Channel Response Prediction for Abandoned Channel Restoration and Applicability Analysis

ARRN Forum 2013

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"Comprehensive treatment of Small & Medium-sized Rivers"

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Yonguk RYU, Il HONG, Joon Gu KANG, Hong Koo YEO

Korea Institute of Construction Technology

Suk Hwan JANG

Daejin University

Contents

Natural River Types

Schematic drawing of a natural river

- Many rivers were in natural conditions before 1970's in Korea.

Artificial Maintenance

Channel straightening

- Artificial maintenance brought about many problems, such as decreasing floodplain and disturbed ecosystem.
- Channel straightening caused geomorphological problems, such as the decreasing of meander rivers and the formation of abandoned channels.

Abandoned Channel Restoration

Abandoned channel restoration

- Abandoned channel restoration is one of the projects related to river restoration.
- This study targets past channels disconnected from main channels.

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Research Objective

- The abandoned channel restoration is about geomorphological restoration for natural channels.
- The restoration channel shape and channel evaluation are very important considerations for channel design.

- **The purpose of the present study is to provide a way of channel design for river restoration projects through analysis of channel planform change and channel stability.**
- **The channel design method targets the assessment of main channel stability prediction preparing for abandoned river restoration.**

Study Procedure & Method

- **Channel Planform change Analysis**
  - Image Analysis Technique
  - Tool : ERDAS IMAGINE, ARC GIS
- **Stable Channel Analysis**
  - Copeland(1994)' s Method
  - Tool : SAM(Stable Channel Analysis Model)
- **Channel Evaluation**
  - Comparison between Channel Planform Change Result and Stable Channel Result
  - Channel Shape, Slope, Width, Depth
- **Direction for Restoration Channel Design**

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Study Procedure & Method

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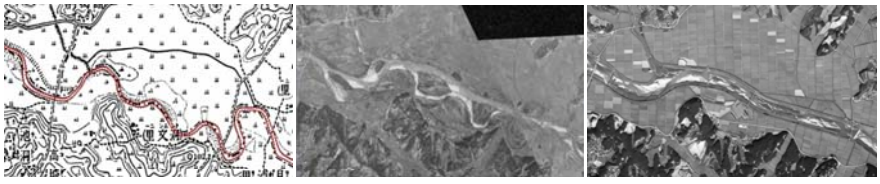
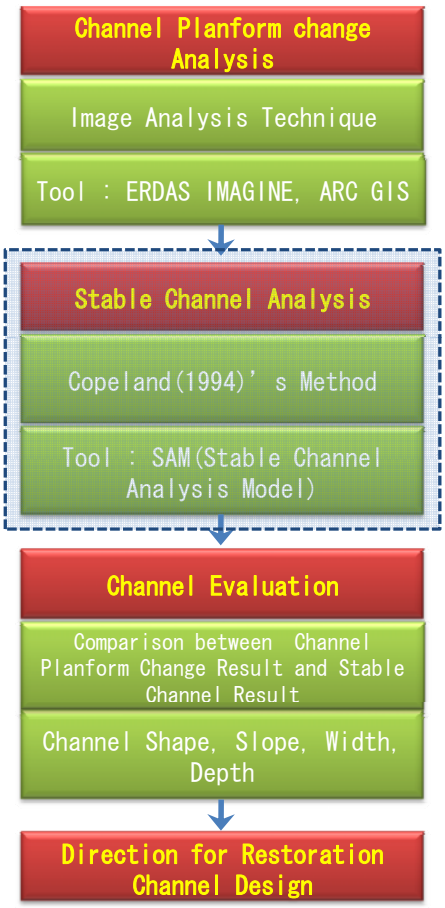
Image Analysis Technique

- The image analysis technique analyzed geomorphological information after coordinate correction of the past and present image data in GIS environment.
- The analysis used the image data of 1918 year's topographical map and aerial photographs.



1918's Topographical map and aerial photographs.

Study Procedure & Method



SAM Hydraulic Design Package

- The stable channel analysis used SAM model from the U.S. Army Corps of Engineers.
- The SAM model (equilibrium method) has been widely used for the plan and design of river restorations.
- The results of SAM modeling can predict hydraulic condition of stable channel, such as a width, depth and slope.

