River Restoration in Korea
- The past, the present and the future -

2006. 11. 09

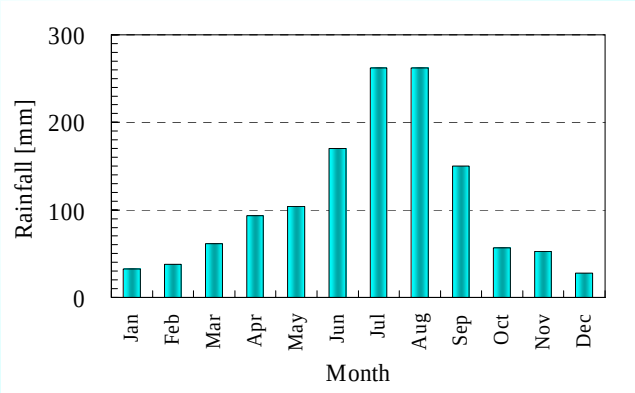
Chang Wan KIM, Ph.D. and Hyoseop WOO, Ph.D.

Korea Institute of Construction Technology

Natural Background

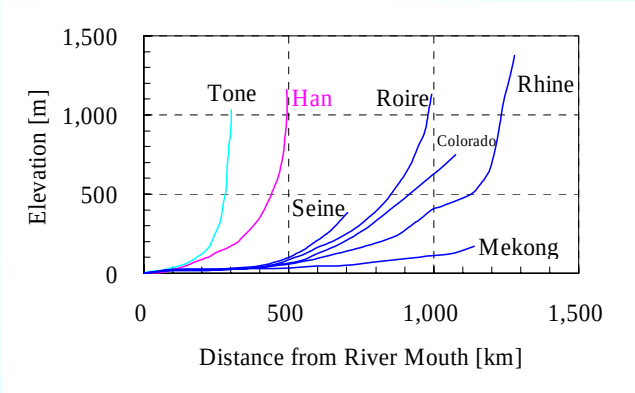
Precipitation

- Large variation of seasonal precipitation
  - ✓ Almost 65 % of annual precipitation concentrates in June to September due to monsoon and typhoons



River Slope

- River bed slopes are very steep
  - ✓ Extreme variation of river flow (Q_{max}/Q_{min}): 100 to 700



Social Background

- Urbanization
  - ✓ City dwellers increased from 36 % in 1960s to 90 % in 2000.
- Industrialization
  - ✓ About 12th largest trade and GDP in the world has accelerated channelization, damming and gravel mining in the rivers. (including readjustment of arable land)
- Water quality
  - ✓ BOD ranges from 1.4 to 6.5 mg/L in five major rivers.

River Management Practice

Natural Stream

- Before 1960s, most rivers were in natural condition with a few artificial structures.

International Forum on Waterfront and Watershed Restoration

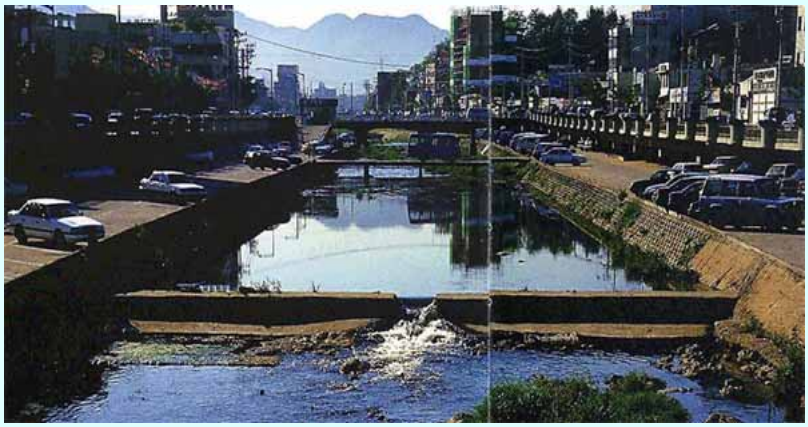
Disaster-Prevention Stream

- In 1970s, river management mainly focused on the flood control (channelization). So rivers lost environmental functions; ecological habitat, self-purification, and riparian scenery.

Korea Institute of Construction Technology
www.kict.re.kr

Occupied Stream

- In 1980s, floodplains of streams were occupied by parking lots, recreation areas, roads and farmland, etc.



