Rivers and Watersheds

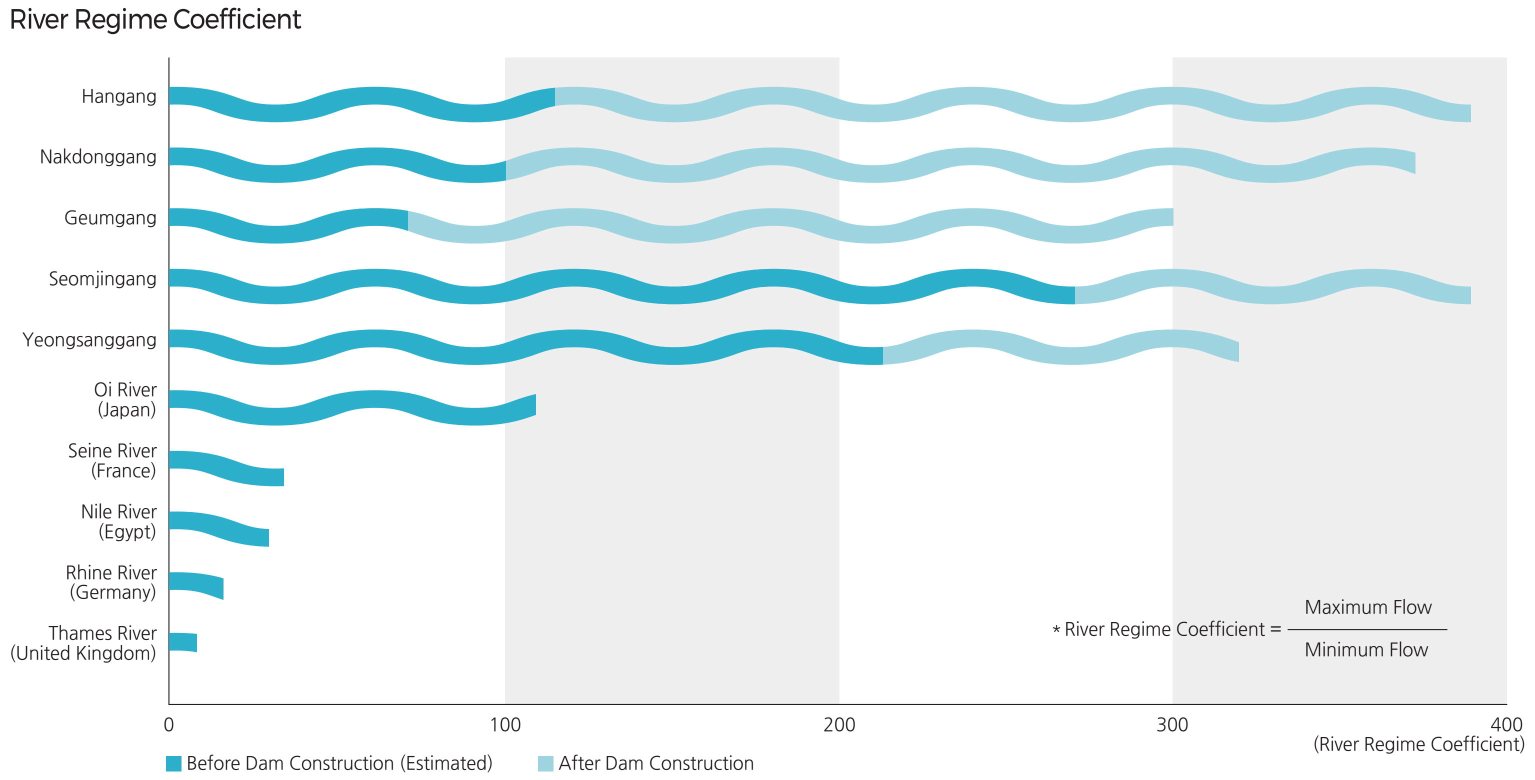
The terrain of Korea is characteristically high along the east coast and low along the west coast. Consequently, most of the rivers flow into the Yellow Sea and the South Sea. The shoreline of the east coast is monotonous and rivers flowing into the East Sea are relatively short and steep-sloped. On the other hand, the shoreline of the west coast is more complex and many rivers flowing to the western and southern coasts are relatively long; they have gentle slopes and wider basins that result in higher flow. In these areas, river sediments shape extensive alluvial plains and alluvial basins, and meandering channels are often formed as well.

In Korea, there are five large rivers: Hangang, Nakdonggang, Geumgang, Seomjingang, and Yeongsangang. Several mid to small-scale rivers are also found in the country, including Anseongchun, Sapgyochun, Mangyeonggang, Dongjingang, and Hyeongsangang. In order to systematically manage river and water resources, the rivers have been divided into 117 sub-basins. Hangang has the largest drainage area of 35,770 km^2 (including the portion in North Korea). It also has an annual runoff volume of 16 billion m^3, which constitutes 35.1% of the nation's total runoff volume. The longest river in Korea is Nakdonggang, with a length of 510 km.

From 2010 to 2019, the average annual precipitation in Korea was approximately 1,263.1 mm, which is equivalent to about 1.6 times the world average. This is enough to classify Korea as a high rainfall region, although seasonal variability is extremely high. Due to seasonal rain and typhoons, 620.7 mm of rainfall (49.1% of the annual rainfall) is concentrated during the summer and often causes floods. Furthermore, rainfall has the tendency to quickly collect in the rivers as over 70% of the land is mountainous with an average slope of about 20%. These geomorphological and climatic characteristics cause high fluctuations in the flow rate of rivers throughout the year, often causing extensive floods and severe droughts.

The river regime coefficient indicates the ratio between the maximum and minimum flow of a river. Seomjingang currently has a river regime coefficient of 270, which is the highest among the five large rivers of Korea, and nine times higher than the Nile River in Africa (river regime coefficient: 30). Before the installation of dams, each of the five large rivers had river regime coefficients that were higher than 300. In particular, Seomjingang and Yeongsangang displayed extremely high levels at 390. Consequently, dams and reservoirs were actively constructed to ensure the reliability of water resources, reduce flood damage, and mitigate the effects of drought. Intensive plans were also implemented to conserve river banks and their surrounding areas.

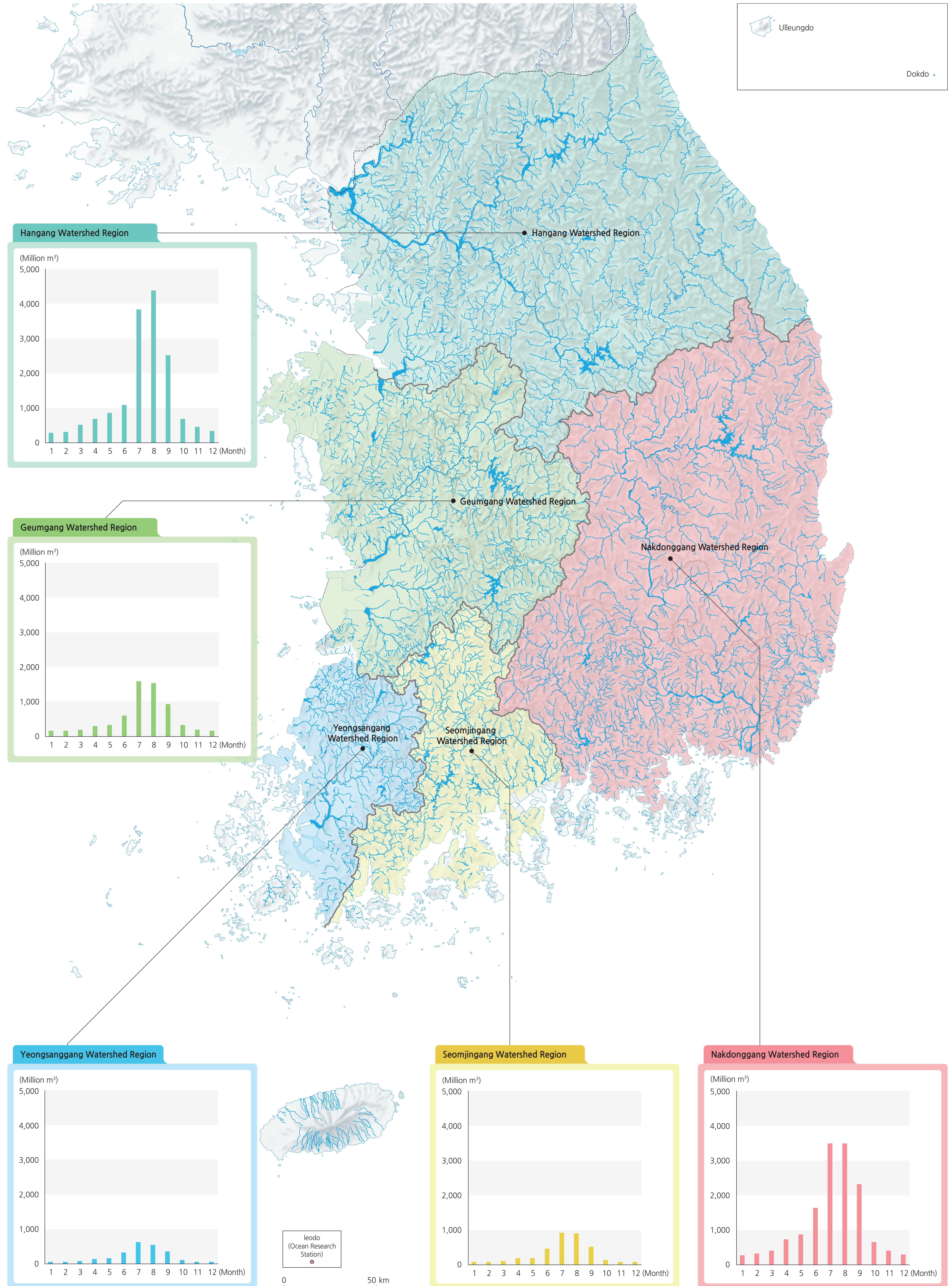
River Regime Coefficient



Ministry of Land, Infrastructure and Transport (2016)

Rivers

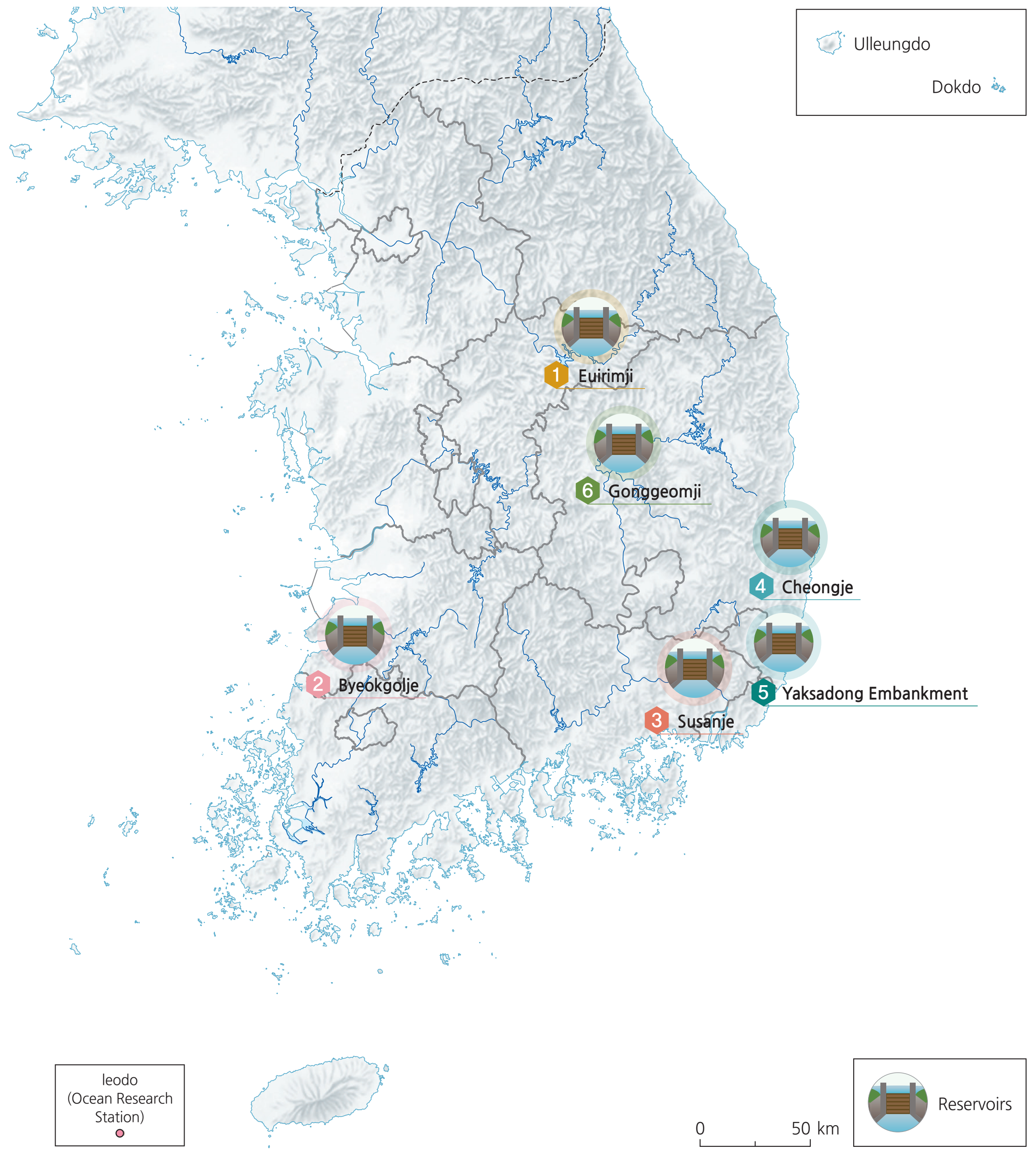
River Networks and Monthly Discharge of Major Watershed Regions



K-water (2015)

History of Hydrological Development

Ancient Reservoirs



Rice was first introduced to the Korean Peninsula in the Neolithic Age and became widespread throughout the south during the Bronze Age. *Samguk sagi*—the first historic record to mention rice farming in Korea—documents that King Daru (the second king of Baekje) established rice paddies across the country in his 6th year of ruling, or A.D. 33. As rice farming grew more central during the Three Kingdoms period, nationwide projects were carried out to build structures such as embankments, waterways, and reservoirs that would facilitate the access and storage of water. *Samguk sagi* also states that King Ilseoung of Silla ordered the construction of river banks and reclamation of wastelands in his 11th year (A.D. 144). As such, the Three Kingdoms period saw the construction of some of the oldest ancient reservoirs in Korea: Byeokgolje in Gimje-si, Euirimji in Jecheon-si, and Susanje in Miryang-si. Various flood control facilities and reservoirs such as the Yaksadong river banks in Ulsan, Cheongje in Yeongcheon-si, and Gonggeomji in Sangju-si were also constructed during this period.

As for the Goryeo dynasty, early records state that *Usubu*—a government bureau in charge of irrigation and waterways—was established in the 14th year of King Seongjong (A.D. 995). During this era, land reclamation was carried out on coastal regions and deserted inland fields, while islands underwent active development. Embankments, breakwaters, and reservoirs were newly constructed or built as an extension of existing structures. The largest embankment of the Goryeo dynasty is Hwangsan-un, estimated to have been built in the early 12th century.

1

Euirimji in Jecheon-si

Euirimji is an ancient reservoir in Mosan-dong, Jecheon-si, Chungcheongbuk-do that is still in use to this day. Although the exact year of construction is unknown, a 2009 radiocarbon dating of sedimentary deposits estimated that it was built during the Three Han States. According to legend, Wooreuk (a renowned kayageum player) blocked off the river during the period of King Jinheung of Silla, while others argue that Mayor Park Euirim constructed the reservoir. The maximum water surface area of Euirimji is approximately 160,000 m^2 and the maximum storage capacity is about 6.6 million m^3.

Painting of the Euirimji

This painting of Euirimji reservoir in Jecheon-si is by Bangwon Lee (1761 – 1815), a landscape painter of the late Joseon dynasty. It features pine and willow trees planted around the embankment and the reservoir. Such forest landscapes, now referred to as Jerim, were artificially constructed to increase the stability of traditional reservoirs.

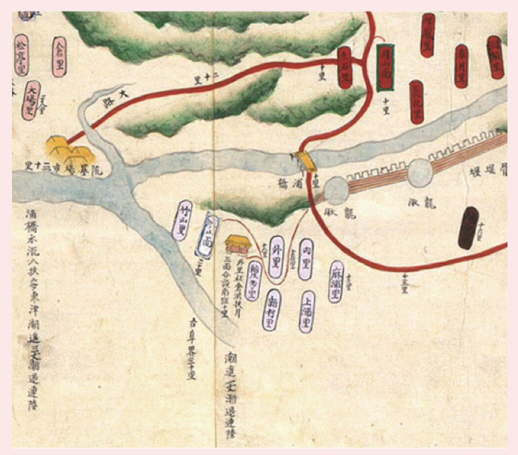
2

Byeokgolje in Gimje-si

Byeokgolje is a reservoir embankment extending from Pogyo to Wolseung-ri that is 3.3 km long and up to 5.6 m tall. According to *Samguk sagi*, it was built in Buryang-myeon, Gimje-si, Jeollabuk-do in the 27th year of King Biryu of Baekje (A.D. 330). Five floodgates were maintained or newly built by the 15th year of King Taejong of the Joseon dynasty (A.D. 1415), but only two remain today. Byeokgolje is an earthen dam with an irrigation area of approximately 95 km^2.

Old Map of Byeokgolje

Byeokgolje is shown in the old map of Gimje-si, created in 1872. It appears in the form of an embankment located downstream of the Juksan (Wonpyeongcheon) tributary of Dongjingang. Unlike other ancient reservoirs that were formed by levees in valleys, Byeokgolje was shaped by dikes built on plains. This has led to an ongoing debate on whether Byeokgolje was originally built to be a reservoir or a seawall.



3

Susanje in Miryang-si

Susanje reservoir, located in Hanam-eup, Miryang-si, Gyeongsangnam-do, was built during the Three Han States. The embankment extends approximately 1 km from Susan-ri to Doyeonsan, a section of which remained until 1928. It has since been converted into rice paddies. A 181 cm high, 152 cm wide, and 25 m long floodgate with a 7 m long connecting waterway was built on natural bedrock.

4

Cheongje in Yeongcheon-si

Cheongje is an earthen dam located in Geumho-eup, Yeongcheon-si, Gyeongsangbuk-do. It is estimated to have been built before the 23rd year of King Beopheung of the Silla dynasty (A.D. 536). Its embankment is 243.5 m long and 12.5 m high, and it has a maximum water surface area of approximately 110,000 m^2. The reservoir has a maximum reservoir storage capacity of about 590,000 m^3 and is still being used today. Historical records reveal that the construction project of Cheongje was a national irrigation project that involved approximately 7,000 people. Wooden stakes and fences were used to build the floodgates.

5

Yaksadong River Banks in Ulsan

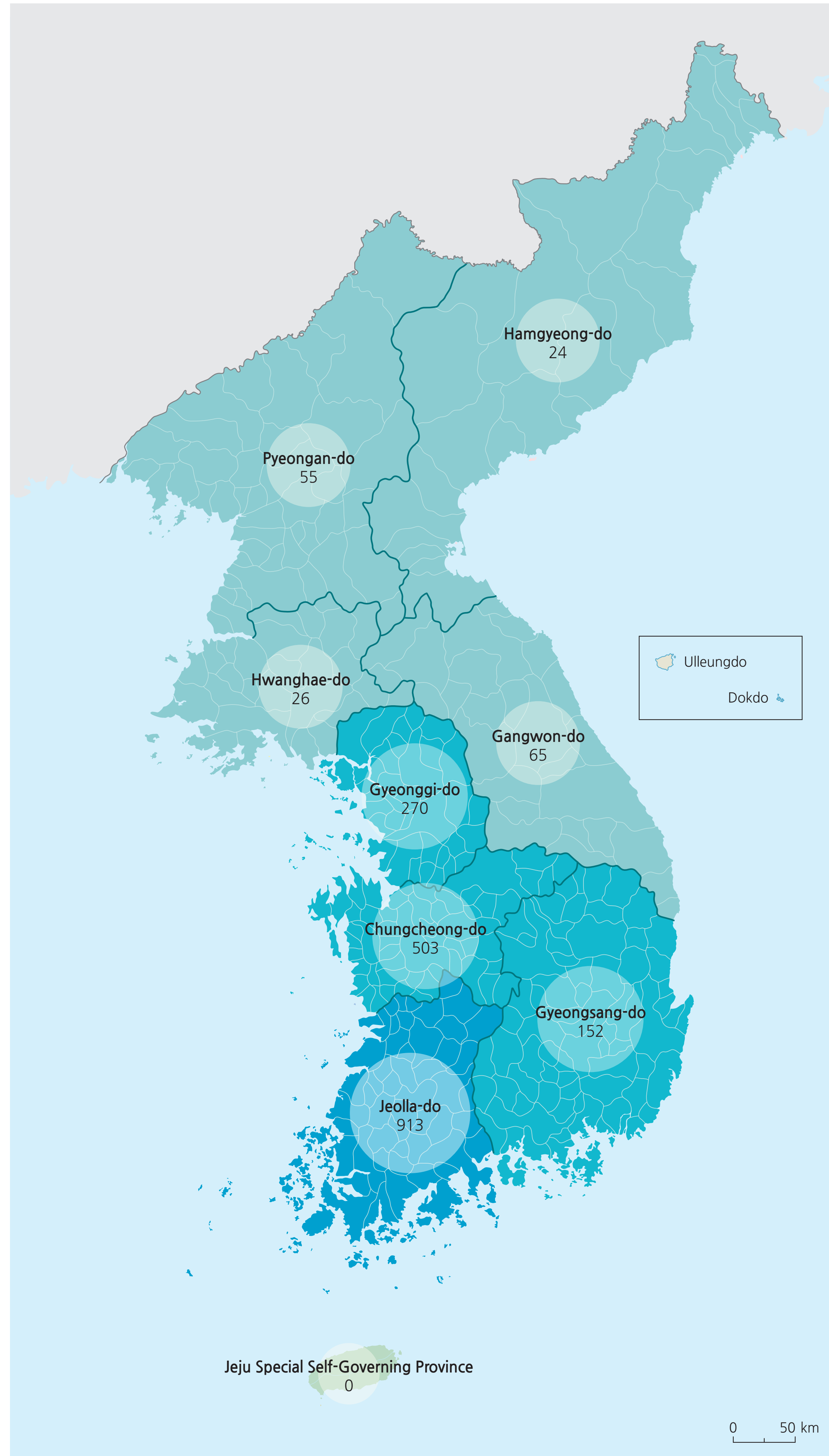
Yaksadong embankment—located in Yaksa-dong, Jung-gu, Ulsan-si—is an ancient irrigation reservoir constructed around the end of the Three Kingdoms period to the early Unified Silla period. It was built by connecting the levees on both sides of the Yaksacheon, and is estimated to be 155 m long and 4.5 – 8.0 m high. Typical ancient engineering techniques were used in the construction of the embankment; the foundation was formed with shells and a silt layer, and leafy twigs were utilized in a leaf mat method.

6

Gonggeomji in Sangju-si

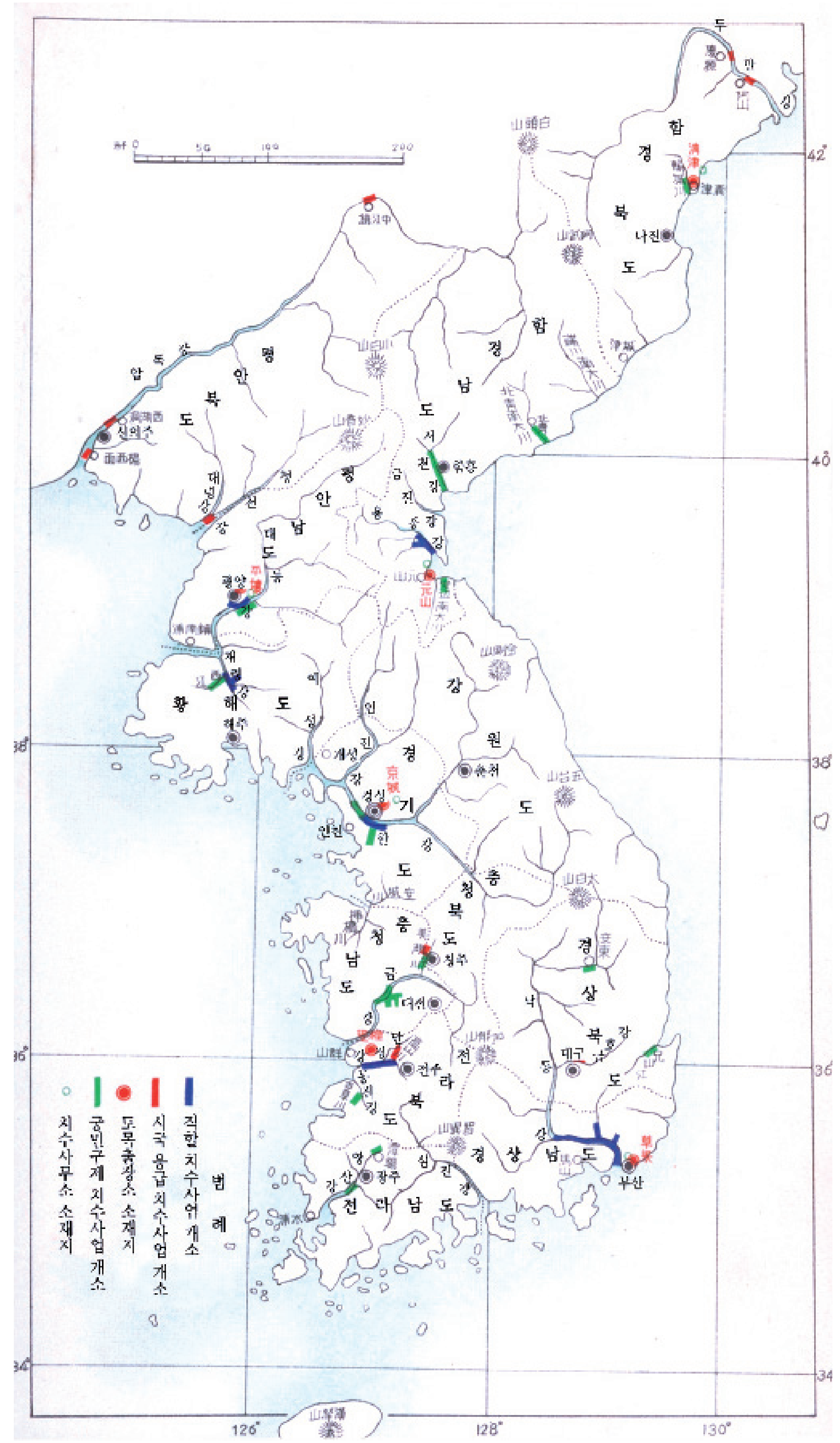
The Gonggeomji reservoir, also known as Gonggalmot, is located in Yangjung-ri, Gonggeom-myeon, Sangju-si, Gyeongsangbuk-do. Although the reservoir is known to have been built during the Three Han States, only a few records remain on the details. According to Sangsanji, Choi Jeongbin (an official accountant in Sangju) repaired the embankment in the 25th year of King Myeongjong of the Goryeo dynasty (A.D. 1195). It was about 860 steps long with a perimeter of 16,647 cheok (the Korean foot: approximately 30.3 cm). Dongguk munheon bigo and Sinjeung dongguk yeoji seungram state that the embankment was approximately 430 m long with a perimeter of 8.8 km and a depth of 5 – 6 m.

