History of Irrigation in Korea
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Ansan, Korea

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Preface

This book describes irrigation-related technologies and institutional systems developed by the old kingdoms of Korea and introduces the irrigation history of Korea in commemoration of the 52nd International Executive Council Meeting and the 1st Asian Regional Conference of International Commission on Irrigation and Drainage (ICID) held in Seoul from 16 to 21 September 2001.

Many carbonized rice kernels and archeological remains of paddy fields make it possible to presume that rice culture started from Bronze Age in Korean peninsular. Irrigation seems to be commenced concurrently with the rice culture as rice plant requires large amount of water during its growing season.

Historical record shows that a large scale reservoir, Byeokgol-je, having capacity to irrigate about 10,000 hectares of farmland was built in 330 A.D. in the Baekje kingdom, and a part of it is still remained. It implies that small scale irrigation systems began to be developed at local or village level at least two thousands years ago.

In Korean history of agriculture, crop cultivation can be classified as paddy field and upland farming depending on the availability of irrigation water. Because rice had been the best crop preferred in the country, the rulers and farmers made great efforts to increase rice yields by providing irrigation water into upland areas all along the history.

Community cooperation and self-help autonomy were initiated and maintained in village level through the intensive irrigation performances all along the history. Irrigation has also contributed to alleviating poverty and making more affluent society by supplying more food as well as by fostering community spirit.

Finally, I deeply appreciate the authors and editors for their great contribution to this publication.

Huh, YooMan, Ph.D.  
Chairman  
Korean National Committee on Irrigation and Drainage
Terminologies

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>bi</td>
<td>monument</td>
</tr>
<tr>
<td>bo</td>
<td>weir or diversion dam</td>
</tr>
<tr>
<td>bu (jim)</td>
<td>a unit to measure land area (100 pa)</td>
</tr>
<tr>
<td>cheok</td>
<td>a unit to measure length</td>
</tr>
<tr>
<td>cheon</td>
<td>creek</td>
</tr>
<tr>
<td>chon</td>
<td>village</td>
</tr>
<tr>
<td>chong</td>
<td>a unit to measure land area (1,000 pa or 10 bu)</td>
</tr>
<tr>
<td>do</td>
<td>province or island</td>
</tr>
<tr>
<td>dong</td>
<td>community</td>
</tr>
<tr>
<td>du</td>
<td>a unit to measure grain volume</td>
</tr>
<tr>
<td>gun</td>
<td>county</td>
</tr>
<tr>
<td>guk</td>
<td>a nation</td>
</tr>
<tr>
<td>gyeol</td>
<td>a unit to measure land area (10,000 pa or 100 bu)</td>
</tr>
<tr>
<td>je</td>
<td>dam or embankment</td>
</tr>
<tr>
<td>je-eon</td>
<td>embankment</td>
</tr>
<tr>
<td>ji</td>
<td>pond or reservoir</td>
</tr>
<tr>
<td>mal</td>
<td>a unit to measure grain volume</td>
</tr>
<tr>
<td>man</td>
<td>bay</td>
</tr>
<tr>
<td>myeon</td>
<td>a division of gun</td>
</tr>
<tr>
<td>pa (jum)</td>
<td>a unit to measure harvest and land area</td>
</tr>
<tr>
<td>ri</td>
<td>township</td>
</tr>
<tr>
<td>san</td>
<td>mountain</td>
</tr>
<tr>
<td>seom</td>
<td>a unit to measure grain volume</td>
</tr>
<tr>
<td>si</td>
<td>city</td>
</tr>
<tr>
<td>sok (mut)</td>
<td>a unit to measure land area (10 pa)</td>
</tr>
</tbody>
</table>
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Introduction

It is assumed that agricultural activities started around the 60th century B.C. in the Korean Peninsula. It was known that agriculture dominated life style started during the bronze age (10th - 4th B.C.) when bronze was introduced by the Huns and rice, barley, beans and other crops were cultivated. The iron civilization (Iron Age) which started around the 4th century B.C. in the Korean peninsula greatly contributed to improving agricultural technology and installing irrigation structures such as Bo (weir) and Je-eon (reservoir) for crop irrigation.

Rice was the major crop cultivated in Korea from her ancient history. All irrigation water was primarily used in paddy fields for rice cultivation and only small portion of the water was used to partially irrigate upland cultivation.

According to ancient Korean history, irrigation of rice paddy was an indispensable practice. This is well shown by a large-scale reservoir, Byeokgol-je in Gimje, Jeonbuk province, which was built in 330 B.C. by King Biryu of Baekje Kingdom during the Three Kingdoms Era. To start with this structure many similar irrigation facilities such as Hwangdeung-je, Hapdeok-je, Nul-je, etc. were built during the Three Kingdoms Era. Such structures evidence the high level of Korean ancestors’ knowledge and techniques in building embankments.

During the medieval age of Unified Silla Kingdom and Goryeo Kingdom (7th - 14th century A.D.), land and water management projects were conducted under the government supervision. The government had a strong will and intention to construct and restore irrigation facilities in order to increase farmland and production.

During the modern age of Joseon Kingdom, the government conducted large-scale reservoir restoration and land reform projects. Levees and weirs were also constructed to prevent flood and to provide irrigation water.

This book introduces geography, geology, water resources, and agriculture during early, medieval and modern ages of Korea. Also presented are changes of societal
and agricultural situations during each historical age, examples of major irrigation facilities and conclusion.

