HIC 2016

12th International Conference on Hydroinformatics

"Smart Water for the Future"

The 11th ARRN Governing Council Meeting(GCM) &
13th International Forum on River Restoration

Asia River Restoration Network (ARRN)

Research Institute for Disaster Prevention, Chonbuk National University

ARRN(Asian River Restoration Network)

The 11th ARRN Governing Council Meeting(GCM) &
13th International Forum on River Restoration

Date&Time : 24 August (WED) - 25 August (TUE), 2016

Venue : Room 105 Songdo ConvensiaA, Incheon Korea

ARRN Official Website : http://www.a-rr.net/

ARRN is a non-political network for exchanging knowledge and technological information on the restoration of rivers and watersheds in Asia. One of the objectives is to provide various opportunities and venues for river restoration related organizations and individuals to share and exchange knowledge and experiences related to the restoration of rivers and watersheds through the network. ARRN aims to enrich the participants' knowledge and scientific technology through mutual and multilateral cooperation, and ARRN also contributes to creation of rich river environment in Asia.

Program

- **ARRN Forum would be a Special Event of International Conference on Hydroinformatics, (www.hic2016.org)**
- **Main Event : The 11th ARRN Governing Council Meeting(GCM)**
  13th International Forum on River Restoration
- **Theme: The Relationship of River Rehabilitation and Drought Under the Climate Change**
- **Moderator : Suk-Hwan JANG (Chair of ARRN)**
- **Technical Tour : Shihwa Tidal Power Plant and Shiwha Wetland**

Time Schedule

Time		Activity	Remarks
23 August (TUE),2016	18:00-20:00	-Welcome Dinner	All Delegates
24 August (WED), 2016	13:30-14:00	-Opening Ceremony · Opening Remark (Suk Hwan Jang, ARRN Chair) · Welcoming Remark (Jae Hwa Noh, KRA Chair) · Congratulatory Remark (Hee Kyu Jeong, MOLT Director)	The 11th ARRN GCM
	14:00-14:10	Coffee Break	
	14:10-15:10	- Discussion on the ARRN 2015 - Planning of the 2017 year (ARRN) - Discussion on next Chair Country Decision - Discussion on MOU between ARRN and MOLT - Discussion on expansion of member countries	
	15:10-16:20	Coffee Break	
	16:20-18:00	- Open Remarks and Introduction - Eco-hydrological River Assessment in the Geum River Baisin, Korea *Jeongkon KIM and Sangyoung PARK* ● Tokyo water disaster and drought crisis looming now *Nobuyuk TSUCHIYA* ● New technical perspectives to break a positive path for the activities of river restoration in Korea *Kyuho KIM* ● Adaptiv management for ecosystems restoration in Haihe basin *Baiyin BAOLIGAO and Wang XIUYING*	13th International Forum on River Restoration under Drought and Climate Change
25 August (THU)2016	8:00-11:30	● Shihwa Tidal Power Plant ● Shihwa Wetland	Technical Tour

- **Participants**

RRN	Name	Institution
ARRN	Prof. Suk Hwan Jang,	ARRN Chair
	Prof. Hyosang Lee	Chungbuk National University
	Prof. Hyun-Han Kwon	Chonbuk National University
JRRN	Dr. Nobuyuki Tsuchiya	Japan RiverFront research Center (RFC)
	Mr. Akira Wada	CTI Engineering Co.,LTD.
	Mr. Mitsuru Abe	Japan RiverFront research Center (RFC)
CRRN	Dr. Xiaosong Wang	China Institute of Water Resources and Hydropower Research (IWHR)
	Dr. Xiangpeng Mu	
	Dr. Fengran Xu	
KRRN	Dr. Jae Hwa Noh	KRA Chair
	Mr. Hee Kyu Jeong	MOLT Director
	Dr. Hong-Koo Yeo	KICT
	Dr. Kyuho Kim	KICT
	Prof. Chang-Lae Jang	Korea National University of Transportation
	Dr. Seungyoon Lee	K-Water
	Dr. Young-Uk Ryu	KICT
	Dr. JeongKon KIM	CEO, Korea Construction and Environment Technology
	Dr. Sangyoung PARK	K-Water

The 11th ARRN Governing Council Meeting(GCM)

Chair : Prof. Jang, Suk Hwan (ARRN Chairperson)

Agenda

- **Discussion on the ARRN 2015**
  - Activities of Member Countries in year 2015 will be presented by KRRN, CRRN, and JRRN and reviewed by participants.

- **Planning of the 2017 year (ARRN)**
  - Programs for year 2017 will be discussed among the participating member countries.

- **Discussion on next Chair Country Decision**
  - Ideas and directions for ARRN Chair for next term will be exchanged among the key member countries.

- **Discussion on MOU between ARRN and MOLT**
  - The possibility and process for an MOU between ARRN and Ministry of Land and Transportation (MOLT), Republic of Korea, will be discussed.

- **Discussion on expansion of member countries**
  - The strategy and possibility for enlarging member countries to include Iran, India, Mongolia, etc., will be discussed.

- Other matters by participants
  - Other matters to be raised by participants will be discussed for possible inclusion as ARRN's future activities.

2015 Annual Activities

JRRN (Japan River Restoration Network)

JRRN annual report 2015-2016
(From May. 2015 to Aug. 2016)

JRRN
Japan River Restoration Network

JRRN: Japan River Restoration Network

Website, Newsletter, News-mail

JRRN operates the website and facebook to enhance information sharing in Japan. JRRN website provides information on topics related to river restoration in Japan and in other countries, examples of restoration projects, events, books, useful resources etc. In addition, JRRN published "JRRN Newsletter" once per month, and distributed "JRRN News-mail" once a week. (vol. 110 newsletters, No. 693 news mails as of Aug. 2016).

In addition, JRRN established and opened new website on the collaborative nature restoration along the river in March 2016 to enhance knowledge sharing on this field. This newly opened website includes "about collaborative nature restoration along the river", "How to step ahead", "Case examples" and "News & Events" etc.

Website: http://www.a-rr.net/jp/

facebook: https://www.facebook.com/JapanRRN

http://www.collabo-river.jp/

JRRN's events

JRRN jointly held three field training & workshop, one symposium on collaborative nature restoration in Japan, and one international symposium on " River Technologies for Innovations and Social Systems".

Series field training & workshop on collaborative nature restoration

- 1st field training & workshop at Iwamoto River, Toyota city, Aich Pref. (Sep. 2015)




- 2nd field training & workshop at Takatoki River, Shiga Pref. (Nov. 2015)




- 3rd field training & workshop at Kamisaigo River, Fukuoka Pref. (Aug. 2016)




4th Symposium on collaborative nature restoration (Sep. 2015)




International Symposium on River Technologies for Innovations and Social Systems (Nov. 2015)




Collaborative Activities

JRRN collaborated and supported regional river restoration activities to raise social interest in river and water, and to activate the activity in the river with public and private sectors.

1) Supporting workshop on regional activation from water front in Higashi Sonogi Cho (November 2015, Nagasaki JAPAN)

2) Supporting regional series workshop on the Onga-Horikawa river restoration (December 2015, Fukuoka JAPAN)

3) Supporting traveling educational exhibition of river and water environment by Japan Water Exhibition Network "JAWANET"

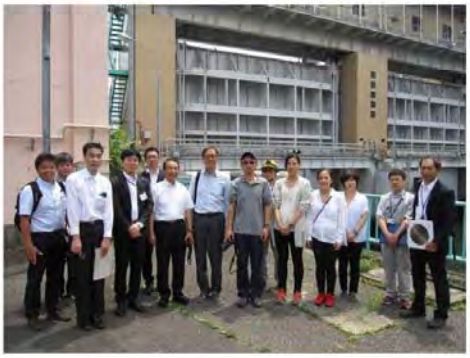
Technical Exchange

JRRN took part in domestic and international symposium and conference on river restoration for further technical exchange with experts.

1) Participation in "18th International Riversymposium" and presentation at "River Restoration in Asia" (September, 2015, Brisbane AUSTRALIA)

2) Technical exchange on river restoration with KRIED (Korea Research Institute of Environment & Development) delegation (March 2016, Tokyo)

3) Technical exchange and supporting site visit on river restoration with DSD, Hong Kong Government delegation (23-25 May 2016, Tokyo)



Research

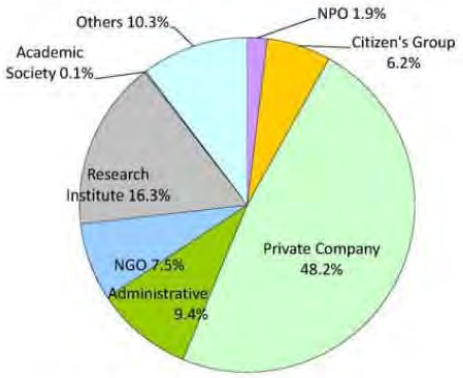
JRRN studied on collaborative nature restoration along river in Japan through partnership approach between river administration and Citizen's group, with experts and JRRN members. (Since 2014)

Publication

JRRN compiled the results of various activities in 2015-2016 as online publication, and promoted efforts to disseminate them through the JRRN website so that they will be widely utilized.

Membership

JRRN consists of about 750 personal and 60 organization members as of August 2016.



Sector breakdown of JRRN personal member

Report on "Series field training & workshop" and "4th Symposium" on collaborative nature restoration

Cherry Blossom and Waterscape Photo Collection 2016

Report on "International Symposium on River Technologies"

CRRN (China River Restoration Network)

1. Forum and seminar

CRRN member participated in the sixth session of the World Conference on ecological restoration in Manchester , and made a report at the conference on 25th August, 2015.

1. Forum and seminar

- **International Symposium on Ecological hydraulics in association with IAHR**
- **the 28th May, 2016, Beijing**
- **About 150 participants**

2. communicate and exchange

- Relying on China EU water resources exchange platform (CEWP), A series of technical communication was made between CRRN and European experts.

- **Investigated The British Ayr Rive fishway project in Aug 2015**

2. communicate and exchange

- Relying on China EU water resources exchange platform (CEWP), A series of technical communication was made between CRRN and European experts.

- **Investigated the project of ecological restoration of Melon Dean river in Portugal in Aug 2015**

2. communicate and exchange

- Relying on China EU water resources exchange platform (CEWP), A series of technical communication was made between CRRN and European experts.

- **Investigated Fish lift machine of Pedro high dam project in Portugal in Aug 2015**

2. communicate and exchange

- Relying on China EU water resources exchange platform (CEWP), A series of technical communication was made between CRRN and European experts.

- **In Sep. 2015, CRRN and the EU expert investigated the Nanxi River, inspected water environment, riparian vegetation, and visited the Nanxi River water supply project and fishway.**

2. communicate and exchange

- Relying on China EU water resources exchange platform (CEWP), A series of technical communication was made between CRRN and European experts.

- In Sep. 2015, CRRN and the EU expert investigated Xin'An river ecological environmental protection project, and discussed with local experts.

2. communicate and exchange

- Relying on China EU water resources exchange platform (CEWP), A series of technical communication was made between CRRN and European experts.

- In Sep. 2015, CRRN and the EU expert visited Water environment treatment project of Taihu River Basin.

2. communicate and exchange

- Organized two technical lectures in Aug, 2015
  - Delineation and management of ecological red line
  - Application of iron in water environment treatment
- On 30th May, 2016, Invited Christopher George, IAHR Executive Director and Francisco Martinez-Capel, Professor to visit CRRN.

2. communicate and exchange

- In Aug. 2016, CRRN investigated Water environment treatment projects in Jiaxing city of Zhejiang province.

2. communicate and exchange

Participated in the graduate student exchange activities of both sides of the Taiwan Straits, and teach "water and ecological environment" course to the Taiwan graduates in 2015 and 2016.

3. technology standards

Writing two ecological restoration technology standards about " sodium bentonite waterproof layer "and" gabion slope protection"

中国工程建设标准化协会
文 件

建标协字[2015]099 号

关于印发《2015 年第二批工程建设协会标准制订、修订计划》的通知

协会各分支机构、各标准归口单位和主编单位：

由协会各分支机构推荐和主编单位自主申报，经协会讨论研究，现将《2015 年第二批工程建设协会标准制订、修订计划》印发给你们，请按计划抓紧落实，认真开展制订、修订工作。关于计划项目的执行情况，请各主编单位于每年年末报告归口单位，并请归口单位汇总后报送我协会。

附件：2015 年第二批工程建设协会标准制订、修订计划

抄报：住房和城乡建设部标准定额司

4. Website Development

- We have completed the construction of the website and Main Page Design, and have a full-time staff operating it.

www.crrn.org.cn

Welcome to the on-line communications and suggestions

IWHR

CRRN
China River
Restoration Network

Thank You!

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KRRN (Korea River Restoration Network)

1. Hosted “The River Management Workshop to Prepare for Climate Change”

○ Date: 2016.04.28.~29

○ Venue: Sun valley Hotel in Yeoju city

○ Sponsored by Ministry of Land, Infrastructure and Transport, Gyeonggi-do, Yeoju city and K-Water

○ More than 500 experts of industry, academia and research field participated in this workshop. The theme of workshop is “The Change of River management Paradigm”.

2. Supported for Research Events

(1) Advanced River measurements Seminar

○ Date: 2015.08.17

○ Presentation and discussion of river monitoring methods with advanced techniques

○ KICT and Dankook University

(2) The 2nd Andong River Experiment Forum (AREF 2015)

○ Date: 2015.10.15 ~ 2015.10.16.

○ The forum was attended by a total of 82 presenters, including those of South Korea, France, the United States, Canada, and the Netherlands.

(3) Green River Research Group Workshop (KAIA R&D)

○ Date: 2016.05.09 ~ 2016.05.10.

○ There were thematic presentations and discussions about “Development of river management techniques to respond to changes in river environment”.

(4) International Joint Seminar between Dankook University (Korea) and Irstea (France)

○ Date: 2016.07.19

○ Theme: Hydro-acoustical suspended sediment measurements

3. Supporting the promotion of the understanding of river area.

(1) The 7th World Water Forum Technical Tour

○ Date: 2015.04.16

○ Venue: KICT-REC

○ Total of 23 persons participated in the United States, Vietnam and so on.

(2) Middle & High school

○ Date: 2015.04.28

○ Visitors: Sungchang woman high school (85 persons)

○ Date: 2015.10.22

○ Visitors: Anjung middle school (98 persons)

○ Date: 2016.06.09

○ Visitors: Sunghee woman middle school (167 persons)

(3) College & University

○ Date: 2015.06.03

○ Visitors: Andong University (36 persons)

○ Date: 2015.09.17

○ Visitors: Myeongji University (4 persons)

○ Date: 2016.04.29

○ Visitors: Gyeonghee University (60 persons)

(4) Public officers and NGO

○ Date: 2015.09.09

○ Visitors: Ulsan city officers (Water quality management department)

○ Date: 2016.02.25

○ Visitors: Gyeongsangbuk-Do officers (River management department, 41 persons)

○ Date: 2016.07.01

○ Visitors: Yeocheon Ecology research group (40 persons)

4. Trying to international collaborative research with TRRN

KRRN and TRRN were trying to Joint Research under the NRF-MOST Cooperative Program. The title of joint research is “Feasibility and technical improvement on restoration of urban stream for ecological purposes – vegetation recover by technical removing the concrete bottom”. The Dr. Yonguk Ryu and Dr. Jungu Kang of KICT in Korea, and Professor Shaohua Marko Hsu of Feng Chia University in Taiwan were planed the joint research. It failed this year but plans to challenge again next year.
NRF: National Research Foundation of Korea, MOST: Ministry of Science and Technology (Taiwan)

13th International Forum on River Restoration under Drought and Climate Change

Eco-hydrological River Assessment In the Geum River Basin, Korea

ECO-HYDROLOGICAL RIVER ASSESSMENT IN THE GEUM RIVER BASIN, KOREA

JEONGKON KIM (1), SANGYOUNG PARK(2), …
(1): CEO, Korea Construction and Envrionment Technology, Inc.
(2): Principal Researcher, K-water Institute

Artificial changes of water quality, flow regime and structures in rivers may lead to physical and ecological changes throughout waterways and their floodplains. A preliminary assessment of the Geum River basin in Korea was conducted by a multi-disciplinary team. Based on the major events which might have affected the ecological system, a conceptual model was formulated to guide desktop and field studies, modeling and scenario evaluations. The result of hydrological analysis indicated that the construction of the Daecheong Multipurpose Dam (DMD) in the Geum River basin has altered flow magnitudes and reduced the river's flow variability. Changes are evident in the magnitude of medium and small flows and the river experiences increased low flows during the dry season. As a result, fewer sensitive riffle-benthic species were observed in the reaches downstream of the Daecheong Multipurpose Dam due to the reduction of suitable habitat conditions such as riffle-pool sequences. Black shinner (an endangered fish species) was selected and analysed to explore relationships between flow regime change by dams and changes to its preferred habitats. The results of this study provide fundamental information from which to develop more sophisticated flow-ecology relationships and revised reservoir operation plans that consider the flow requirements of the downstream river ecosystem.

Keywords: Eco-hydrology, River Assessment, Flow Variability, Physical Habitat Condition, Riffle-benthic Species, Dam Operation, River Management

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References

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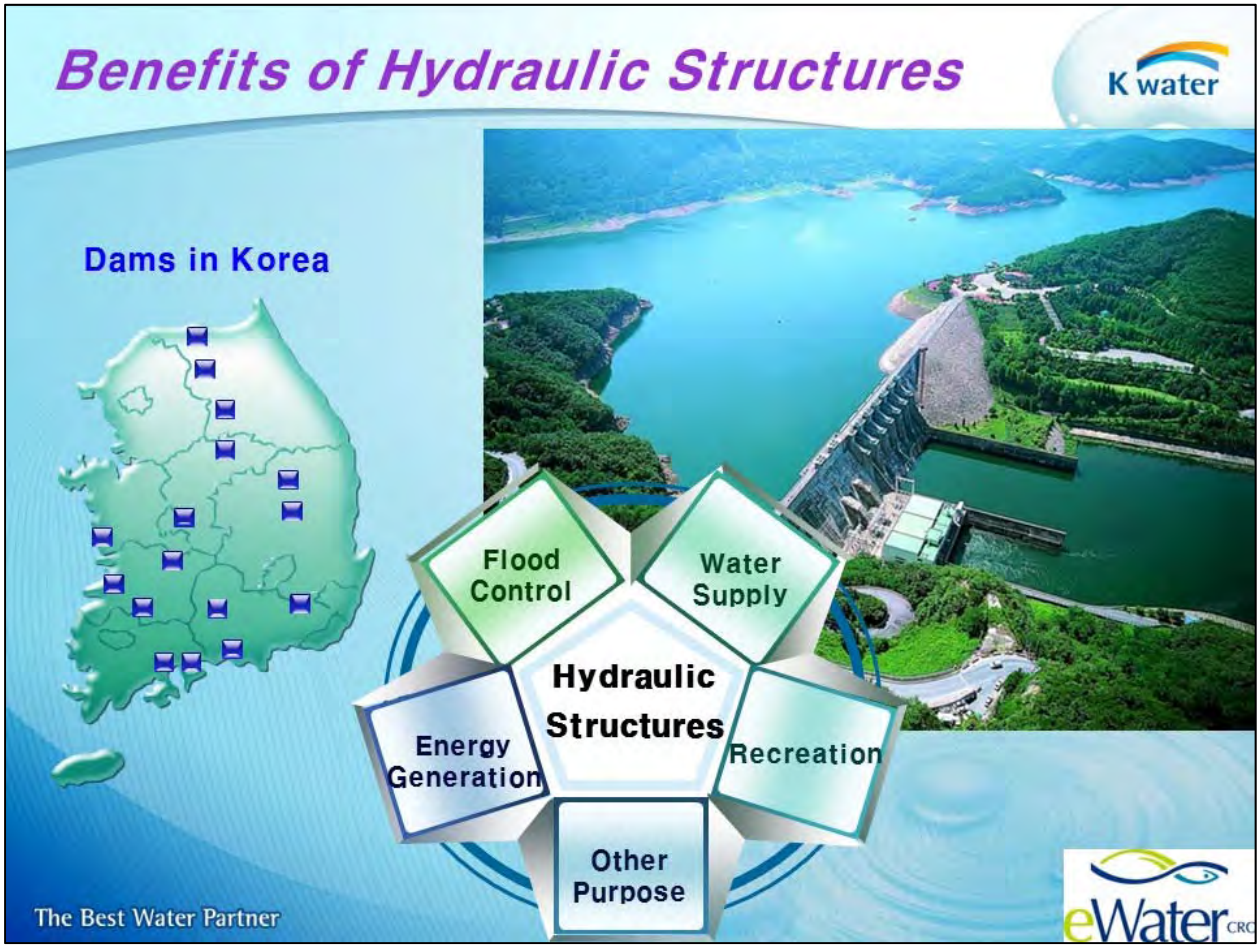
6. Jorde, K. 2006. Reservoir Operations and Ecosystem Losses, The 2nd International Workshop on River Environment, KICT, Korea, pp. 41-66.
7. Poff, N. L., Allan, J. D., Basin, M. B., Karr, J. R., Presegarrd, K. L., Ritcher, B. D., Sparks, R. E., and Stromberg, J. A. 1997. The Natural Flow Regime, Bioscience, 47(11), pp. 769-784.

