POLICY IMPROVEMENT FOR PROMOTION OF URBAN WATER CIRCULATION

By

YANG, Jung Won

CAPSTONE PROJECT

Submitted to

KDI School of Public Policy and Management

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF PUBLIC MANAGEMENT

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Approval as of December, 2018

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ABBREVIATIONS

IWA: International Water Association

KDI: Korea Development Institute

LID: low impact development

ME: Ministry of Environment

MoIS: Ministry of the Interior and Safety

MoLIT: Ministry of Land, Infrastructure and Transport

SWMM: Storm Water Management Model

ABSTRACT

In order to reduce urban flood damage caused by climate change and urbanization, to secure alternative water resources, and to improve the urban water environment, most specialists consent that it is important to effectively circulate urban water resources through diffusion of water cycle cities and low impact development (LID) measures.

The purpose of this study is to investigate the present state of domestic and foreign policy on urban water circulation and LID, and to study policy direction and improvement plan for promotion of urban water circulation and LID appropriate to the situation in Korea.

This study reviews the current problems and suggests improvements in aspects of 'Institutional system, Industry fostering, and Public consensus' according to the situation in Korea based on the premise that urban water circulation needs to be expanded to ensure sustainability of cities. In the aspect of institutional system, it is necessary to establish a joint legal system among the Ministry of Land, Infrastructure and Transport, the Ministry of Environment, and the Ministry of the Interior and Safety. In the aspect of industry fostering, in order to maximize the effects by urban water circulation, it is necessary to adopt development certification program for LID planning and design in development projects and city management. And, in the aspect of public consensus, it is needed to collect opinions and disseminate consensus on related policies and technologies through establishment of urban water circulation forum, campaign, etc.

1. Introduction

1.1. Current state of water resources in Korea

Regarding precipitation of Korea, the average annual volume is approximately 1,270mm, which is not a small amount compared with other countries. However, the seasonal variation is large and 69% of the total precipitation is concentrated in summer, and measures against flood (summer) and drought (winter) are needed.

Korea's water use has been securing water through the construction of water infrastructures such as dams, reservoirs and water in the outskirts or upstream area of the city, and has supplied water to the required areas. In a year, 26.3% of the total water resources of 129.7 billion ㎥, 33.3 billion ㎥ is being utilized.

In the case of water disaster management, Korean government has been managing land and cities by constructing continuous river maintenance and flood control dams such as embankment construction and dredging oriented on flood vulnerable sections.

1.2. Climate change

Recently, the frequency and intensity of droughts are increasing, and rainfall patterns are changing due to the increase of local rainfall. Due to climate change, our urban areas are experiencing a variety of meteorological disasters every year, including heat waves, tropical storms, typhoons, urban floods and droughts. These meteorological disasters are accompanied by numerous human and property damage. The frequency of heavy rainfall is also increasing every year. Urban flood damage has been increasing due to the increase in impervious area due to urbanization and the increase of short term heavy rainfall due to climate change. As of 2017, the

impervious area of Korean cities is 54% in Seoul, 30% in Busan, 27% in Gwangju and 23% in Daegu. In addition, due to the destruction of the water circulation system in the city, depletion of groundwater, streamlining of rivers, ecosystem disturbance, tropical nights and heat island phenomenon are deepening.

In order to minimize urban flood damage caused by recent climate change and urbanization, to secure alternative water resources, and to improve the urban water environment, it is necessary to effectively circulate urban water resources through diffusion of water cycle cities and low impact development (LID) measures.

The purpose of this study is to investigate the present state of domestic and foreign policy on urban water circulation and low impact development, and to study policy direction and improvement plan for promotion of urban water circulation and low impact development appropriate to the situation of Korea.

2. Urban Water Circulation Management Policy Status

In Korea, water resources development proceeded from the 1960s through the 1970s, and as water resources were secured in the 1980s, it became a driving force for urbanization and industrialization. The water resources thus obtained are purified in a water purification plant and supplied to domestic water and industrial water through a water supply process. The water used generally is treated at the sewage treatment plant via the sewage line and then discharged or reused through additional treatment. This artificial system circulation was completed in 1990. (Kim, 2014)

As the importance of water environment preservation became more important due to the phenol pollution incidents that occurred in Daegu in 1991, the public interest in development and

environmental harmonization began to grow after the 2000s.

Rainwater, which is the source of water circulation in nature, has been recognized as to be rapidly discharged to the rivers through sewerage in the meantime. However, in 2001, the regulation on rain water utilization facilities was introduced in the ‘Water Supply Law’, and rainwater began to be recognized as a new alternative water resource in the city.

As urban floods become more frequent due to typhoons and climate change, the government has recommended the installation of stormwater reduction facilities through the 'Natural Disaster Countermeasures Act' in 2004 as part of efforts to reduce rainwater spills in urban areas. In addition, the 'Law on the Protection of Water Quality and Aquatic Ecosystems' was established in 2007, emphasizing the importance of non-point source management as well as point source management.