International Forum on Waterfront and Watershed Restoration

Park Stream

- In late 1980s, parks in urban streams were constructed. Most parks were constructed on the floodplains.

Korea Institute of Construction Technology
www.kict.re.kr

Ecological Stream

- Since mid 1990s, ecological river improvement techniques have been employed to enhance the environmental function of the stream.

International Forum on Waterfront and Watershed Restoration

Transition of River Management Practice

Natural Stream → Disaster Prevention Stream → Occupied Stream / Park Stream → Ecological Stream

Korea Institute of Construction Technology
www.kict.re.kr

Situation of Stream Restoration

History of River Environment

- Before 1980's:
  - ✓ River regulation focused on flood control and water use
- Late 1980's:
  - ✓ Social needs for improvement of river environment (water quality and aesthetics)
- In 1990's:
  - ✓ Research projects on stream restoration and some demonstration projects
- In 1999:
  - ✓ Revision of River Act: Legislation of river environment and implementation
- In 2004:
  - ✓ Publication of River Planning Guideline

River Planning Guideline

- Emphasis on reflection of residents and NGO to river projects
- Zoning of a river into three categories for better management
  - ✓ Conservation zone for ecosystem and culture
  - ✓ Restoration zone
  - ✓ Amenity zone
- Introduction of environmentally sustainable new flood control method

River Restoration Projects

- **In early 1990s:**
  - ✓ Introduction and adaptation of nature-friendly river improvement works from Japan and Germany to Korea (MOCT/KICT)
- **In mid 1990s:**
  - ✓ A research-oriented project of stream restoration (MOE/KICT)
- **In late 1990s:**
  - ✓ Implementation of demonstration restoration projects (Osan-cheon, Gyeongan-cheon, Anyang-cheon, etc)
- **In early 2000s:**
  - ✓ Implementation of the Cheonggye-cheon Project (Seoul)

Stream Restoration Research Works

Location of Project Site

- **Yangjae-cheon (stream)**
  - ✓ Secondary tributary of the Han river
  - ✓ Drainage area: 59 km^2
  - ✓ Slope: 1/300-1/500
  - ✓ Discharge
    - Normal period: 1 m^3/s
    - Flood period: 300 m^3 /s
  - ✓ Severely impaired habitat due to channelization
  - ✓ D_{50} of bed material: 1-10 mm
  - ✓ BOD: 3.0 - 10.0 ppm

Upstream Test Reach of Yangjae-cheon

Before (1996)

After (1997)

After (1998)

Recent View

International Forum on Waterfront and Watershed Restoration

Downstream Test Reach of Yangjae-cheon

Before (1998)

After (1999)

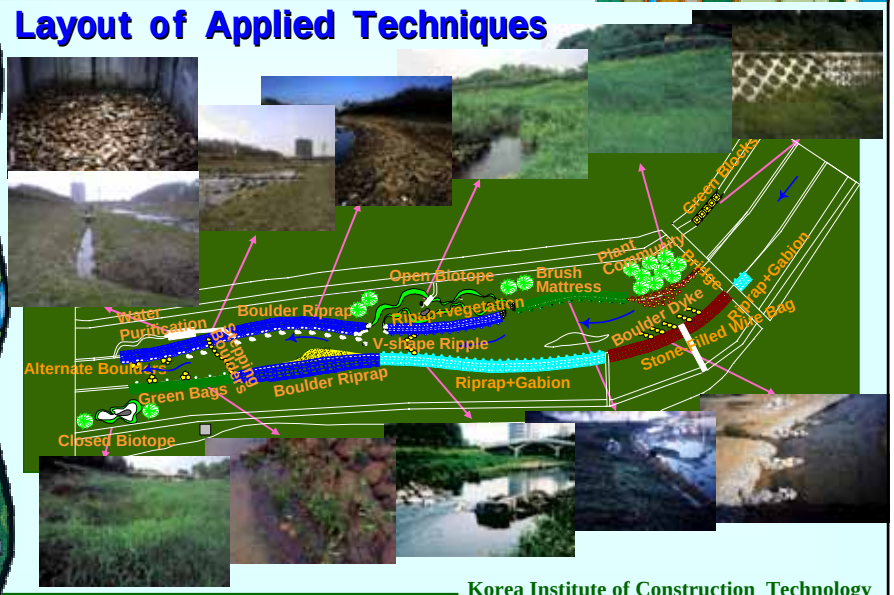
After Flood (1999)

