.32% since 2012, while the agriculture/fishing industry has grown by 0.69%\textsuperscript{17}. The demand for industrial water use naturally depends on the economic status and outlook. Indeed, the data analysis shows that the growth of industrial water demand is a definite indicator of the economic growth. The total amount of water used for industrial purpose was recorded at 4,533 million m\textsuperscript{3} in 2007. Approximately, 46% of the demand was covered by the public water services, while the remaining 54% was recycled industrial process water. The predicted public water demand for industrial-purpose use in 2020 is 3,205 million m\textsuperscript{3}/year, a 45% increase from 2007. Efforts are being made to reduce it by 2,202 million m\textsuperscript{3}/year, and make the remaining 68.7% of total use provided by on-site reuse\textsuperscript{18}. The total reuse of industrial water in 2008 was 62,037,000 m\textsuperscript{3}/year, out of which 46,993,000 m\textsuperscript{3}/year was gray water from factory facilities and 15,044,000 m\textsuperscript{3}/year from wastewater treatment facilities. The MOE is working to improve the reuse significantly, up to 62,563 m\textsuperscript{3}/year, by 2020\textsuperscript{19}.

Water demand for agricultural-purpose is closely related to farmland area and depends also on a number of associated policies. The total farmland area measured in 2007 was 1,728,000 ha (1,070,000 ha of rice paddies and 712,000 ha of other general farming fields), and reflecting the recent decreasing trend the projected area for year 2020 is 1,638,000 ha (963,000 ha of rice paddies and 675,000 ha of general farming fields). Accordingly, the demand of agricultural water is expected to go down from 15,909 million m\textsuperscript{3}/year in 2007 to 15,399 million m\textsuperscript{3}/year in 2020\textsuperscript{20}. The research on the virtual water of crops is still in its infancy, and it appears that there is no standardized methodology in Korea. In the research conducted by Seungwhan Yoo et al. (2009), the total estimated agricultural virtual water was 15.07 billion m\textsuperscript{3}, while that of rice, the most

\textsuperscript{17} Ministry of Education, Science and Technology(2009), “Outlook of Supply-Demand of Primary and Secondary School Teacher During 2009-2030”


\textsuperscript{19} Korean Ministry of Environment(2010), “A Study for Establishing Water Reuse Master Plan”

representative crop in Korea, was 1,600.1 m³/ton.

About 678 million tons/year of treated wastewater is being reused, and the ratio of the amount of reused water to the total treated wastewater was 10.8% in 2008. The most reused purpose was to maintain functional river stages, followed by industrial purpose and agricultural purpose. Reusing for the industrial and agricultural purposes is encouraged by a number of government policies and thus growing steadily.

For example, the “Water Reuse Act” was enacted in 2010, and has since provided a legal basis to establish a national “Basic Water Reuse Plan” every 10 years. The very first national water reuse plan, having been pursued since 2010, aims to increase the total reused wastewater to 1,576 million m³/year, which is 5.7 times higher than the amount reused in 2008. The equivalent target reuse ratio is 20.3%, of which 507 million m³/year (32%) will be used for industrial purposes, 106 million m³/year (7%) for agricultural, 778 million m³/year (49%) for river and stream management, and 185 million m³/year (12%) for general urban use purposes. The total amount of water discharged from 60 industrial-scale wastewater treatment plants across the country was recorded at 631,589 m³/day at the end of year 2008. A pilot program to reuse 28,470,000 m³/year has been launched at seven selected plants.

3.2 Energy

The consumption of fossil fuel energy in Korea is expected to grow at an average rate of 1.5% per year until 2030, and the consumption of electrical energy is growing even faster with a growth rate of 3.2%. Accordingly, developing new renewable energy sources and associated technology to break fossil fuel dependency became a highly important subject. The portion that renewable energy sources occupy in the total energy was meager 2.79% in 2008. The current national renewable energy target is 11.27% by 2030, and the policies aim to shift the current portfolio that heavily depends on the waste heat toward employing more natural renewable energy sources such as

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biogas, solar and wind energy\textsuperscript{24}. The total consumption of energy produced by non-renewable source was 200.1 million TOE in 2011, and the projected total consumption in 2030 is 245.6 million TOE. To reach the national target, however, this should reduce by at least 11.5\%, or to 217.3 million TOE\textsuperscript{25}.

Water and wastewater services are energy intensive, and the electricity consumed in water and wastewater facilities (3,232GWh\textsuperscript{26}) accounts for 0.49\% of the overall and 12\% of the public-sector annual electricity consumption (27,384GWh\textsuperscript{28}). The energy consumed for wastewater treatment has been increasing at an annual growth rate of 10\% due to both expansion of the services and the efforts to meet stricter emission regulations. The most energy intensive parts of wastewater treatment facilities are aeration blowers and induction pumps, which typically take up 60\% of the total consumption. Some energy can be recovered during the treatment, mostly from the heat generated during sludge digestion (75\%), and 59 out of the nation’s 347 wastewater treatment facilities are now equipped with waste heat recovery facilities, for which the total capacity of sludge digestion was measured at 413,558 m\textsuperscript{3}/day in 2007\textsuperscript{29}.

The MOE is in the process of implementing a plan to reduce the energy consumption of wastewater treatment facilities through application of green technologies and to increase the use of on-site renewable energy sources. If successful, the off-grid energy use rate by the wastewater facilities will grow to 50\% by 2030\textsuperscript{30}. Hydro and pumped storage power generations represent just 0.8\% and 0.7\% of the total electricity generation, respectively, as of 2012\textsuperscript{31}, and therefore, there have been no major water supply issues with respect to generation plants (thermal plants and nuclear plants) because most of them

\textsuperscript{24} Ministry of Trade, Industry and Energy(2008), “3\textsuperscript{rd} Basic Planning for Renewable Energy Technology Development, Use and Supply (2009-2030)”
\textsuperscript{25} Ministry of Trade, Industry and Energy(2014), “2\textsuperscript{nd} Energy Basic Planning”
\textsuperscript{26} Korean Ministry of Environment(2012), “Statistics of Waterworks 2011”
\textsuperscript{27} Korean Ministry of Environment(2010), “Master Energy Independence Plan”
\textsuperscript{31} Ministry of Trade, Industry and Energy(2008), “3\textsuperscript{rd} Basic Planning for Renewable Energy Technology Development, Use and Supply (2009-2030)”
are located in the coastal areas and use sea water as cooling water. The hydro-electric generation in the nation is not significant, but it is still considered as an important part of the energy supply as an emergency power source.

### 3.3 Ecosystem Service

The total wetland and forest areas are 2.67% (coastal wetland 2,487.2km² and Ramsar wetland 177km²)\(^{32}\) and 63.9% (6,369,000 ha)\(^{33}\) of the land, respectively, of which 10.3% are designated protection area. The portion of protected area is planned to be increased to 17% by 2020\(^{33}\).

### 4. Water Quality

The public wastewater service coverage in 2012 was 91.6%. Out of the nationwide total of wastewater generated per day, 15,722,000 m³, only 6.5% is generated outside the sewage service zone. There exist more than 546 sewage treatment plants with their capacity over 500 m³/day\(^{34}\). Sewer pipes in most large cities, unless they are relatively new, are the combined type, which is not an ideal situation for separate treatment of stormwater. According to the weather data collected over the last three decades, the peak rainfall intensity has been increasing, and the current national average of the peak is 76.8(±15.3)mm/hr. However, only 20% of the local governments have facilities that can withstand such intensity, which is close to the 30-year frequency intensity (70mm/hr), or higher. The probability of the peak rainfall intensity over 70mm/hr based on the data from the past 30 years is 52%.

The water quality standards for the effluent discharged from wastewater treatment plants have been carefully and successfully managed for biological oxygen demand (BOD) target. As for the non-biodegradable, inorganic nutrients such as nitrogen and phosphorus, however, quality management has been more challenging. In a water quality assessment in 2014, 98 out of

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\(^{32}\) www.index.go.kr/portal


114 major rivers monitored (86%), were reported meeting the “Good” quality standards, overachieving the management target of 86%. On the other hand, only 33 of 49 (67%) major lakes and reservoirs across the country were rated as “Good” quality, not reaching the target of 94%. This is mainly because the criteria for the removal of nitrogen and phosphorus for wastewater, a point source of pollution, were unrealistically high based on the available technologies at that time, as well as due to insufficient management as a result of improper system, insufficient investment and poor technical review on point sources of pollution associated with industrial wastewater and other related treatment. It is also partially due to the lack of understanding and management plan for diffused sources of pollution, which represent a substantial portion of the pollution in the water stream. Recently, the regulatory criteria have been tightened, and investments are being made, targeting phosphorus treatment to prevent eutrophication. However, nitrogen problem is still largely overlooked both for point and non-point sources even though it is one of the fundamental ingredients of non-biodegradable contaminants. It is necessary to strengthen nitrogen management in the wastewater treatment plants, as the biggest known source of nitrogen pollution. Introduction of total organic carbon (TOC) is also planned as a new indicator of discharge water quality for more systematic and scientific water quality management.

Any unauthorized discharge of industrial wastewater is prohibited in Korea, and the party discharging effluents to environment assumes liability in any pollution damages caused, according to the “polluter pays” principle. However, there are practical limitations for the local governments to administer the principle on the illegal dischargers, and public awareness on potential harm and liability of illegal discharges need to be raised. In addition, water quality standards related with industrial effluents need to be reviewed for additional hazardous chemical substances and endocrine disruptors that may have significant impacts on human health and environment but are not currently regulated. The 60% of industrial wastewater is treated at individual

small-scale on-site treatment facilities and is discharged directly to the water ecosystem, while 40% is transported to and treated at the public wastewater treatment plants. Therefore, the set of standards applied for industrial wastewater should be designed differently from those applied for the wastewater treatment facilities reflecting the fate of discharge. Some endocrine disruptors other than phenol, which is currently regulated, may need to be added as pollutants for treated water directly discharged to the water eco-system. Chemicals causing problems in bio-treatment processes in treatment facilities should also be identified and managed for industrial wastewater transported to and treated at wastewater treatment plants. Currently, a new system is being established to monitor and report the water quality of effluent discharged from individual wastewater treatment facilities and wastewater treatment plants, and will be expanded to include a wider range of regions using a new automated measurement network.

Agricultural pesticides and chemical fertilizers are major non-point sources of pollution, and the total use per unit area in 2013 was 10.9kg/ha for pesticides and 262kg/ha for fertilizers, according to the statistics published by the MOAFRA\(^\text{36}\). The river and stream pollution by non-point sources was estimated to be responsible for 68\% of the total pollutant loadings in 2010, which is projected to reach 72\% by 2020 due to urbanization and resulting increase of paved impervious areas. The efforts to improve the water quality through the management of point sources are generally expected to mature in near future. Nearly KRW 12 trillion has been invested for management of point sources over 13 years (1998~2010) for the Han River only, while quality targets are yet to be met. BOD is continuously improving since the late 1990s, but chemical oxygen demand (COD) improvement, due to the persisting non-degradable substances, has been slowing down since 2000. Stormwater is suspected as the main culprit of the problem, calling strongly for the better management of non-point sources\(^\text{37}\).

