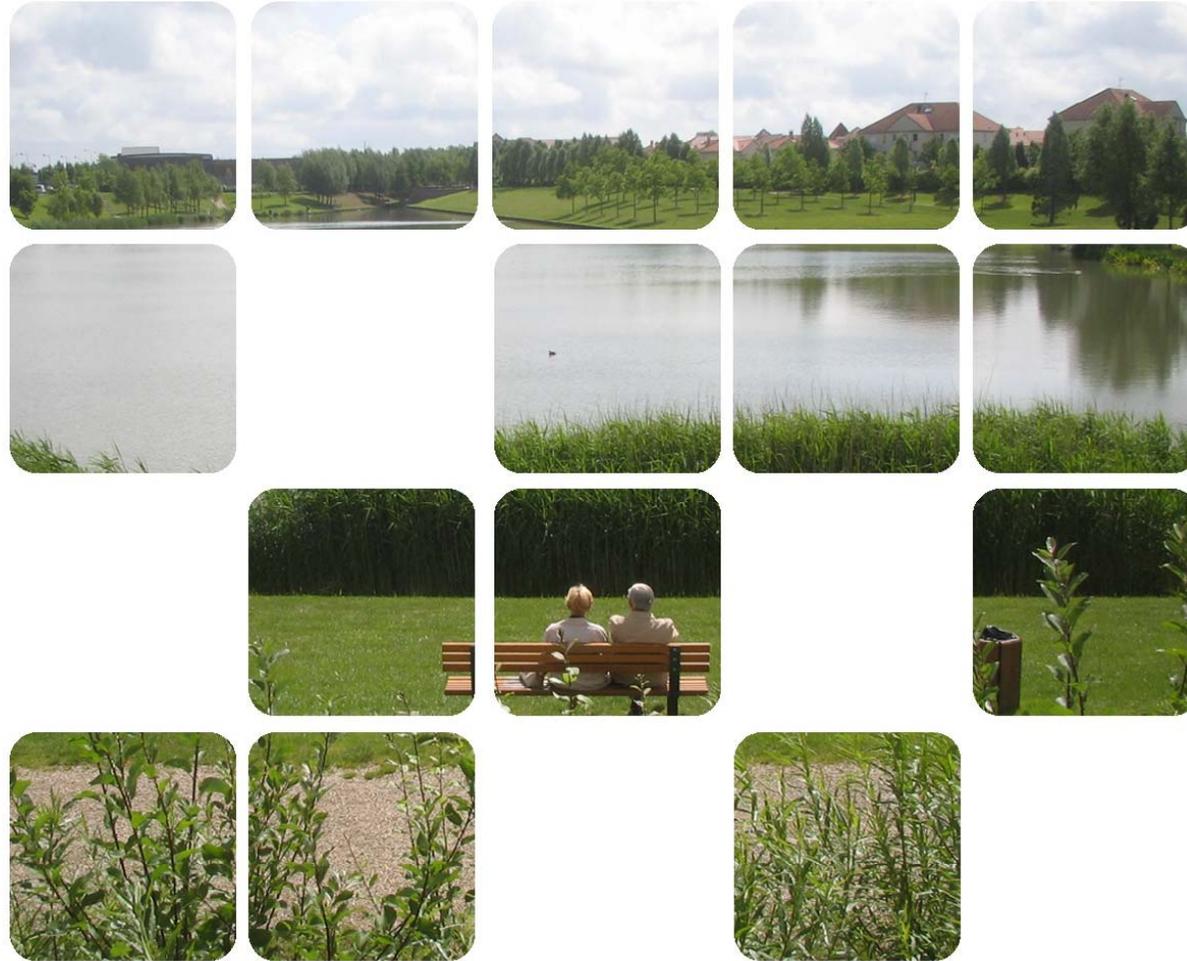


WETLAND RESTORATION TO ENHANCE BIODIVERSITY IN URBAN AREAS : A COMPARATIVE ANALYSIS



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* This paper has been presented at the URBIO 2010, Nagoya, Japan, as the paper for keynote speech.



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1. Introduction

1.1. Objectives

- § To identify conflicting values of wetlands in terms of planning system and wetland restoration issues in cities
- § To conduct a comparative analysis of wetland restoration methods and techniques