Distribution of Reservoirs in the Joseon Dynasty



K-water (2000)

River Conservation Work during the Japanese Colonial Period

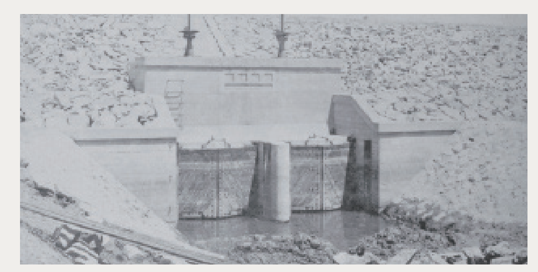


K-water

River Improvement Projects on Nakdonggang

Bank Construction in Chojung (Chojung-ri, Haja-myeon, and Chooldoo-ri, Daejeo-myeon in Gimhae-gun)

- Total Length 775 m
- Cost 2,000 ￥
- Initiation 1935/10/16. Completion 1935/12/4.



Floodgate Construction of Myoungji Dam (Myeongji-myeon, Gimhae-gun)

- Width 1.85 m, Height 1.25 m, Length 24.5 m
- Cost 12,000 ￥
- Initiation 1935/11/01. Completion 1936/03/31.

Dam Establishment in South Korea during the Japanese Colonial Period

	Water Use	Electricity Power	Irrigation	Total
Year 1910—1940	4	1	31	36 (26.7%)
Year 1941—1945	3	2	94	99 (73.3%)
Total	7 (5.2%)	3 (2.2%)	125 (92.6%)	135 (100%)

K-water (2000)

As the Joseon dynasty was a predominantly agrarian society, it experienced significant improvement in flood control and irrigation management techniques. For instance, the Gwonnonggwan system was first established in the 4th year of King Taejo (A.D. 1395). It introduced government officials who promoted agricultural development and pushed for the construction of reservoirs. In A.D. 1419 (the 1st year of King Sejong), two copies of *Jeon daejang* were completed to provide a full list of reservoirs across the country. A bureau named *Jeeonsa* was also established in order to administrate dams and other facilities. According to *Dongguk munheon bigo*, there were 3,378 dams recorded in 1782, most of which were located in the southern part of the Korean Peninsula.

During the Japanese Colonial Period, the Japanese imperial government intended to utilize Korea as a strategic military base for invading the Asian continent. For this reason, Japan built dams and reservoirs all across the country. Of the 30 dams constructed in the northern part of Korea, 25 were for electricity and five were for irrigation. A total of 135 dams and reservoirs were built in the southern part of Korea—most were for irrigation purposes while three were for electricity and seven were for domestic and industrial uses. The larger dams, mostly built after 1940, were constructed to serve local needs rather than for the comprehensive development of watersheds.

In the early 1910s, Japan launched an extensive investigation on Korean rivers in order to solve its food security problem. After conducting two cycles of research on 25 major rivers, it devised a river repair plan which later served as the basis for the *Joseon Rivers Survey* (published in 1928). According to the publication, river improvement projects began on Mangyeonggang and Jaeryeonggang in 1925, and Hangang, Nakdonggang, Daedonggang and other major rivers in 1926. These projects included the construction of dams and river banks for irrigation purposes, as well as the straightening of river channels. From 1911 to 1945, Japan also carried out three rounds of a nationwide survey on hydraulic power to supply information for the further construction of dams and reservoirs.

Structure of Watersheds

Hangang Watershed

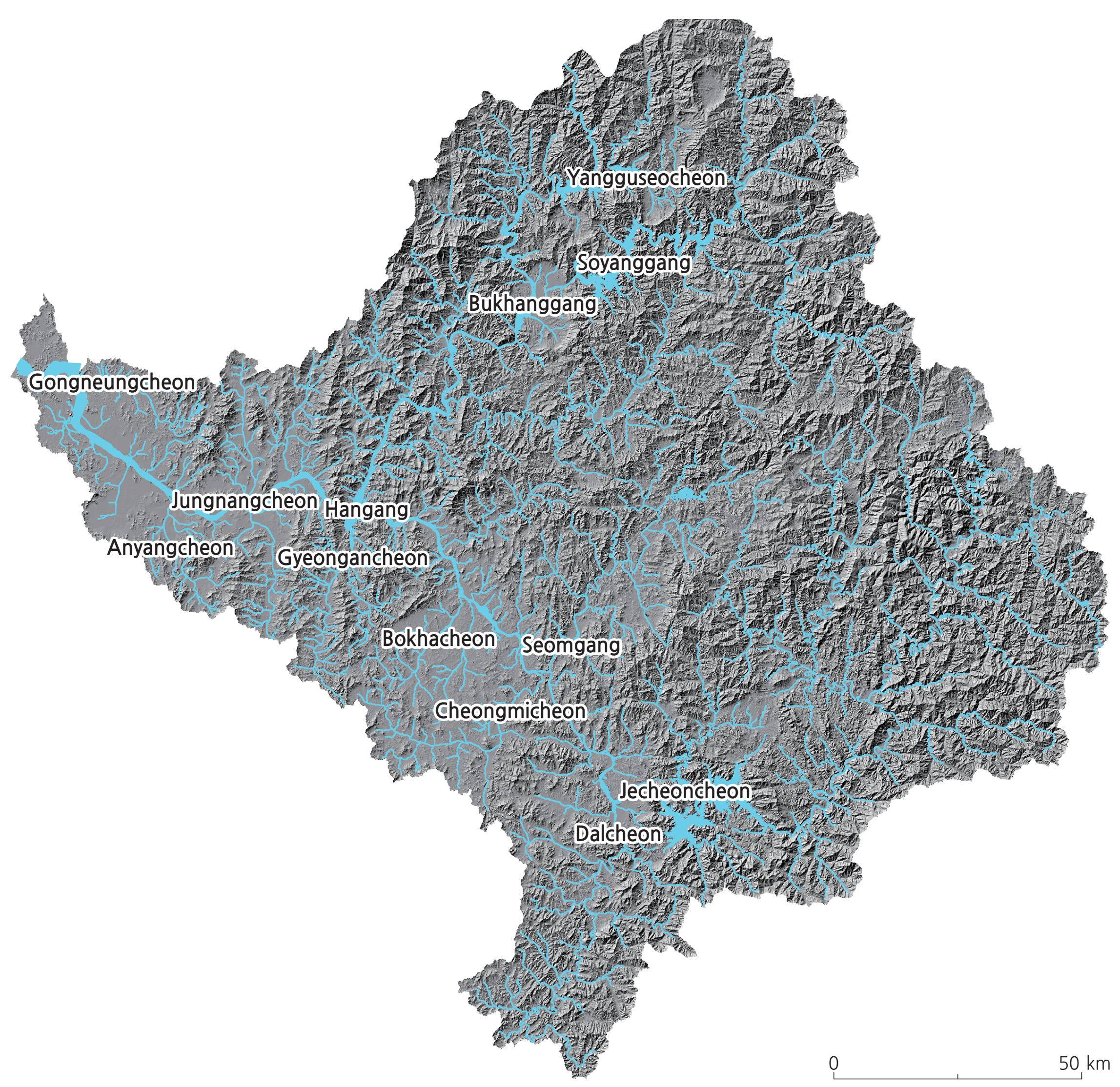
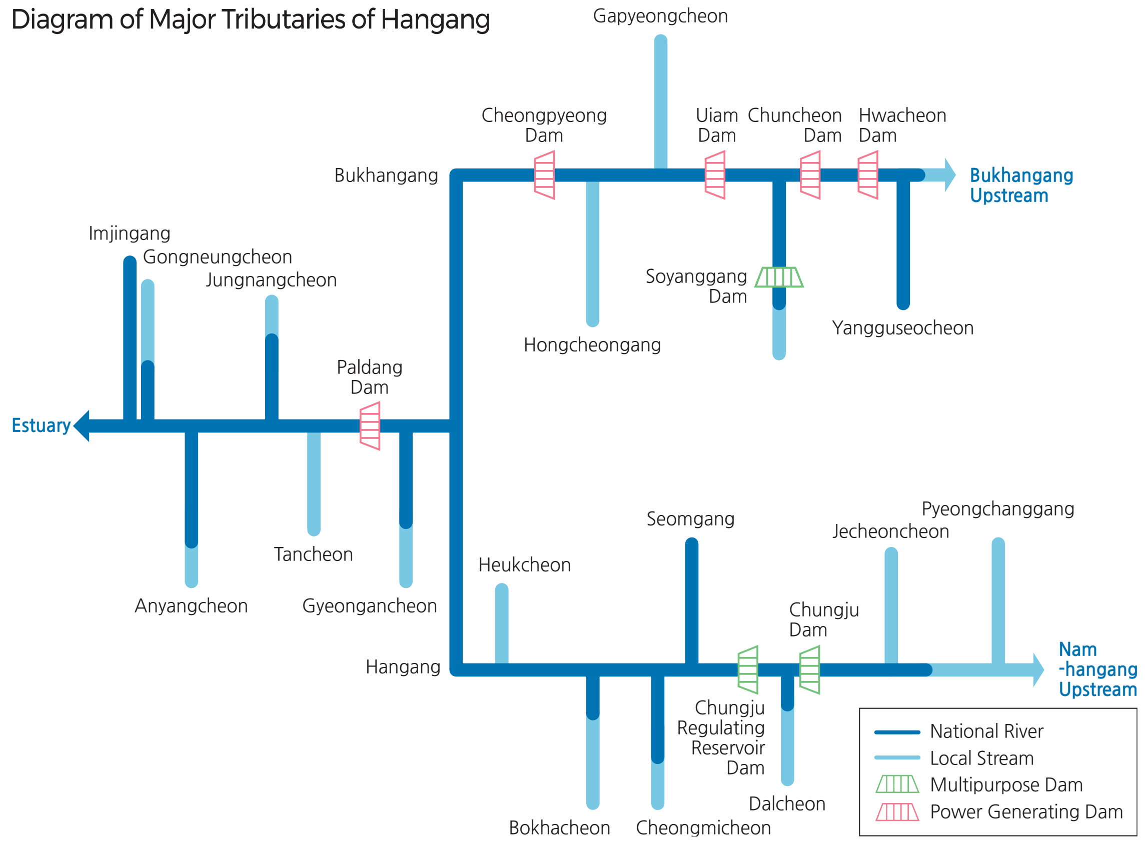
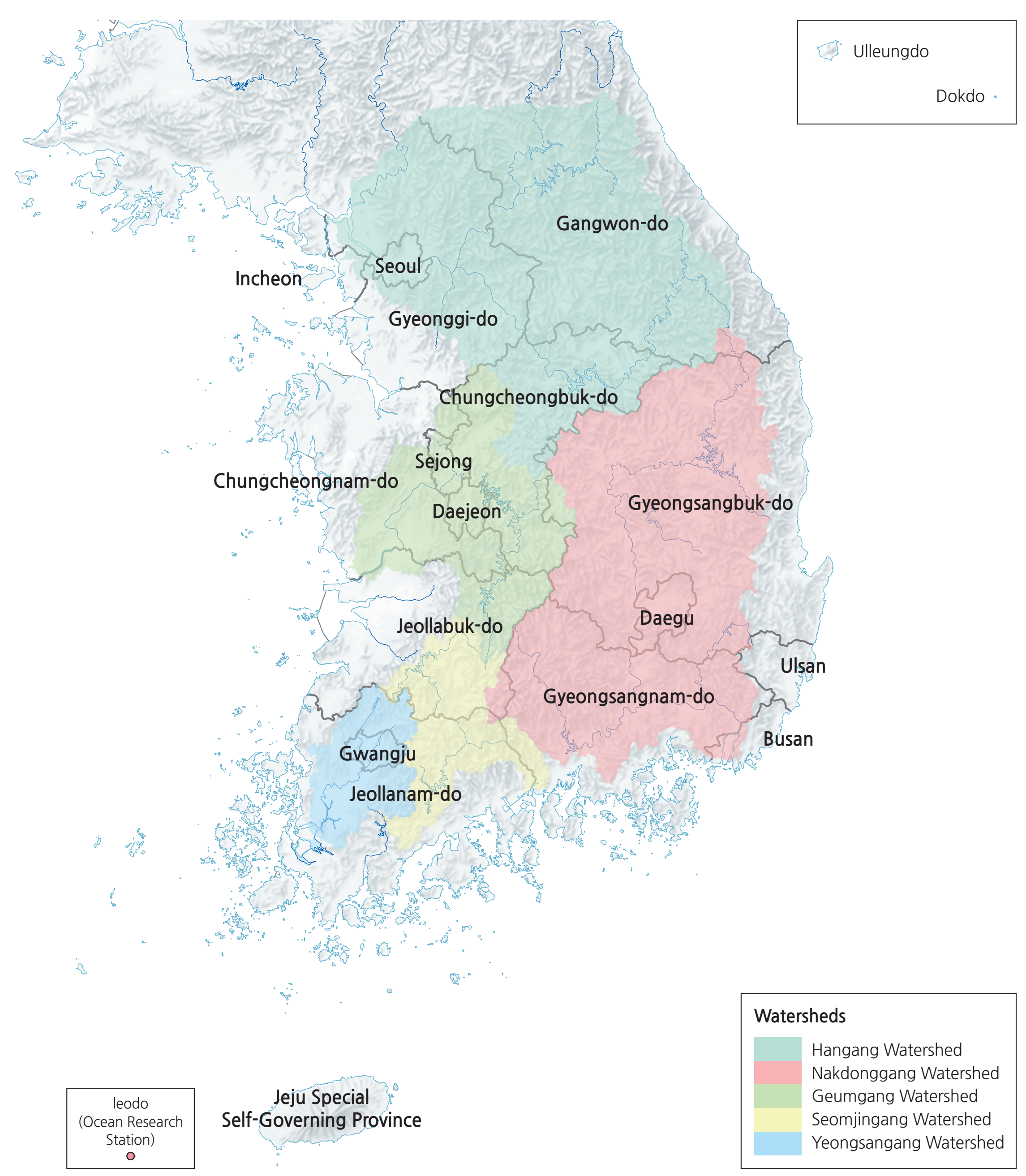


Diagram of Major Tributaries of Hangang



K-water (2015)

Watersheds of Five Major Rivers



K-water (2015)

Nakdonggang Watershed

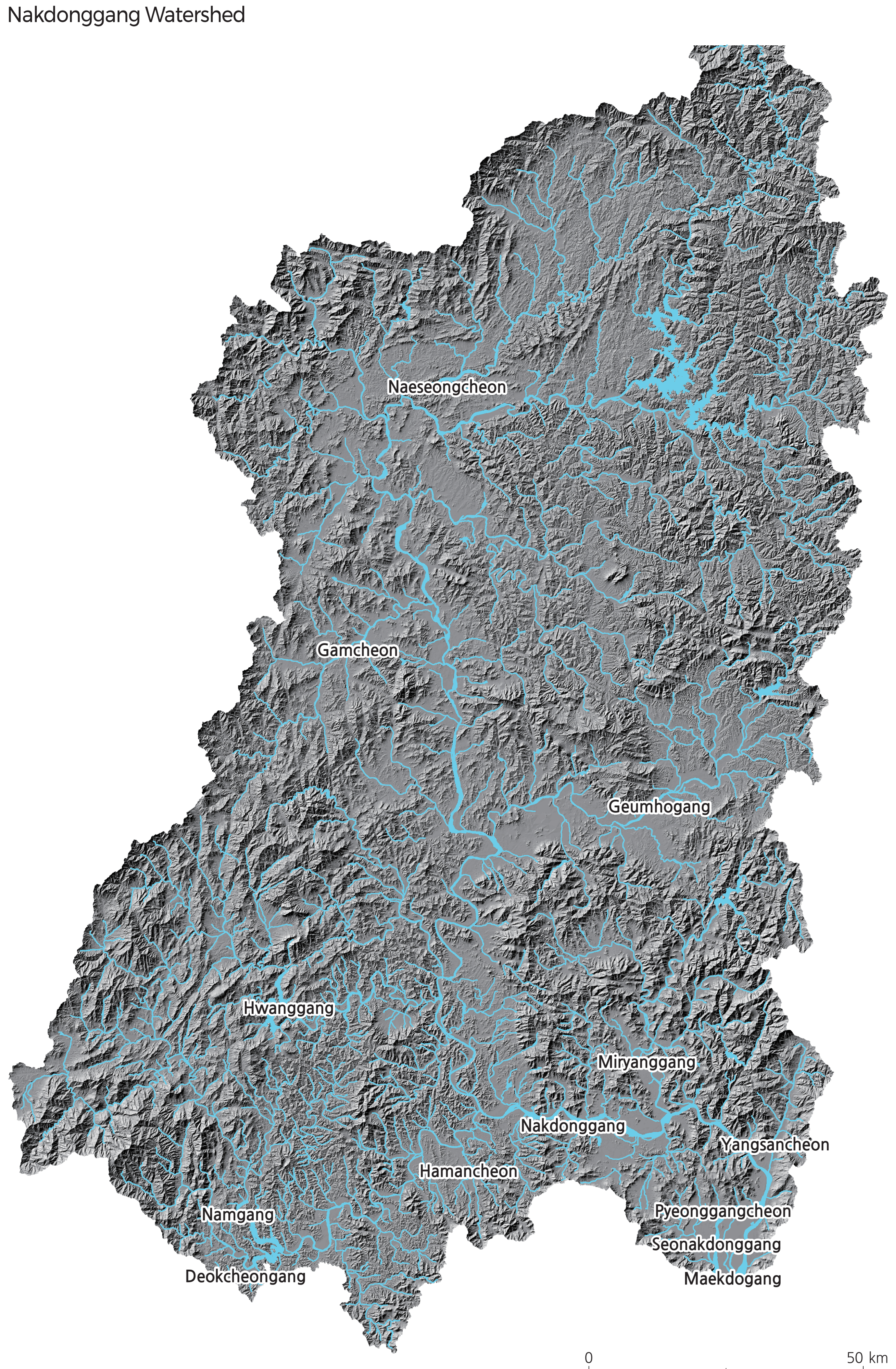
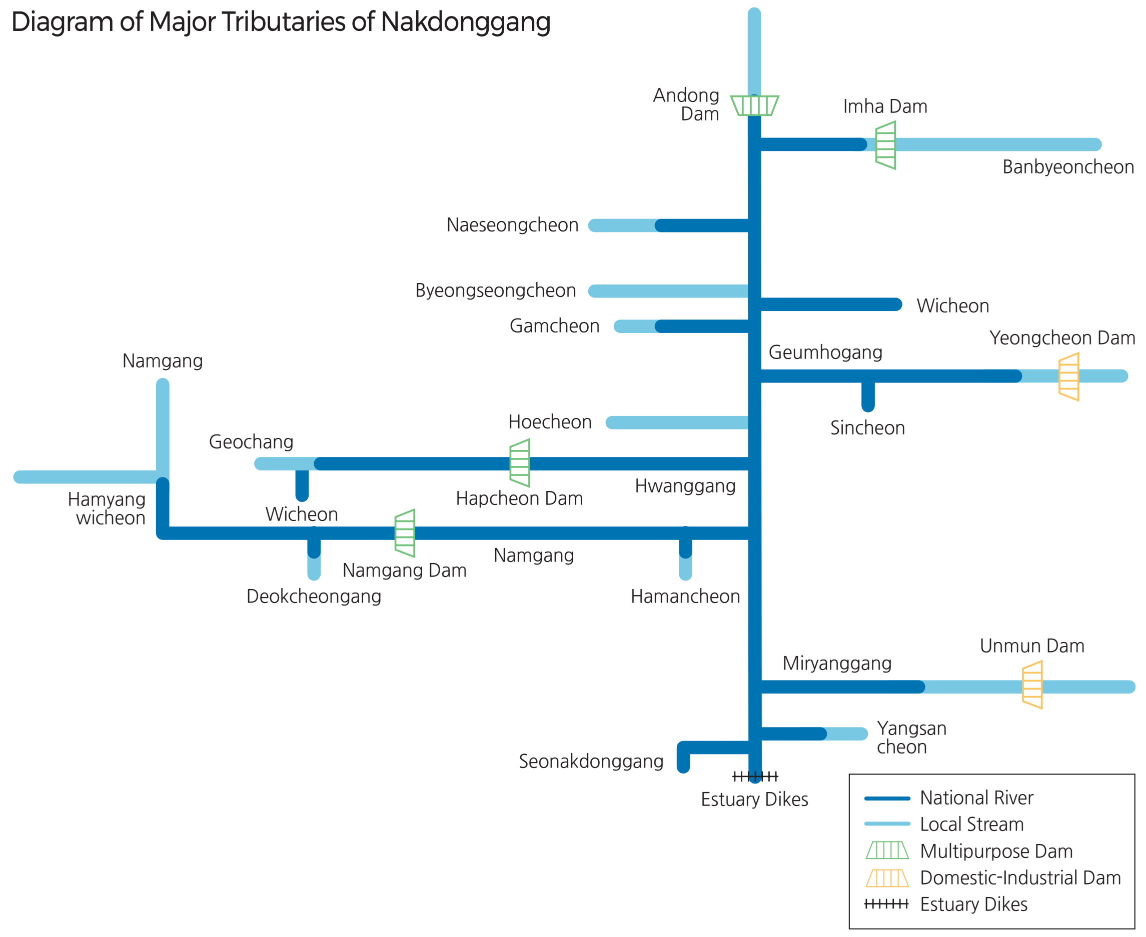
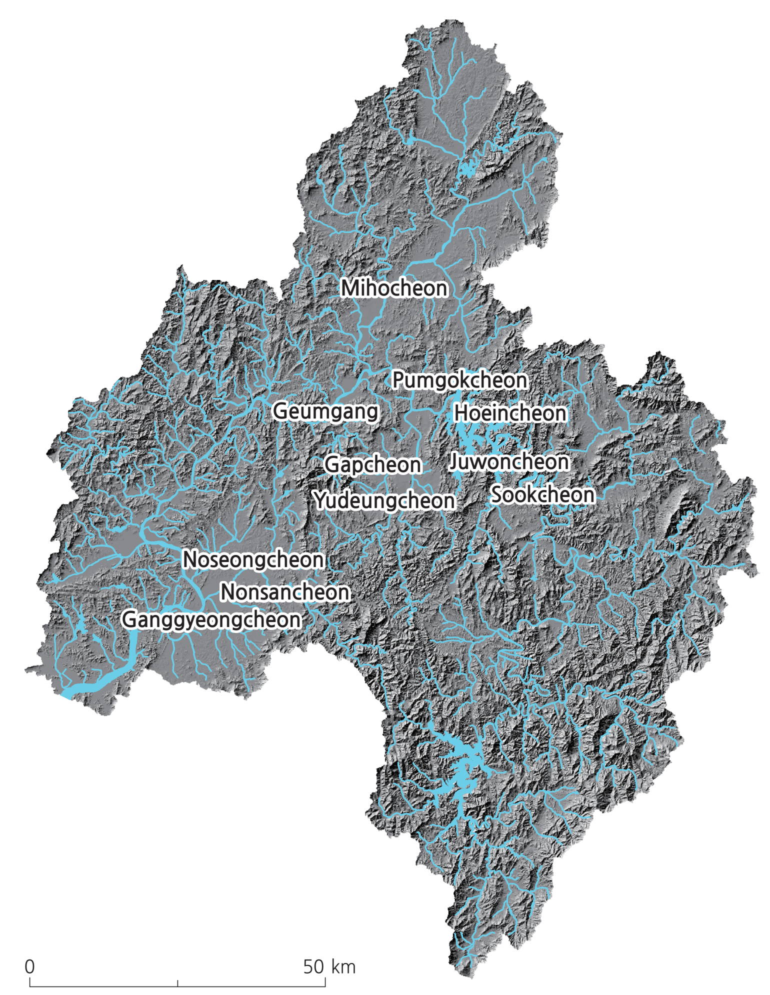