\(^{36}\) Ministry of Agriculture, Food and Rural Affairs(2013), “2013 Agrichemical Year Book”

III. Implementation

1. Water Resources

Climate change is causing unusual drought disasters and intense flooding damages, while the public is demanding higher quality drinking water and better access to water for tourism and leisure activities. Multiple river and stream restoration projects have been successful in securing and managing water resources, and they are better adapted to climate change. Those projects also have made substantial contributions to the academic research and understanding of water resources and associated technological developments. However, a paradigm shift is needed to integrate the sustainability within the current water management framework, improve the water-related laws and policies, and reform institutional framework and its associated systems. At implementation levels, in particular, technologies to collectively and systematically control the quality and quantity issues of water simultaneously, and a collaborative administration and management system should be addressed as a top priority.

The fifth “Long Term Water Resource Management Master Plan (2011~2020)” contains three major goals, with the vision of “2020 Water Leader, Green Korea”: fresh and abundant water supply both for people and for nature, progressive water technology development and proactive water resource management research and development (R&D). The master plan also includes active measures of preparing drought contingency water resources by constructing eco-friendly mid-/small-scale dams and launching public groundwater supply services for the areas vulnerable to drought, together with other measures to diversify the sources of fresh waters, riverbank filtered and/or underground-dammed groundwater and desalinated sea water. Significant efforts are also required to resolve the regional conflicts of distribution, use and development of water resources, and to keep the water resources stable and their usage efficient. While it is expected that the flood risk will increase in the future due to more intense rainfall linked with climate
change, the four major rivers seem to have brought most of the flood risks in the main streams under control. However, enhancement of flood prevention capabilities for tributaries and small-scale rivers and streams are still an ongoing issue. In addition, there are several other areas that should be addressed, including stormwater management system, floor risk maps and flood forecasting system. At the same time, a plan is being implemented to reach 90% of the level of the best available technologies of the advanced countries through systematic R&D. The R&D roadmap includes the development of technologies to dominate new markets in the water resource management industry such as: the one that predicts the effects of climate change on the water resource availability; another to utilize existing water resource facilities to better adapt to climate change; the ones created by matching and staging various technologies available in high-tech industries such as IT, BT, ET and NT for establishment of an urban energy-saving water use and reuse systems; and technologies involved with the development of a smart water grid.

2. Water, Sanitation and Hygiene (WASH) Access

Since the 1960s, Korea’s public water and wastewater services have expanded at an outstanding speed; the public water service rate that was only 19% in 1960s is now a near 100%, and over 90% of wastewater is now being treated while almost no treatment was available in the 1960s. The success factor that has driven such fast progress was the demand for water and wastewater infrastructure and services based on the sharp growth of the economy. The government has been implementing proper financial schemes in an effective and timely manner both for the public and the private sectors, along with an institutional framework for management.

Despite the progress, a gap between urban and rural service accessibility exists, and it becomes one of the most urgent issues that should be addressed now. Therefore, the government is focusing on facilitating and funding the projects to improve the services in rural areas. There are imbalances in various scales between the production costs and service tariffs, depending on
the regional factors such as the service population and the economic wellbeing. People living in the areas with a large service population tend to benefit with a relatively low service charge and tariff. For example, there are significant regional differences of wastewater treatment costs; the cost in cities with a population lower than 50,000 is 2,311 KRW/m³, about 4.8 times higher than the cost in cities with a population over one million\textsuperscript{38}.

Another major issue to be addressed is financially stable and sustainable operations of the service facilities. Still a large portion of the treatment cost is covered by government subsidies, meaning that the service tariff is not reflecting the actual cost. The subsidies from the central government cover 10\% of all water and 60\% of wastewater services costs. This is mainly because the costs of construction and operations of treatment facilities are accrued over time while the service tariff stays unchanged. As a result, the financial burden on the central and local governments keeps increasing. The profitability ratios are 79.7\% ('12)\textsuperscript{39} for water and 40.0\% ('12)\textsuperscript{39} for wastewater services. More reasonable financial management is required, particularly as additional investment is strongly needed for stormwater management and treatment facilities for wastewater services.

The government has been putting a great deal of effort into providing sustainable water and wastewater services, especially to provide affordable service of safe water to everyone. The MOE has established and been implementing a long-term 10-year plan to improve the service coverage in rural areas. According to the plan, the government is either upgrading old/improper water supply facilities in rural areas or at least reinforcing operation and management of the facilities located in remote areas. Advanced treatment technologies such as membrane filtering as well as process optimization technologies are being introduced in order to improve the quality of drinking water. At the same time, substantial efforts are being made to lower water consumption through replacing old infrastructures as well as raising public awareness on the value of fresh water and the need to conserve it.

In terms of the wastewater system, the local governments are responsible


for preparing and implementing mid/long-term operation and maintenance plans of 20 year periods, and keeping a five-year monitoring schedule for any necessary revisions. Approval of the central government (MOE) should be obtained in advance to construct new wastewater facilities. The “2050 Sewage Vision Establishment Research” has presented “Create future value and provide services that are safe and allow people to feel the benefit” as its 2050 vision, and “Provide safe and sustainable sewerage” as the policy goal. Reinforcement of stormwater management and improvement of reuse rate have been identified as important and immediate issues. Sewer maintenances as well as stormwater sewer constructions are being implemented actively, prompted by the public demands for eliminating old sewer odors as well as for the use of food waste disposal at home.

The government is strongly pushing through the consolidation of water and wastewater institutional framework in a bid to improve the efficiency of services operations. As a result, the management units, scattered around over 164 different local utilities based on their local government jurisdictions on top of the watersheds they belong to, will be consolidated to just 39 units by 2020, and further down to 10 by 2030. Furthermore, a program to enhance the operation efficiency and reduce the operating expenses by inviting private operators has been launched. If successful, privatization will contribute to adjusting the service tariffs to more realistic levels. The ownership of 71% of all wastewater treatment facilities has been already transferred either to private companies or to government-owned corporations as of late 2012 and, it has been found that the costs of operations had been reduced by 30~40% as a result.

3. Water Management and Sustainable Use/Reuse

The MOLIT and MOE have established the Long Term Master Plan for Water Resource Control (2011~2020) and the Master Water Reuse Plan (2011~2020) for sustainable water use. Particularly critical are the plans to save

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water, a foundation of society, through stronger water demand management in preparation for anticipated issues related to climate change. They are trying to build a system to reinforce the monitoring system as a part of a smart demand forecast system in order to more accurately predict the use of agricultural and industrial water depending on changes in the environment. For industrial water, the plan to promote the reuse of water inside the factory by more than 5.2% (from 54% in 2007 to 59.2% in 2020) through an improvement of the water reuse ratio within the manufacturing process is in place and being executed. In addition, the plan to improve the ratio of saved agricultural water by more than 2.6% (from 3.3% in 2007 to 5.9% in 2020) through the improvement of the structures of the water paths and the introduction of an automatic water management system is also in place and being executed.

Administrative and financial supports are provided in a range of areas such as: compulsory installation and use of rain water for buildings over a certain scale such as factories, commercial buildings, condominiums or schools; a compulsory reuse rate over 10% for wastewater treatment plants; and expansion of tax reductions and incentives. The basis for the system to promote the reuse of water has been prepared by establishing the guidelines for systematic water reuse for the local governments and the quality criteria for recycled water. On the technical side, the general level of Korea’s water and wastewater service technologies is competitive with more advanced countries, and an intensive investment is being made in the development of core technologies such as new material membrane and the convergence of IT and water/wastewater technologies in fields where noticeable gaps have been identified.

With the aim of revitalizing renewable energy, the government has set the goals of the development and industrialization of technologies related to renewable energies such as solar, wind power, biomass, earth heat, small-scale hydro-electric energy and tidal power by 2030. Core fields have been selected and the government is actively trying to promote the propagation and commercialization of technologies through a concentrated investment over 5-10 years, and is also trying to move away from the concept of

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41 Applied in 2007 to the 2002-2005 average of 54% four years
government-driven development and deployment processes to private company driven development and deployment, and promote the participation of private companies in order to improve efficiency. In terms of water and wastewater facilities, the plan includes support for the reduction of greenhouse gas and energy independence and a policy to use water and wastewater facilities as the base to produce renewable energies. Ideas of generating energy from the digested gas generated from sludge in the treatment facilities, from small-scale hydro-electric power generators utilizing the waterfall inside the facility and from solar and wind power generators using the facility’s land are being implemented. Various activities to establish a systematic foundation are being executed, including the introduction of an energy efficiency grade certification system for wastewater treatment plants, enforcement on the use of highly energy-efficient equipment, and mandatory installation of individual energy meters for high energy consumption facilities and unit processes.

4. Water Quality

The central government (MOE) established the National Water Environment Master Management Plan in 2006 and has implemented comprehensive measures to achieve the water quality improvement goals. Also, since 2004, it has established and executed the collaborative execution plans between departments for the control of non-point sources of pollution.

Recently, the effluent limitation of wastewater has been tightened and nutrient removal technologies have been developed in the wastewater treatment process. Also, mandatory installation of stormwater treatment facility has been regulated for public wastewater treatment plants in a combined sewer system in order to treat diffused pollutants entering the sewer, along with inflow/infiltration of stormwater. Also, the government has been encouraging eco-friendly farming to reduce the use of agricultural

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pesticides and chemical fertilizers. An array of farming support services such as education and technology deployment have been provided to promote an eco-friendly farming environment\(^{44}\) and a direct payment system for fallow has been in operation. The voluntary participation of farmers is required to make the eco-friendly farming policy successful. Guidelines on the use of agricultural pesticides and fertilizers have been generated, and the infrastructure to distribute and provide the related consulting services has been constructed in order to reduce the use of agricultural pesticides and chemical fertilizers. Since the water quality is exposed to heavy metal pollution owing to the improper management of mines distributed across the country, a system to prevent the pollution resulting from mines should be established, and technologies to prevent pollution from mines should be developed to manage the heavy metal pollution. Furthermore, the total pollution load control system should be reinforced along with the capability to manage the diffused sources of pollution from livestock and farming areas.