1.2. Methods

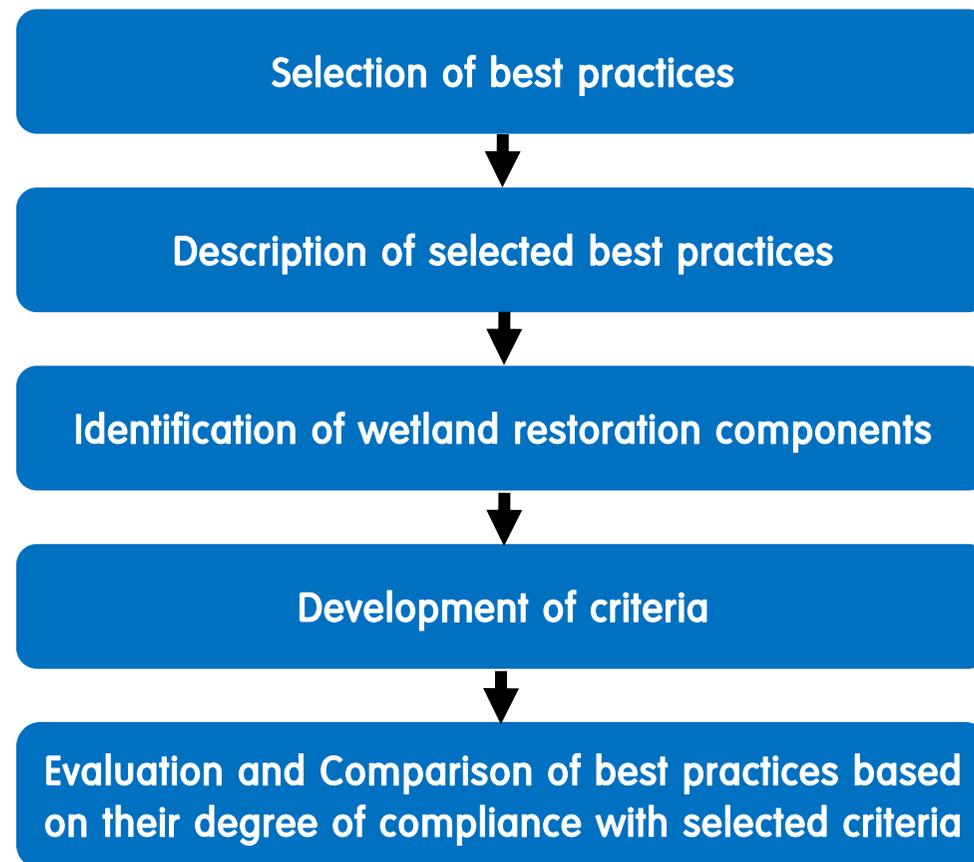
- § Selection of wetland restoration best practices cities
- § Identification of components for wetland restoration
- § Development of criteria for evaluating the identified components of wetland restoration methods and techniques
- § Analysis and comparison of selected best practices based on their degree of compliance with selected criteria

2. Conflicting Values of Wetlands in Cities

- For centuries, wetlands were considered a source of disease and pestilence, a quagmire of precarious earth and blood-thirsty insects
- Today, wetlands have shed their dismal image and are finally valued for their enormously important environmental and economic functions such as flood control and the provision of wildlife habitat
- Conflicting needs on wetlands have caused many controversies and conflicts between conservation and development of wetland

3. Method for Selection and Comparative Analysis of Wetland Restoration Best Practices in Cities

3.1. Analytical Process



Analytical Process

3.2. Selection of Wetland Restoration Best Practices in Cities

§ Description of Best Practices

(1) Cheonggye Stream, Seoul, Korea

■ Riverine

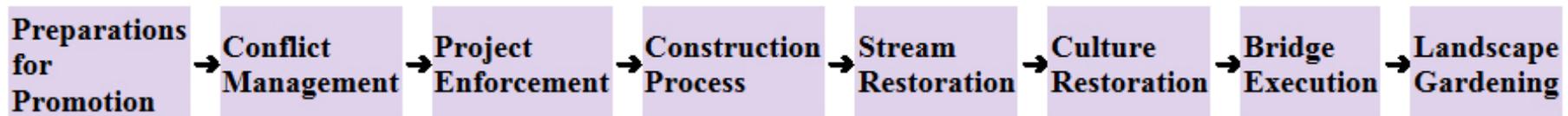
▣ Overview

◆ Problem

- After the Korean War (1950~1953), more people migrated into Seoul to make their living and settled down along the stream in shabby makeshift houses
- The accompanying trash, sand, and waste, and deteriorating conditions resulted in an eyesore in the city.
- The stream was covered up with concrete step by step for 20 years since 1958, and a 5.6 km-long, 16 m-wide elevated highway was completed in 1976
- This area became an example of 'successful industrialization and modernization'

◆ Solution

- The revitalization scheme of the Cheonggyecheon (Cheonggye Stream) was progressed through the following 8 stages, and Seoul Municipal Government aimed at restoring eco-system to improve nature's autogenous capacity, by recovering water circulation system- root of life- through the Revitalization of the Cheonggyecheon and also aimed at developing "Urban Stream where Nature breathes."



Revitalization Stage for Cheonggyecheon

Section	Photos of present conditions	Description
<p>Cheonggyecheon Square~Gwangtong Bridge</p>		<p>[Beginning with an artificial appearance of the Cheonggyecheon, centering on humans' use and emphasizing cultural aspects]</p>
<p>Gwangtong Bridge~Jangtong Bridge]</p>		<ul style="list-style-type: none"> ▪ Lakefront Restoration is achieved by using vegetation
<p>Jangtong Bridge~Gwansoo Bridge</p>		<ul style="list-style-type: none"> ▪ Lakefront Restoration is achieved while giving change to water flow using stones

Major Appearances after Revitalization of Cheonggyecheon by section

Section	Photos of present conditions	Description
Vicinity of Yeongdo Bridge		<ul style="list-style-type: none"> •Putting more emphasis on ecological aspects by developing only one side for pedestrians' sidewalk
In the neighborhood of the Biwoodang Bridge		<ul style="list-style-type: none"> •By developing only one side for pedestrians' pathway with the width of a stream wider, ecological aspects of a stream is highlighted.
The Jungryang Stream confluence section for preservation area for migratory birds		<ul style="list-style-type: none"> •It was restored with its ecological aspects emphasized almost without human use of it.