Diagram of Major Tributaries of Nakdonggang

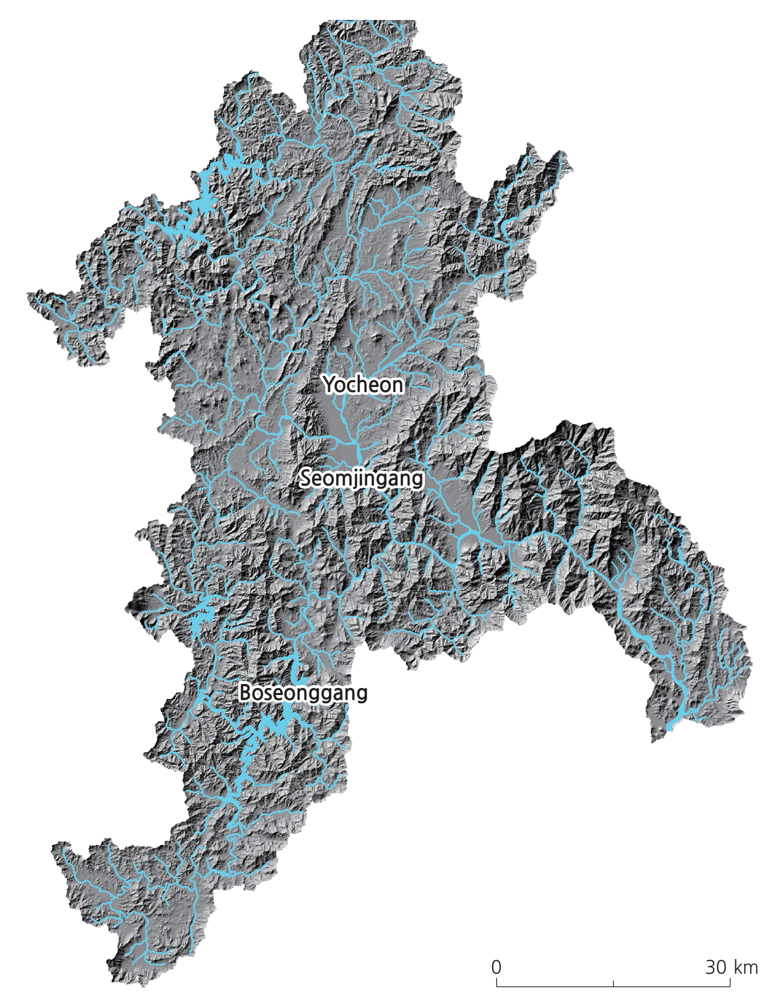


K-water (2015)

Geumgang Watershed



Seomjingang Watershed



Yeongsangang Watershed

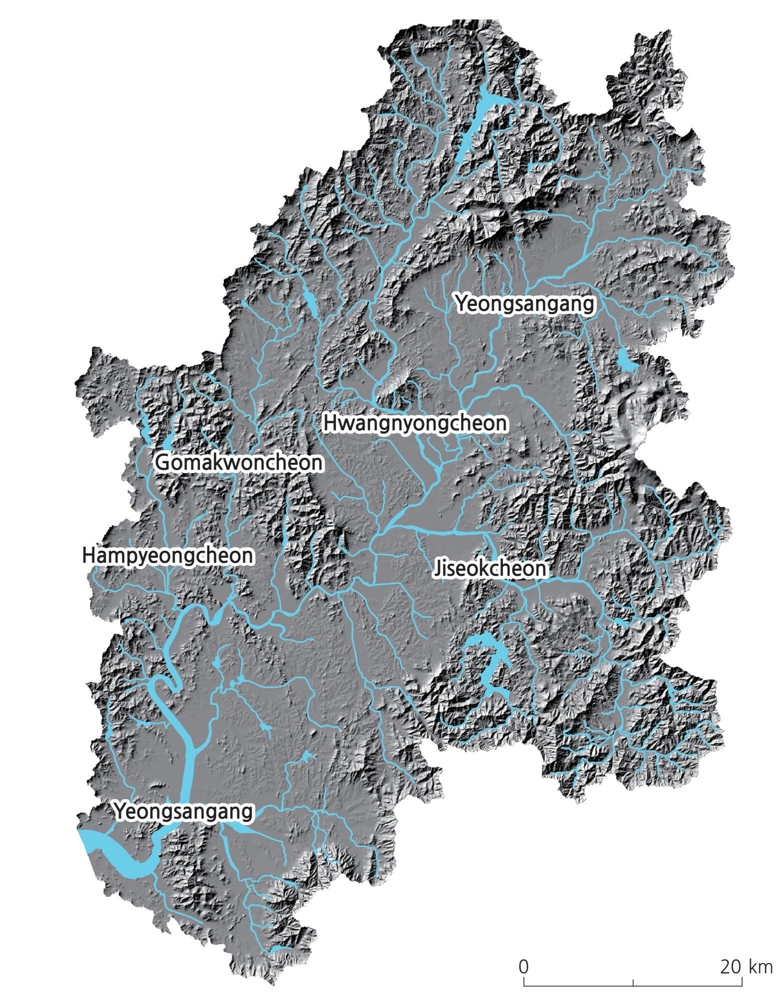
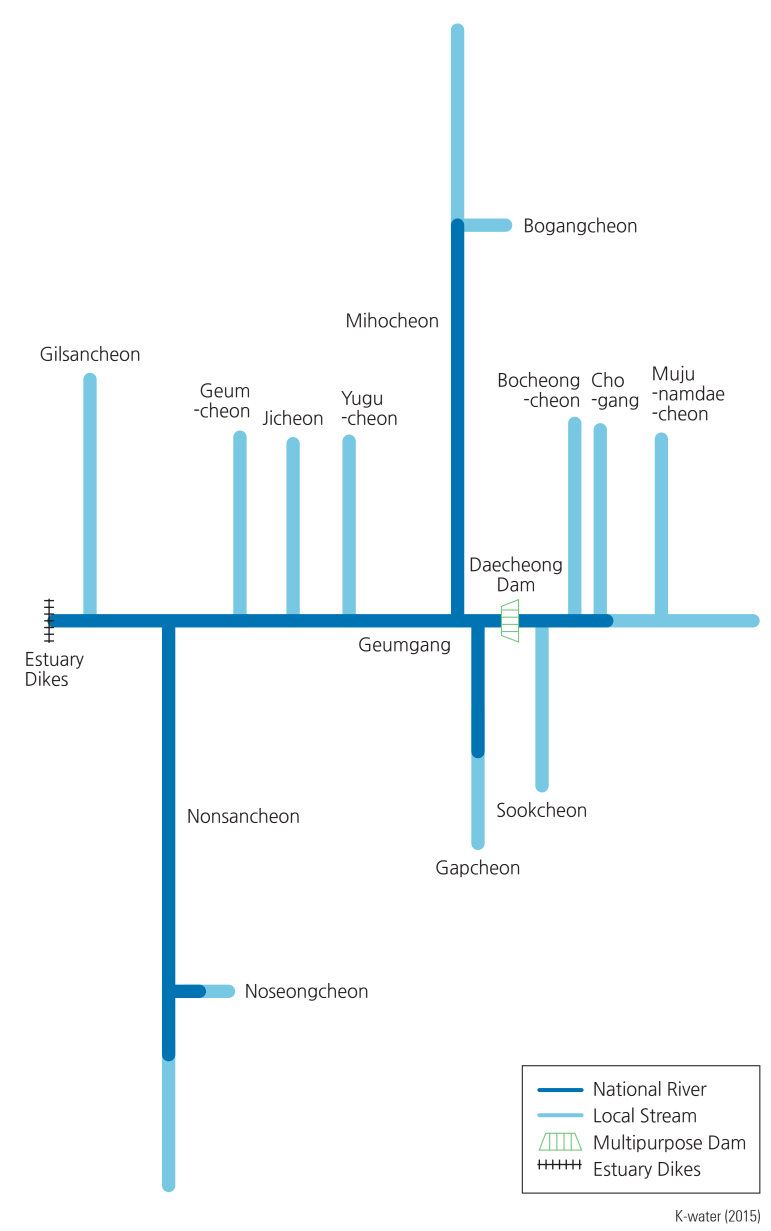
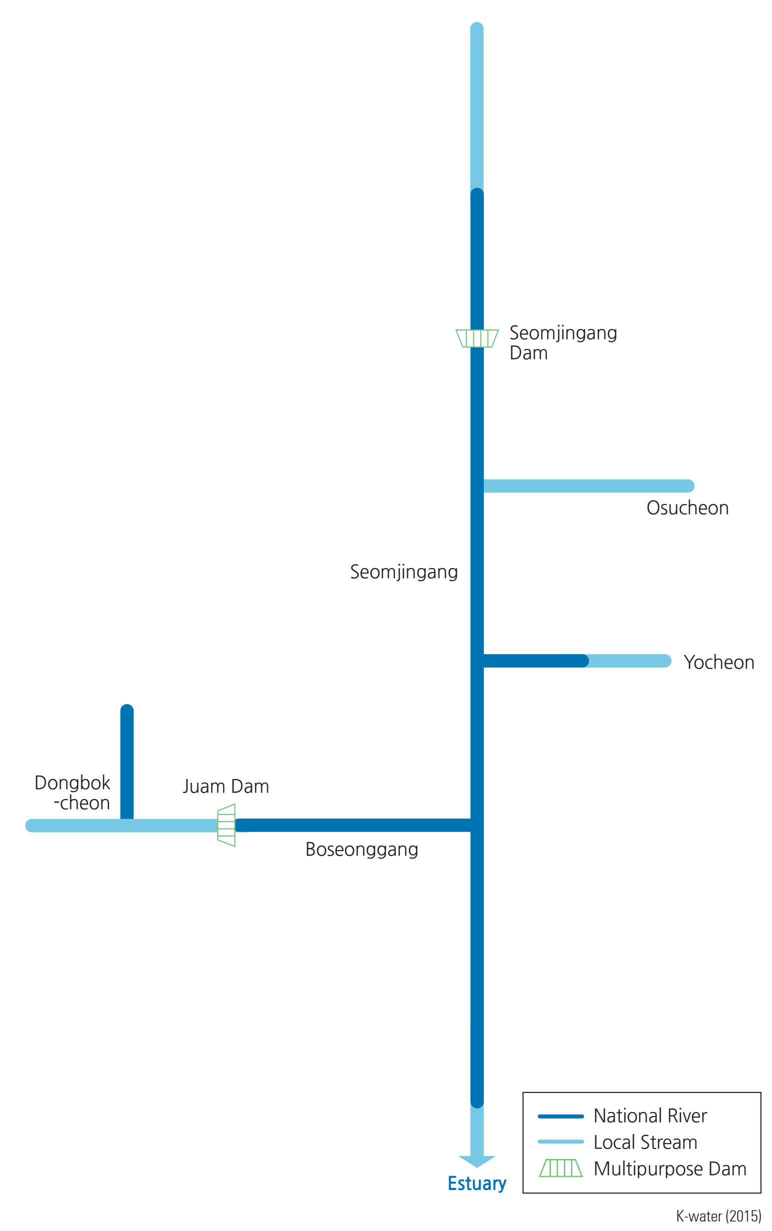


Diagram of Major Tributaries of Geumgang



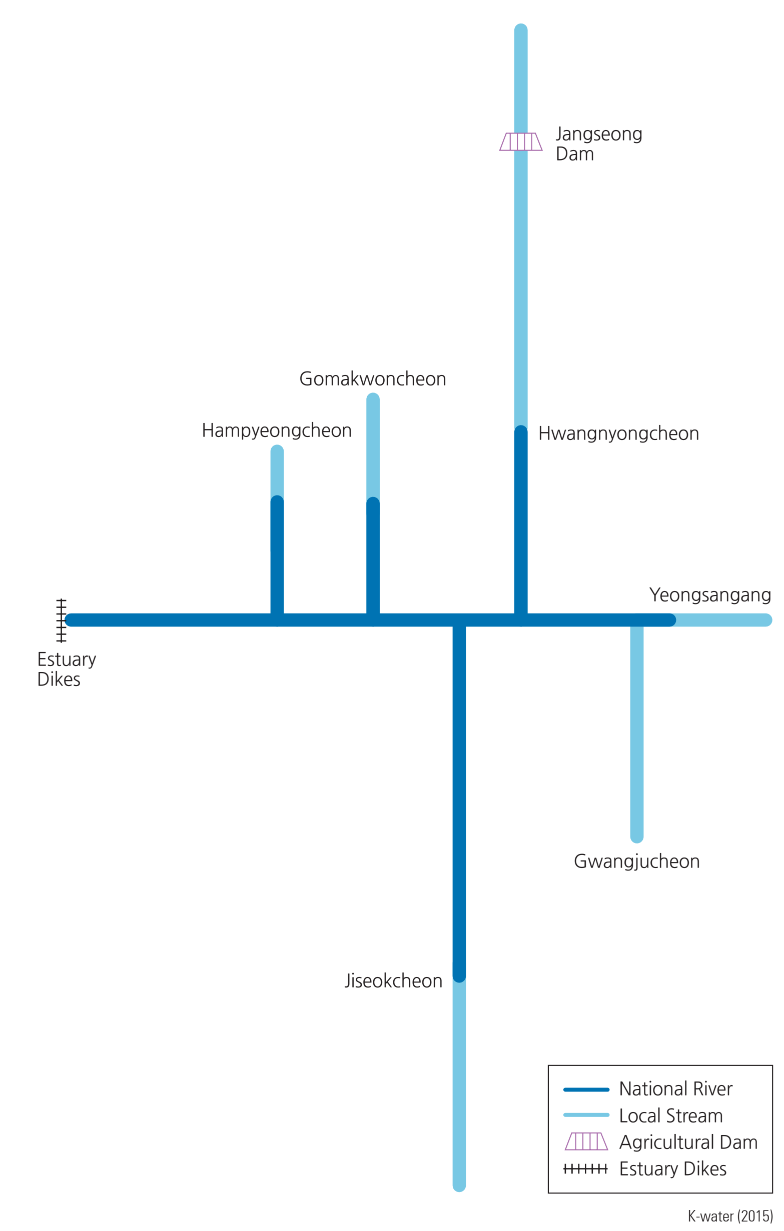
K-water (2015)

Diagram of Major Tributaries of Seomjingang



K-water (2015)

Diagram of Major Tributaries of Yeongsangang



K-water (2015)

Hangang is a river that flows horizontally across the midsection of the Korean Peninsula. It is 494.4 km long and has a drainage area of 25,953 km^2, or 35,770 km^2 including the section in North Korea. Lying mainly in Gangwon-do and Gyeonggi-do, the Hangang watershed extends into Seoul, Incheon, Chungcheongnam-do, and Chungcheongbuk-do. Hangang is largely divided into Bukhangang (North Hangang) and Namhangang (South Hangang). The two rivers join at Yangsu-ri, Yangseo-myeon, Yangpyeong-gun, Gyeonggi-do, flow through Seoul, and finally drain into the Yellow Sea at Bogugot-ri, Wolgot-myoen, Gimpo-si. Namhangang, the main stream of Hangang, originates in Geomryongso of Geumdaebong (1,418 m) in Changjuk-dong, Taebaek-si, Gangwon-do. Dalcheon, Sumgang, Cheongmicheon, and Bokhacheon are some of the streams that flow into Namhangang. Bukhangang, which is the largest branch of Hangang, originates in Danbalryeong (1,241 m), Geumgang-gun, Gangwon-do, and is joined by Yangguseocheon and Soyangang.

Nakdonggang, which flows south through the southeastern part of the Korean Peninsula, is 510.3 km long and has a drainage area of 23,384 km^2. The Nakdonggang watershed is located across Busan, Daegu, Gangwon-do, Gyeongsangnam-do, and Gyeongsangbuk-do, and also lies along the boundaries of Jeollanam-do, Jeollabuk-do, and Chungcheongbuk-do. Nakdonggang stems from Hwangji Pond on the eastern side of Hambaeksan in Taebaek-si, Gangwon-do and discharges into the South Sea through an estuary dike and delta in Busan. Seonakdonggang branches off at the delta located at the river mouth of Nakdonggang.

Geumgang starts in the center of the Korean Peninsula and flows northwest and southwest. It is 397.8 km long with a drainage area of 9,912 km^2, and its watershed lies mainly in Sejong-si, Daejeon, Chungcheongnam-do, Chungcheongbuk-do, and Jeollabuk-do. Originating in Tteunbongsaem Spring of Sinmusan (896.8 m), Subun-ri, Jangsu-eup, Jangsu-gun in Jeollabuk-do, Geumgang flows northwest through Daejeon, Daecheong reservoir, and Sejong, and then flows southwest through Gongju and Buyeo before finally discharging into the Yellow Sea. Until the completion of the Geumgang Estuary Dike in 1990, high tide seawater would flow upstream as far as Ganggyeong-eup, Nonsan-si, Chungcheongnam-do.

Seomjingang, flowing south in the southern part of the Korean Peninsula, is 223.9 km^2 long with a drainage area of 4,911 km^2. It has a watershed that is located across Jeollanam-do, Jeollabuk-do, and Gyeongsangnam-do. Starting at Demisaem Spring on Palgongsan (located at the boundary of Jinan-gun and Jangsu-gun, Jeollabuk-do), Seomjingang flows through Jeollanam-do and Gyeongsangnam-do and discharges into the Gwangyang Bay in the South Sea.

Yeongsangang is located in the southwestern region of the Korean Peninsula. It is 129.5 km long with a drainage area of 3,467 km^2 and has a watershed that lies mainly in Jeollannam-do, Jeollabuk-do, and Gwangju. It originates in Yongso of Gamagol in Yongyeon-ri, Yong-myeon, Damyang-gun, Jeollanam-do, runs through the Naju Plains, and finally reaches the Yellow Sea at an estuary dike. The dike was constructed in 1981 to prevent seawater from flowing upstream at high tide. Hwangryonggang, Jiseokcheon, Gomakwoncheon, and Hampyeongcheon are some of the streams that flow into Yeongsangang.

River Management

Based on watershed area, the 10 largest rivers in South Korea are Hangang, Nakdonggang, Geumgang, Seomjingang, Yeongsangang, Anseongcheon, Sapgyocheon, Mangyeonggang, Hyeongsangang, and Dongjingang. The Hangang watershed is the largest in terms of area and volume; it has a drainage area of 25,953 km² and a volume of 17.4 billion m³. Nakdonggang is the longest river, with a length of 510 km. The Seomjingang watershed has the highest average precipitation of 1,457 mm, while the Hyeongsangang watershed has the lowest annual precipitation of 1,157 mm.

Rivers in Korea are divided into two categories: legally designated rivers and small rivers. Legally designated rivers encompass both national and local rivers, while the Small River Maintenance Act designates small rivers. National rivers are relatively larger bodies (drainage area greater than 200 km²) that are important for environmental conservation and the economy of the country. Some examples include upper stream rivers affected by drainage from reservoirs, lower stream rivers located downstream from multipurpose dams, and rivers that flow through densely populated or protected areas. Local rivers are often relevant with public use and are managed by regional governments.

The River Master Plan is a comprehensive river maintenance, conservation, and utilization plan for the functional sustenance and prevention of natural disasters in river systems. Based on the analysis of weather conditions, terrain, and the social and natural environment of each watershed, each plan is implemented and revised every 10 years to preserve and manage rivers systematically. As of December 2015, the River Master Plan has been established for approximately 84.0% (25,013.5 km) of all rivers in Korea: 99.1% (2,968.9 km) of national rivers and 82.3% (22,044.6 km) of local rivers. By administrative district, Seoul, Incheon, and Daegu each showed a 100% establishment rate, while Jeju Special Self-Governing Province (61.4%), Gyeongsangbuk-do (73.7%), and Jeollabuk-do (77.4%) showed lower establishment rates.

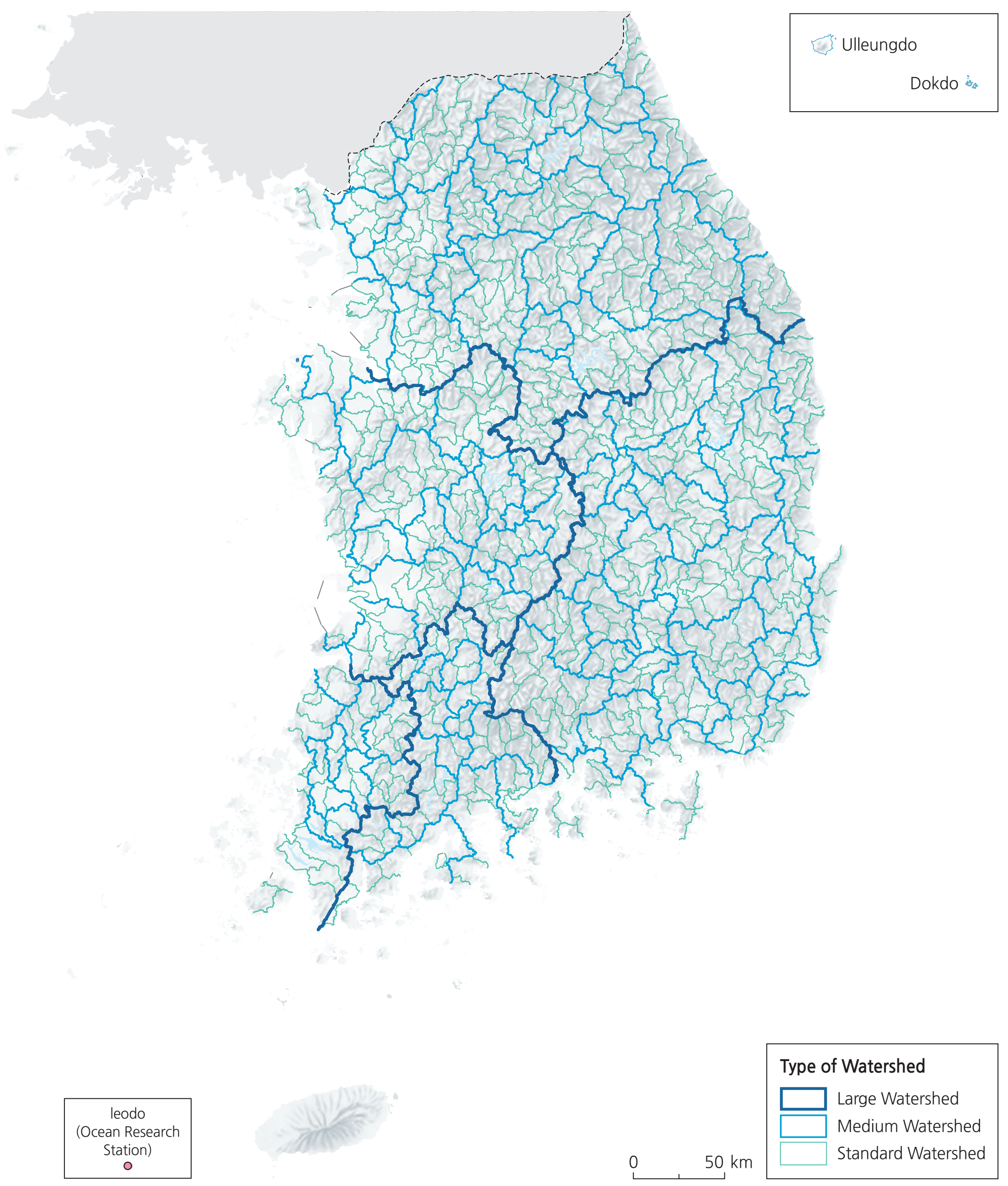
Top 10 Longest Rivers

Name	Area of Watershed (km²)	Length of River (km)	Annual Discharge (Hundred Million m³)*	Annual Precipitation (mm)*	Number of Channels
Hangang	25,953**	494	174	1,260	699
Nakdonggang	23,384	510	158	1,203	781
Geumgang	9,912	398	78	1,271	468
Seomjingang	4,911	224	44	1,457	283
Yeongsangang	3,467	130	30	1,340	169
Anseongcheon	1654	71	12	1,215	102
Sapgyocheon	1,649	59	12	1,227	98
Mangyeonggang	1,527	77	12	1,282	70
Hyeongsangang	1,140	62	7	1,157	30
Dongjingang	1,136	51	8	1,242	87

* Annual discharge and precipitation values are based on the 30-year average from 1978 to 2007.
** The area is 35,770 km² when including watershed areas in North Korea.