As it is recognized that the water quality targets for surface water may not be achievable without controlling diffused sources of pollution, which make a high contribution to overall pollution, comprehensive measures have been implemented to control non-point sources of pollution through collaboration across various departments related to the management of diffusion pollutants\(^{45}\). The first stage of execution includes the introduction of the system to report the installation of non-point sources of pollution (Apr, 2006), the introduction of the system to designate the non-point source of pollution control zone (Aug, 2007), prohibition of new farming around rivers (2008), support for the installation by local government of facilities to reduce non-point sources of pollution such as the formation of a wetland area (KRW 97.2 billion, 2004~2010) and the maintenance of the foundation for general farming areas (KRW 1,652.1 billion, 1994~2010). Even with this level of effort, the system to check the actual performance and to make an assessment in relation to the implementation of these measures has turned out to be insufficient, as indicated in the result of the assessment, and financial support and

\(^{44}\) Rural Development Administration(2004), “Synthetic Fertilizers Pesticides Reduction Measures Core Action Plans”

\(^{45}\) Relevant Ministry(2012), “2nd Non-Point Source Pollution Management (’12~’20)”
technology development are required to reduce the effects of non-point sources of pollution. In the second stage, various plans collectively driven by various departments of the central government as well as local governments have been established to remove all of the point and non-point sources of pollution such as the night soil of livestock for the purpose of non-point pollution source control around the four major rivers, to improve the water cycle in the areas affected by climate changes and to resolve the issues of additional inflow of stormwater⁴⁶.

5. Water Governance

5.1 Water Policy

Water policy has been established and executed on a 10-year basis. Water resource policy is based on the Long Term Water Resource Management Master Plan since 1965, driven by the MOLIT. The fifth master plan (2011~2020) includes the plan to deal with climate changes in the water resource areas. “Water Leader, Green Korea” was set as the 2020 vision, and the following three goals were established: 1) fresh and abundant water supply both for people and nature, 2) progressive water technology development, and 3) proactive water resource management R&D.

Water environment policy is established by the MOE, and the Master National Water Environment Plan (Rivers, streams, lake, and aquatic ecosystem) (2006~2015) has been established and is being implemented. “Quality standards applied to allow fish and children to swim safely together” was presented as the 2020 vision, and the goals to be achieved by 2015 are as follows: (1) 85% of rivers & streams, 94% of lakes water quality improvement up to “good”, (2) restoration of 25% of deteriorated rivers & streams to natural state, and (3) regulate 30% of drinking water source areas as “designated aquatic ecology protection belt” areas. In addition, “Water splashing festival of our lives” has been presented as the 2030 water

⁴⁶ Relevant Ministry(2012), “2nd Non-Point Source Pollution Management (’12~’20)”
environment vision by the MOE in 2012.

“Stable water supply that ensures rich public welfare and national development support” was set as the vision of the national water service master plan, and the goals to be achieved by 2015 were set as: (1) public water supply target rate: 96.5%, (2) number of people supplied public water: 48,062,000, (3) volume of public water supply: 223-363L, (4) accounted supply target rate: 84.3%. In addition, the plan to secure 28 billion m$^3$ of water resources through the “new reservoir embankment storage capacity enhancement projects” in 113 regions by 2015 was established to supply the required agricultural water demand. Recently, “2050 Water Supply Vision: Worry-free water near us, always forward” was set as the 2050 vision. Also, for groundwater, “Sustainable groundwater use for public welfare” was set as the vision for the development and protection of groundwater by 2012, and the goals were set as: (1) installation of 169 new monitoring well, (2) preliminary and comprehensive investigations, (3) 10 separate island area groundwater development projects, (4) operation of a groundwater information center$^{47}$.

The vision in the sewerage area was set in 2006 as “Sewerage management for a clean and safe living environment” and the corresponding goals to be achieved by 2015 are: (1) improvement of treatment influent quality through sewage maintenance and repair 93%, (2) sewerage service rate: nationwide 92%, rural areas 47%, (3) sludge reuse rate 70%, (4) treated water reuse rate 18%$^{48}$. “Safety and future-oriented, service fitting just for you” has been recently set as the 2050 Sewerage Vision$^{49}$. Establishment of a national water reuse plan and execution plan for each local government have become mandatory in order to promote water reuse, and the goals to achieve by 2020 were set as annual reuse target of 2.57 billion m$^3$ (rainwater 78 million m$^3$/year, gray water reuse 489 million m$^3$/year, wastewater reuse 1,576 million m$^3$/year, industrial wastewater reuse 28 million m$^3$/year).

Unlike the existing policies for each area of water management, the main

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difference in the contents presented by the 2030 vision is the shift in the weight from conventional government-oriented visions to stakeholder-involved progressive strategies.

### 5.2 Water Law

The MOE has the authority and responsibility for water quality control and protection of the water ecosystem. The relevant laws include the “Water Quality and Ecosystem Conservation Act”, “Water Supply and Waterworks Installation Act”, “Drinking Water Management Act,” “Promotion of and Support for Water Reuse Act” and “Act on Water Management and Resident Support in the Four River Basins”. In addition, the MOLIT has the authority and responsibility for developing and managing the quantity of water resources, and the relevant laws include the “River Act”, “Groundwater Act” and “Act on Dam Construction and Assistance, etc. to Neighborhood Areas”. The MOAFRA has the authority and responsibility over the development and use of agricultural water, and the relevant laws include “Rearrangement of Agricultural and Fishing Villages Act”.

As can be seen, the quantity and quality of water are managed separately by different departments inside the central government (MLIT and MOE), and the inefficient interface between the central government and the local governments in terms of collaboration has been identified as a fundamental issue to address in establishing efficient and comprehensive water management policies. Therefore, the need for the integration and reformation of laws for collective management of water resources including quantity, quality, ecosystem and jurisdiction has been highlighted by expert groups and water industry.

### 5.3 River Basin Management

Policies that are most relevant to river basin management include: (1) total water pollution load management system (TPLM), (2) designation of riparian buffer zones and (3) water use charges and river basin management fund. The purpose of the TPLM system is to improve the efficiency of water resource
management in order to achieve the water quality goals in target areas, and it is a means to protect the environment and to balance the economic development among various target river basin areas by limiting the total amount of water quality pollution loadings applicable to each river basin area. This policy sets a limit on the total amount of pollution loading in each target region, allocates specific pollution loading for each area in the target region within the limit of total target pollution loading, specifies the methods to reduce pollution loading exceeding the upper limit, checks the progress of execution and imposes penalties if the execution goals are not satisfied, and allows the development of certain parts when the goals are satisfied.

The riparian buffer zone is an area that has a substantial impact on water pollution and is set as a protected region by law, and any activities that would result in water pollution shall be prohibited. Government should purchase the target land from individuals if required. This area is a buffer zone that filters out the diffused pollutants to prevent them from flowing into the rivers and streams.

Other plans for securing the budget required to protect the water supply source such as water use charge and water ecosystem operation fund are also in place. The concept of the water use charge is to charge the part of the expense spent for the development of water supply source and distribution of water to users on top of the existing water service tariff based on the “polluter pays principle”, in which the bill is proportional to the amount of water use, and this is converted to a water ecosystem operation fund which is used for the protection of water supply source, water treatment and support of residents living in the areas where development is restricted.
## 5.4 Codes, Standards, and Performance Measures

Table 1. Codes, Standards, and Performance Measures

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<th>Acts</th>
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<th>Performance Measures</th>
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| Enforcement Decree of the Framework Act on Environmental Policy | Rivers & streams and lakes water standards | - Achieved water quality target rate: rivers & streams 80.7%, lakes 12.2% in 2013  
- “Good” quality achievement rate: rivers & streams 85.1%, lakes 77.6% in 2013 |
| | Public welfare protection | |
| | Biological benchmarks for water and aquatic environment quality | Good (B rate) (benthic diatoms: fair (C), benthic invertebrates: good(B), fishes :good(B), aquatic and riparian habitat quality: good(B)) |
| Water Quality and Ecosystem Conservation Act | Industry effluent standards, discharge standards | Assessing effluent / discharge guidelines exceedances |
| Sewage Act | Wastewater discharge standards | |
| Drinking Water Management Act | Use-dependent quality standards of drinking water | Assessing use-dependent quality standards exceedances |
| Promotion of and Support for Water Reuse Act | Water reuse standards | |
5.5 Monitoring

Annual monitoring plans should be established as a compulsory requirement by the corresponding laws. There are 754 general monitoring points in rivers and streams, 189 points in lakes, 805 points in agricultural water source, 37 points in major urban water drainages and 70 points in rivers and streams near industrial complexes. Flow rate and water quality are monitored on 270 other points every 10 days for the purposes of the TPLM system. In addition, a remote monitoring system has been installed in 69 locations across the country for real time water quality management. 225 sites with a sediment monitoring system (177 sites in rivers & streams and 50 sites in lakes) and 2,611 sites with an underground monitoring system are in operation\(^{50}\) \(^{51}\). A real-time remote water quality monitoring system (Sooshiro) has been installed in 740 sewage and wastewater treatment plants for the purpose of managing point pollution sources to enable integrated monitoring from the Total Water Environment Information System\(^{52}\).

5.6 Public Reporting

The status of the surface water monitoring system is published through the web-based Water Environment Information System\(^{53}\), and data collected from 762 sites (573 sites of rivers and streams and 189 sites of lakes and ponds) are reported online, with the findings on the water ecosystem presented in the annual report. The status of waterworks and sewage services are reported online through the National Waterworks Information System (NWIS) and the National Statistics of Waterworks on a yearly basis, and the status of groundwater monitoring are reported online through the Soil & Groundwater Information System (SGIS). The status of waste discharging facilities is

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\(^{53}\) Water Environment Information System (www.water.nier.go.kr)
reported once a year. Currently, the integration of the independent monitoring systems for each target into a GIS-based unified Waterworks Information System is in progress.

5.7 Stakeholder Participation

The central government participates in various environmental committees such as the Central Environment Policy Committee, Water Quality and Water Ecosystem Policy Deliberation Committee, Water Reuse Policy Committee, etc. Non-governmental organizations also participate in the monitoring system by establishing organizations related to the private water quality monitoring activities or through nonprofit environmental corporations and groups. In addition, various parties of interest such as committees related to the monitoring system, including the Water Ecosystem Management Committee of each region, are also part of the program and participate in the process of making policies. Opinions of the parties of interest are accommodated through various channels including public hearings.
IV. Implications - Finance and Policy

A sound financial structure is very important for sustainable water use management in the future. It is necessary to secure the investment resources and establish a systematic fund recovery mechanism for proper expense sharing by establishing a resolving fund to form a rational service tariff policy and rationalize the financial operation; thus, reformation of the financial support structure required to realize a reasonable service tariff from waterworks and sewage services is absolutely needed.