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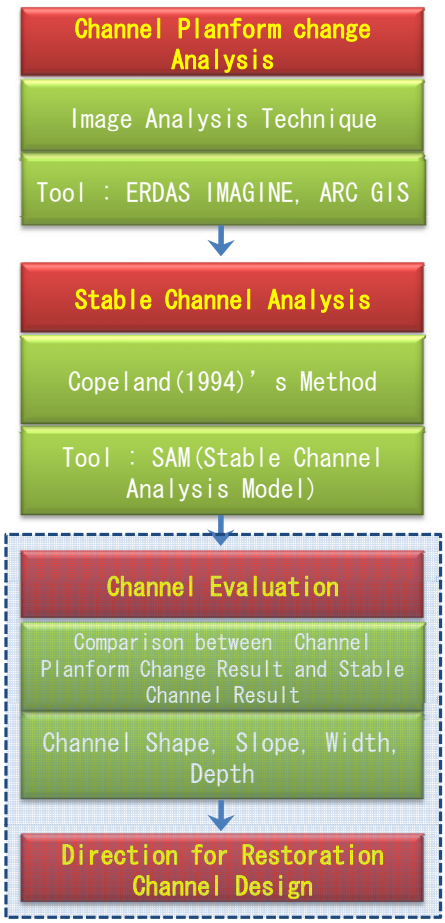
Study Procedure & Method

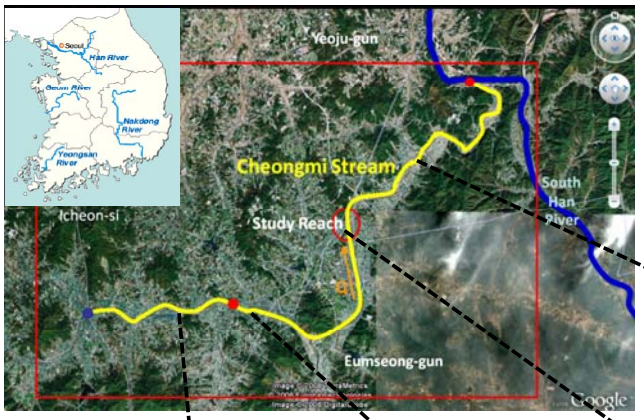


Channel Evaluation & Channel Design

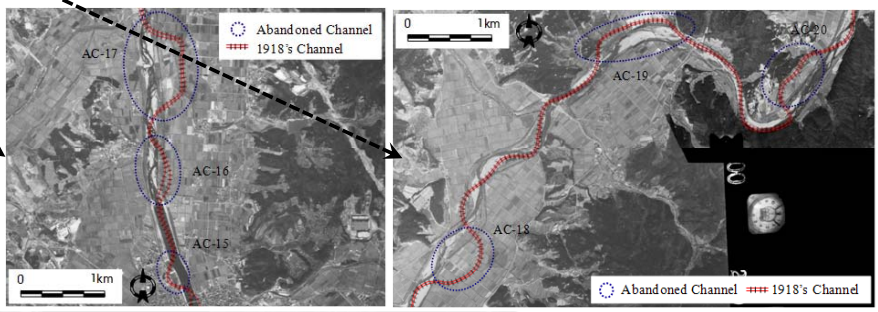
- For the channel evaluation, the measured channel planform change results were compared with the stable channel analysis using SAM model.
- The restoration channel design will be determined after considering the channel evaluation.