Ministry of Land, Infrastructure and Transport (2019)

Watershed Boundary Map



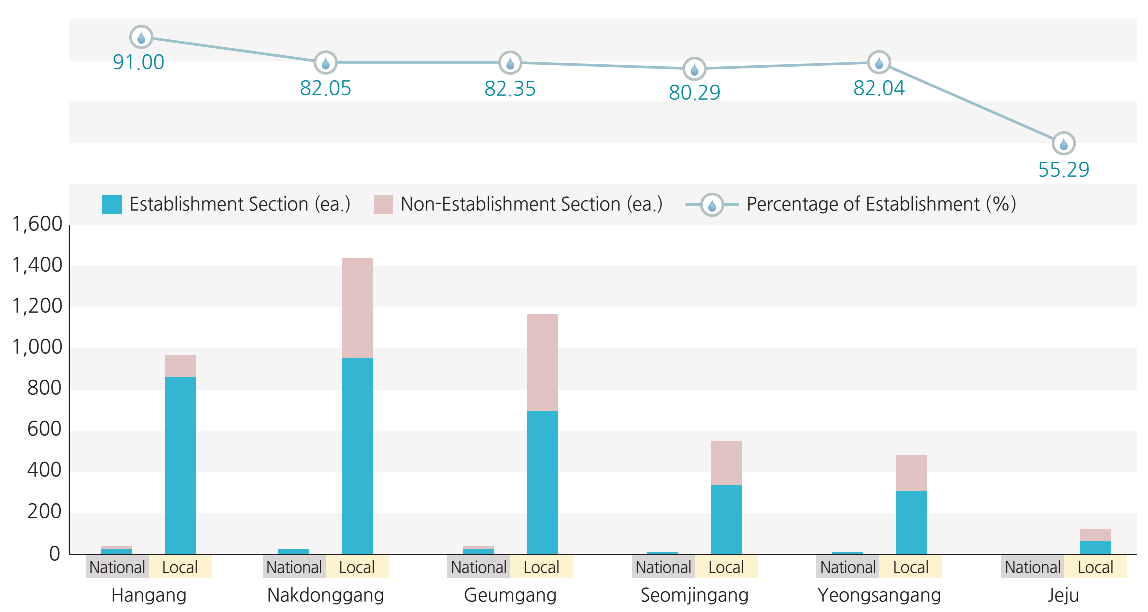
Ministry of Land, Infrastructure and Transport (2013)

River Master Plans by Class

Class	With Plan			Without Plan		Total	
	Number of Channels	Length (km)	Completion Rate by Length (%)	Number of Channels	Length (km)	Number of Channels	Length (km)
National Rivers	62	2,968.85	99.12	3	26.29	65	2,995.14
Local Rivers	3,177	22,044.64	82.29	1,507	4,743.96	4,684	26,788.60
Total	3,239	25,013.49	83.98	1,510	4,770.25	4,749	29,783.74

Ministry of Land, Infrastructure and Transport (2019)

Establishment Percentage of the River Master Plan



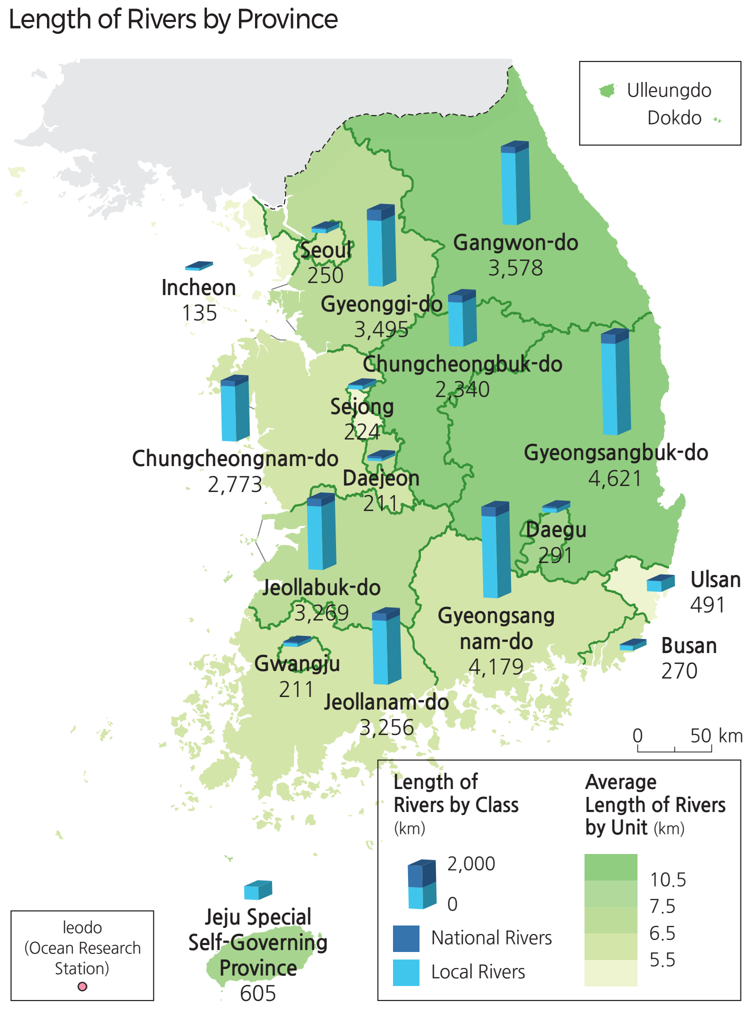
Ministry of Land, Infrastructure and Transport (2019)

River Maintenance by Class

Class	Maintenance Completed		Reinforcement Needed		Infrastructure Needed		Total (km)
	(km)	(%)	(km)	(%)	(km)	(%)	
National Rivers	2,574.57	80.71	492.89	15.45	122.31	3.84	3,189.77
Local Rivers	14,356.72	48.57	7,684.53	26.00	7,517.62	25.43	29,558.87
Total	16,931.29	51.70	8,177.42	24.97	7,639.93	23.33	32,748.64

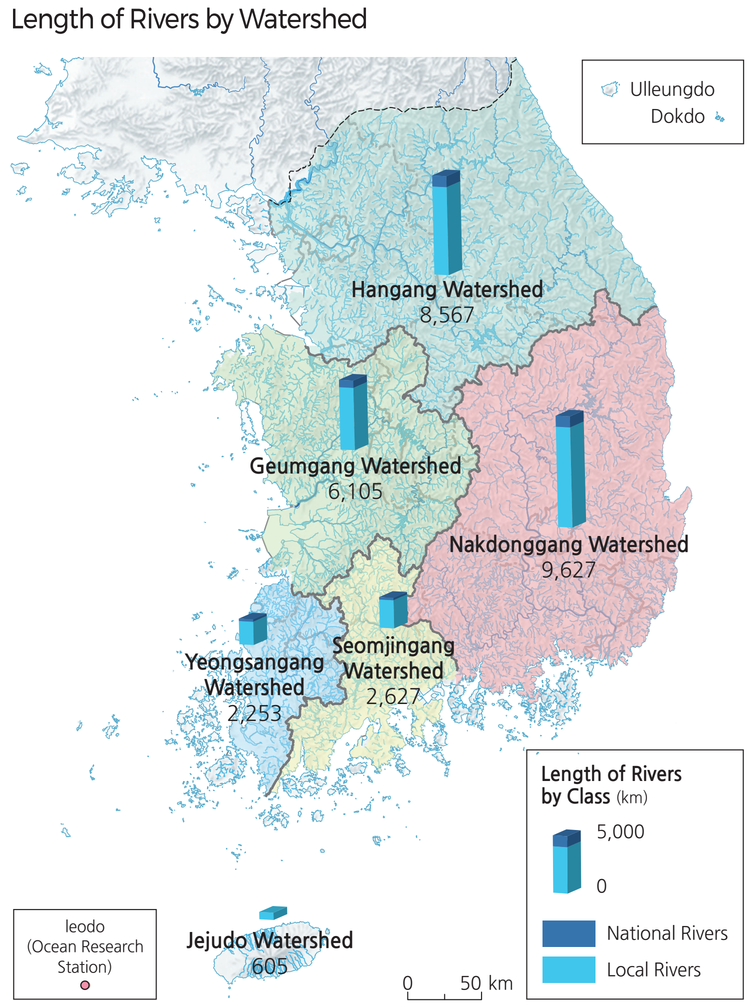
Ministry of Land, Infrastructure and Transport (2019)

Length of Rivers by Province



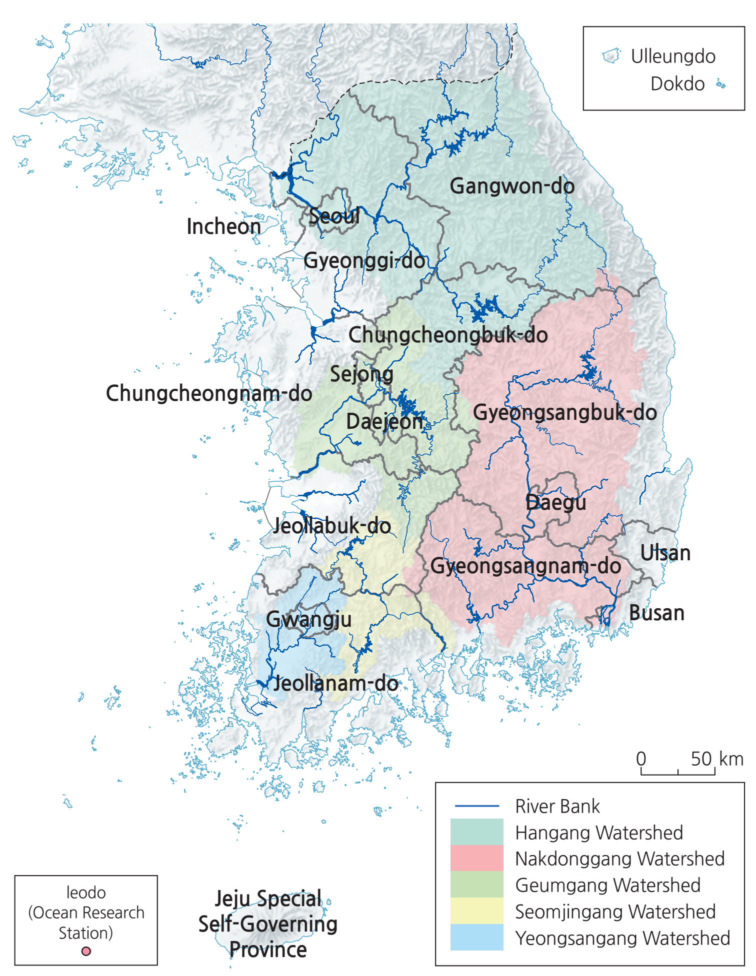
Ministry of Land, Infrastructure and Transport (2019)

Length of Rivers by Watershed



Ministry of Land, Infrastructure and Transport (2019)

River Banks



Ministry of Land, Infrastructure and Transport (2013)

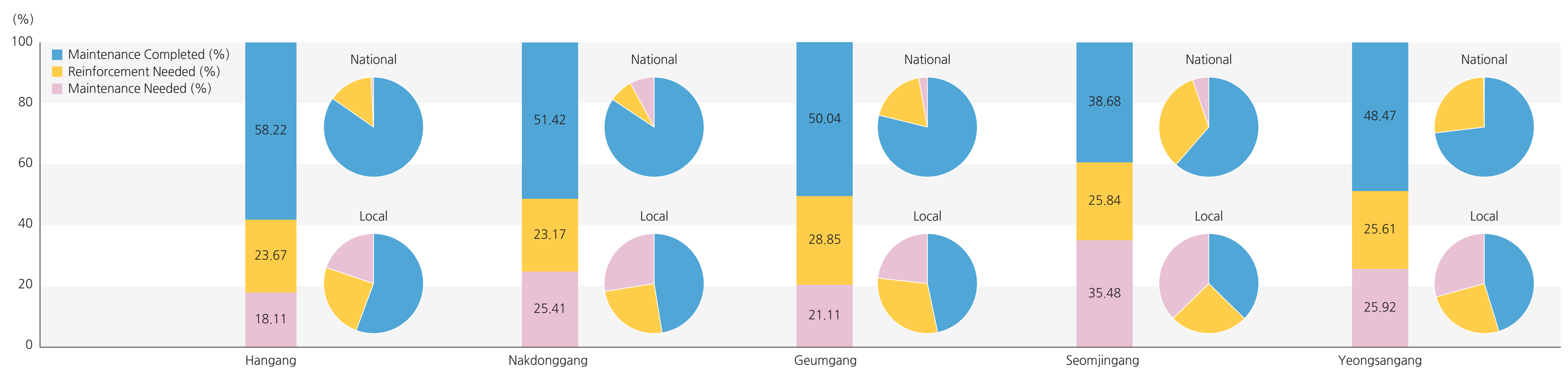
Based on the River Master Plans, river banks are reinforced to prevent flooding by calculating the area of cross-section depending on flood discharge standards for each river. By December 2014, river bank reinforcement had been completed on 51.7% of the total length of legally designated rivers: 80.7% of the total length of national rivers and 48.6% of the total length of local rivers. About 24.9% of the total length of legally designated rivers still need to be reinforced: 15.5% of the total length of national rivers and 25.9% of the total length of local rivers. About 23.3% of the total length of legally designated rivers is required to build new river banks: 3.8% of the total length of national rivers and 25.4% of the total length of local rivers.

Among the five major rivers, Hangang has the highest percentage of reinforced river bank sections at 58.2%, followed by Nakdonggang at 51.4%, while Seomjingang comes last (38.7%). Geumgang has the highest percentage of river bank sections needing reinforcement (28.9%), while Nakdonggang has the lowest (23.2%). Seomjingang has the highest percentage of river sections that need to build new river banks (35.5%), while Hangang has the lowest (18.1%).

By municipal district, Seoul has the highest percentage of stabilized river bank sections at 95.8%, followed by Gwangju (87.1%) and Daegu (76.3%). Sejong shows the highest percentage of river bank sections that need reinforcement (34.4%), followed by Chungcheongnam-do (30.8%) and Jeollabuk-do (29.2%). Districts with the highest percentage of river sections that need to build new river banks are Incheon (45.6%), Jeollanam-do (32.2%), and Jeju Special Self-Governing Province (31.5%).

In terms of small-scale rivers, there are a total of 22,823 rivers, with 43.1% of the total length of their river banks now stabilized. Daegu has the highest percentage of river bank stabilization at 67.5%, followed by Daejeon (60.1%), Gwangju (60.1%), and Seoul (54.1%), while Jeju Special Self-Governing Province comes last (20.9%).

Maintenance of the Five Major Rivers

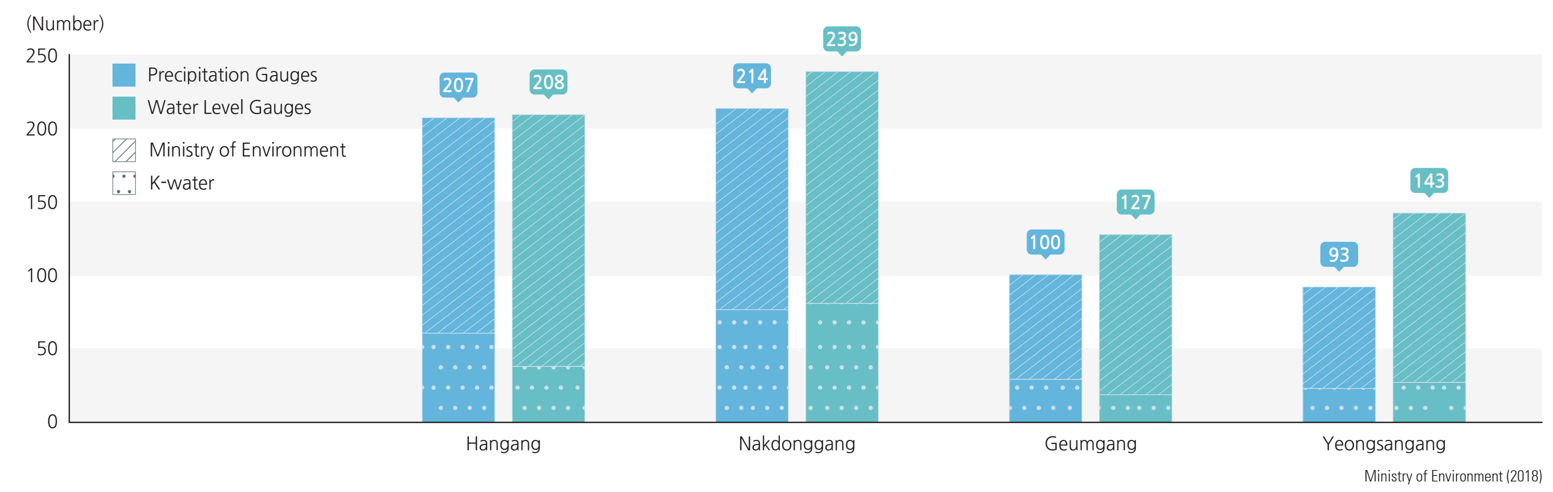


Ministry of Land, Infrastructure and Transport (2020)

River flow data is important for calculating the quantity of water resources and developing comprehensive water resource management plans and policies. Water level gauging stations are established to record water levels consistently every 10 minutes and calculate flow rate using the stage-discharge relationship formula. A total of 684 precipitation gauges and 618 water level gauges are currently installed along watersheds all across the nation. The Nakdonggang watershed has the largest number of water level gauges at 193, followed by the Hangang watershed at 167 and the Geumgang watershed at 152. The Seomjingang and Yeongsangang watersheds have 58 and 48 water level gauges, respectively.

Recent changes in global climate have led to an increase in localized heavy rain, which in turn brought about a rise in consequential damage. Over the past ten years (2005–2014), 383 separate severe flooding events caused more loss than the national subsidy limit. As such, Korea implemented a flood control system that prevents floods to minimize potential casualties and property damage. Initially focused on vulnerable areas of large rivers, the system is expanding to include those of small rivers as well. As of 2015, Korea has a total of 46 flood control offices nationwide. Hangang has 13 offices, including Hangang Bridge and Jamsu Bridge; Nakdonggang has 12, such as Waegwan Railway Bridge in Waegwan-eup, Chilgok-gun, Gyeongsangbuk-do; Geumgang has 8, including Geumgang Bridge, Gongju-si; and Yeongsangang has 13 offices, including Naju Bridge in Naju-si, Jeollanam-do.

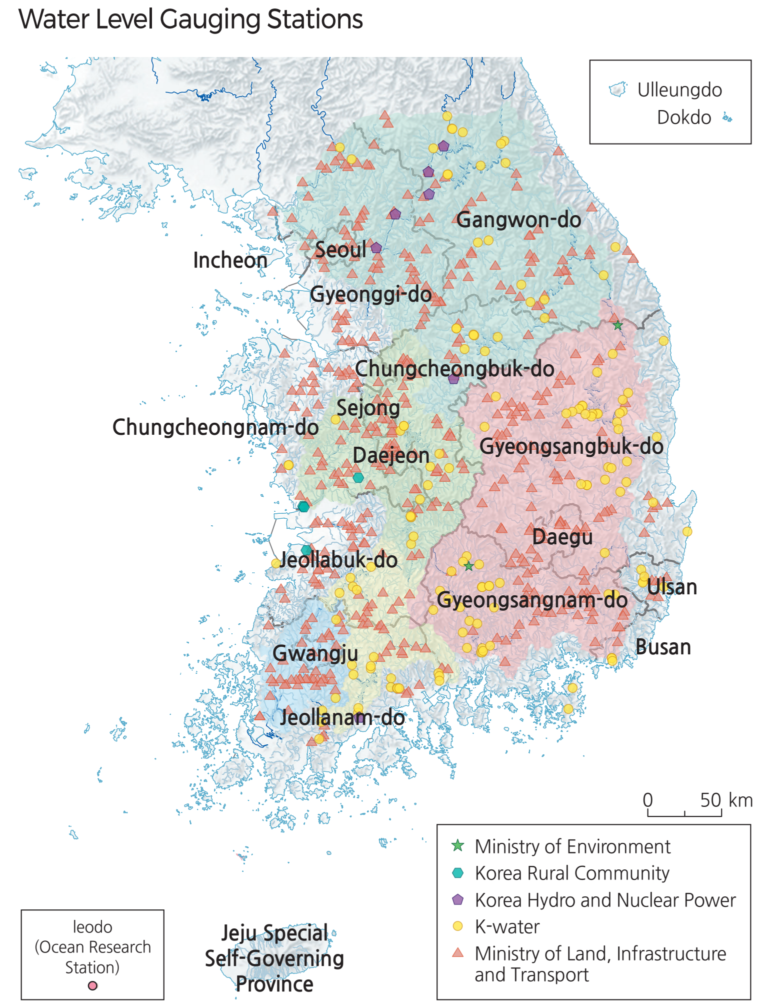
Distribution of Precipitation Gauging Stations and Water Level Gauging Stations



Ministry of Environment (2018)

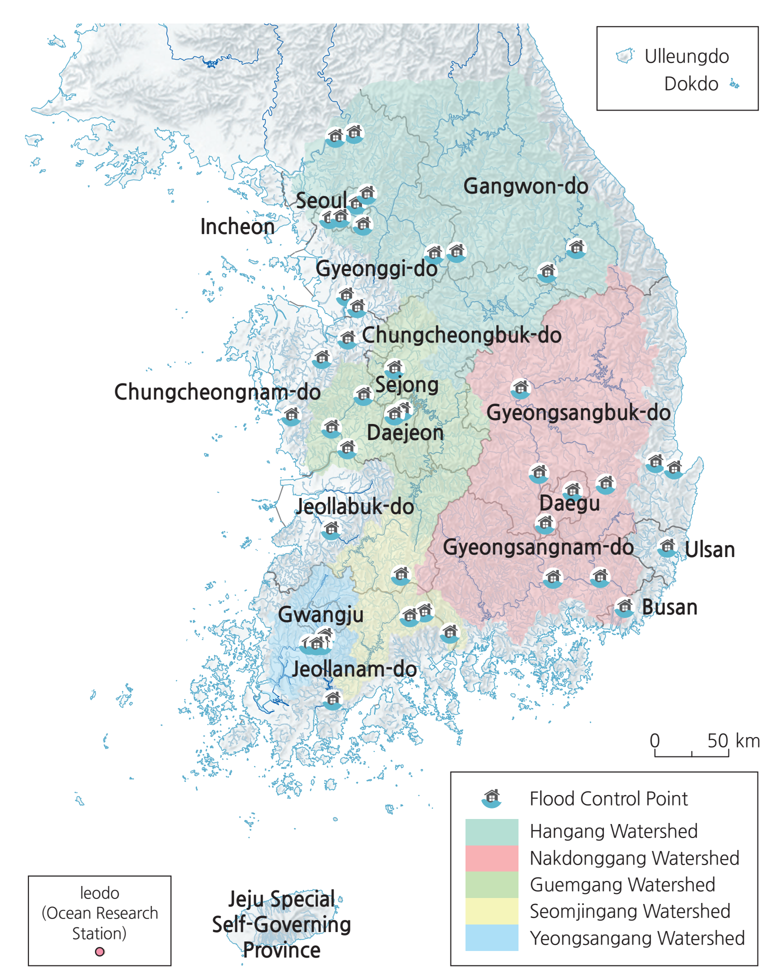
The frequency of localized heavy rains of more than 100 mm per day has increased due to recent global climate change. The amount of damage has also increased as localized heavy rains occur more frequently. In the last 10 years (2009–2018), There were 295 events in which the damage caused by the flood exceeded the criteria of national subsidy. The regions with the most frequent flooding were Seocheon-gun (six events) in Chungcheongnam-do and Jeju-si (six events), followed by Yeoncheon-gun (five events) in Gyeonggi-do, Goheung-gun (five events) in Jeollanam-do, and Wanju-gun (five events) in Jeollabuk-do, respectively. On the other hand, the areas where flood damage above the criteria of national subsidy rarely occurs were mainly metropolitan areas, except for one gu (local district) in Seoul, 12 gus in Busan, and two gus in Gwangju. Gangwon-do, which is geographically vulnerable to flooding, and the southern coastal areas where typhoons often make landfall, have a relatively high number of flood events that cause damage above the criteria of national subsidy.