Chapter I covers geography, climate, agriculture and historical backgrounds.

Chapter II presents agricultural and irrigation systems during the early ages of the Three Kingdoms. This chapter introduces examples of irrigation facilities such as Byeokgol-je, Hwangdeung-je, Nul-je, Si-ji, Uirim-ji, Susan-je, and Hapdeok-je.

Chapter III describes agricultural situation, land policy, land reclamation, and irrigation facilities of the Unified Silla Kingdom and Goryeo Kingdom and introduces examples of restored Gonggeom-ji of Goryeo Kingdom.

Chapter IV discusses agricultural situation, land ownership and land management, and development and management of irrigation facilities during modern ages. Also discussed are agricultural weather measurement and organization, measured weather data, invention and distribution of rain gages. This chapter presents development of reservoirs, weirs, irrigation canals, water pumps, construction of flood control systems such as levees during the Joseon Kingdom and irrigation systems development and management during the Japanese colonial period. Examples of irrigation facilities introduced in this Chapter are Eojidun-bo, Gyeong-ugung-bo, Chukman-je, Unam-je, and Dae-a dam.

Chapter V describes the summary and conclusion including major achievements during Joseon Dynasty.

It is desired that the introduction of the above-mentioned development processes of irrigation and irrigation technology during early, medieval and modern ages of Korea contributes to the future development of Korean irrigation systems. Also desired is to help the members of the national committees of the ICID (International Commission on Irrigation and Drainage) understand the development of irrigation technologies in Korea.
Chapter I

Overview

1. Geography and Geological Characteristics

Korean peninsula is located in the northeast part of the Asian Continent (33~43 degrees latitude North and 124~132 degrees longitude East). The country borders with China and Russia on the north divided by the Yalu and Duman Rivers and faces Japan across the East Sea. The peninsula is approximately 300 km from east to west and the longest distance from north to south is about 1,070 km. The country was divided at the 38th parallel North at the end of the 2nd World War in 1945. The southern part of the peninsula is administered by the Republic of Korea (ROK) and the northern one by the Democratic People’s Republic of Korea (DPRK) which are commonly known as South Korea and North Korea, respectively.

The total area of the peninsula is 222,196 square kilometers where South Korea occupies 99,434 square kilometers, approximately 45% of the total area. Almost 70% of the peninsula is mountainous landscape mainly located in the north and east. Majority of the plains is located in the south and west of the peninsula. Most major rivers originate from the north and east and discharge to south and west.

Various geological formations cover the Korean peninsula, from pre-Cambrian period to Quaternary formations. More than half of the peninsula is formed with metamorphic sequence and the basement composed of the Mesozoic. There are more non-marine strata than marine sediments in the formation.

Soils of the peninsula are primarily composed of weathered residuum of sandy and acidic soils, and alluvial soils are uncommon. Due to the widely distributed granite in the peninsula, sandy soils are the most common type of soils formed by the weathered granite saprolite. Also because of the humid climate and the sandy soils the high drainage has caused loss of alkalinity in the soils. This condition along with acid condition of granite has developed acid soils. Because of the shallow weathered soil layer, the World Soils map classifies the peninsula’s soils as forest soils such as podzolic soil, brown forest soil and red-yellow podzolic soil, according to genetical classification system.
2. Climate and Water Resources

Geographically Korea is located in the far east of the Northern Hemisphere. The country belongs to a temperate region, which has well defined four seasons; spring, summer, fall and winter. It has relatively cold temperatures in winter, and humid and hot in summer, showing different seasonal variation from the European countries on the similar mid-latitude. Because of the influence of the migratory high atmospheric pressure the weather is generally clear and dry in spring and fall. The mean annual temperature is 6~16 degrees Celsius depending on the region. The regional temperature variation is high. Except for the mountainous region the mean annual temperature is 10~16 degrees Celsius. The warmest month is August with the mean monthly temperature of 25 degrees Celsius and the mean monthly temperature of the coldest month, January is minus 0.7 degrees Celsius.

Generally the northwestern monsoon is stronger than the southeastern monsoon, especially from December to February. Wind is mild in September and October when southeastern monsoon changes to northwestern monsoon. Humidity is highest in July, showing 80~90% nationally and lowest in January and April showing 30~50%. In September and October, it is pleasant with humidity of 75%. Rainy spell in early summer starts in the later part of June and continues for about 30 days. Sometimes rainy spell occurs in the first part of September. Typhoon occurs mainly in the period from June to October, and 2 or 3 typhoons directly and indirectly affect on the Korean peninsular.

The average annual precipitation is 1,274 mm in South Korea and 1,040 mm in North Korea. The overall average is 1,245 mm, 1.3 times of the world average annual precipitation of 973 mm. The average annual water resource in volume is 126,700 million cubic meters (2,900 cubic meters per person) in the South and 127,100 million cubic meters (5,300 cubic meters per person) in the North, totaling 253,800 million cubic meters. Per capita water resource in volume is 10-20% of the world average of 26,800 cubic meters per person. The regional variation of the precipitation is high with 550 mm to 1,600 mm and the annual variation of the precipitation is from 700 mm to 1,700 mm. Precipitation variation is seasonally more extreme. The rainy season from June to September receives about 2/3 of the total precipitation and only 1/5 occurs during dry season from October to March. This extreme seasonal variation is the main culprit of occasional summer floods and droughts in spring and fall in the Korean peninsula.