The total revenue required for the waterworks in 2010 was USD 5,668 million (KRW 5,985.9 billion)\textsuperscript{54}, of which 84.9% came from capital revenue, 11.8% from government subsidies and 3.3% from bonds. Not all the required revenue can be covered by water tariff alone, and there is a significant dependency on government subsidy. The national average water tariff in 2010 was 610.2 KRW per ton, which covers only 78.5% of the production cost of 777.2 KRW per ton, with the remainder covered by the government subsidy. Total expenditure of 2012 was USD 5,668 million, which includes 34.0% construction cost, 40.7% maintenance cost, 4.4% principal and interest payment and 20.9% other carry-overs. The debt as of the end of 2010 reached USD 949 million dollars (KRW 1,001.9 billion)\textsuperscript{55}.

About USD 35,852 million (KRW 37,860 billion) in funds seems to be needed to expand the waterworks facilities of rural areas by 2030\textsuperscript{56}. The budget required to improve the water revenue rate is the highest at 69% of the total, followed by the budget to improve the water treatment facilities, which is 15% of the total. 70% of the total cost required for the expansion of water service facilities in rural areas is provided by the central government, and 30% is covered by the local governments. People living in the rural areas will

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\textsuperscript{54} Revenues from regional water supply system operation by K-water are not included in total revenue


\textsuperscript{56} Korea Environment Cooperation / Korea Environment Cooperation(2013), “A Study for Establishing Waterworks Policy Master Plan”
be able to have clean and secure water supply services as a result of this project. It is also expected that the quality of life will be improved and tourism to rural areas expanded through the improvement of the living environment in rural areas. The estimated amount of funds required to introduce the advanced water treatment system to 77% by 2030 is about USD 1,124 million (KRW 1,186.8 billion). Inconveniences to the public, such as water with bad odors and taste, will be minimized through this project\(^57\).

The ratio of revenue covered by the sewage tariff is only 38.1% (‘10), and as such the sustainability of the financial operation cannot be expected. The total budget for sewage services as of 2010 was KRW 6,330 billion\(^58\), and the expected budget amount required to support sustainable services until 2030 is about KRW 69 trillion and KRW 455.5 billion. One of the projects within the scope is the stormwater management that is causing flooding in cities as a result of climate changes, which will require KRW 405,778 billion, or 58.4% of the total budget\(^59\). A sewage cost sharing system should be established and the new financial sources should be identified along with the strengthening of flood prevention services, and a plan to secure the fair tariff system and realistic tariff policy is required. Recently the introduction of a stormwater tariff has been proposed, but it has failed to build a consensus.

Sewer systems have been continuously improving since 2002, but it has been difficult to remove all septic tanks because the direct injection of night soil is difficult while sewer systems are maintained. For this reason, the existing septic tanks remaining in some areas have become culturing grounds for mosquitoes, and caused sanitation problems that are more common in less developed countries. It is time to reclaim the value of sewer systems from the perspective of sanitation. As the number of households with one or two family members is increasing and more people are eating out, it is difficult to get food waste out on the same day it is generated, which causes sanitation problem resulting from spoiled food and bad smells. General perspective on the value of food waste processing should change from now on, as cost of


sanitation should be considered in addition to the convenience factor.

About KRW 7,025 billion is expected to be required by 2020 in order to achieve sustainability of the water reuse system, including KRW 3,534.6 billion for rain water use facilities, KRW 679.5 billion for gray water system, KRW 2,700 billion for sewage treatment facility and KRW 75.7 billion for industrial wastewater treatment facilities. The MOE has a plan to fund the project with KRW 2,240.2 billion from the central government (32%), KRW 2,444.5 billion from local governments (35%) and KRW 2,340.4 billion from private investment (33%)\(^{60}\).

The total investment required for achieving the renewable energy goals will increase from KRW 6.5 trillion by 2030 from KRW 2 trillion in 2008, and the total cumulative amount of investment until 2030 is expected to be around KRW 111.4 trillion\(^{61}\). The energy independence of sewage treatment plants requires KRW 542.6 billion by 2015 in the first stage and a total of KRW 3,466.6 billion by 2030 throughout three stages of the program. Achieving the goal of 50% energy independence by 2030 has the expected effects of replacing 907GWh/year of electric energy and reducing greenhouse gas emissions by 558,000 CO\(_2\) ton/year\(^{62}\), but R&D for the function to maximize the utilization of potential energies that can be extracted from the sewage treatment facilities is urgently required, from the functional perspective.

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V. Discussion and Future Growth

The investment on water sectors in Korea over the last five decades has been focused on the development of infrastructure required to meet the economically and socially required water demands. The infrastructure has become sufficiently mature to provide the required services with the investment in a timely manner, and now the focus is shifting to the sustainable water infrastructure and services as the infrastructures are in the maintenance stage. The experiences accumulated in the field of water sectors so far can be summarized as follows.

Firstly, understanding the deep connection between water infrastructure and economic development is very important. The water infrastructure in Korea has been developed in accordance with a plan to promote the economic development. The construction of the metropolitan wide area waterworks system that started in the 1970s was a huge project that was designed to supply water for residential and industrial facilities in Seoul and the surrounding area. The investment in water infrastructure at the initial stage of economic development was possible thanks to foreign aid. Like any other industry, investment in waterworks requires activities and economic investment, and these efforts have contributed to technology development and job creation, either directly or indirectly.

Secondly, there have been important lessons learned from the experiences, from an economic perspective. Careful investment and an efficient operation management system are required, and the scale of business should be considered in the water infrastructure. Until now, government has driven the policies, project execution and financial support plan in order to meet the rapidly growing demands, in line with the fast-growing economy. And the local governments have set the execution plans approved by the central government based on the national development plan before making decisions on their own investment. It was difficult for local governments that are not financially independent to provide water services that satisfy the demand of local residents under this structure, and excessive and/or duplicated
investments have come to the point of causing a substantial risk to the sustainability of water services due to a failure to reflect the realities of each region. From the economic perspective, the water infrastructure management system that is distributed in an inefficient way needs to be reformed to a more reasonable management system considering the scale of business in order to achieve sustainable financial operation, and the Korean government has been driving the consolidation of waterworks and sewage services with a strong will in this context.

Thirdly, it is important to reinforce the capabilities of each of the governing departments, and clarify the jurisdiction. Each governing department of water resource management in Korea has progressed along with the development of each area. The partitioning of the roles of each department has been conducted based on the responsibilities and rules made for financial investment and operation management of the water infrastructure. Although the roles of each department are well defined, the issue of over-distributed administrative structure should be addressed first. An insufficient degree of cooperation between the departments in the central government (MOE and MLIT) has introduced difficulties in coordination between quantity and quality management, and become a barrier to building an effective total water management. The government has recognized these problems recently and is trying to reform the system for total management water resources in order to deal with future climate changes efficiently.

Fourthly, sustainability of the financial system should be secured, and operation of a transparent and reasonable subsidy system is required. Investment in waterworks areas comes from user tariff and tax collected from people that is provided to facilities in a form of government subsidy. The ratio of government subsidy to the total revenue of water service and sewage service are 12% and 60%, respectively. Until now, the water infrastructure industry has had huge dependencies on government subsidies, based on the excuse that the water industry has major environmental externalities. Government subsidies have been very helpful in the early stage of development. However, it is expected that the dependency on government subsidy will gradually reduce as expense recovery through the realization of a realistic water tariff is emphasized in the future. It is important to use the
government subsidy under clear guidelines for financial investment and operation.

Fifthly, the continuous research and development of water management technologies is important. Korea has recognized the importance of research and development in improving the efficiency of waterworks operation and management, and has made substantial investments starting from the environment engineering technology development project with the funding of KRW 357 million in 1992, and the investment in research and development has contributed to the development of pollution prevention technologies. About KRW one trillion has been injected into the next generation core environment technology development project (Eco-Technopia 21, or ET21), as research to support environmental industry since 2001. This kind of investment has contributed to the development of waterworks and sewage treatment technologies, as well as to the cultivation of highly talented researchers.

Currently, the central government is taking various initiatives related to the reformation of waterworks and sewage structure, the establishment of a sound financial system and measures for climate change, which are identified as immediate and important issues to be resolved for sustainable water services.

1) Realization of general and fair water supply and access to sanitized environment

One of the most important issues in Korea is the gap in living standards between urban and rural areas. Long term goals to expand the environmental infrastructures of the rural areas including water and sewage treatment facilities have been established, and a substantial amount of funds has been allocated for this purpose. However, the deployment of water infrastructure in Korea has almost been completed, and the long-term goals of the past for quantitative expansion don’t seem to make a lot of sense anymore. The overall amount of supplied water is sufficient, but the water supply is still not well connected to small-scale farming/fishing villages or remote island areas. The expansion of facilities with the required financial support is planned for about
123 local governments and 51 remote islands, including the target areas of waterworks facilities in 177 rural areas. The plan of government is to improve 280 village waterworks and 74 old facilities. In addition, the government plans to increase the sewage service rate from 53.3% (2009) to 75% by 2020. To this end, the government is planning to establish a total operation management system to manage the operation of small-scale waterworks and sewage services.\(^{63}\)

On the other hand, the government policy is renewed every five or ten years, including the planning of the budget required to execute various projects. Project execution depends on the allocated budget. A long-term plan until 2030 is included in the research report of the government institutes, but it is difficult to accurately predict the validity of goals and the possibility of their realization. For example, the goal of a 90.2% penetration rate of waterworks in rural areas by 2030 is the highest level that is technically feasible by converting all village waterworks and small scale water supply facilities to wide area/municipal waterworks, but its economic validity has not been confirmed. The ratio of government support has a wide range between 50% and 70%, and the local governments should prepare a certain level of matching funds.

2) Realization of scale of business

Water resource management systems have been over-distributed. Many water-related projects are being operated in the unit of small and medium-sized cities, based on 164 units of local governments, and the excessively distributed management system has reduced the operation efficiencies. Furthermore, the unit production cost of water in small-scale rural areas is relatively higher. In this situation, the execution of the plan to consolidate the number of waterworks units from 164 regions to 39 regions (32 in small and medium scale cities and 7 in large scale cities) by 2020 for more integrated management with a smaller number of units is underway.\(^{64}\) The consolidation is expected to resolve the issue of an imbalance between regions in terms of the availability of water, and to improve the economic efficiency.


This type of consolidation of waterworks and sewage services is executed through a strong drive by the central government instead of voluntary participation of the local governments. For waterworks, the government is trying to encourage voluntary participation of the local governments through incentive programs such as the support for pipe maintenance project, the old pipe replacement project and advanced water treatment facilities. There are a few criteria for consolidation such as the availability of water source, service area with over 500,000 population, regional characteristics and consolidation of administrative zones. The economic effects of consolidation are predicted to be twice as high as those of general cost reduction. Consolidation of waterworks and sewage works are being executed in a similar way, and the only difference is that the units are divided into 115 regions, based on 30 river basin areas around four major rivers, and the division of detailed consolidated operation regions is based on the consolidated operation with corresponding water ecosystem or water quality.