In 2010, for the efficient use and management of water in urban areas, the rainwater utilization facilities in the ‘Waterworks Act’, the water-reuse facilities in the ‘Sewerage Act’, and the reuse of newly treated wastewater were referred to as 'Water Reuse Promotion and Support Act'. In addition, the ‘Low Carbon Green Growth Act’, enacted in 2010, stipulates that the government should establish and implement measures to effectively deal with natural disasters such as drought caused by climate change, water shortages, deterioration of water quality and changes in aquatic ecosystems. In particular, the ‘Special Act on the Utilization of Waterfront Areas’, enacted in 2010, stipulates that the minimization of pollutant loads and the minimization of the influences of river flows by the development of Waterfront Area should be planned in the waterfront development plan. The ‘Guidelines for the Establishment of Waterfront Areas’ (2011) stipulate that the LID technique should be applied to the land-use plan and the urban water circulation system should be constructed by using the LID technique to minimize

water pollution.

In 2012, the 'Sewerage Act' was amended to define the 'sewage storage facility', a facility for temporary storage of sewage, and a system was established to support flood damage, prevention of water pollution, and reuse of sewage. In addition, the 'Urban Parks and Greenery Act' provides an institutional apparatus that can create parks with disaster prevention functions. And, in accordance with the ‘Green Buildings Support Act’, the green building certification standard was revised in 2013, and the ‘water resources’ evaluation item was changed to the ‘water circulation management’ item, which transformed the green building into a space for water management.

The ‘Regulation on Installation Urban Planning Facilities’, which was amended in 2013, requires minimizing the leakage of rainwater for restoration of natural resources and considering the installation of distributed rainwater management. Therefore, most urban planning facilities have been subject to the establishment of decentralized water management facilities, which provide a basis for restoration of natural water circulation by reducing the runoff from the source. In particular, in the case of planting strip, it has been stipulated that rainwater should be installed at a level lower than the level of the adjacent road. It has become a meaningful institutional improvement in terms of encouraging participation in the landscape.

The ‘Law on the Promotion and Support of Water Reuse’ in 2014 was revised to support it more efficient to use water at the sources by mandating the use of rainwater in private houses such as apartment complexes, large sales facilities and golf courses. However, The level of the mandatory target had been limited and its effectiveness has become a problem.

The Ministry of the Interior and Safety (MoIS) revised the ‘Natural Disaster Countermeasures Act’ in 2014 to regulate it necessary to install stormwater reduction facilities

for small-scale development projects. In 2016, it established the ‘Standard of Storm Runoffs Reduction Plan by Developers’. It is expected that the decentralized rainwater management at the source will spread in earnest.

In 2014 and 2015, the legislation on the ‘Promotion and Support of Water Cycle Cities’ (draft) and the ‘Basic Law on Water Management for the Creation of a Sustainable Water Environment’ (draft) have been submitted by the legislatures of the National Assembly.

As such, institutional supplementation related to water circulation management is continuing. This improvement also serves as a basis for transforming urban infrastructure into a space for systematic water management from the space where water is simply used.

At the local government level, Suwon and Namyangju metropolitan municipal governments enacted water circulation regulations in 2009, and commenced on implementation of water circulation policies in cities. Since then, the City of Seoul has revised the existing ‘Regulations on Rainwater Management’ in 2014, and has established the ‘Water Circulation Recovery and Low Impact Development Ordinance’, which will be applied not only to water management departments but also to various fields such as urban planning, building construction and landscape, established the basis for the involvement of city water circulation management. These efforts became the starting point for full-scale water cycle recovery and low impact development in the City of Seoul. From 2015, the ordinance stipulated allocation of the amount of rainwater to be allocated for permission and construction of rainwater management facilities for 41 kinds of development projects including the construction of new buildings with a land area of 1,000 m2 or more. Also, in the case of sidewalks, permeable packaging was obligatory. Thus, the central government and some local municipalities are developing and implementing urban water circulation policies.