Flash floods commonly occur due to the shallow soil in forest and steep slope of riverbeds. The seasonally high summer precipitation causes high stream flow and low stream flow occurs during drought period. The average annual runoff rate is approximately 60% of the precipitation with estimated 55% in the South and 65% in the North. The annual water use in South Korea is 30,100 million cubic meters; 50%
for agricultural uses, 29% for municipal and industrial uses and 21% for stream maintenance. Most of the water is supplied from streams and reservoirs, and the ground water supplies only 8%.

3. Agriculture

Before the country was modernized the majority of the Korean had been engaged in agriculture. The population in 1997 was 45,991 thousand in South Korea and 23,855 thousand in North Korea, totally 69,846 thousand. And the total population involved in agriculture is 4,468 thousand or 9.7% in South Korea and 8,802 thousand or 36.9% in North Korea, totaling 13,270 thousand.

There are a total of 3,916 thousand hectares of farmland. The land area of 1,739 thousand hectares or 44% of the total is rice paddy and remainder, 2,177 thousand hectares is used for upland cultivation. It is estimated that 60% of the land is rice paddy in South Korea but 29% in the North. The large upland agriculture in the North is due to the North Korea’s hilly landscape.

<table>
<thead>
<tr>
<th>Types</th>
<th>Total</th>
<th>South Korea</th>
<th>North Korea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>3,916 (100%)</td>
<td>1,924 (100%)</td>
<td>1,853 (100%)</td>
</tr>
<tr>
<td>Paddy</td>
<td>1,739 (44%)</td>
<td>1,163 (60%)</td>
<td>586 (29%)</td>
</tr>
<tr>
<td>Upland</td>
<td>2,177 (55%)</td>
<td>761 (40%)</td>
<td>1,267 (71%)</td>
</tr>
</tbody>
</table>

Note: 1997 statistics

Rice is the main diet in Korea and most paddy fields cultivate rice. The 5-year average rice production from 1994 to 1998 is 39.9 metric tons per hectare. Per hectare rice yields between South Korea and North Korea are highly different, 48.2 metric tons in the South and 24.5 metric tons in the North. Self-sufficiency rate of grain is very low. The 5-year average major grain (rice, barley, maize, etc) production in 1994-1998 is 5,853 thousand tons in the South and 3,728 thousand tons in the North. Rice is 88% of the total grain production in the South, while maize and rice are 50% and 35% of the total grain produced in the North, respectively.

History shows that irrigation water was primarily supplied to cultivate rice. Barley, maize and vegetables were the major upland agricultural products. These crops were mainly cultivated during the rainy season and no irrigation was used.
4. Historical Background

General historical background of Korea is briefly presented to help the readers understand the following chapters which discuss irrigation of different historical periods of Korea. Korea has her own language and culture completely different from the neighboring China and Japan, and she is composed of a single people. With a slight variation, the territory of Korea is limited within the Korean peninsula. People started to live in the peninsula during the Paleolith, 700 thousand years ago. The Neolith period started in 6000 B.C. and they made clothes using weaving and supplied food through hunting, fishing, gathering along with cultivating millet and barnyard grass, etc.

The Bronze Age started in the 10th century B.C. in the peninsula. Social classes emerged through increased agricultural production, which was the base of formation of a nation. During this period agricultural production expanded to cultivating rice, barley, beans, and sorghum. Based on the bronze civilization the first organized nation, Go-Joseon (Old Joseon) started in 2333 B.C. and continued until 108 B.C. The territory of Go-Joseon ranged from northern part of the Korean peninsula to northeastern China.

The Iron Age started in the 4th century B.C. and iron tools for agriculture first appeared from the 1st century B.C. Through the development of iron civilization, numerous new tribal nations emerged in the Korean peninsula and vicinity, i.e. Buyeo, Goguryeo, Okjeo, Dong-ye and Samhan. The Samhan was located in the west and south of the peninsula. Rice was the major diet of the Samhan. The Samhan prayed for a good harvesting in May and celebrated harvesting in October. These activities prove that they fully supported rice cultivation.

Strong establishment of these tribal nations in the 2nd to 3rd centuries was the base of beginning of the Three Kingdoms, Goguryeo, Baekje, and Silla. The Three Kingdoms were highly civilized based on agriculture. Goguryeo Kingdom was located in the mountainous region of the north and primarily cultivated upland crops such as millet, and Silla and Baekje Kingdoms were located in the plains of the south where rice was the major crop cultivated.

The Silla Kingdom unified the other two Kingdoms in 676 A.D. to become the Unified Kingdom of Silla. It is common to call the historical period before the Unified Kingdom of Silla “the early age civilization”.

After a short chaotic period the Goryeo Kingdom was founded and merged the Unified Kingdom of Silla and reunited the peninsula in 936 A.D. Goryeo Kingdom continued until 1392 A.D. The period which covers the Unified Kingdom of Silla and Goryeo Kingdom is called medieval age.
Goryeo Kingdom was followed by Joseon Kingdom. Joseon Kingdom continued prosperity for 500 years until the Imperial Japan colonized the Kingdom in 1910 A.D. Joseon Kingdom fully promoted agriculture through a national policy which improved food production. The Kingdom increased farmland, improved irrigation facilities and seeds and developed new agricultural techniques such as a new transplanting method and double cropping. The Kingdom promoted sericulture and apiculture, etc. Special crops such as fruits, medicinal plants, cotton, etc. also were cultivated and new agricultural techniques and hybrid seeds were developed to meet the climatic conditions of the Kingdom. The Kingdom invented rain gage to measure precipitation scientifically and flow stage meters were installed at major streams to measure stream levels. Also invented was land survey instrument (Injui).