■ Riverine

(2) Qinhuai River, Nanjing, China

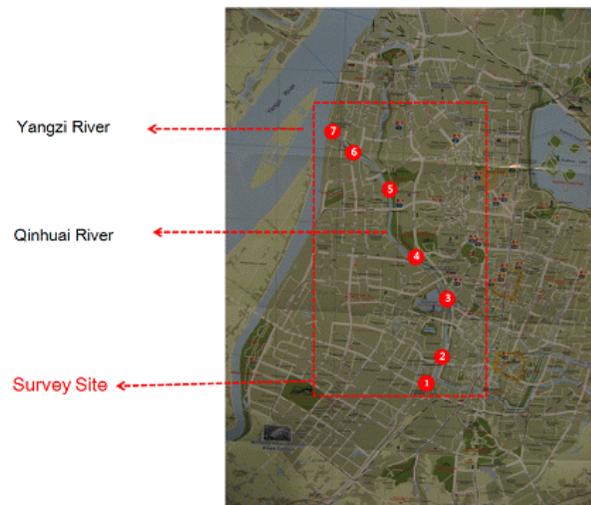
▣ Overview

◆ Problem

- Major waterway through Nanjing
- Cultural facilities, residential and commercial areas developed over centuries along riverbanks
- Rapid industrialization and urbanization caused water pollution with discharge of wastewater, solid waste, and slum areas along river banks

◆ Solution

- Qinhuai River Improvement Project (Phase I), Nanjing Municipal Government invested 400 million USD during 2002–2005
- 500 wastewater outlets on 16km, 97 polluting factories and 4,365 homes relocated
- Old slums rebuilt into parks with 1 million km² trees
- UN–HABITAT nominated Nanjing as a pilot city in water environment improvement in the Asian Cities Water Program



Nanjing City Map and Indication of the boundaries of the present condition survey

Survey site 1 : Confluence of Qinhuai River and small stream



Point where a brand stream joins the River



Natural appearance of planting on the riverfront



Removal work of floating matters on the riverfront



Appearance of the waterfront adjacent to a residential complex

Survey site 2 : Near to Jiqingman



Appearance of the walks on the waterfront



It shows a varicolored landscape development through diverse planting on every pathway

Survey site 3 : Near to Shuiximen



Waterfront and Recycling Housing and Appearance of rainwater circulation system establishment in the complex adjacent to the waterfront

Survey site 4 : Near to Military Education Park & Stone Citadel



It shows the appearance of soil exposed to the riverfront where afforestation of its slope side is needed.



Appearance of the walks on the riverfront near Military Education Park

Survey site 5 : Near to Zijin Tower



The waterside district has been more revitalized through the Zijin Tower near the waterfront



By defining a river, humans, and using space through the planting of luxuriant forest trees, river eco-system is being preserved

Survey site 6 : Down stream of Qinhuai River

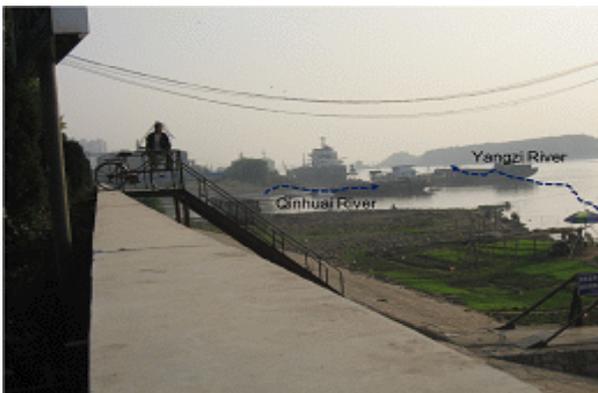


Appearance of the walks along the downstream



Appearance of the dams on the downstream

Survey site 7 : Confluence of Yangzi River & Qinhuai River



Appearance of the point which joins the Yangtze



Appearance of Qianzhou island

Lucastrine

(3) London Wetland Centre, London, UK

Overview

◆ Problem

- The site for London Wetland Centre was previously water supply reservoir

◆ Solution

- concrete surface was removed, and 30 different types of habitats and wetlands were created
- Now located in the heart of the city with beautiful walkways set amongst lakes, ponds, meadows and reedbeds.
- Home to a wide variety of wildlife including over 180 species of birds, water voles, amphibians, bats, grass snakes, slow worms, butterflies and moths
- Impressive visitor centre with restaurant, gift shop and a cinema showing a short 'wetlands' documentary
- Heated viewing observatory
- Six hides so you can get up close to the wildlife
- A collection of rare birds
- Explore adventure area and interactive Discovery Centre for children
- A regular programme of children's activities during weekends and holidays.