Water Level Gauging Stations



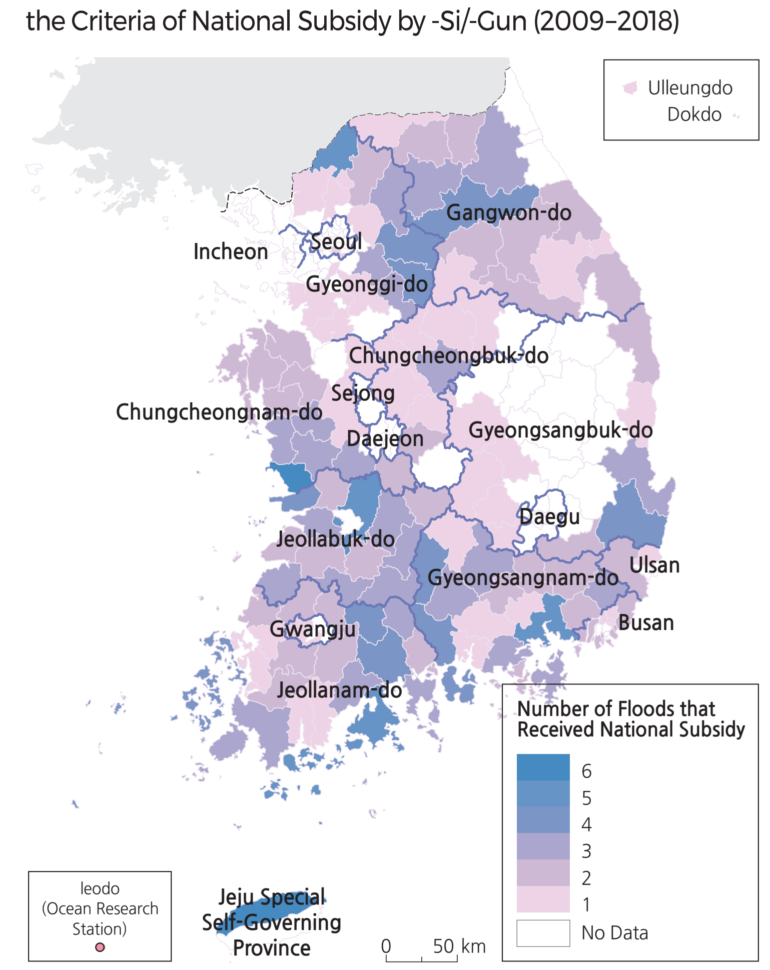
Ministry of Land, Infrastructure and Transport (2013)

Flood Control Points



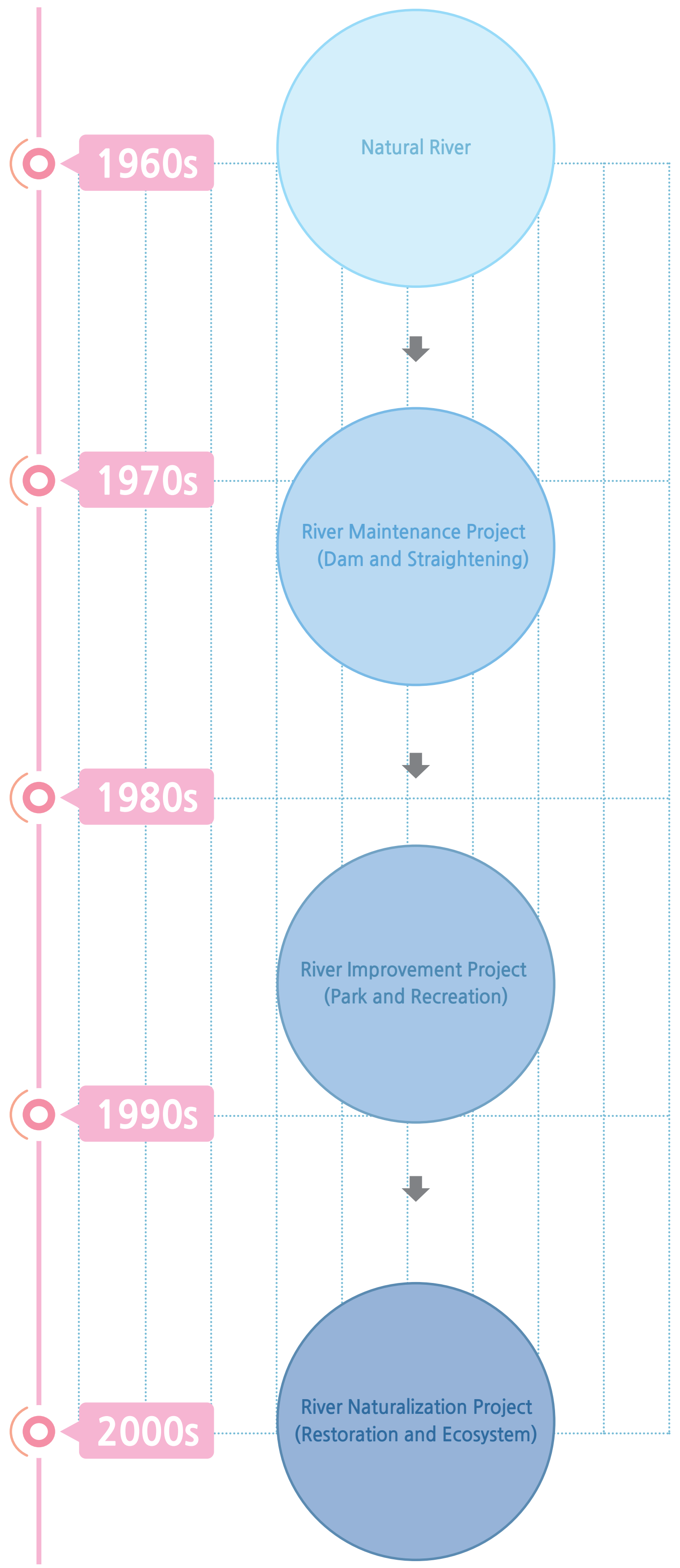
Ministry of Land, Infrastructure and Transport (2013)

Number of Flood Events that Caused Damage above the Criteria of National Subsidy by -Si/-Gun (2009–2018)



Ministry of Land, Infrastructure and Transport (2019)

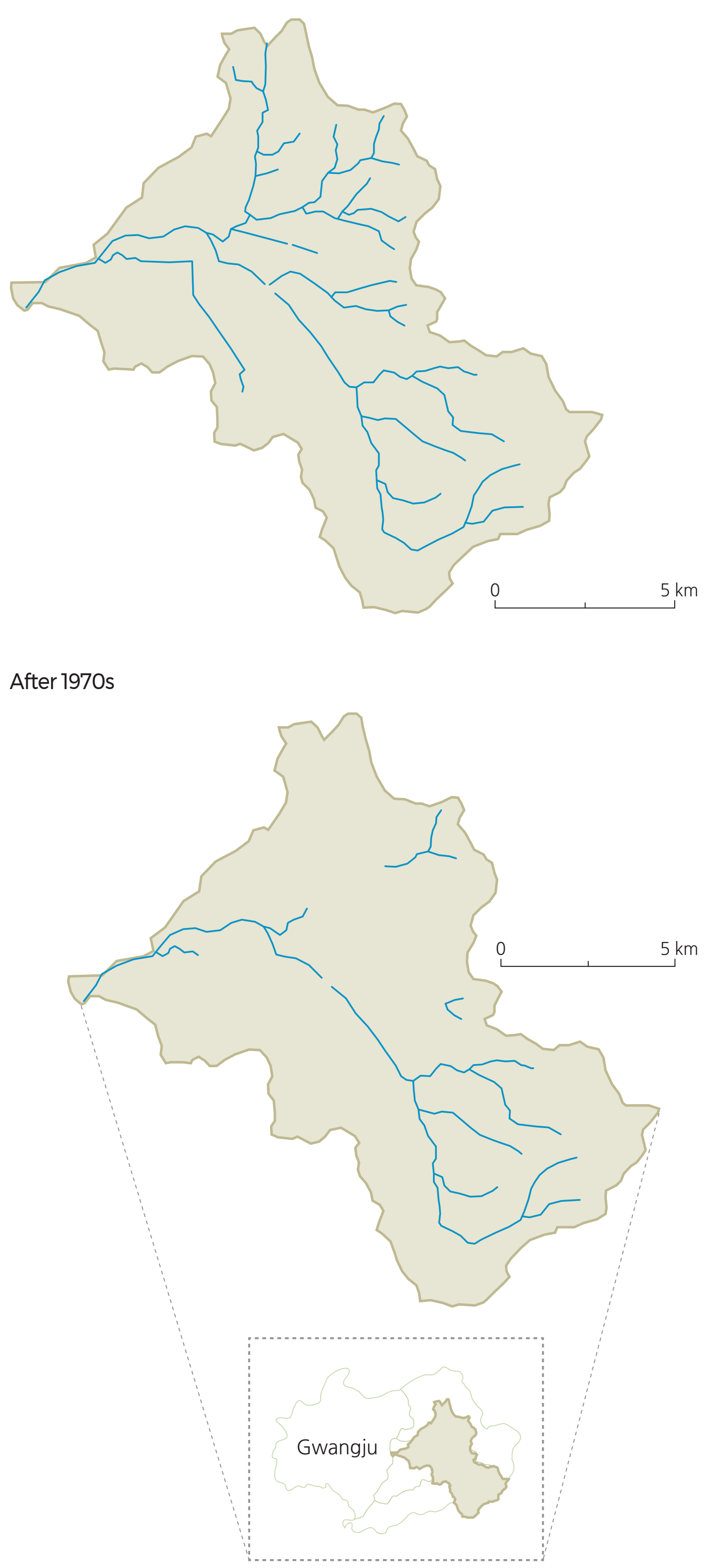
River Management Policy



Covered Channels in Gwangjucheon

Before 1970s

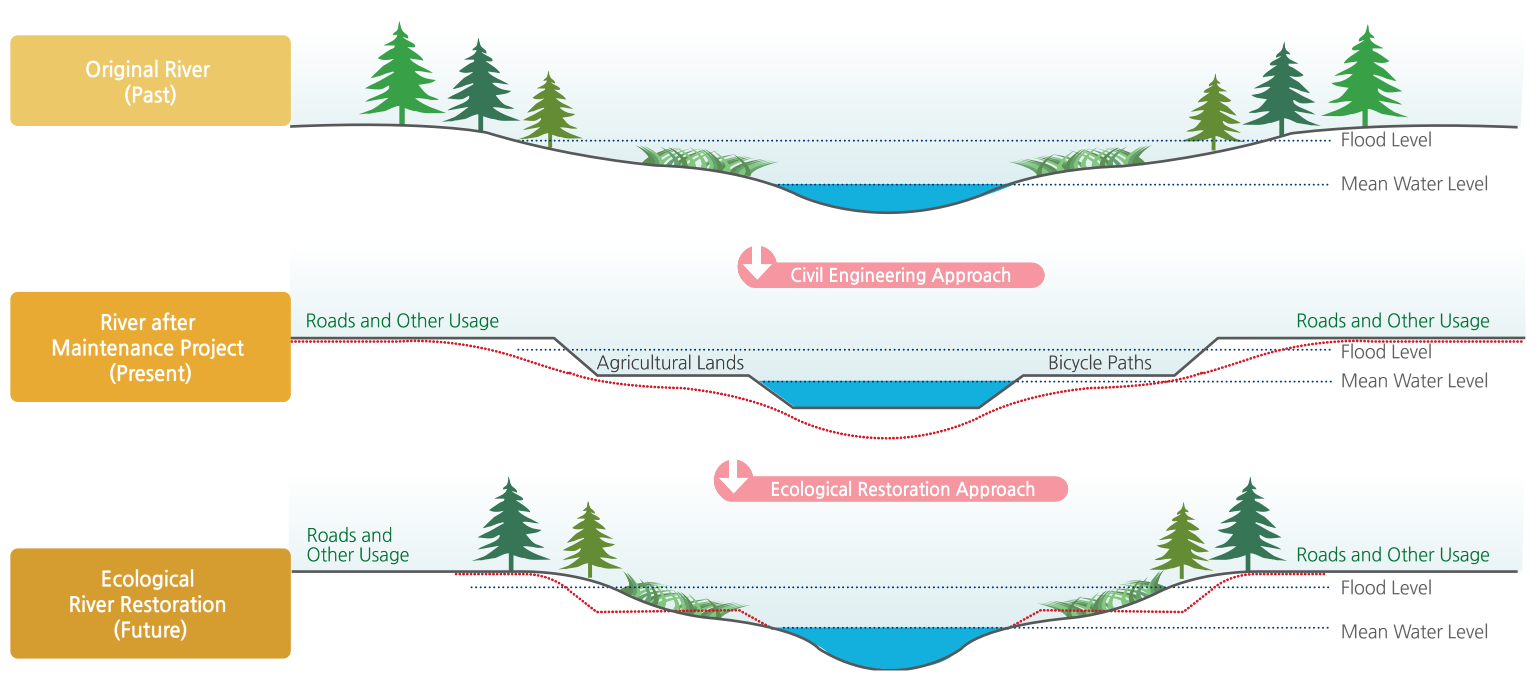
After 1970s



Change in the River Management Policy

Year	Target	Main Activities
Before 1970s	Water Resource Development and Establishment of River Maintenance System	Enactment of River Act (1961), Establishment of Korea Water Resource Corporation (1966), 10-Year Water Resource Development Plan (1966 – 1975)
1970 – 1980	Development of Integrated Watershead Management and Construction of Multipurpose Dams	Establishment of 4 Major Watersheds Development Plan (1971 – 1981), Multipurpose Dam; Soyanggang Dam (1973)
1981 – 2001	Basic Plan for a Long-Term Integrated Development of Water Resources	Provides Stable Water Supply, Increase in River Improvement Rate, and Hydroelectric Power
1990 – 2000	Development of Environmentally-Friendly Rivers	Organizing Integrated Water Management such as Irrigation Works, Flood Control, Water Quality Conservation on Hydrologic Units, Riparian Area Maintenance.
After 2000	Intergrated Water Resource Management Policy	Dualistic Management of Water Quantity and Quality, Flood Control Based on River System, and Development of a Water Management Policy Relative to Ecology and Culture.

Ecological River Restoration Map



Ministry of Environment (2007)

Up until the 1950s and 1960s, most rivers in Korea were in their natural state. However, in accordance with the rapid urbanization of the 1970s, many tributaries were covered or revamped, and meandering channels were straightened out in rural areas.

As environmental issues gained attention in the 1990s, various environmental improvement projects (such as the construction of waterfront parks and promenades) were launched in areas around rivers.

In the 2000s, the concept of improvement evolved beyond the simple concept of parks to recognize the ecological and scenic conservation value of rivers for ecosystems and humans.

Soyanggang Dam Construction

With the river maintenance project, various dams were constructed to access water for agriculture and generate hydroelectric power. In 1965, Korea's first multipurpose dam, Seomjingang Dam, was built. Soyanggang Dam—Korea's largest storage reservoir—was established in 1973. While these dams were beneficial for securing water and other hydroelectric resources, their construction provoked various social conflicts, including environmental issues and resident displacement.

River Refurbishment Projects

Initiated around the 1970s, the river maintenance project mostly focused on straightening river channels and building concrete levees for flood control. By the 2000s, 80% of the river maintenance had been completed, and many river reservations were turned into farmlands. However, such vigorous development involving artificial structures resulted in an increase in stream velocity rates and a devastation of ecological functions and self-restoration abilities.

Ecologically Restored River (Seunggicheon in Incheon)

As part of the rapid urbanization that followed the 1970s, many rivers surrounding cities were covered to make way for roads and parking lots. Beginning in the 1990s, projects were initiated to convert rivers into parks, fueling discussions to restore rivers that were previously covered. A major example is the Cheonggyecheon Restoration Project, completed in 2005.

Before the Restoration of Cheonggyecheon

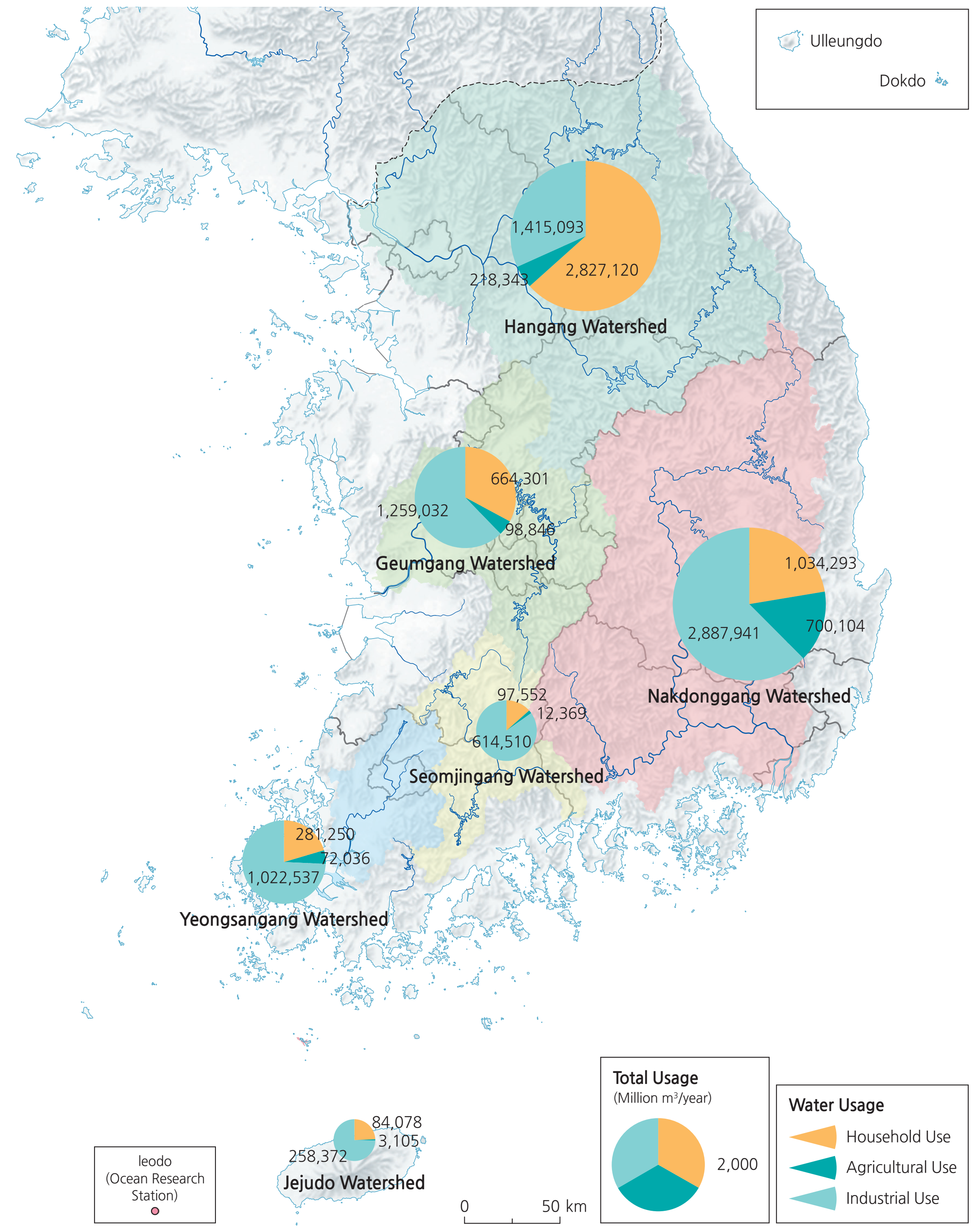
After the Restoration of Cheonggyecheon

World Water Forum

The 7th World Water Forum was held in Daegu/Gyeongsangbuk-do of Korea on April 12, 2015 under the theme "Water for Our Future." 168 countries participated and 40,000 people registered, making it the largest event in the history of the forum. The main agenda of the World Water Forum is to discuss a variety of water-related topics —such as climate change, disasters, and green growth—from social, economic, and environmental perspectives. National governments, academia, research institutions, and businesses are just some of the participants that take part in the dialogue. By hosting the forum, Korea expects to heighten its international recognition and value, strengthen its global competitiveness, and increase opportunities for companies to expand overseas.

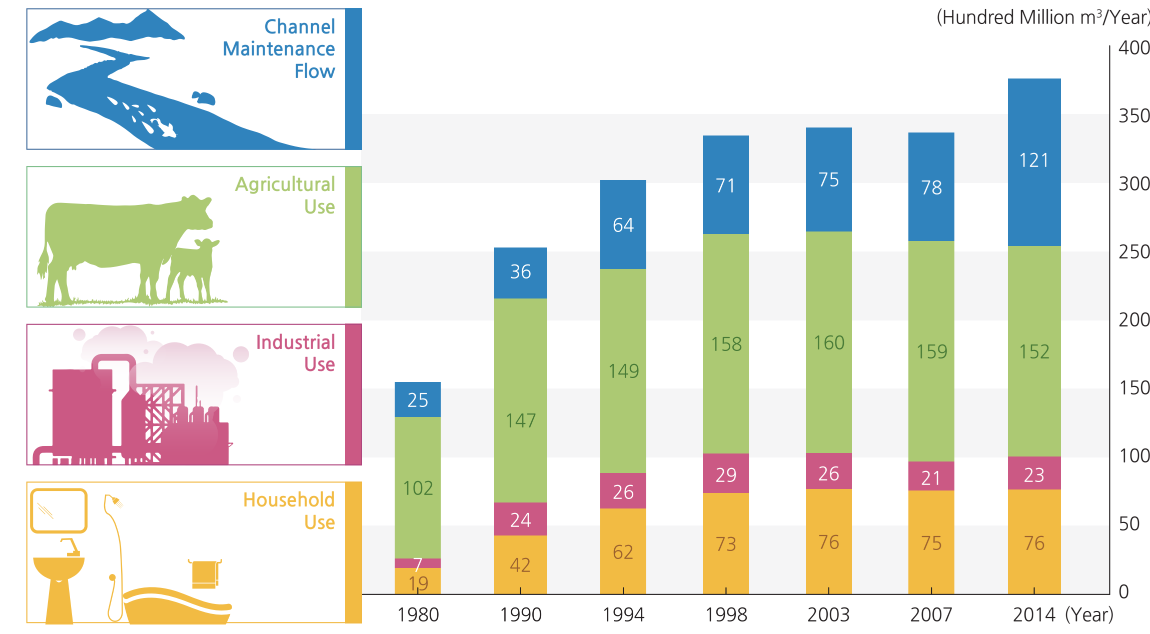
Water Distribution and Usage

Water Usage by Watershed



Ministry of Land, Infrastructure and Transport (2015)

Water Usage by Year



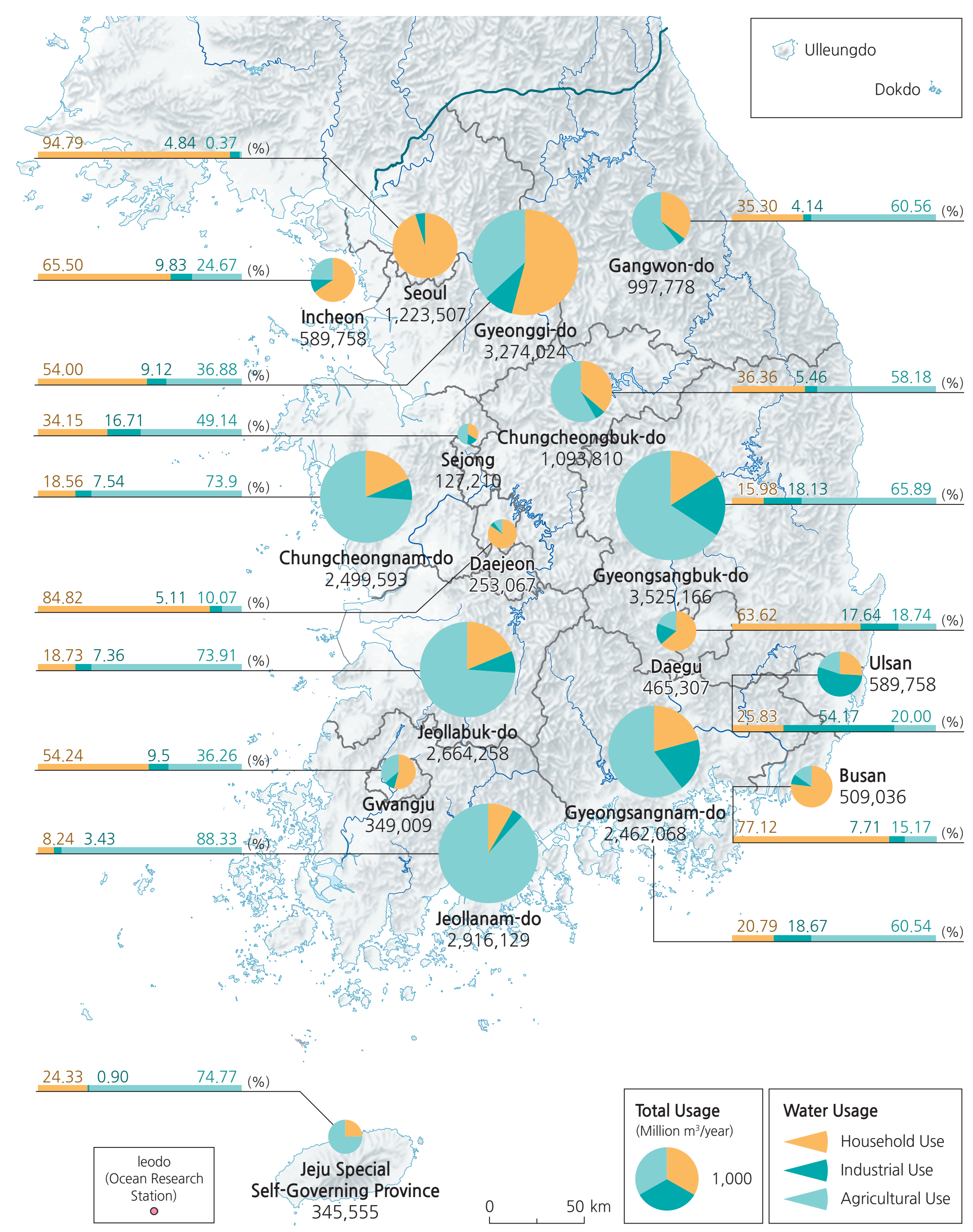
Ministry of Land, Infrastructure and Transport (2015)

The total water use of Korea increased more than six times from 5.12 billion m³ in the 1960s to 33 billion m³ in the 1990s. This steep rise can be attributed to population growth, economic advancement, increased industrial development, and an increasing number of irrigation facilities. Accordingly, channel maintenance flow also increased to protect water quality, ecosystems, and landscapes. Since the 2000s, however, the rate of increase for water usage has been slowing down.

In 2014, agricultural use accounted for the largest proportion of total water use at 40.9%, followed by channel maintenance flow (32.5%), domestic use (20.4%), and industrial use (6.2%). Domestic and industrial water usage has remained about the same since 1998, while agricultural use has experienced a decrease over the same time period. On the other hand, channel maintenance flow – which is used for maintaining river functions – has gradually increased. As of 2011, the Hangang watershed was recorded as the largest area of water use at 5.23 billion m³, followed by the Nakdonggang watershed (5.1 billion m³), Geumgang watershed (2.61 billion m³), Yeongsangang watershed (1.5 billion m³), and Seomjingang watershed (0.9 billion m³).