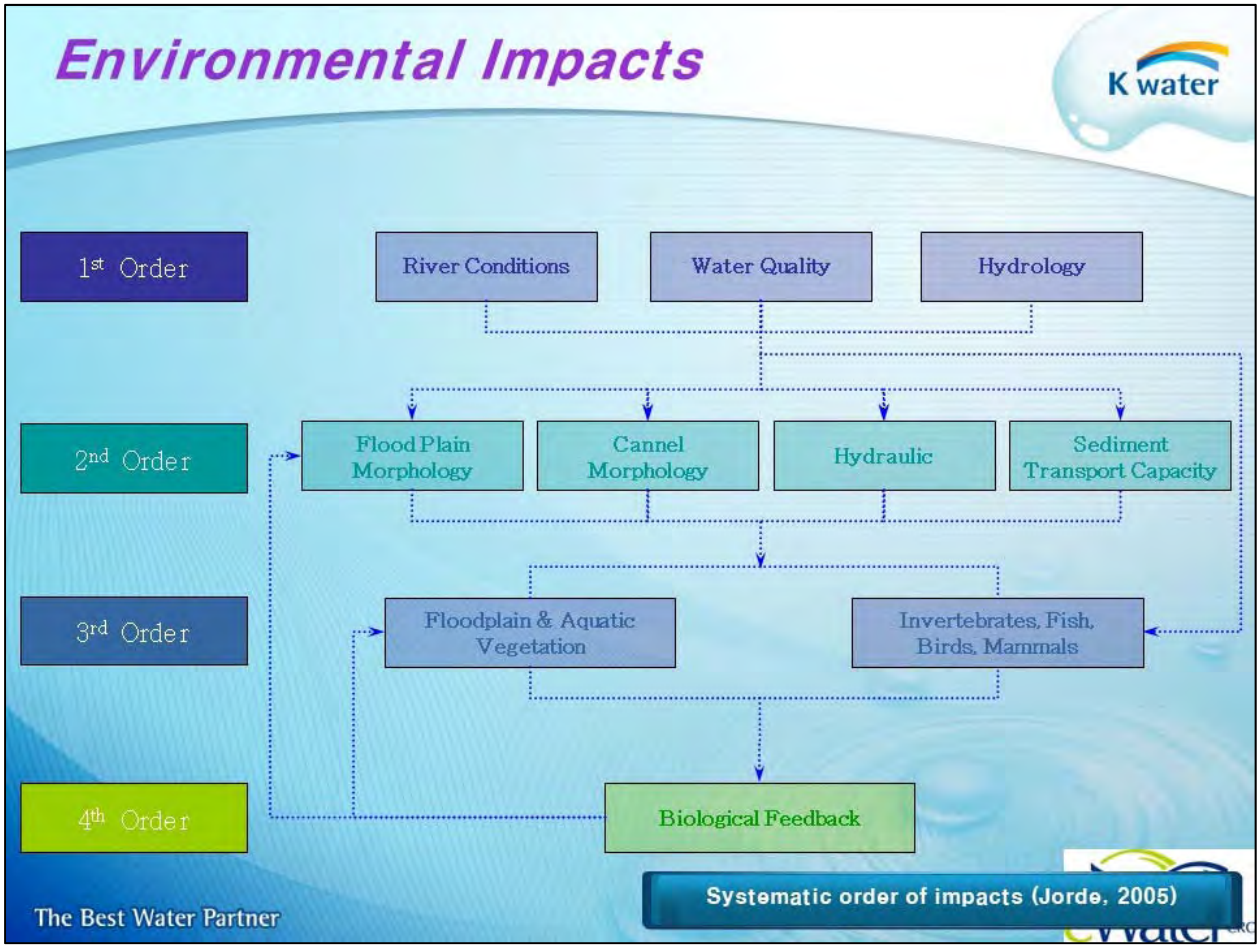

The Best Water Partner
Eco-hydrological River Assessment in the Geum River Baisin, Korea
Sangyoung Park*, Sanguk Lee*
and Jeongkon Kim**,
*K-water, ** KoCET
eWater CRC
K water


Contents
I Introduction
II. Methodology
III. Assessments
IV. Concluding Remarks
K water
The Best Water Partner

Benefits of Hydraulic Structures



Environmental Impacts



Objectives

eFlow Project
(K-water & eWater CRC)

- To study the impacts of flow regime changes on physical and ecological changes for ***sustainable management*** of the Geum River Basin
  - Holistic/conceptual Approach
  - Multi-disciplinary Expert Team (MET)
- Improved reservoir operation/management scheme for sustainable management of rivers downstram reservoirs

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Basin Steps

1	Preparation	Assemble team, compile & review data, statistics and knowledge
2	Familiarisation	Team visit to river (1), Sept. 2006 identify key flow and non-flow issues
3	Conceptual Overview	Conceptual models, flow-ecology relationships, knowledge/data gaps
4	Expert Assessment	Field Trip (2), Mar. 2008 Management objectives, additional discharge of DMD
5	Scenario analysis & modelling	RAP-HA, TSA, TSM, develop management options
6	Test & Communicate	Test and communicate with other scientists, engineers and stakeholders

The Best ...artner

Multi-disciplinary Expert Team (MET)

Organization of MET (Multi-disciplinary Expert Team)

- Various areas covered by researchers from eWater CRC and K-water (1st case in env. flow estimation in Korea)

Category	K-water	eWater CRC
Hydrology and reservoir operation	Ick Hwan Ko Sinuk Kang	Gary Jones
Echo-hydraulic river assessment	Jeongkon Kim Sangyoung Park	Bill Young
River hydraulics	Junwoo Noh	Michael Stewardson
Riverine geomorphology	Changlae Jang	Robert Argent
River water quality	Sang-Uk Lee	Gary Jones
Fish ecology	Jinwon Seo, Junwook Hur	Angela Arthington
Vegetation ecology	Hojun Kim	Angela Arthington
Macro invertebrate	Insil Kwack(Jeonnam Univ.), Seahyun Kim	Richard Norris

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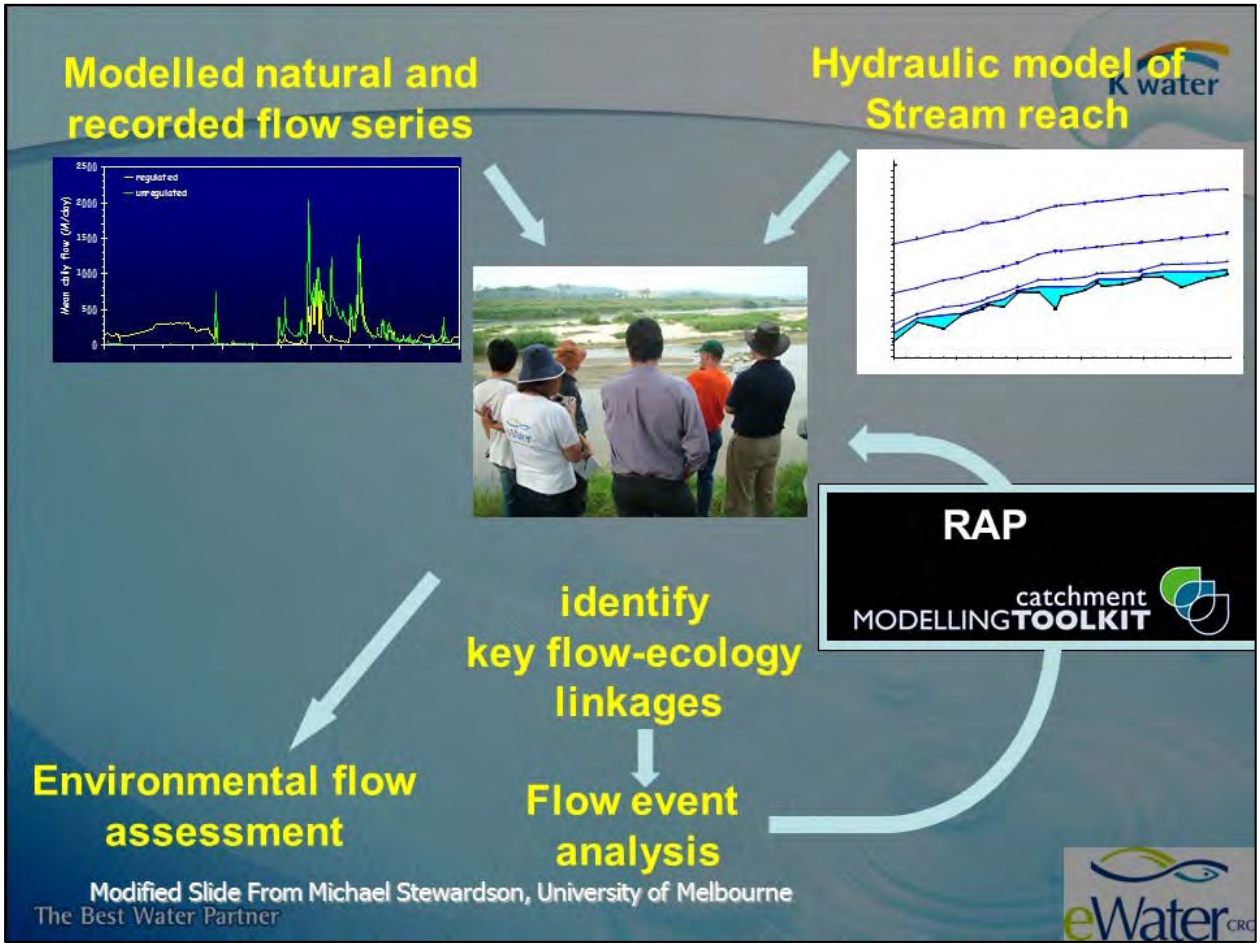
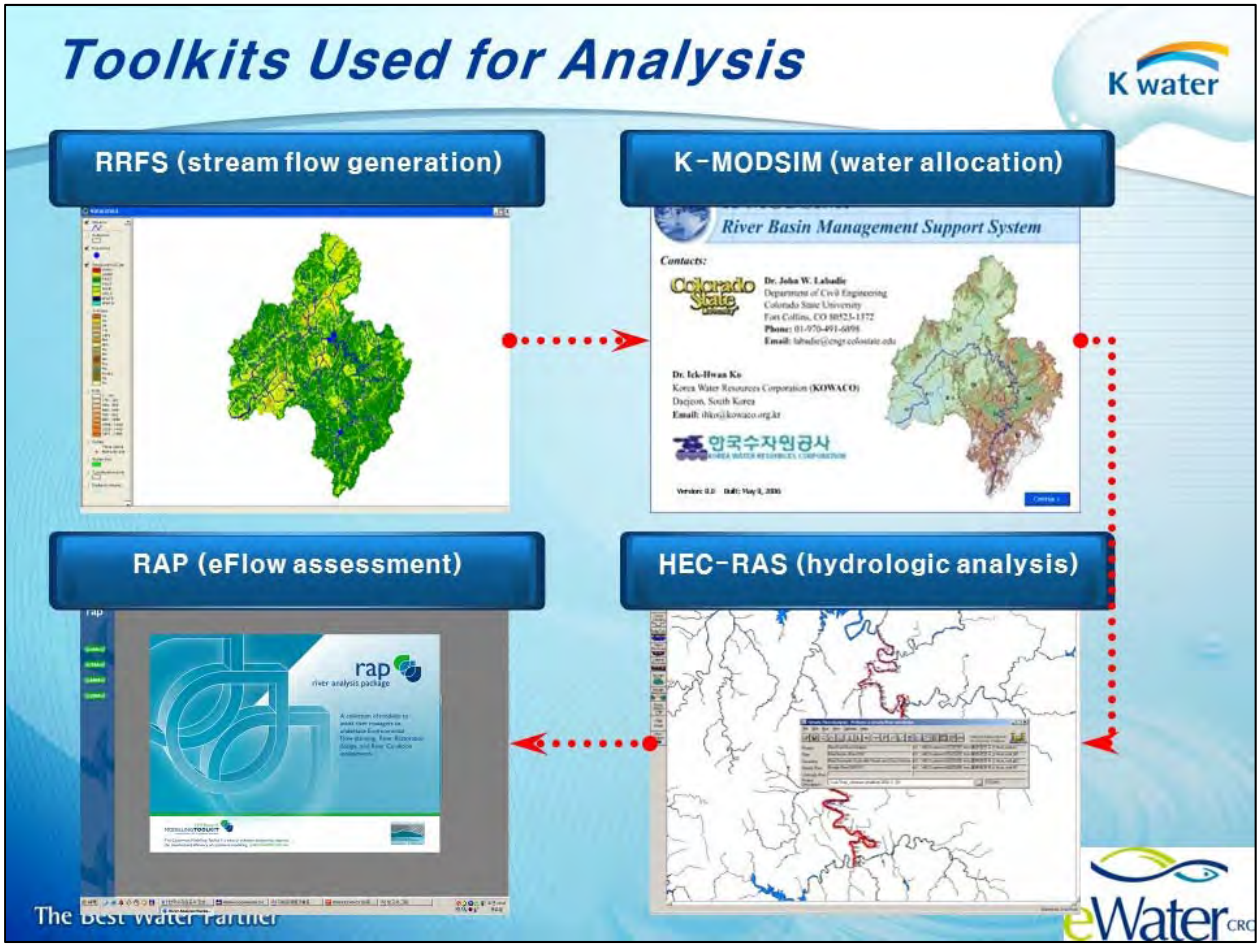

Modelled natural and recorded flow series
Hydraulic model of Stream reach
K water
regulated
unregulated
Mean daily flow (Ml/day)
RAP
catchment MODELLING TOOLKIT
identify key flow-ecology linkages
Environmental flow assessment
Flow event analysis
Modified Slide From Michael Stewardson, University of Melbourne
The Best Water Partner
eWater CRC


Toolkits Used for Analysis
K water
RRFS (stream flow generation)
K-MODSIM (water allocation)
River Basin Management Support System
Contacts:
Colorado State University
Dr. John W. Labadie
Dr. Ick-Hwan Ko
Korea Water Resources Corporation (KOWACO)
한국수자원공사
RAP (eFlow assessment)
rap
river analysis package
HEC-RAS (hydrologic analysis)
The Best Water Partner
eWater CRC

Ⅰ. Introduction

Ⅱ. Geum River Basin

Ⅲ Assessments

Ⅳ. Concluding Remarks

K water

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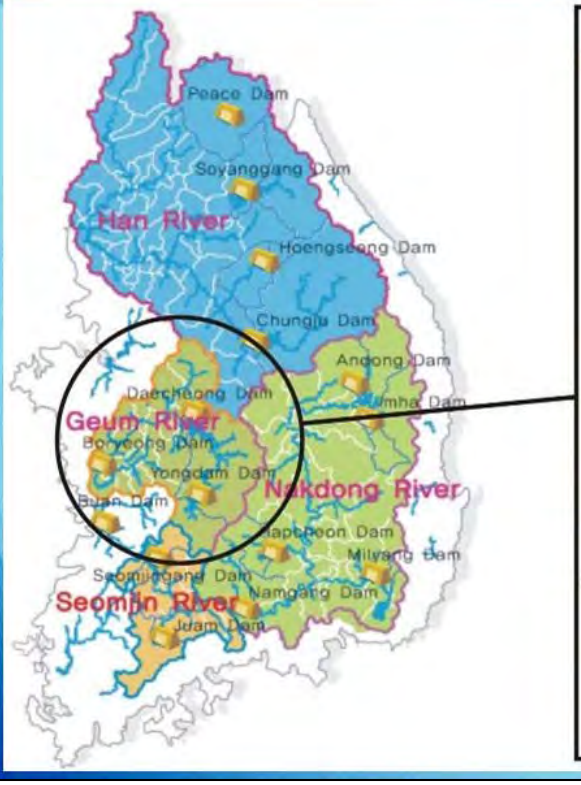
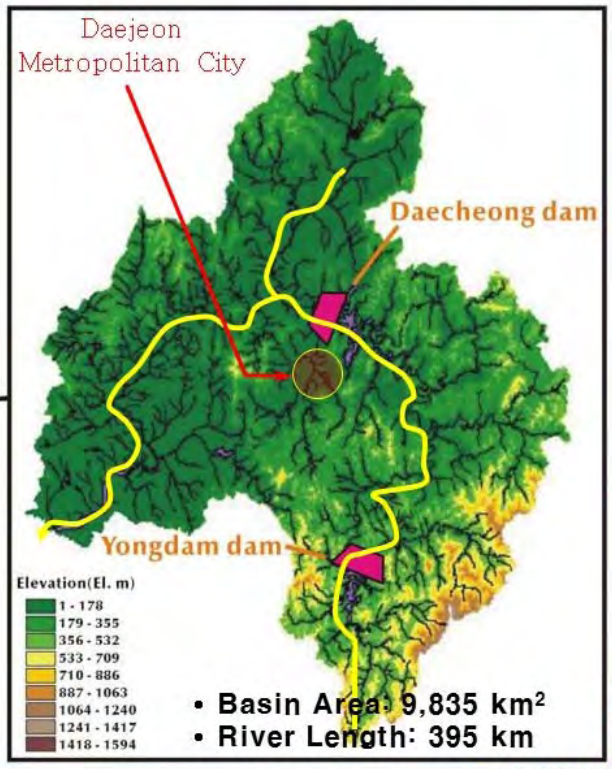
Geum River Basin

K water





Daecheong Multipurpose Dam

- Constructed in 1980
- Located at 150 km upstream from the Geum river estuary
- Catchment area: 4,134 km^2
- Gross storage capacity : 1,490 Mm^3
- Flood control capacity : 250 Mm^3
- Reservoir area : 72.8 km^2
- Height : 72.0m
- Annual energy output : 196-240 GWh
- Annual water supply : 1,649 Mm^3

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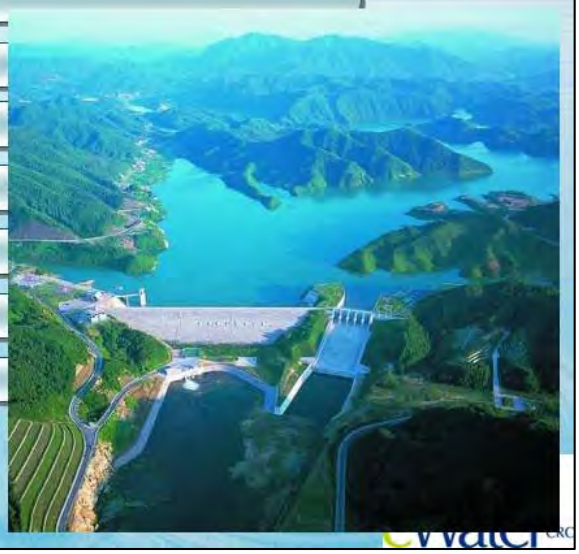
Yongdam Multipurpose Dam