Nearby residential area



지붕녹화의 파굴리와 주변의 갈대군락 관찰로 주변의 녹지 습지센터와 인접한 주거단지의 모습



Sedum류 피복의 조류관찰대



피트닉장의 모습



진입부의 습지 전경



비지터센터앞 습지 전경



습지공원 진입부



Grazing Marsh 와 Reed Bed의 모습



전망대 및 조류관찰대



Sheltered Lagoon의 모래톱



Sheltered Lagoon의 전경



Grazing Marsh의 전경 및 배후의 주거단지



비지터 센터 전경



테마형 습지



조류관찰대 (지붕녹화)

Master Plan



Nearby residential area



Information boards on visible birds



Diverse types of wetlands for bird habitat

Palustrine

(4) Greenwich Peninsula Ecology Park, London, UK

Overview

◆ Problem

– The site was known as Greenwich Marsh and had been destroyed due to the industrialization of the 1880s.

◆ Solution

– Since 1997, restoration projects have been conducted with the creation of water aeration and circulation system

– Ecology Park was created in the middle of the complex, and the two lakes were surrounded by marsh and woodland. Also, seven major habitats were created.

– A fascinating variety of wildlife thrives in the Park, including frogs, toads and newts, while there is a huge array of 'minibeasts'

– Specially designed bird hides allow a visitor to watch the many different species, both local and visiting, without disturbing them. As the seasons change, so do the types of birds a visitor is likely to see



Wetland and visitor center in front of the residential complex



Observatory deck



Master Plan



Resting place and habitat for birds

■ Palustrine

(5) Bi-dang Ecological Park, Palduk, Taiwan

▣ Overview

◆ Problem

– There were much valuable environment resources such as Bi-dang and old trees, but had been occupied by the illegally built structures previously

◆ Solution

– The park was established after demolishing the illegal buildings in June 1996 and officially opened at July of 1997

– It has positioned as the conserved and cultural place of scene of country village and local features by restoration of the wetland scene by means of ecology and laws besides being provided as the space of multi environment of wetland and relaxation area to the citizens



Visitor Center



Observatory deck for view of Bi-dang



Pavilion near Bi-dang



Master Plan



Stream flow can be controlled by putting the block at the center of the water passageway



Habitat for the multiple plants by acquiring the open water surface



The island is built at the center of lake

Natural Drainage System

(6) Portland Stormwater Chain, Portland, USA

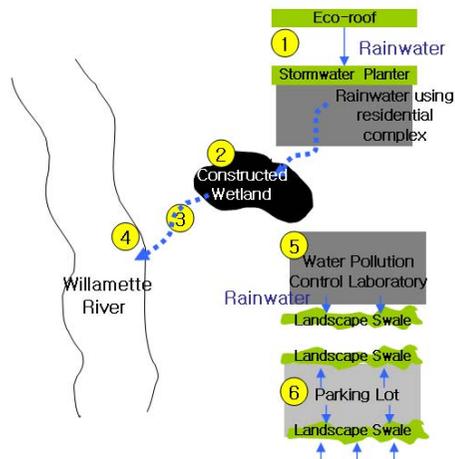
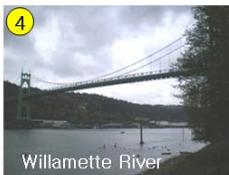
Overview

Problem

- Rainwater runoff on the residential complex could cause damage to human built environment and ecosystem.
- Rainwater is too valuable resource to simply dump through drainage pipes

Solution

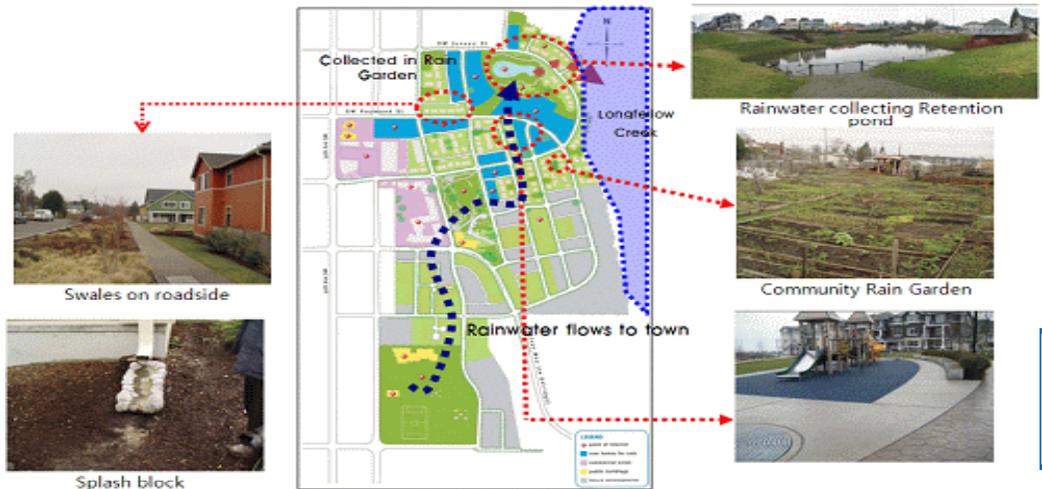
- A stormwater chain was built by using rainwater in parking lots and roofs
- In particular, stormwater from residential complexes was purified in a constructed wetland