The consolidation described above is being implemented with the aim of improving the efficiency of major existing facilities. Actual cooperation and participation of local government is absolutely required for successful consolidation, and significant efforts and time are expected to be needed. The level of government subsidy varies from 10% up to 70% of the operation expense depending on the scale of local government and the degree of efficiency improvement.

3) Improvement of expense recovery ratio

Recovery ratio for the constantly increasing expense requires an increase in the water tariff, but the political and social situation prevent that. However, the water tariff is expected to grow gradually over time. The total financial expenditure for waterworks and sewage services correspond to about 1% of the average household income (based on 2012 average monthly household water tariff KRW 11,42965). Considering that the global average is around 3~4 %66, there seems to be some room to raise the tariff. A more direct way to

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65 Ministry of Land, Infrastructure and Transport (MOLIT) press release(2012.12.21), “K-water, Rate hike of Metropolitan wide area waterworks system and Dam water”
improve the recovery ratio of expenditure is to use the private companies. The Public-Private Partnership (PPP) option is one way of collaboration by establishing a consortium between private companies and public corporations that provide the waterworks and distribution services. The saving in the operation cost of unit service is expected in the form of regional companies in the corresponding region.

4) Reinforcement of quality criteria of discharged water

The quality criteria for discharged water were introduced to the sewage treatment facilities for the first time in 1964 by the Pollution Prevention Act. This was a simple and nominal introduction of a water quality standard for simple primary and secondary treatment process when there were no properly constructed sewage treatment facilities. It was not until 1976 that the first modern sewage treatment plant was constructed in Seoul. Water quality standards advanced in 1978 as the technologies to reduce nitrogen and phosphor were introduced in the late 1970s. Since then, the water quality standards have been reinforced by factor of four to five times depending on the degree of pollution and treatment level, while those processes also helped in achieving the economic goals. Recently, the water quality standards have been tightened even further in order to resolve the problem of algal bloom, while stretching the criteria even to the level of bio-toxicity, in accordance with the water quality improvement projects for four major rivers.

5) Reinforcement of sewage network

In the past, sewage treatment facilities were constructed before building sewer systems. As a consequence, the overall efficiency was compromised because the design could not keep up with the increasing pressure of inflowing sewage and corresponding biological loading. Furthermore, the sewage flowing into the sewage treatment plant was diluted beyond the design factor. As these issues were recognized, efforts were made to improve the sewer network to direct all sewage generated from households in the corresponding region in a well-coordinated way, and the sewer network was improved in terms of separation between sewage and stormwater. Proper scale of the drain system as a result of these efforts has prevented flooding in
urban areas, and it allows the inflow of sewage with higher concentration into the treatment facilities. Currently, facility improvement and expansion projects such as sewer maintenance and stormwater treatment facilities are being performed for the purpose of extending the design strength from 5~15 years to 30~50 years in order to address the stormwater drainage system issues caused by climate change.
VI. Conclusion

With the rapid economic growth that began in the early 1960s, Korea has made great strides in improving and constructing the infrastructure and service enhancement of water supply and sanitation. Waterworks service is now provided to almost all regions in the country except for some vulnerable rural areas. On the other hand, more than 90% of sewage generated is collected and treated properly. The key success factors for a successful water service system included the government-initiated financial investment, which has been executed in a timely manner to deal with the steeply accelerating water demand as a result of briskly growing economy, plus the adequate preparation of a water resource management system for various fields of waterworks and sewage services. At present, the maintenance of existing facilities and improvement of service quality in terms of sustainability are our biggest challenges in dealing with the task of water supply and sanitation in Korea, rather than the quantitative expansion of infrastructure. Some of the major outstanding issues include the low operation efficiency of existing facilities due to duplicated or over-investment in the past in consequence of inaccurate demand forecast, challenges in consolidated operation management as the quantity and quality of water are managed separately by different departments, structural financial problems of a waterworks and sewage system that has high dependency on government subsidy and the requirement of additional funds to address the climate change issue and the increased demand for high quality water. The government is trying to change the existing water management system based on the existing administrative district to an integrated management system given the scale of business with a view to address those outstanding issues. Furthermore, it is also taking steps to encourage the participation of private companies in water service areas in a bid to facilitate the operation efficiency. However, as of now, there remains an assortment of other major issues to be dealt with including the reformation of laws and a sustainable financial operation system, before the goal of establishing a total water management system is achieved.
Reference


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Relevant Ministry. 2012. “2nd Non-Point Source Pollution Management (’12-’20)”.


UNOSD, INWEH/UNU and SEI. 2013. “Catalyzing Water for Sustainable Development and Growth; Framing Water within the Post 2015 Development Agenda: Options and Considerations”.

OECD. 2009. “Pricing Water Resources and Water and Sanitation Services”.

The Bank of Korea (www.bok.or.kr)

Water Environment Information System

(www.water.nier.go.kr
  /waterBoard/waterBoardSelect.do?boardType=weis/2_data&frontYn=Y&returnUrl=/front/waterPress/PDSList.jsp)

www.index.go.kr/portal

## Appendix

### 1. Water Resources

<table>
<thead>
<tr>
<th></th>
<th>Status</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Current</td>
<td>Aspirational (2030)</td>
</tr>
<tr>
<td></td>
<td>National</td>
<td>Private</td>
</tr>
<tr>
<td><strong>Surface</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual available water resources per capita (m³/year/person)</td>
<td>1,553</td>
<td>2</td>
</tr>
<tr>
<td>Annual available water resources (100 million m³/year)</td>
<td>753</td>
<td>2</td>
</tr>
<tr>
<td><strong>Ground</strong></td>
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</tr>
<tr>
<td>Annual groundwater consumption (million m³/year)</td>
<td>3,725</td>
<td>2</td>
</tr>
<tr>
<td>Potential for sustainable water resource development (million m³)</td>
<td>10,852</td>
<td>2</td>
</tr>
<tr>
<td>Mean groundwater level (m)</td>
<td>6.19</td>
<td></td>
</tr>
<tr>
<td><strong>Rainfall regime</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual precipitation per capita (m³)</td>
<td>2,629</td>
<td></td>
</tr>
<tr>
<td>Wet season/flood season intensity</td>
<td>0.74</td>
<td></td>
</tr>
<tr>
<td><strong>Climate Change Impacts (current/future)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual mean temperature (degC)</td>
<td>12.5</td>
<td>3</td>
</tr>
<tr>
<td>Annual mean drought periods (months/year)</td>
<td>0.5</td>
<td>2</td>
</tr>
<tr>
<td>Annual precipitation (mm)</td>
<td>1,230</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2) YR 2007
3) Definition: renewable water resources, Equation: (normal stream discharge) / (total population)
4) YR 2016
5) YR 1971-2000
6) IPCC SRES A2 scenario in 2013-2060
7) YR 1977-2006
8) IPCC SRES A2 scenario in 2061-2090
9) IPCC SRES A2 scenario in 2031-2060
2. Water, Sanitation and Hygiene (WASH) Access

<table>
<thead>
<tr>
<th>Status</th>
<th>Current</th>
<th>Aspirational (2030)</th>
<th>Difference</th>
<th>Capacity</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td></td>
<td></td>
<td></td>
<td>National</td>
<td>Private</td>
</tr>
<tr>
<td>water supply ratio in township ('myon' in Korean)</td>
<td>62.2%</td>
<td>90.2%</td>
<td>28.0%</td>
<td>Identification of priority targets</td>
<td>Remote control system of scattered small-scale water supply facilities</td>
</tr>
<tr>
<td>Percentage of improved toilet in rural areas</td>
<td>84.8%</td>
<td>None</td>
<td>None</td>
<td>Promotion of rural development projects</td>
<td>Improvement of small-scale waterworks</td>
</tr>
<tr>
<td>Urban</td>
<td></td>
<td></td>
<td></td>
<td>National</td>
<td>Private</td>
</tr>
<tr>
<td>water supply ratio in city</td>
<td>98.9%</td>
<td>None</td>
<td>None</td>
<td>Asset management Full cost recovery</td>
<td>Public-private partnership</td>
</tr>
<tr>
<td>Percentage of tap water produced by advanced water treatment system</td>
<td>19%</td>
<td>77%</td>
<td>58%</td>
<td>Securing the required budget</td>
<td>Water-leakage detection</td>
</tr>
<tr>
<td>School &amp; Healthcare facilities</td>
<td></td>
<td></td>
<td></td>
<td>National</td>
<td>Private</td>
</tr>
<tr>
<td>Percentage of schools hiring a health teacher</td>
<td>64.6%</td>
<td>100%</td>
<td>35.4%</td>
<td>Expansion of school health offices</td>
<td>Education at the certified universities (dept. of nursing)</td>
</tr>
<tr>
<td>Equity</td>
<td></td>
<td></td>
<td></td>
<td>National</td>
<td>Private</td>
</tr>
<tr>
<td>The most important issue on equity in Korea is the gap of water supply ratio between rural and urban areas</td>
<td>Refer the water supply ratio in township</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The aspirational target of rural water supply ratio reflects such concern</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Appendix: 43
1) Populations who get the waterworks services through village water supply system or small size water facility were excluded  
3) By converting all village waterworks and small scale water supply facilities to wide area / municipal waterworks, but its economic validity has not been confirmed  
4) The ratio of flushing toilets  
3. Water Management (and Sustainable Use/Reuse)

3.1 Industry

<table>
<thead>
<tr>
<th>Status</th>
<th>Current</th>
<th>Aspirational (2030)</th>
<th>Difference/Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>sector value/contribution to GDP</td>
<td>31.1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>year over year sector growth</td>
<td>4.32%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>amount of water consumed</td>
<td>2.1 billion m³/year</td>
<td>3.21 billion m³/year</td>
<td>1.11 billion m³/year</td>
</tr>
<tr>
<td>untreated wastewater produced</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>sludge management/use</td>
<td>0.21 million m³/year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>water and wastewater reuse (actual and potential)</td>
<td>0.062 billion m³/year</td>
<td>0.625 billion m³/year</td>
<td>0.563 billion m³/year</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Implementation</th>
<th>Capacity</th>
<th>Science, Technology and Innovation</th>
<th>Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>National</td>
<td>Private</td>
<td>Sludge</td>
</tr>
</tbody>
</table>

1) Source: The Bank of Korea
2) YR 2013, Manufacturing Industry sector
3) Growth of Manufacturing Industry Sector from 2012 to 2013
5) Industrial water usage
6) Prospect in 2020
7) YR 2008, Wastewater treatment sludge of Designated waste from business (Environmental Statistics Portal), incineration 1,585 m³/year, landfill 176,002 m³/year, reuse 28,772 m³/year
9) YR 2008, Plant wastewater reusing system usage 0.047, usage of industrial water from treated wastewater 0.015
10) Wastewater reusing system usage 0.099, usage of industrial water from treated sewer 0.507, usage of treat wastewater 0.019
### 3.2 Agriculture