- Constructed in 2001 at upstream of Deacheong dam
- Located upstream of the Geum river
- Supply water to nearby Jeonju area
- Catchment area: 930.0 km^2
- Gross storage capacity : 815 Mm^3
- Effective storage capacity : 672 Mm^3
- Flood control capacity: 137 Mm^3
- Height : 70.0m
- Annual energy output : 198.5 GWh
- Annual water supply : 650.4 Mm^3



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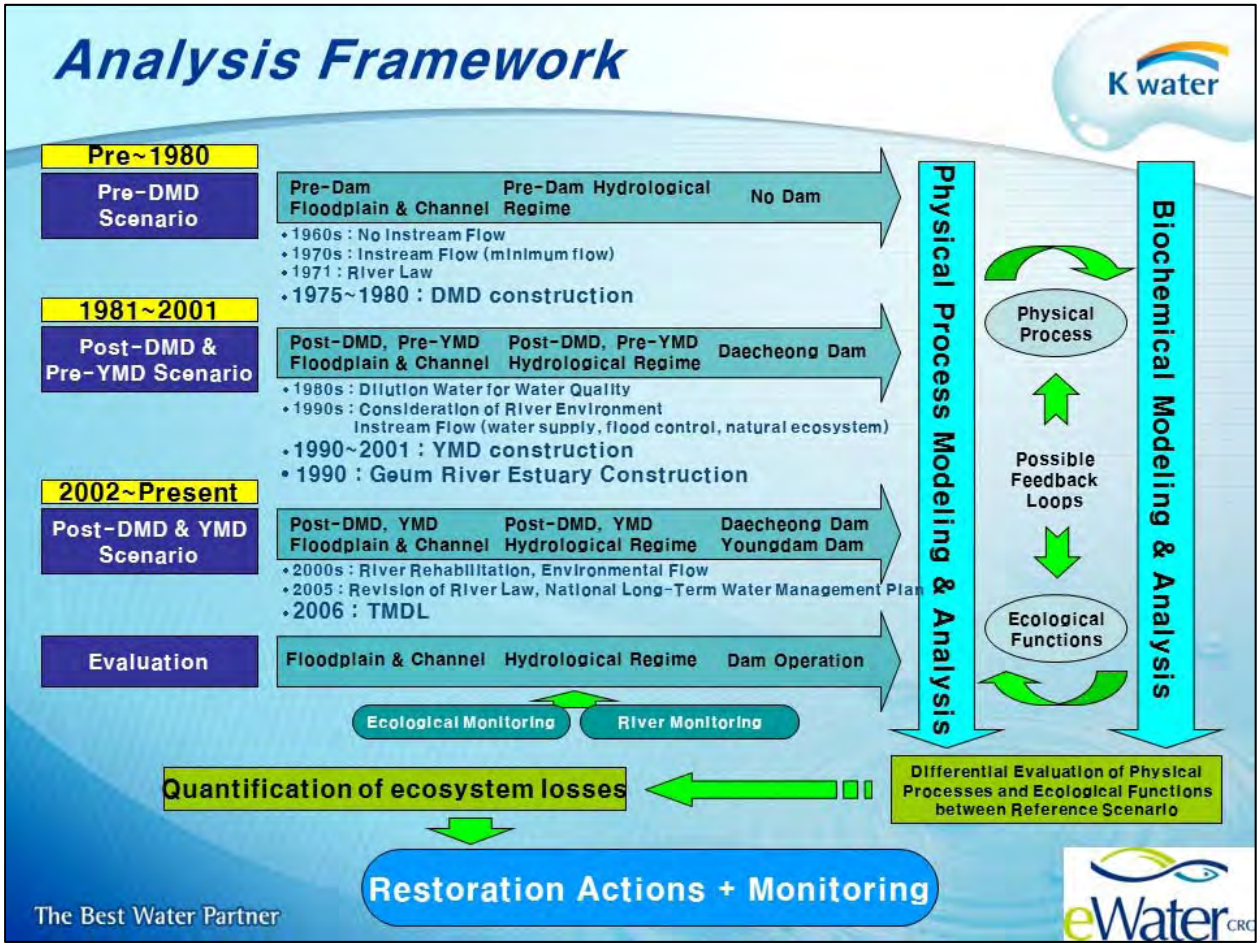
Analysis Framework
K water
Pre~1980
Pre-DMD Scenario
Pre-Dam Floodplain & Channel
Pre-Dam Hydrological Regime
No Dam
•1960s : No Instream Flow
•1970s : Instream Flow (minimum flow)
•1971 : River Law
•1975~1980 : DMD construction
1981~2001
Post-DMD & Pre-YMD Scenario
Post-DMD, Pre-YMD Floodplain & Channel
Post-DMD, Pre-YMD Hydrological Regime
Daecheong Dam
•1980s : Dilution Water for Water Quality
•1990s : Consideration of River Environment
Instream Flow (water supply, flood control, natural ecosystem)
•1990~2001 : YMD construction
• 1990 : Geum River Estuary Construction
2002~Present
Post-DMD & YMD Scenario
Post-DMD, YMD Floodplain & Channel
Post-DMD, YMD Hydrological Regime
Daecheong Dam
Youngdam Dam
•2000s : River Rehabilitation, Environmental Flow
•2005 : Revision of River Law, National Long-Term Water Management Plan
•2006 : TMDL
Evaluation
Floodplain & Channel
Hydrological Regime
Dam Operation
Ecological Monitoring
River Monitoring
Physical Process Modeling & Analysis
Biochemical Modeling & Analysis
Physical Process
Possible Feedback Loops
Ecological Functions
Differential Evaluation of Physical Processes and Ecological Functions between Reference Scenario
Quantification of ecosystem losses
Restoration Actions + Monitoring
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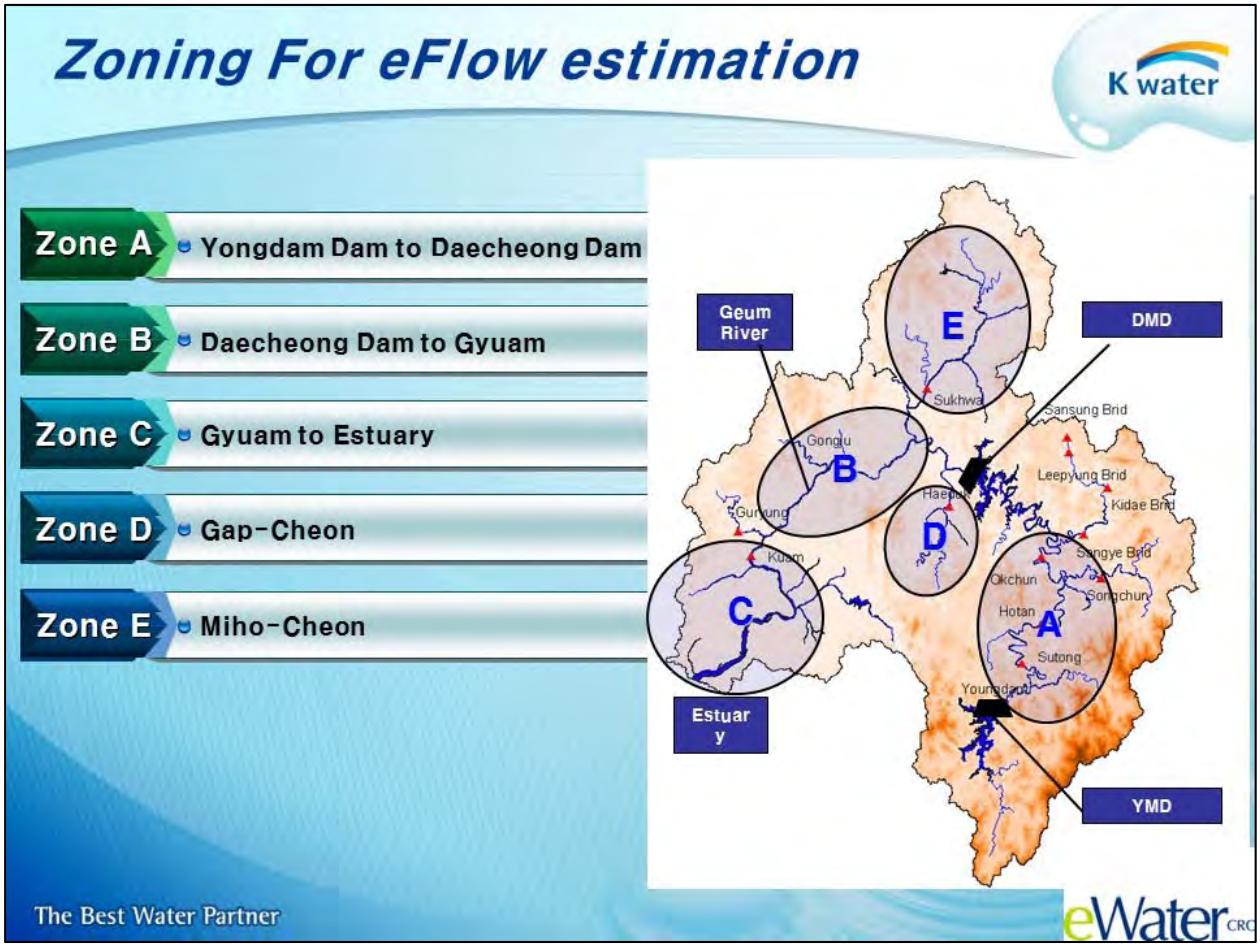
eWater CRC


Zoning For eFlow estimation
K water
Zone A
Yongdam Dam to Daecheong Dam
Zone B
Daecheong Dam to Gyuam
Zone C
Gyuam to Estuary
Zone D
Gap-Cheon
Zone E
Miho-Cheon
Geum River
DMD
YMD
Estuary
E
B
C
D
A
Sukhwa
Gongju
Gunung
Kusm
Haepoh
Sansung Brid
Leepyung Brid
Kidae Brid
Songye Brid
Okchun
Songchun
Hotan
Sutong
Youngdam
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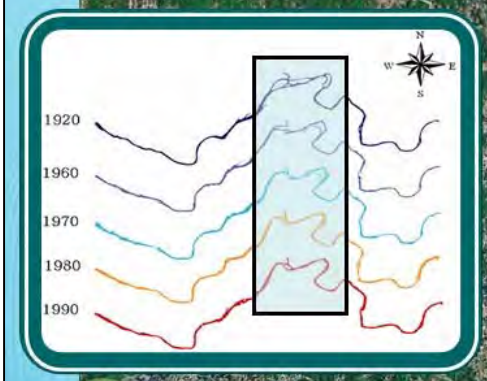
Changes in River Geomorphology

K water

Generating basic information to analyze the relationship between flow pattern change and river geomorphology



- **Single channelization from multiple**
  - ▸ Sediment interception
  - ▸ Flow control

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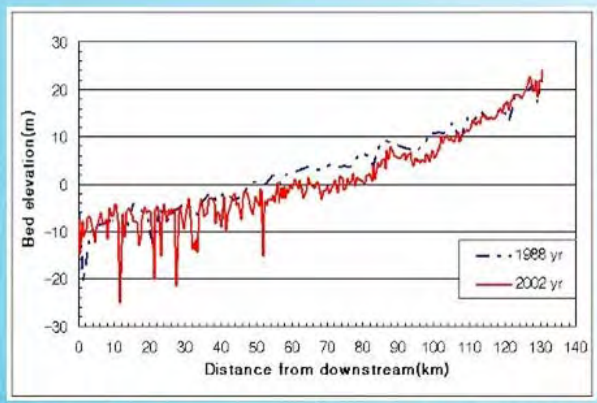
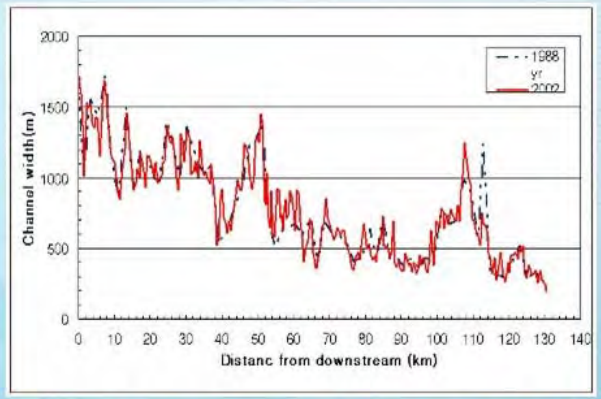
Geomorphic Change

K water



Bed Elevation (1988~2002)



Channel Width (1988~2002)

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Change of fish group in Guem River Basin

Preparation of basic data for correlation analysis from change of flow characteristics and fish group

	Up-and downstream of YMD		Up-and downstream of DMD	
	Before 2000	'02 ~ '04	Before 2000	'02 ~ '04
Fish fauna	11 Families 49 species	11 Families 42 species	20 Families 77 species	11 Families 52 species
Natural monument	1	0	0	0
Endangered species	4	3	6	1
Korean endemic species	21	20	27	15
Introduced species	0	3	1	6

- Historical data not reliable
- Monitoring methodology and sections not well established
- Fish groups to be better defined considering ecologically valuable fish group, economically valuable fish group, class variability

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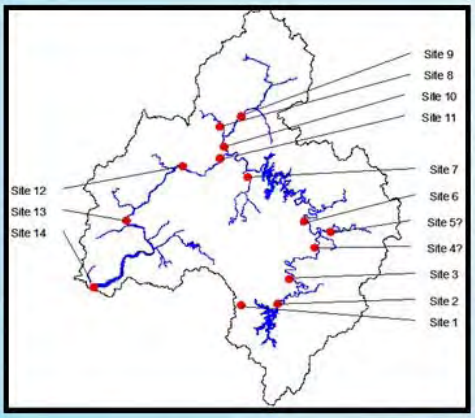
Field Survey in 2006



- Field survey was conducted to identify and classify study zones for eFlow estimation
  - Analyzing river characteristics at major points
  - Identifying individual factors of stream environment
  - Analyzing associated relationships between eFlow and other properties
  - Developing a method classifying stream zoning

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Field Assessment by MET






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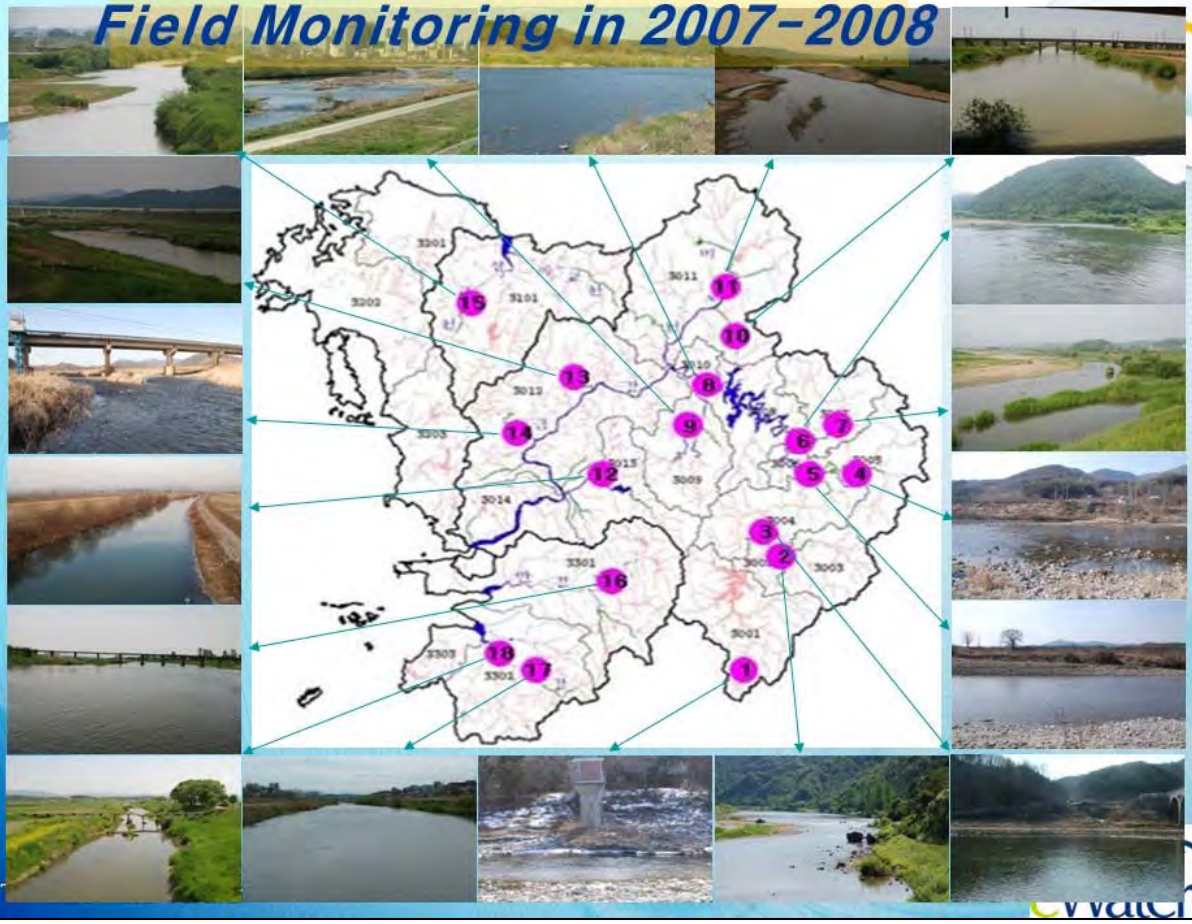
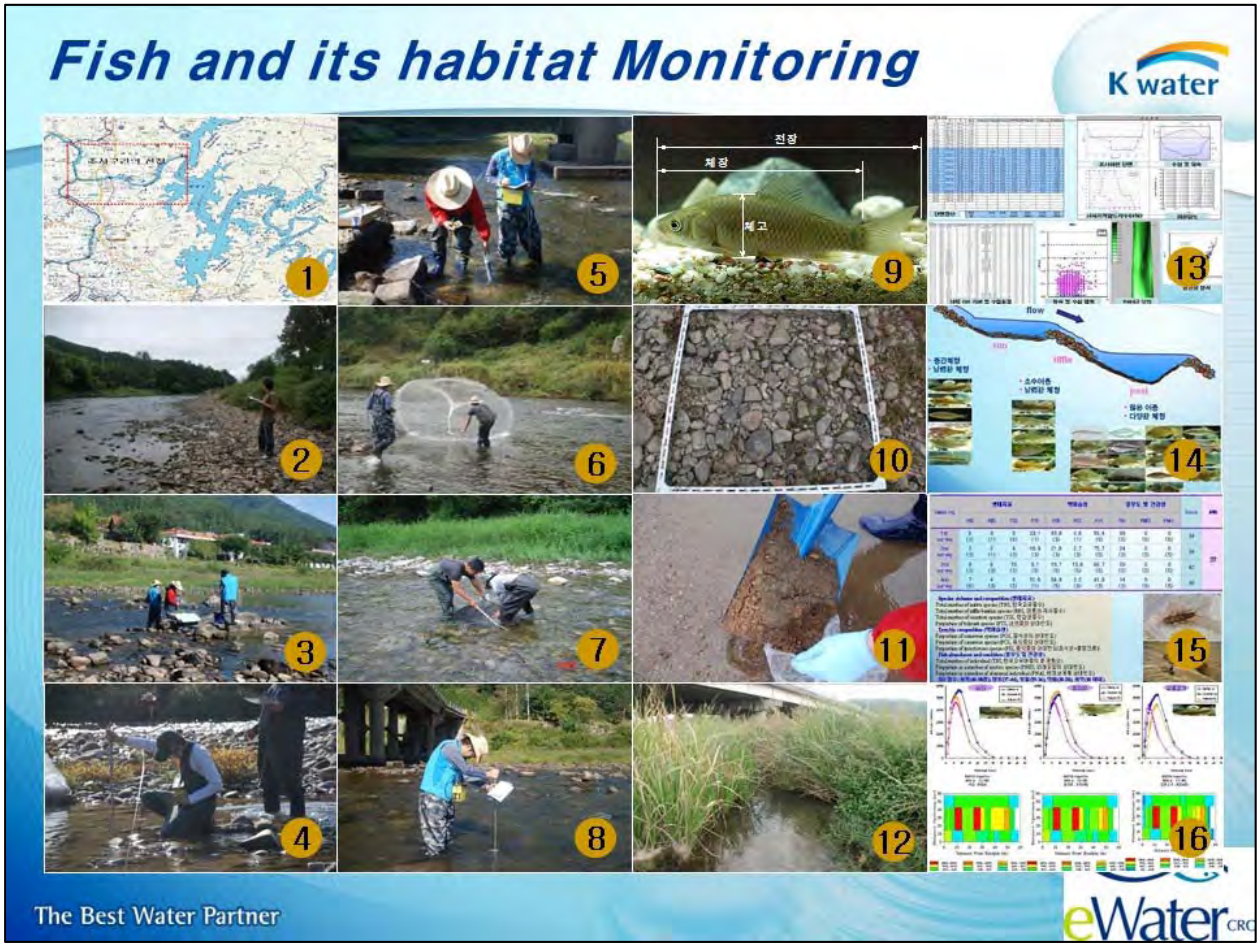
Field Monitoring in 2007-2008