During the Japanese colonial period from 1910 to 1945, Japan enforced various projects to supply food for the 2nd World War. These projects include land survey and irrigation projects, etc. With the support of the large landowners, irrigation associations were formed, and they operated and maintained newly constructed irrigation facilities. After the independence from Japan in 1945 the peninsula was divided into two nations, capitalism nation of the Republic of Korea (ROK) in the south and communism nation of the Democratic People’s Republic of Korea (DPRK) in the north.
Chapter II

Early Times
(Before the 6th Century A.D.)

1. Beginning of Agriculture

1) Introduction of Agriculture and Rice Farming to Korea

According to the relics excavated in Korea it is estimated that the settled life style started 600 thousand years ago. Agriculture dominated life style started during the Bronze Age (10th - 4th century B.C.). This was estimated by a carbon test of chaff sharpened rice kernels found in a peat bog at Gawaji, Ilsan, Goyong-gun, Gyeonggi province which proved that the rice was 5,000 years old. And this is also supported by carbonized rice kernels (about 3,000 years old) found in an ancient relic at Heun-am-ri, Yeoju-gun, Gyeonggi province (Figure 2-1).

Remains of a paddy field during the Bronze Age were found in Mugeo-dong, Ulsan and Majeon-ri, Nonsan. The size of the field plot was about 3 m square or irregular shapes, and irrigation ditches were also found (Figure 2-2).

The iron civilization (4th century B.C.) introduced by the Han people through the east Manchuria provided a momentum for a rapid development of knowledge and techniques of cultivating rice.
Also the oldest rice kernels were found at a peat bog in Soro-ri, Oksan-myeon, Cheongwon-gun, Chungbuk province in March 1998. The results of DNA analysis of the rice kernels showed that they are 13 thousand years old. This may change the theory of the beginning and evolution of rice in Korea and is important information for research in Korean agriculture and irrigation.

2) Samhan Civilization (Confederated Kingdoms of Samhan, the Three Han States; 75 B.C. - 100 A.D.)

In parallel to the Iron Age, Samhan States (Mahan, Jinhan, Byeonhan) consisting of 78 tribal states were established. Geographically Mahan was composed of 54 tribal states located Gyeonggi, Chungcheong, and Jeolla provinces, Jinhan was composed of 12 tribal states in Youngnam region at the east of the Nakdong river, and Byeonhan centered at Gimhae near the Nakdong river which is composed of 12 tribal states. At this period the nation of a castle town or federation formed allied countries. This was the time that small countries were united to allied countries that eventually evolved to full-scale ancient nations.

During this period the nations had well developed civilization through the advanced civilization imported and introduced from China, which drastically
improved technologies as well as political, economical, and overall social conditions. Especially production of iron was well developed along the Nakdong river as shown in the trading relationship between Samhan and Japan. This is shown from the remains of iron manufacturing facilities and related relics found at Seongsan shell mound in Masan, Majang-ri of Gapyeong, Yonggang-ri of Yeongheung, and Odong of Hoeryeong. The iron manufacturing technology was well advanced and widely used to make weapons as well as farming tools and tools for daily life. This helped rapid development of agriculture and rice cultivation in the peninsula.

It is thought that early irrigation water source facilities were primarily to diverge stream flows by installing weirs across the stream. Later, to meet the increased demand of water to cultivate rice, embankments were built to store water in reservoirs. There were no historical record of embankment, but small embankments might have been built in this period. Also the advancement of agriculture started such national traditions as praying to God and celebration for harvesting in spring and fall, respectively with various offerings. During Samhan period the people prayed to their ancestors in spring (Dan-o in lunar calendar May) and fall (October in lunar calendar) for good harvesting which became the national tradition in Korea. Table 2-1 shows the changes and formation of tribal nations in Korea and chronology of the surrounding nations.

2. Agriculture and Irrigation Facilities of Samguk (the Three Kingdoms) Era (57 B.C. - 668 A.D.)

1) Societal and Agricultural Situations

In 1932 ancient iron plows and forked rakes were excavated along with rice hulls from an ancient Silla tomb near Hwang-o-ri, Gyeongju (Figure 2-3). These tools are very similar to the modern ones. This evidences that rice farming technology in the 4th - 5th century was well advanced.

Other evidences showing rice farming systems were recorded in Silla Bongi (Silla section) of Samguksagi. The book recorded that Byeokgol-je was built in 330 A.D., but Nul-je and Hwangdeung-je were not known for its exact date of construction. During the Three Kingdoms era, along with the construction of Cheong-je (563 A.D.) many reservoirs and irrigation facilities were constructed and restored.