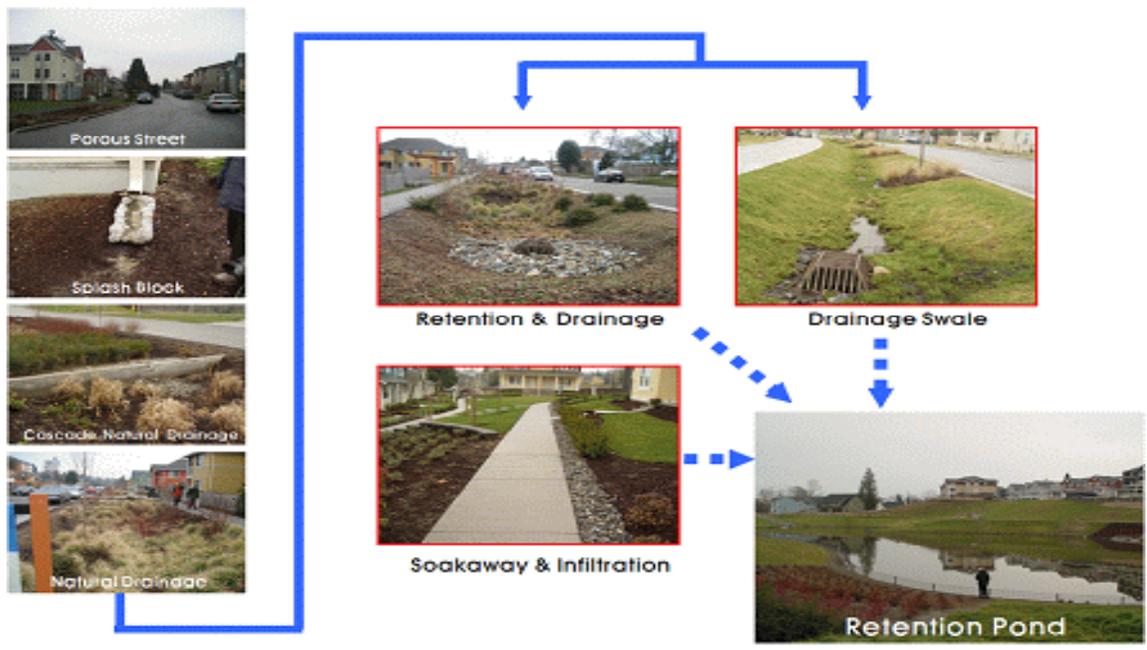
Stormwater Chain by Water Pollution Control Laboratory in Portland, Oregon

Natural Drainage System

(7) Seattle Stormwater Chain, Seattle, USA



Sites of Stormwater Chain in High Point Neighborhood in Seattle, Washington



Mimetic Diagram of Stormwater Chain in High Point Neighborhood in Seattle, Washington

Green Rooftop

(8) Rain Garden on the UNESCO Green Rooftop, Seoul, Korea

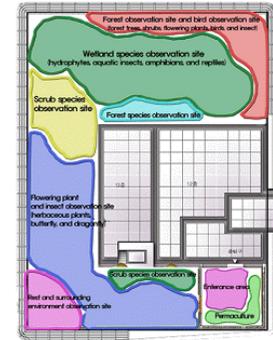
Overview

Problem

- In urban areas, a rooftop is a space with great potential to reborn as a habitat of organisms, a place for environment education & experience and an urban biosphere reserve as well as securing a biotope