Fish and its habitat Monitoring
K water
전장
체장
체고
flow
The Best Water Partner
eWater CRC


Benthic Macro-Invertebrate Monitoring
K water
The Best Water Partner
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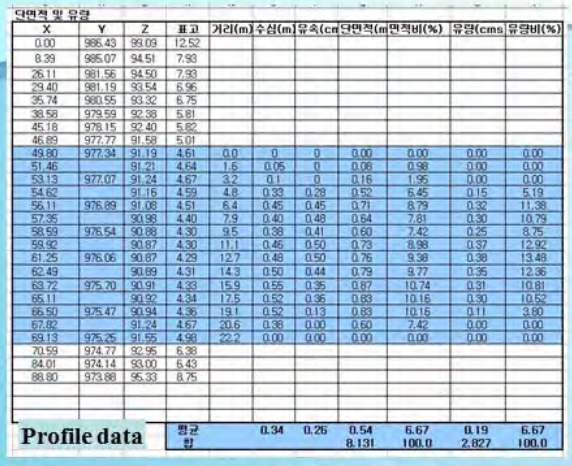
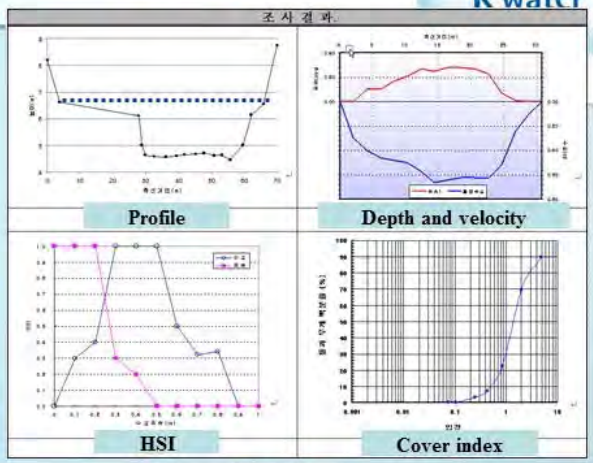
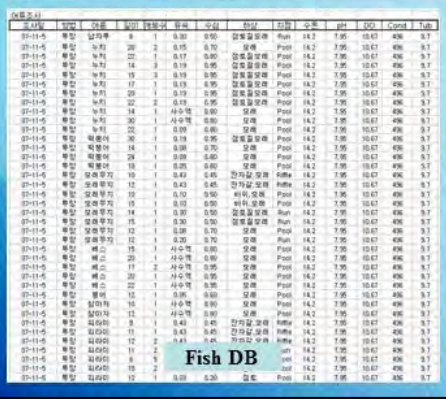
Data Base Building and Analysis

K water

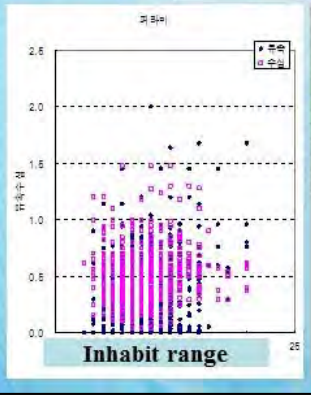


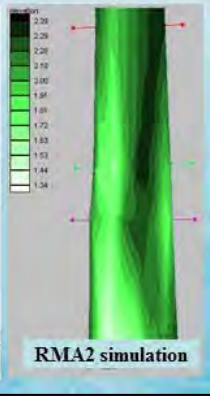
Profile data

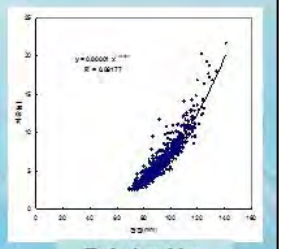




Fish DB







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Biological Integrity (IBI) Analysis

K water

Sampling	Species richness and composition				Trophic composition			Fish abundance and condition			Score	AVG
	TNS	RBS	TSS	PTS	POS	PCS	PIS	TNI	PNES	PNAI		
1st survey	6 (3)	3 (1)	8 (5)	23.1 (1)	43.8 (3)	0.8 (1)	55.4 (5)	89 (5)	0 (5)	0 (5)	34	37
2nd survey	3 (3)	2 (1)	4 (3)	18.9 (3)	21.6 (3)	2.7 (3)	75.7 (5)	24 (3)	0 (5)	0 (5)	34	
3rd survey	9 (3)	6 (3)	10 (3)	9.1 (3)	19.7 (5)	13.6 (5)	66.7 (5)	50 (5)	0 (5)	0 (5)	42	
4nd survey	7 (5)	4 (3)	8 (5)	51.6 (1)	54.8 (5)	3.2 (3)	41.9 (3)	14 (3)	0 (5)	0 (5)	38	

Species richness and composition (생태지표)
Total number of native species (TNS, 한국고유종수)
Total number of riffle-benthic species (RBS, 여울성-저서종수)
Total number of sensitive species (TSS, 민감성종수)
Proportion of tolerant species (PTS, 내성종의 상대빈도)
Trophic composition (먹이습성)
Proportion of omnivore species (POS, 잡식성의 상대빈도)
Proportion of carnivore species (PCS, 육식종의 상대빈도)
Proportion of insectivores species (PIS, 충식종의 상대빈도(초식성+플랑크톤))
Fish abundance and condition (풍부도 및 건강성)
Total number of individual (TNI, 한국고유어종의 총 개체수)
Proportion as a number of exotics species (PNES, 외래도입의 상대빈도)
Proportion as a number of abnormal individual (PNAI, 비정상개체 상대빈도)

IBI score: Excellent (45-50), Good (37-44), Fair (29-36), Poor (10-28), Very poor (10).

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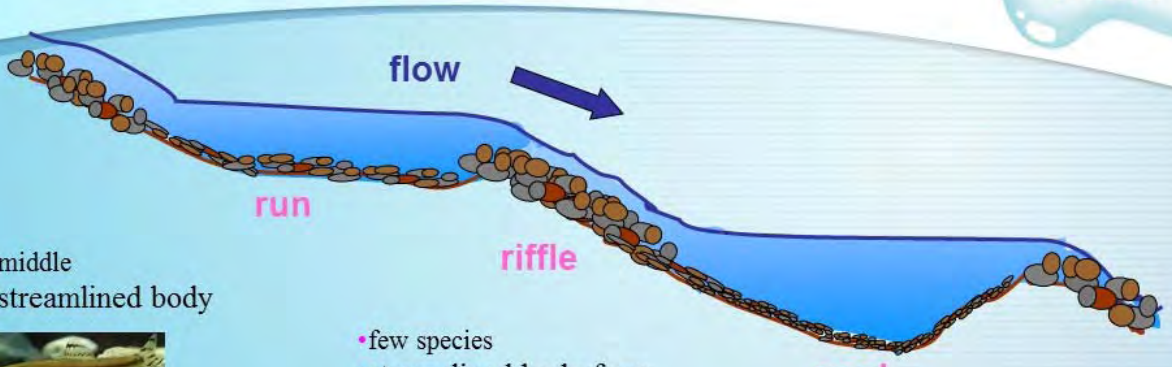
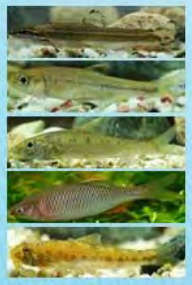
eWater CRC

Fish Habitat Preferences

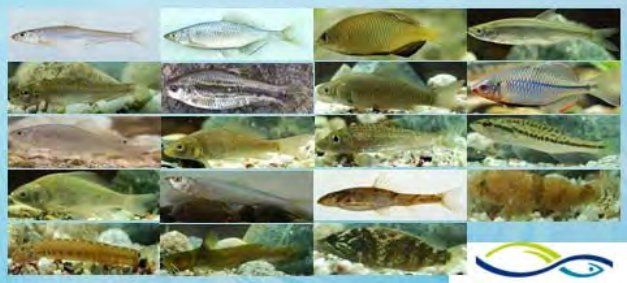


- middle
- streamlined body

- few species
- streamlined body form



- many species
- diverse body shapes



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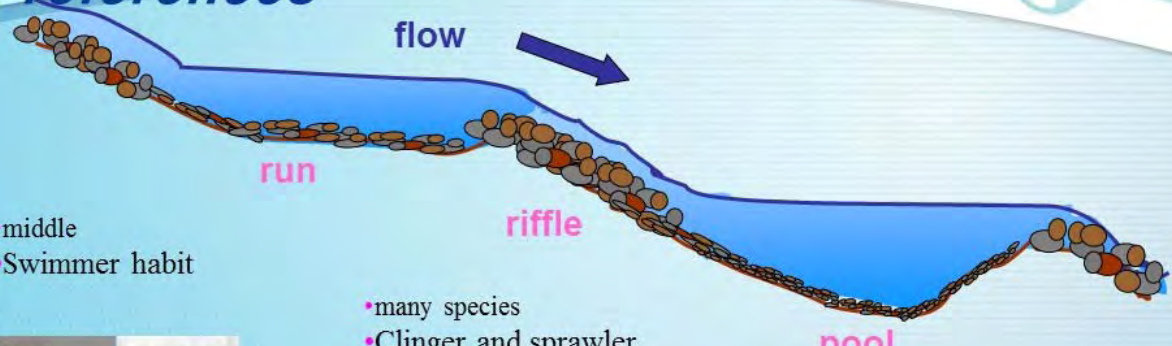
Macro Invertebrate Habitat Preferences



- middle
- Swimmer habit

- many species
- Clinger and sprawler

- few species
- Planktonic and diver

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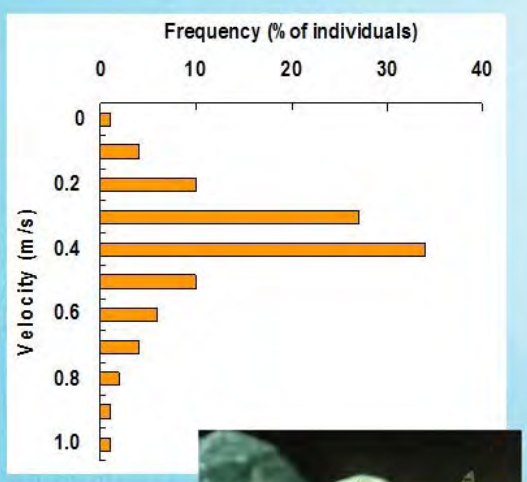
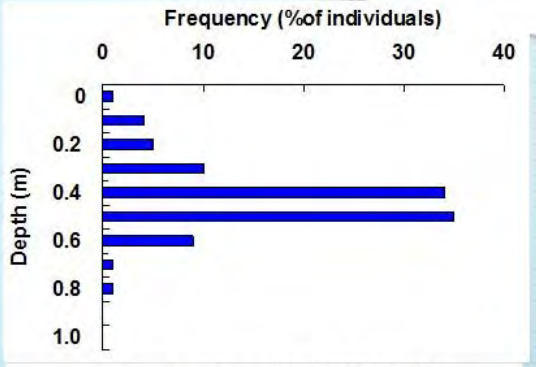
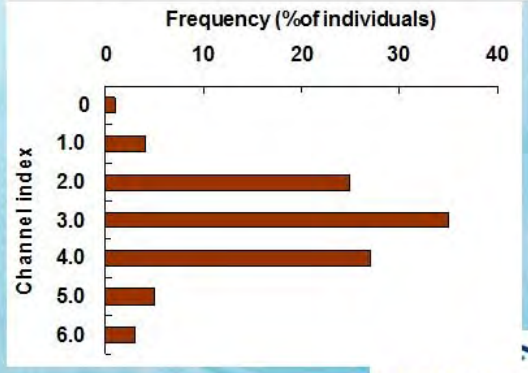
Frequency Distributions in River



감돌고기 Black shinner,
Pseudopungtungia nigra





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Habitat Suitability Index (HSI)

Species	Season (Month)	Velocity (m/s)	Depth (m)	Channel index
쉬리 Korean shinner, *Coreoleuciscus splendidus* 	Spring (4)	0.1~0.4	0.3~0.5	3.0~4.0
	Summer(6)	0.2~0.6	0.2~0.6	3.0~4.0
	Autumn (9)	0.2~0.5	0.2~0.5	3.0~4.0
피라미 Pale chub, *Zacco platypus* 	Spring (4)	0.1~0.5	0.3~0.5	3.0~4.0
	Summer(6)	0.1~0.6	0.3~0.6	1.0~4.0
	Autumn (9)	0.2~0.4	0.2~0.7	3.0~4.0
감돌고기 Black shinner, *Pseudopungtungia nigra* 	Spring (4)	0.2~0.5	0.2~0.4	2.0~3.0
	Summer(6)	0.2~0.7	0.3~0.6	1.0~4.0
	Autumn (9)	0.1~0.4	0.4~0.6	2.0~3.0

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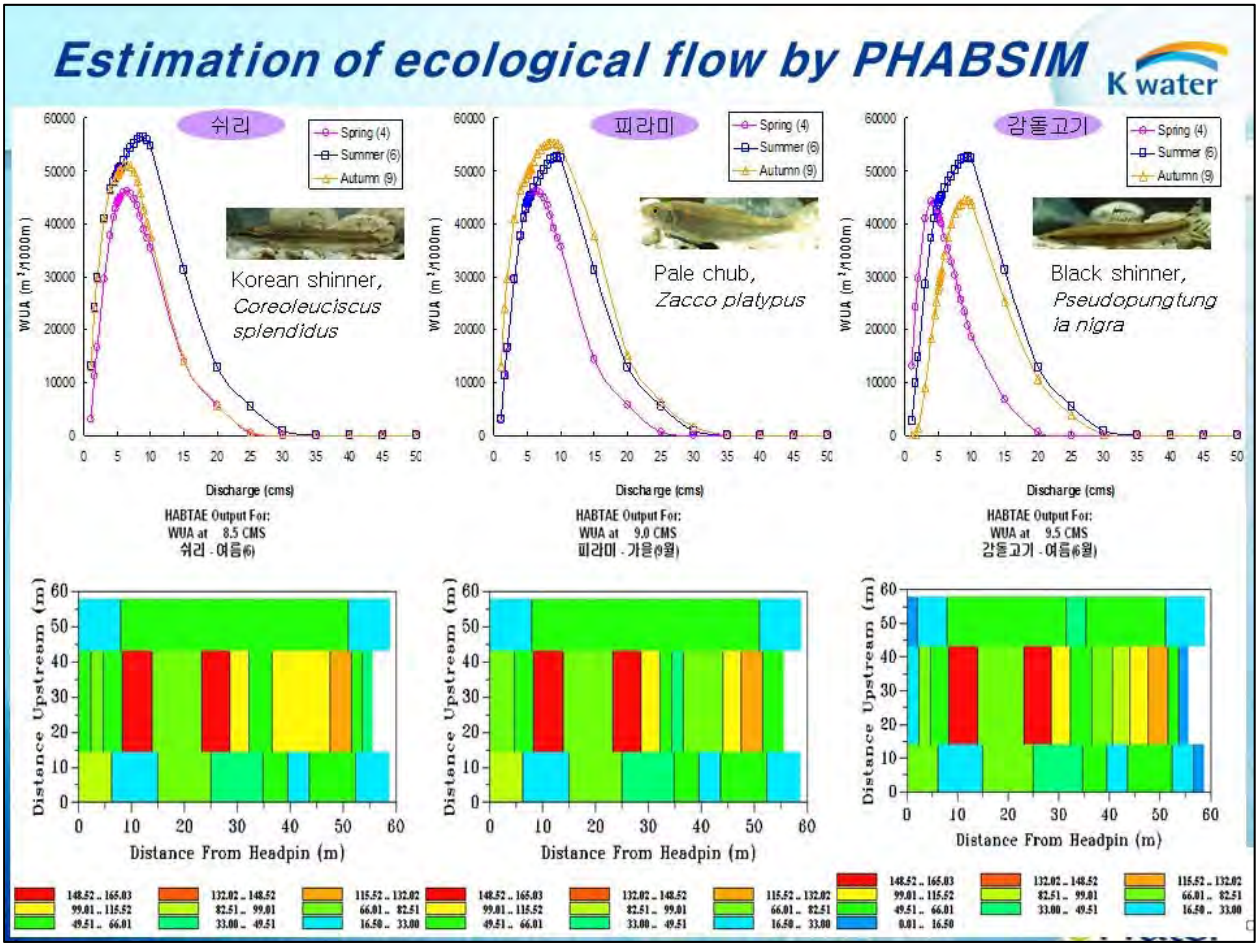
Estimation of ecological flow by PHABSIM



Scenario analysis of flow characteristics change using Modeling Toolkits

RRFS — Measured discharge

K-Modsim — Dishcarge data from dam operation

HEC-RAS — River hydraulic data

- Three scenarios
  - before DMD
  - after DMD ~before YMD
  - after DMD & YMD

Scenario analysis

RAP

- Hydraulic analysis module
- Time series analysis module
- Time series management module
- Ecosystem response module

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Flow Scenario Generation

- Flow Scenario was generated by KModSim
- Flow Regime Change Scenario :

  1)pre DMD 2) post DMD – pre YMD 3) post YMD
- Simulation period: 1984.1 – 2006.6
- 14 subcatchment and daily network for Geum river basin
- RRFS was employed to generate inflow and water use for each subcatchment
- YMD operation rule: 2002.1-2006.6 and expend
- DMD operation rule: 1984.1-2006.6 measured data

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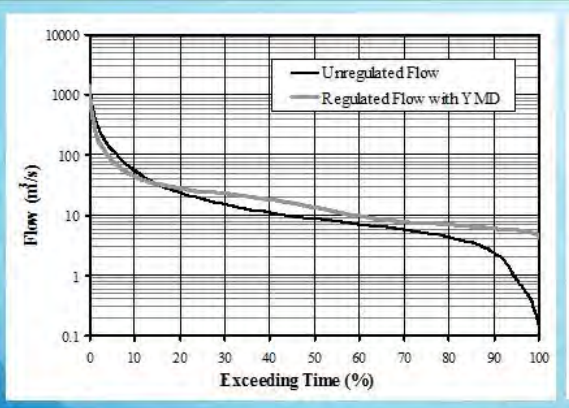
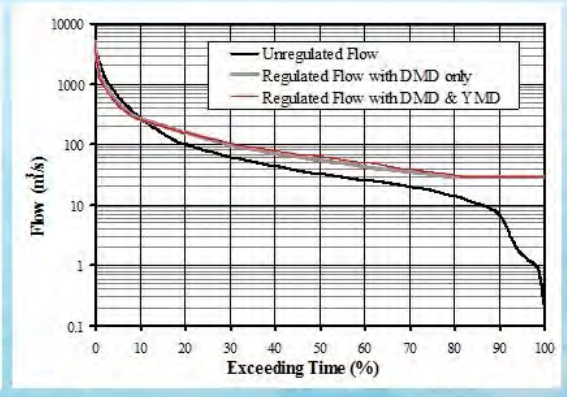
Time Series Analysis (TSA)