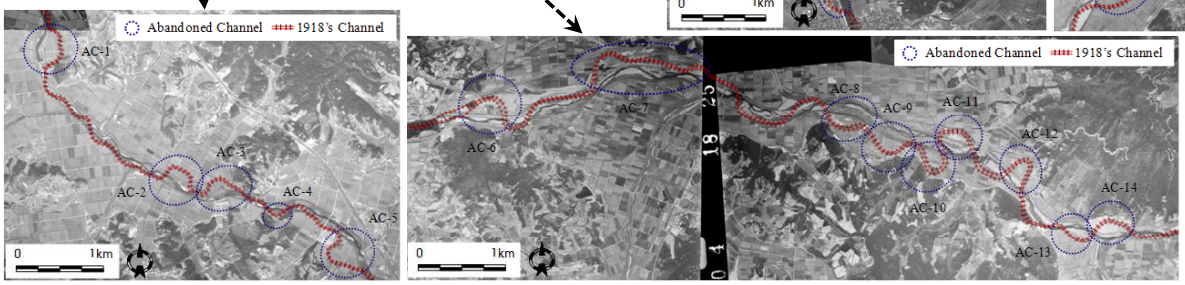
Study Area: Cheongmi Stream

- The Cheongmi Stream is 60 km long and is located in the middle of South Han River.
- The abandoned channels of Cheongmi stream are AC-1 to AC-20 sites.
- **AC-17 site has been decided for the current project site after considering its feasibility.**



Location of Cheongmi Stream





Overlap of 1918's Topographical map and 2006's aerial photograph

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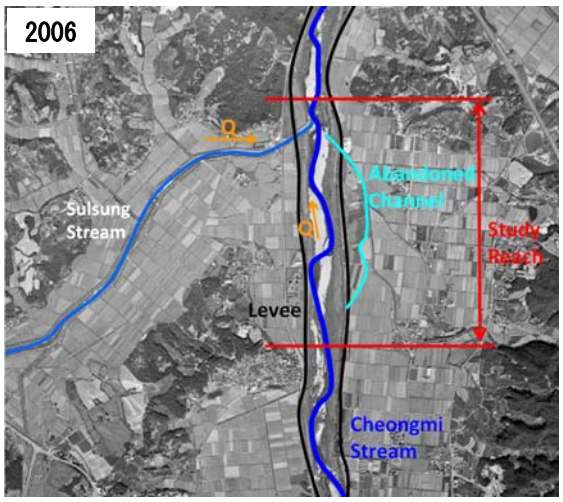
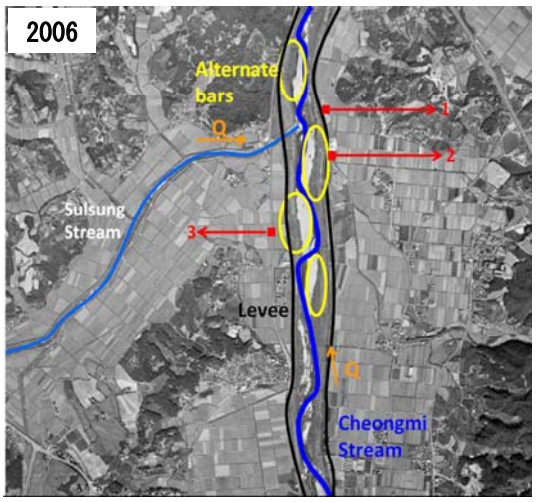
Study Area: Cheongmi Stream