Solution

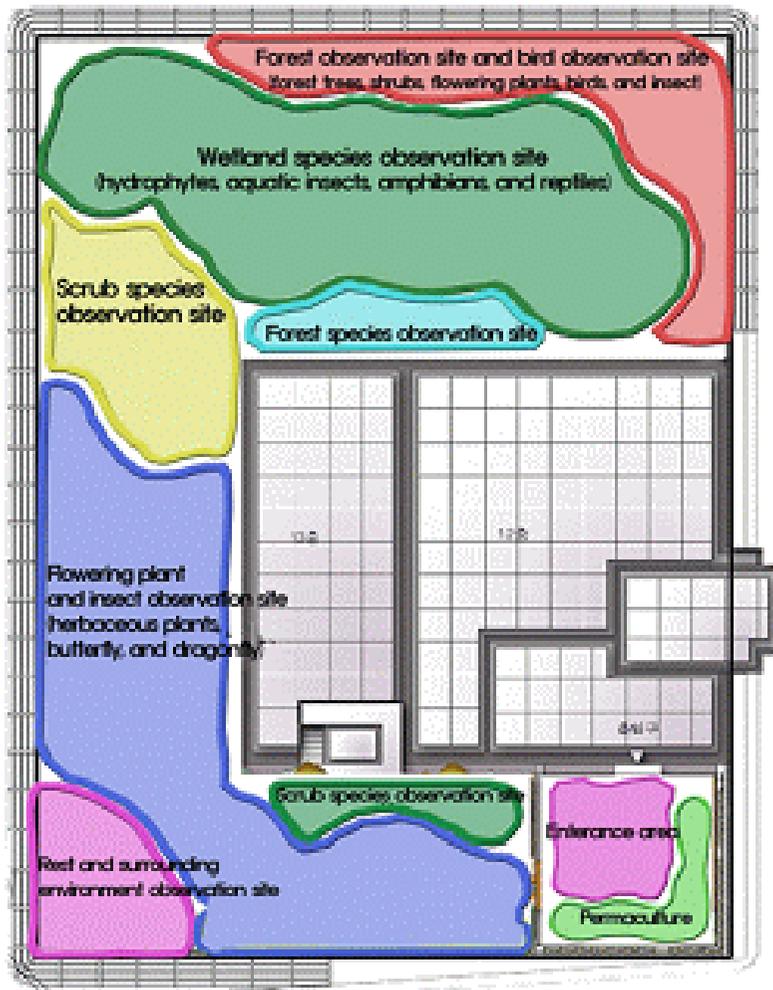
- Rain Garden on the UNESCO Green Rooftop was created in April 2003.
- Its site spans about 628m²
- The UNESCO biosphere reserve concept was applied to planning
- The entrance of the rooftop garden was planned as a transition area since people come in and out and use this space the most
- By synthesizing ideas conceived earlier, the basic concept map of the UNESCO Green Rooftop was prepared. In each space, following organisms and facilities were introduced



Basic Plan



Wetland Plan Using Rainwater



Basic Concept Map



A Post-construction View from Another Building



Wetland and Observation Deck in the Core Area



Wetland and Hygrophytes in the Core Area



Grasslands and Shrubs & Forest Trees in the Buffer Area



A Vegetable Garden in the Transition Area



A Frog Living in a Wetland



A Flock of Sparrows

(9) Eco-Bridge on the Donghae Line, Gosung County, Korea

▣ Overview

◆ Problem

- With the construction of the Donghae Line and the South-North connecting road, there came out a rupture between forest areas and coastal areas
- Its subsequent difficulty in creatures' traveling brought species stress and damages of inbreeding to animals.

◆ Solution

- Eco-passages were developed and become a habitat for native animals and plants, helps them travel and helps genes between populations, getting a highly positive value.
- Particularly, this area is very high in bio-diversity as the demilitarized zone and eco-bridges function as a major habitat.