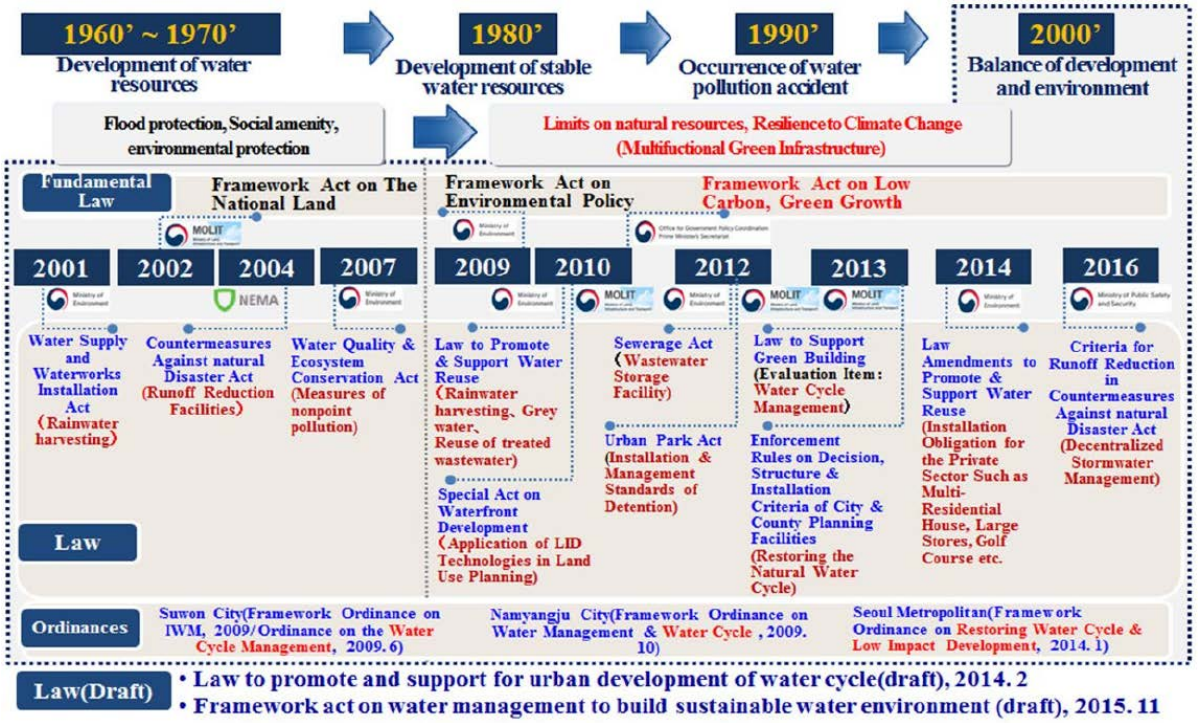

Figure 1. Laws on water cycle management for resilience to climate change in Korea (Kim, 2014)

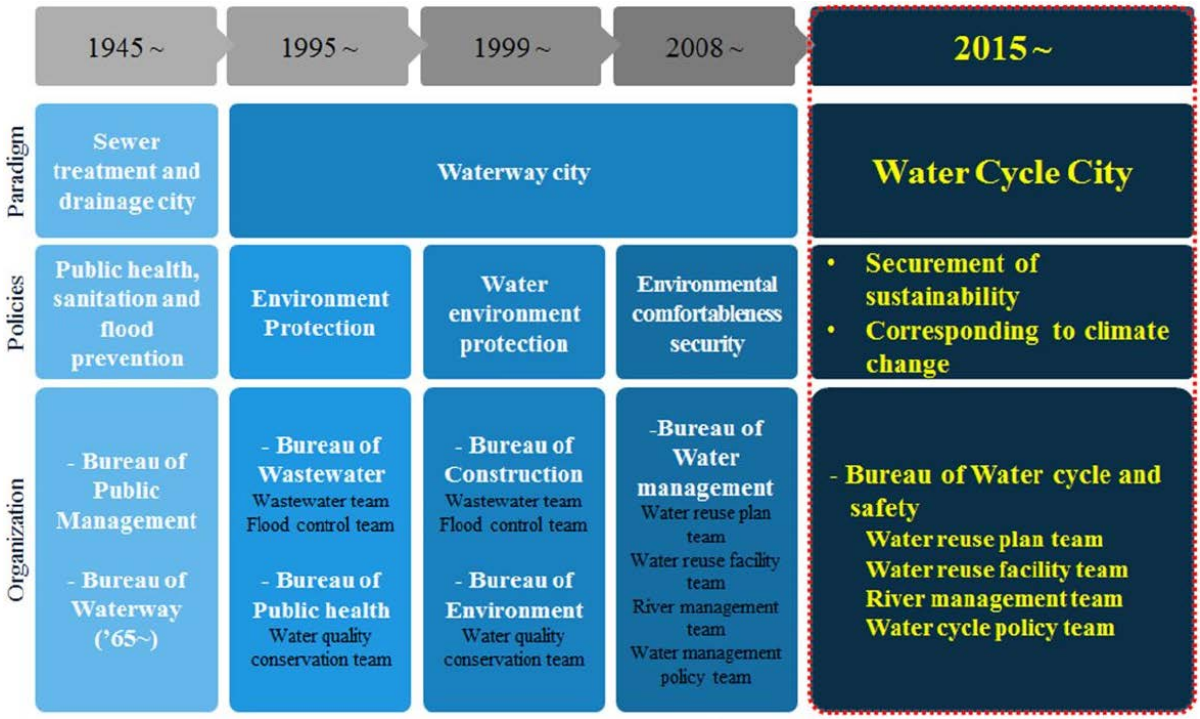

Figure 2. Reorganization of the administrative structure of the Seoul Metropolitan for LID (Kim, 2016)

2.1. Water management paradigm shift for sustainable cities

Recently, we might say 'sustainability' is one of the most important issues in terms of urban management and environment in many countries including Korea. In UN HABITAT III (2016), sustainability is treated as a top goal of climate change and urban resilience. In particular, the paradigm in the field of water management, which is an important factor in constructing and maintaining cities, is being changed drastically.

