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2012 Modularization of Korea's Development Experience:

Korea's River Basin Management Policy

2013

Ministry of Land, Infrastructure and Transport

KDI SCHOOL
KDI School of Public Policy and Management

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Korea's River Basin Management Policy

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Preface

The study of Korea's economic and social transformation offers a unique opportunity to better understand the factors that drive development. Within one generation, Korea has transformed itself from a poor agrarian society to a modern industrial nation, a feat never seen before. What makes Korea's experience so unique is that its rapid economic development was relatively broad-based, meaning that the fruits of Korea's rapid growth were shared by many. The challenge of course is unlocking the secrets behind Korea's rapid and broad-based development, which can offer invaluable insights and lessons and knowledge that can be shared with the rest of the international community.

Recognizing this, the Korean Ministry of Strategy and Finance (MOSF) and the Korea Development Institute (KDI) launched the Knowledge Sharing Program (KSP) in 2004 to share Korea's development experience and to assist its developing country partners. The body of work presented in this volume is part of a greater initiative launched in 2010 to systematically research and document Korea's development experience and to deliver standardized content as case studies. The goal of this undertaking is to offer a deeper and wider understanding of Korea's development experience with the hope that Korea's past can offer lessons for developing countries in search of sustainable and broad-based development. This is a continuation of a multi-year undertaking to study and document Korea's development experience, and it builds on the 40 case studies completed in 2011. Here, we present 41 new studies that explore various development-oriented themes such as industrialization, energy, human resource development, government administration, Information and Communication Technology (ICT), agricultural development, land development, and environment.

In presenting these new studies, I would like to take this opportunity to express my gratitude to all those involved in this great undertaking. It was through their hard work and commitment that made this possible. Foremost, I would like to thank the Ministry of Strategy and Finance for their encouragement and full support of this project. I especially would like to thank the KSP Executive Committee, composed of related ministries/departments, and the various Korean research institutes, for their involvement and the invaluable role they played in bringing this project together. I would also like to thank all the former public officials and senior practitioners for lending their time, keen insights and expertise in preparation of the case studies.

Indeed, the successful completion of the case studies was made possible by the dedication of the researchers from the public sector and academia involved in conducting the studies, which I believe will go a long way in advancing knowledge on not only Korea's own development but also development in general. Lastly, I would like to express my gratitude to Professor Joon-Kyung Kim and Professor Dong-Young Kim for his stewardship of this enterprise, and to the Development Research Team for their hard work and dedication in successfully managing and completing this project.

As always, the views and opinions expressed by the authors in the body of work presented here do not necessary represent those of the KDI School of Public Policy and Management.

May 2013

Joohoon Kim

Acting President

KDI School of Public Policy and Management

Contents | LIST OF CHAPTERS

Summary 12

Chapter 1

Introduction 15

1. Prologue 16
   1.1. Purpose of Research 16
   1.2. Study Contents 17
2. Korean River Basin 18

Chapter 2

Background and History of Korean River Basin Maintenance and Management Policy 23

1. Colonial Years under Japan to Post Emancipation: Modern Water Resource Development 24
   1.1. Restoration of River Basin Based on Water Control 24
2. Modern River Basin Governance System Development (1960-1970s) 25
   2.1. Comprehensive River Basin Management Framework (1960-1970s) 25
   2.2. Introduction to the 10-Year Comprehensive Water Resource Development Plan 27
   2.3. Hydro Power and Organization of the Management System 30
   2.4 .The Four Major River Basin Investigation Projects 31
3. Construction of Multi-Purpose Dam and Comprehensive Development by River Basins (1970-early 1990) 33
   3.1. Comprehensive Development of Four Major River Basins 33
4. Comprehensive Management of Water Resources (Late 1990s-2000s) 36
   4.1. Comprehensive Management Based on Water Level and Sector 36
   4.2. Increased Demand for Comprehensive Management of Water Resources 38

5. Four Major River Area Comprehensive Development and Long-term Development Plan (1970-1990s) ····· 40
5.1. Four Major River Area Comprehensive Development Plan (1971-1981) ····· 41
6. Long-term Comprehensive Development of Water Resources – Basic Plan (1981-2001) ····· 42
6.1. Plan Necessity ····· 42
6.2. Results and Accomplishments ····· 43
7. 1990-2000: Comprehensive Management of Water Resources and Environment - Friendly River Basin Development ····· 44
7.1. Long-term Comprehensive Water Resources Plan (1991-2011) ····· 44
7.2. Plan Accomplishments ····· 46
7.3. Long-term Comprehensive Plan for Water Resources - Amending and Supplementing (1997-2011) ····· 46

Chapter 3

Major Projects ····· 49
1. Long-term Comprehensive Water Resources Plan (2001-2020) ····· 50
1.1. Purpose and Characteristic of the Plan ····· 50
2. Long-term Comprehensive Water Resource Plan (2006-2020) ····· 55
2.1. Background of Plan and Implementation Strategy ····· 55
3. Chunggyechun Restoration Project ····· 58
3.1. Background of the Project ····· 58
3.2. Project Summary and Implementation Method ····· 59

Contents | LIST OF CHAPTERS

Chapter 4

Evaluation of River Basin Maintenance and Management Policy within the Framework of Water Resource Development ····· 63

1. Water Resource Development and Korean Economic Development ····· 64
2. Multi-Purpose Dam Construction and Maintenance of River Basins ····· 66
   2.1. Unique Characteristics of Korea's Water Resources and Dam Development ····· 66
   2.2. Formation Process of Multi-Purpose Dam Construction ····· 66
3. Details and Evaluation of Major Multi-Purpose Dam Projects ····· 67
   3.1. Sumjin River Multi-PurposeDam ····· 67
   3.2. Nam River Multi-Purpose Dam and its Reinforcement ····· 67
   3.3. Soyang River Multi-Purpose Dam ····· 68
   3.4. Andong Multi-Purpose Dam ····· 68
   3.5. Daechung Multi-Purpose Dam ····· 69
   3.6. Chungju Multi-Purpose Dam ····· 69
   3.7. Hapchun Multi-Purpose Dam ····· 70
   3.8. Chuam Multi-Purpose Dam ····· 70
   3.9. Nakdong River Mouth Dyke ····· 71
   3.10. Imha Multi-Purpose Dam and Youngchun Water Corridor ····· 71
   3.11. Booan Multi-Purpose Dam ····· 72
   3.12. Hwaengsung Multi-Purpose Dam ····· 73
   3.13. Milyang Multi-Purpose Dam ····· 73
   3.14. Yongdam Multi-Purpose Dam ····· 73
   3.15. Youngwol Multi-Purpose Dam ····· 74

4. Dam Location ····· 74
4.1. Multi-Purpose Dams and Accomplishments ····· 75
4.2. Contribution to Economic Development ····· 77
4.3. Water Resource Development: Accomplishments and Tasks ····· 77

Chapter 5

Lessons and Recommendations ····· 83

1. Lessons of Korean Water Resource Development Experience for Developing Countries ····· 84
1.1. Contribution to Water Supply for Economic Growth, Flood Control and Electric Supply ····· 84
1.2. Contribution to Economic Development through Government Led Large Scale Civil Engineering Projects ····· 85
1.3. Improved Urban Image ····· 85
2. Recommendations ····· 86
2.1. Korean Government ····· 86
2.2. ODA for Developing Countries ····· 86

References ····· 87

Contents | LIST OF TABLES

Chapter 1

Table 1-1 Korean River System (Rivers by River System) ····· 20

Chapter 2

Table 2-1 Main Points of River Basin Law Proclaimed in 1961 ····· 26
Table 2-2 10-Year Comprehensive Water Resource Development Plan (1966-1975) ····· 27
Table 2-3 Major Contents of Four Major River Basin Investigations ····· 31
Table 2-4 Dam Storage ····· 34
Table 2-5 Supply of Consumable Water in Korea ····· 34
Table 2-6 Korea's Water Resource Usage ····· 35
Table 2-7 Korea's Paradigm Change for Water Resource ····· 37
Table 2-8 Collection of Income from Rivers ····· 39
Table 2-9 Comprehensive Long-term Water Resource Plan (1991-2011) ····· 45
Table 2-10 Long-term Comprehensive Plan (1997-2011): Revised Contents ····· 47

Chapter 3

Table 3-1 History of Revisions and Supplementation of Long-term Comprehensive Water Resource Plan ····· 51
Table 3-2 Ten-Year Plan for Water Resource Development in 1970s ····· 57

Contents | LIST OF FIGURES

Chapter 1

Figure 1-1 Flow of the Study ····· 18
Figure 1-2 Korean River Basin Systems ····· 19

Chapter 3

Figure 3-1 Background and Development of Chunggyechun Restoration Project ····· 59

Summary

This report reviews the impact of Korea's river basin maintenance and management policies on overall national land development and preservation along with industrial and agricultural development in Korea. Water resource development, which was initiated during the economic development period of 1960-1980 in Korea, pursued environmentally-friendly river maintenance and dam development, which was implemented on the basis of water use and water control. Development of dams brought about economic development and an upgrade in quality of life and national land value. Water resource development policy can be classified according to quality and quantity. In the beginning, the general emphasis was on quantitative development policy, which was intended to solve economic problems. However, after some economic progress, Korea confronted environmental problems such as degradation of water quality by realigning its water resource development policy to improving the quality of water in a more environmentally friendly way.

Water resource development in Korea in the early period was pursued with a mission for modernization by achieving economic development and controlling the annually recurring problems of flood, draught and ensuing food supply crises. With an objective to achieve a fundamental solution for such problems, the government focused on water resource development policy that emphasized construction of large multi-purpose dams as well as dams for industrial, agricultural and consumer use. However, with economic growth and the improvement of people's quality of life, there has been a shift in water resource development policy responding to an increase in people's awareness of environment-friendly lifestyles as well as preservation of the ecological system and cleaner living environments.

The goal of this research is to present a basic direction and recommendation for water resource policy in preparation for the 21st century by reviewing the history of water resource policy, as well as noting the experience gained from past errors and evaluating the currently pursued policies.

Water resource policy in Korea can be classified in the following way: the modernization period dating from Japanese imperialism to post liberation; the restoration period after the Korean War; the water resource development period dating from the Five-Year Economic Development in 1962 when multi-purpose dam construction was pursued with a view to preventing floods and supplying agricultural and industrial water; and finally, the transition period dating from the 1980s where the paradigm on water resource policy changed to adopt a more environment-friendly focus. This research reviews the history of river maintenance and development policy, examines and evaluates the projects and policies adopted during each period aforementioned, summarizes the relevant laws, systems and implementation structures, and puts forth lessons to be learned from the experience.

In chapter 2, the policies and projects adopted during each period are summarized in the following five ways: first, the river basin maintenance and management policy that began with modern water control projects and dam construction, initiated under Japanese rule; second, the river basin maintenance policy that was focused on water control and water use, conducted by ODA after the Korean War; third, the background of the Ten-Year Comprehensive Water Resource Development policy that was initiated during the 1960s; fourth, modernization of river basin management methods pursued in the 1970s and the Four Major River Basin Comprehensive Development Plan that was also planned during that time; and fifth, comprehensive water resource management and environment-friendly river basin maintenance and restoration dating from 1990 to the 2000s.

In Chapter 3, the main contents of Chapter 2 are analyzed in more detail in terms of projects and backgrounds of each project pursued in each period.

In Chapter 4, the river basin maintenance and management policy pursued within the framework of water resource development policy Korea is evaluated. Furthermore, the water development policy based on construction of multi-purpose dams and river basin maintenance, as well as its impact on Korea's economic development is examined in detail. The environment-friendly river basin management policy that was pursued as a measure to handle unusual floods or draughts caused by climate change is examined in detail to determine the accomplishment and limitation of such policies. Further, the Chunggyechun restoration project, which is considered a successful case, and other similar river basin maintenance projects are also reviewed in detail.

Finally, in Chapter 5, the connections between Korea's river basin management policy and national economic and social development are examined and lessons are extracted. The possibility of developing countries' adopting Korea's water resource development policy are also reviewed in detail.

Chapter 1

Introduction

1. Prologue
2. Korean River Basin

Introduction

1. Prologue

1.1. Purpose of Research

The policy for maintenance and management of river basins in Korea has been responsible for preserving and enhancing overall land and promoting sustainable agricultural and industrial development. In Korea, water resource development had been pursued by maintaining environment-friendly river basin and dam construction, which was focused on water use and water control. Such water resource development brought about economic development, enhanced quality of life, and readjusted national land value.

Water resource development policy can be divided into two parts: quality and quantity. Generally, at the outset, the emphasis of development policy is on the quantitative side of securing livelihood, industry, and agricultural water – all of which address economic problems. However, once a certain level of economic development has been achieved, environmental issues surface, and the policy shifts to corresponding changes in qualitative water resource development.

In the beginning, water resource development was pursued with a broad objective of modernization and economic development to solve the fundamental problems of flooding, draughts, and the food supply problems resulting from such natural disasters. Thus, water dams specially designed to address water supply problems for livelihood, industry and agriculture and large scale multi-purpose dams were constructed as a matter of priority. However, as the nation prospered, people's demand for higher quality of life increased in terms of healthier lifestyles, cleaner environment, and preservation of natural life, which resulted in an increasing change in the focus of water resource policy to environment-friendly use of water resources.

This study seeks to shed light on the historical direction of Korean water resource policy and recommend changes for the 21st century by reviewing the history of water resource policy implemented thus far. The difficulties experienced because of flooding, draughts, water quality incidents and other disasters, as well as changes in the water resource environment through the years will, combined with today's water resource policy, provide assistance to setting the direction and recommending changes for future water resource policy.

1.2. Study Contents

The history of Korean water resource policy can be categorized into various periods: Colonization under Japan with traditional water resource development; restoration after the Korean war; water resource development period under the Five-year Economic Development Plan starting in 1962 – where the primary focus was industrialization emphasizing construction of multi-purpose water dams to prevent flooding, supplying electricity, and water for agriculture, etc.; and the transition period from the 1980s where the paradigm has shifted to environment-friendly river basin maintenance.

The contents of the study include the following: a review of the history of the policy which shifted from water resource development to river basin maintenance and management; review of water resource policies and business implementation adopted for the different periods; review of the legal framework, implementation system, its background and contents, and evaluation; and lessons to be learned from such experiences and recommendations for the future.