Dec. 26, 2006

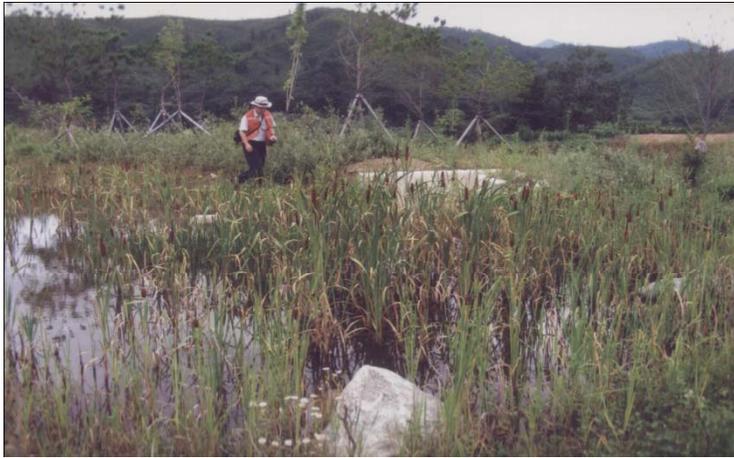


April 9, 2007



June 19, 2007





Aug. 7 2007



Nov. 23, 2007

Appearance of the Change in Habitats of Eco-passage

Oct. 24, 2005



Pit viper



Vestige of a wild boar leg

Dec. 26, 2006



Faces of water deer



Excrements of a wild boar

April 9, 2007



Notonecta triguttata



Ranatra chinensis



Feces of raccoon



Water deer's feces

June 19, 2007



Cattail



Wild rose



Feces of roe deer



Black-spotted pond frog



pit viper

Aug. 7, 2007



Sapling for the tomato



Leg trace of a roe deer



feces of raccoon



Mole's tunnel

■ Replacement Wetland

(10) Replacement wetland for Donghae Line in Gosung DMZ, Gosung County, Korea

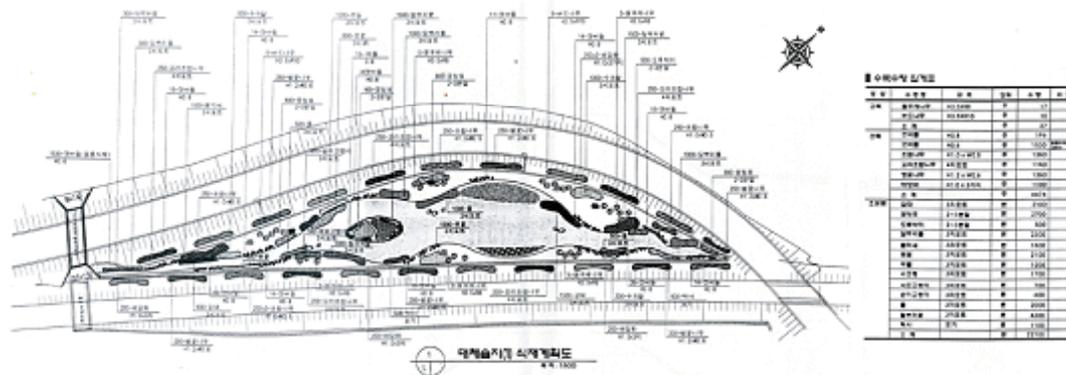
▣ Overview

◆ Problem

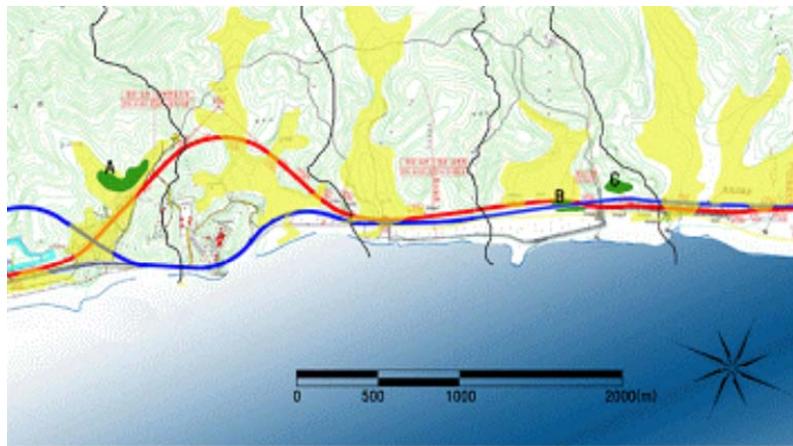
- The water gates are most seriously influenced inside the district by the project of Donghae railway and connection road construction North and South
- The changes in flows and quantity of flowing at the gates were influenced by the roads across to the entire wetland

◆ Solution

- The compensation for the damaged and influenced wetlands is necessary and the ratio of compensation has to be bigger than the buried wetland for the proper structuring and functioning as wetlands.
- The replacement wetland is selected and planned reflecting on such characteristics
- To make the smooth circulation of thrust, nutritional material and sediments in the area
- As the target area of Donghae replacement wetland is the proximity of river flowing into the sea, it has to be fostered to make this river to be connected as continuous stream.
- Fostering the habitat of amphibians within replacement wetland
- Fostering the shelters and breeding place focused at the living birds at wetland



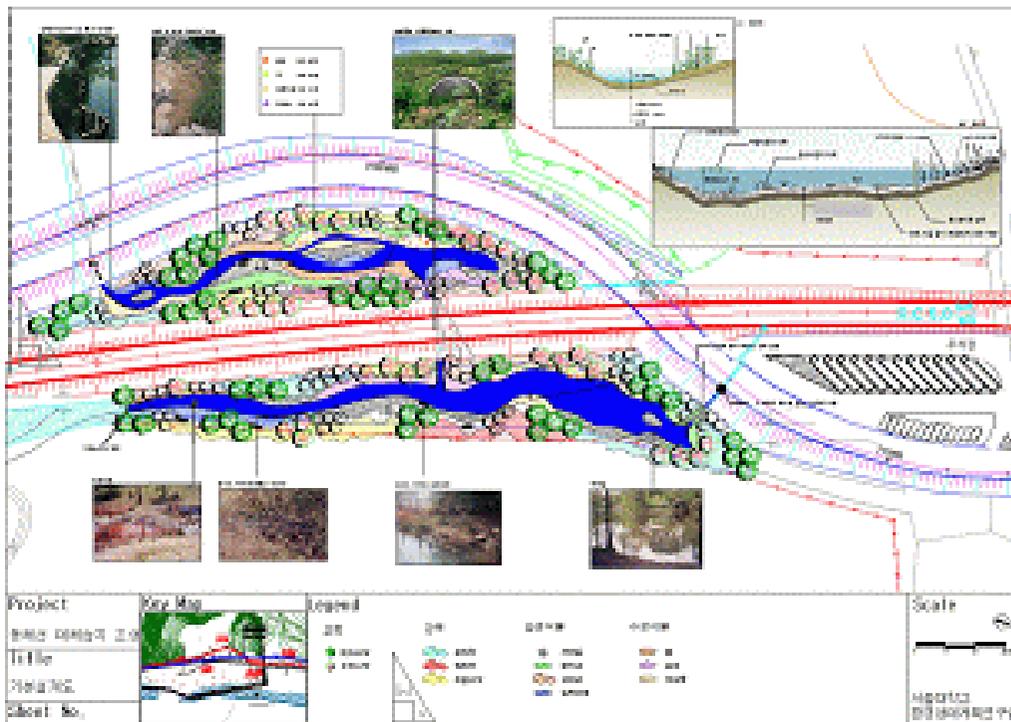
Basic drawing of Donghae Line replacement wetland



