

A Study on the Application and Assessment of Urban River Restoration in the Anyang River

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안양천 도시하천 복원의 실행과 평가에 관한 연구

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ABSTRACT

The Anyang River which located in an urban area near Seoul had been managed focusing on supplying home and industrial water and preventing floods, coping with rapid industrialization and urbanization. Consequently, it was changed into a deadly river during 25 years. Its channel was straightened by concrete and water quality deteriorated to BOD 190mg/l. In addition, water quantity has been rapidly decreased and has been drying up. Also, as the river ecosystem, landscape, water-friendly function, and so forth were seriously deteriorated, people turn away from the urban river. From 2001, the master plan under the 10-year has been actively carried out centering on the preceding items, which are healthy river in which fishes inhabit, safe river free from floods and droughts, and pleasant river where citizens visit. As a result, its water quality was remarkably improved by BOD 5mg/l in 2005 and some upper zones were improved enough to allow people to swim. Moreover, various animals including fish and birds gather around the river. Now, the 'Anyang River Restoration Project' is recognized as the first comprehensive and systematic nature-friendly urban river improvement in Korea.

Key Words : *River Ecosystem Restoration, Channel Improvement, Water Quality Improvement, Water Quantity Security, The Anyang River.*

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I. INTRODUCTION

The demand on high-quality living has been remarkably increased while nationwide river channelization rate for water use and flood control reaches the peak. As the result, the main project in rivers has been changed to the 'nature-friendly' or 'close-to-nature' river improvement in these days.

Since the early 1990s, river improvement projects considering river environment are being actively carried out in Korea, in particular, based on 'Nature-Friendly river Environment Improvement Project' of Ministry of Construction and Transportation, 'Close-To-Nature river Purification Project' of Ministry of Environment and 'Ecological river Project' of the local governments. These activities became possible as the articles on 'the improvement and conservation of river environment' were added to the River Act in 1999.

Formerly, the Anyang River had been managed focusing on supplying home and industrial water and preventing floods, coping with rapid industrialization and urbanization. Although it was successful take the situation in those days into account, it was changed into a deadly river during 25 years. Its channel was straightened by concrete and water quality deteriorated to BOD 190mg/l. In addition, water quantity has been rapidly decreased and has been drying up. Also, as the river ecosystem, landscape, water-friendly function, and so forth were seriously deteriorated, people turn away from the urban river.

'A task-force team for reviving the Anyang River,' consisted of specialists from the related fields, was organized in August 1999 to solve problems of the Anyang River. And this T/F team established comprehensive and systematic plans reflec-

ting the condition of the river characteristics. In April 2004, the team also established 'A Master Plan for Restoring the Anyang River,' covering several items such as (1) Channel improvement, (2) Water Quality Improvement, (3) Water Quantity Security, (4) River Ecosystem Restoration, and (5) Citizens' Active Participation.

From 2001, the master plan has been actively carried out centering on the preceding items under the 10-year plan. As a result, its water quality was remarkably improved by BOD 5mg/l in 2005 and some upper zones were improved enough to allow people to swim. Moreover, various animals including fish and birds gather around the river. Now, this project is recognized as the Korea's first systematic and comprehensive plan for river environment improvement.

This study was performed to introduce the major contents of the master plan and to examine the details of important projects.

II. SCOPE AND CONTENTS

1. The condition of the Anyang River

The Anyang River is the primary tributary of the Han River. It covers 14 municipalities (7 cities in Gyeonggi Province and 7 local governments in Seoul) and the basin of 286.55km².

As shown in Figure 1, this plan targets on the river of 32km long within Anyang City and the basin of 58.48km² (accounts for 20.4% of total). Four tributaries (Hakeui R., Suam R., Samsung R., and Sammak R.) subjected to this area.

Similar to typical Korean climatic characteristics, the annual mean rainfall of the basin is 1,203mm. Figure 2 show its longitudinal profile of mean bed level, the change of river width, and the riverbed materials of channel, respectively.



Figure 1. The basin of the Anyang River and target area.