Korea Institute of Construction Technology
www.kict.re.kr

International Forum on Waterfront and Watershed Restoration

Korea Institute of Construction Technology
www.kict.re.kr

Layout of Applied Techniques



International Forum on Waterfront and Watershed Restoration

Demonstration Projects

Osan-cheon Stream Restoration Project

Before (1999)

After (2001)

Korea Institute of Construction Technology
www.kict.re.kr

Gyeongan-cheon Stream Restoration Project

Before (2001)

After (2003)

International Forum on Waterfront and Watershed Restoration

Anyang-cheon Stream Restoration Project

Before (2001)

After (2003)

Korea Institute of Construction Technology
www.kict.re.kr

Hakyi-cheon Stream Restoration Project

Before (2001)

After (2001)

Urban Stream Restoration Projects

Cheonggye-cheon Stream Restoration Project

Before (1959)

Before (2002)

After (2006)

- **Video Clips:**
  - ✓About Restoration Project
  - ✓Before Restoration
  - ✓After Restoration

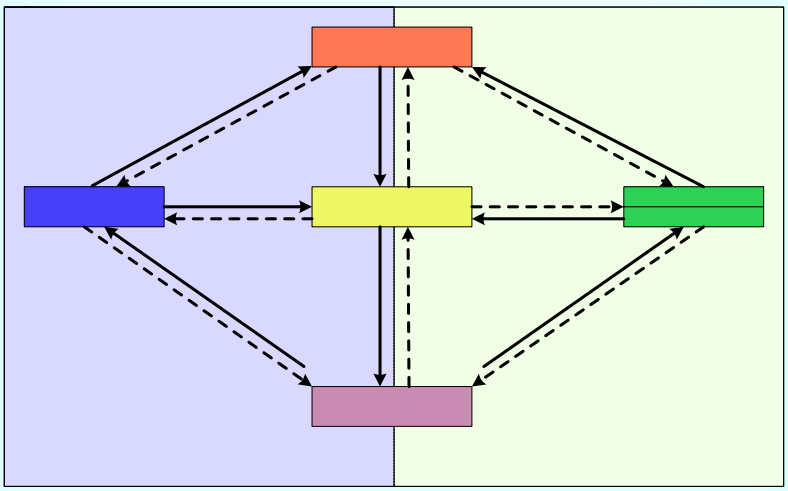
Limitations of Urban Stream Restoration

- **Water quality:**
  - ✓ Poor water quality is a very serious constraint on the implementation of stream restoration projects in the urban streams.
- **Water quantity:**
  - ✓ Pavements with non-permeable material such as asphalt and concrete in urban areas cause lack of groundwater recharge and thus lack of stream flow.
- **Variation of stream flow:**
  - ✓ Large floods in summer render eco-engineering approach in the stream restoration works sometimes dangerous.
- **Price of land:**
  - ✓ High land price renders project managers discouraged.

International Forum on Waterfront and Watershed Restoration

Future Prospect

Interaction among five abiotic/biotic factors



Korea Institute of Construction Technology
www.kict.re.kr

Problems in Ecological River Engineerng

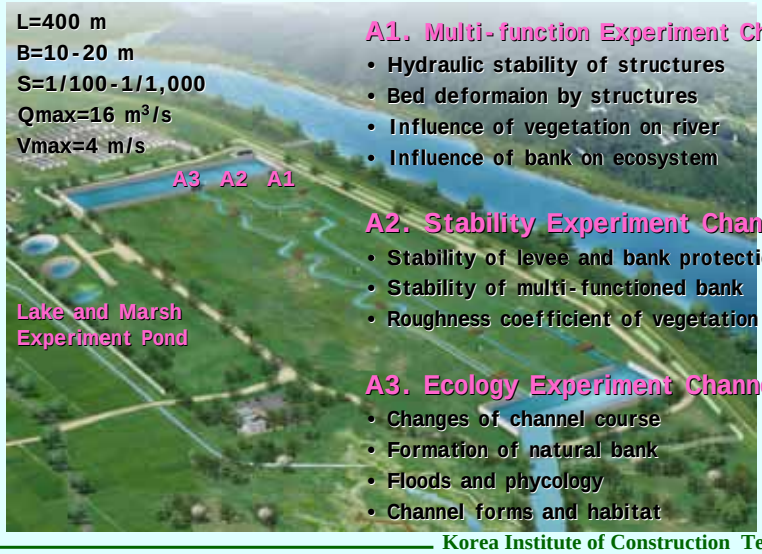
- Interaction between hydraulic and ecological factors in rivers is not fully understood.