Chapter 2 reviews policy and business implementation of water resource development in five different periods: traditional water dam construction during the colonial era under Japan; maintenance of river basins after the Korean War; the years leading up to the Ten Year Comprehensive Water Dam Construction Plan pursued in the 1960s; modernization of the river basin maintenance method pursued in the 1970s, as well as the Comprehensive Development of the Four Major River Plan that was put together during this time; and the combined management and environment-friendly maintenance and restoration policy from the 1990s to the 2000s.

In Chapter 3, the background and businesses implemented during the different periods are reviewed in detail.

Chapter 4 seeks to evaluate the river basin maintenance and management policies within the framework of water resource development that was followed in Korea. The limits and accomplishments of the Korean water resource policy are assessed by analyzing the Chunggyechun restoration project, which is considered a success story, as well as analysis of other similar river basin maintenance projects.

Finally, in Chapter 5, the economic and social lessons learned from the Korean river basin maintenance and management policy and the possibility of applying these experiences to developing countries are discussed in detail.

Figure 1-1 | Flow of the Study

2. Korean River Basin

According to the River Act, a river is a water way formed mainly by rain and snow, is closely related to public interest, and is categorized in as a national and regional river based on governance. Rivers can also include facilities and the river basin. <Table 1-1> illustrates the Korean River system. [Figure 1-2] illustrates the Korean River Basin. A National River is differentiated from a Regional River based on if its governance is national or local.

A river basin is the extent or area of land where surface water from rain and melting snow or ice converges to a single point, usually at the exit of the basin where the waters join another body of water, such as a river, lake, reservoir, estuary, wetland, sea, or ocean.

Other terms that are used to describe a river basin are catchment, catchment area, catchment basin, river area, river basin and water basin. In North America, the term watershed is commonly referred to as a river basin (although in other English-speaking countries, it is used only in its original sense, to mean a river divide). River basins drain into other river basins in a hierarchical pattern, with smaller sub-river basins combining into larger river basins.

In closed river basins, the water converges to a single point inside the basin, known as a sink, which may be a permanent lake, dry lake, or a point where surface water is lost underground. The river basin includes both the streams and rivers that carry the water as well as the land surfaces from which water drains into those channels, and is separated from adjacent basins by a river divide.

The river basin acts as a funnel by collecting all the water within the area covered by the basin and channeling it to a single point. Each river basin is separated topographically from adjacent basins by a geographical barrier such as a ridge, hill or mountain.

Drainage basins are similar but not identical to hydrologic units, which are drainage areas delineated so as to nest into a multi-level hierarchical drainage system.

Figure 1-2 | Korean River Basin Systems

Table 1-1 | Korean River System (Rivers by River System)

BY river system	Basin area (km^2)	Length (km)	River grade	No.	River length (km)
Total	90,938.26 (*100,755.09)		Total National River Regional River	3,837 62 3,775	29,840.55 2,997.32 26,843.23
Hangang	25,955.60 (*35,770.41)	494.44	Total National River Regional River	699 14 685	7,111.48 818.70 6,297.78
Nakdonggang	28,884.21	510.88	Total National River Regional River	781 11 770	7,305.38 835.43 6,469.95
Guumgang	9,912.15	597.79	Total National River Regional River	488 7 481	8,761.04 481.50 8,279.54
Seomjingang	4,911.89	228.88	Total National River Regional River	288 8 280	1,980.62 288.00 1692.62
Yeongsangang	8,467.88	129.5	Total National River Regional River	189 5 184	1,269.57 191.88 1,078.24
Anseongcheon	1,666.78	59.50	Total National River Regional River	103 4 99	614.15 86.84 527.51
Sapgycheon	1,649.59	58.60	Total National River Regional River	98 3 95	616.54 68.02 558.52
Mangyeonggang	1,504.85	80.88	Total National River Regional River	70 3 67	586.72 68.00 518.72
Hyeongsangang	1,140.00	81.95	Total National River Regional River	30 1 29	280.40 36.00 244.40
Dongjingang	1,129.80	51.08	Total National River Regional River	37 4 33	492.76 69.80 422.98
Taehwagang	646.96	46.02	Total National River Regional River	59 1 58	308.70 11.27 297.48

BY river system	Basin area (km^2)	Length (km)	River grade	No.	River length (km)
Tamjingang	508.58	55.07	Total National River Regional River	36 1 35	206.46 34.52 171.94
Yangyang Namdaecheon	474.80	54.00	Total National River Regional River	3 - 3	102.48 - 102.48
Samcheak Ohsipcheon	894.72	56.80	Total National River Regional River	3 - 3	64.50 - 64.50
Youngdeok Ohsipcheon	874.50	55.18	Total National River Regional River	7 - 7	90.16 - 90.16
Seo Nakdonggang	286.08	26.40	Total National River Regional River	18 3 15	125.28 38.98 86.30
gangneung Namdaecheon	258.65	82.86	Total National River Regional River	6 - 6	55.90 - 55.90
Other	18,289.59	-	Total National River Regional River	912 2 910	4,918.49 29.18 4,889.81

Source: Ministry of Land, Transport and Maritime Affairs, River Management GIS, K-Water, WAMIS

Chapter 2

Background and History of Korean River Basin Maintenance and Management Policy

1. Colonial Years under Japan to Post Emancipation: Modern Water Resource Development
2. Modern River Basin Governance System Development (1960-1970s)
3. Construction of Multi-Purpose Dam and Comprehensive Development by River Basins (1970-early 1990)
4. Comprehensive Management of Water Resources (Late 1990s-2000s)
5. Four Major River Area Comprehensive Development and Long-term Development Plan (1970-1990s)
6. Long-term Comprehensive Development of Water Resources – Basic Plan (1981-2001)
7. 1990-2000: Comprehensive Management of Water Resources and Environment-Friendly River Basin Development

Background and History of Korean River Basin Maintenance and Management Policy

1. Colonial Years under Japan to Post Emancipation: Modern Water Resource Development

1.1. Restoration of River Basin Based on Water Control

Under Japanese rule in early 1910 and several decades thereafter, Korea's river basin development was based on securing a food supply by controlling floods and thereby protecting agricultural land. Thus, the water resource development plan was based on investigating river basins and activating construction of river banks to protect agricultural land.

1.1.1. Investigation of River Basins

This period can be summarized as a time when Japan initiated adoption of modern methods of civil engineering and water gate research. Japan conducted a nationwide investigation on water resources in order to establish Korea as its base for food supply and heavy industry manufacturing. From 1914 to 1927, Japan established a river basin development plan based on a study of fourteen major river basins across Korea and published a report on this finding.

1.1.2. Construction of Dams

Japan built many large-scale hydropower dams around the northern part of Korea with a view to industrializing Korea as a food supply base. Japan conducted two major investigative studies on 25 major river basins throughout Korea during 1915-1939. Until 1945, a total of 135 dams were built in the southern part of Korea. In particular, the Soopoong Dam located

in the northern Korean region was built in 1937 and utilized technology from the American Hoover Dam. This dam was considered one of the advanced technologies of its time. Japan had sent nine civil engineers to the U.S. to acquire the technology and knowhow from the American Boulder Dam and Grand Coulee Dam.

Japan also built many irrigation dams in pursuit of land cultivation to increase food supply. According to statistics for 1941, Japan built 256 dams in 1920-1941 and, among these, there were 63 dams that measured higher than 15 meters. Under Japanese rule until 1945, there were 87 irrigation dams that were built in the southern part of Korea that measured higher than 15 meters.

1.1.3. Amalgamation (Fusion) of Water Control and Water Use

With the onset of World War II in the 1940s, water control based water management underwent significant changes. Supplying industrial water, hydropower and consumable water became an important matter as society became more industrially developed. Thus, the government looked into ways to consume – as well as to control – water. However, such amalgamation of water control and water-use based studies was sporadic or region-focused and often a short-term effort.

2. Modern River Basin Governance System Development (1960-1970s)

2.1. Comprehensive River Basin Management Framework (1960-1970s)

The Korean river basin management framework began with river basin registration in 1961. River basin system management focused on water supply for daily living, agricultural and industrial usage, as well as flood control. The Government of Korea classified rivers into national rivers (2,997.32km) and regional rivers (26,843.23km). A national river is managed by the central government and is usually financed by the national government. Local governments carry out maintenance projects.

The regional rivers are financed and maintained by the local governments. Exceptions are expensive projects such as canal construction and river bank construction. These projects are financed 60-70% by the national government.

2.1.1. Legislation of River Basin Law (1961)

The fact that a comprehensive water resource development plan was established and implemented during the 1960-70s is a significant accomplishment for this period. The River Basin law was legislated on December 30, 1961. The main points of the legislation are summarized in the following table.

Table 2-1 | Main Points of River Basin Law Proclaimed in 1961

Classification	Main Content
Management of river basin	- Managing Authority: river basins designated by law to be overseen by the local minister - Selecting and changing river basin areas - All public works related to river basins to be implemented - Book on river basin data to be recorded and kept
Use of river basin	- Main content: use of river basin and process to be followed in the event of use - Levying of fees and restriction fees
Preservation of river basins and sharing of expenses	- Restriction on use of river basin (toxic material, damaging facilities etc.) - Entry to land and use of land designation of coastal areas and restriction on certain behaviors in the selected region - Prohibition or restriction of river basin
Expense and revenues on river basin	- Main principles on sharing of expenses (divided according to national or local expense) - Establishing guidelines on calculation of expenses and revenues concerning management of river basins - Assistance on expenses and charging expenses accordingly
Supervision on management	Main content: imposing penal consequences for legal violations - Collection of shared expenses
Damage compensation	- Compensation for damages to be shared in common - Compensation of damages occurring from supervision

Source: Ministry of Land, Transport and Marine Affairs

Water Resource Development Corporation was established with funds from the government with a view to improving people's quality of life and contributing to national economic development by developing and preserving national water resources.

The main responsibilities of Water Resource Development Corporation were as follows:

1. Management of water resource facilities, construction, restoration and operation thereof, etc.

2. Cultivation and reclamation of public water areas related to water resource development plan

3. Investigation, study, planning, testing and research related to water resource development facilities

4. Comprehensive Ten-Year Water Resource Development Plan (1966-1975)

2.2. Introduction to the 10-Year Comprehensive Water Resource Development Plan

This Plan was established to prepare the nation for its growing water needs as the economy grew by constructing multi-purpose dams that could handle water control, water use and energy development. The key points regarding the Ten-Year Comprehensive Water Resource Development Plan are listed in <Table 2-2>.

Table 2-2 | 10-Year Comprehensive Water Resource Development Plan (1966-1975)

Classification		Current Situation (1965)	Goal (1975)
River improvement	Important	28,000km total length of rivers: 12,800km total length of major rivers Goal: 5,114km Length of existing river banks: 3668km (71% of goal) Protection of agricultural land: 289,550 hectares Protection of residential dwellings: 468,307 units	Prevention of flooding in major areas including 116,604 hectares of agricultural land and 303,189 units of residential dwellings
	Special Case	Han River: downstream, and 47km-distance from coastal areas to Seoul designated as flood area Nakdong River: 52km from Namkang Dam to downstream areas in Chungamkyo identified as vulnerable to flooding	

<table>
<tr><th colspan="2">Classification</th><th>Current Situation (1965)</th><th>Goal (1975)</th></tr>
<tr><td>River improvement</td><td>Small scale</td><td>Small scale river length: 15,200km
Goal: 2,993km
Length of existing river banks: 423km
Protection of agricultural land: 147,805 hectares
Protection of residential dwellings: 90,677 units</td><td></td></tr>
<tr><td colspan="2">Flood control through river maintenance and management</td><td>Danger zones due to deficient repair and maintenance: 528km
Flood alert communication system: 15 locations</td><td>Improvement in river basin facilities, maintenance of relevant danger zones, establishment of flood alert communication system, and strengthening of management</td></tr>
<tr><td colspan="2">Storage facility for flood prevention</td><td>Flood Damage
<table><tr><th>classification</th><th>maximum per year</th><th>annual average</th></tr><tr><td>Han River</td><td>5.7 billion won</td><td>660 million won</td></tr><tr><td>Nakdong River</td><td>6.60 billion Won</td><td>920 million Won</td></tr><tr><td>Keum River</td><td>3.3 billion Won</td><td>380 million Won</td></tr><tr><td>Total</td><td>15.3 billion Won</td><td>196 million Won</td></tr></table></td><td>Plan for reduction of flood quantity from a location reference point
<table><tr><th>Classification</th><th>location</th><th>quantity of reduction</th></tr><tr><td>Han River</td><td>Koan area</td><td>8,000M²/sec(23.3%)</td></tr><tr><td>Nakdong River</td><td>Jindong area</td><td>5,000M²/sec(25%)</td></tr><tr><td>Keum River</td><td>Kong Ju area</td><td>2,000M²/sec(18%)</td></tr></table></td></tr>
</table>

Source: Korea Water Resource Associations (1997)

2.2.1 Conception of Development

a. Satisfaction of Demand for Water Control and Water Use Incorporated in Government Plans

Water demand increases as export, food supply and industrialization increase through programs such as the Seven-Year Food Supply Increase Plan, industrialization plan to promote exports, and the long-term power supply plan. Thus, the increasing needs must be met and in a timely manner.

b. Multi-Use Development for Water Resources

Floor and draught prevention in the major river basins is the main emphasis, but demand for industrial, agricultural and hydropower must also be satisfied. Building multi-purpose dams should be able to address such problems in an economically efficient manner.

c. Balance between Water Control and Water Use

A combined river basin control method where water control and water use can coexist along with greater river basin flood control and lower river basin restoration is necessary. For major river basins, the water control issue should be addressed by restoring lower river basins as well as maintaining flood control in the reservoirs located in the upper and mid parts of the river basins.

d. Development of Coastal Land based on Uniform Development of Water Systems

The significance of water control and safety issues along the coastal land areas as well as their water usage needs must be fully taken into account in the course of resolving conflicts that may arise between water control and water use issues. Such measures must be taken in order to ensure maximum use of water resources.

e. Small Scale Restoration of River Basin for Pan National Water Control

Small-scale restoration of river basins and repair work must be put into action with voluntary collaboration from the relevant communities throughout the nation.

f. River Basin Maintenance and Prevention of Disasters

Strict management of lower river basins along with restoration of water bank facilities must be maintained. Facilities around river basins must be preserved, and natural disaster prevention must be made by modernizing water control communication facilities as well as normalizing river basin maintenance and management systems.

g. Cultivation Project for Relocation of Homeless from Flood Submerged Areas

Finding a new home for the homeless from flood-submerged areas is an important project that must be met through continuous cultivation and expansion of land alongside increasing food supply.

h. Investigation of Water Resources

A detailed investigation on river valley areas, their topographical makeup, lower rivers, underground water, flood damage studies, etc., are all important basic investigative studies that form the fundamental basis for water resource development.