III. PRACTICE AND DETAILS OF THE ANYANG RIVER PLAN

1. Water Quality Improvement Project

Ascertaining the former data, the Anyang River was relatively clean with BOD 7.7mg/l. However, the numeric has been increased by 100mg/l in the late 1970s. In particular, its BOD indicated the worst numeric of 193.3mg/l in 1984. Fortunately, the numeric has been gradually decreased thanks to the sewage treatment plant established in 1995; it was decreased from 50mg/l (1995) to 20mg/l (2000). Any creature cannot inhabit in the Anyang River for the past 25 years.

2. Goals and Missions

The basic concept and concrete goals of the master plan established in 2001 referring to brain storming, citizens' opinion, governmental policy and something else synthetically. In particular, water quality improvement, water quantity security, and channel improvement were intensively carried out so that various creatures including fish can inhabit there.

Simultaneously, it was performed to form the nature friendly river suitable to the restoration of river ecosystem and the security of flood control.

1) Practice for Pollutants and Sewage

As previously stated, the water quality improvement of the Anyang River was critical. This project performed the water quality improvement project through preventing pollutants, improving and managing sewerage, constructing sewage treatment plant, introducing advanced treatment process, removing the heavy metals of the Sammak River (a tributary of the Anyang River) and dredging riverbed deposits.

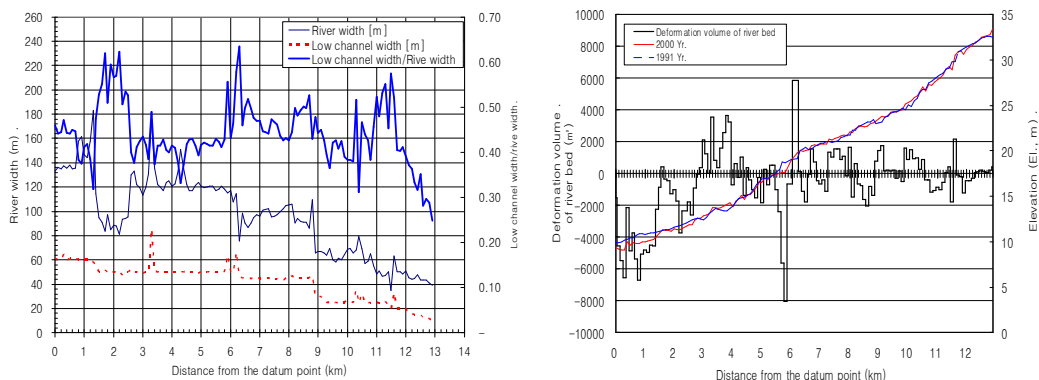


Figure 2. The annual change of deformation of river bed (left) and the longitudinal change of river width (right).

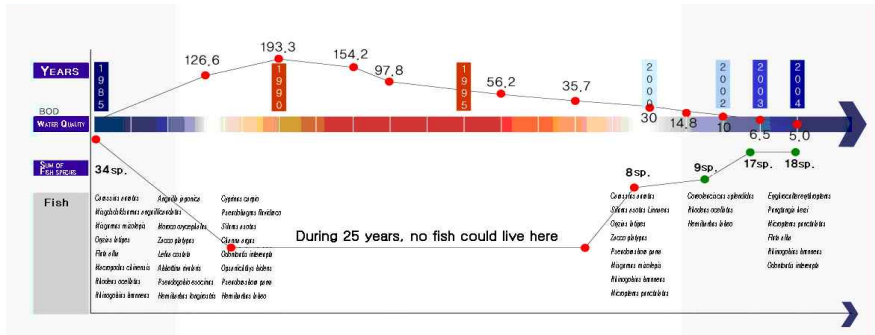


Figure 3. The Annual State of Water Quality and Improvement Effect in the Anyang River.



Figure 4. Sewage Treatment Plants (Left : Bakdal Plants established in 1995/Right : Seoksu Plants established in 2002).

2) River-Purifying Facilities

The river-purifying facilities were directly equipped in order to improve the water quality within the channel. As concerns suitable to the Anyang River, the ‘gravel-contact oxidation purification’ was applied because it has high efficiency on removing suspended solids, needs low power

and is easily manageable. Actually, the technique daily purifies the Anyang River and Hakeui River by 2,500 ton and 7,250 ton, respectively.