- Description of hydrological change as background to discussion of ecological impacts
- Assessing changes in the temporal pattern of habitat conditions
- Specifying environmental flow targets which allow for (or require) temporal variation in flow regime





Sutong

Gongju

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Spell Analysis

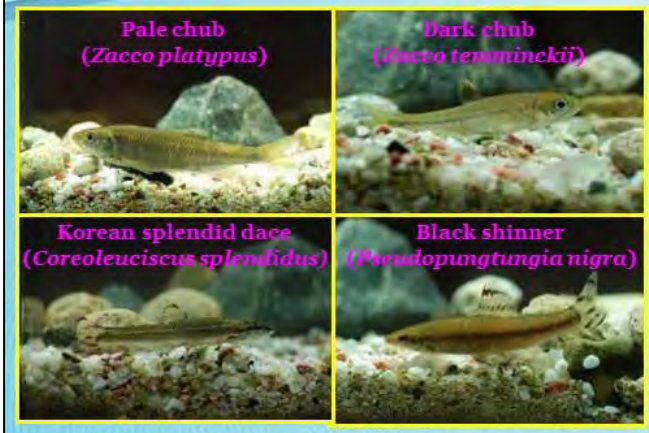
Gongju gauging station

- Threshold : 10 , 90 Percentile
- Low flow events have been increased by dam construction

(Unit: 1,000 CMD)

Categories	Ungrulated Flow SuTong(without YD)	Regulated Flow SuTong(with YD)	Unregulated Flow GongJu	Regulated Flow GongJu(with Daechung only)	Regulated Flow GongJu(with Daechung and Youngdam)
High Spell Threshold	3,815	3,815	23,823	23,823	23,823
Number of High Spell	300	274	250	256	251
Longest High Spell	15	13	17	17	17
Mean Magnitude of High Spell	17,917	14,296	99,370	74,787	70,086
Mean Duration of High Spell	3	2	3	2	2
Total Duration of High Spell	951	804	804	753	708
Low SpellThreshold	528	528	588	588	588
Number of Low Spell	294	140	117	4	0
Longest Low Spell	86	80	48	30	NaN
Mean Magnitude of Low Spell	299	471	204	60	NaN
Mean Duration of Low Spell	8	5	6	10	NaN
Total Duration of Low Spell	2,617	813	805	43	NaN

Ecological Habitat issues

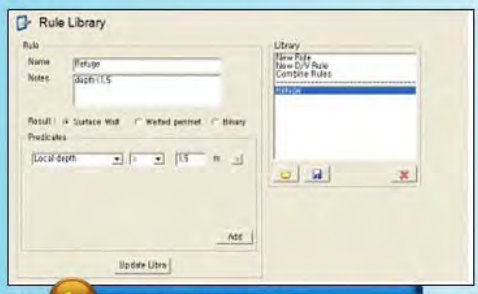


Determination of fish species
- Dominant species
- Korean endemic species
- Endangered species
- Spawning period
- Food sources
- Habitat condition

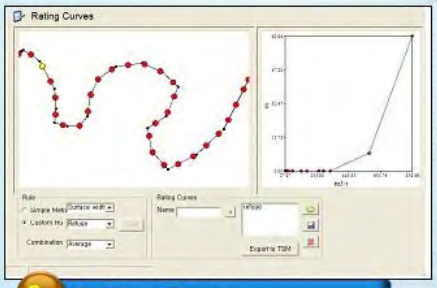
Need to expend the group, components and attributes

- Comparison of fish fauna and communities
  - Before and after dam construction
  - Longitudinal gradient of species number
- Finding references for data loading
- - unreliable information on fish ecology
- - discussion with specialists
- Consideration of local ecology
- - Differences of stream/river environment between Korea and Australia

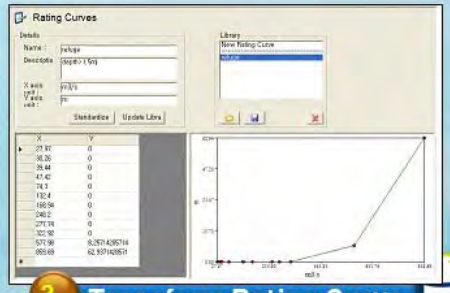
Reach based Hydraulic Analysis



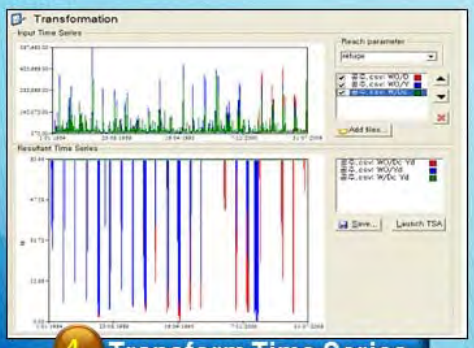
1 Rule Library



2 Rating Curve



3 Transform Rating Curve



4 Transform Time Series

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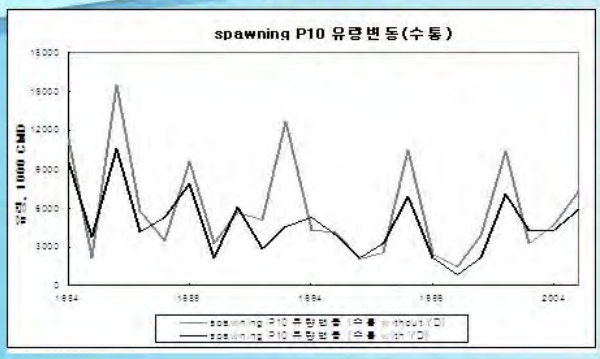
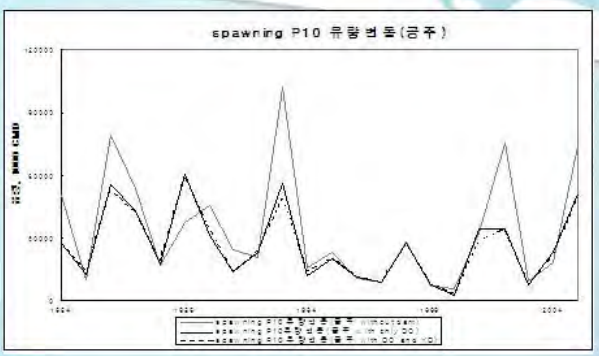
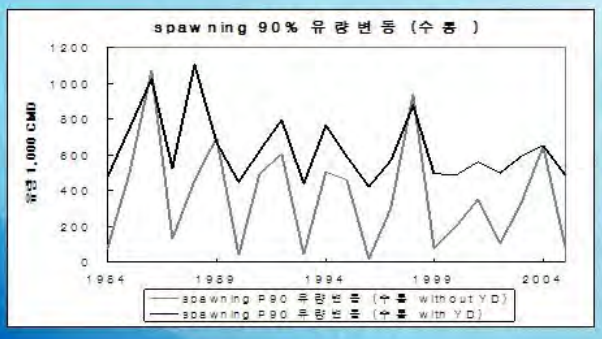
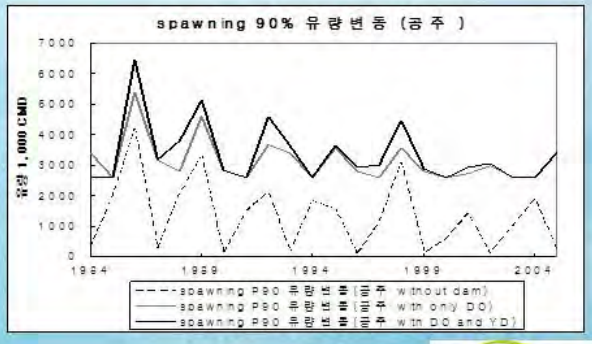
Flow characteristic of Spawning Season (May, Jun, July)









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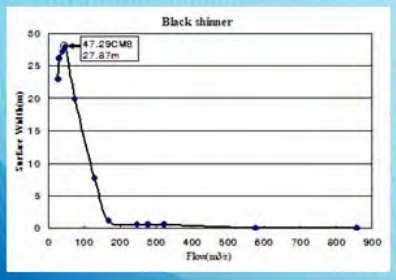
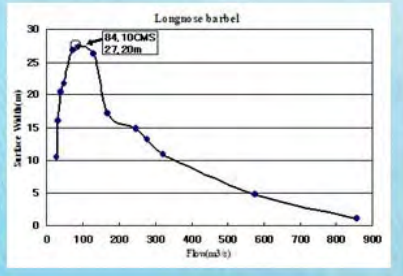
Fish Habitat Availability

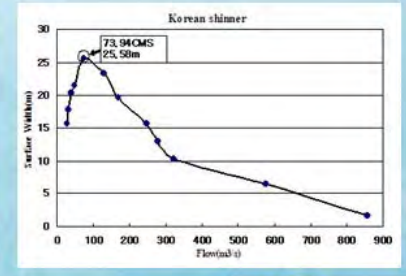
감돌고기(black shinner)
- Depth: 50-80cm
- Velocity: 10-30cm/s

참마자(long nose barbel)
- Depth : 50-80cm
- Velocity : 20-50cm/s

쉬리(korean shinner)
- Depth : 20-50cm
- Velocity : 30-80cm/s



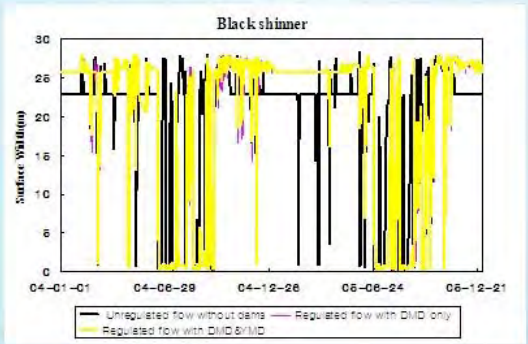


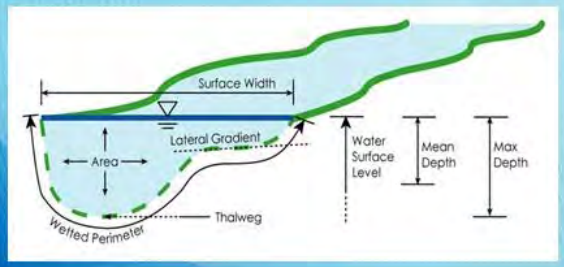


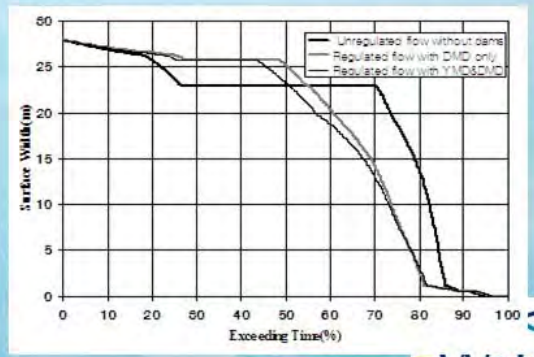
The Best Water Partner

Black Shinner

Downstream of DMD







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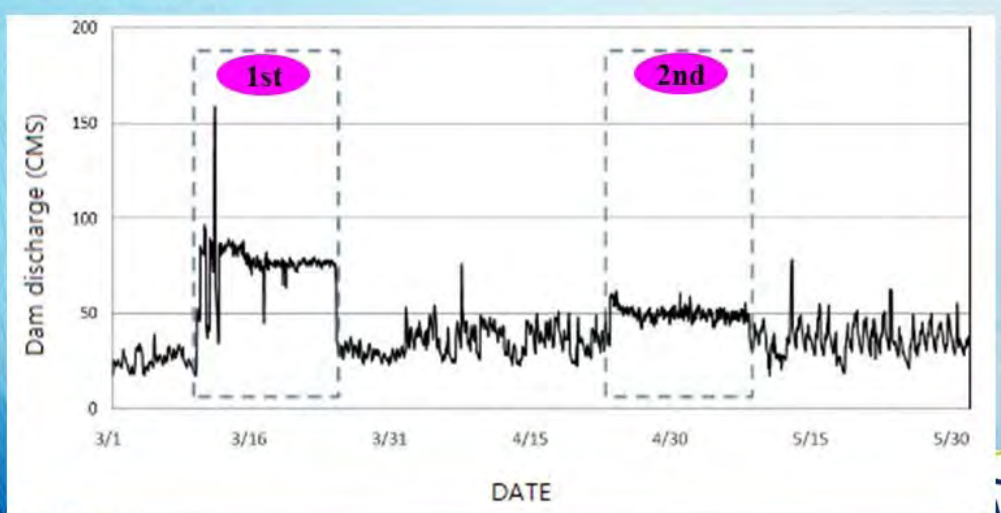
Flushing Release from Daecheong Multipurpose Dam (DMD)

Date	DMD	
	Discharge (CMS)	Flushing amount (M㎥)
1st Mar 2~24, 2008	90	66
2nd Apr 23~May 8, 2008	70	18



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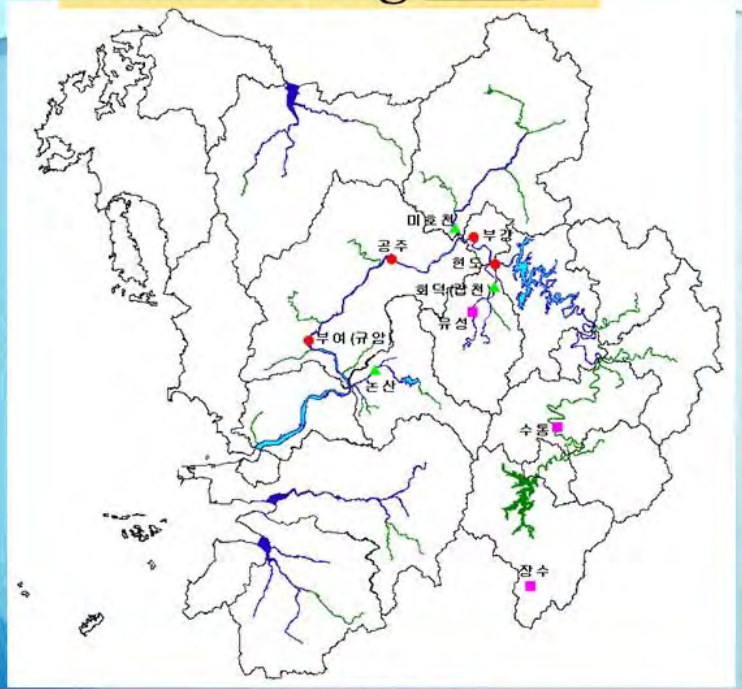
eWater CRC

Monitoring Sites



● :quality of water
■ : fish and benthic macro-invertebrate
▲ : suspended solid

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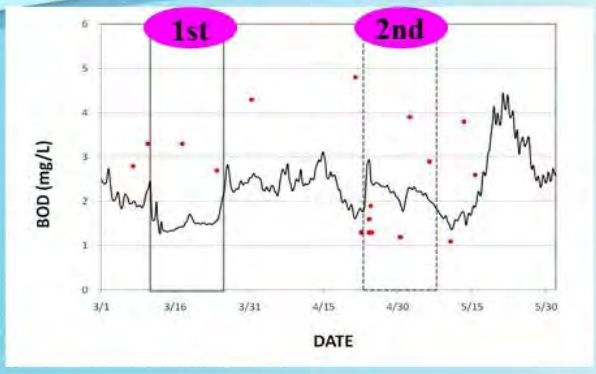
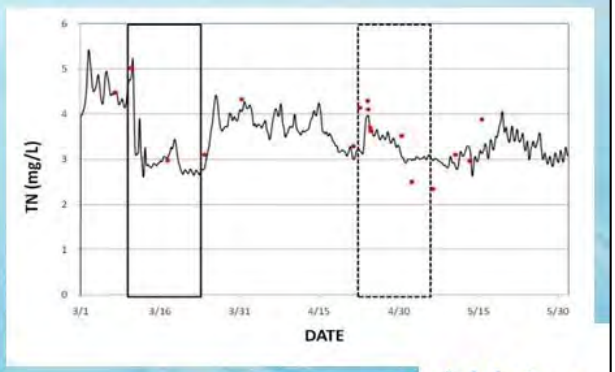
Monitoring Result at Gongju



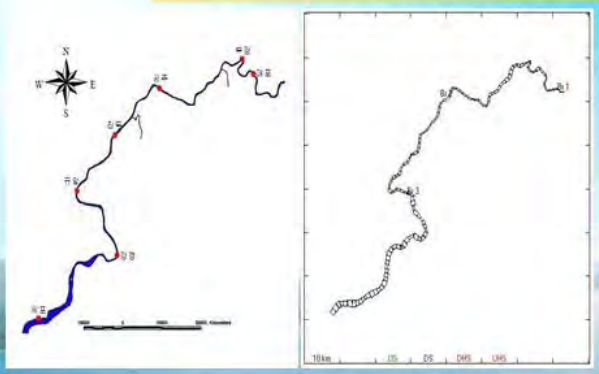


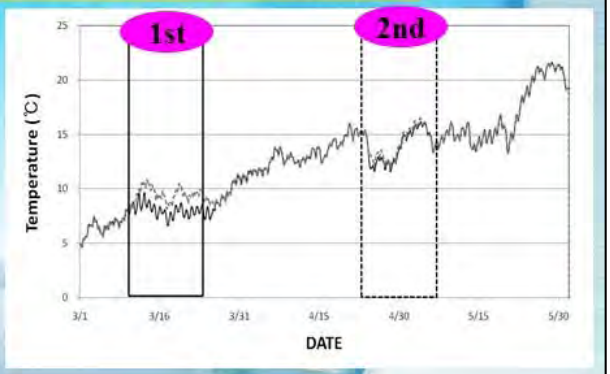
The Best Water Partner

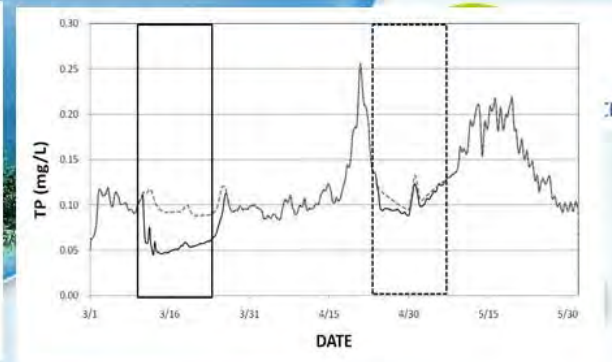
eWater CRC

Effect of Flushing Release at Gongju

The Best Water Partner

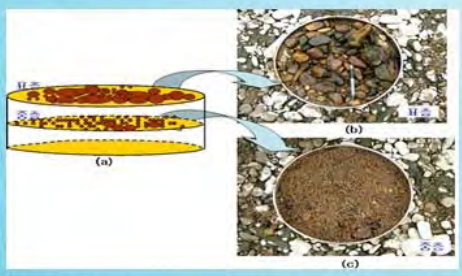


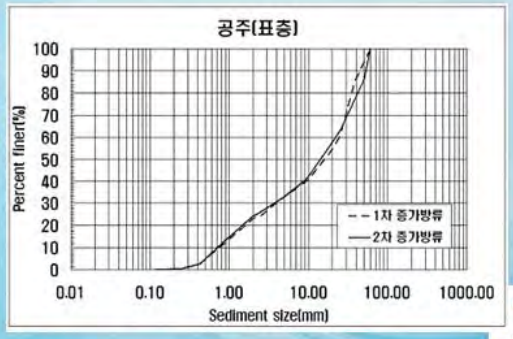




Other Assessment Results

- Some changes in sediment size distribution were observed
- Some evidence of increased number of invertebrate was observed after flushing release downstream the Dam
- No evidence of effects on fish conditions was observed
- Long-term effect of flushing discharge has yet to be examined more.