2.3. Hydro Power and Organization of the Management System

2.3.1. Ten-Year Comprehensive Water Resource Development Plan: 1966-75

The objective of the Ten Year Plan was multi-purpose: control draughts for the purpose of increasing food supply; maintain the water supply for advancing industrialization; make efficient use of national land by controlling flooding and ensuring the safety of the people; increase hydropower by building hydro dams that contain large-size reservoirs; and create employment.

Some of the major elements of the Ten Year Plan:

- Satisfy demands for increased water use by people and various industries in a timely manner.
- Develop a multi-purpose plan that can economically address water use and water control demands, which include flood control, hydropower development, and agricultural and industrial water supply.
- Encourage efficient use of water resources by controlling the elements of water control and water use issues, beginning with the water source and down to the river mouth in and around the coastal regions.
- Strictly maintain control over river basin capacity management and restore water barriers. Place emphasis on preservation of water basin appendages and prevention of natural disasters.
- Conduct a systematic investigative study of topography, geography and the geological makeup of river valley areas as well as other basic studies such as flood damage, water use statistics, underground water issues, water gates, etc., as a fundamental study for organized water resource development.
- Instill various laws relating to water resource development such as the Acceleration of Water Resource Development Law, Specific Multi-Purpose Dam Law, Korean Water Resource Development Corporation Law, Reclamation Project Law, etc.
- Regarding financing, pursue opportunities to obtain foreign financing in international domains; and for domestic financing, promote participation from the private sector. Repayment should be financed through revenues generated through the projects.

2.3.2. Ministry of Construction and Korea Water Resources Development Corporation

Recognizing the importance of water resource development, which is an essential part of economic development, the Ministry of Construction proposed a law for establishing an organization dedicated exclusively to the task of water resource development. The Korea Water Resource Development Corporation was passed in 1966.

2.4 .The Four Major River Basin Investigation Projects

2.4.1. Process and Implementation of Projects

As the Five-Year Economic Plan continued to make successful progress, it became necessary to conduct an investigative study on the four major river basins because of the need for a fundamental basis for adequate water resource supply. The government proceeded to establish the Ten-Year Comprehensive Plan for Water Resource Development in 1965. An investigative study was initiated on four major river basins as part of the Ten-Year Plan. From 1966, it took approximately six years (until 1972) to conduct the investigation on the four major river basins – the Han, Nakdong, Keum and Youngsan River basins. Further investigation by regions was conducted for two to three years to actualize the Comprehensive Plan by region.

Table 2-3 | Major Contents of Four Major River Basin Investigations

River Basin	Major Contents of Investigation
Han River	December 1966-March 1972 (expense: 9.936 billion Won) - Joint investigative geological research with the Ministry of Construction and American Ministry of Internal Affairs - 1968 May Formation of a joint investigative team to study the four river basins under the auspices of the Korean Water Resource Development Corporation - Research and survey conducted in ten areas including water gates, land use, economy, water supply, flood control, and fisheries
Nakdong River	December 1966 – March 1972. Completed in August 1972 (expense: 832 million Won) - Joint collaborative investigative study with the Korean Water Resource Development Corporation, UNDP, and FAO - Research and survey conducted in ten different areas including earth makeup, adjustment of salt levels in river mouth areas, measurement of aerial photos, etc.

River Basin	Major Contents of Investigation
Keum River	December 1966 – February 1972. Completed in April 1972 (expense: 477 million Won) - Collaborative investigative study conducted with Korean Water Resource Development Corporation and Japanese Company - Study conducted in ten different areas including water gates, climate, etc.
Youngsan River	July 1968 – December 1971. Completed in December 1971 (expense: 997 million Won) - Sole implementation by Korean Water Resource Development Corporation - Study conducted in nine different areas including Jooeun river mouth development, etc.

Source: Korea Water Resource Society 1997

The investigative study for the Han River basin was initiated upon findings by USAID and the Ministry of Construction. It was decided that a full investigation should be made on the entire river basin area, which included a survey of underground water and ground water. As a result, financing assistance was obtained from the American government, and a full investigative study was conducted in joint collaboration with the technical team made up of American geologists and scientists, as well as a Korean technical team. The study was completed in December of 1971.

The investigative study on the Nakdong River basin was completed in March 1972 in joint collaboration with international experts and Korean experts.

The Keum River basin investigative study was completed in February 1972 after a joint collaborative study involving Korean and Japanese experts.

The Youngsan River basin investigative study was completed in December 1971 independently by the Korean Water Resource Development Corporation using the expertise of those who participated in the Han and Nakdong River studies.

2.4.2. Accomplishments of River Basin Investigation Project

The Four Major River Basin Investigation projects were significant in that the concept of comprehensive river basin development was adopted in Korea for the first time. Such a concept was the universally recognized strategy for water resource development at the time. The basic purpose of water resource development is efficient control of seasonal water volume to adjust according to need so as to supply enough water when needed. Stable industrial and economic development would be achieved through such efficient management of water supply.

The basic direction of the river basin investigative study was to establish long-term water resource development that takes into account economic needs and objectives, was based on river basins, takes into account all factors concerning hydropower development, and can accomplish multi-development objectives.

3. Construction of Multi-Purpose Dam and Comprehensive Development by River Basins (1970-early 1990)

3.1. Comprehensive Development of Four Major River Basins

The government had established the Four Major River Basin Comprehensive Development Plan ("Comprehensive Plan" of 1971-81) based on the findings of the investigation. Water resource development was to be connected to the bigger objective, namely development of national land to ensure a steady supply of industrial water and efficient use of national land so that agricultural and industrial development could be achieved without major disruptions.

There was a clear objective that the Comprehensive Plan was to accomplish. Namely, for controlling water, the objective was to reduce by 50% damages occurring from yearly flooding. The plan also called for increasing restoration of river basins by 90% as well as increasing the supply of industrial water by 3.8 times.

3.1.1. Construction of Multi-Purpose Dams

From 1970 to the early 1980s, several multi-purpose dams were constructed based on experience and technical knowhow accumulated from the previous investigative studies of the four major river basins. During this time, multi-purpose dams like Chungju, Soyang River, Andong, Daechung, Chooam, and Imha were constructed.

Construction of multi-purpose dams secured control of water supply for those large urban areas located in the four river basin areas, thereby making a significant contribution to expediting urban development in those areas. Such accomplishments were considered to be a turning point in the history of water resource development of Korea.

a. Construction of Soyang River Multi - Purpose Dam: Largest in Asia

The Soyang River multi-purpose dam, which was completed in 1972, was one of the largest multi-purpose dams in Asia at the time. It became one of the fundamental cornerstones of Korean economic development by satisfying 52 percent of flood control capacity for the entire capital region.

b. Multi-Purpose Dam Construction for Four Major River Basins

Due to consistent pursuit of water resource projects since the 1960s, there are 15 multi-purpose dams throughout the country at present. The total capacity for water retention is about 12.5 billion square meters, and total effective reservoir capacity is 8.8 billion square meters <Table 2-4>.

Table 2-4 | Dam Storage

(Unit: Million m^3, mm, %)

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Precipitation (mm)	1,829	1,495	1,285	1,454	1,464	906	1,172	1,374	1,668
Amount of Inflow (Million m^3)	29,928	20,197	16,254	22,191	20,969	9,254	12,854	19,495	25,867
Amount Discharge (Million m^3)	29,299	21,150	16,923	22,398	19,083	11,708	12,140	17,533	25,711
Average Storage Amount (Million m^3)	7,310	6,748	6,139	6,170	6,463	6,069	5,602	6,445	7,295
Average Storage Ratio (%)	58.1	53.6	48.8	49.0	51.4	48.2	44.5	51.2	57.7

Source: Ministry of Land, Transport and Maritime Affairs(Korea Water Resources Corporation)

In 2003, there were 1207 dams that measured 5-15 meters in height with a reservoir capacity of more than 300 million square meters in Korea. Of these, there were 15 multi-purpose dams, 16 user dams (water supply for industrial, agricultural and consumption needs), 10 hydropower dams and 1166 agricultural water reservoirs. With efficient control of multi-purpose dams, an average of 3 billion square meters of flood control was achieved, and 2.8 billion square meters of water was supplied in the event of a draught.

As for the supply of consumable water, there was an increase in per capita water supply of 111 liters in 1980 to 450 liters in 2005.

Table 2-5 | Supply of Consumable Water in Korea

Classification	1965	1970	1980	1990	1995	2000	2005	2010	Annual average increase (%)
Total Pop. (thousand people)	28,705	32,241	38,124	42,869	45,974	47,977	49,268	49.470	1.4
Water Usage (Million m^2/day)	877	1,274	3,087	5,903	7,110	7,450	7,723	-	5.6

Classification	1965	1970	1980	1990	1995	2000	2005	2010	Annual average increase (%)
Daily Water Usage per Person (l/person/day)	84	108	222	377	424	425	429	-	4.2
Daily Water Supply per Person (l/person/day)	106	158	256	369	398	360	351	333	3.0

Source: Ministry of Land, Transport and Marine Affairs (2012); Ministry of Environment (2012)

Table 2-6 | Korea's Water Resource Usage

(Unit: hundred million m^2/ year)

	1965	1980	1990	1994	1998	2003	2007	2011	Annual Average Increase (%)
Total Amount	1,100	1,140	1,267	1,267	1,276	1,240	-	-	-
Total Usage	51 (100)	153 (100)	249 (100)	301 (100)	331 (100)	337 (100)	337 (100)	333 (100)	5.1
Living Consumption	2 (4)	19 (12)	42 (17)	62 (21)	73 (22)	76 (23)	76 (23)	75 (23)	9.6
Industrial Consumption	4 (8)	7 (5)	24 (10)	26 (8)	29 (9)	26 (8)	26 (8)	21 (6)	5.0
Agricultural Consumption	45 (88)	102 (67)	147 (59)	149 (50)	158 (48)	160 (47)	160 (47)	159 (48)	3.4
Reserve	-	25 (16)	36 (14)	64 (21)	71 (21)	75 (22)	75 (23)	78 (23)	4.9

Source: Water Resource Comprehensive Plan (2006), Statistic Korea (2012)

3.1.2. Water Control Projects

Korea started pursuing modernization of river basins from the 1970s. The method of development adopted in the 1970s was based on developing multi-purpose dams around Korea's four major Han, Nakdong, Keum and Youngman River basins.

In the 1980s, a balanced national land development policy was adopted. In the 1980s, 2,549km of river basins were restored, and the percentage of restoration increased from 48.3% in 1979 to 55.4% in 1989.

In the 1990s, an objective was set to increase the percentage of restoration of relatively underdeveloped regional river basins. In December of 1990, the Comprehensive long-term Water Resource Development Plan (1991-2001) was established, which set the basis for river basin development and management. Thus, the percentage of restoration of river basins was increased from 55.4% in 1989 to 70.3% in 1999.

In the 2000s, the law on river basins was revised to incorporate water control measures. This change was a turning point in the history of water control measures in Korea. The intent was to overcome the limitations of dependence on river banks and dykes in river basins. Instead, flood control was to be conducted by addressing damage control throughout the river valley. Thus, the entire river valley area was to be prepared adequately for flood control. A Comprehensive Water Control Plan by River Valleys was set up, and the Plan was initiated in August 2001. By 2009, the Plan was completed for all major 13 rivers in Korea.

4. Comprehensive Management of Water Resources (Late 1990s-2000s)

By the 1980s, a basic water resource preservation and distribution system was accomplished. The 1990s can be seen as a period of maturity in water quality diversification and water use. Relative stability was achieved on water supply from construction of multi-purpose dams. As quality of life improved because of economic development, the focus shifted towards concerns of environmental protection from the ensuing consequences of dam construction and operation.

4.1. Comprehensive Management Based on Water Level and Sector

Securing pure water becomes an increasingly difficult task as water quality in the lower river valley areas becomes contaminated. As living quality improves with higher standards of living, water use also changes from agricultural to recreational or industrial use.

Prior to industrialization, when water supply was abundant and no capital investment was made to secure it, water had no economic value. But in recent days, where water supply has become scarcer, water started to retain commercial and economic value. Thus, management of water resource and supply started to include a pragmatic approach to the value of water.

Table 2-7 | Korea's Paradigm Change for Water Resource

	1960~70	1970~90	1990~2000	After 2000
Types of Goods	Free Goods	Low value; Semi Free Goods	Medium value Economic Goods	High value economic goods
Resources	Unlimited resources	Ordinary consumer goods	Resource consumer goods	Rare resource goods
Management of Water Resources	Securing hydropower and agricultural water resources	Securing industrial, agricultural and living consumption water and flood control	Comprehensive water use plan: management of water control and water quality	Comprehensive management by water use and section
Policy	Policy on agricultural civil engineering	Water resource development policy	Parallel operation of management policy on water amount and water quality	Comprehensive water resource management

Source: Ministry of Land, Transport and Marine Affairs, River Management GIS, K-Water

Another important development in water resource management is the adoption of a system for charging a fee for water use, as well as the measurement system on water contamination around the four major river valley areas. The Ministry of Environment had been making efforts to improve water quality in the river basins. However, there were limitations. So the Ministry imposed a system for measuring contamination levels and, when the set contamination level was exceeded, penalties were imposed, and development around the area was restricted. The penalty revenue was to be used for improving water quality around the upper river area.

In 2004, the Ministry of Construction and Transportation adopted a new policy on water control that was more environment-friendly. The traditional water control system was replaced by a more ecological and flood reservoir based water control system. For example, agricultural areas were formed as reservoirs, which could be used to control flooding. But during ordinary times, the area was to be used as ecological parks. Restoration of river basins continued, as well as flood control efforts where flood prevention was concentrated at the river mouth area, distributing equally throughout the entire river valley areas.

4.2. Increased Demand for Comprehensive Management of Water Resources

As society became more developed, water resource management also became more complex, requiring a comprehensive water resource management system to ensure efficient use of water. The main focus of comprehensive water management was to resolve river basin area issues by approaching them from an administrative authority (local authority, central government, citizenry, etc.) that had a stake in the river valley effort. There have been many conflicting opinions on how to achieve this, and no real progress has been made. However, currently, the basic guideline agreed upon is to pass a law on basic water management and form a plan for national water resource management.