Likewise, the team has continuously publicized that the use of detergent should be decreased, waste oil should be reused, leftover foods should be separately wasted, illegal wastewater release

Table 1. The Estimation of Maintenance water in the Anyang River and Supply Plan. (Unit : ton/day)

	Upper river	Mid-river	Lower river
Minimum Flow	4,500	16,800	24,000
Estimation of Maintenance water	10,500	23,000	30,000
Secured Quantity	6,500	6,200	6,000
Supply Plan	Treated Wastewater Seepage Water of Subway Basin Management	5,000 1,680 -	

should be observed, etc. together with citizens' organization.

2. Water Quantity Security Project

Ordinarily, developing new water resource, apply-

ing the existing water resource, strengthening wastewater treatment, deriving other water resources, circulating maintenance water, reusing the treated wastewater, etc. are applied to secure water quantity. However, the maintenance water of the Anyang

Table 2. Maintenance Water-supplying Methods.

Maintenance Water Security Method	Water Quantity	Application
<p>(1) The Application of Treated Wastewater</p> <p>Applying the water treated by advanced treatment process at the plant</p>	<p>36,000m³/day</p>	
<p>(2) The Application of Seepage Water in Subway</p> <p>Applying the ground water from 3 subway stations (1,680m³/day, 2,520m³/day and 1,200m³/day, respectively) in Anyang City</p>	<p>5,400m³/day</p>	
<p>(3) The Inflow of Clean Water from riverlet</p> <p>Preventing wastewater from flowing in through the partition between wastewater and river water</p>	<p>3,000m³/day</p>	
<p>4) The Discharge of Reservoir Water</p> <p>Applying the water restored in Baekun Reservoir (Established in Dec. 1999/Suppled in Dec. 2001)</p>	<p>2,000m³/day</p>	
<p>(5) The Construction of a Small-Scale Dam</p> <p>Building a small-scale dam for securing maintenance water (established in Sep. 2002)</p>	<p>Discharge 32,000m³</p>	

River should be securing within the basin as it is realistically impossible to be supplied from other basin.

1) The Estimation of Maintenance water in the Anyang River

The maintenance water of urban river is a minimum quantity necessary to natural function (protecting ecosystem and maintaining sights) and artificial function (water-friendly function). In case of estimating the maintenance water of the Anyang River, higher numeric was calculated between natural and artificial function.

2) Results and application of Supply Plan

Formerly, the water quantity of the lower Anyang River was approximately 25,000 ton/day and it was nearly impossible for underwater creatures to inhabit there. However, the Team secured the water quantity of 47,000 ton/day, secured stable quantity, and improved the ecological environment. As a result, the 18 species of fishes including minnows inhabit in the Anyang River as of 2005 as well as the water quantity of 72,000 ton is being supplied every day.

3. Riverine Ecosystem Restoration Project

As the Anyang River's channel was straightened and its water quality deteriorated in the process of urbanization, its inherent ecological functions were seriously damaged. The Team conducted overall survey of the current condition of ecosystem around the Anyang River, with the intension of restoring the Anyang River ecosystem and solving related problems.

1) Survey of the riparian ecosystem and zoning the space

In order to restore the damaged ecosystem and nature-friendly environment, the team thoroughly investigated channel characteristics of the Anyang River and its tributaries. The Team also surveyed animals and plants shown in Figure 5. Based on the survey results, the surrounding spaces were divided into 3 zones : conservable zone, restorable zone, and improvable zone.

2) Nature-friendly river improvement

The Team made the restoration plans into 'general' and 'local' habitat plans for the nature-friendly river improvement. In addition, the project