<table>
<thead>
<tr>
<th>Land</th>
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</tr>
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<tr>
<td></td>
<td>Current</td>
<td>Aspirational (2030)</td>
</tr>
<tr>
<td>crop per drop</td>
<td>1600.1 m³/ton</td>
<td></td>
</tr>
<tr>
<td>sector value/contribution to GDP</td>
<td>2.34%</td>
<td></td>
</tr>
<tr>
<td>year over year sector growth</td>
<td>-0.69%</td>
<td></td>
</tr>
<tr>
<td>export versus domestic consumption</td>
<td></td>
<td></td>
</tr>
<tr>
<td>amount of water consumed</td>
<td>159 billion m³/year</td>
<td>154 billion m³/year</td>
</tr>
<tr>
<td>amount of irrigated land</td>
<td>1.78 million ha</td>
<td>1.64 million ha</td>
</tr>
</tbody>
</table>

11) Virtual water of rice  

12) Source: The Bank of Korea

13) YR 2013, Agriculture, Forestry, Fishery sector

14) Growth of Agriculture, Forestry, Fishery sector from 2012 to 2013


16) Agricultural water usage

17) Agricultural water demand prospect in 2020

18) 2007 Area of Cultivated Land (paddy Field & Upland)


19) 2020 Area of Cultivated Land Prospect

### 3.3 Energy

<table>
<thead>
<tr>
<th>Status</th>
<th>Current</th>
<th>Aspirational (2030)</th>
<th>Difference /Metrics</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Science, Technology and Innovation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>National</td>
</tr>
<tr>
<td>Renewable 20</td>
<td>use of renewable energy</td>
<td>2.80%</td>
<td>11%</td>
<td>8.2%</td>
</tr>
<tr>
<td></td>
<td>renewable energy purchased</td>
<td>0</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>renewable energy generated (actual versus potential)</td>
<td>7,566*1000 toe</td>
<td>33,027*1000 toe</td>
<td>25,461*1000 toe</td>
</tr>
<tr>
<td></td>
<td>% population using local renewable energy for cooking, lighting, electronics, or all energy requirements</td>
<td>0.80</td>
<td>7.38</td>
<td>1,000,000/house</td>
</tr>
<tr>
<td></td>
<td>% national energy produced/purchased</td>
<td>no purchase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-renewable</td>
<td>use of non-renewable energy 22</td>
<td>2001*million toe</td>
<td>reduce 11.5% (245.6 - &gt; 217.3 million toe)</td>
<td>28.3 million toe</td>
</tr>
<tr>
<td></td>
<td>non-renewable energy purchased</td>
<td>301,425*1000 toe 22</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>non-renewable energy produced</td>
<td>35,421*1000 toe 22</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>oil and gas reserves (actual versus potential)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>% population accessing energy grid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>% national energy produced / purchased</td>
<td></td>
<td></td>
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</table>

22) Data in 2011
### 3.4 Ecosystem Service

<table>
<thead>
<tr>
<th>Food Production</th>
<th>Status</th>
<th>Implementation</th>
</tr>
</thead>
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<tr>
<td>value of ecosystem services (if measured)</td>
<td>no measured</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>length of coastline (if applicable)</td>
<td>14,963m</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>% wetlands</td>
<td>2.67% (coastal wetland 2,487.2 sq m &amp; Ramsar wetland 177 sq m)</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>% forest cover</td>
<td>63.9% (6,369,100 ha)</td>
<td>Not Applicable</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sustainability</th>
<th>Status</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>% wetland/forest change year over year</td>
<td>(-)12,000ha per year (for forest)</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>existence of protected areas (% of total)</td>
<td>10.3%</td>
<td>17%</td>
</tr>
<tr>
<td>conservation legislation (implemented, in existence but not yet implemented, or under development)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

23) [http://www.index.go.kr/potal](http://www.index.go.kr/potal)


25) In 2020

### 4. Water Quality

#### 4.1 Wastewater

<table>
<thead>
<tr>
<th>Status</th>
<th>Current</th>
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<th>Difference /Metrics</th>
<th>Capacity</th>
<th>Implementation</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>National</td>
<td>Private</td>
</tr>
<tr>
<td></td>
<td>Percentage of un-sewered population</td>
<td>84.1</td>
<td>0</td>
<td>-Strengthen the management of small domestic sewage system</td>
<td></td>
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<tr>
<td>Untreated Water</td>
<td>Number of wastewater treatment plants greater than 500 m³/day</td>
<td>546</td>
<td></td>
<td>-Promotion of decentralized wastewater management system</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-Strengthen effluent limitations</td>
<td></td>
</tr>
<tr>
<td>Safe Wastewater Reuse</td>
<td>Percentage of wastewater reused</td>
<td>30.8%</td>
<td>31.1%</td>
<td>20.3%</td>
<td>-Expansion of obligatory facilities of wastewater reuse</td>
</tr>
<tr>
<td></td>
<td>Amount of wastewater reused</td>
<td>226 million m³/year</td>
<td>486 million m³/year</td>
<td>260 million m³/year</td>
<td>-Incentive program for wastewater reuse</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-Establishment of water quality criteria for wastewater reuse</td>
<td></td>
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<tr>
<td>Nutrient Pollution</td>
<td>Application of pesticides per ha (kg/ha)</td>
<td>10.9</td>
<td>NONE</td>
<td></td>
<td>-Surveillance of insect proliferation</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-Farm consulting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Application of chemical fertilizer per ha (kg/ha)</td>
<td>262</td>
<td>NONE</td>
<td></td>
<td>-Promotion of eco-friendly farming</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-Technical support for fertilizer application</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-Promotion of direct payment scheme</td>
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</tbody>
</table>

2) The national ratio of sewage system deployment 91.6% (2012)
3) YR 2012
5) YR 2008, Reuse ratio of sewage 12.2% (2012)
6) YR 2020
9) Source: Rural Development Administration(2004), “Synthetic fertilizers pesticides reduction measures core action plans”
### 4.2 Pollutants

<table>
<thead>
<tr>
<th>Status</th>
<th>Implementation</th>
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<tbody>
<tr>
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<td>Science, Technology and Information</td>
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<td>Current</td>
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<tr>
<td>Aspiration (2030)</td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td></td>
</tr>
</tbody>
</table>

| River Pollution | - Mine Effluent Pollution Management |
| (% rivers in good condition) | - Water Environment Measures Preparation Under Consideration of Lake Characteristics |
| 86% in 2012 | - Pollution Prevention and Post Management System Enforcement by Lakes |
| 85% in 2015 | - Water Quality Improvement of Costal Area and Recovery of Ecological Nature |
| -1.0% | - Establishment of Integrated Estuary Environment Management System |
| | - Supporting System Enforcement of Water Pollutants Total Load Management |
| | - Establishment of Reasonable Guidance and Examination System |
| | - Establishment of Integrated Water Environment Monitoring System |
| | - Promotion of Integrated Water Environment Investigation and Research Project Plan |
| | - Establishment of Integrated Assessment System of Water Environment Policy |
| | - Improvement of Budget Distribution System and Modification of Financial Management System |
| | - Improving Efficiency of Water System Management Funds Management |
| | - Non-point Pollutant Source in Urban Section |
| | - Non-point Pollutant Source in Agricultural Section |
| | - Development of Non-point Pollutant Source Research |
| | - Education of Non-point Pollutant Source Promotion |
| | - Non-point Pollutant Source Common |
| | - System Reorganization for Mine Damage Prevention and Technology Development |
| | - Eco-friendly Management and Utilization Diversification for Lake with Low Utility Value |
| | - Introducing of Future Lake management Technology Such as Bionanipulation |
| | - "Water Quality Improvement of Small-to-Medium Size Stream in Costal Area and Ecological Restoration Stream-Reconstruction Project Promotion" |
| | - Development of Projects on Integrated Management System for Estuary Water Quality Improvement and Demonstration |
| | - Expansion of Technological Support for Pollutants Total Load Management System |
| | - Introducing of Economical Guidance and Examination System |
| | - Improvement of Water quality Prediction Model |
| | - Road Mapping(TRM: Technology Road Map) for Water Environment Research Development |
| | - Improving Efficiency of Financial Investment for Water Quality |
| | - Establishment of Evaluating System for Water System Management Funds Supporting Project |
| | - Expansion of Non-point Pollutant Source Reduction Facilities Installation Based on Urban Infrastructure |
| | - Life-cycle Management from Generation and Disposal of Livestock Manure |
| | - Research and Development of Non-point Pollutant Source Management Technology for Korean Streams |
| | - Development and Operation of Awareness Raising Program of Non-point Pollutant Source |
| | - Expansion of Installation Support for Non-point Pollutant Source Reduction Facilities (Governmental Financial Supporting Project) |

| Lake Pollution | - Mine Effluent Pollution Management |
| (% Lakes in good condition) | - Water Environment Measures Preparation Under Consideration of Lake Characteristics |
| 67.3% in 2012 | - Pollution Prevention and Post Management System Enforcement by Lakes |
| 94% in 2015 | - Water Quality Improvement of Costal Area and Recovery of Ecological Nature |
| 26.7% | - Establishment of Integrated Estuary Environment Management System |
| | - Supporting System Enforcement of Water Pollutants Total Load Management |
| | - Establishment of Reasonable Guidance and Examination System |
| | - Establishment of Integrated Water Environment Monitoring System |
| | - Promotion of Integrated Water Environment Investigation and Research Project Plan |
| | - Establishment of Integrated Assessment System of Water Environment Policy |
| | - Improvement of Budget Distribution System and Modification of Financial Management System |
| | - Improving Efficiency of Water System Management Funds Management |
| | - Non-point Pollutant Source in Urban Section |
| | - Non-point Pollutant Source in Agricultural Section |
| | - Development of Non-point Pollutant Source Research |
| | - Education of Non-point Pollutant Source Promotion |
| | - Non-point Pollutant Source Common |
| | - System Reorganization for Mine Damage Prevention and Technology Development |
| | - Eco-friendly Management and Utilization Diversification for Lake with Low Utility Value |
| | - Introducing of Future Lake management Technology Such as Bionanipulation |
| | - "Water Quality Improvement of Small-to-Medium Size Stream in Costal Area and Ecological Restoration Stream-Reconstruction Project Promotion" |
| | - Development of Projects on Integrated Management System for Estuary Water Quality Improvement and Demonstration |
| | - Expansion of Technological Support for Pollutants Total Load Management System |
| | - Introducing of Economical Guidance and Examination System |
| | - Improvement of Water quality Prediction Model |
| | - Road Mapping(TRM: Technology Road Map) for Water Environment Research Development |
| | - Improving Efficiency of Financial Investment for Water Quality |
| | - Establishment of Evaluating System for Water System Management Funds Supporting Project |
| | - Expansion of Non-point Pollutant Source Reduction Facilities Installation Based on Urban Infrastructure |
| | - Life-cycle Management from Generation and Disposal of Livestock Manure |
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5. Disaster Mitigation