Brown (2012) asserts that many benefits of the traditional centralized urban water servicing model has provided for society in many aspects. However, it is increasingly ill-equipped to cope with the prevalence of extreme weather events, climate uncertainty and other variable socio-technical trends. In the solution of these problems, a new model of adaptive water management seeks essential shifts in management approaches. Brown analyzes the differences between the 'Traditional and Adaptive Urban Water Management Regimes' in the aspects of attributes such as System boundary, Management approach, and etc. as below

Table 1. Attributes of Traditional and Adaptive Urban Water Management Regimes (Brown 2012)

Attributes	Traditional Regime	Adaptive Regime
System Boundary	Water supply, sewerage and flood control for economic and population growth and public health protection	Multiple purposes for water considered over long-term timeframes including waterway health, transport, recreation/amenity, micro-climate, energy etc.
Management Approach	Compartmentalisation and optimisation of single components of the water cycle	Adaptive, integrated, sustainable management of the total water cycle (including land-use)
Expertise	Narrow technical and economic focussed disciplines	Interdisciplinary, multi-stakeholder learning across social, technical, economic, design, ecological spheres
Service delivery	Centralised, linear and predominantly technologically and economically based	Diverse, flexible solutions at multiple scales via a suite of approaches (technical, social, economic, ecological etc.)
Role of public	Water managed by government on behalf of communities	Co-management of water between government, business and communities
Risk	Risk regulated and controlled by government	Risk shared and diversified via private and public instruments

In addition, according to research by Brown and colleagues (2009) on multi-year Australian cities, changes in urban characteristics in terms of water management systems have progressively been made according to socio-political drivers. These studies are categorized into six types of water management systems: water supply, sewered, drained, waterways, water cycle and water sensitive.

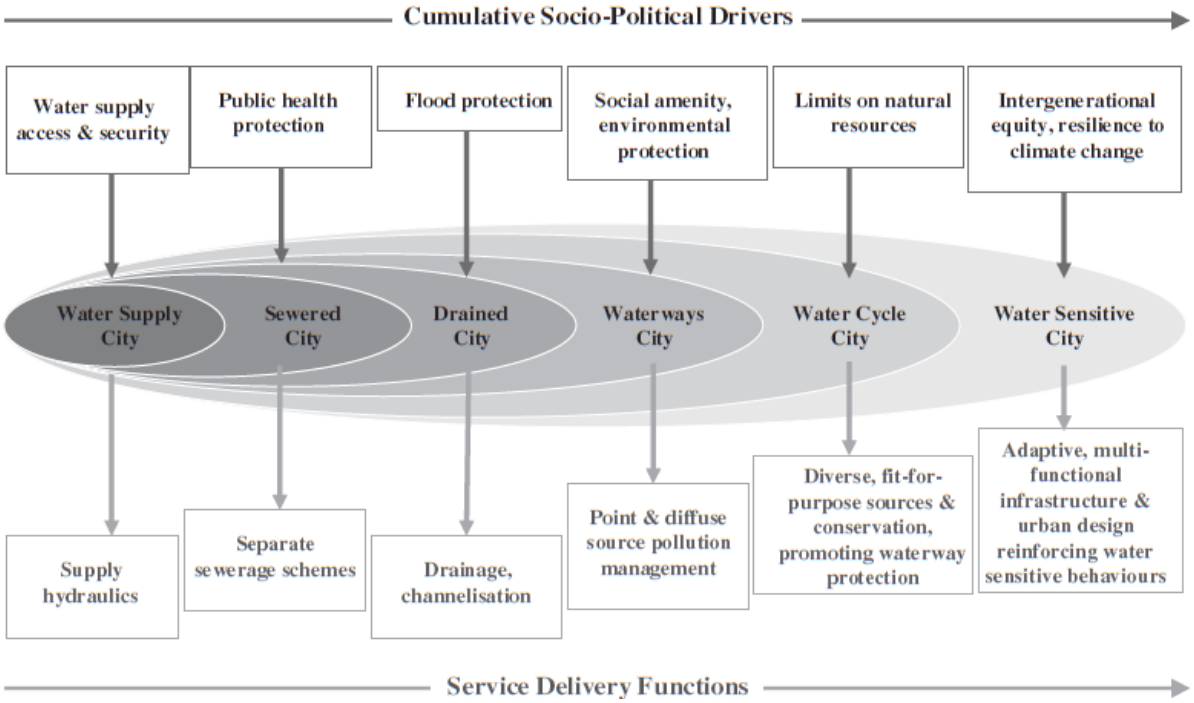

Figure 3. Urban Water Management Transitions Framework (Brown et al., 2009)

In terms of water management system, the attribute of the city gradually transformed in the water supply city which is the basic requirement for the urban people and the city operation in the beginning, and it is finally being transformed to the water sensitive city. As such, the direction of the transformation is the course of enhancing functional diversity and integration from simple functions in the first phase, enhancing urban resilience to climate change, and securing sustainability of cities.

2.2. Definition of urban water circulation and LID

2.2.1. LID (Low Impact Development) and GI (Green Infrastructure)

In case of new town development or implementation of an urban management project in the existing city, unlike conventional concentrated form management systems that install rainwater pumping stations and sewage treatment plants, the LID method restores urban water circulation and installs and manages water circulation facilities from urban watersheds and sources, reducing urban flood, reducing non-point pollution, And water management techniques to reduce carbon emissions.