4.2.1. Structure for Implementation and Procurement of Financial Resources

Financial resources were secured and implementation of projects achieved through the Korean Water Resource Development Corporation. The cost for dam construction and river basin improvement was paid by the central government and certain local governments. <Table 2-8> illustrates financing by different sources.

Table 2-8 | Collection of Income from Rivers

By Year	Classification of rivers	Total	Use fee	picking fee	Abandoned river disposal fee
1999	Total	90,171	35,928	42,484	11,814
	National River	61,998	24,054	37,582	412
	Regional 1st River	3,999	1,416	2,210	878
	Regional 2nd River	24.174	10,453	2,692	11.029
2000	Total	77,298	68,721	-	19,207
	National River	48,261	42,777	-	484
	Regional 1st River	2,845	2,586	-	259
	Regional 2nd River	31,822	13,358	-	18,464
2001	Total	66,958	48,739	-	18,219
	National River	29,951	28,895	-	1,556
	Regional 1st River	5,500	4,616	-	884
	Regional 2nd River	31,507	15,728	-	15,779
2002	Total	84,286	68,658	-	25,578
	National River	42,982	42,078	-	909
	Regional 1st River	4,585	4,246	-	289
	Regional 2nd River	86,719	12,339	-	24,880
2003	Total	89,646	72,660	-	17,095
	National River	42,621	40,640	-	1,881
	Regional 1st River	6,748	6,077	-	671
	Regional 2nd River	40,376	25,833	-	14,548
2004	Total	117,268	73,339	-	43,924
	National River	44,161	40,084	-	4,077
	Regional 1st River	5,746	5,450	-	296
	Regional 2nd River	67,856	27,805	-	89,551
2005	Total	88,122	60,125	-	27,997
	National River	42,282	40,863	-	1,1869
	Regional 1st River	6,897	4,248	-	2,654
	Regional 2nd River	88,993	15,019	-	23,974
2006	Total	71,180	60,818	-	10,817
	National River	48,552	41,826	-	1,726
	Regional 1st River	4,291	8,867	-	424
	Regional 2nd River	28,287	15,120	-	8,167
2007	Total	72,198	61,044	-	11,164
	National River	42,101	40,468	-	1,688
	Regional 1st River	4,485	4,201	-	284
	Regional 2nd River	25,662	16,880	-	9,282
2008	Total	53,786	48,498	-	10,298
	National River	24,950	24,625	-	825
	Regional River	28,886	18,868	-	9,968

By Year	Classification of rivers	Total	Use fee	picking fee	Abandoned river disposal fee
2009	Total	92,050	82,961	-	9,089
	National River	35,672	84,848	-	824
	Regional River	66,378	48,118	-	8,265
2010	Total	37,354	88,944	-	3,410
	National River	19,489	19,161	-	828
	Regional River	17,865	14,788	-	3,082
2011	Total	28,152	24,528	-	3,614
	National River	14,822	12,903	-	1,919
	Regional River	13,330	11,625	-	1,705

Note: 1) User fee after 2000 includes picking fee

2) Regional 1st class and regional 2nd class rivers were merged into Regional river after 2008

Source: ministry of Land, Transport and Maritime Affairs, Division of River Basin

a. Financial Resource Procurement and Repayment

Effort was made to procure international loans, while participation from the private sector was the encouraged medium for securing domestic funds. Repayment plans were made by using revenues from the facilities.

4.2.2. Results and Accomplishments

The Comprehensive Ten-Year Water Resource Plan marked a significant point in water resource development in Korea because it was a long-term plan designed to achieve several important tasks such as prevention of natural disasters, use of valuable water resources, construction of hydropower plants, efficient use of national land and stabilization of people's livelihood. The Plan made a significant contribution to Korean economic development.

5. Four Major River Area Comprehensive Development and Long-term Development Plan (1970-1990s)

Water resource development can be divided largely into two parts: one, the Four Major River Comprehensive Development Plan pursued in 1971-1981; and two, construction of multi-purpose dams after 1981. The projects pursued by period are as follows.

5.1. Four Major River Area Comprehensive Development Plan (1971-1981)

5.1.1. Plan Objectives

This plan was designed to uniformly implement water resource development for the four major river areas in order to stabilize agricultural management and industrial development with an overall view to building quality, habitable national land. At the time, the four major river areas constituted the nucleus occupying 63.7 percent of national land. The population in the four river areas was 62 percent, GNP was 67 percent, acreage under cultivation was 53.7 percent, quantity of residual water resource was 62.2 percent, annual average of flood damage was 69.5 percent and damage from draught was 60 percent.

a. Development Objectives

Some of the objectives for the comprehensive development plan for the four major river areas were as follows:

1) Reduce damage from flooding by fifty percent

2) Increase tap water supply from 30.6 percent to 65 percent, as well as industrial water supply by 3.8 times

3) Prevent flooding by increasing restoration of major lower river basins to 90 percent in areas ordinarily vulnerable to flooding

4) Prevent backfilling of salt water from the sea into the river mouth and address deterioration of water quality because of ever increasing pollution

For the Han River area, 99.5 billion won was invested to build the Soyang river dam, which controlled flooding by 650 million square meters.

For the Nakdong River area, 111.4 billion won was invested to build the Andong dam, as well as other dams like the Youngsun Dam and Hapchun Dam. The investment also went toward restoring 2,349km of river basin, which supplied 3.4 billion square meters of water area in 1981.

For the Keum River area, 4.5 billion won was invested to build the Daechung multi-purpose dam, achieving 200 million cubic meters of flood control per year. About 1276km of the lower river basin was restored, and 1.6 billion cubic meters of water supplied.

For the Youngsan River area, 5.7 billion won was invested to build other dams including the Chungsung Dam, Damyang Dam, and Dongbok Dam etc., resulting in 200 million cubic meters of flood control, 776km of lower river basin restored, and 797 million cubic meters of water supplied.

b. Construction of Soyang River Dam (1967-73) and Multi-Purpose Dam

Another major achievement of the 1970-90 period apart from the Four Major River Basin Comprehensive Development Plan was the construction of a multi-purpose dam and pursuit of the metropolitan capital regional area's tap water project. A total of 123.7 billion won was invested to build 12 multi-purpose dams around the country.

c. Results and Achievements

Although some changes were made in the process of implementation, most of the objectives of the Four Major River Basin Development Plan were generally achieved. Thus, along the Han River, several dams including the Soyang River Dam and Chungju Dam were built. Along the Keum River, the Daechung Dam was built, and near the Nakdong River, five dams including the Andong Dam and Youngsan Dam were built. Around the Youngsan River area, four dams including the Chungsung Dam and Danyang Dam were built.

6. Long-term Comprehensive Development of Water Resources – Basic Plan (1981-2001)

6.1. Plan Necessity

Due to rapid industrialization in Korea, water shortage and contamination were problems that required a response to ensure consistent and stable water supply on a long-term basis. Most of the Korean soil consists of mountains with a climate that has intense rainfall for three months in the summer. Flood and hurricane damage were common occurrences, and a long-term plan to ensure efficient supply of water as well as protection of land and people from natural disasters were major priorities.

6.1.1. Basic Objective

The Plan was designed to be implemented for more than 21 years in 1981-2001 with the following objectives:

1) Increase water supply from 3.314 million cubic meters to 12.753 million cubic meters by 2001

2) Increase restoration of river basins from 30 percent to 70 percent by 2001

3) To comply with the government's policy to reduce dependence on oil, increase hydropower energy from 1,202 billion kw to 4.102 billion kw by 2001

6.1.2. Basic Policy

The basic tenets of the policy behind the plan were as follows:

1) Satisfy the needs for water control and water use as incorporated in the plans of respective government departments and branches

2) Achieve focused development with multi-purpose infrastructure

3) Supply water for metropolitan areas

4) Actively pursue natural damage prevention and preservation of national land

5) Conduct investigative studies on water resources

6) Develop the legal infrastructure for water resource development

7) Establish comprehensive regulation authority to control plans from different government branches and their implementation

8) Establish an Industrial Facility Development Corporation

9) Establish methods for supplying financial resources to fund the projects

10) Put forth an effort to obtain low interest loans from foreign countries and proactively identify ways to reinvest revenues and generate financing internally

11) Put forth an effort to build multi-purpose dams with national funds until 1991 and, afterward, use revenues from dam operations to build the same

6.2. Results and Accomplishments

The Comprehensive long-term Water Resource Plan has been consistently amended and enhanced since its inception in 1965. The accomplishments of such efforts were as follows:

1) Investigation and analysis were based on characteristics of the water resources, as were the establishment of plans and strategies proposed

2) A comprehensive water use plan was devised to ensure stable supply of water resources

3) Flood control methods were strengthened, and a water control plan was established

7. 1990-2000: Comprehensive Management of Water Resources and Environment - Friendly River Basin Development

Water resource development policy from 1990 to present can be summarized as comprehensive water resource management and environment-friendly river basin development. A new measure for water resource management was required as a result of the changes that followed rapid industrialization and improved living standards. Demand for water increased, and there was discontent over the increasingly contaminated river basins. Conflicts regarding water supply occurred between regions, and water development that was environment-friendly became a new paradigm for river basin restoration initiatives.

7.1. Long-term Comprehensive Water Resources Plan (1991-2011)

7.1.1. Plan Purpose and Major Objectives

This Plan was linked to the Third Comprehensive National Land Development Plan (1992-2001). Detailed development plans were limited to 2001 because the Plan was implemented simultaneously with the National Land Development Plan, which ended in 2001. However, the basic guidelines and directions for the Plan were set out until 2011 as follows:

1) Ensure stable and sufficient supply of clean water

2) Restore river basins and comprehensively manage water control and water use issues

3) Preserve the quality of water in river basins and establish a water-friendly environment to meet the needs of the people

4) Continue to develop hydropower energy to prepare for emergencies

5) Comprehensively manage water control, water use, preservation, and other factors by river valley areas

7.1.2. Project Content

<Table 2-9> shows the five major objectives of the Comprehensive long-term Water Resource Plan (1991-2011).

Table 2-9 | Comprehensive Long-term Water Resource Plan (1991-2011)

Classification	Major Contents
Timely development of water resources	Timely development of water resources based on water control and water use needs in accordance with national economic growth
Multi-purpose water resource development	Construction of multi-purpose dams according to water system, restoration of river basin environment, uniform and comprehensive development for preservation of water control and water use
Development of water resources based on water basin system	Development of water resources for multi-purpose needs of water supply, flood control, hydropower energy, environment-friendly habitats, etc.
Water supply based on region	River basin repair and management. Water supply imbalance regulated by dividing body of water into four regions to ensure balanced water distribution
Water control policy based on flood damage reduction	Address the regional and river basin area imbalance by dividing body of water into four regions to ensure balanced water distribution
Protection of water reservoir	Protection of water reservoir, expansion of sewer and waste water facilities, etc.
Secure resting space for people in environment-friendly habitat	Form a new water culture for people to recognize the importance of preservation of water resources and secure resting space for people in environment-friendly habitats
Comprehensive water management system in river basin areas	Form a uniform and comprehensive water management system in accordance with river basin areas
Pursue research and development	To scientifically manage and develop water resources, pursue research and development as well as conduct investigative studies of floodgates, river basins, etc.
Reform water resource administration system	Reform water resource administration system by revising water resource laws in phases to solve problems of submerged areas; and preserve and use water resources efficiently
Collaborative pursuit to joint use of river basins bordering North and South Korea	Pursue state level negotiations to investigate and develop water resources around the Han River, Imjin River, etc.

Source: Ministry of Land, and Marine Affairs, River Management GIS, K-Water, WAMIS

7.2. Plan Accomplishments

The accomplishments of the Plan (1991-2011) were as follow:

1) Underwater management system was adopted and facilitated the development of a concept for river basin environment maintenance management

2) Constructed mid-size dams such as the Woonmoon Dam, Hoengsung Dam, and Milyang Dam, which measure less than 100 million cubic meters

3) Flood warning alarm system around five rivers was completed and further expanded to medium and small water systems

7.3. Long-term Comprehensive Plan for Water Resources - Amending and Supplementing (1997-2011)

7.3.1. Plan Purpose

As urban areas became industrialized in the early 2000s, a shortage of water supplies was expected nationwide, which would inhibit economic growth significantly. Further, severe draughts and flooding were expected as a result of the greenhouse effect (El Nino, etc.), requiring a long-term comprehensive policy to deal with such problems in the 21st century.

a. Major Objectives and Policy

Three major objectives were established as follows:

1) Pursue stable nationwide water supply

2) Form habitable water areas and prevent flooding and natural disasters

3) Stimulate investigative studies and research on water resource management

The major policies are set out below in <Table 2-10>.

Table 2-10 | Long-term Comprehensive Plan (1997-2011): Revised Contents

Classification	Major Contents
Timely development of water resources	Timely development of water resources based on water control and water use needs in accordance with national economic growth
Multi-purpose water resource development	Construction of multi-purpose dams according to water system, restoration of river basin environment, and uniform and comprehensive development for preservation of water control and water use
Development of water resources based on water basin system	Development of water resources for multi-purpose needs of water supply, flood control, hydropower energy supply, environment-friendly habitats, etc.
Water supply based on wide area	Repair and manage river basins. Water supply imbalance regulated by dividing body of water into four regions to ensure balanced water distribution
Strengthening of management of water quantity	To make efficient use of limited water resources, revise tap water billing system, distribute water saving devices, and actively pursue water conservation movements among public
Diversification of water resource development	Make proper use of rain water, underground water and sea water in accordance with regional characteristics
Proactive promotion of water resource development	Form a new water culture for people to recognize importance of preservation of water resources and secure resting space for people in environment-friendly habitat; and pursue optimal use of water resources
Collaborative pursuit to joint use of river basin bordering North and South Korea	Pursue a state level negotiation to investigate and develop water resources around Han River and Imjin River
Review ways to secure and manage water resource supply (long-term) in preparation for 21st century environment changes	Shift water supply structure from demand focused to supply capability focused structure, and continuously pursue water management based on efficiency and alternative developments

Source: Ministry of Land, and Marine Affairs, River Management GIS, K-Water, WAMIS

Chapter 3

Major Projects

1. Long-term Comprehensive Water Resources Plan (2001-2020)
2. Long-term Comprehensive Water Resource Plan (2006-2020)
3. Chunggyechun Restoration Project

Major Projects

1. Long-term Comprehensive Water Resources Plan (2001-2020)

1.1. Purpose and Characteristic of the Plan

The basic structure of the long-term Comprehensive Plan was already formed in 1997, but a more comprehensive Plan became necessary to embrace the changing social demand and diversification of water needs as time progressed. Furthermore, the reform of the River Basin Law in 1999, which brought about a newer legal structure and authority over water resource development matters, necessitated a more comprehensively accommodating plan for water resource development.