<table>
<thead>
<tr>
<th>Status</th>
<th>Implementation</th>
<th>Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>Aspirational (2030)</td>
<td>Difference /Metrics</td>
</tr>
<tr>
<td>Flood</td>
<td></td>
<td></td>
</tr>
<tr>
<td>River/stream planning establishment rate (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>River/stream improvement rate (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flood control storage capacity of multi-purpose dams (million m³/year)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flood control storage capacity of hydroelectric power dams (million m³/year)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flood control storage capacity (Overall) (100 million m³/year)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic damage due to floods ($100,000)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Available water resources during drought periods (100 million m³)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water supply capacity of multi-purpose dams (million m³)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water supply capacity of hydroelectric power dams (million m³)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water supply capacity of other dams (million m³)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual water supply capacity (million m³)</td>
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</tbody>
</table>

- Comprehensive flood control plans
- Building integrated flood prevention countermeasures considering river basin environments
- Phased improvement of national and regional rivers
- Building an efficient flood prevention plan
- Building a flood risk information system
- Improving early warning capacity for short-term intervals (1hour)
- Build a flood hazard map; Build a landslide responding system
- Improving flood prevention system including local community
- Constructing flood control dams
- Constructing multi-purpose water retention facilities
- Comprehensive water use plans
- Improving groundwater development and use
- Building an emergency response system among water supply infrastructures
- Adjusting and enhancing water supply system
- Co-management of dam, weir and reservoirs
- Developing existing dams for multi-purpose usage
- Managing social conflicts in water distribution
- Enhancing capacity in water demand management
- Assessing water use; Estimating water demand
- Constructing multi-purpose water retention facilities in small and medium size
- Investing on alternative water resources
- Improving a reliability in water supply
- Co-operating emergency system in water supply facilities
- Enhancing improved water supply infrastructure in rural areas

2) Based on River length

3) Based on River length: complete improvement rate (61.9%) + incomplete improvement rate (18.0%)

4) YR 2010

5) Definition: 45% of annual available resources

6) YR 2020

## 6. Water Governance

### 6.1 Water Policies

| Status | Aspirational (2030) | Implementation
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>Science, Technology and Information</td>
<td>Infrastructure</td>
</tr>
<tr>
<td><strong>1) Comprehensive Water Resource Development &amp; Management</strong>&lt;br&gt;(Vision) Water Leader, Green Korea&lt;br&gt;(2020 Target)&lt;br&gt;- Fresh and abundant water supply both for people and for nature&lt;br&gt;  - Progressive water technology development&lt;br&gt;  - Proactive water resource management R&amp;D</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2) Water Bodies (Rivers &amp; streams &amp; streams, lakes) &amp; Aquatic Ecosystem</strong>&lt;br&gt;(Vision) Quality standards applied for fish and children to swim safely together&lt;br&gt;(2020 Target)&lt;br&gt;- 85% of rivers &amp; streams 94% of lakes water quality improvement up to “good”&lt;br&gt;- Restoration of 25% of deteriorated rivers &amp; streams to natural state&lt;br&gt;- Regulate 30% of drinking water source areas as &quot;designated aquatic ecology protection belt&quot; areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>3) Domestic &amp; Industrial Water Supply</strong>&lt;br&gt;(Vision) Stable water supply that ensures rich public welfare and national development support&lt;br&gt;(2020 Target)&lt;br&gt;- Public water supply target rate: 96.5%&lt;br&gt;  - Public water supplied number of people: 4,806,200&lt;br&gt;  - Volume public water supply: 223→363L&lt;br&gt;  - Accounted supply target rate: 84.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>4) Agricultural Water Supply</strong>&lt;br&gt;(2020 Target) 113 new reservoir embankment storage capacity enhancement projects for 280 million ton of new water resource</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>5) Groundwater Development &amp; Protection</strong>&lt;br&gt;(Vision) Sustainable Groundwater Use for Public Welfare&lt;br&gt;(2020 Target)&lt;br&gt;- Installation of 365 new monitoring wells&lt;br&gt;  - Preliminary and comprehensive investigations&lt;br&gt;  - 10 separate island area groundwater development projects&lt;br&gt;  - Operation of a groundwater information center</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>6) Sewage</strong>&lt;br&gt;(Vision) Sewage management for clean and safe living environment&lt;br&gt;(2020 Target)&lt;br&gt;- Improvement of treatment influent quality through sewer maintenance and repair 93%&lt;br&gt;  - Sewage service rate: Nationwide 92%, Rural areas 47%&lt;br&gt;  - Sludge reuse rate: 78%&lt;br&gt;  - Treated water reuse rate 18%</td>
<td></td>
<td></td>
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<tr>
<td><strong>7) Water Reuse</strong>&lt;br&gt;(Vision) Developing sustainable water resource through water reuse&lt;br&gt;(2020 Target)&lt;br&gt;- Annual reuse target 25 Billion ton (rainwater 78 Billion ton/year, gray water 48 Billion ton/year, wastewater reuse 1.57 Billion ton/year, treatment water reuse 2 Billion ton/year)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) 2030 Water Environment Future Vision: Water splashling festival of lives
2) 2050 Water Supply Vision: Worry-free water near us, always forward
3) 2030 Sewage vision: Safety and future oriented service lifting just for you

Shift towards stakeholder-involved progressive strategies from conventional government-oriented visions
### 6.2 Water Law

<table>
<thead>
<tr>
<th>Status (Current)</th>
<th>Aspirational (2030)</th>
<th>Difference Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3) Jurisdiction of Ministry of Agriculture, Food and Rural Affairs: responsible for “Agricultural Water Development and Use”</strong>&lt;br&gt;- Reorganization of Agricultural and Fishing Villages Act</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 6.3 IWRM (Integrated Water Resource Management)

<table>
<thead>
<tr>
<th>Status</th>
<th>Current</th>
<th>Aspirational (2010)</th>
<th>Difference /Metrics</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Under development (Necessity of IWRM is accepted by society including policy but specific plan is under discussion)</td>
<td>Restrictively implemented (the detailed implementation plan for IWRM is prepared by Water Basic Bill)</td>
<td>Partial implementation of IWRM</td>
<td>Cooperative work in among agencies</td>
</tr>
</tbody>
</table>

### 6.4 Cross Sector Coordination and Management Mechanism

<table>
<thead>
<tr>
<th>Status</th>
<th>Current</th>
<th>Aspirational (2010)</th>
<th>Difference /Metrics</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Currently being implemented restrictively (largely four major agencies are involved and other agencies' agreement is required for implementation of any river basin management policy and plan)</td>
<td>Certain degree of integration of agencies and integration setting of water policy and planning</td>
<td>Integration of agencies and existence of water policy and planning</td>
<td>Unification or integration of government agencies</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Science, Technology and Information</th>
<th>Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>National</td>
<td>Private</td>
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</tbody>
</table>

Baseline water control system such as Smart Water Grid System which allows efficient way of water usage and reuse.
### 6.5 River Basin Management Mechanism

<table>
<thead>
<tr>
<th>Status</th>
<th>Current</th>
<th>Aspirational (2018)</th>
<th>Different Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Total Water Pollution Load Management System: Target Water Quality and annually allocated pollution load (Basic Plan) -&gt; Local governments’ Implementation Plans -&gt; Periodic performance monitoring and evaluation -&gt; penalty when target not met</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) Designation of Riparian Buffer Zones: Designate and manage Riparian Buffer Zones for watershed protection from pollution sources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3) Water Use Charges &amp; River Basin Management Fund (Purpose) Secure the funds for protection and quality improvement of drinking water sources, source area neighborhood community support, and new treatment facilities by charging the users based on “polluter pays” principle (Water Use Charges) Levy and collecting a charge in proportion to water consumption from each end user to whom raw water drawn from public waters is supplied, Transferring the charge to the Basin Management Fund (River Basin Management Fund) In order to efficiently managing water use charges levied and collected, Operated and managed by the River Basin Management Committee</td>
<td></td>
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</tr>
<tr>
<td>4) Land Purchase System: A system that designates and/or purchase Riparian Buffer Zones when needed for recovering the qualities of drinking water sources</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>5) Program for Supporting Residents: Establish and implement a supporting system for residents in water source management area for the river basin management</td>
<td></td>
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</tbody>
</table>

### 6.6 Codes, Standards and Performance Measures

<table>
<thead>
<tr>
<th>Status</th>
<th>Current</th>
<th>Aspirational (2018)</th>
<th>Different Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Codes, Standards</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Rivers &amp; streams and lakes water standards for human health protection, standards for public welfare protection, biological benchmarks for water and aquatic environment quality (Enforcement Decree of the Framework Act on Environmental Policy)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>- Industry effluent standards, discharge standards (Water Quality and Ecosystem Conservation Act)</td>
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<td></td>
</tr>
<tr>
<td>- Wastewater discharge standards (Sewage Act)</td>
<td></td>
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<tr>
<td>- Use-dependent quality standards of drinking water (Drinking Water Management Act)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Water reuse standards (Promotion of and Support for Water Reuse Act)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) Performance Measures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Achieved water quality target rate: rivers &amp; streams 80.7%, lakes 12.2% in 2013</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Good” water quality achievement rate: rivers &amp; streams 85.1%, lakes 77.6% in 2013 (Aquatic life health)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Point source) Assessing effluent/discharge guidelines exceedances</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Drinking water) Assessing use-dependent quality standards exceedances</td>
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</tr>
</tbody>
</table>
### 6.7 Monitoring Evaluation Enforcement

<table>
<thead>
<tr>
<th>Status</th>
<th>Aspirational (2030)</th>
<th>Difference /Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Current</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Monitoring is mandatory in accordance with the relevant regulations. Annual monitoring plans for periodic sampling are mandatory as well.</td>
<td></td>
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</tr>
<tr>
<td>2) Public water monitoring system</td>
<td>- General monitoring network: rivers &amp; streams (574 sites), lakes (189 sites), agricultural use water (803 sites), urban water mains (37 sites), rivers &amp; streams near industrial complexes (70 sites)</td>
<td>Structured and integrated management based on a systematic monitoring plan</td>
</tr>
<tr>
<td>- Monitoring network for Total Water Pollution Load Management System: 170 sites</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Automated water quality monitoring network: 69 sites</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Sediment monitoring network: rivers &amp; streams (1,777 sites), lakes (50 sites)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Groundwater monitoring networks: 2,611 sites (Ministry of Environment 111 sites, Ministry of Land, Infrastructure and Transportation 361 sites, Ministry of Agriculture, Food and Rural Affairs 117 sites, Local governments 2,022 sites)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Aquatic life health monitoring and assessment network: 960 sites</td>
<td></td>
<td></td>
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<tr>
<td>- Flow measurement network: 173 sites</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3) Point-source Monitoring: Take-monitoring system on wastewater discharge facilities (Sooshin): 740 sites (municipal wastewater treatment facilities 441 sites, wastewater treatment plants 98 sites, industry effluents 231 sites)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