In the land use planning stage, the LID method is divided into 'unstructured technique' that considers urban water circulation in aspects of engineering design, soil improvement, improvement of urban waterway, etc., and 'structural technique' that use water circulation facilities such as rooftop greening, rain gardens, permeable pavement, vegetation trenches, and infiltration trenches to provide water circulation function (evaporation, infiltration and storage) in the urban infrastructures such as roads and traffic facilities, residential and industrial complexes, etc. These two techniques are collectively called Green Infrastructure (GI). (Lee, 2015)

Legally, in the ‘Waterfront Area Development Guidelines’ (2011), LID is defined as ‘a land use planning technique that consider the infiltration, reservoir, and water circulation system of rainwater for reducing flood and water pollution’. And, The National Institute of Environmental Research (2012) defines LID as 'development methode minimizing the impact on nature, and it implements the process of infiltration and storage of nature and integrates devices (bio-retention, etc.) to manage rainfall runoff’.

2.2.2. Principles of water circulation management in LID techniques

The fundamental principles of water circulation management in LID techniques are 'unstructured approach, source management, distributed management, hydrological approach and multi-functional green infrastructure'.

First, as an 'unstructured approach', in the early stage of urban planning, it is necessary to utilize the existing natural ecological space as much as possible, to maintain the natural waterway, to restore the soil and to maintain the permeable area.

The second is the 'source management', which means it is advantageous to manage at the source where we live in, such as residential areas, commercial districts, industrial parks, public parks and parks than installation of facilities such as sewage pipe lines and river facility.

As the third 'distributed management', which means it is advantageous to manage distributedly at existing facilities such as buildings, roads, sidewalks, parks, etc. than water management method that collects, processes and manages water such as sewage, sewage treatment plant, dam, river and so on, in one place.

Fourth, the hydrological approach is to regain the hydrological functions of nature, namely evaporation, infiltration, reservoir and pumping, to regulate the intensive outflow of good and nonpoint pollution in the impervious area and to restore the water circulation.

Finally, the principle of multi-functional green infrastructure is to build a green infrastructure that gives versatility to existing gray facilities for a single purpose, that is, multipurpose green functions such as effluent reduction, non-pollutant reduction and CO2 reduction.

2.3. Urban water circulation and LID status (Overseas)

In other countries, various terms have brought about changes in the water management paradigm. Nevertheless, they pursuing a common goal by means of management of stormwater runoff sources, green infrastructure of existing infrastructure facilities, recycling of rainwater, etc.

Table 2. Terms in the water management paradigm in overseas countries

Countries	Terms	Attributes
Germany	Decentralized Urban Design (DUD)	· Decentralized rainwater management · Management and utilization of storm water
U.S	Low Impact Development (LID)	· Pollution source and rainwater management
U.K	Sustainable Urban Drainge System (SUDS)	· Water quality, quantity integrated design · Field management (design, maintenance, education)
Japan	Well Nalanced Hydrological System (WBHS)	· Flow control, water use, balance of water environment · Facilitation of rainwater storage and infiltration facilities
Austrailia	Water Sensitive Urban Design (WSUD)	· Climate change adaptive rainwater Management · Management and use of rainwater runoff

* In the case of the United States (New York, etc.) and Japan, currently being translated into the term 'green infrastructure'

2.3.1. Overseas (Japan) Water Circulation Management Systemization Status

Particularly, in the case of Japan, the weather conditions such as rainfall are comparatively similar to Korea, and so the legal system is, in several aspects. Therefore, it is meaningful to examine the Japanese system in more detail.

The rainfall distribution in Japan is large in regional and timing aspects, and the annual average precipitation is approximately 1,700㎜, which has abundant water resources which is

twice the average global rainfall. In this circumstances, Japan continuously tries to expand the policy for institutionalization by recognizing the effect of social and environmental aspects such as prevention of urban flood, mitigation of urban water disaster, restoration of natural ecosystem, reduction of burden of sewage facilities, and mitigation of urban heat island effects.

The Japanese government has enacted the ‘Rainwater Utilization Promotion Act’ in 2014 to promote efficient use of water resources in the cities. By enactment of the ‘Water Circulation Basic Law’, a governmental organization for unification of the relative water resources administrations was established. And It is pursuing comprehensive policies to maintain and restore sound water circulation.

In case of 'national land formation plan' as a national plan, it was revised to include 'green infrastructure' in 2015. By the ‘Social Capital Maintenance Priority Plan’ established in 2015, green parks with natural rivers, green embankments, and fire prevention functions are being maintained.

In the case of stormwater storage and utilization promotion system, the Ministry of Land, Infrastructure and Transport enacted the ‘Special Measures for Taxation for Rainwater Reservoirs and Utilities’. And when installing a facility to store or use a certain amount of rainwater in a metropolitan area since 1998, incentives are applied.

In addition, the support for urban rainwater maintenance loan, rainwater reuse house, and rainwater utilization facility are implemented to spread the urban water circulation.

2.4. Policies on Water Cycle and LID in Korea

In terms of the statutory plans related to urban water circulation, The ‘3rd Science and Technology Basic Plan’ (2013-2017) established by the Ministry of Science, Technology and

Communication included ‘water management advancement through advanced technology of integrated water management system.’