The basic purpose of the Plan was to create a friendly water environment and healthy use of water to enable consistent social improvement. To actualize such a basic objective, consistent hydropower development and use that was based on efficient water power management and preservation of living creatures and restoration of the water environment that formed a fundamental basis for an environment-friendly social system was necessary. A policy structure based on divided concentration of water use, water control and protecting the river basin environment was to be pursued to achieve such objectives.

As for water use, the objective was set on "healthy and stable water use." As for water control, the objective was set on "establishing a social structure that was well prepared for flooding." As for the river basin environment, the objective was set on "formation of river basins well-balanced with nature."

At present, it is becoming more pressing to come up with a solution involving a more structured method to address the problems of water resource development that started surfacing back in the early 90s. Issues such as economic development-based water resource policy, public criticisms thereof and future water resource shortages became more prominent with the progress of industrialization in the 90s. Further, a more proactive water resource policy was necessary in order to address diverse perspectives in accordance with the Fourth Comprehensive National Land Development Plan as well as the continuously changing water resource needs.

1.1.1. Background of Implementation of Long-term Comprehensive Water Resource Plan

<Table 3-1> presents revisions to and the supplementation history of the long-term Comprehensive Water Resource Plan from 1966.

Table 3-1 | History of Revisions and Supplementation of Long-term Comprehensive Water Resource Plan

Classification	Term of the Plan	Year of Establishment	Basis of Plan
1970-1980	1970-1980	1965	1. Development of multi-purpose dams
1981-2001	1981- 2001	1980	2. Water control and dam development project
1991-2011	1991-2011	1990	3. Management and development of hydropower
1996-2011	1996- 2011	1996	4. Environment-friendly water resource management and development
2001-2020	2001- 2020	2001	5. Formation of healthy and safe water friendly environment

Source: Ministry of Land, and Marine Affairs, River Management GIS, K-Water, WAMIS

1.1.2. Pursuit of Plan and Contents

a. Plan Contents and Implementation: Basic Guidelines

The basic guidelines for implementing the Plan are as follows:

1) Pursue a comprehensive strategy that addresses in a proactive way the problems of how to save water and achieve a set goal on water savings

2) Expand water resources by conducting combined management of existing multi-purpose dams

3) Pursue new water resource development strategies to secure safe water use

4) Expand use of water resources to enable water quality enhancement and preservation

5) Pursue measures to handle unusual draughts or flooding situations

6) Plan for joint development and use of river basins between North and South Korea

b. Accomplishment of Set Goals on Water Use Reduction consistent with Use Management Policy

As part of the government's efficient water management strategy, a goal was set to reduce water use as follows: for drinking and industrial water, save 900 million cubic meters by 2006; agricultural water, save 700 million cubic meters for a total of 1.6 billion cubic meters of water; by year 2011, save 1.2 cubic million meters of consumable and industrial water; and for agricultural water, save 1 billion cubic meters by 2011 for a total of 2.2 billion cubic meters.

To save drinking water, plans were set on the following: a) taking a pragmatic approach to addressing higher water costs; b) install water saving devices on 11.63 million homes and 11,500 business facilities; and c) reduce water leakage by 14 percent by replacing 27,000km of old drainage structures by 2006.

As for industrial water, the goal was set to save 30 million cubic meters of water (10 percent) by encouraging recycling of water.

As for agricultural water, a goal was set to save 800 million cubic meters of water by changing facilities to agricultural water use, as well as to save an additional 200 million cubic meters by 2011 by pursuing TM/TC (automatic freight management system) of the agricultural water distribution system.

c. Expansion of Water Resource Distribution through Joint Operation of Existing Multi-Purpose Dams

A total water shortage of 1.803 billion cubic meters was expected by 2011. However, 600 million additional cubic meters of water was to be supplied by 2011, equivalent to an increased supply by 33 percent, by linking and jointly operating multi-purpose dams and single purpose development dams.

d. Project for Eliminating Salt from Sea Water

The time frame for conducting this project was 2001-2020 and divided into three phases. The first phase is 2001-2011; the second phase is long-term from 2012 to 2020; and the third

phase is 2012-2020. New water to be supplied through this project conducted in phases and by region is expected to result in an extra 0.4 percent in water savings by creating 8 million cubic meters of water for the entire country.

e. Expansion of Tap Water in Metropolitan Area

It is necessary to secure a consistent and stable supply of water by making efficient use of existing facilities without necessarily pursuing other alternatives or new water resource development projects. Thus, plans were made to increase the water distribution rate from 85.2 percent in 1998 to 95 percent in 2011. Implementation was to take place on a priority basis, taking into account urgency, project feasibility, and other factors.

f. Development of Under-Water Dams and Filtered Water near Rivers

Due to difficulties in developing new forms of surface water, research and investigations were to be conducted, as well as mid- and long-term development plans to be pursued for building underwater dams and filtered water dams.

g. Recycling of Rain Water and Sewage

Adopt an incentive system for expansion of rain water use facilities and use of rain water for hygienic use or for cleaning. Further, efforts were to be made to join the issues of flood prevention in connection with enhancing the function and preservation of rain water to prevent flood.

h. Consistent Monitoring of Water Usage and Volume of Sewage

Water quantity and water usage around the five river basins were to be monitored to enable use of such data to supplement water resource development policy. By 2006, such a monitoring system was to be installed for regions surrounding the Nakdong, Keum, Youngsan, and Sumjin Rivers and, by 2009, mid-size river basins were to be targeted for installing the system.

i. Strengthening of Underground Water Quantity Maintenance

Management plan for underground water was established for a ten-year term to be amended and supplemented every five years to ensure efficient development and use of underground water. A scientific investigation of fundamentals and a comprehensive information maintenance system should be installed to monitor depletion of underground water, to deal with contamination problems as well as preservation of underground water.

j. Enhancement of Information and Knowledge on Water Resource Quantity and Use

A state level investigation and study should be conducted on river basin water quantity and water use, which is pertinent to present and future situations. Further, information is

necessary to predict future water volume need and to foresee water resource supply. Further, cooperation and participation from people should be induced by supplying adequate information and statistics easily understood by ordinary people.

k. Continuous Implementation of Water Quality Preservation Measures for Four River Regions

To preserve tap water quality around the Han River regions, various efforts should be made including preventive management, expansion of environmental facilities, imposition of stricter disposal standards, and reduction of contaminated garbage. Furthermore, the water quality around the Han River area should be improved to level I standards by 2005, and all the tap water quality around the area should be improved to level II standards.

l. Management of Underground Water Quality

To properly manage underground water and preserve its quality, various measures are required, including establishment of a water quality information system, organizing relevant underground water laws in a more environment-friendly way, strengthening the ability of organizations to research and manage underground water issues, thorough investigation of contaminated underground water and restoration, and prevention of underground water contamination.

m. Implementation of Proactive Measures to Address Unusual Draughts and Other Disasters

Measures that can readily handle unusual problems resulting from climate changes in recent years must be adopted in a systematic manner. Serious draughts never experienced before may occur in the future, and adequate water resources must be preserved as well as efficient measures adopted to distribute and manage water supply.

1.1.3. Major Accomplishments and Significance of the Plan

Until the 1980s, there was little priority on managing river basins in an environment-friendly way. After the 1990s, there was a better understanding of environmental issues, and many projects were initiated to better manage river basins.

The long-term Comprehensive Water Resource Development Plan established in 2001 can be interpreted as a Plan that presents a long-term vision on environment-friendly river basin management. Furthermore, the Plan also activated various implementation measures such as preservation, restoration of river basins, and activation of multi-purpose use of river basins, as well as nurturing a water culture that the public can readily identify with.

2. Long-term Comprehensive Water Resource Plan (2006-2020)

2.1. Background of Plan and Implementation Strategy

2.1.1. Background of Plan

The background for the Comprehensive Plan established in 2006 was first prompted by the environmental, social and economic changes that occurred since the Plan of 2001. There was a need to supplement water resource supply because of environmental changes such as spring draughts. In particular, the draught of 2001 was one of the worst in history and one of the rarest natural occurrences in decades.

Second, there was a need for comprehensive measures that could properly address large-scale flood damage problems. The years 2002 and 2003 witnessed hurricanes that resulted in extensive flood damage in terms of property and lives.

Third, there has been an increase in demand by people for adequate water resource management and a pleasant water environment. Many civic organizations and people-based demands were made for the establishment of adequate water resource planning and management.

2.1.2. Implementation Strategy

The three basic purposes of the Plan were first, establishing a broad guideline for national water resource policy; second, forming a regional water resource policy taking into account regional particularities and statistical analyses of the pertinent regions; and third, establishing a plan that accommodates social and people demands.

In particular, active participation from various government bodies including the Ministry of Environment, Ministry of Agriculture, and Ministry of Industry and Resources was to be encouraged, and their long- and mid-term water resource management policies were to be reflected in the Plan. Furthermore, to properly reflect the demands of the people, an expert group composed of various local community organizations, civic organizations, representatives of relevant ministries and technical experts was formed to participate in the early stages of planning.

The organization chart for implementing the 2006 long-term Comprehensive Water Resource Plan is presented in Diagram 3 below.

2.1.3. Detailed Contents of the Plan and Implementation Process

a. Submission of Objectives and Strategy for Water Resources

A basic guideline for the Plan was formed based on an evaluation of social and economic changes, as well as opinions from civic organization and experts.

b. Analysis of Water Resource Characteristics and Conditions

Several points were established in the 2006 Plan, including: 1) a reference point based on an analysis of water circulation; 2) an analysis of the water circulation process with references to water use and the water supply process; 3) evaluation of the current policy on water quality as well as an analysis of changes in water quality; and 4) a comparative study against developed countries and their experiences, as well as a calculation of the water resource environment index.

c. Establishment of Comprehensive Water Use Plan to Secure Stable Water Supply

Long- and mid-term plans were formulated based on an evaluation of recent water policies, the results of water management efforts, regional water distribution, and other factors. Efficiency of water distribution, water distribution capacity, water supply needs from economic and social references, and other factors were also analyzed when formulating the Plan.

d. Establishment of Comprehensive Water Control Plan for Flood Control

To establish an effective flood control strategy, a basic guideline has to be formed by investigating and analyzing statistics on water use, water resources and the river basin environment based on the surrounding region and areas specific to the river basins.

e. Establishment of Environment-Friendly River Basin Area Management

A basic guideline for the Plan that is connected to the evaluation of the river basin management plan as well as specific projects was established. In addition, multi-purpose use of the river basin based on an environment-friendly, comprehensive river basin plan was to be presented.

f. Investigation, Research and Development of Technical Knowhow

Water resource investigation and research were conducted to provide guidelines as well as revision methods to relevant organizations working on water resource management.

g. Significance of Comprehensive Water Resource Plan

The basic objectives and accomplishments of past comprehensive plans can be summarized as follows: In the 1970s, commencement of multi-purpose dams accompanied by water use and water control objectives; in the 1980s, development and construction of

large scale multi-purpose dams and metropolitan area-based water supply efforts expanded nationwide; and in the 1990s, the river basin management concept was adopted along with development of mid-size dams.

Table 3-2 | Ten-Year Plan for Water Resource Development in 1970s

Classification	Objectives	Achievement
1970s Ten-Year Plan for Water Resource Development	- Development of agricultural reservoirs to ensure a stable supply of agricultural water to expand food supply - Develop a single purpose hydropower dam to address growing demand for electricity - Investigate Four River Basin Area	- Develop water resources accompanied by water control and water use methods - Commencement of large scale multi-purpose dams such as the Soyang River Dam - Commencement of a water supply system around the capital region - Formation of an alarm system for flood notification for the Han River - Pursuit of river basin restoration project
1980s Long-term Comprehensive Development Plan for Water Resources	- Construction of multi-purpose dams and exclusive water-use dams to secure stable water supply - Acceleration of river basin restoration projects to mitigate natural disaster damage and stabilize quality of life - Expand hydropower and energy in accordance with government policy to reduce dependence on oil	- Develop large-scale multi-purpose dams such as the Chungju Dam - Expand the metropolitan area water supply system on a nationwide basis - Setting up an alarm notification system for flooding around the Nakdong River area - Commencement of a water control project based on the water system
1990 Long-term Comprehensive Water Resources Plan	- Stabilization of water supply on a nationwide basis - Formation of a pleasant water environment and flood prevention - Initiation of research to rationalize water resource management	- Development of mid-size dams such as the Woonmoon Dam - Completion of alarm notification system for flooding around the five river areas and expansion of mid- and small-size water systems - Adoption of the river basin environment management concept in the event of water basin maintenance - Adoption of underground water management system

Source: Ministry of Land, Transport and Marine Affairs, River Management GIS, K-Water, WAMIS

In contrast, the Comprehensive Water Resource Plan of the 2000s is significant in the sense that it represented an effort to comprehensively manage river basins from the environmental perspective. The five major characteristics of the Plan are as follows:

1) Securing transparency on the planning process

2) Division of roles and functions of relevant ministries

3) Active reflection of opinions from local governments and regions

4) Verification and evaluation of relevant ministries on water resource management

5) Establishment of a river basin environment plan and nature-friendly water control system

3. Chunggyechun Restoration Project

3.1. Background of the Project

Chunggyechun was formed as a man made stream during the Chosun dynasty and continued to exist throughout the history of Seoul. However, the stream turned into a sewage canal during the Japanese occupation. In the 1960s, the stream was covered as a part of an infrastructural development project aimed at improving the city's hygiene and expanding the street. However, the areas around Chunggyechun became a social problem due to aging buildings, squatters, and other factors, which led to an imbalance between the northern and southern part of Seoul from the economic, cultural and environmental development perspective. Thus, the city of Seoul initiated a redevelopment plan for Chunggyechun as a part of the city's larger initiative to make Seoul an environment-friendly city where people, nature and culture can coexist.

Chunggyechun had several problems. First, the area experienced heavy traffic jams with a daily average of 168,000 cars – 62.5% of which were just passing through. There were also 18 buses, but only an average of one person per bus stopping at the station. Commuters were further discouraged from using public transportation and preferred privately owned vehicles.