- Stability of river restoration works is not still verified.

- Quantative evaluation of ecological enhancement is difficult.

International Forum on Waterfront and Watershed Restoration

Real-scale River Experiment Station

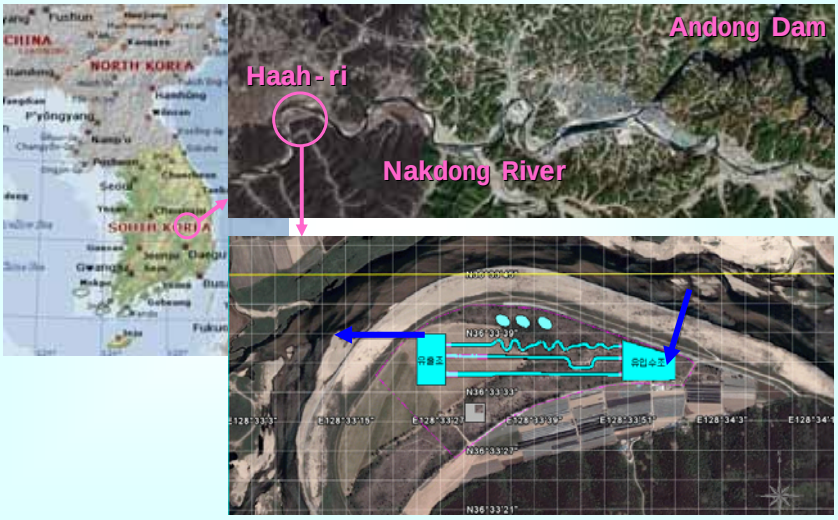


A1. Multi-function Experiment Channel
- Hydraulic stability of structures
- Bed deformaion by structures
- Influence of vegetation on river
- Influence of bank on ecosystem

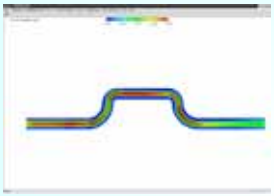
A2. Stability Experiment Channel
- Stability of levee and bank protection
- Stability of multi-functioned bank
- Roughness coefficient of vegetation

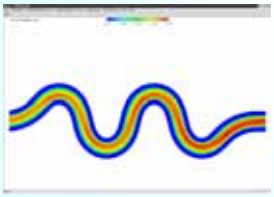
A3. Ecology Experiment Channel
- Changes of channel course
- Formation of natural bank
- Floods and phycology
- Channel forms and habitat

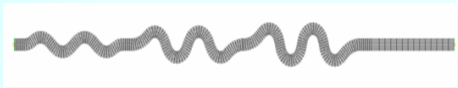
Korea Institute of Construction Technology
www.kict.re.kr

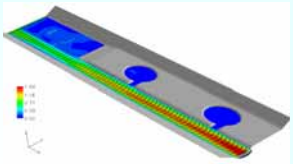


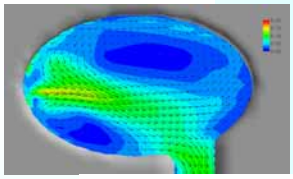
Numerical Simulation

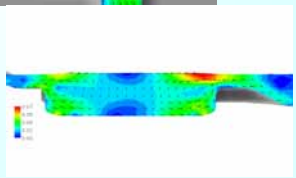












Conclusions

- A paradigm shift of flood control and stream restoration is needed.
- Incorporating ecological engineering approach into every sector of flood control works is needed. Stream restoration can be implemented only when flood safety is ensured.
- It is needed to consider restoring stream ecosystem to be an ultimate goal of stream restoration and enhanced biodiversity to be a major output expected from the stream restoration works.
- We have to progress further the interdisciplinary approaches, among engineers, ecologists, landscape architect, geomorphologists, economists and sociologist.

International Forum on Waterfront and Watershed Restoration

Thank you!

Korea Institute of Construction Technology
www.kict.re.kr