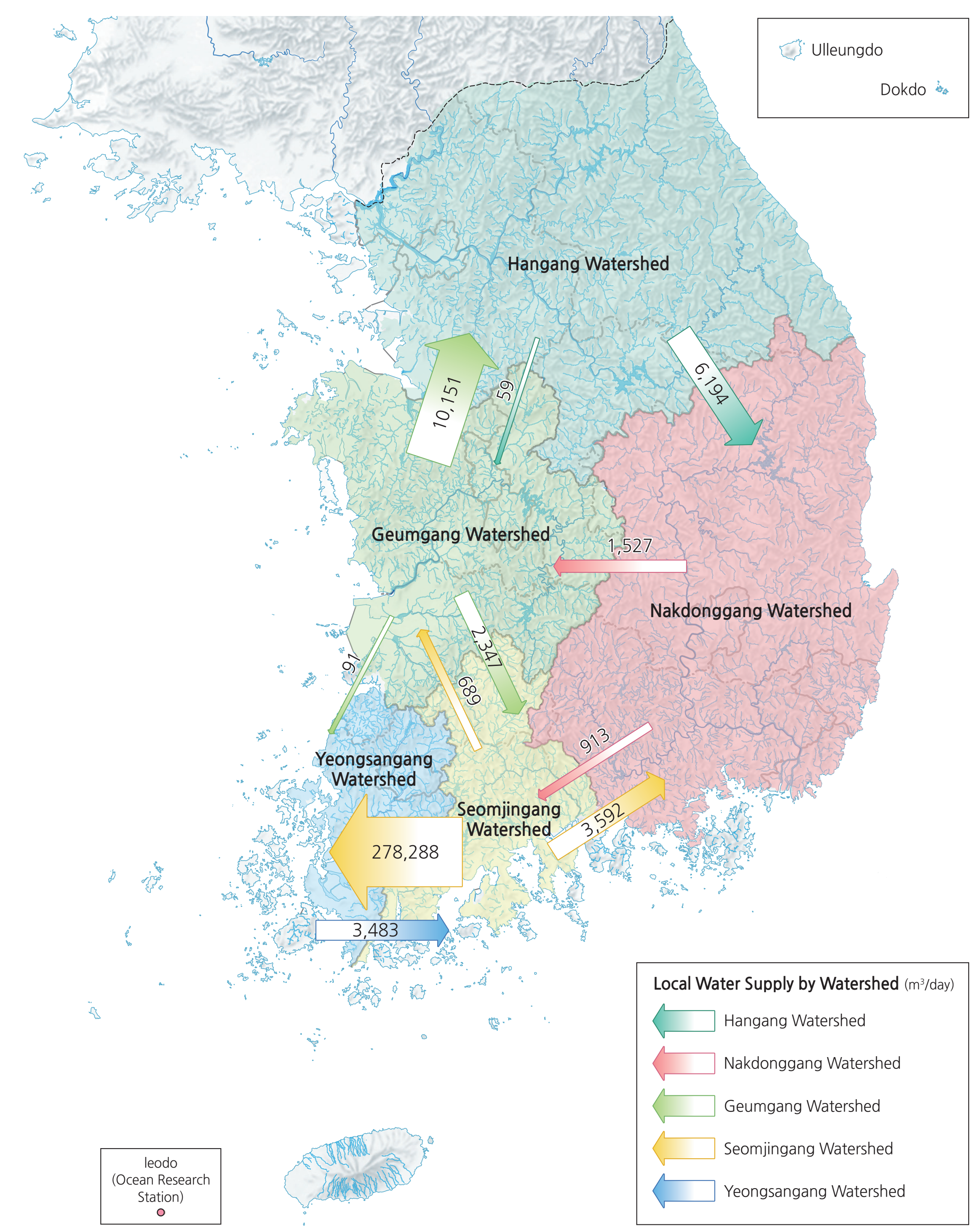
In the Hangang watershed, domestic water use took the highest proportion of water use at 63.4%, while agricultural and industrial water use accounted for 31.7% and 4.9%, respectively. For all other watersheds, agricultural water use had the highest proportion, followed by domestic and industrial water use. The rate of domestic water use is highest in the Hangang watershed due to the large population that inhabits the area. Large industrial complexes contribute to the relatively high rate of industrial water use in the Nakdonggang watershed (15.1%), while a smaller population and fewer industrial facilities are responsible for the relatively high rate of agricultural water use in the Seomjingang watershed (84.8%).

Water Usage by Province



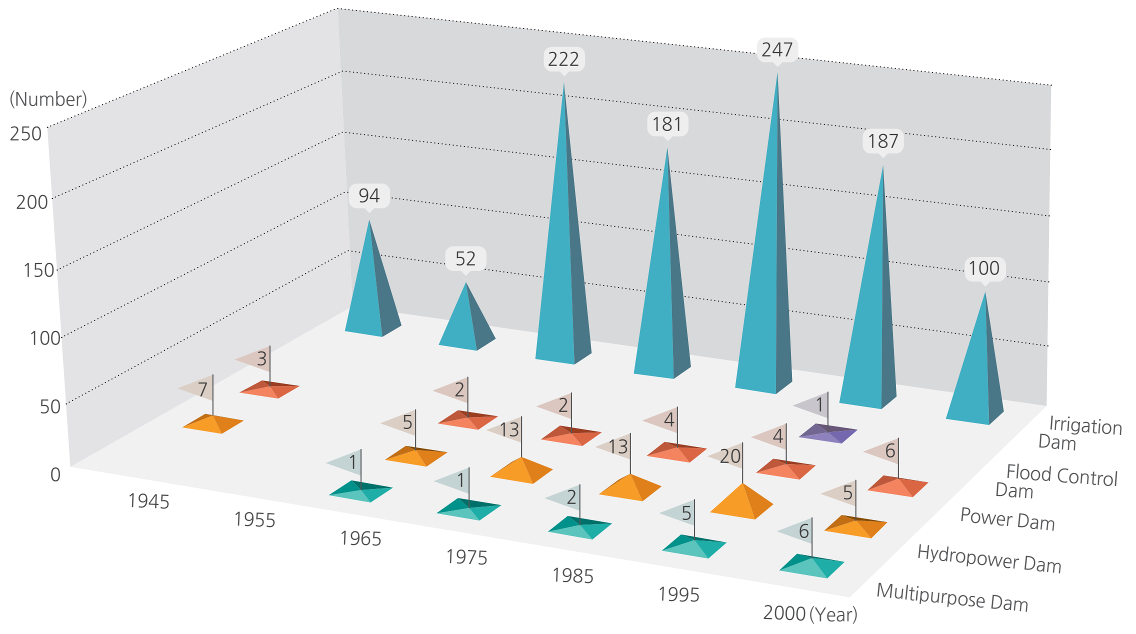
Ministry of Land, Infrastructure and Transport (2015)

Local Water Supply by Watershed

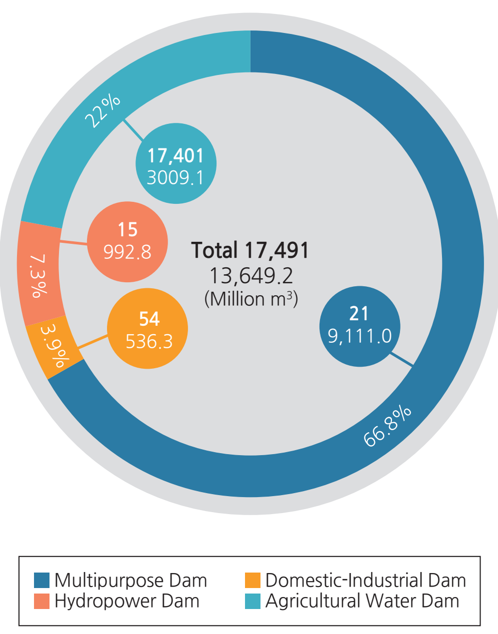


Ministry of Land, Infrastructure and Transport (2015)

Number of Dams Constructed by Year



Available Reservoir Storage

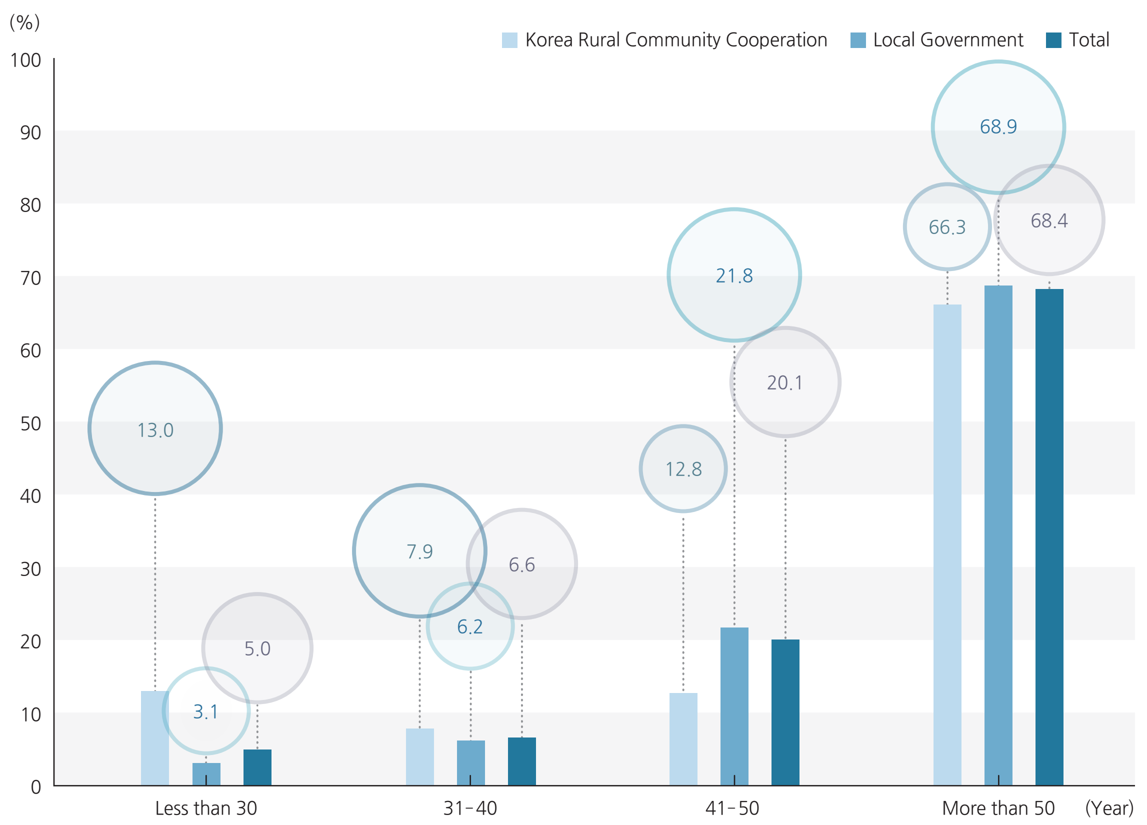


Potential Hydropower Generation by Watershed

Potential Volume (Thousand TOE)	Theoretical Potential Volume	Geographical Potential Volume	Technical Potential Volume
Hangang	10,988	5,834	1,867
Nakdonggang	8,035	4,248	1,359
Geumgang	3,301	1,821	582
Seomjingang	2,361	1,304	417
Yeongsangang	1,356	781	251
Jeju Special Self-Governing Province	834	153	49
Total	26,875	14,141	4,525

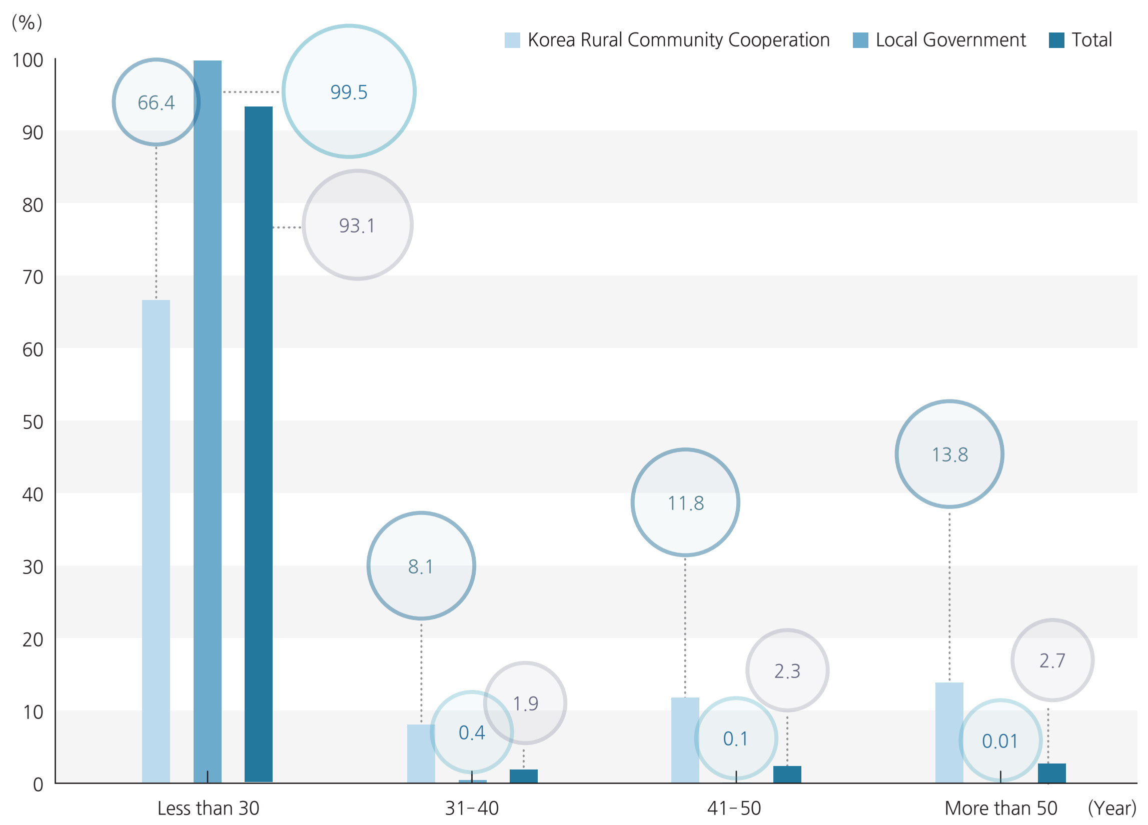
Ministry of Environment (2020)

Age of Reservoirs



Ministry of Land, Infrastructure and Transport (2013)

Reservoir Storage Volume



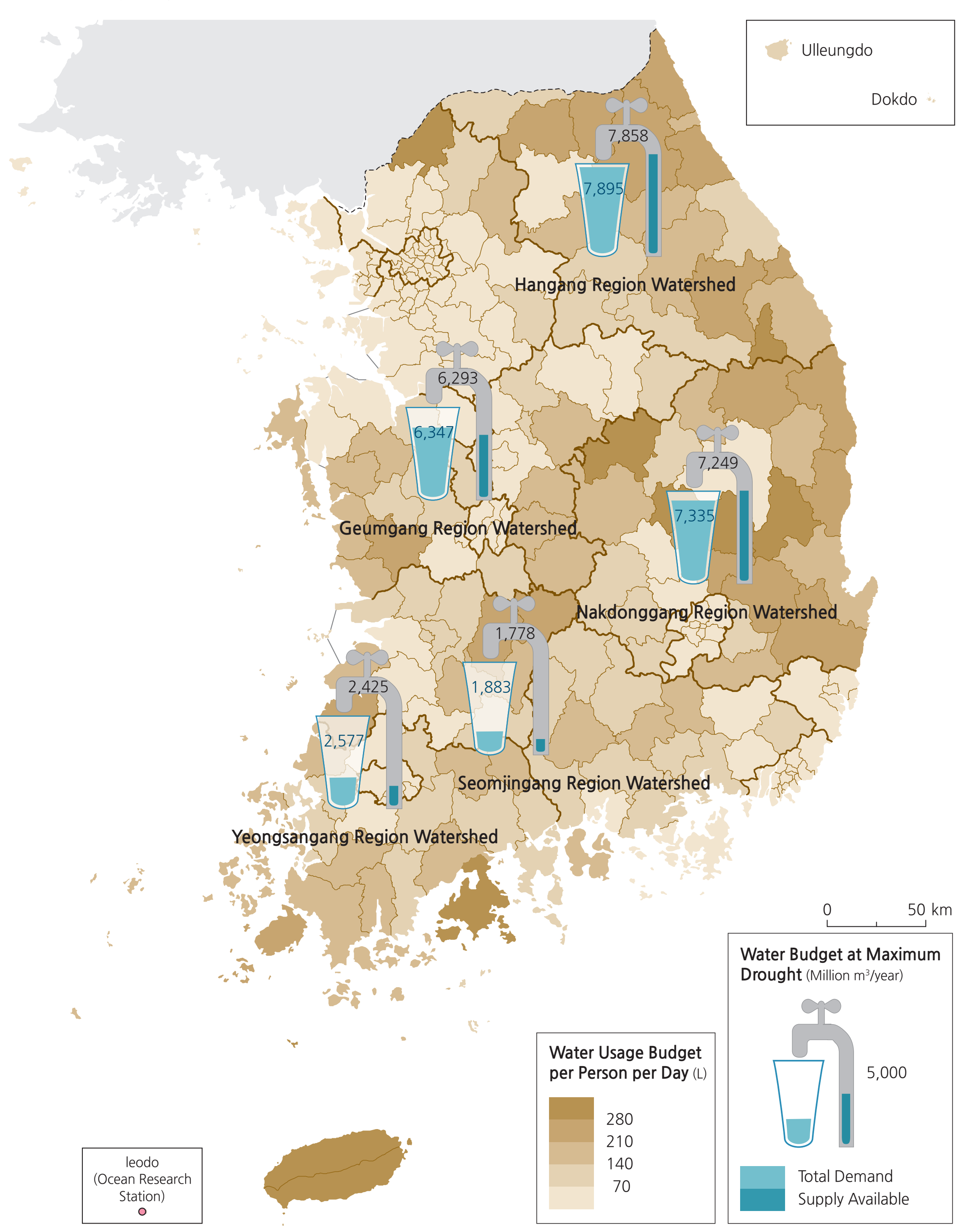
Ministry of Land, Infrastructure and Transport (2013)

As of 2014, Korea has a total of 17,735 dams and reservoirs, including those under construction. This number includes 20 multipurpose dams, 54 domestic and industrial dams, and 12 hydroelectric dams, with the rest being small-scale agricultural dams. In terms of hydropower capacity, multipurpose dams account for 68.1% of all structures. There are also two dams for flood control: "Dam for Peace" and Gunnam Flood Control Reservoir. The Hantangang Dam was recently completed.

The distribution of dams by watershed indicates that 27 are located in the Nakdonggang watershed, 24 in each of the Hangang and Geumgang watersheds, and nine in each of the Yeongsangang and Seomjingang watersheds. In the Hangang watershed, 37.5% of the dams are hydroelectric dams, while 33.3% are hydropower dams. Domestic/industrial (37.0%) and multipurpose (29.6%) dams account for 66.6% of dams in the Nakdonggang watershed. Agricultural dams account for about 75% of Geumgang dams and 77.8% of Yeongsangang dams, while all types of dams are relatively evenly distributed in the Seomjingang watershed. Overall, the Nakdonggang watershed has the most multipurpose and domestic/industrial dams, the Geumgang watershed has the most agricultural dams, and the Hangang watershed has the most hydroelectric dams.

The "Major Rivers Restoration Project" was launched in February 2009 to promote local development by building weirs, thus securing water resources, enhancing water quality, and developing the leisure industry. A total of 16 weirs were newly installed on the four rivers (Hangang, Nakdonggang, Geumgang, and Yeongsangang). Various leisure facilities such as riverside parks and bicycle paths were created as well. However, there are serious ongoing debates concerning water quality degradation and the effectiveness of the project.

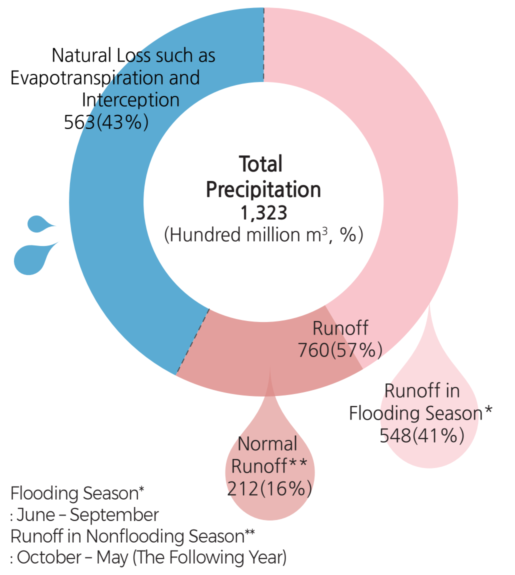
Water Budget by Watershed and Province



* Water Budget = Supply - Demand (Usage)

Ministry of Environment (2014)

Total Water Resources



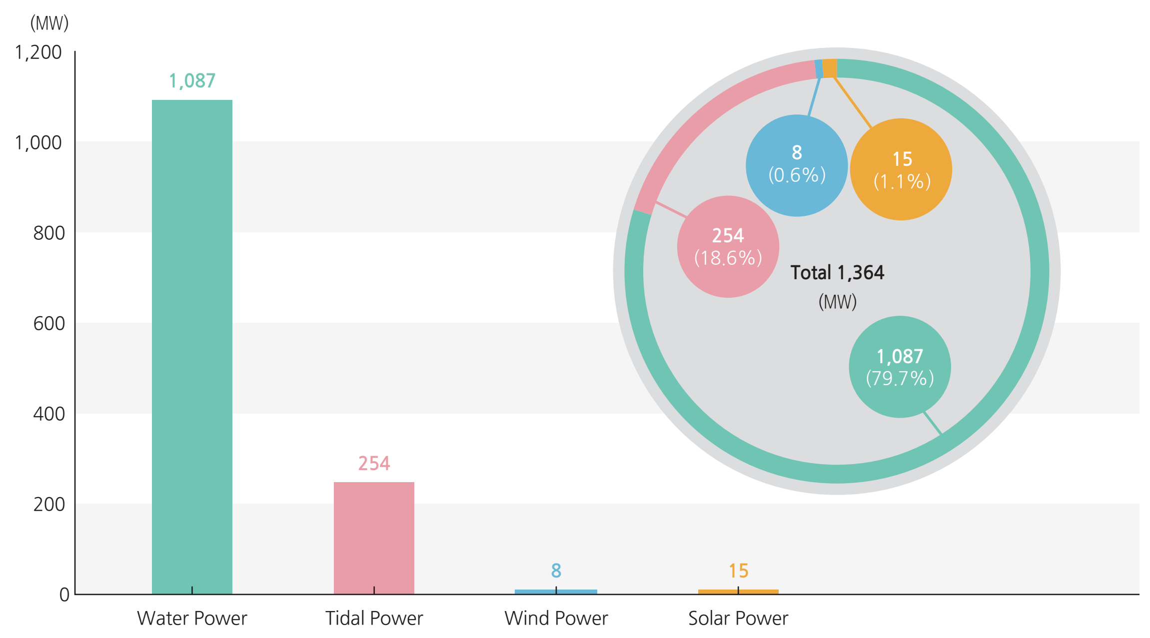
Ministry of Land, Infrastructure and Transport (2019)

Available Water Resources by Watershed

(Million m³)

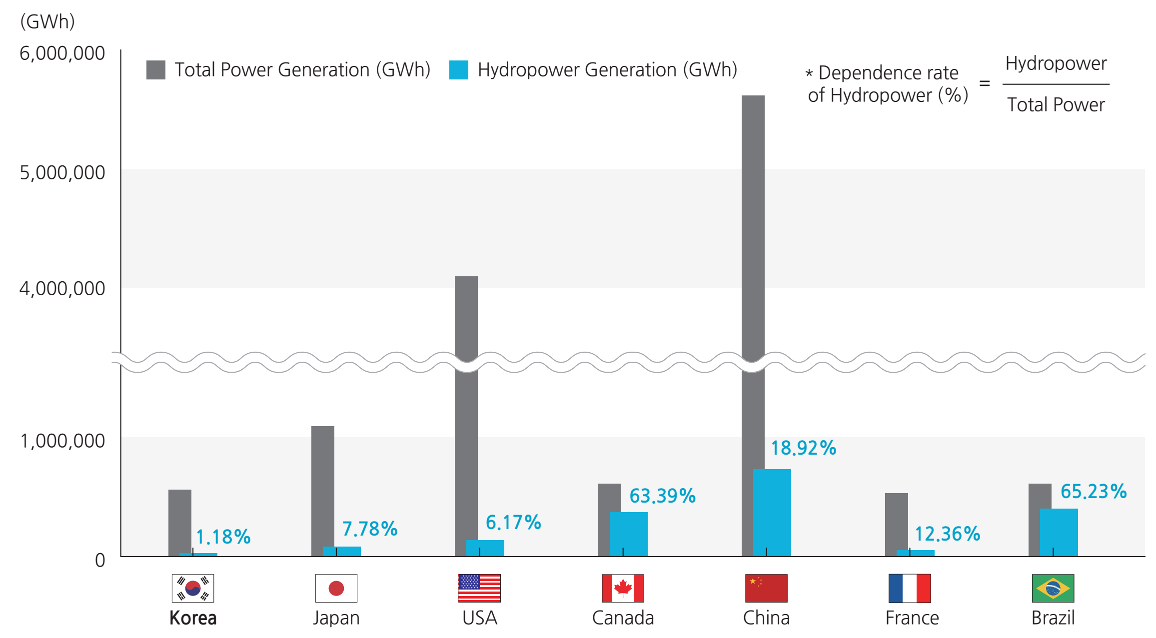
Region	Average Available Water Resource	Available for Usage during Maximum Drought
Nationwide	75,300	33,676
Hangang	23,100	14,400
Nakdonggang	16,500	8,733
Geumgang	11,000	5,577
Seomjingang	4,400	2,808
Yeongsangang	3,000	2,158

Status of Renewable Energy



Ministry of Trade, Industry and Energy (2019)

Hydroelectric Power Generation by Country

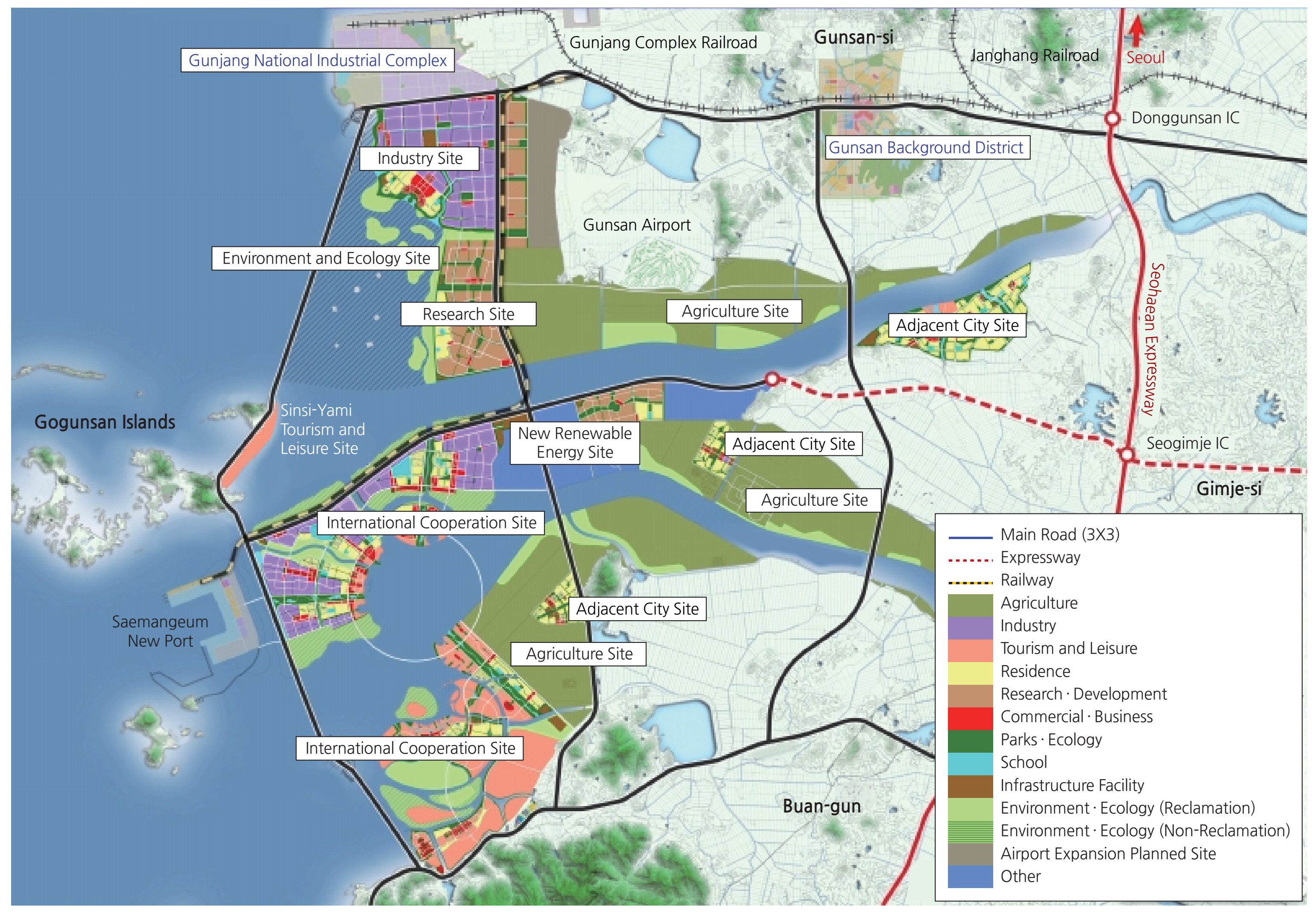


Korea Power Exchange (2018)

According to the Long-Term Water Master Plan (2011–2020), Korea is projected to have a water shortage of 0.43 million m³ if severe drought occurs in 2020. The prediction states that the Yeongsangang watershed will have the largest shortage (0.15 billion m³), followed by the Seomjingang watershed (0.1 billion m³), the Nakdonggang watershed (0.09 billion m³), the Geumgang watershed (0.05 billion m³), and the Hangang watershed (0.04 billion m³). Coastal regions, islands, and mountain areas will most likely experience the greatest lack of available water due to a deterioration of water resources or supply systems.