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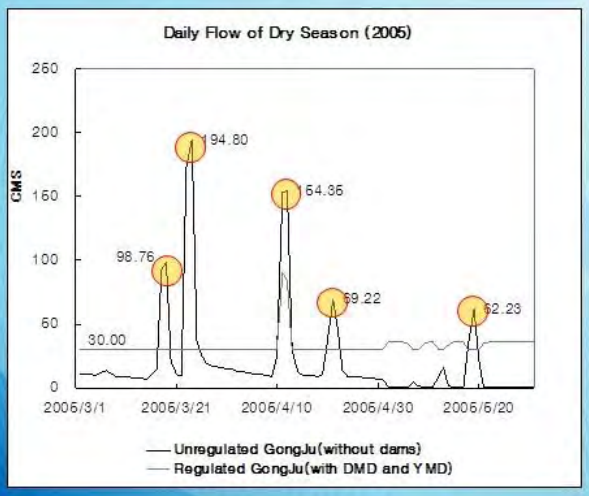
Flow Pattern Analysis for Dry Periods (3,4,5)

- Gong Ju
  - Mean Flow: 56 CMS
  - Max Flow Mean: 625.2 CMS
  - Mean P10: 127.8 CMS



Statistics of Flow Regime Change at GongJu for Day Season (March, April, May), Unit: CMS

Name	Unregulated Flow GongJu	Regulated Flow GongJu(with DMD only)	Reguated Flow GongJu(with DMD and YMD)
Mean of dry Mean	56	65	74
Mean of dry Minimum	1.4	27.4	30.3
Mean of dry Maximum	625.2	369.6	430.2
Mean of dry Percentile 10	127.8	112.7	123.5
Mean of dry Percentile 90	3.6	30.2	32.3
Mean of dry CV	0.021	0.011	0.01

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Suggestion for timing, duration, magnitude of flushing/increased discharge

- High spell analysis basin on the 1st flushing discharge(90CMS)
  - Avg. occurrence frequency: 4.6 times/(3,4,5 months)
  - AvG. flow: 343CMS
  - Avg. duration: 2.6 day
  - Avg. total duration: 12.3 days

Table 2. High spell analysis results of GongJu for Dry Season, Unit:CMS)

Name	GongJu		
	Unregulated Flow GongJu	RegulatedFlow GongJu(with DMD only)	ReguatedFlow GongJu(with DMD and YMD)
Mean of dry High Spell Threshold	90	90	90
Mean of dry Number of High Spell	4.6	6.2	6.9
Mean of dry Longest High Spell	4.1	5.0	7.0
Mean of dry Mean Magnitude of High Spell	343	205	215
Mean of dry Mean Duration of High Spell	2.6	2.4	2.8
Mean of dry Total Duration of High Spell	12.3	16.9	20.7

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Acknowledgement!

This study was conducted by many specialists
as a team from K-water and eWater CRC.
The authors sincerely appreciate their contribution.

Concluding Remarks

- A methodology, tookits, and conceptual framework were developed to evaluate the potential hydrological and ecological effects caused by modification of the Geum River Basin.
- An assessment was conducted using the toolkits Based on intensive monitoring data.
- The effects of flushing/increased discharge from Daecheong Multipurpose Dam on water quality and ecosystem were assessed.
- The methodology and toolkits might be used to study the effects of 4 major river restoration projects.
- Finally, combined habitat condition assessment & rehabilitation action plans can be tested for enhanced river basin management.

The Best Water Partner

Tokyo water disaster and drought crisis looming now

TOKYO WATER DISASTER AND DROUGHT CRISIS LOOMING NOW

NOBUYUKI TSUCHIYA (1)
(1): NOBUYUKI TSUCHIYA, Ph.D.

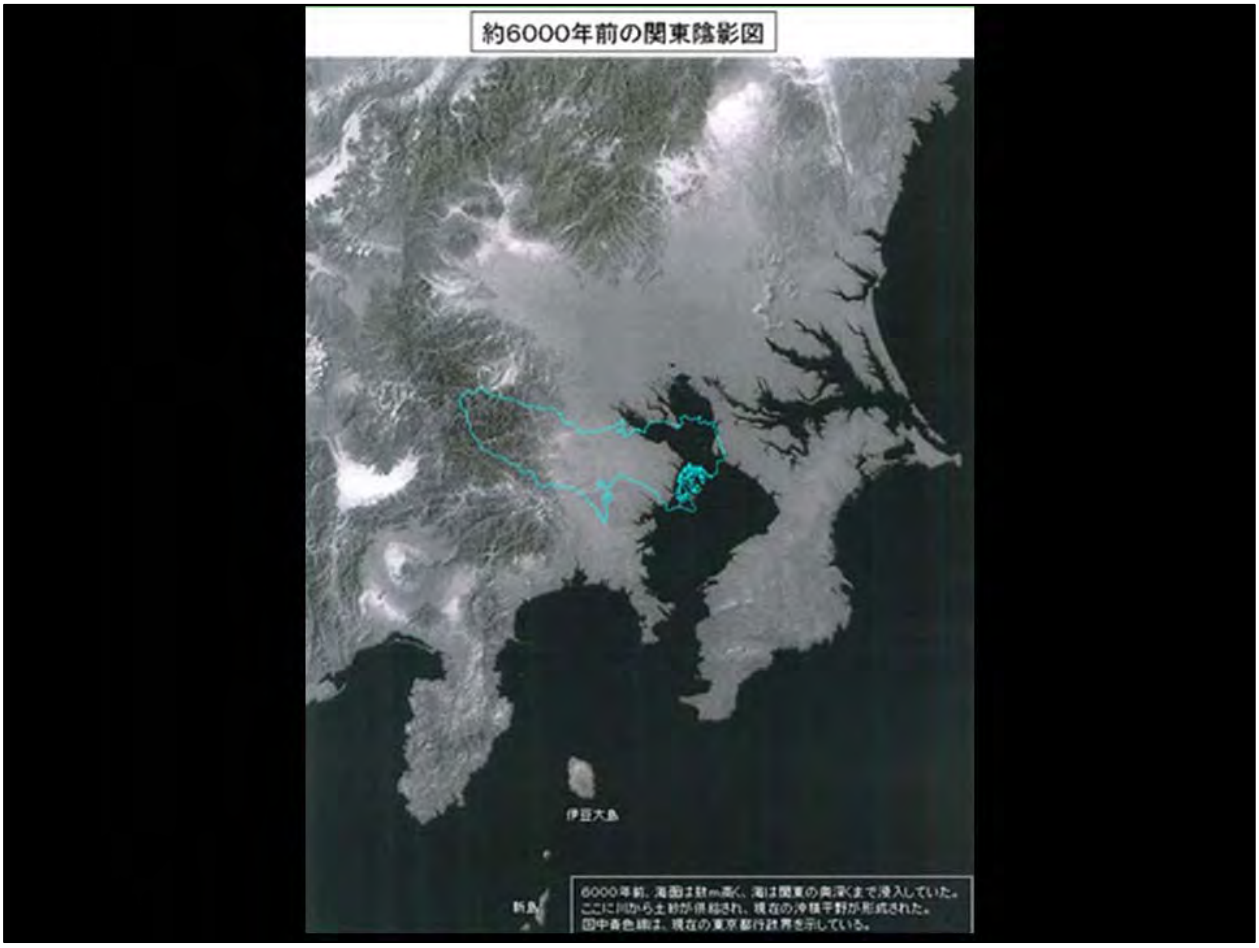
When we think about flood damage in Tokyo, it is a necessary to focus on four kinds flooding method in Tokyo district.

In downtown area, ground subsidence came up to 5m by pumping large amount of groundwater in the course of high economic development, and formed a vast below sea level area in the capital region. Such low land, it is necessary to pumping drainage 365 days a year to keep land dry and above water. In such low-lying areas, there is a risk of three types of flood, such as "River flooding" caused when embankment collapsed, "overland flooding" caused by lack of drainage function, and water damage caused by “storm surge” in land below sea level.

If further embankment and sluices collapsed in the earthquake, there is also a danger of immediately seawater infiltration, which is called "earthquake flood". In other words, Tokyo has a possibility of flood occurrence even without a drop of rain water. Indicating the measures against these issues. It was to the simultaneous approach to flood control and drought management add river restoration as a result.

River Restration and Drought Under the Climate Change In JApan

Nobuyuki Tsuchiya,Ph.D.
Chairperson Japan River Restration Network




Rich land which rivers made


The river has led to settlements

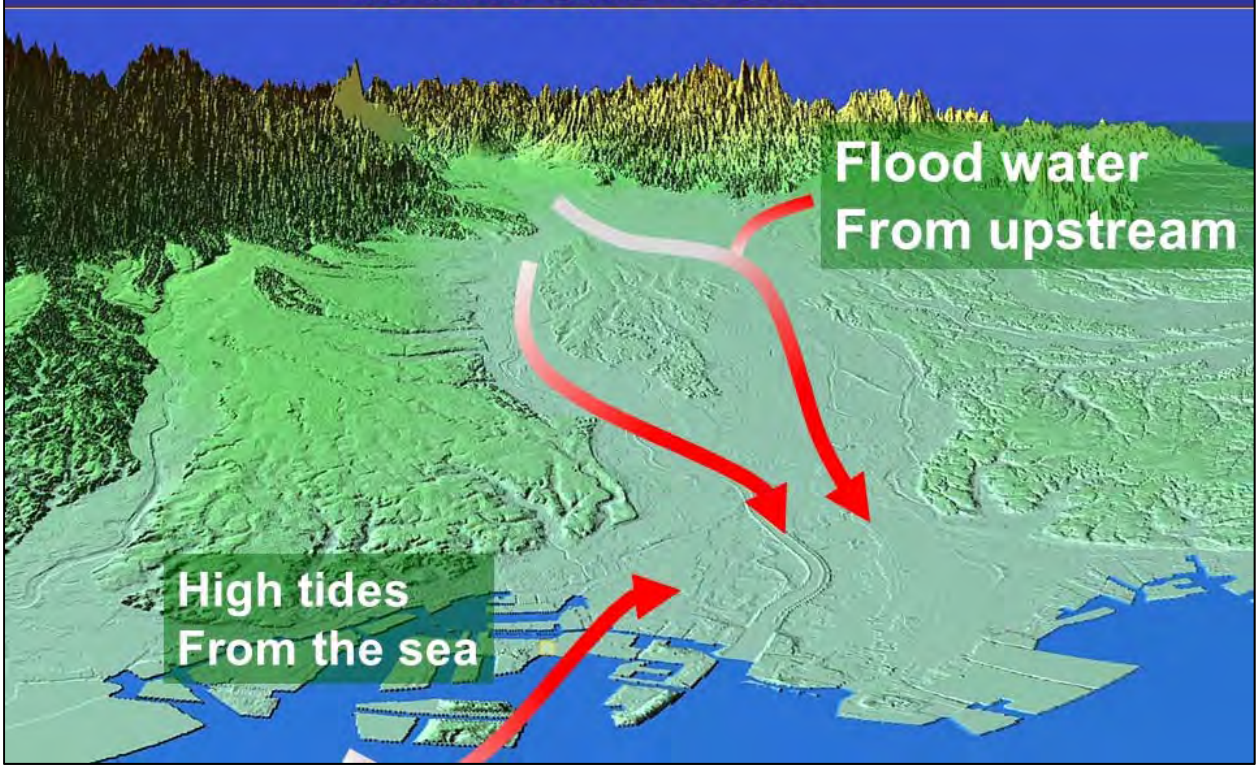
River water was supported by the industry

Metropolis was supported than river water


City is located in the river and the sea

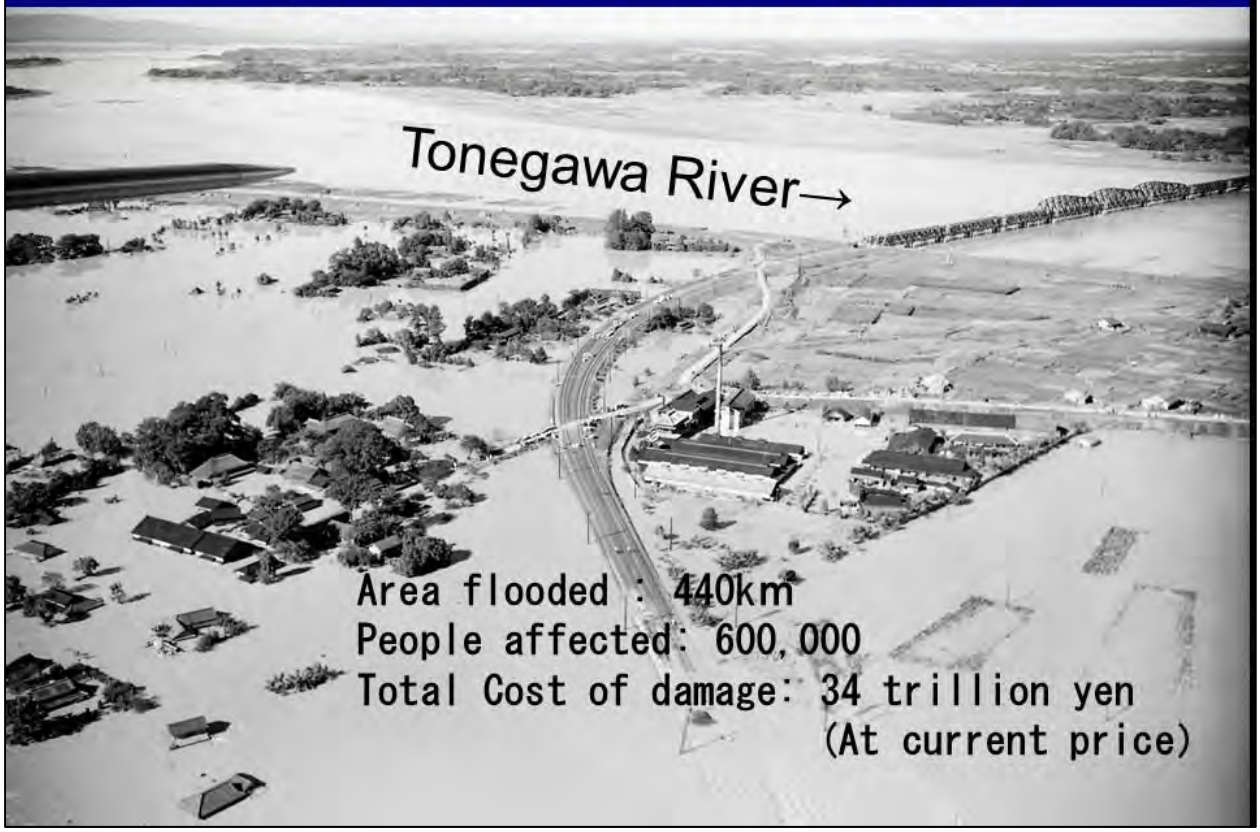

The city has been exposed to
Flood and Drought Crisis

Flood comes also attacked from the sea



The Great Tokyo Flood (1910)

Typhoon Kathleen (1947)

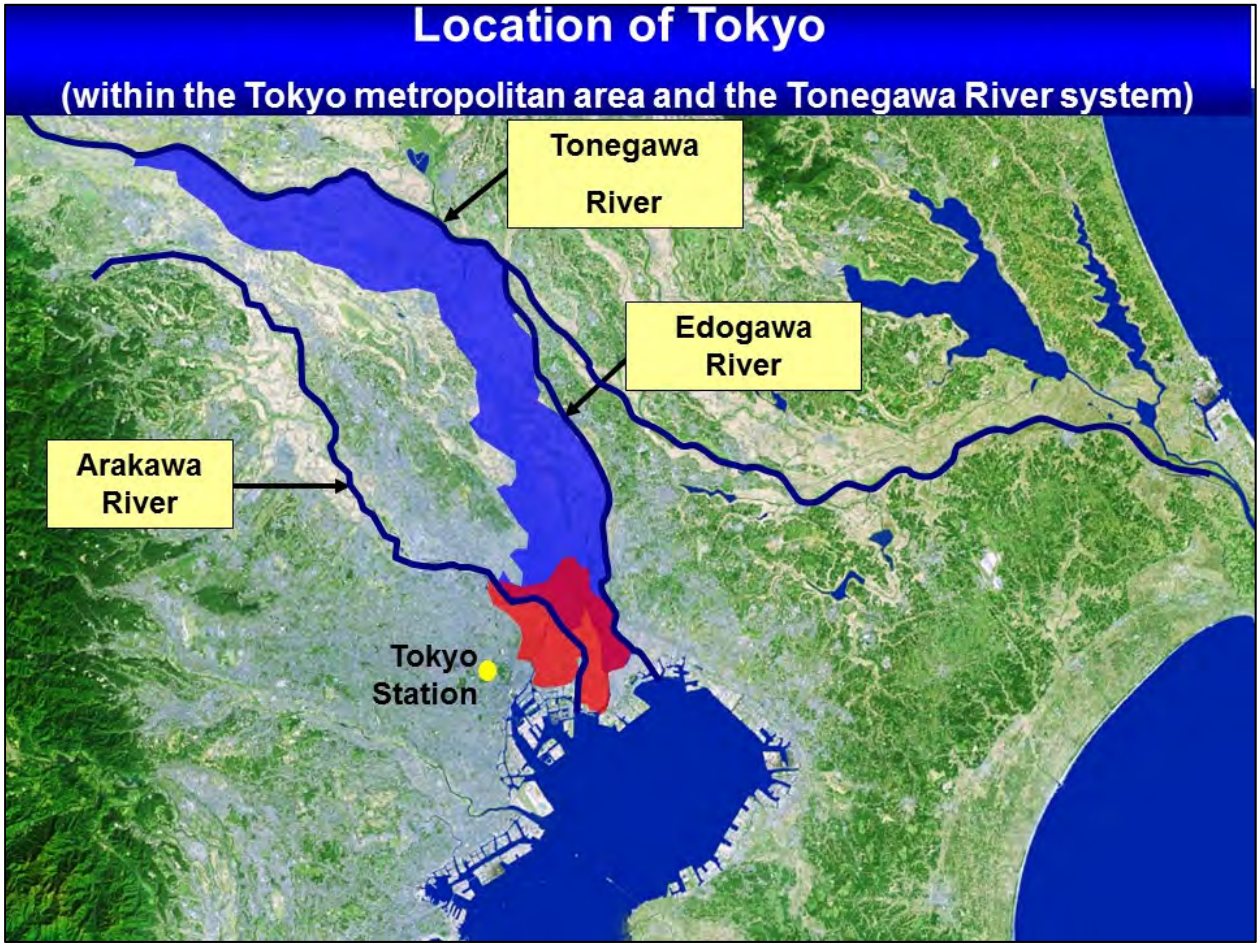


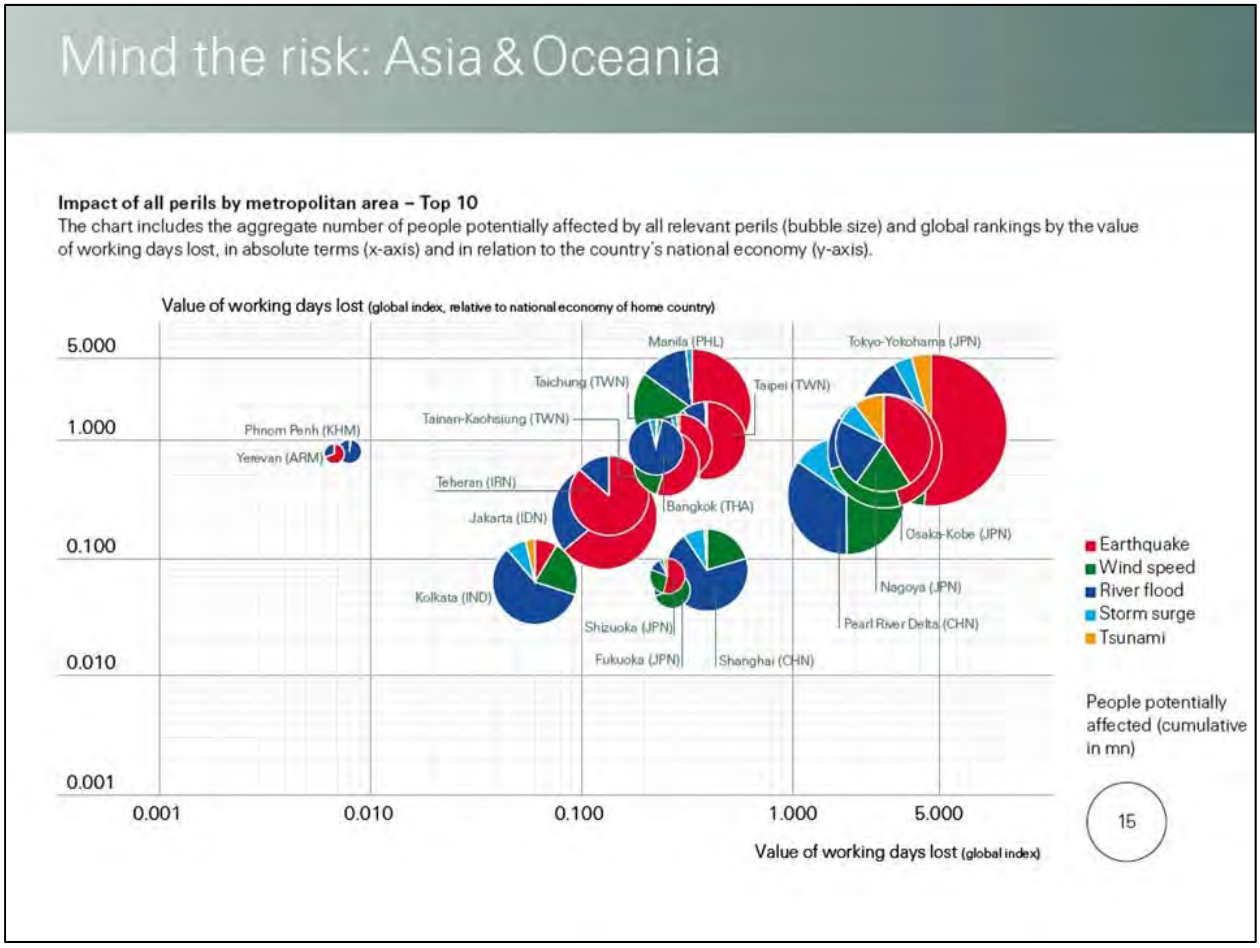
Typhoon Kathleen (1947)