< Legend >

- The influenced wetland
- The candidate area for replacement wetland

Locations of the influenced wetland and replacement wetland



Basic diagram of Donghae Line replacement wetland



November 17, 2004

March 30, 2005

June 28, 2005



August 31, 2005



October 24, 2005



December 27, 2005

Locations of the
influenced wetland
and replacement
wetland



Vegetation



Vegetation

			
Vegetation	Protacanthopterygi, Moroco lagowski	Bathing signs of wild boars	Amphibians
			
Fishes		Insects	
			
Foot prints and excretions of mammals		Birds	
			
Amphibians			
			
Amphibians	Insects		

Major biological species found at replacement wetland in front of Donghae Line

3.3. Identification of Components for Wetland Restoration

- Wetland Assessment
- Wetland Planning
- Wetland Restoration Design
- Construction Oversight
- Environmental Monitoring
- Community Outreach

3.4. Selection of Criteria for Evaluating the Identified Components

Criteria	Question
Wetland assessment	<ul style="list-style-type: none"> ○ Whether proper wetland characteristics survey on a selected site was conducted ○ Whether a selected site had habitat condition for wildlifes
Wetland planning	<ul style="list-style-type: none"> ○ Whether division for wetland management (core, buffer, transitional area) has been done ○ Whether the plan was established to lead the diverse functions of wetland(biodiversity, water purification, etc.)
Wetland restoration design	<ul style="list-style-type: none"> ○ Whether the restored wetland had similar structure as the original ecosystem ○ Whether the restored wetland had similar productivity as the original ecosystem
Construction oversight	<ul style="list-style-type: none"> ○ Whether the construction was done correctly and safely within the budget and time period ○ Whether the construction was done considering the impacts to the surrounding ecosystem ○ Whether the materials from the local area was used for the construction
Environmental monitoring	<ul style="list-style-type: none"> ○ Whether regular monitoring was conducted on wetland components and species ○ Whether early warning system was created to predict and evaluate the ecological changes in wetland
Community outreach	<ul style="list-style-type: none"> ○ Whether education or recreational activities on wetland had been active ○ Whether local citizens participated in wetland management

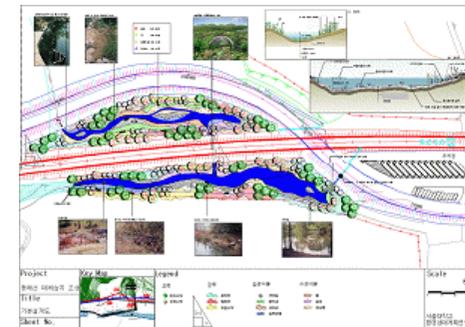
4. Results of the Comparative Analysis

The best practices that achieve the greatest degree of compliance with the selected criteria include :

§ London Wetland Centre, London, UK

§ Greenwich Peninsula Ecology Park, London, UK

§ Replacement wetland for Donghae Line in Gosung DMZ, Gosung County, Korea



5. Implications of the Comparative Analysis for Wetland Restoration in Cities

- There are many strategic issues facing the planner and manager who have to implement urban wetland policies. There are many complex questions still to be resolved in wetland conservation and restoration in urban areas and it is important not to be tempted into generalizations.
- When the manager is trying to do the reverse, and apply ecological principles to a specific site, it is important to remember to consider the needs of the exceptions and minority plant and animal groups as well. Accordingly, generalization about "good" restoration practice can be such a risky approach.
- For a combination of reasons including access, an engineered approach to drainage, ease of construction, safety and a dislike of some wetland pests the tendency has been to sanitize waterbodies by surrounding them with concrete and hard surfaces, while the land around is drained. A quick review of the local names of many estuary-based towns and cities, such as London, will quickly show how dramatic this change has been.
- A workshop with the goal of development of "Guide for Urban Development, Biodiversity and Wetland Management" was recently held by UN-HABITAT and the Ramsar Convention. This guide which will be applied in a new program after tested in selected cities is expected to greatly contribute to achieving the sustainable development and the Millennium Development Goals (MDGs).

6. Conclusions

- This study examined the tendency of wetland ecological restoration in restoration planning process and technical aspects, and has found out that there is a diversity of wetland restoration practices in the world.
- Urban and regional wetlands planning approach is necessary. Site-specific mitigation options include restoration, enhancement, creation, mitigation banking or replacement. The comparative analysis in this study found out that the creation was most often used mitigation option. Creation has been the subject of more journal articles than any other form of mitigation.
- It is difficult to generalize the site-specific practice. Different ecological principles should be applied on the basis of different conflicting value and site. The creation of 'Guide for Urban Development Biodiversity and Wetland Management' , however, can be persuasive, as function and value of an urban wetland is considered during the planning process. Lastly, it is important to note that a large amount of wetland is not an absolute requirement, but culturally specific.

Thank You !!!