### 6.8 Public Reporting

<table>
<thead>
<tr>
<th>Status</th>
<th>Aspirational (2030)</th>
<th>Difference /Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Current</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Water Quality Monitoring: &quot;Water Information System&quot; - Monthly, Online Reporting on 762 Monitoring Stations (Rivers 573 sites, Reservoirs 189 sites)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) Ecosystem: Yearly Reporting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4) Sewerage: &quot;National Statistics of Sewerage&quot; - Yearly, Online Reporting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5) Groundwater: &quot;Soil &amp; Groundwater Information System (SGIS)&quot; - Online Reporting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6) Wastewater Discharge Facility: Yearly Reporting</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Establishing "Integrated Water Information System" - Integration of water information using GIS - Building digital information base for water management and analysis

Appendix | 57
6.9 Stakeholder Participation

<table>
<thead>
<tr>
<th>Status</th>
<th>Aspirational (2020)</th>
<th>Difference Achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td></td>
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</tbody>
</table>

1. National Environmental Policy Commission, Water and Aquatic Life Policy Commission, Water Reuse Policy Commission, and other environmental committees operated by the national government
2. Voluntary water quality monitoring and other activities for water quality issues by nonprofit environmental corporations and groups
3. Stakeholder involvements in Watershed Management Commission, and other specified issue-based commissions
4. Policies reflecting the outcomes of public hearing and other public opinion sharing events

Implementation

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Science, Technology and Information</th>
<th>Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>National</td>
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<tr>
<td>Private</td>
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Water and Sustainable Development in Korea : A Country Case Study
국문요약

한국 물환경 정책의 지속가능 발전 사례 연구

한국은 태평양 동아시아에 위치하고 있으며, 상대적으로 온화하고 다습한 4개절이 뚜렷한 기후를 가지고 있다. 연평균 강수량은 1,277 mm로 많은 양이 내리지만 지역적으로 불균등하게 분포되어 물 이용성이 지역에 따라 차이를 나타내며, 강우의 높은 계절 변동성은 기 기 동안의 빈번한 침수와 건강의 가뭄을 유발하여, 수자원 관리가 어려운 환경적 특성을 가진다. 이러한 가운데 최근 심해지고 있는 기후변화는 가뭄과 침수위험성을 증대시키는 추가적인 부담이 되고 있으며 이에 대한 적응대책 마련이 요구되고 있다.

한국의 물 분야 개발은 경제개발과 밀접하게 발전되어온 주요 국가 사업으로 간주되어 왔다. 물 공급은 대부분 지표수에 의존하고 있는 취약성을 가지고 있음에도 불구하고, 지난 40년 동안 (1965년에서 2007년) 6배로 증가되어 51억㎥에서 255㎥이 공급되고 있으며, 상수도보급률은 1960년대 초 20%에 불과하였으나 현재는 보편화된 수준 (98.1%)에 도달하였다. 또한, 하수도의 수집 및 처리를 위한 인프라시설이 전무한 상태에서 현재 90% 이상의 하수도보급률에 도달하는 급격한 증가를 이루었다. 이처럼 매우 짧은 시간에 물 분야의 광범한 발전의 주요 성공요인은 정부주도의 수자원 개발과 함께 관리체제를 강화하려는 연속적인 노력을 기인한다. 특히, 산업화 및 도시화에 의해 야기된 환경오염문제가 1980년대 말 심각한 사회적 문제로 대두되면서 정부의 시각적절하고 적극적인 환경정책 마련과 예산지원은 주요한 역할을 하였으며, 개발초기 관련분야의 많은 전문 엔지니어와 과학자의 배출은 물 관리 및 이용 기술에 기초한 물 인프라 개선을 이루었다.

한국의 물 관리 및 이용 체제의 근간이 되는 물 관련 주요 법규로
는 광역수공급과 홍수관리 등의 수량관리를 위한 국토교통부 관할 의『하천법』,『지하수법』,『댐건설 및 주변지역 지원 등에 관한 법률』 등의 법규와 환경부가 관할권을 가지는 수질관리 및 수생태 보전에 관한 법률로『수질 및 수생태계 보전에 관한 법률』,『수도법』,『먹는 물 관리법』,『물의 재이용 촉진 및 지원에 관한 법률』,『4대강 수계 물관리 및 주민지원에 관한 법률』 등이 있다. 또한, 농업용수 개발 및 이용에 관한 관할권을 가진 농림수산식품부는『농어촌정비법』이 있다. 이처럼 주요 중앙 부처가 관련 법규에 연관되어 부문별 국가 중장기 기본계획이 수립되고, 지방자치에서는 시행계획을 수립하고 이행하게 된다. 관련 사업의 투자와 시행을 위해서는 개발단계로부터 많은 행정적 가이드라인이 설정되어 사업수행 시 적용되고 있다. 또한, 투명한 재정지원체계와 수행을 점검하기 위한 환류시스템이 구축되어, 재정지원은 지자체의 사업수행 계획에 따라 중앙정부의 승인을 거쳐 지급되며 예산집행과 사업수행 평가는 매년 차년도 정부보조금 지원 정도를 결정하기 위해 수행된다.

한국 물 분야는 지난 50년간의 개발시기에서 현재 유지관리의 시대로 접어들면서 대두되고 있는 주요이슈 중의 하나는 중앙정부의 수량과 수질을 모두 고려하는 통합관리 체계의 기반구축이다. 수질 및 수생태 분야는 환경부 관할, 수량관리는 국토교통부와 농업수산 부의 관할로 단순히 이원화된 구조는 통합적 물관리의 장애요인으 로 나타나고 있으며, 최근 기후변화 대응의 필요성이 증대됨에 따라 시급히 신체되어야 하는 사안이 되고 있다. 이를 위해서는 수량, 수 리권, 수질 및 수생태 등을 종합하기 위한 관련 법들의 통합 및 개 혁이 필요하며, 이를 뒷받침 할 수 있는 국가물기본법의 제정 필요성이 수년 동안 물 관련 전문가 그룹에서는 강하게 문제로 제기되고 있으나 중앙정부의 구체적 추진은 불투명한 상황이다.

한편, 정부는 최근 상하수도 운영체계의 통합화를 강력히 추진되고 있다. 합리성이 결여된 과다 수요예측으로 인한 중복 또는 과다 투자는 물 인프라 시설의 가동률 저하를 초래하고 있어 이에 대한 개선이 필요한 상황이다. 그 예로 상수도시설의 경우 1991년 가동률이 80% 수준이었으나, 2006년 현재 가동률은 50%로 떨어지는 상
황을 초래하고 있으며, 주요요인은 투자계획 당시 과도한 수요예측에 기인된다고 할 수 있다. 이에 따라 현재 정부는 상하수의 통합화를 통해 규모의 경제를 고려한 운영체계로의 구조개편을 통해 합리적인 투자계획의 수립과 운영의 효율성 제고를 위한 노력을 하고 있다.

또 하나의 중요한 현안이슈는 재정의 지속가능성 확보에 있다. 현재 한국의 상하수도 수입은 총비용을 충당하지 못하고 있다. 이에 정부의 보조금시스템은 전국의 상하수도 시설의 확충 및 시설개선의 주요 재원확보 방안이 되어왔다. 정부보조금 지원비용은 요구되는 투자규모에 의해 정해지게 되며 지역간 물 분야 불균형을 해소하기 위해 주로 농어촌 및 도서지역 등 여전의 물 이용의 혜택이 필요한 지역을 위주로 추진되어 왔다. 하지만, 지나치게 정부보조금에 의존하는 구조 때문에 재정건전성의 훼손이 우려되고 있는 상황이다. 상수도의 경우, 전국 평균 수도요금(2010년 610.2원/m²)은 단지 생산원가(777.2원/m²)의 78.5%에 해당되며, 부족한 비용충당은 보조금에 의존하고 있는 실정이다. 수년에 걸쳐 상수도 보조금은 약10%대를 유지하여 왔으나, 최근 경제규모와 공공지출의 비율을 고려하여 점진적으로 보조금을 줄이는 정책을 추진하고 있다.

하수도의 경우에도 처리비용 대비 요금비율은 2004년까지 점진적인 증가로 62.5%까지 도달되었으나, 2005년 이후 다시 감소되어 2009년 현재 40% 수준으로 멀어졌다(전국평균 하수도요금은 240원/톤으로 하수처리비용 715.6원 대비 38.3%에 해당). 비용회수율을 높이고 보조금 의존도를 줄이기 위해서는 하수도 요금의 현실화가 필요하다는 판단에 따라 하수도 분야 경영에 민간 기업의 참여를 적극 유도하고 있다. 민간기업의 참여는 운영효율의 향상과 서비스 및 환경적 개선을 유발하고, 이에 따라 지방정부의 재정적 부담을 줄일 수 있을 것으로 기대하고 있다. 실제로 1998년부터 2008년까지 민간 자본이 투입되어 약100개 하수처리시설 건설에 투자되어 운영되고 있으며, 2009년까지 약70%의 하수처리시설이 민간에 의해 운영되고 있다. 이러한 상황은 장기화될 것으로 예상되며, 운영기간의 계약도 점차 장기화될 것으로 기대된다.
기후변화로 인한 환경변화와 국민의 물 복지에 대한 기대는 한국 물 분야의 지속가능성 측면에서 새로운 현안이슈가 되고 있다. 기후 변화에 따라 점차 심해지는 도시침수 및 가뭄 관리를 위해서는 상하 수도의 공공서비스 역할의 확대를 요구하고 있으며, 이에 대한 추가 적인 재정확보가 필요한 상황이다. 또한, 생활수준의 향상에 따라 여 가활동을 위한 물 접근성에 대한 국민적 요구가 증대되고 있으며, 이를 위해 선결해야 할 것은 물의 가치에 대한 인식의 변화가 선 행되어야 하는 상황이다.

주제어: 물거버넌스, 물관리, 상하수도, 수질, 지속가능발전
| Biographies |

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**Major Publications**  
Adaptation Strategies and Potential Costs to Climate Change in Water and Wastewater Sectors (2012, KEI)  
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Water Quality Management Strategy in the Context of Climate (II) (2011, KEI)

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**Green Growth**

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