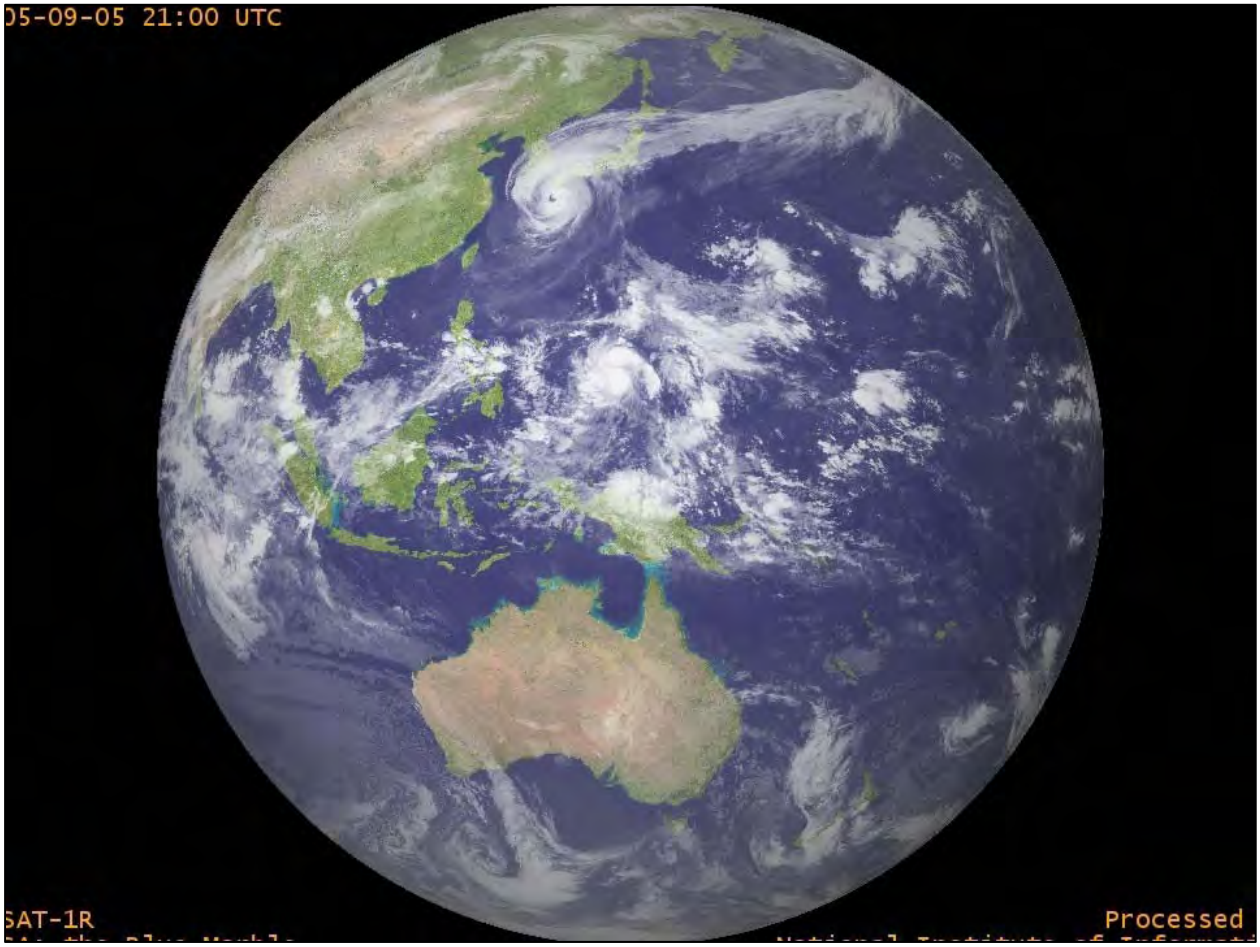
Typhoon Kitty
(1949)

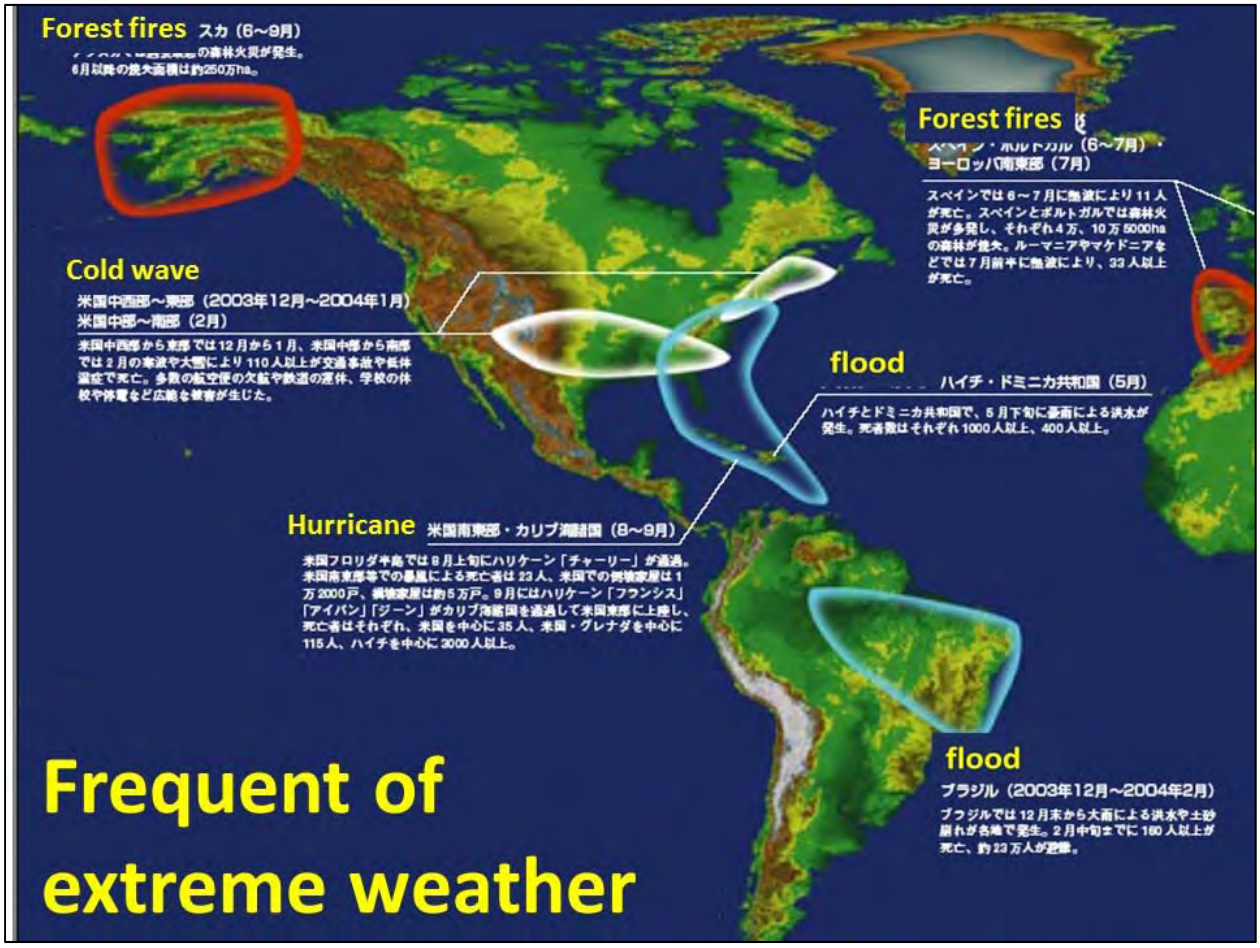
The Great Ansei Flood (1858)

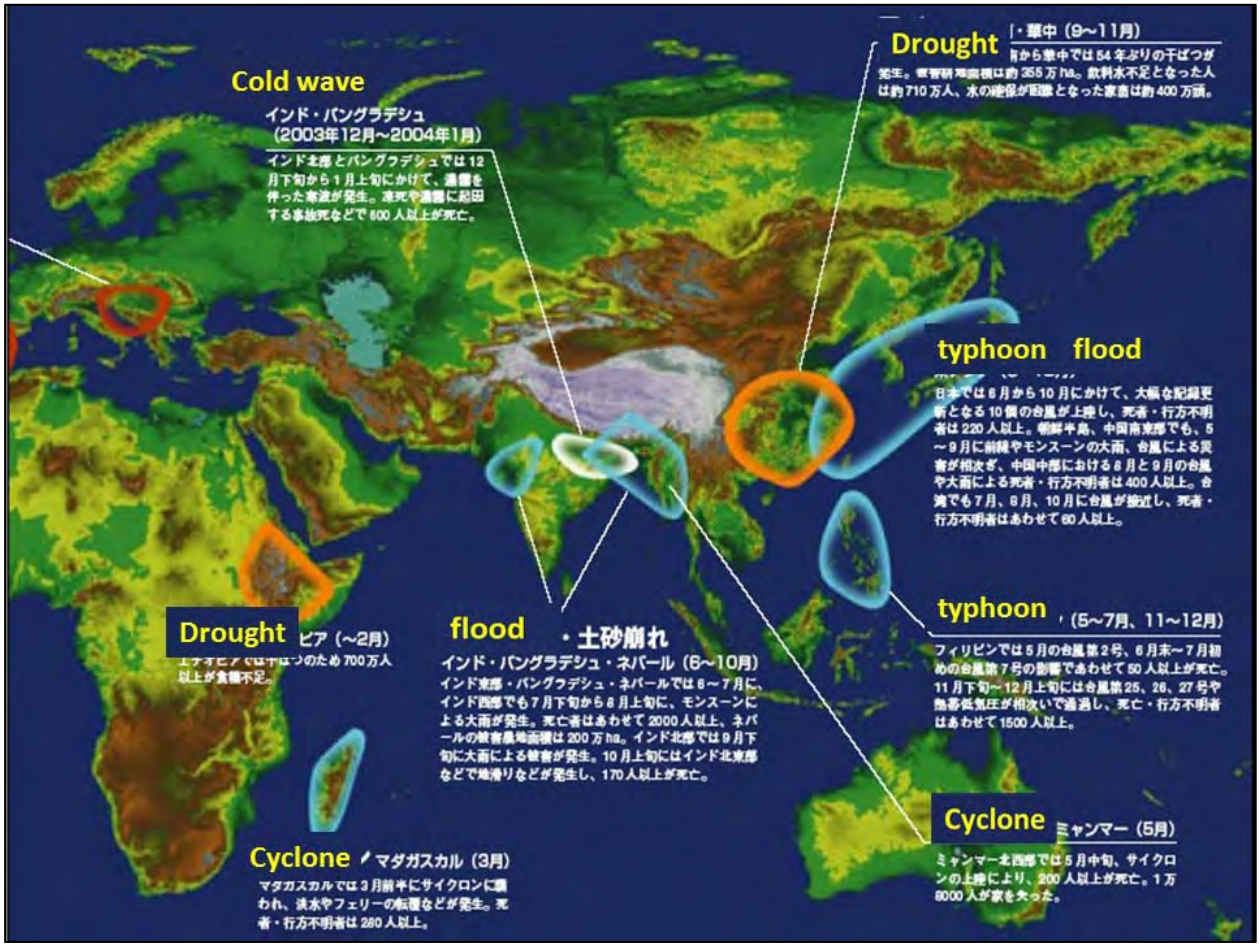
Flood damage 250 times during 270 years from 1603 to 1867.

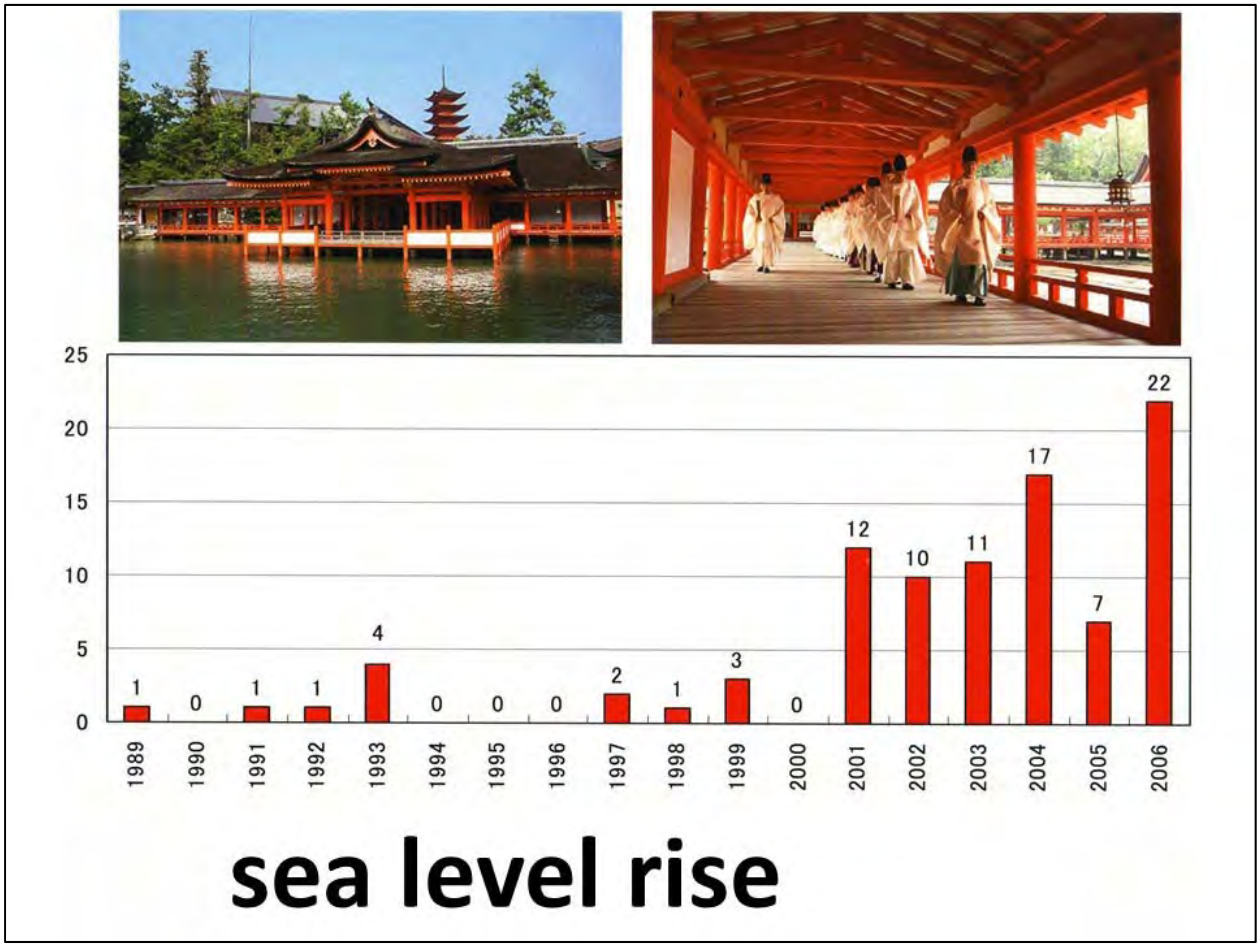

Location of Tokyo
(within the Tokyo metropolitan area and the Tonegawa River system)
Tonegawa River
Edogawa River
Arakawa River
Tokyo Station


Mind the risk: Asia & Oceania
Impact of all perils by metropolitan area – Top 10
The chart includes the aggregate number of people potentially affected by all relevant perils (bubble size) and global rankings by the value of working days lost, in absolute terms (x-axis) and in relation to the country's national economy (y-axis).
Value of working days lost (global index, relative to national economy of home country)
5.000
1.000
0.100
0.010
0.001
Manila (PHL)
Tokyo-Yokohama (JPN)
Taichung (TWN)
Taipei (TWN)
Tainan-Kaohsiung (TWN)
Phnom Penh (KHM)
Yerevan (ARM)
Teheran (IRN)
Bangkok (THA)
Jakarta (IDN)
Osaka-Kobe (JPN)
Kolkata (IND)
Nagoya (JPN)
Shizuoka (JPN)
Pearl River Delta (CHN)
Fukuoka (JPN)
Shanghai (CHN)
Earthquake
Wind speed
River flood
Storm surge
Tsunami
People potentially affected (cumulative in mn)
15
0.001
0.010
0.100
1.000
5.000
Value of working days lost (global index)


05-09-05 21:00 UTC
SAT-1R
Processed


Forest fires スカ（6～9月）
の森林火災が発生。
6月以降の焼失面積は約250万ha。
Forest fires
スペイン・ポルトガル（6～7月）・
ヨーロッパ南東部（7月）
スペインでは6～7月に熱波により11人が死亡。スペインとポルトガルでは森林火災が多発し、それぞれ4万、10万5000haの森林が焼失。ルーマニアやマケドニアなどでは7月前半に熱波により、33人以上が死亡。
Cold wave
米国中西部～東部（2003年12月～2004年1月）
米国中部～南部（2月）
米国中西部から東部では12月から1月、米国中部から南部では2月の寒波や大雪により110人以上が交通事故や低体温症で死亡。多数の航空便の欠航や鉄道の運休、学校の休校や停電など広範な被害が生じた。
flood
ハイチ・ドミニカ共和国（5月）
ハイチとドミニカ共和国で、5月下旬に豪雨による洪水が発生。死者数はそれぞれ1000人以上、400人以上。
Hurricane 米国南東部・カリブ海諸国（8～9月）
米国フロリダ半島では8月上旬にハリケーン「チャーリー」が通過。米国南東部等での暴風による死亡者は23人、米国での倒壊家屋は1万2000戸、損壊家屋は約5万戸。9月にはハリケーン「フランシス」「アイバン」「ジーン」がカリブ海諸国を通過して米国東部に上陸し、死亡者はそれぞれ、米国を中心に35人、米国・グレナダを中心に115人、ハイチを中心に3000人以上。
flood
ブラジル（2003年12月～2004年2月）
ブラジルでは12月末から大雨による洪水や土砂崩れが各地で発生。2月中旬までに160人以上が死亡、約23万人が避難。
Frequent of extreme weather