At the same time, droughts and floods were serious national problems. It was indispensable national activities to build irrigation facilities along with dikes to control such natural disasters and to protect rice production. It was also shown that the Three Kingdoms pursued to improve people’s living standard and crop production by minimizing the damages due to droughts and floods.
### Table 2-1 Changes and formation of tribal nations in early ages and chronology of the surrounding nations

<table>
<thead>
<tr>
<th>Period</th>
<th>Korea</th>
<th>China</th>
<th>Japan</th>
<th>The West</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B.C.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5,000</td>
<td>Xia (21st-10th Century B.C.)</td>
<td>Jomon Period</td>
<td>Early Mesopotamia</td>
<td>Egyptian Kingdoms</td>
</tr>
<tr>
<td>2,000</td>
<td>Shang Dynasty (1766-1122)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oracle bones</td>
<td></td>
<td></td>
<td>Egyptian Kingdoms</td>
</tr>
<tr>
<td></td>
<td>Chou (1122-256)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proto-feudal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1,000</strong></td>
<td>Spring and Autumn Era (770-476)</td>
<td></td>
<td>Greek Civilization</td>
<td>Founding of Rome (735)</td>
</tr>
<tr>
<td><strong>500</strong></td>
<td>Ancient Joseon</td>
<td>Warring States Era (475-221)</td>
<td></td>
<td>Socrates (469-399)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Qin Dynasty (221-206) Great wall</td>
<td></td>
<td>Alexander the Great (356-323)</td>
</tr>
<tr>
<td><strong>200</strong></td>
<td>Buyeo (206 BC -25 AD)</td>
<td>Eastern Han Dynasty (25-220)</td>
<td></td>
<td>First Punic War (264-211)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The era of the three kingdoms (Wei, Shu, and Wu) (220-280)</td>
<td></td>
<td>Second Punic War (219-201)</td>
</tr>
<tr>
<td><strong>100</strong></td>
<td>Confederated Kingdoms of Samhan (Three Han States)</td>
<td>Siji (Historical record), Silk route</td>
<td></td>
<td>Julius Caesar (101-44)</td>
</tr>
<tr>
<td><strong>A.D.</strong></td>
<td>Three Kingdoms: Silla (57 BC - AD 935)</td>
<td></td>
<td></td>
<td>Birth of Jesus Christ</td>
</tr>
<tr>
<td></td>
<td>Goguryeo (37 BC - AD 668)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Baekje (18 BC - AD 660)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>200</strong></td>
<td>Gaya (42-562)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>400</strong></td>
<td>Byeokgoi-je (330), Nul-je, Hwangdeung-je</td>
<td>Northern Dynasties (386-581)</td>
<td></td>
<td>Christianity established a state religion of Roman Empire (392), Roman Empire split in two (395)</td>
</tr>
<tr>
<td><strong>500</strong></td>
<td>Si-je (429)</td>
<td>Southern Dynasties (420-589)</td>
<td></td>
<td>Anglo-Saxons established in Britain (449)</td>
</tr>
<tr>
<td><strong>600</strong></td>
<td>Ulrim-ji (540), Hapdeog-je</td>
<td>Sui Dynasty (581-618) Grand Canal</td>
<td>Asuka Period (552-645)</td>
<td>Mohammed (570-632)</td>
</tr>
<tr>
<td><strong>700</strong></td>
<td>Balhae Kingdom (669-928)</td>
<td>Tang Dynasty (618-906)</td>
<td>Nara Period (645-794)</td>
<td>Hegira (622)</td>
</tr>
<tr>
<td></td>
<td>Unified Silla Kingdom (668-935)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Based on the historical evidence of rice culture in ancient times, it is assumed that many embankments for storing water were built. This is also shown by the size of embankments built in the ancient times. During this time it may be assumed that many irrigation facilities were constructed but most of the historical records show repair or rehabilitation of these facilities instead of new construction.

2) Goguryeo Kingdom (37 B.C. - 668 A.D.)

The Goguryeo was a country of hunting and animal grazing, as its geographical condition was mountainous and lack of fertile low lands. But Goguryeo expanded its territory from Manchuria to northern part of the Korean peninsula. This made the Kingdom start an agricultural society. But no historical records of irrigation works of the Kingdom have been found. However, it was recorded that agriculture and trading were promoted and agriculture became the base of life style during the late Goguryeo (583 A.D.).
3) **Baekje Kingdom (18 B.C. - 660 A.D.)**

Baekje Kingdom was established by a group of people from Buyeo in Manchuria who migrated to the south and settled in Baekje, one of 50 tribal nations of Mahan. The Kingdom conquered Mahan and later unified other neighboring tribal nations in 350 A.D. and became a Kingdom. Baekje Kingdom was located in the southwestern part of Korean peninsula that has adequate climate and geographical location for agriculture. With the advantage of these conditions the Kingdom was well advanced in agricultural civilization.

The following shows the historical records of agriculture and irrigation facilities of Baekje Kingdom.

- In 33 A.D., the first rice culture in Baekje Kingdom was recorded in the History Book of the Three Kingdoms.
- In 116 A.D., a high rainfall for 10 days in June caused overflow of the Han river and loss of houses. King ordered an official to repair damaged rice paddy fields.
- In 222 A.D., the King ordered an official in February to repair embankments damaged during the flood of May in the year 221 A.D.
- In 242 A.D., promoted the people to reclaim land, develop paddy fields for rice cultivation.
- In 330 A.D. Byeokgol-je was constructed in Gimje, which was the first record of large reservoir construction.
- In 510 A.D., constructed embankments and ordered returning of the idled people to farming.

Hwangdeung-je was constructed to supply irrigation water to the low lands of the Okgu-gun and the Iksan-si areas. Even though it was not known for its exact date of construction it was built around the middle Baekje Kingdom. This reservoir construction supports the theory that the Kingdom’s agrarian society was strongly interested in rice culture and irrigation works.