The MoLIT established the ‘Water resource long-term comprehensive plan’ (2011-2020) which contains ‘balanced flow of land through balanced water circulation’ and ‘establishment of standards for sound water circulation centered on urban areas such as rainwater utilization and penetration promotion.’ And the ME (Ministry of Environment)'s ‘Basic Plan for Water Environment Management’ (2013-2023) is to 'promote the LID techniques for expanding urban rainwater penetration area'. Thus, the MoLIT and the ME are mostly responsible for policies on urban water cycle and LID in Korea. The following are the relevant laws and regulations of these two institutions.

Table 3. LID-related laws and regulations of the MoLIT and ME

MoLIT	ME
*Special Act on the Utilization of Waterfront Areas (2010) *Waterfront Area Development Guidelines (2011) *Sustainable New City Planning Standards (revised, 2012) *Regulation on Installation Urban Planning Facilities (revised, 2014)	*LID Technique Application Manual in Environmental Impact Assessment (2013) *Guidelines for LID Technology Elements(2013) *Regulations on Water Quality and Water Conservation (revised, 2014)

Regarding the detailed trends in the policies of MoLIT, first, from the institutional point of view, the land developers are stipulated the LID technique that restores the natural water circulation by minimizing the rainwater runoff from urban, housing, and architectural aspects, to be considered. And, according to the ‘Green Building Promotion Act’, incentives such as the

floor area ratio are given to the development projects that apply the LID technology to a certain level or more.

Table 4. Details of LID-related laws of the MOLIT

Regulations	Contents
Green Building Promotion Act	· Including rainwater utilization facility as a sub-index of water circulation management part in green building certification standard * Incentives such as lowering the floor area ratio (up to 15%) when receiving the top two grades
Waterfront Area Development Guidelines	· LID and green infrastructure (GI) specified to minimize runoff and pollutant emissions
City and County Management Plan Guidelines, Regulation on Installation Urban Planning Facilities	· Stormwater management facility (GI) to consider the restoration of natural water circulation and induce storage and infiltration of rainwater in urban areas when establishing city and country management plans and city and country planning facilities.
Sustainable New City Planning Standards	· Rainwater management facilities for storage and infiltration to manage rainwater and provide effective management and use of water resources

In terms of technology development, R&D is being pursued with the goal of realization of LID cities that promotes natural water circulation. The ‘Green Infrastructure and Low Impact Development Center in Korea (Busan)’ has been established and operated. (Shin, 2016)

In addition, in order to spread LID, commencing Asan-Tangjung land development project which is the first new city scale in Korea applying the LID technique, the development project of Godeok, Pyeongtaek New Town (LH), Eco Delta City and Songsan Green City (K-Water) (Lee,

2014) are under construction.

The trend of the Ministry of Environment, in terms of the institution, is introducing manuals and LID techniques as a non-point pollution abatement facility in the watershed (Water Quality and Water Conservation Act).

Table 5. Details of LID-related laws of the ME

Regulations	Contents
Water Quality and Water Conservation Act (2014)	· A nonpoint pollution reduction plan to be prepared considering the technique that contributes to restoration of the natural water circulation by minimizing the rainwater runoff from the impervious layer due to the development project
Guidelines for LID Technology Elements (2013)	· Prevention of environmental problems due to development of land use change and urban water cycle distortion, and suggestion of application to environmental impact assessment
LID Technique Application Manual in Environmental Impact Assessment (2013)	· Application of LID technique in consultation of environmental impact assessment for development projects, LID application to urban development, industrial complex development, road development, etc. related to improvement of water circulation function and reduction of nonpoint pollutant

In addition, as a policy for spreading to local governments, a demonstration projects (Ochang, Jeonju) for stormwater runoff zeroing campaign and water-circulation-leading urban projects (since 2016, Gwangju; Daejeon; Ulsan; Gyeongbuk; Andong; Gyeongnam; Kimhae) are promoted.

In particular, several municipalities are actively pursuing urban water circulation and LID policies. First of all, the Seoul Metropolitan Government has enacted and regulated water

circulation and low impact development ordinances. Since 2013, the Seoul Metropolitan Government has been promoting the transition to a water cycle city in earnest on the basis of laws, regulations, and research results since 2004.

In case of Suwon City, since the enactment of the 'Ordinance on Water Circulation Management' in 2009, the city recommends and supports the installation of rainwater management facilities in urban development and building permits. In particular, Suwon City is actively promoting the Rain City project, and from 2015 to 2018, projects are being implemented to improve the water circulation structure in 13 urban areas with high impervious area. On the one hand, Suwon City is developing diverse scaled rainwater storage facilities such as an athletic field, a World Cup stadium, an overpass road, a school, rainwater storage houses for private homes, and 197 sites for rainwater storage facilities of 77,000 ㎥ reflecting the concepts of green infrastructure and LID in the process of creating rainwater utilization facilities, rainwater infiltration facilities and rain gardens. (Lee, 2014)

3. Urban Water Circulation Promotion Policies, Problems and Improvement

3.1. Problems with current policies

It is might to say, to a certain level, there is a consensus on the effectiveness of urban water circulation especially among the developed countries which applied the Urban Water Circulation Promotion Policies to a considerable degree in development projects or urban management. In the case of Korea, technical studies are underway, and the importance and utility of city water circulation is acknowledged. For example, in the study of Ahn et al. (2017), the results of analyzing the effects of low impact development for urban water cycle showed that 34.5% of the

rainfall is retained when the existing development method without LID facility is applied through SWMM (Storm Water Management Model) analysis And 59.2% after installation of LID facility. Besides, various studies have been conducted on the effect of rainwater infiltration storage as well as the reduction of water pollutants emission through application of LID. Throughout these efforts, the effects of urban water circulation and LID are being verified.