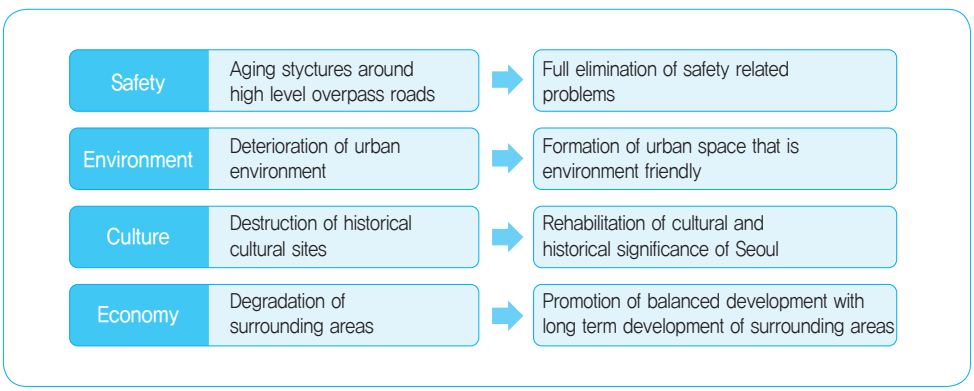
Another problem was air and noise pollution, levels for which were higher than the city average. At that time, the average quantity of contaminated materials around the Chunggyechun roadside areas was also above the city standard. This was also the case for carbon dioxide levels. Benzene, which is toxic to the human body, also reached very high levels.

The problems of the Chunggyechun area extended to nearby cultural heritage sites. Many of the historical bridges and dams sustained local and environmental damage, to the degree where the original shape was hard to trace. Furthermore, the dykes that had been built to help maintain the river basins were largely damaged in the restoration process.

Overall deterioration of the area reduced the economic competitiveness of the northern part of Seoul. The area lost more than 50,000 residents, and the employed population was reduced by 80,000. The number of companies that located their main offices in the northern area was only 63% of those located in the southern part of Seoul. The lack of private sector capital investment further hindered development efforts in the area.

Hence, the Seoul city government decided to redevelop the Chunggyechun area, focusing on renovating old building structures, reforming the city environment, restoring historical sites and stimulating the city economy.

Figure 3-1 | Background and Development of Chunggyechun Restoration Project



3.2. Project Summary and Implementation Method

The Chunggyechun Project commenced in July 2003 and was completed on October 1, 2005. It took two years and three months and 111 billion won to complete the task.

a. Restoration Process

The Chunggyechun Restoration Citizen's Committee was given the task of working together on the project. The Chunggyechun Restoration Project Research Support Team was an ad hoc organization that had the role of providing research materials and support for establishing the major guidelines to complete the project in a successful manner. The Team was organized in July 2002 and served its function until June 2006. The Citizen's Committee was active in providing major directives by serving as a window to accommodate people's concerns and promote the project throughout the nation.

b. Implementation Method

The Chunggyechun Restoration Project was implemented by conducting a feasibility study and fundamental planning by embracing the opinions of average citizens, interest groups and relevant experts. The Project required not only support from the city of Seoul, but also relevant city borough groups (Gu).

3.2.1. Project Characteristics and Financing

The Chunggyechun Restoration Project has the characteristic of a public project led by the city government, involving the demolition of 5.8km of covered building structures located throughout the central part of Seoul. The estimated budget for the project was 349,423 million won at the beginning, which increased to 386,739 million won on July 1, 2003, to accommodate changes in the blueprint, inflation and additional tasks.

3.2.2. Project Contents

a. Project Details

The restoration project can be divided mainly into two categories: demolition and stream improvement. Demolishing the elevated streets of Chunggye was completed on August 3, 2003, and construction of the Samil Elevated Street was completed on October 5, 2003.

A total of 22 Chunggyechun bridges (seven sidewalk bridges, and 15 car bridges) were built in such a way so as to create a harmonious balance with the surroundings. The basic design for the stream's improvement was to evoke a more urban image as the stream progresses to the lower stream area; and the surrounding walls were designed to display a cultural theme for people to enjoy.

b. Traffic Problem Solutions

Seoul City planned the Chunggyechun area with a focus on public transportation. Thus, the number of one-way streets was increased, and central bus lanes and circular bus systems were adopted. Based on data collected after the restoration project was launched, a consistent vehicle speed and the central traffic pattern was reasonably-well established. The area saw public transportation users increase by 11% compared to December of the previous year. The number of subway users increased 13.7% around the central part of Seoul.

3.2.3.Chunggyechun Restoration Project: Significance and Evaluation

Along with the objective of stream restoration, there was also a focus on restoring history and culture. The objective of the project was to demonstrate that it was an advanced, environment-friendly project. Approximately 6.27 million people visited the area within one month of the project's completion.

The Chunggyechun Restoration Project can be evaluated as a success from the cultural, economic, tourist and historical perspectives; and the area has become a tourist landmark enjoying visitors from both Korea and abroad every year. Culturally, the area boasts many historical sites such as Kwangleung Bridge and Soopyo bridge, which represent significant historical times. As for economic contributions, the relatively less advanced Kangbuk area became more popular as a residential area, and the commercial activities around the Chunggyechun area were significantly stimulated. From the environmental perspective, the ecologically-friendly area became home to stream houses, living creatures, and people seeking tranquility in the midst of urban life. According to research, the surrounding area averages about 2-5% lower temperatures, which is a welcome change from the heat of asphalt and surrounding concrete streets.

In spite of these achievements, problems related to the lack of diversity among the creatures living in the stream, as well as the restoration of the remaining historical sites, persist.

Chapter 4

Evaluation of River Basin Maintenance and Management Policy within the Framework of Water Resource Development

1. Water Resource Development and Korean Economic Development
2. Multi-Purpose Dam Construction and Maintenance of River Basins
3. Details and Evaluation of Major Multi-Purpose Dam Projects
4. Dam Location

Evaluation of River Basin Maintenance and Management Policy within the Framework of Water Resource Development

1. Water Resource Development and Korean Economic Development

Korea has continuously pursued water resource research and development projects for water resource for more than 90 years since 1910, when the first river basin investigation was conducted under Japanese rule. Water resource policy can be divided into several stages and further classified according to the changing historical backgrounds and national objectives.

The first phase can be classified as the 1910-1940 period, when the policies pursued were mainly focused on river basin restoration based on water control issues. The results of 14 river basin studies throughout the Korean peninsula were used to formulate a river basin restoration plan. A publication in 1928 that contained the results of these investigations is still used today.

The second phase can be classified as the post-Korean war period of the 1950s. During this period, a single purpose development was pursued based on water control and water use. During this stage, the use of river basins expanded from a traditional agricultural land protection objective to the more diverse and technologically advanced hydropower development and water supply. However, at the time, the population density was low, and industrial activity was sparse, so water resource development was restricted to only certain sections.

The third phase is classified as 1960-1970, when long-term water resource development was pursued from the economic development perspective. The fact that the first long-term comprehensive water resource management plan was formulated in 1965 has historical significance.

The fourth phase can be classified as the 1970-1990 period, when comprehensive river valley area development and multi-purpose development were jointly pursued. During this period, a six-year investigative study was conducted on the river valley areas of the Han, Youngsan (including Sumjin), Keum and Nakdong Rivers, involving foreign experts, Korean civil servants, and other scientists. An advanced water gate analysis method was adopted from developed countries.

The results of the six-year investigation were significant and far-reaching enough so that the study is still used today in establishing a long-term comprehensive plan on water resources. The government used the results of the investigative study when putting together the Four Major River Valley Comprehensive Development Plan (1970-1981), as well as other major plans.

The fifth phase is from the late 1990s to 2000s, when economic development created a large-scale demand for water use, leading to deterioration in water quality. Furthermore, the draughts of 1994 and 1995, increased water demand from residents, and the difficulties of finding alternative water sources all pointed to a need for a new paradigm in water resource management policy. Against such a backdrop, it is worthwhile to note that a concept for comprehensive management and environment friendly river basin development was adopted.

However, even with such proactive efforts on the part of the government, the problems of water quality and quantity were not easily resolved, and there was widespread distrust in the quality of tap water. Water-related issues continued to spread throughout the nation, causing conflict between local governments. Thus, the central government tried to address the problem on a more pan national level and created an organization called the water quality improvement team under the prime minister's office that was designed to focus on water issues.

In recent years, the focus of the government's water resource policy changed to environment-friendly river basin management and development. This means that the traditional perspective on water quantity has changed to focus on water quality-related issues.

2. Multi-Purpose Dam Construction and Maintenance of River Basins

2.1. Unique Characteristics of Korea's Water Resources and Dam Development

The water used for public consumption comes mainly from the river basins. When there is too much water in the river basin, this causes flooding. When there is too little, a draught ensues. However, there is an imbalance of water due to seasonal and regional differences. In Korea, the imbalance in space and time is rather severe, which explains why there is so much flooding and draught problems.

The rainfall in Korea is mainly concentrated during three months in the summer between June and August when two-thirds of the entire year's rainfall occurs. Topographically, the topsoil layer around the river valley is thin, and the river channel extension is short and steep, causing vulnerability to flooding. Further, the annual differences in rainfall volume vary greatly by season in Korea. Thus, the country's topographic characteristics are such that flooding and draught (October to May) exist all year long. Furthermore, the regional differences in rainfall volume are so vast that where the southeastern provinces are vulnerable to rainfall shortages, the Jeju and southern provinces tend to receive excess rainfall.

With such topographic characteristics, one of the first measures considered important was the adjustment of the river basins by building many dams. From very early on, Korea emphasized the importance of reservoir development. Damage control from flooding, which was an issue during industrialization and urbanization, was addressed mainly through the construction of multi-purpose dams.

2.2. Formation Process of Multi-Purpose Dam Construction

Water resource development is usually planned to address more than one goal. Such goals include flood control, supplying consumable and industrial water, hydropower development, recreation, tourism, river valley management, protection of wild animals and fisheries, water quality improvement, and employment creation. The process of dam construction, which forms the major basis of water resource management, was no exception and took into account many of the same objectives.

In the 1960s, the export driven economy that emphasized self-sufficient food supply, modernization of the industrial structure and development of technology, necessitated a social infrastructure for water and electric power. The government formulated a Ten-Year Water Resource Development Plan in 1965.

In the 1960s, there was a law governing river valleys. However, such legislation concentrated mainly on water control matters, which primarily restricted river valley access. Thus, a new law that addressed the priorities regarding water management and multi-purpose water utilization, as well as efficient distribution and supply, was needed. Furthermore, to encourage private sector participation jointly with government investment, there was a need to legislate a law on multi-purpose dams.

On April 23, 1966, the Specific Multi-Purpose Dam Law addressed various issues including financing of the construction of dams, support for flood victims, rational use and development of water resources to promote economic development and enhance the quality of life.

3. Details and Evaluation of Major Multi-Purpose Dam Projects

3.1. Sumjin River Multi-Purpose Dam

The Sumjin River is long, measuring 212km in length. It runs from the Cholla Province southeast bound through Kyungsang Province and into the South Sea. The Dong Jin River flows 45km from the upper part of the Sumjin River into the Yellow Sea. Most of its river valley consists of large plains. The lower part of the river is suitable agricultural land. However, the area has always suffered from drought problems due to an insufficient water source. As a result, plans were made to build a dam measuring 40 meters high. This became one of the first efforts to build a multi-purpose dam in Korea, commencing construction in 1925 and completed in 1929.

3.2. Nam River Multi-Purpose Dam and its Reinforcement

The Nam River multi-purpose dam was originally included in the Nakdong River comprehensive restoration plan back in 1920-25, when restoration work took place in 1928-1934. The Nakdong River restoration plan was intended to reduce flooding by 0.7 meters by discharging flood waters from the Nam River to the Gulf of Sachun. However, due to incompletion of the Nam River canal, existing dykes were destroyed, and there was must damage as a result. The Nam River canal project was pursued actively as a result of such flood damage, and construction commenced in 1939 until it was interrupted in 1944. Construction resumed in 1949 with the aid of an international organization, but was interrupted again with the outbreak of the Korean War in 1950.

The Nam River multi-purpose dam was completed in 1970 after the decision to resume construction was made in 1961 as a part of the First Five-Year Economic Development Plan. It was agreed that building a multi-purpose dam was more suitable from the perspective of water control and water utilization rather than limiting construction to the original restoration of Nakdong River.

The Nam River valley area is a region where the monsoon climate in the summer and warm waves of the South Sea coast meet to create hurricanes or massive rainfall. Its annual rainfall volume amounts to 1,416 millimeters. Thus, flood damage before the construction of the Nam River dam amounted to an annual average of 2 billion won.

With the construction of the Nam River dam, most flood problems were resolved, and there was an adequate supply of consumable and industrial water for the southern part of Kyungsang province. The dam became a source of economic growth for that southern and western part of Kyunggi Province due to its uncontaminated hydropower energy.

3.3. Soyang River Multi-Purpose Dam

The feasibility study and fundamental investigation for building a multi-purpose dam in the Soyang River took place as early as the 1950s. In the 1960s, development of the dam became more justified with the onset of industrialization and urbanization, where water demands from the Han River area increased quickly. With the Five-Year Economic Plan of the Korean government, the Four Major River comprehensive development plan was formulated. In 1966, a combined investigation team was formed to convert construction of dams from a single purpose dam to more diversified multi-purpose dams.

In 1968, the investigation team conducted a major study and presented a river valley comprehensive development plan that included construction of the Soyang River multi-purpose dam. The Soyang River Dam was included in the second 5-Year Economic Development Plan, and construction commenced in April of 1967 and completed in October of 1973.

3.4. Andong Multi-Purpose Dam

Studies into the Andong multi-purpose dam began as early as 1961. However, water resource development directives at the time were more focused on singular hydropower development, so the breadth of the plan was rather limited. However, with the need for more expansive water resource development, another investigation was conducted in 1966 for the Andong dam, as well as a basic study for the Nakdong River valley.

After researching widely into various areas to satisfy the growing needs for water supply, several dams were selected for feasibility studies. The Andong multi-purpose dam became a priority, and construction was proposed. The dam was constructed with a loan from the Asia Development Bank, 3.26 billion won from domestic sources, and 17.1 million dollars in foreign loans. Construction commenced in April of 1971 and completed in October of 1976.