Baekje Kingdom was the center of rice culture among the Three Kingdoms and technology to construct embankments for irrigation was highly developed in the Gimje plain. The embankments such as Byeokgol-je, Nul-je, Hwangdeung-je, etc. were constructed during the early and middle ages of the Kingdom which show that the Kingdom was the center of agriculture and irrigation in the Korean peninsula. The embankment technology of Baekje Kingdom was introduced to Japan along with ceramic techniques and other civilization.
4) Silla Kingdom (57 B.C. - 668 A.D.)

The main power of Silla Kingdom was Saro-guk, one of the 12 tribal nations of Jinhan. Saro-guk was a union of 6 tribal groups located in present Gyeongju area. The national policy of Silla Kingdom was based on the phrase “Agriculture is the foundation of the nation” and the Kingdom pursued to develop agriculture through irrigation and land reclamation. According to a record in Samguksagi the Kingdom (18 A.D.) prepared for droughts and famine through distribution of food and grains and exemption of taxes to relieve the people’s losses.

The following shows the historic records of agriculture and irrigation facilities of Silla Kingdom.

- In 144 A.D., repaired embankments and ordered to reclaim more lands.
- In 429 A.D., repaired Si-je.
- In 523 A.D., ordered an official to repair embankments.
- In 536 A.D., constructed Cheong-je in Yeongcheon, Gyeongbuk province.
- In 540 A.D., constructed Uirim-ji in Jecheon, Chungbuk province.
- In 790 A.D., mobilized 7,000 people from 7 provinces including Jeonju to restore Byeokgol-je in Gimje.

Uirim-ji has been well preserved and is still used to supply irrigation water. Compared to Baekje Kingdom, Silla Kingdom did not have large plains. This could be the reason that the reservoirs of the Silla Kingdom were small but numerous. Construction of small-scale reservoirs and weirs along the Nakdong river began during this Kingdom. There were numerous small ponds scattered around Gyeongbuk province but most of them have no record of construction except Cheong-je in Yeongcheon.

3. Examples of Irrigation Facilities

1) Byeokgol-je of Gimje

The name Byeokgol during Baekje Kingdom was the expression of Byeotgol (village of rice). Byeokgol-je is the oldest and the largest reservoir recorded in Korea. According to Samguksagi it was constructed during the King Biryu of Baekje Kingdom (330 A.D.).

The following shows historical changes of the Byeokgol-je.

- In 790 A.D., restored by mobilizing the people from seven districts including Jeonju.
- In 1010 - 1031 A.D., restored to the original shape.
- In 1143 A.D., King ordered to destroy the restored structure due to cursed words by a shaman.
- In 1415 A.D., mobilized 10,000 people and 300 government officials from each surrounding county to repair the structure and installed a monument of restoration (the epitaph of the monument is recorded in a history book, Dongguk-yeojiseungnam).
- In 1416 A.D., established a farm cultivated by soldiers for military uses near the downstream of the embankment.
- In 1420 A.D., a flood broke the embankment and inundated 2,000 hectares of paddy fields.
- In 1428 A.D., the Byeokgol-je was abandoned because of several reasons such as potential flood damages, etc. Since then no restoration of the embankment was performed due to various disasters, i.e. Sahwa (political massacres), Dangjaeng (political feud), Imjin-waeran war (Japanese invasion), Horan war (Manchurian invasion), and other man-made disasters.
- In 1684 A.D., moved the restoration monument to the top of the embankment and later moved to the south peak of Sinteol-me (hill).
- In 1925 A.D., the original shape of the embankment was badly damaged during construction of irrigation canals as a part of irrigation project. Currently the original embankment stretches 3.3 km along north-south with two stone columns in Pogyo-ri and Wolseung-ri of Buryang-myeon, Gimje-si. When Dongjin Land Improvement Association used the embankment as a main irrigation canal site the original embankment was badly damaged and the reservoir area was cultivated.
- In 1975 A.D., partial excavation started to restore the gates. Through the excavation of two gate sites it was found that the embankment construction was extremely large for the period and advanced technology was used.
- In 1980 A.D., during the rearrangement of the Byeokgol-je site the monument of restoration was moved to the current location.
- In 1998 A.D., opened the Museum of Byeokgol-je Irrigation Relics.

a. Embankment dimensions

The technique to build Byeokgol-je was described in the restoration monument installed in 1415 A.D. The
epitaph of the Byeokgol-je recorded in the Dongguk-yeojiseungnam (a history book of Joseon Kingdom) shows that the embankment cross section was a trapezoidal shape with 21 meters of bottom width, 10 meters of top width and a height of 5.7 meters. Based on the total length of 3,250 meters, the total volume of the embankment is 248,625 cubic meters. The total area of the reservoir water surface was 37 square km. These numbers coincide with the data shown in the Samguksagi.

b. Spillways and water intake gates

Byeokgol-je has five water intake gates. Among them those in north and south (left and right) respectively functioned as spillways which were called Suyeo-geo and Yutong-geo. The three gates in the middle were used to take the stored water and called Jangsaeng-geo, Jungsim-geo, and Gyeongjang-geo, respectively.

The water was conveyed to southwest of Mangyeong as well as northeast of Buan and west of Tae-in. Each intake gate was composed of two granite stone columns (5.5 meters above ground surface and 1.5 meters under ground) spaced in 4.2 meters. Each column has a groove of 20 cm wide and 12 cm deep where a gate made of plank moves up and down for operation. The bottom of the gate area is covered with large stones to prevent scouring (Table 2-2 and Figure 2-5).