However, there has not yet been enough consensus on cost-effectiveness and urgency of application. In addition, in general, the effect of urban water circulation is relatively long-term in comparison with the effect of installation of the current general urban infrastructure such as roads and bridges. However, as the possibility of disaster due to climate change has increased recently and the importance of urban resilience to secure urban sustainability has increased, the expansion of urban water circulation has become an important issue in order to maintain and improve urban sustainability. It is no longer a matter of last priority.

In this context, this chapter reviews the current problems and suggests several improvements based on the premise that urban water circulation needs to be expanded to ensure sustainability of cities and that Korean cities should be managed or developed in the direction of Water Cycle City or Water Sensitive City.

Brown et al. (2009) summarized the obstacles to urban water circulation diffusion as follows.

- insufficient skills and knowledge
- organisational resistance
- lack of political will
- limited regulatory incentives
- unsuitable institutional arrangements
- lack of community engagement
- policy failure at implementation

Referring the seven obstacles derived from the previous studies, in this study, the problems are summarized in terms of 'Institutional system, Industry fostering, and Public consensus' according to the situation in Korea.

Table 6. Brief problems of urban water circulation promotion policies in 3 aspects

Aspects	Problems
Institutional system	- Absence of Basic Law on Urban Water Circulation - Lack of expansion and specificity of water cycle concept for urban management plan
Industry fostering	- Lack of industry base to spread urban water circulation business
Public consensus	- Lack of awareness of general public

3.2. Improvements

As IWA uses Water Wise City as a different term from Water Sensitive City. in any case, IWA proposes 4 levels of action, and 17 principles for each 4 levels of action. These are also useful principles for the proliferation of urban water circulation in Korea.

Table 7. The IWA Principles for Water Wise Cities (reproduced from IWA)

4 Levels of Action	17 Principles for Water-Wise Cities
1. Regenerative Water Services	• Replenish Waterbodies and their Ecosystems • Reduce the Amount of Water and Energy Used • Reuse, Recover, Recycle • Use a Systemic Approach Integrated with Other Services • Increase the Modularity of Systems and Ensure Multiple Options

2. Water Sensitive Urban Design	• Enable Regenerative Water Services • Design Urban Spaces to Reduce Flood Risks • Enhance Liveability with Visible Water • Modify and Adapt Urban Materials to Minimise Environmental Impact
3. Basin Connected Cities	• Enable Regenerative Water Services • Design Urban Spaces to Reduce Flood Risks • Enhance Liveability with Visible Water • Modify and Adapt Urban Materials to Minimise Environmental Impact
4. Water-Wise Communities	• Empowered Citizens • Professionals Aware of Water Co-benefits • Transdisciplinary Planning Teams • Policy Makers Enabling Water-Wise Action • Leaders that Engage and Engender Trust

In the following three sections repectively, the improvement measures to overcome the problems in each sector are examined.

3.2.1. Institutional system

It is necessary to strengthen the institutional basis for the creation and support of Water Circulation Cities that integrate rainwater management at city level and link them with urban planning. And, establishment of the basic law (tentative name, ‘water circulation city and LID business promotion and support law’) for the vitalization of the water circulation city, revision of the impact evaluation system and revision of the current regulation (City management plan establishment guideline and district unit plan guideline, etc.) is necessary to be considered.

In addition, in the long run, it is necessary to improve and secure urban water circulation on the basis of ‘region’ and ‘watershed’ in accordance with water management integration policy.

3.2.1.1. Problems and Improvements

First of all, there is not enough legal system for spreading and promoting urban water circulation and LID. Laws related to LID techniques have been enacted or amended, however they are mostly sporadic. It is necessary to establish the 'Basic Law for the Vitalization of the Water Cycle City' as a high-level law that can integrate the related laws and regulations.

In addition to the enactment of the Basic Law, the legal system for the implementation of 'LID industries' is insufficient. It is necessary to establish a subordinate statute for the implementation of the LID techniques under the act.

Besides, due to the nature of LID techniques, there are few legal systems that can be integrated in the MoLIT, the Ministry of Environment, and the Ministry of the Interior and Safety. A water management consultation body is needed for consultation with major ministries. It is also necessary to establish a joint legal system.

Particularly, in the process of urban development, environmental impact assessment and disaster impact assessment are mandatory procedure to approve development projects of larger than a certain scale. The Ministry of Environment and the Ministry of Public Administration and Security are in charge respectively. The environmental impact assessment covers the outflow of non-point source pollutants, on the one hand, the disaster impact assessment covers the water-related disaster. These processes are disadvantageous in terms of the consistency and efficiency of the measures required by each consultation. Thus, it is desirable to integrate these two types of impact assessments related to low impact development, since LID is pursuing the multi purpose

of reducing the burden of non-point source pollutants and rainwater runoff amount simultaneously. If integration is difficult currently, it is necessary to establish procedures for simultaneous deliberation by each institution as an alternative. Additionally, in case of disaster impact assessment, it is required to replace the storm drainage amount exceeding the pre-development stage due to the development project with the rainwater reservoir installation plan. It is necessary to be revised to allow and guide the replacement of LID-based planning and design.