Various plans are required to prevent the projected water shortage across the nation; an integrated supply system for waterworks must be established, existing facilities should be maintained to uphold effective operation, and small reservoirs should be constructed to obtain new water sources. Global climate change may further intensify the water shortage by 1.8–3.5 times by extending droughts and increasing demand for water. As such, it is also necessary to facilitate the capability to cope with such potential extreme water shortages.

Land Use Plan of the Saemangeum Land Reclamation Project



Saemangeum Development and Investment Agency

Chronological Table of the Saemangeum Land Reclamation Project

- 1987 Presidential Candidate Roh Tae-woo announces the Saemangeum Development Pledge
- 1989 The Saemangeum Land Reclamation Comprehensive Plan (100% farmland) is established
- 1991 Seawall construction begins
- 1997 Environmental organizations initiate a campaign against the Saemangeum Development Project
- 1998 The Presidential Transition Committee thoroughly reviews the Saemangeum Development Project
- 2001 Environmental organizations, religious circles, and civic groups launch hunger strikes to stop reclamation of Saemangeum
- 2006 Environmental organizations lose the Supreme Court lawsuit that requested the cancellation of the Saemangeum Development Project
- 2006 Seawall construction is completed
- 2007 The Master Plan for Land Development in Saemangeum (72% farmland, 28% industry and tourism) is established
- 2008 The Master Plan for Land Development in Saemangeum (30% farmland, 70% industry and tourism) is revised
- 2011 The Saemangeum Comprehensive Development Master Plan is confirmed
- 2013 The Saemangeum Development and Investment Agency opens
- 2014 The Saemangeum Comprehensive Development Master Plan is revised

National Geographic Information Institute

The Saemangeum land reclamation project was the world's longest seawall construction project at 33.9 km, connecting Bieungdo-dong, Gunsan-si and Daehang-ri, Byeonsan-myeon, Buan-gun, Jeollabuk-do, and was completed in 2006. The total cost of the construction of the seawall was 2,949 billion won. This project aimed to create a reclaimed land area of 291 km² and lake area of 118 km² inside the embankment and to build residential facilities for 290,000 people, transportation infrastructure such as roads and ports, and infrastructure for high-tech and renewable energy industries. This project further aimed to build a center for global free trade and economic cooperation.

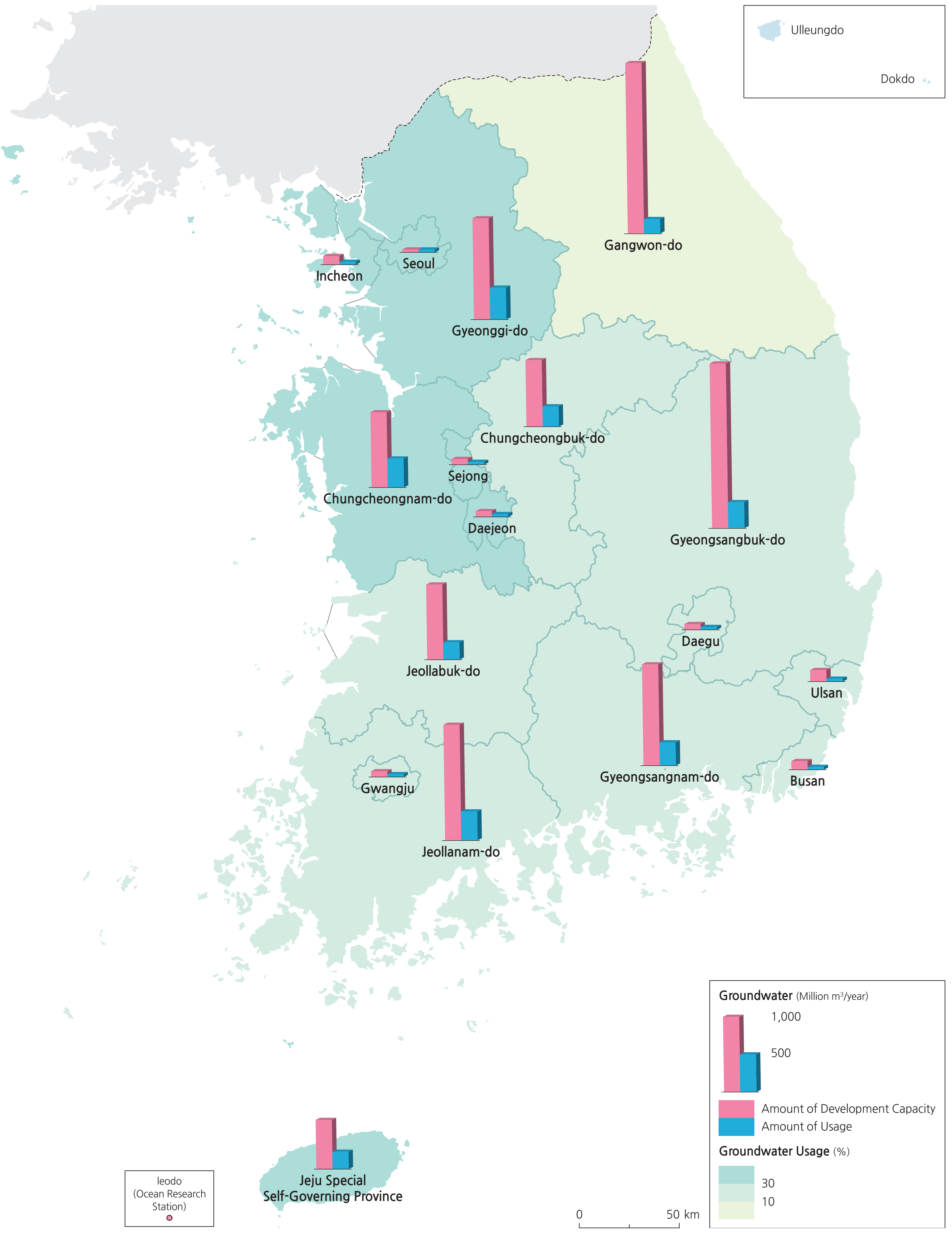
However, this project was engulfed by fierce opposition from the beginning, with concerns over water pollution in the Dongjingang and the Mangyeonggang and the destruction of the tidal flats and the marine ecosystem. This project was suspended due to opposition from many domestic and foreign organizations, including environmental organizations, religious organizations, academia, local governments, and foreigners. The project also became involved in a court case. In addition to environmental issues, many developing projects remain neglected to this day due to sluggish development and failure to attract investment. After the completion of the seawall in 2006, a total of 22.2 trillion won (10.9 trillion won of national funds, 1 trillion won of local funds, and 10.3 trillion won of private investment) was planned to invest in the Saemangeum National Industrial Complex Development Project to create 72.5% of the reclaimed land planned by the project until 2020, when the first phase of the Saemangeum Master Plan was completed. However, due to several changes in the development plan and the absence of a control tower, this project is not being carried out properly. In 2017, only 12.1% of the area planned for reclamation was completed, and 36% is under development.

Before the Saemangeum Land Reclamation Project
: Aerial Photograph (1989)

Groundbreaking Ceremony of
the Saemangeum Land Reclamation Project (1991)

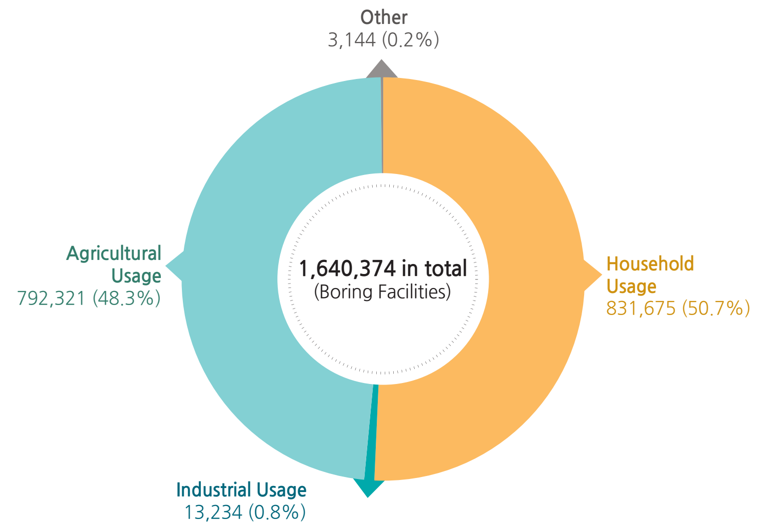
Establishment of Saemangeum Development Corporation (2018)

Groundwater Usage by Province

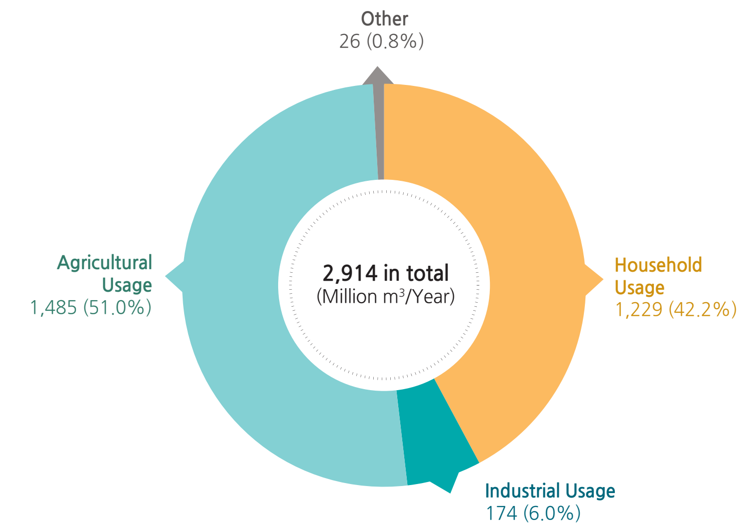


National Groundwater Information Center (2020)

Groundwater Facility by Usage



Groundwater Usage



National Groundwater Information Center (2019)

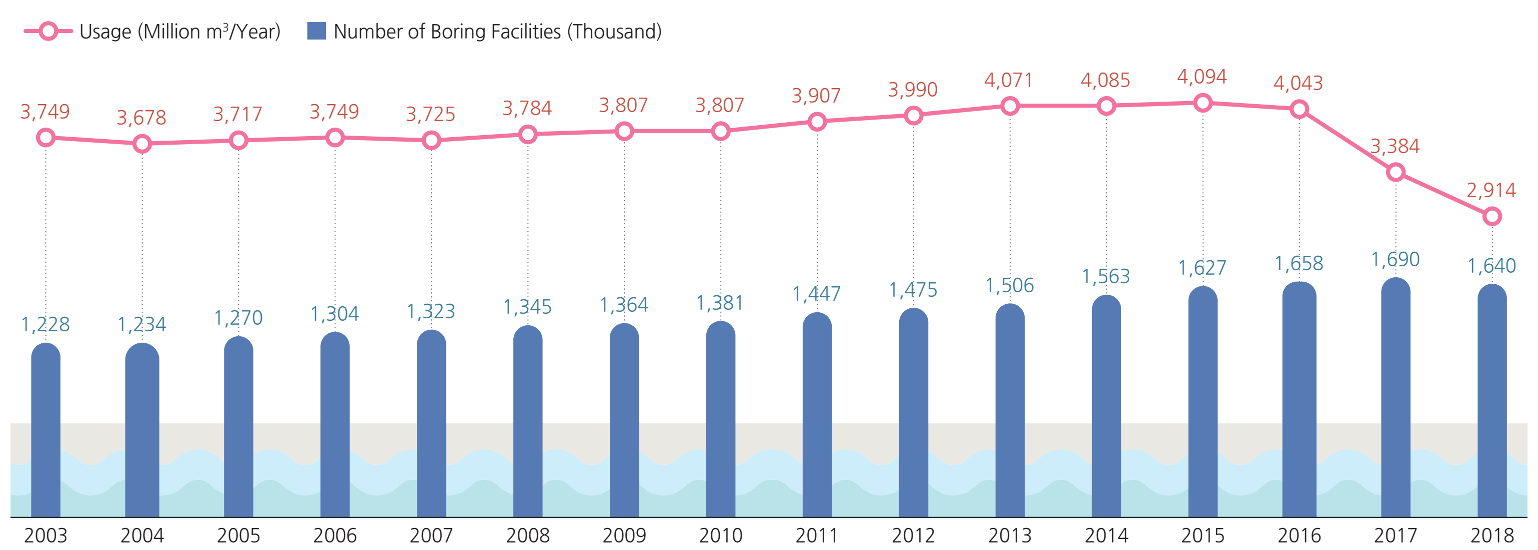
The development and use of groundwater have been increasing every year due to population growth and industrial development. The amount of groundwater used is decreasing as the supply of tap water has recently increased. As of 2018, the country used 2.9 billion tons of groundwater through approximately 164 million tube wells. Compared to 2003, this is a 34% increase in facilities and a 22% increase in usage.

The sustainable development yield of groundwater, which is the largest amount of groundwater that can be used continuously as the inflow and outflow of groundwater are in equilibrium, is about 13 billion m^3 per year. The volume of groundwater is calculated based on the data collected from the observation network. The annual use of groundwater is about 2.9 billion m^3, which is about 22% of the sustainable development yield and is equivalent to the storage capacity of 2.9 billion m^3 of the Soyang Multipurpose Dam. The most common groundwater-related facilities are residential water facilities. As for groundwater use, agricultural water is about 1.48 billion m^3 per year, followed by residential water (1.23 billion m^3 per year). About 93% of the annual use of groundwater is for agricultural and domestic water.

By administrative district, Gyeonggi-do accounts for 13.9% (0.406 billion m^3) of the annual use of groundwater, followed by Jeollanam-do at 12.9% (0.376 billion m^3) and Chungcheonnam-do at 12.5% (0.364 billion m^3).

Alluvial aquifers are widely distributed around large rivers such as Hangang and Nakdonggang. The total area of these aquifers is 27,390 km^2, about 27% of South Korean territory. The depth of these aquifers is about 2–30 m, and the production of groundwater is 30–800 m^3/day per one borehole. The production by region shows a pattern similar to that of Korean terrain, which is high in the east and low in the west. Due to the westward flow of most rivers, there is more recharge in the eastern region and more discharge in the western region.

Groundwater Development and Usage



K-water (2019)

Groundwater Depth by Watershed

Classification		Hangang	Nakdonggang	Geumgang	Seomjingang	Yeongsangang
Bedrock Groundwater Observation Well	Mean	1.34 – 44.76	1.43 – 46.73	0.88 – 14.60	1.96 – 16.20	2.36 – 27.48
	Minimum	0.00 – 33.38	0.41 – 34.03	0.33 – 11.69	1.19 – 12.91	1.07 – 12.72
	Maximum	1.77 – 52.04	2.53 – 75.16	1.86 – 17.07	2.24 – 68.32	2.88 – 56.66
	Variability	0.68 – 19.20	1.27 – 65.90	0.70 – 9.34	0.89 – 62.77	0.94 – 45.32
Alluvium Groundwater Observation Well	Mean	1.66 – 10.86	1.48 – 13.30	1.61 – 13.51	1.94 – 13.31	2.34 – 7.46
	Minimum	0.64 – 8.86	0.20 – 9.98	0.99 – 11.75	0.31 – 6.15	0.49 – 5.99
	Maximum	2.28 – 12.58	2.36 – 18.21	1.97 – 14.93	2.20 – 19.85	2.87 – 9.31
	Variability	0.68 – 10.44	1.27 – 12.23	0.72 – 6.74	0.86 – 14.32	1.18 – 6.40

National Groundwater Information Center (2020)

Distribution of Ground Water

Classification		Bedrock Groundwater Observation Well		Alluvium Groundwater Observation Well	
		Observation Point (Number)	Groundwater Level (m, El.)	Observation Point (Number)	Groundwater Level (m, El.)
Elevation (m, El.)	0 – 50	136	-8.92 – 44.98	71	-1.56 – 45.00
	50 – 100	63	34.50 – 94.55	35	46.28 – 92.62
	100 – 200	53	94.65 – 191.21	28	102.88 – 193.79
	More than 200	41	195.54 – 970.59	14	196.78 – 561.21
Total		293	-8.92 – 970.59	148	-1.56 – 561.21

* Elevation Range of Monitoring Wells for Bedrock Groundwater: - 8.92 – 970.59 m,
Elevation Range of Monitoring Wells fo Alluvium Groundwater: -1.56 – 561.21 m

National Groundwater Information Center (2020)

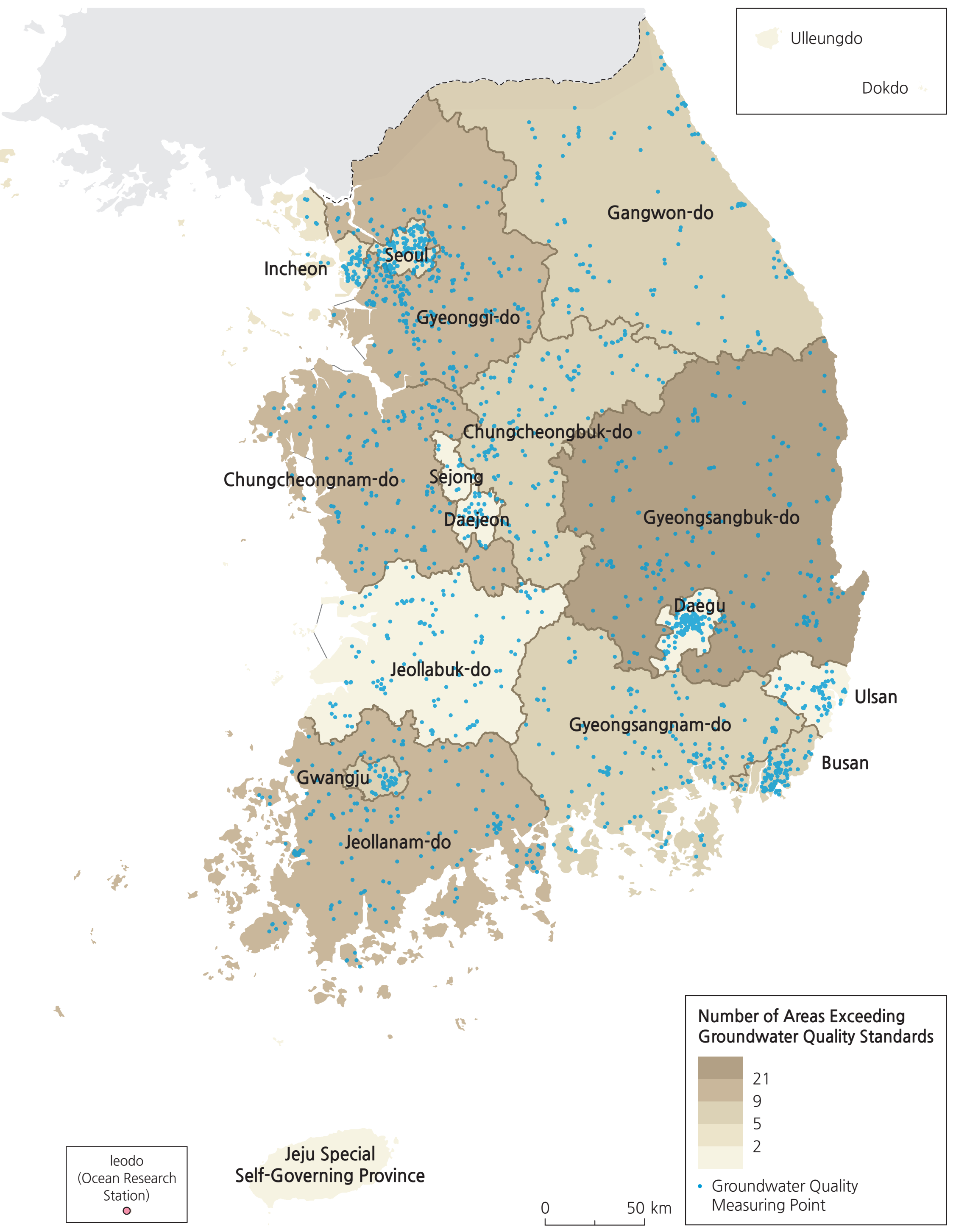
The National Groundwater Monitoring Network regularly monitors groundwater level and water quality. This network aims to prevent groundwater-related problems such as lowering groundwater levels, groundwater source depletion, and groundwater pollution. It also aims to establish a rational development and maintenance plan for the efficient use and management of groundwater resources.

The first 15 observatories were installed in 1995, and 442 observatories were installed by 2018. The National Groundwater Monitoring Network observes water level, electrical conductivity, water temperature 24 times a day, and conducts water quality inspections according to groundwater quality standards for residential water twice a year.

The hydrogeological map is a reclassification that divides alluvial and bedrock aquifers in Korea into eight hydrogeological units by rock configuration (such as type, rock sheet, pore shape, and topography). The geological characteristics of each region largely determine the quality of groundwater.

The Taehwa River estuary and Hyeongsan River estuary on the east coast, which are sedimentary rocks of the Gyeongsang system, generally show better groundwater output than other areas. Gyeonggi-do, Chungcheong-do, and Gyeongsangnam-do, which have a wide distribution of crystalline rocks, have relatively abundant groundwater yields in the lower weathering zone of Jurassic granites. Groundwater yield is also in good condition in upstream Namhangang and in the limestone areas in the eastern part of Korea. Jejudo, composed of porous basalt from volcanic activity, has water resources that consist entirely of groundwater. As such, it also shows good recharge and production rates.