3.5. Daechung Multi-Purpose Dam

The Daechung multi-purpose dam was constructed as a part of the Four Major River Valley Development Plan, which was activated from the latter part of the 1960s to early 1970s. At first, the Yongdam area was a candidate for a single purpose hydropower dam. However, as the study was conducted for the Keum River area and its abundant water resources, decisions were made to try to develop these water resources on a broader level for the entire metropolitan area.

Under the initiative of the Ministry of Construction, the Korean Water Resource Development Corporation investigation branch office was set up around the Keum River area in 1967. A final investigative study for this region was executed for five years, and a final report was submitted in 1972. The report recommended construction of the Daechung multi-purpose dam.

3.6. Chungju Multi-Purpose Dam

Construction of the Chungju multi-purpose dam was part of the Four Major River Valley Comprehensive Development Plan. The objective of building this dam was to develop the water resources of the Han River water systems to its maximum capacity so as to be able to supply consumable and industrial water for the metropolitan area of the capital region, as well as the lower area of the dam, and prevent flooding problems. The southern part of the Han River where the Chungju Dam is located covers a river valley area of 12,514 square km and river channel of 373km of a long river basin. It meets the Bukhan River (northern Han River) 20km east of Seoul and fuses into the main stream of the Han River.

The study conducted by the Ministry of Construction and the U.S. over a five-year period recommended construction of the Chungju multi-purpose dam. A feasibility study was conducted from December of 1975 until March of 1977, and construction commenced in June of 1978, and completed in December of 1985. A total of 555 billion won in domestic and foreign investments were made.

3.7. Hapchun Multi-Purpose Dam

The rapid industrialization of the heavy industry and chemical industry in the 1970s, as well as the concentration of population increases in urban areas led to a surge in water demand. Contamination of river basins increased rapidly as well. The government continuously pursued comprehensive development of national land to properly develop water resources.

The investigative study of the Nakdong River valley area conducted by UNDP and the FAO from November of 1966 to March of 1972 recommended construction of the Hapchun multi-purpose dam. The government formulated a plan for construction of the Hapchun multi-purpose dam in 1973. However, pragmatic problems such as overlapping of the plan with the construction project for the Nakdong River area interrupted efforts for financing from foreign sources and led to a financing shortage from the government. Thus, the government decided to pursue the construction of the Hapchun multi-purpose dam separately, and construction was commenced in December of 1983. It was completed in May of 1989 with an investment of 262 million won.

3.8. Chuam Multi-Purpose Dam

Water resources for the Sumjin River valley areas were developed on a partial basis with the building of dams, including the Sumjin River dam, Bosung River dam, and Dongbok River dam. Hence, the water needs for Kwangju City and surrounding areas were met. The Sumjin River valley areas received large volumes of rainfall in the late summer, and they were discharged in a short period of time, subjecting the whole area to regular flood damage. Furthermore, water shortages were regular problems in spite of the fact that the area retained an abundant water resource. Rapid economic growth and urbanization with rapid population increases necessitated an urgent water resource development solution to meet the water supply needs of Kwangju City and the southwestern part of the country.

The government conducted investigations into the dam development area from 1977 to 1979 and selected the Chuam Dam area as the location for development. After a one-year feasibility study, the basic plan was formulated in 1984.

This project is evaluated as a significant accomplishment that channeled water supply for Kwangju City to the southern coastal areas of Korea by connecting the water systems of the two ends from the Bosung River to the Leesachun area through a tunnel – whereby an abundant water supply from the Bosung River area traveled to the southern coastal areas.

3.9. Nakdong River Mouth Dyke

The government realized the need for comprehensive river basin development and conducted an investigation of the four major river basins with the assistance of UNDP/FAO in 1966-1972. The investigation of the Nakdong River valley was part of this study. Through this study, construction of the Andong multi-purpose dam was recommended as a priority construction project, and the dam was completed in 1976 as the first multi-purpose dam for the Nakdong River valley area development plan.

Another investigation of the Nakdong River valley was conducted with the assistance of UNDP/FAO in 1974-1977 because of the unexpected discovery of salt water infiltration in the river mouth area. Thus, it was necessary to conduct an investigation to determine the second priority dam based on the results of the study. In the investigation, the unique characteristics of the salt water infiltration problem as well as permanent prevention methods were thoroughly studied.

As a result of the thorough investigation, it was recommended that building dykes along the river mouth would be efficient and economical while enabling a stable supply of water from the Nakdong River basin area. Thus, the recommendation was incorporated into the Fifth Five-Year Economic Development Plan, and construction of the river mouth dykes of the Nakdong River commenced in November of 1983, completing in May of 1987.

The salt water infiltration problem was a serious issue, and there have been numerous investigations and studies to address the problem since the 1960s. There were interruptions in consumable water supply in the Busan City area for 45 days in 1979, and the situation worsened in 1982 when industrial and agricultural water supply was also interrupted – impacting consumable water supply and even factory operations. Thus, the problem became a major social issue.

As the government recognized the importance and seriousness of the salt water problem, it worked closely with the Korea Water Resource Corporation and the City of Busan to achieve early launching of the dam's construction. Thus, the water problem was solved after completion of the dam in 1983.

3.10. Imha Multi-Purpose Dam and Youngchun Water Corridor

With the construction of the Andong multi-purpose dam in the upper Nakdong River area, an annual 926 cubic meters of water was supplied to the surrounding areas, and the flood level was adjusted – effectively reducing flood damage. Furthermore, an annual 158 million kw of electrical power was supplied, and salt water infiltration and contamination were also eliminated with the dam.

It was expected that the Andong dam alone would be insufficient in responding to the increasing need for industrial, consumable and agricultural water for the inner city areas such as Daegu and Kumi. Thus, severe water shortages were predicted in 1987. Thus, to meet the increasing water needs, the Imha multi-purpose dam was constructed.

Studies into the development of the Imha multi-purpose dam were initiated as far back as 1966 over several occasions. Recommendations had been made by several entities that participated in various investigative studies including UNDP/FAO, Japanese foreign economic cooperation team and the Dowha Comprehensive Technology Company.

A decision had been made after reviewing all of the recommendations from various entities. It was decided that the lower dam area should be developed and would yield the most efficient return. Further investigation into the feasibility of developing the lower dam area took place, initiating in 1983 and competing in 1984. Thus, the results of the investigation were incorporated into the basic plan, as well as the implementation of the comprehensive plan.

According to the Feasibility Study Report on the Restoration of the Keum River, it was pointed out that identifying current problems and solutions in those areas that would benefit from the dam such as Kyungju City and Pohang City etc was important.

3.11. Booan Multi-Purpose Dam

The area around Booan, including Gochang and the surrounding western coastal regions, was having difficulty obtaining water supply to such an extent that water was supplied on alternate days during six months of the year. It was critical that a daily supply of water reach 26,000 cubic meters by 2017. And to secure such water supply, dam construction in Booan was proposed.

The type of dam that the government emphasized for construction up until that point was a large-scale multi-purpose dam that was built on the main stream of the large river valley. Such dams normally did not benefit the mid- or smaller-size areas, and so regional communities that were located in the smaller areas did not obtain an adequate supply of water. Thus, the government planned construction of mid-size dams that covered areas of 50-100 square km with a total reservoir capacity of 2 to 110 million square meters. Feasibility studies were conducted from 1985 to 1986 throughout the country with a view to finding appropriate locations for 15 mid-size dams. As for the Booan Dam, a feasibility study was conducted for a one-year period in 1987.

In 1990, Korean Water Resource Corporation and the Ministry of Construction agreed on the construction details, and the site investigation and designing of the dam was done for first time with the sole technology of the Korean Water Resource Corporation. Other studies

such as investigations of the geological make up, environmental evaluations, and material sources were outsourced. The dam was completed in 1996.

3.12. Hwaengsung Multi-Purpose Dam

The Chungju Dam, which was built around the river valleys of the southern part of the Han River, supplied water to the coastal regions around the lower and main part of the river valley. However, cities like Wonju or the tributary areas of the Sum River, which were located around the lower river valley of Sum River, suffered water shortages, as well as threats from flooding. Thus, the government made plans to promote balanced development of national land and proceeded to plan construction of a dam in the Sum River area, which was located around the tributary of the southern part of the Han River.

As the government's efforts concerning dam construction focused mainly on building large-scale multi-purpose dams on the main stream of the river valley, the lesser regions did not benefit from such dam construction. Thus, the government proceeded to conduct a feasibility study to build 15 mid-size dams throughout Korea. Feasibility studies were conducted from December 1986 for ten months for this purpose. The rationale for construction of the Hwaengsung Dam was accepted, and the Korean Water Resource Corporation used its own technology to make fundamental plans to implement the project.

3.13. Milyang Multi-Purpose Dam

The water supply rate for the Milyang area measured 44 percent, which was significantly lower than the national average of 74 percent. As part of the government measure to achieve balanced economic growth throughout the nation, industrial complexes were planned. Further, several large-scale industrial complexes around the southern part of Kyungsang province were at their saturation points in terms traffic, land supply, water supply, and other resources. People sought to relocate to other areas with better living conditions, and higher demand for water supply was expected around the area. Thus, the government's plan enabled stable supply of water in the future for the surrounding areas of Milyang and growth of the local economy.

3.14. Yongdam Multi-Purpose Dam

The government had made comprehensive plans to develop the western coastal areas of Korea due to their potential for economic growth as harbors. The western coastal areas of Korea indicated potential for trade growth due to their proximity to the Pacific Ocean. Korea saw its position as an economic and trade leader in this Pacific area and was at the time in the process of establishing diplomatic relations with the Eastern Bloc such as Russia and China.

With the potential for growth in the western coastal regions, the government planned to build several local industrial complexes around major cities such as Jeonju, Kunsan, and Iri. Given this anticipated growth, a shortage of water around the major cities and surrounding areas was expected.

All of the western coastal cities are located near the Mankyung River, which has a small river valley. Thus, securing water supply from the local source was difficult to start off with. It became critical to develop new water resources and corresponding facilities, leading to the decision to construct a multi-purpose dam to supply water needs for the area and achieve balanced economic growth. Thus, they proceeded to pursue construction of the Yongdam multi-purpose dam.

Based on the feasibility study for the region that was conducted in 1988 for one year, the dam to be built in Yongdam was to be multi-purpose and require six years to complete. However, there existed the possibility that water shortage problems for Jeonju could surface before completion of the dam, so construction of the dam should be expedited.

3.15. Youngwol Multi-Purpose Dam

Construction of the Youngwol Dam was part of the long-term comprehensive plan to develop water resources in the Han River valley area. The water resources retained by the Youngwol Dam, which is located on the upper part of the southern part of the Han River, should be put to efficient and multi-purpose use. At the time, the Chungju multi-purpose dam already existed on the southern part of the Han River. But construction of the Youngwol multi-purpose dam was pursued as a solution to address the flood control problem, which usually occurred in the 117km area between the Youngwol Dam and Chungju dam, and the 204.8km area between the lower tributaries of the Chungju Dam and the lower mouth of the Han River. The Youngwol Dam would prevent flood damage as well as achieve balanced economic growth between the river valley areas. Further, the dam was to make a significant contribution to securing water supplies, uncontaminated electric supplies, and long-term national land development plans.

4. Dam Location

One of the best places for building a dam is the narrow part of a deep river valley; and the valley sides could then act as natural walls. The primary function of the dam's structure is to fill the gap in the natural reservoir line left by the stream channel. The sites are usually those where the gap is the minimum required for storage capacity. The most economical arrangement is often a composite structure such as a masonry dam flanked by earth embankments. The current use of the land to be flooded should be dispensable. There

are also other engineering and engineering geology considerations when building a dam, including the following:

- Permeability of the surrounding rock or soil
- Earthquake faults
- Landslides and slope stability
- Water table
- Peak flood flows
- Reservoir silting
- Environmental impacts on river fisheries, forests and wildlife (see also fish ladder)
- Impacts on human habitations
- Compensation for land being flooded as well as population resettlement
- Removal of toxic materials and buildings from the proposed reservoir area

4.1. Multi-Purpose Dams and Accomplishments

4.1.1. Water Supply

The primary purpose of dams is to retain water in the reservoir during high rainfall and supply the water during seasons of draught. Water supply from multi-purpose dams was sufficient to prevent draught problems. There was severe draught throughout the nation in 1978, 1981, 1992, and 1994. However, multi-purpose dams supplied adequate and stable amounts of water so that the regions around the lower river mouth and coastal regions did not experience any draughts.

Some lessons learned from excessive reliance on multi-purpose dams include, for example, when there were contamination problems involving bad odor or accidental toxic material released, an emergency measure was to release extra amounts of water to dilute the contamination problem. However, the temporary solution to improve water quality was insignificant compared to the amount of water lost. Thus, a separate measure to handle contamination problems became necessary.

4.1.2. Flood Control

The flood control function of a dam refers to how a dam controls and retains large amounts of flood water and releases the water slowly so as to prevent flooding in the lower river valley areas. In particular, large-scale multi-purpose dams can maintain a high level of

control on river valley water quantity to reduce flood damage as well as convert the water resources for supplying various types of water needs, such as industrial, agricultural, and consumable water.

The effectiveness of a dam is very significant. In the event of heavy rainfall, the dam almost completely stops flooding, especially in the lower river mouth areas. A dam controls flooding by maintaining low water levels and prepares for large amounts of rainfall.

On August 31-September 3, 1984, there was massive flooding in the Han River valley area where the amount of rainfall around the Soyang River multi-purpose dam area was 449.7 mm. The maximum capacity of the dam's intake per hour was 11,994 m, and the rainfall nearly reached its maximum level – the highest since the dam's construction. But water level was controlled at the Soyang multi-purpose dam such that the water level on the pedestrian overpass of the Han River was lowered by 1.23 meters, thereby reducing flood damage around the entire capital region. This incident is a testament to the importance of a multi-purpose dam in flood control.

Another example of flood control by a multi-purpose dam occurred during the massive rainfall of September 1990. The water level on the pedestrian overpass at the Han River reached its third highest in history at 11.27 meters as a result of rainfall from September 9 to 12. The areas that sustained damage were mainly around the Han River valley. Efficient water control made possible by both the Soyang Dam and Chungju Dam succeeded in lowering the water level on the pedestrian overpass at the Han River to 2.05 meters.