Study reach on Cheongmi Stream



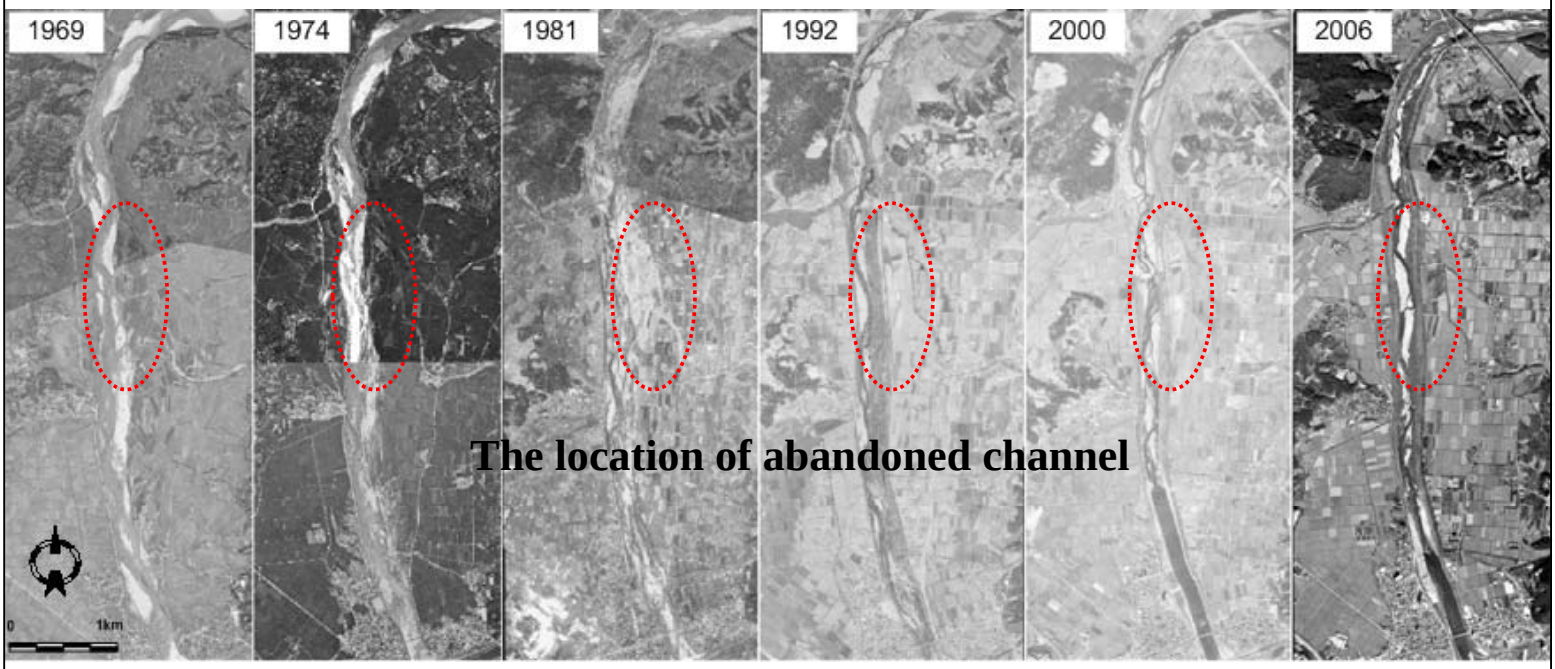
Shape of bars in Cheongmi Stream

Study Area & Shape of Bars

- Alternate bars are located along the study reach of Cheongmi Stream.
- The study area was straightened and levees were constructed.
- The presence of vegetation on some alternate bars suggests that they are old.

Channel Planform Changes Using Aerial Photograph

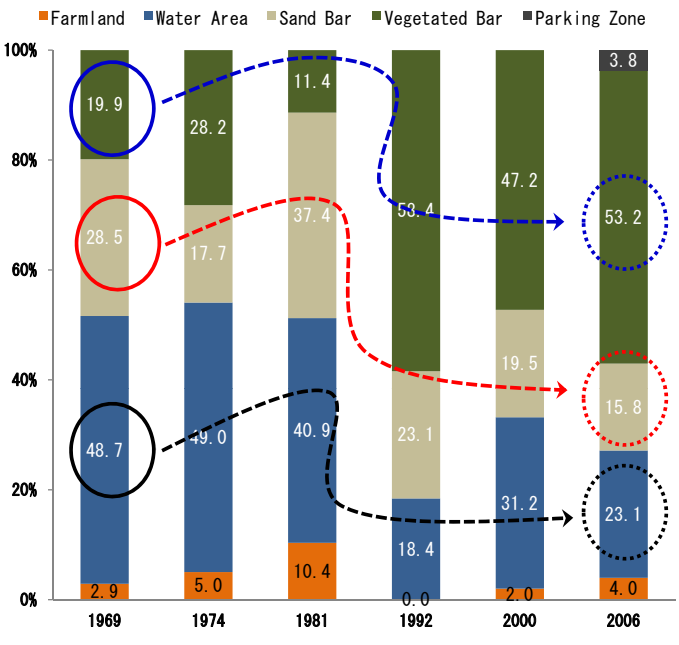
- It is observed that bars and flows in channel has been changed.
- We have quantitatively identified the channel planform change.