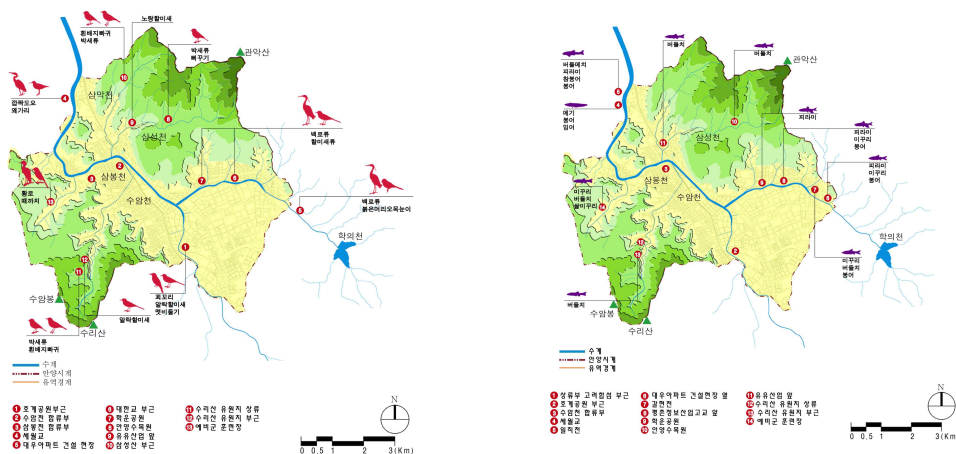


Figure 5. The Ecological Map of Waterfowl & Fisheries in the Anyang River Basin.

was begun at the upper river focusing on water quality improvement. The environmental revetment, riffle and pool, fish habitat and wetland were formed, and parking lots were removed or repaired.

IV. CONCLUSION

The ‘Anyang River Restoration Project’ is recognized as the Korea’s first comprehensive



(1) Forming revetments using natural materials



(2) Forming gently-declined revetment



(3) Securing the continuity of river by improving barrier and small dam (considers fishes)



(4) Forming creatures’ habitat by removing parking lots (considers frogs’ habitat)



(5) Improving the straight channel (considers the mobility of riverbed materials)



Figure 6. Nature-friendly River Improvement.

and systematic nature-friendly urban river improvement project. The master plan was established considering the environmental function not to mention water use and flood control, under the motto : (1) Healthy Anyang River in which Minnows inhabit, (2) Safe Anyang River Free from Floods and Droughts, and (3) Pleasant Anyang River where Citizens Visit.

Also, based on the annual plan, projects on water quality improvement, water quantity security, ecosystem restoration, citizens' participation, etc. have been systematically carried out up to now.

Thanks to such passionate activities, the Team was awarded President's Prize in 'The Day For Water' in 2003. It means that the project is recognized as a Korea's representative campaign. Such results are caused by the passionate efforts of government, municipalities, industrial bodies, academic institutions, and so forth. They continuously have made efforts to solve the problems of the Anyang River, such as water pollution, insufficient water quantity, the damage of ecosystem, citizens' indifference, etc.

The river is a particular system because it is composed of the water and various materials flowed in from the surrounding basin as well as it is closely related to natural system and human world. The river ecosystem improvement is archived gradually and slowly for a long time differently from land. In case the citizenry understand such facts, the Anyang River Restoration Project will be accelerated as well as it will be its worth.

LITERATURE CITED

- Anyang City. 2001. "The Anyang River Restoration Master Plan".
- Ministry of Construction and Transportatio. 1983. "A Report on the Anyang River Basin".
- Samhee LEE et al. 2001. "Deformation of Characteristics of river bed in the Anyang River" Proceeding Papers, Korea Association Civil Engineering.
- Gregory, K. J. 2006. The human role in changing river channels, *Geomorphology*, 79 : 173-175.
- Yarnell, S. M. Mount, J. F. and Larsen, E. W. 2006, The Influence of relative sediment supply on riverine habitat heterogeneity, *Geomorphology*, 80 : 310-324.
- Lee, S., K. Fujita., T. Tsukahara., S. Watanabe, and K. Yamamoto. 1998. The effect of flood and fine sediment flow on stable vegetation in a gravel bed river. *Annual Journal of Hydraulics Engineering, JSCE*, 42 : 433-438.
- Fujita, K. S. Watanabe and S. Lee. 1998. The importance of sedimentation on vegetation change in a gravel bed stream, *Proceedings from the 4th seminar on river water use and environment, River Division of Hydraulics Engineering Committee, JSCE*, pp.117-122.
- Mulder, T., and Alexander, J. 2001. The physical character of subaqueous sedimentary density flows and their deposits. *Sedimentology*, v.48, p.269-299.