In addition, it is necessary to improve the LID-based district unit plan guide. In the process of urban development, it is the ‘District Unit Plan’ that finely adjusts the site plan and the architectural plan. In addition, the district unit plan has a very direct and close relationship with the application of LID-related plans and designs. Therefore, it is important to improve the district unit planning guidelines in order to ensure that the LID concept is appropriately realized in the planning and construction plan in the development project or city management.

Moreover, in the long term, it is necessary to establish a ‘water circulation master-plan’ for each watershed. Successively, it is also necessary to consider the introduction of a ‘water circulation total amount system’ (tentative term) that can be linked to or supplemented with the ‘total amount of pollution system’, which is currently being implemented, to improve urban water circulation. Through this, we can expect to improve the integrated urban water circulation on the basis of watershed and region.

3.2.2. Industry fostering

In order to expand the water cycle city, it is necessary to establish urban water circulation and LID related certification system such as LID business certification, performance certification for related technology products, and new technology certification.

In terms of the performance certification, the MoLIT established the Korea Green Infrastructure and LID Center to certify the performance of LID technology products in order to vitalize the LID related business. On the one hand, the Ministry of Environment is promoting the establishment of a non-point pollutant abatement facility certification center with the goal of certification of non-point pollutant abatement technology. On the one hand, The Seoul Metropolitan Government has applied the TR mark certification system through the ‘permeability performance persistence verification test’ when applying the permeable pavement, and has been using the products with the highest grade first. In addition, the green building certification system of the MoLIT in the field of architecture is being implemented (2013) through the 'Green Buildings Support Act'. As the water circulation management item, the grade is evaluated according to whether the rainwater effluent reduction facility is installed and the rainwater utilization facility is installed.

3.2.2.1. Problems and Improvements

In the case of the technology certification center, the MoLIT and the Ministry of Environment have established or are promoting certification centers, respectively. There are many possibilities to be redundant investment by each department, and the consistency of LID technology policy might be insufficient.

Recently, according to the unified policy of water management by the central government, most water resources functions are integrated into the Ministry of Environment, and the functions of the technology performance certification center being promoted by respective ministries need to be integrated.

In addition, certification function for 'development' performance is required besides the certification center for 'facility' performance. In other words, in addition to LID facility technology certification, it is necessary to introduce 'development certification program' for LID planning and design in development project and city management. The United States and Japan operate business certification programs on planning and design process as follows.

* US, NGICP, National Green Infrastructure Certification Program:
  certification standards for green infrastructure construction, inspection and maintenance established by DC Water and WEF (Water Environment Federation) (2016)

* Japan, SoRA, Status of Rainwater Advantage:
  Certification system for reservoir, infiltration and reuse facilities contributing to city water circulation and reuse

3.2.3. Public consensus

In the case of Korea, it is difficult to consent that the recognition of urban water circulation and LID has formed public consensus. It is necessary to collect opinions and disseminate consensus on related policies and technologies through establishment of urban water circulation forum, campaign, etc.

Through the above-mentioned development certification program, it is necessary to secure urban water circulation in development projects and urban management. Simultaneously, in the aspect of the role of the public sector, technical consultation, water cycle city planning and design support (e.g. establishment of customized rainwater management district unit plan guideline for local area, etc.), impact assessment on water circulation plan in development project and city management plan are needed for disseminating and proliferation of urban water circulation and LID.

4. Conclusion and Prospects

Most experts acknowledge the necessity of applying LID techniques, technology and facilities for climate change response, and sustainable urban development and management. However, in order to build public consensus for making our cities more liveable and sustainable by means of 'urban water circulation and LID', continuous research and appropriate policy are important.

In addition to the policy regarding the structural techniques for rainwater runoff and non-point pollutant abatement facilities, unstructured methods (techniques) such as site planning, construction design and district unit planning (urban design) are important factors as well, i.e., it is necessary to develop LID measures in terms of spacial planning. And, the LID measures need to be considered from the planning stage of new town and site.

In order to transform the gray infrastructure space of the current urban development paradigm into a green infrastructure space to manage rainwater as a result of the low impact development paradigm, participation and cooperation among diverse fields such as urban planning, architecture, roads, landscapes, water resources, and environment are indispensable. In the course of the participation and cooperation, urban development and management measures also require a higher level of integrated access and implementation of the public sector.

Our cities must be guided to become a climate-change responsive and water sensitive sity, beyond only water cycle restoration function. According to Graaf et al. (2012) there are two conditions for cities to successfully go to water sensitive city. The first condition is including urban water management innovations in spatial planning and development. The second condition is stakeholder receptivity to urban water management innovations.

In order to establish a sustainable city in the era of climate change, the public sector including the central government need to play a role in inducing and urban water management

innovations and increasing stakeholder receptivity. In addition, it is important to improve laws and institutional improvements for urban water circulation and low impact development, to foster relative industry and to spread public consensus.

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