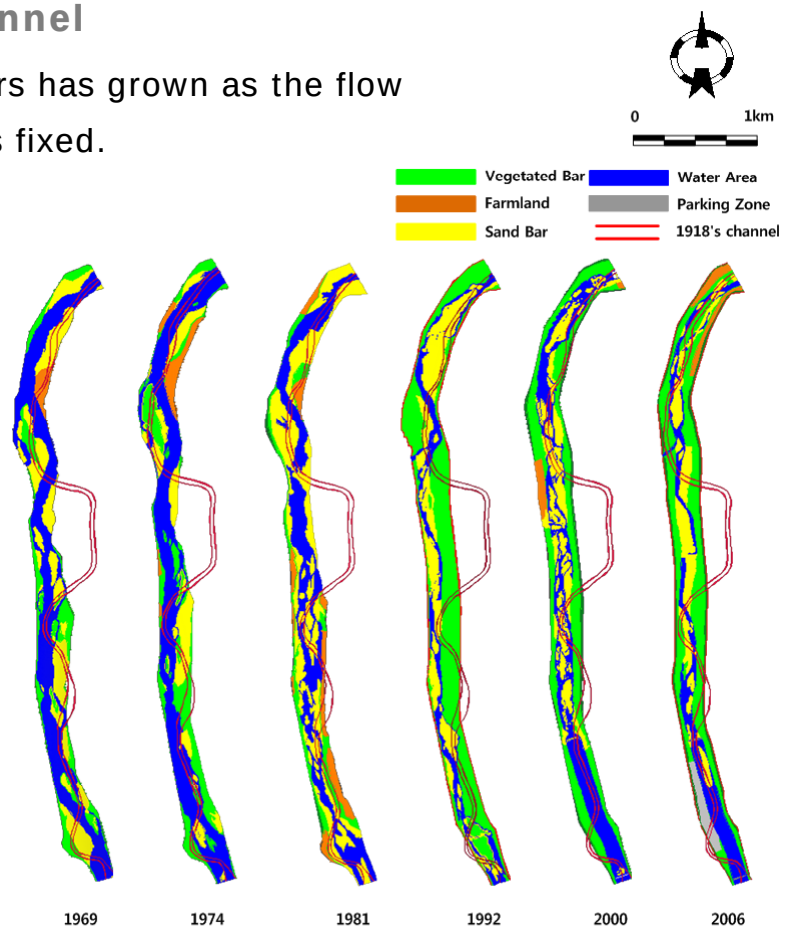
Aerial photographs from 1918 to 2006

Change of Micro-landform in Channel

- We can see that the vegetation on bars has grown as the flow width has decreased and sand bar has fixed.



Ratio of micro-landform area from 1969 to 2006

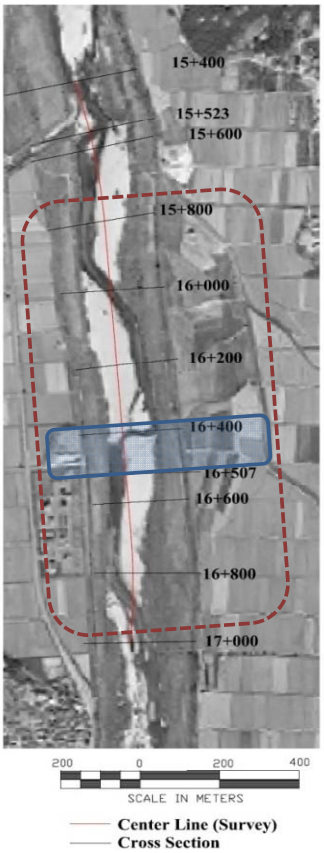


Comparison of channel planform change from 1918 to 2006

SAM Modeling for the Study Site

Cross Section Map for Study Site

- The study site is located within station 16+800 to 15+800.
- The standard cross section is station 16+400.



Cross section map

SAM (Stable Channel Analysis Method) Input Data

- Bankfull Discharge : Q_b = 488 m^3/s
- Specific Gravity : G = 2.65
- Valley slop : S_v = 0.00088
- Bank Side Slope : 2.3
- Bank Roughness : 0.03
- Bed Material Gradation : d_{84} = 2.18 mm, d_{50} = 1.1 mm, d_{16} = 0.63 mm