Similar success stories were recorded regarding the water control mechanism in the Keum River valley areas by the Daechung Dam. Furthermore, the Peace Dam that was constructed specifically for the purpose of flood control in preparation for a possible water attack by North Korea was designed to control any level of flooding by controlling the drainage tunnel. Such dams also made significant contributions to flood control around the capital region.

4.1.3. Hydropower Development

Korea's effort to secure electric power supply focused at first on hydropower. But after the division of North and South Korea, electric power supply was interrupted, and South Korea concentrated on supplying electric power through thermal power. Recently, nuclear power plants have begun to replace such power supplying mechanisms. However, nuclear power plants are inadequate in instances where supply control is difficult. Thus, the problem of residual excess electric power supply needed to be addressed by building facilities to store such excess electricity in order to enable stable supply of electric power.

Multi-purpose dams were initially built with a singular view to developing hydro power supply. However, during the feasibility study investigation period, the importance of having various types of water supply became apparent, and dams became increasingly multi-purpose. Accordingly, for many multi-purpose dams, the highest budget is allocated for hydropower development, and efforts are made to secure funds for this purpose.

4.2. Contribution to Economic Development

Multi-purpose dams made many contributions apart from just supplying water, controlling flooding and supplying hydropower. Building multi-purpose dams was a major large scale construction effort for the country that generated many employment opportunities. Furthermore, the skills, knowhow and experience accumulated from building such major structures were useful as exported skills to other countries. In fact, Korea's ability to export such skills played a major role in reviving the Korean economy during the times of the oil crisis and severe foreign currency shortages.

The employment created by multi-purpose dam construction reduced the unemployment level by 0.02 percent between 1968 and 1990, and an estimated 0.18 percent economic contribution resulted.

A stable water supply from the multi-purpose dams reduced tap water bills for people and infectious diseases to virtually 0 percent. Thus, the quality of life was improved significantly.

4.3. Water Resource Development: Accomplishments and Tasks

4.3.1. Accomplishments of Water Resource Development

In the 21st Century, people's interest in and level of awareness of environmental issues increased. The government responded to this growing awareness by restoring the environment surrounding river valleys and undertaking similar water resource projects. In the case of streams and river valleys around the city, efforts were being made to prevent water from drying out or, as in the case of Chunggyechun, to restore water streams that had already dried up. Projects that provide recreational space or restoration of water environments are well-received by the people. Further, preservation of wetlands or river valleys in their natural states for future generations is also a newly appreciated effort.

a. Establishment of Long-term Plan for Restoration of River Valleys and Environment-Friendly Use

Rivers have always been the source of water supply for people. Rivers also have a cleaning function of discharging waste into the sea, as well as an important transportation medium for ships. Furthermore, rivers also protect people's livelihoods and property by flushing out overflowing water into the sea. However, the recently favored usage of rivers is as a cultural setting for people to enjoy for recreational purposes, promoting a balanced harmonious relationship between nature and people.

When there isn't enough rain, the river bottom appears immediately. Such drying of the river causes problems with water supply. In the case of small- or mid-size rivers, economic problems could result in the event of a water shortage or contamination of water. When there is a shortage of river water, water quality becomes contaminated, resulting in a shortage of consumable water. Under such conditions, it would be impossible to expect the river to serve as a cultural space for people to enjoy. Thus, in order to provide a recreational space for people, securing a reliable water supply is a prerequisite.

In order to prevent rivers from drying out, it is necessary to recharge the ground water. Sometimes, an artificial retention system must be set up to ensure that water flow is maintained. Normally, a dam would serve such a purpose as it collects the water to be released when needed. However, due to environmental and ecological and social reasons, construction of dams is difficult. In the case of the Han River, the large-scale multi-purpose dams situated on the upper river area controls water flow, so rivers drying up are a relatively rare phenomenon. Recently, there have been efforts to pump back the residual water that remains in the lower river disposal sites to maintain river flow and prevent the upper river area from drying up.

When it comes to maintaining river water, a minimum level and quantity of water should be maintained in the river for various purposes, including protection of river area facilities, fisheries, and scenery, as well as water quality maintenance of the river. To ensure such maintenance of river flow, certain environment-friendly measures such as securing water in natural reservoirs and extending the water release time for more natural activity can be considered.

Twenty years worth of long-term comprehensive plans have been formulated since the 1960s. Recent efforts have focused on improving water quality, while in the past, the priority was primarily increasing water quantity. In particular, the long-term comprehensive plan of 2001 and 2006 focused on maintaining a continuous flow of river water, which will solve water supply problems as well as provide environment-friendly cultural and recreational space.

b. River Restoration Project

The river restoration projects, which centered on urban river stream restoration, created a new need for river management policy. With improved living standards, there has been an ever-increasing call for quality improvements in environment-friendly water recreational space. Local governments are actively restoring water areas to meet such public demands. The Ministry of Land and Maritime Affairs adopted management systems that divided the relevant regions in accordance with different preservation needs, such as ecological protection, restoration, and water-friendly areas.

The Chunggyechun Restoration project became a leading role model for restoration projects that not only targeted river streams, but also overall environment-friendly river stream development and historical culture preservation. The project also created tourism and cultural space, as well as succeeded in reviving the economic competitiveness of the northern area of the Han River. The project is significant in the sense that it transformed Seoul into an environment-friendly ecological city while also succeeding in providing a river stream as a space for relaxation and recreational use.

c. Water Relaxation Space and Recreation

From the mid-2000s, Koreans began to enjoy a five-day work week with two-day weekends, which increased overall interest in recreational activities. Water does not only provide for biological needs, but also plays a major role in recreational activities. Such water source-related projects affect not only individuals but also society in general. Water-related recreational activities that attract tourism will affect the local economy and create employment and thus can be expanded into local economic growth. The manmade lakes and water-friendly spaces created through dam construction would provide a recreational space and play a role in creating cultural relaxation space.

d. Comprehensive and Systematic Water Resource Management on National Level

The systematic framework for a pan-national effort for water resource development policies was provided through past individual plans pursued for water resource development. In particular, the long-term comprehensive plan that was established in 2001 pursued investigative studies on river valleys and formed systematic plans to implement river valley water control systems. Furthermore, maintenance of water resources also took on a more systematic form as a result of formal planning based on the results of the investigative studies. The central government and local governments collaborated to establish a long-term management plan for water resource development.

e. Limitations of Domestic Water Resource Development

After the Korean War in the 1950s, the government formulated a Five-Year Economic Development Plan and proceeded to secure necessary water supply and flooding prevention by building multi-purpose dams and conducting investigative studies of river valleys. In 1965, the water resource use level was 5.12 billion cubic meters, and this number increased to 33.7 billion cubic meters in 2008. Water use per capita had increased from 82 liters a day to 450 liters a day. With the construction of multi-purpose dams, flood prevention capability had increased significantly, and the tap water distribution rate was higher than 90 percent. However, due to recent climate changes and the greenhouse effect, there was an increase in flooding, draught and contamination problems, posing new challenges in water management policy. In this regard, there is an increasing need for environment-friendly water resource development, river maintenance, securing of water resources for river restoration, investment in basic facilities that can adequately respond to flood or draught problems, and other measures.

Korea faces several limitations in terms of water resource development. First, there is a lack of materials on river environment conditions and evaluations thereof. Despite a few investigative studies, some basic data accumulated, and sporadic evaluations for use in the planning process, there is not enough fundamental data on river environment conditions that can be used nationwide on a uniform basis. This limited data makes it difficult to formulate a comprehensive plan with any precision.

Second, water quality is still not a top priority. Although there has been improvement in the way water quality issues are incorporated into the planning process, generally, priority is given to water control and water use issues when making policy decisions on river environment maintenance.

Third, plans and implementation are initiated and led by the government. Community participation is usually lacking in these processes, and the needs and concerns of the community are often inadequately reflected. Although this situation has somewhat improved over the years, even when constructing large-scale multi-purpose dams, not enough consideration is given to community concerns, resulting in environmental and regional problems.

Fourth, establishing a river development plan that adequately reflects regional characteristics is important. When making plans, the unique characteristics of the river as well as the history and culture surrounding the area should be taken into account. However, in reality, the focus of the planning process tends to be on uniform application of river maintenance policies, which sometimes creates conflict with regional factions.

Fifth, concerns regarding stable supply of adequate water resources that is both high quality and quantity remain at the foundation of any initiative. While public demand for water supply is increasing, the conditions for building dams are becoming more difficult. Dam construction must take into account several important factors such as traffic interruption for freight due to water channel blockage, ecological changes, climate changes such as fog and high rainfall, changes in underground water levels, earthquakes or landslides, changes in sulfur in the river, destruction to the environment, and noise pollution. All of these matters must be taken into account, and environmentally hazardous factors must be eliminated when building dams.

Sixth, there is the problem of redevelopment of existing dams. The purpose of multi-purpose dams reflects the prevailing water management conditions of that time of construction. However, management is based on current, existing environmental conditions. At present, multi-purpose dams are managed in the best way possible, taking into account current environmental conditions. But formal data such as distribution of reservoir quantity and division of expenses in accounting according to spending by purpose are limited. These constraints make it sometimes difficult to handle a problem in a proactive and pragmatic manner. While planning as to whether a dam should be redeveloped is a question of policy, how to respond effectively to various problems is a management issue. Flexible management of water resources is required to efficiently operate multi-purpose dams and, if necessary, structural changes should also be considered to solve the problem.

Another task for proper water resource management is conversion into a total comprehensive management system. There should be a system that allows for a total review and locates alternative policy solutions by reviewing how the dams can be efficiently managed, the benefits of constructing a new dam, safety water supply systems, development of water resources and underground water, and other activities. An efficient water use solution should be formed, reflecting regional particularities and being based on the water resource management experience of that region.

It is time for proactive preparation for averting future water crisis situations due to changes in the environment and this planet. Preparations should be made in stages to facilitate effective development, supply and distribution of water resources. Water problems are not only an environmental concern, but also directly related to livelihoods –not to mention the moral responsibility of this generation to pass on clean and pure water resources to future generations.

There is also a need for total uniform measures that are connected to long-term policies of the government. It is necessary to maintain two distinct water resource development directions – total management and environment-friendly management. Such policy

directions are important because of the international culture on water policy being green growth and environment-friendly development. Any industry that neglects environmental issues and products that discharge contaminated materials, or any nation that has not established environment-friendly water management policies will face restrictions in the international community. Environment issues are connected with politics, economics, society and culture like chains in a link, and finding alternate solutions for one area will not solve the entire problem.

2012 Modularization of Korea's Development Experience
Korea's River Basin Management Policy

Chapter 5

Lessons and Recommendations

1. Lessons of Korean Water Resource Development Experience for Developing Countries
2. Recommendations

Lessons and Recommendations

1. Lessons of Korean Water Resource Development Experience for Developing Countries

1.1. Contribution to Water Supply for Economic Growth, Flood Control and Electric Supply

Water is an irreplaceable element in this world and essential for people to survive. Water supply and hydropower form the fundamental basis of social infrastructure. A stable water supply was critical in ensuring domestic economic development. Thus, the construction of multi-purpose dams made a major contribution to solving water shortage problems. Such experience will serve as a useful example for developing countries on the verge of launching economic development plans.

Multi-purpose dams make tremendous contributions to flood control, water supply, electric power supply through hydropower plants, and other energy-related activities. Construction of multi-purpose dams and infrastructure for tap water systems that connect river valleys allows for tap water to be supplied to people at a relatively low price. Furthermore, such systems can also lower the breakout rate of infectious diseases. It is important for developing countries to understand these extended benefits when building their water supply infrastructure so as to minimize misguided resistance.

1.2. Contribution to Economic Development through Government Led Large Scale Civil Engineering Projects

In the early years of economic development in the 1960s, when poverty prevailed throughout the country, a large-scale project such as construction of a multi-purpose dam created many employment opportunities, thereby playing a major role in economic growth at the time. From 1968 to 1990, the unemployment rate decreased by 0.02 percent as a result of employment creation from dam construction, and the national GNP rose by 0.18 percent.

Construction of a multi-purpose dam was a large-scale comprehensive project that served as the fundamental cornerstone for the growth of the civil engineering industry in Korea. Given such experience, Korea could export its knowhow to foreign countries. In fact, during the two major oil crises, when Korea suffered a shortage of foreign currency, exporting such knowhow in construction did serve to relieve some of Korea's economic problems. Such experience can set a model example for developing countries.

The planning of multi-purpose dams was done by the Ministry of Construction Transportation, with the exception of the Sumjin River and Nam River multi-purpose dams. These were implemented directly by the government. It was the Korean Water Resource Corporation that implemented all of the other projects. The investigation and designing processes were mostly done by foreign companies by contract with the exception of those few cases in which the government oversaw the project and later delegated the work to the Korean Water Resources Corporation. This organization also audited the work of foreign companies. Dam construction was done almost exclusively by foreign companies, but civil engineering was provided by Korean companies, and the supervision and inspection procedures were conducted by the Korean Water Resource Corporation. Such experience shows that foreign knowhow was transferred to Korea through the experience of joint collaboration with foreign entities during the process of constructing dams, also contributing to the growth of the civil engineering industry.

1.3. Improved Urban Image

The restoration of Chunggyechun was not simply restoration of a river stream, but a restoration project with historical and cultural implications for the city as well. The real significance of Chunggyechun is that it was an advanced environment-friendly river stream restoration project. It served to form a fundamental basis for transforming Seoul into an environment-friendly city with ecological consciousness that brought about a fresh river stream and recreational space for its people. Project Chunggyechun is a testament to the possibility that a city's image as a developing country can be changed to that of an advanced country, and developed in kind through water maintenance and well planned restoration projects.

2. Recommendations

2.1. Korean Government

The current river basin management is divided into the national river basin and regional 1, 2 class river basins (small river basin). Furthermore, the system divides management into administrative structures. It is necessary to recognize that water streams and stream corridors combine the water streams into a comprehensive management structure. And it is important to promote cooperation between the different departments.

2.2. ODA for Developing Countries

Overseas Development Assistance (ODA) has several benefits. It could prevent disruptions in river basin development, as well as mitigate the appearance of swamps and ponds caused by water use and poor water control in the course of river basin management. Integrated Water Resource Management (IWRM) is an integrated water resource management concept that could improve the efficiency of water resource policies. Strengthening water storage capacity leads to improved dam management methods for effective water resource management. ODA also facilitates the adoption and application of the most efficient models for linked management of single purpose dams with multi-purpose dam operation methods. Finally, redevelopment of agricultural reservoirs and existing dams is an important consideration when formulating and executing water resource development policy.

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