2) Hwangdeung-je of Iksan

Hwangdeung-je is one of three reservoirs along with Byeokgol-je and Nul-je. The period of construction is not known but it is estimated around the middle period of Baekje Kingdom (Munheonbigo - Yeojigo: History book). According to the history book the embankment was 1,100 meters long and it irrigated a total of 3,300 hectares. Record shows that it was restored in 1790 A.D. Because it had been ignored for a long time the reservoir lost its original function due to sedimentation. In 1909 Imik Irrigation Association restored and enlarged the embankment and renamed it as Yogyo-je.
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3) Nul-je of Gobu, Jeong-eup  
(nicknamed Soejeong-i bo)

The construction period of Nul-je is not known except it is assumed during the period of the Three Kingdoms. But Yeongju-ji recorded that it was built by King Gyeonhwon of the Hu-Baekje Kingdom. Nul-je is one of three embankments, called major three reservoirs (Sam-je) along with Hwangdeung-je and Byeokgol-je. The area around the Nul-je is considered as the origin of rice culture since a piece of plain earthenware with a mark of rice seed was discovered at Sosan-ri, Jusan-myeon, Buan-gun which is 4 km from Nul-je (Source: Book 2 of the Donghak Munhwa of Jeong-eup).

Table 2-2  Dimensions of Byeokgol-je

<table>
<thead>
<tr>
<th>Meaning of the name</th>
<th>Byeo (paddy) + gol (village) + je (embankment or dike)</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Historical Monument #111</td>
<td></td>
</tr>
</tbody>
</table>

| Length of dike | 3,250 m |
| Dike area | 187,471 m² |
| Number of gates | Five |
| Irrigated area | 10,000 ha (Gimje, Jeong-eup, Buan, Sintae-in) |
| Present location | Yongseong-ri and Wolseung-ri of Buryang-myeon, Gimje-si |
| Water Sources | 1. Wonpyeong-cheon |
| (Stream) | 2. Duwol-cheon |
| Construction method | Embankment: red pine tree frame covered with gravel and clay |
| Gate column | Stone columns which weigh around 8 tons, 5.5 m high and distance between columns was 4.2 m. |
| Gate construction | Column has a groove of 20 cm wide and 12 cm deep where a gate made of zelkova plank moves up and down to operate |
| Bottom of gate | Stone cover with melted iron filled the gaps between stones |
| Remains | Gate columns |

**Figure 2-6** Yuji-bi (Site Monument) of Nul-je
The downstream side of Nul-je was the Gobu bay where fresh water and salt water meet. Because of the location of Nul-je, an embankment was used to prevent the intrusion of the seawater from the bay for the purpose of cultivation of rice. Dimensions of the Nul-je were: 1,400 meters long, 16,000 meters of the total water line of the reservoir, total water surface area of 600 hectares. It had three gates.

In 1418, the first year of King Sejong, there was a restoration work of the Nul-je with 11,580 people for 2 months. However, the flood in August next year damaged the embankment and it was abandoned without further restoration. In 1916 A.D. Gobu Irrigation Association cultivated the reservoir and embankment area. There are two commemorative monuments where the Nul-je was located.

4) Si-je (location unknown)

Si-je was constructed in 429 A.D. and embankment was 3,918 m long. The location is not known.

5) Uirim-ji of Jecheon

Uirim-ji is located at Mosam-dong of Jecheon-si, Chungbuk province. According to a legend the pond started when a musician Ureuk built a dike to hold water from the Mt. Yongdu (871 meters high) during King Jinheung of Silla Kingdom (540 - 575 A.D.). About 700 years later a chief official of the county, Park Uirim mobilized people from four nearby counties and built 3 layers of stone and earth walls around the pond to prevent water leakage. He also built intake gate with several layers of large stones and carved his name on the stone.

The original name of Uirim-ji was Im-ji. In the 11th year of King Seongjong of Goryeo Kingdom (992 A.D.), the King changed names of gun and hyeon. Jecheon was renamed as Uiwon-hyeon or Uicheon. Later one of the old names of Jecheon, “Ui” was added to Im-ji to be called Uirim-ji. The original shape of Uirim-ji is currently preserved. The length of Uirim-ji is relatively short, only 160 m but because of its deep depth of 8~13 meters the reservoir could supply irrigation water up to 400 hectares. When Uirim Irrigation Association was founded dimensions of Uirim-ji were: 16 hectares of total water surface, 2,000 meters of total water line, 12 meters of maximum water depth, and 277 hectares of irrigation area. During King Sejo (1455 - 1469 A.D.) of the Joseon Kingdom, Chechalsa (a supervisory official), Jeong Inji, visited the site and recruited 1,500 soldiers from three provinces to restore the embankment. Since then there were three repair works in 1910, 1948 and 1973.
Uirim-ji was extremely important in the area where water for agriculture was not sufficient. Cheongjeon-dong was located adjacent to the embankment which totally relied on the water from Uirim-ji for its agriculture. During the restoration work it was found that the gate was made of an Onggi (a pottery). This finding provided important information to study agricultural techniques of the Three Kingdoms. Currently the reservoir is used for recreation instead of irrigation water supply. There are various recreational facilities around the reservoir which made the reservoir a wonderful scenic area. The pavilions such as Yeongho-jeong and Gyeongho-ru, many years old pine and willow trees and a 30 meters high natural water fall are famous. The great Gayageum (a string musical instrument) musician, Ureuk spent his late years in the area. There are a rock named Ureuk-dae (nicknames; Jebi-bawi, Yeon-am, and Yong-bawi) where Ureuk played Gayageum and a water spring named Ureuk-jeong where he drank.