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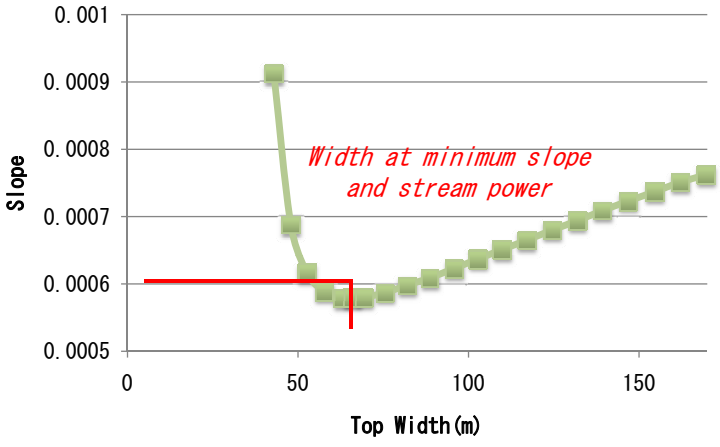
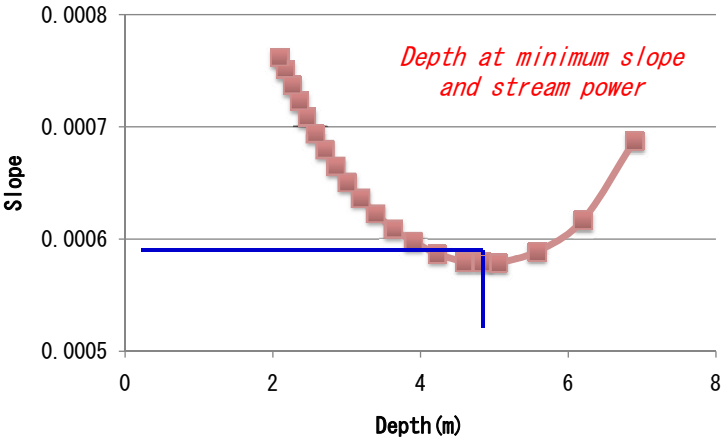
SAM Modeling for the Study Site

Conditions for Stable Channel

- The width of stable channel : 40 m ~ 160 m
- The depth of stable channel : 2.1 m ~ 7.6 m
- The slope of stable channel : 0.0007 ~ 0.0009
- **These points are suitable for stable channel condition.**



Stable channel slope and width from SAM



Stable channel slope and depth from SAM

SAM Modeling vs. Channel Planform Change

Comparison between SAM Results and Actual Values

- Top Width (SAM Results) << Top Width (Actual Values)
- Depth (SAM Results) >> Depth (Actual Values)
- Slope (SAM Results) < Slope (Actual Values)

Comparison between SAM results and actual values

River Station	Discharge (m^3/s)	SAM Modeling Results			Measurements		
		Slope	Depth (m)	Width (m)	Slope	Depth (m)	Width (m)
16+400	488	0.00058	4.183	65.918	0.000747	2.08	158.60

Comparison between Stable Channel Evaluation and Channel Planform Changes

- The SAM modeling simulated that, in the stable channel, the width narrows and the depth gets deep.
- From the results of the aerial photograph, it is also observed that the width narrows and vegetated bar increases.
- The results of channel planform change and stable channel results show good agreements.

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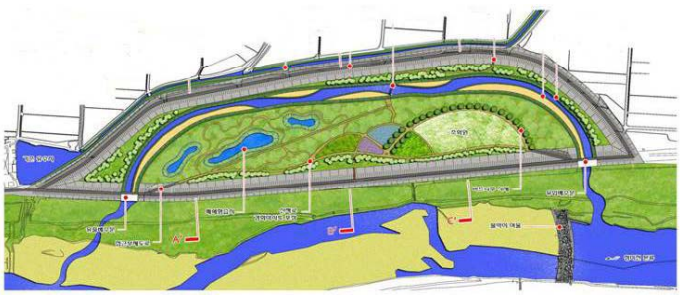
Conclusions

Channel Evaluation

- We know that, in the present channel, the width narrows and the depth gets deeper.
- We can see that the vegetated area is increases.

Use of the Method for Abandoned Channel Restoration Design

- The prediction by the equilibrium method and channel evaluation helps to design abandoned channel restoration with keeping the stable conditions of the main channel.
- The application of the method is expected to give a good answer for future shape of channels in case channel changes should be carried out.




Thank you
Photos by Korea River Association
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Korea River Restoration Network