Number of Areas (-Si/-Gun) Exceeding Groundwater Quality Standards by Province



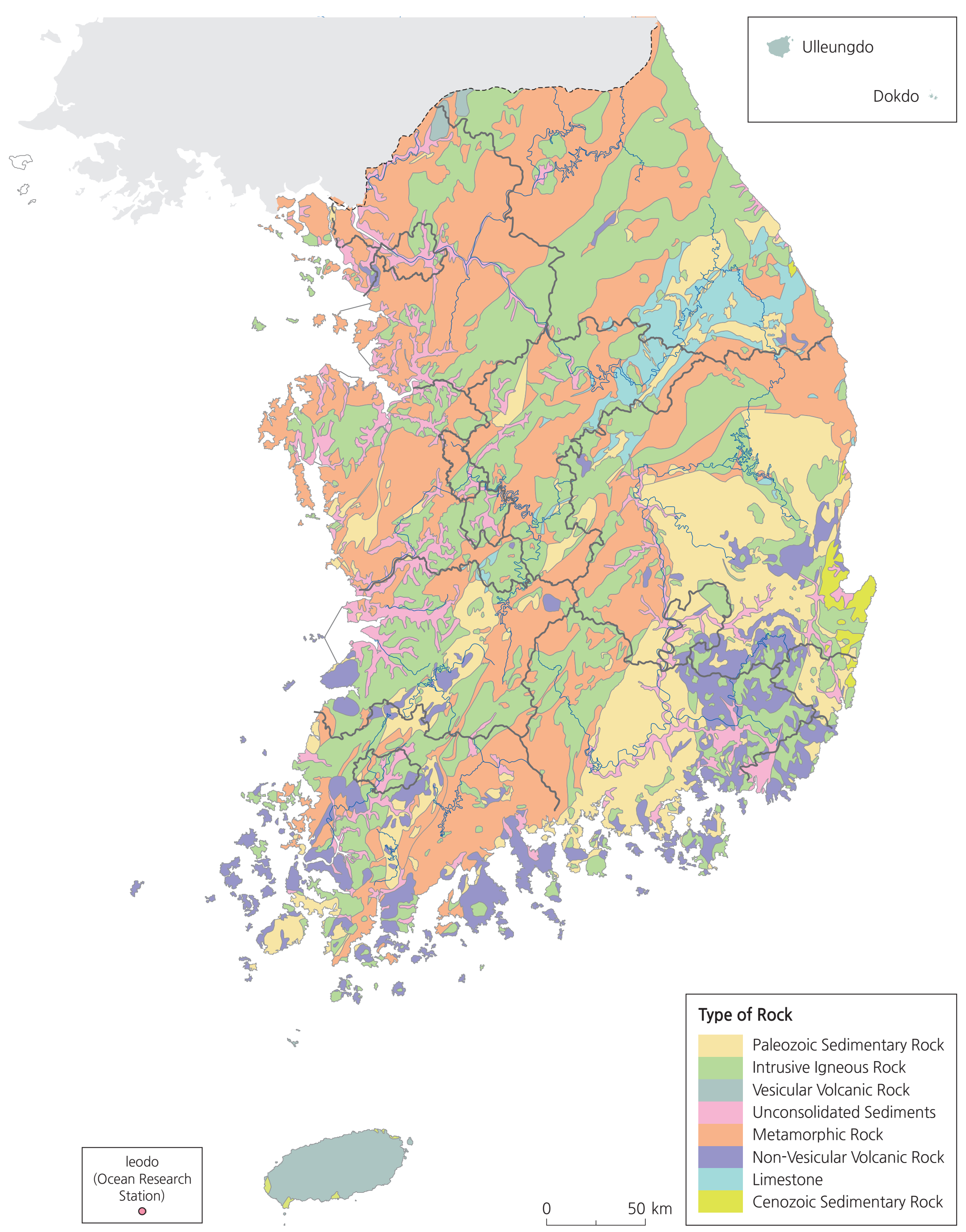
National Groundwater Information Center (2015)

Number of Inspections Exceeding Groundwater Quality Standards by Province

Province	Number of Inspections	Number of Inspections Exceeding	Excess Rate (%)
Seoul	1,457	41	2.8
Busan	1,856	113	6.1
Daegu	770	8	1
Incheon	882	19	2.2
Gwangju	467	0	0
Daejeon	564	4	0.7
Ulsan	913	17	1.9
Sejong	375	1	0.3
Gyeonggi-do	15,773	674	4.3
Gangwon-do	5,263	444	8.4
Chungcheongbuk-do	3,554	16	0.5
Chungcheongnam-do	4,730	70	1.5
Jeollabuk-do	3,664	84	2.3
Jeollanam-do	3,037	26	0.9
Gyeongsangbuk-do	6,219	35	0.6
Gyeongsangnam-do	9,639	297	3.1
Jeju Special Self-Governing Province	701	12	1.7
Total	59,864	1,861	3.1

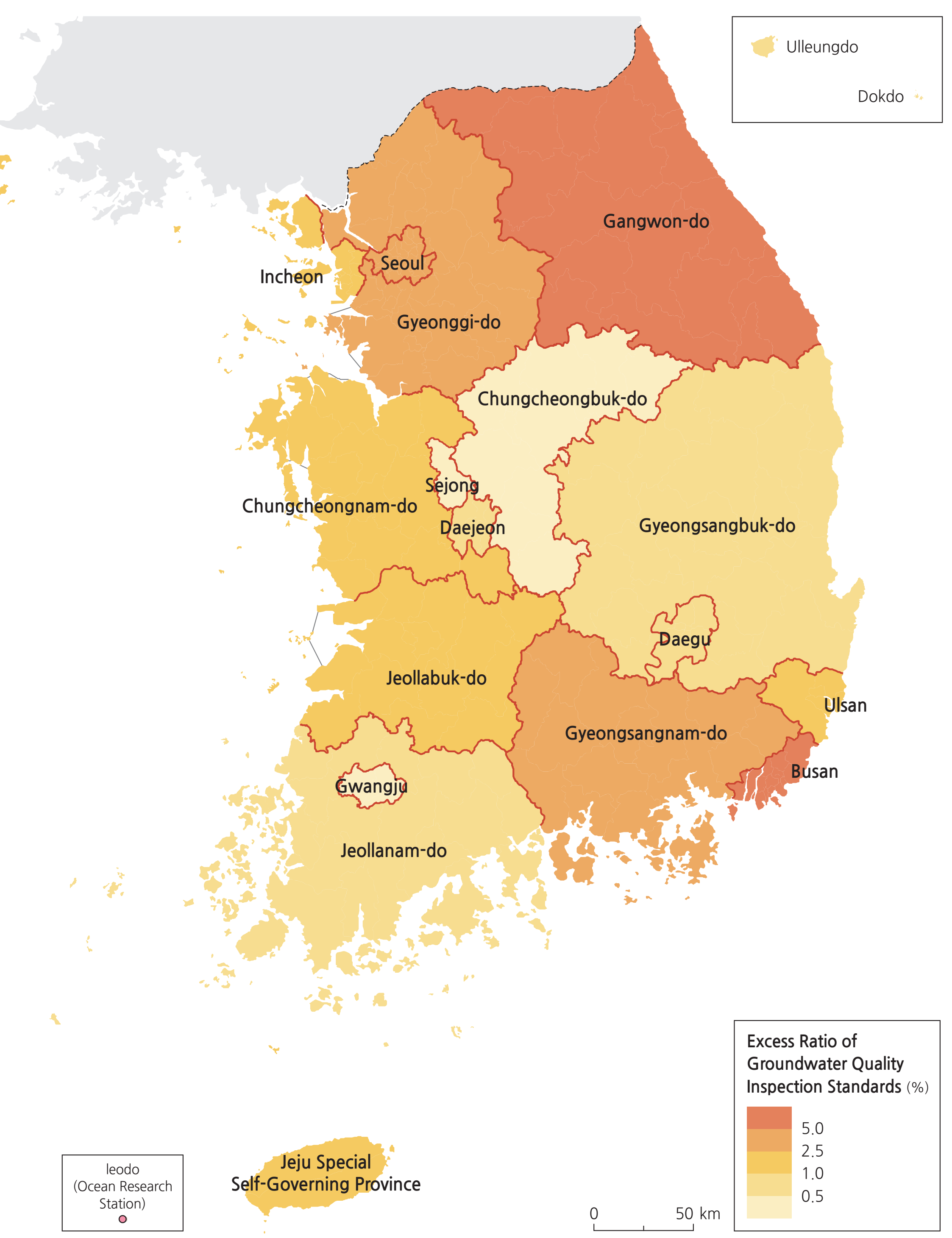
K-water (2019)

Hydrogeological Map



National Groundwater Information Center (2015)

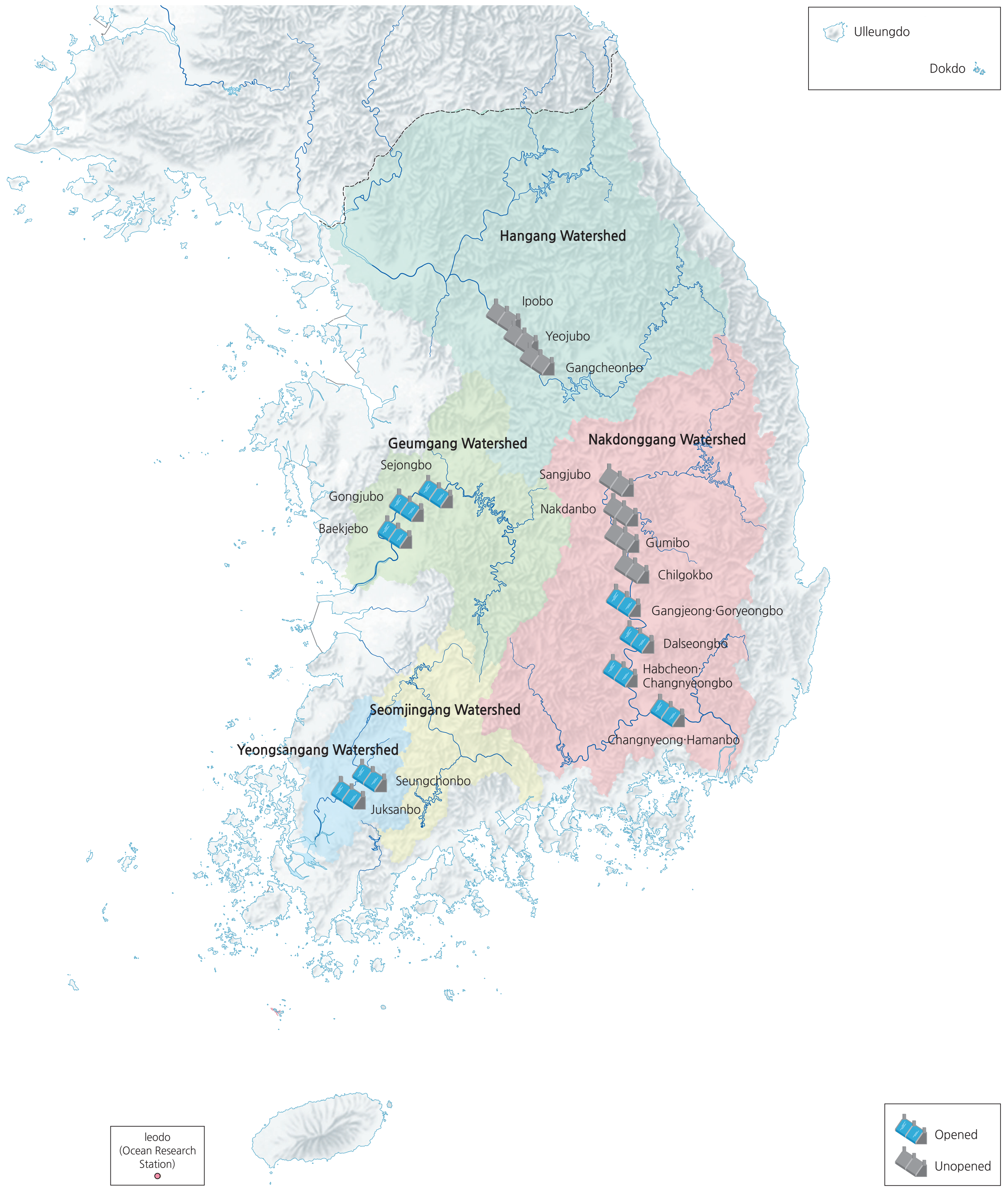
Groundwater Quality by Province



National Groundwater Information Center (2019)

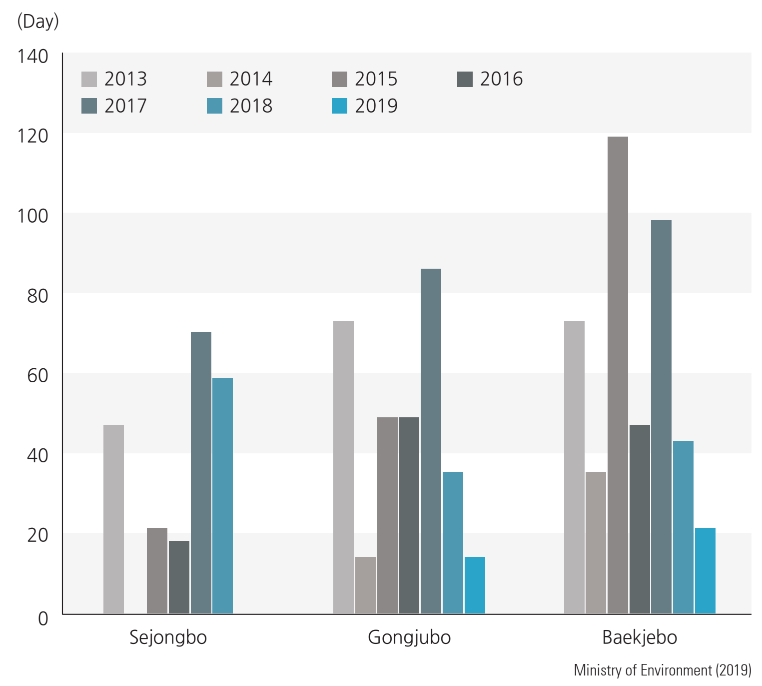
Opening of the Weirs on Four Major Rivers and Change in Water Environment

Status of Opening of the Weirs on Four Major Rivers



Ministry of Environment, Water environment information system (2020)

Changes in the Number of Days to Issue the Stage of Interest at Three Weirs on the Geumgang



Ministry of Environment (2019)

A total of 16 weirs were installed on the Hangang, Nakdonggan, Geumgang, and Yeongsangang by the Four Major Rivers Project, which started in 2008 and was completed in 2012. However, the aquatic ecosystem has changed greatly due to the ecological disconnection of the river, and the river bed has changed due to the accumulation of sediments. The riparian landscape has been severely damaged, and environmental problems such as the frequent occurrence of green algae and deteriorating water quality have emerged. In February 2019, the Public-Private Joint Four Major Rivers Survey and Evaluation Planning Committee comprehensively evaluated environmental performance and economic feasibility, as well as water use and water control. The committee proposed treatment plans for the five weirs installed in the Geumgang and the Yeongsangang. Currently, the President-directed State and the Four Major Rivers Water Management Committee are preparing a decision on a treatment plan to restore the nature of the Geumgang and the Youngsangang.

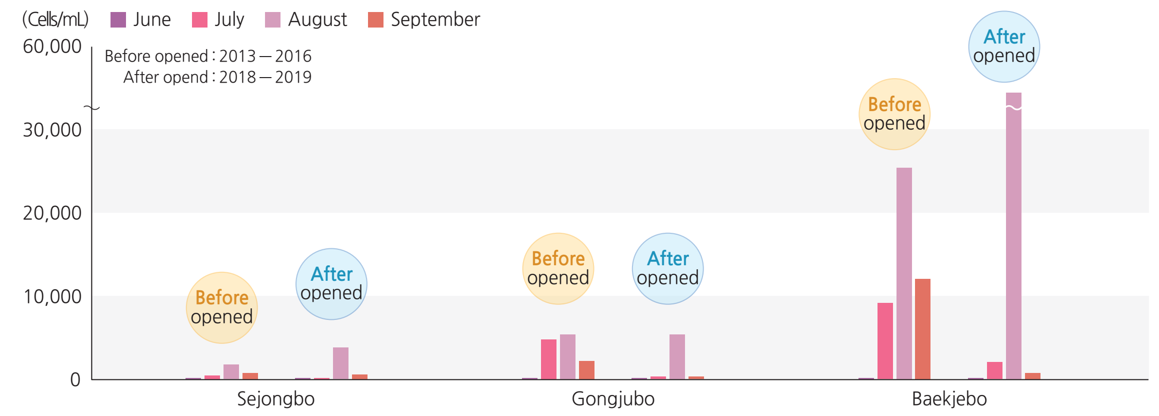
A project monitoring the change in the water environment began through multilateral surveys and analysis in 2011 in the three weirs of Geumgang (Sejongbo, Gongjubo, and Baekjebo). The survey reported the deterioration of the aquatic ecosystems, such as mass mortality of fish (2012), an outbreak of mosquito moss (2014), and discovery of sludge worms and blood worm larvae (2015) after the installation of the weirs. As such environmental problems arose, since 2017 the Survey and Evaluation Planning Committee decided to open weirs to restore the nature of the four major rivers and to monitor changes in rivers due to the opening of the weirs.

The most significant changes due to the opening of the weirs are an increase in the flow rate, a decrease in residence time, and a substantial decrease in algae.

In particular, sludge worms and blood worm larvae in river sediments disappeared, the ratio of sand and gravel increased, and water pollution was significantly improved.

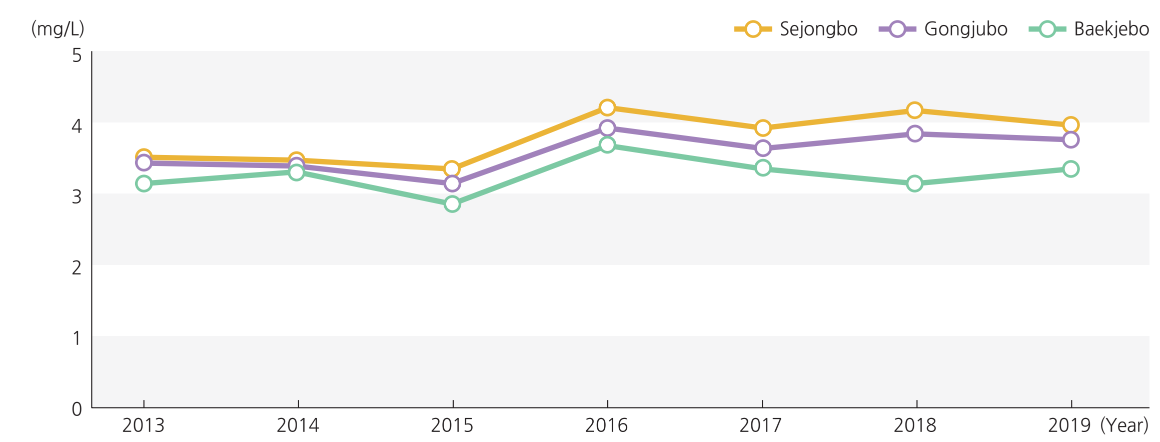
The possibility of natural recovery of the river was confirmed, such as the regeneration of sandbars and rapid growth of vegetation on sediments exposed. Gobiobotia naktongensis, an Endangered Wildlife Class I that has disappeared for the past 10 years due to the Four Major Rivers Project, was discovered downstream of the Sejongbo weir, which was opened first. On the other hand, the water quality index did not improve significantly in the two years following the opening of the weirs. It is believed to be due to external variables such as precipitation and inflow of upstream pollutants. Long-term monitoring is necessary to clearly understand the change in water quality due to the opening of the weirs.

Average Number of Harmful Blue-Green Algae Cells Before and After the Opening of the Weirs during June and September

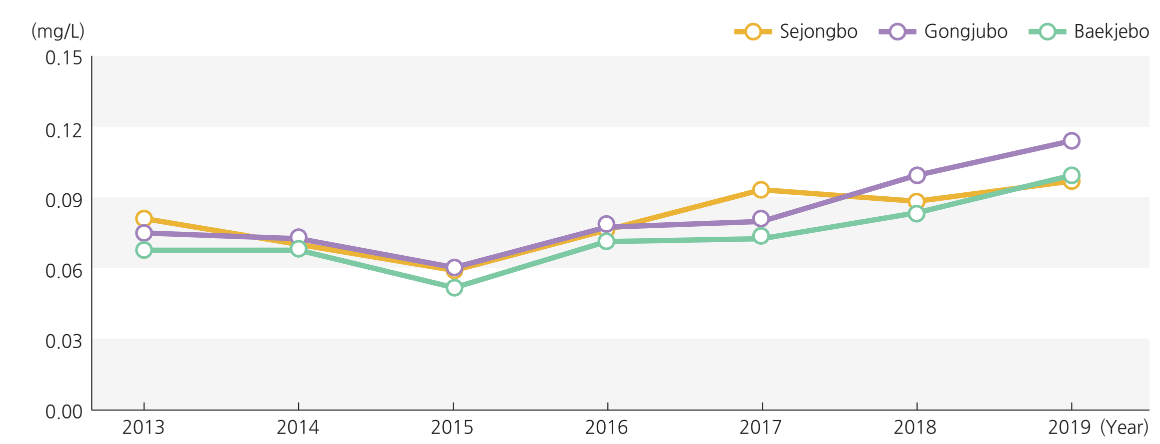


Ministry of Environment (2019)

Changes in Total Nitrogen of the Three Weirs of Geumgang

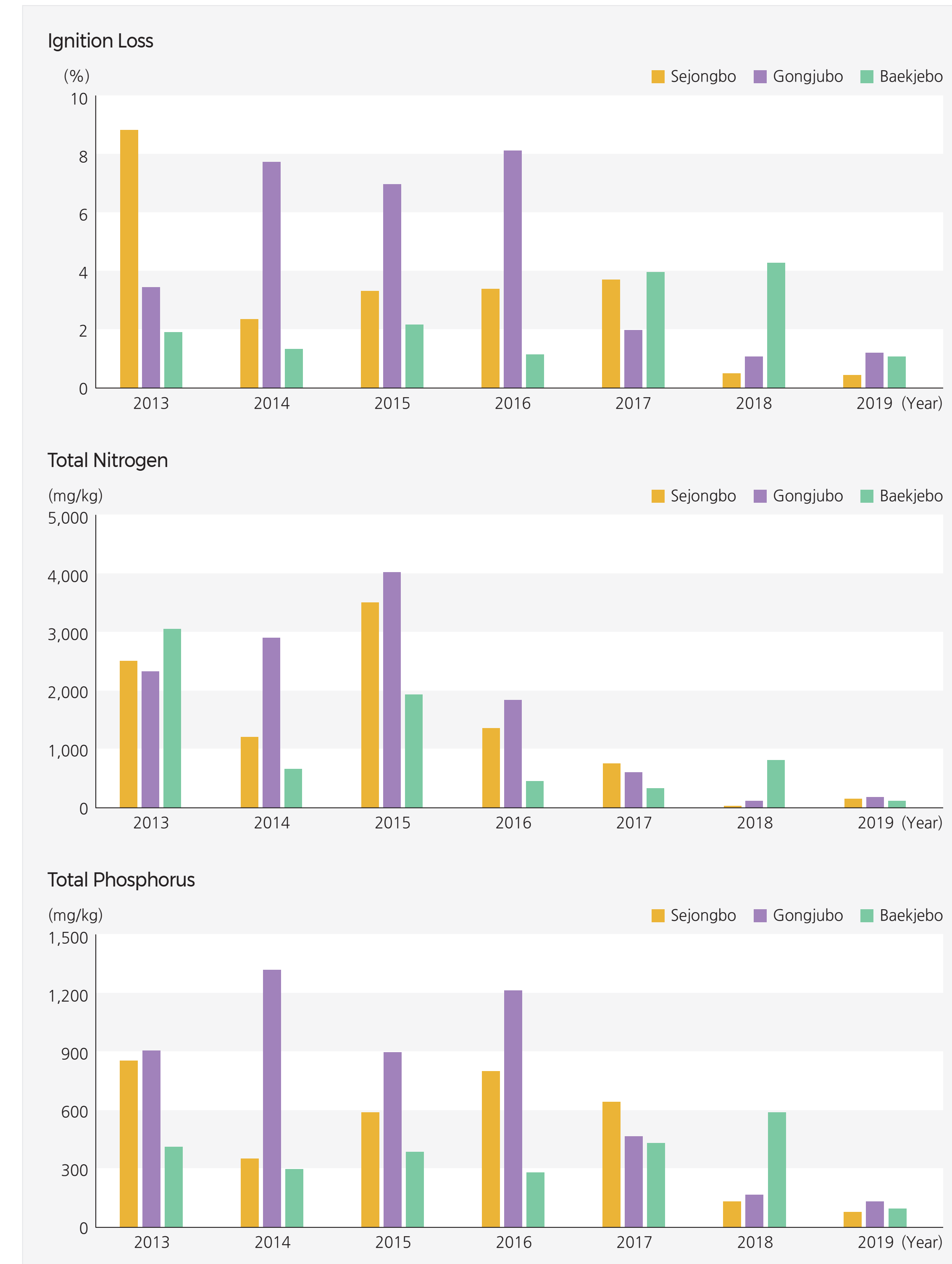


Changes in Total Phosphorus of the Three Weirs of Geumgang



Ministry of Environment (2019)

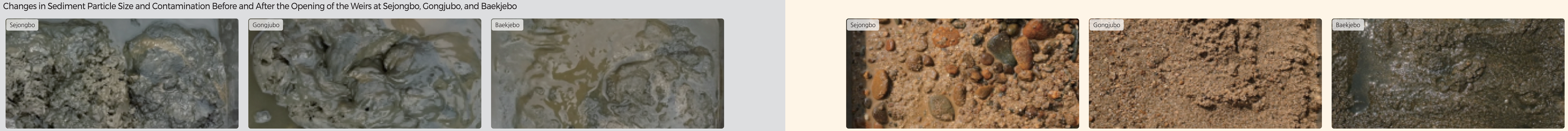
Changes in Sediment Pollution of the Three Weirs of Geumgang



Ministry of Environment (2019)

Changes in Aquatic Ecosystem Before and After the Opening of the Weirs

Changes in Sediment Particle Size and Contamination Before and After the Opening of the Weirs at Sejongbo, Gongjubo, and Baekjebo



Ministry of Environment (2019)