6) Susan-je of Milyang

Susan-je is located at Susan-ri, Hanam-eup, Milyang-gun, Gyeongnam province and it was a large reservoir with its shoreline length of 8 km. It was built for rice paddy irrigation. The intake gate of the Susan-je has been designated as a local com-
memorative relic No. 102. An embankment was built for Susan-je to prevent over-
flow of the river and a Dun-jeon (a farm cultivated by soldiers who are regularly
assigned to serve in an area) was established in the area. It was recorded that
General Kim Banggyeong of Goryeo Kingdom ordered to restore the Susan-je to
increase food production for a military expedition to Japan (Dongguk-yeojiseung-
nam). Later Chechal-sa, Jo Seokmum, in 1467 (13th year of King Sejo) mobilized
people from the surrounding 9 villages to repair the embankment and established a
Gukdun-jeon (National land) to cultivate rice.

After the Imjin-waeran
war (Japanese invasion) the
area was abandoned and lat-
er changed to marshland.
Relics such as shell mounds,
old tombs, dolmens, etc.
found in the area support an
assumption that the area was
an old settlement near a nat-
ural lake fed by the
Nakdong river. The Susan-je
was located at the side of
large river, different from
other reservoirs, that the
embank-ment was inundated
frequently. The other names of the Susan-je are Susan-guknongso, Susan-je gukdun-
ji during the early Joseon Kingdom, and Susan-ji or Guknong-ho during the late Joseon
Kingdom.

7) Cheong-je of Yeongcheon

Cheong-je was a reservoir located in Geumho-myeon, Yeongcheon-gun. It was
one of the old embankments located on the east of the Geumho river, approximately
6 km south of Yeongcheon-eup. At the north of the reservoir Cheong-je-bi (monu-
ment) is located. The old monument recorded about the Cheong-je built during the
Three Kingdoms in 536 A.D. The second monument recorded about the repair work
of Cheong-je in 796 A.D. and provided important information on ancient irrigation
practices.

The monument was made of a natural stone plate. Originally it did not have a
cover stone and it is not known whether it had a supporting stone. The front side
recorded the information about the repair work of the Cheong-je but the rear side is
not legible.
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The monument recorded the objective of setting the monument, dimensions of the reservoir, number of people worked, ranking, responsibility, names of officials in charge, and methods to mobilize people from local and central regions. It is recorded that “The King sent a Yangnaesa (a supervisory official) in the 14th year of Jeongwon of Tang dynasty of China (798 A.D.) to mobilize 14,800 people to rebuild a reservoir, and this monument was set to commemorate the event”.

Table 2-3  Location and content of Cheong-je-bi

<table>
<thead>
<tr>
<th>Name of monument</th>
<th>Yeongcheon Cheong-je-bi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designation</td>
<td>National Treasure No. 517 designated in 1969</td>
</tr>
<tr>
<td>Location</td>
<td>San 7-1, Donam-dong, Yeongcheon-si, Gyeongbuk province</td>
</tr>
<tr>
<td>Content</td>
<td>A both-side monument which recorded in Idu (an ancient writing in Silla Kingdom) about the reservoir built in the 6th century A.D. of Silla Kingdom</td>
</tr>
</tbody>
</table>

8) Hapdeok-je of Dangjin

Hapdeok-je was a reservoir supplying irrigation water to Hapdeok plain. The reservoir was located in Hapdeok-eub, Dangjin-gun. The reservoir has been changed to cultivated field but the embankment has been well preserved in its original shape. The construction date is not known but it is estimated around the Late Three Kingdoms period (554 - 641 A.D.). According to the legend, King Gyeonhwon of the Hu-Baekje Kingdom built the embankment to feed about 12,000 soldiers stationed in the area when he was engaged in a war against King Wanggeon of the Goryeo Kingdom.

The dimensions of Hapdeok-je are: 1,771 meters long and 4 meters high embankment, 8~9 km total reservoir circumference, 6.5 meters crest height, 11~18 meters embankment bottom width. It is the second largest irrigation structure after Byeoogol-je. The water surface area of the reservoir in full stage is 102 hectares and it supplied irrigation water to a total of 720 hectares. With one spillway and 9 intake
structures the reservoir could supply water in various directions.
The historical changes of Hapdeok-je after its construction are as follows.

- In 1474, the embankment was repaired after damage by a flood in 1473.
- In 1506, the King Yeonsan-gun of Joseon Kingdom granted cultivation at the inside of the reservoir.
- In 1630, the reservoir was dredged.
- In 1768, the chief official of Hongju, Hong Ryangho mobilized 11,000 people to dredge and repair the Hapdeok-je.
- In 1788, two parts of damaged embankment were repaired by 4,553 people from the county area and 3,500 from the surrounding areas.
- In 1792, it was repaired by 3,000 people from the county area and 3,500 from the surrounding areas.
- In 1800, a chief official, Kim Iho restored the embankment.
- In 1851, the reservoir was dredged.
- In 1913, protected the inside slope of the embankment with vertical stone walls.
- In 1925, restored the spillway with concrete.
- In 1956 - 1959, reconstructed the inside of the embankment with sloped stone walls.
- In 1964, converted to rice paddy area due to construction of Yedang reservoir in the upstream.