Cold wave
インド・バングラデシュ
(2003年12月~2004年1月)
インド北部とバングラデシュでは12月下旬から1月上旬にかけて、濃霧を伴った寒波が発生。凍死や濃霧に起因する事故死などで600人以上が死亡。
Drought
・華中（9~11月）
から華中では54年ぶりの干ばつが発生。被害耕地面積は約355万ha。飲料水不足となった人は約710万人、水の確保が困難となった家畜は約400万頭。
typhoon flood
日本では8月から10月にかけて、大幅な記録更新となる10個の台風が上陸し、死者・行方不明者は220人以上。朝鮮半島、中国南東部でも、5~9月に前線やモンスーンの大雨、台風による災害が相次ぎ、中国中部における8月と9月の台風や大雨による死者・行方不明者は400人以上。台湾でも7月、8月、10月に台風が接近し、死者・行方不明者はあわせて60人以上。
typhoon
(5~7月、11~12月)
フィリピンでは5月の台風第2号、6月末~7月初めの台風第7号の影響であわせて50人以上が死亡。11月下旬~12月上旬には台風第25、26、27号や熱帯低気圧が相次いで通過し、死亡・行方不明者はあわせて1500人以上。
Drought
ピア（~2月）
エチオピアでは干ばつのため700万人以上が食糧不足。
flood
・土砂崩れ
インド・バングラデシュ・ネパール（6~10月）
インド東部・バングラデシュ・ネパールでは6~7月に、インド西部でも7月下旬から8月上旬に、モンスーンによる大雨が発生。死亡者はあわせて2000人以上、ネパールの被害農地面積は200万ha。インド北部では9月下旬に大雨による被害が発生。10月上旬にはインド北東部などで地滑りなどが発生し、170人以上が死亡。
Cyclone
マダガスカル（3月）
マダガスカルでは3月前半にサイクロンに襲われ、洪水やフェリーの転覆などが発生。死者・行方不明者は260人以上。
Cyclone
ミャンマー（5月）
ミャンマー北西部では5月中旬、サイクロンの上陸により、200人以上が死亡。1万8000人が家を失った。


25
20
15
10
5
0
1
0
1
1
4
0
0
0
2
1
3
0
12
10
11
17
7
22
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
sea level rise

Increasing the number or Temuzubaria is close

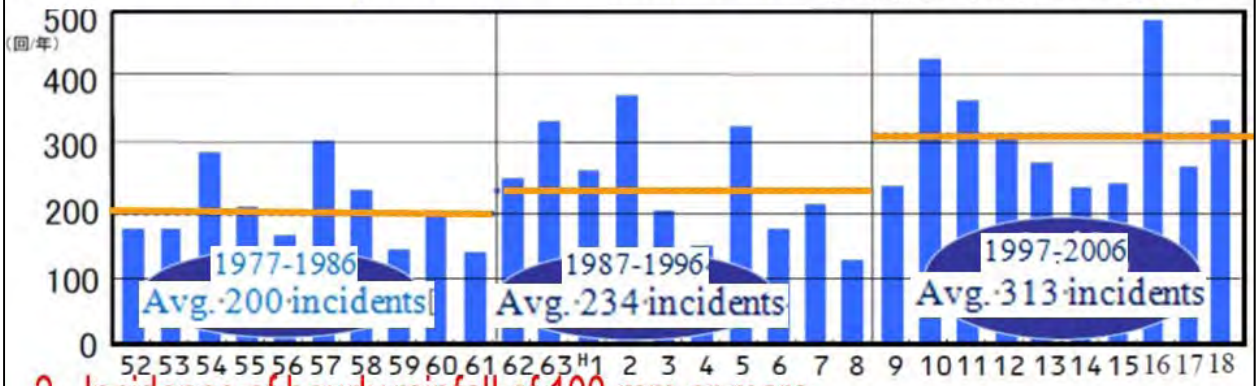
The number of annual gate closure of Thames tide floodgate
El número de puerta de cierre anual del río Támesis marea Floodgate

British Ministry of the Environment / Ministerio británico de Medio Ambiente 19

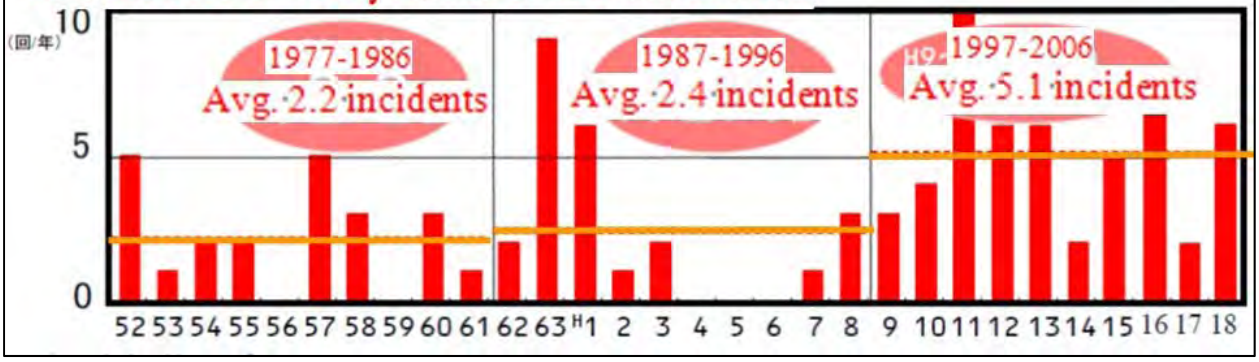
More Frequent Heavy Rainfall

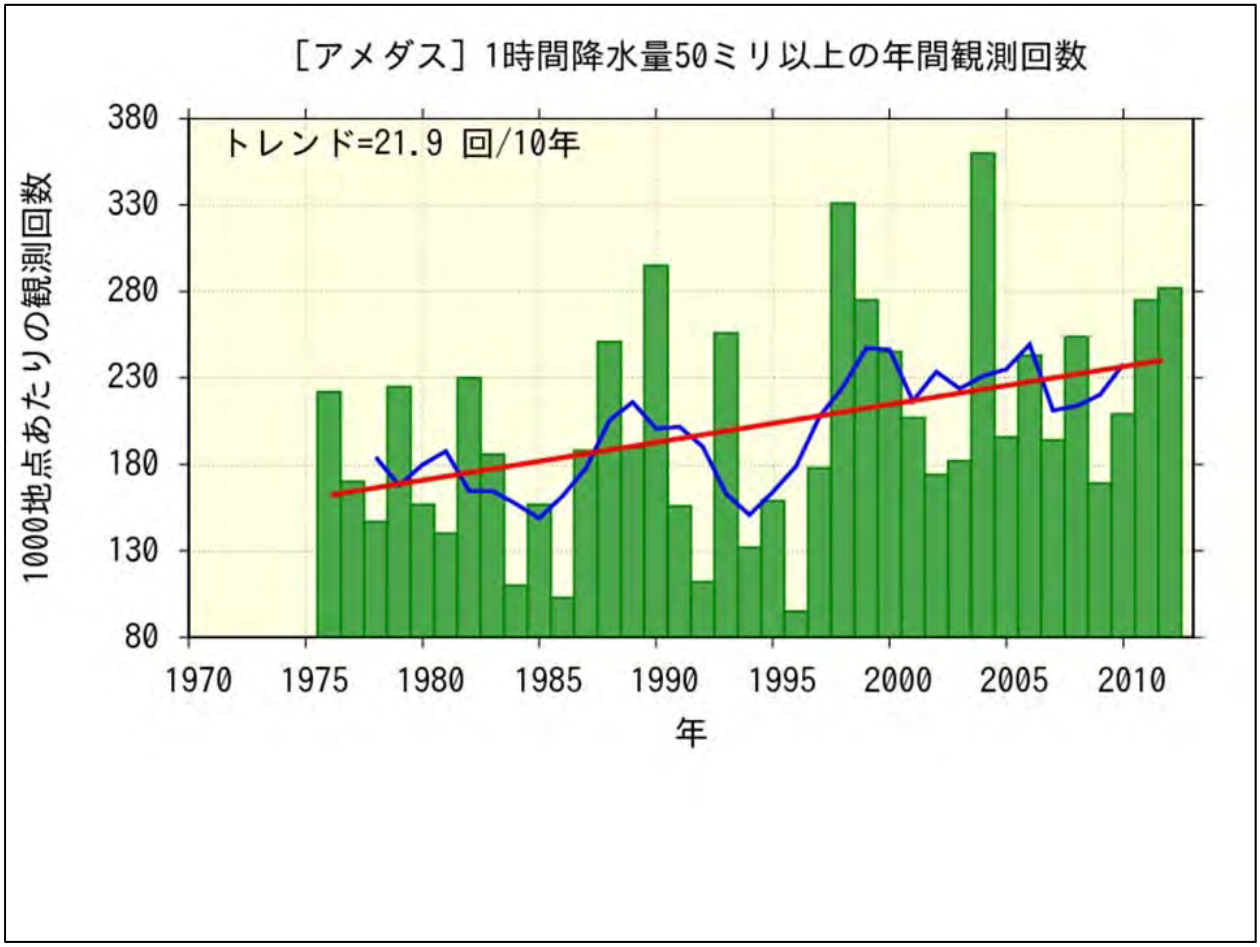
1. Incidence of hourly rainfall of 50 mm or more

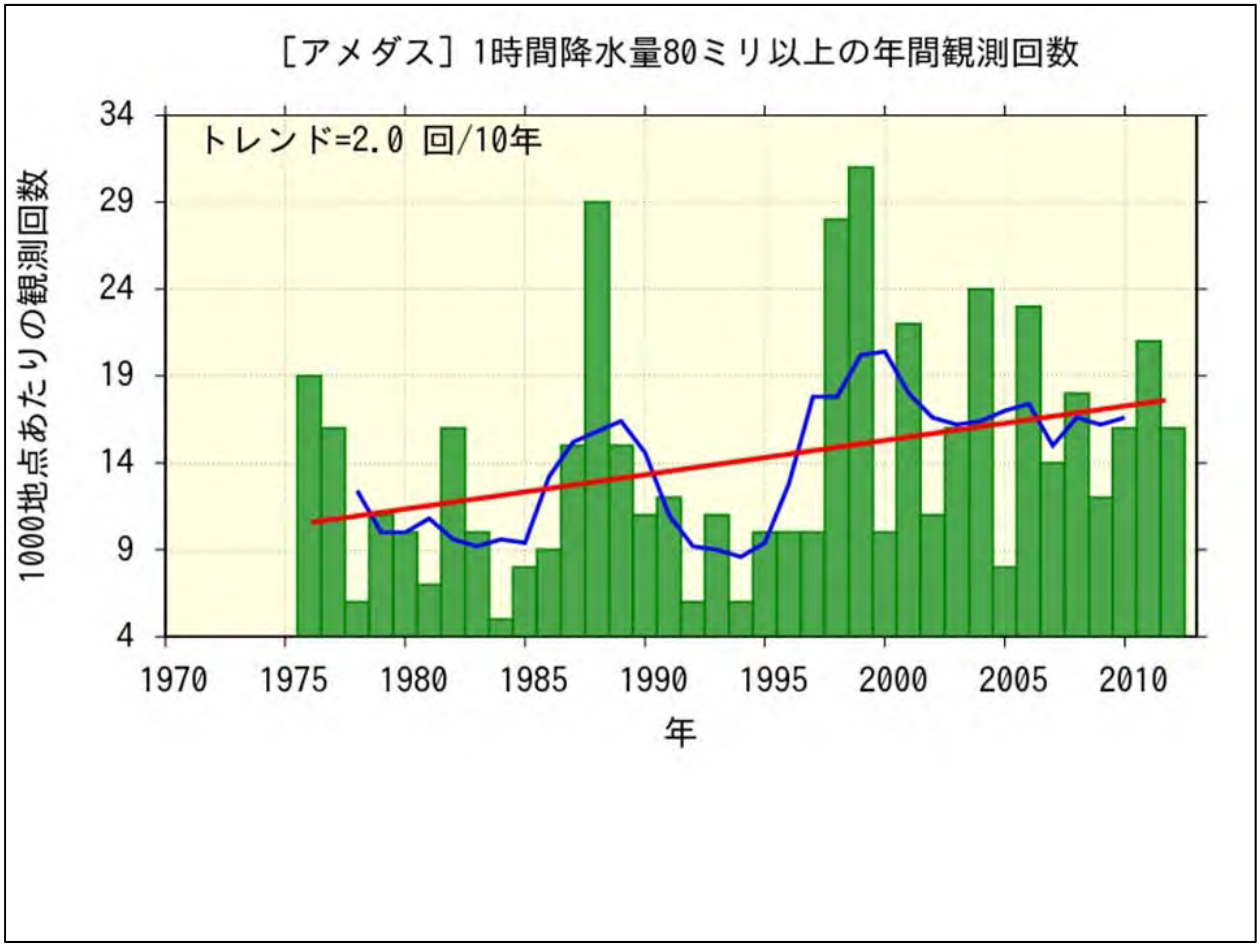
Annual incidence of heavy hourly rainfall
(From approx. 1,300 AMeDAS sites nationwide

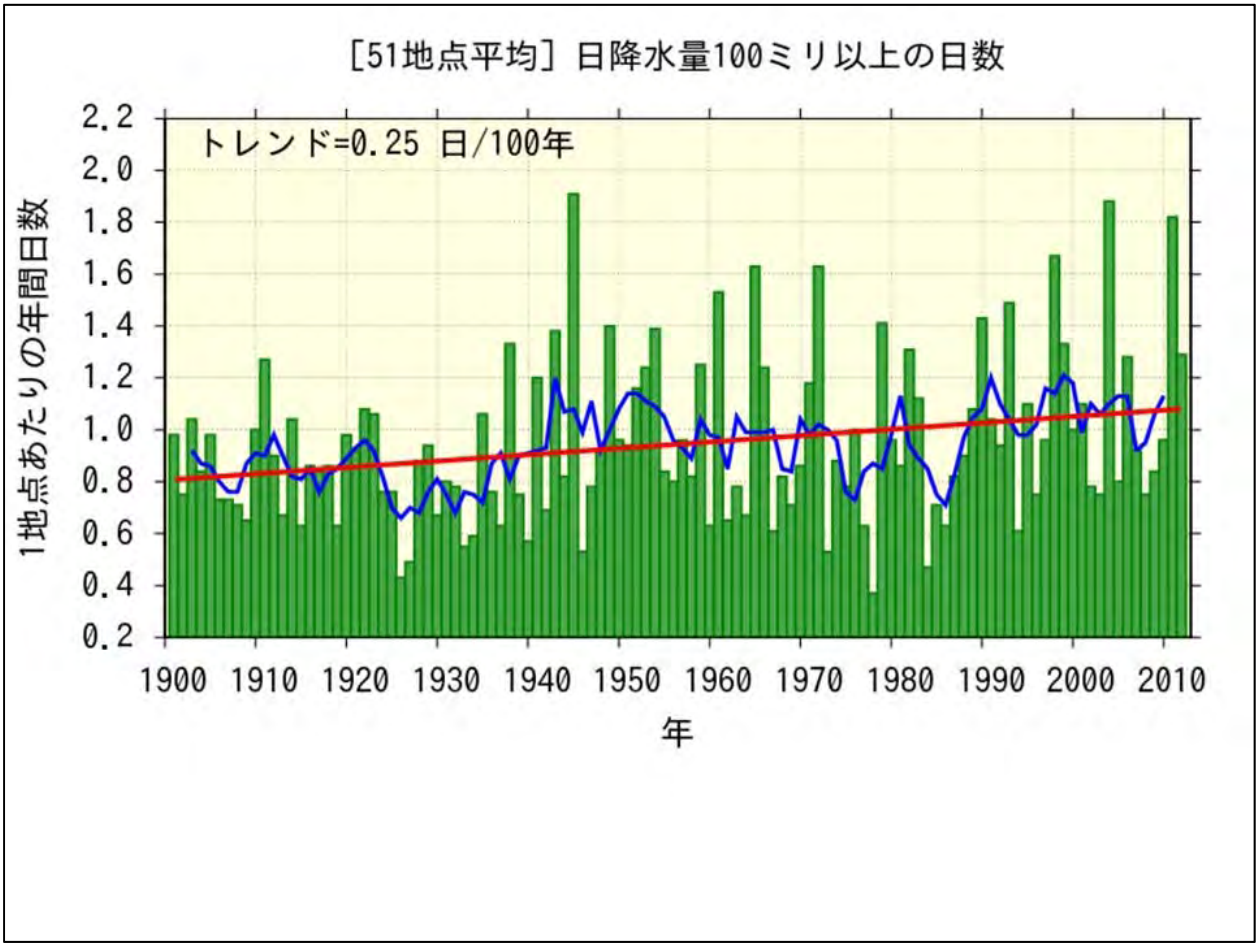


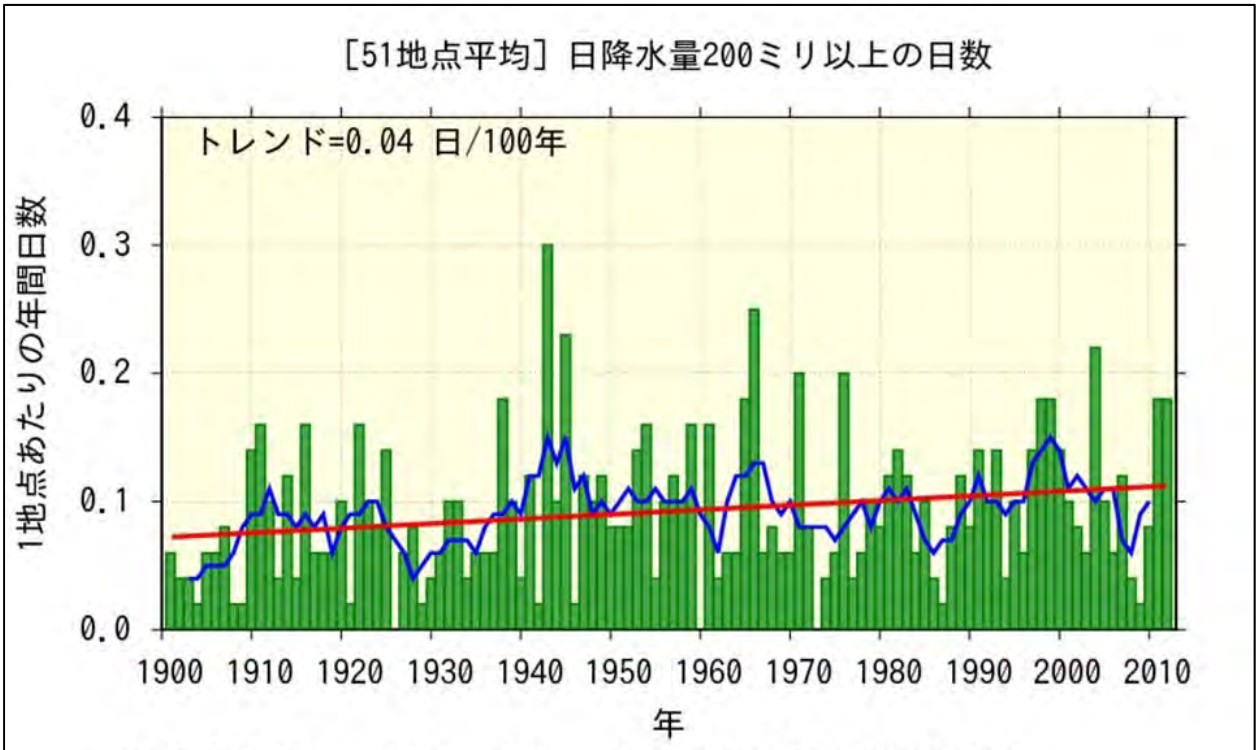
2. Incidence of hourly rainfall of 100 mm or more



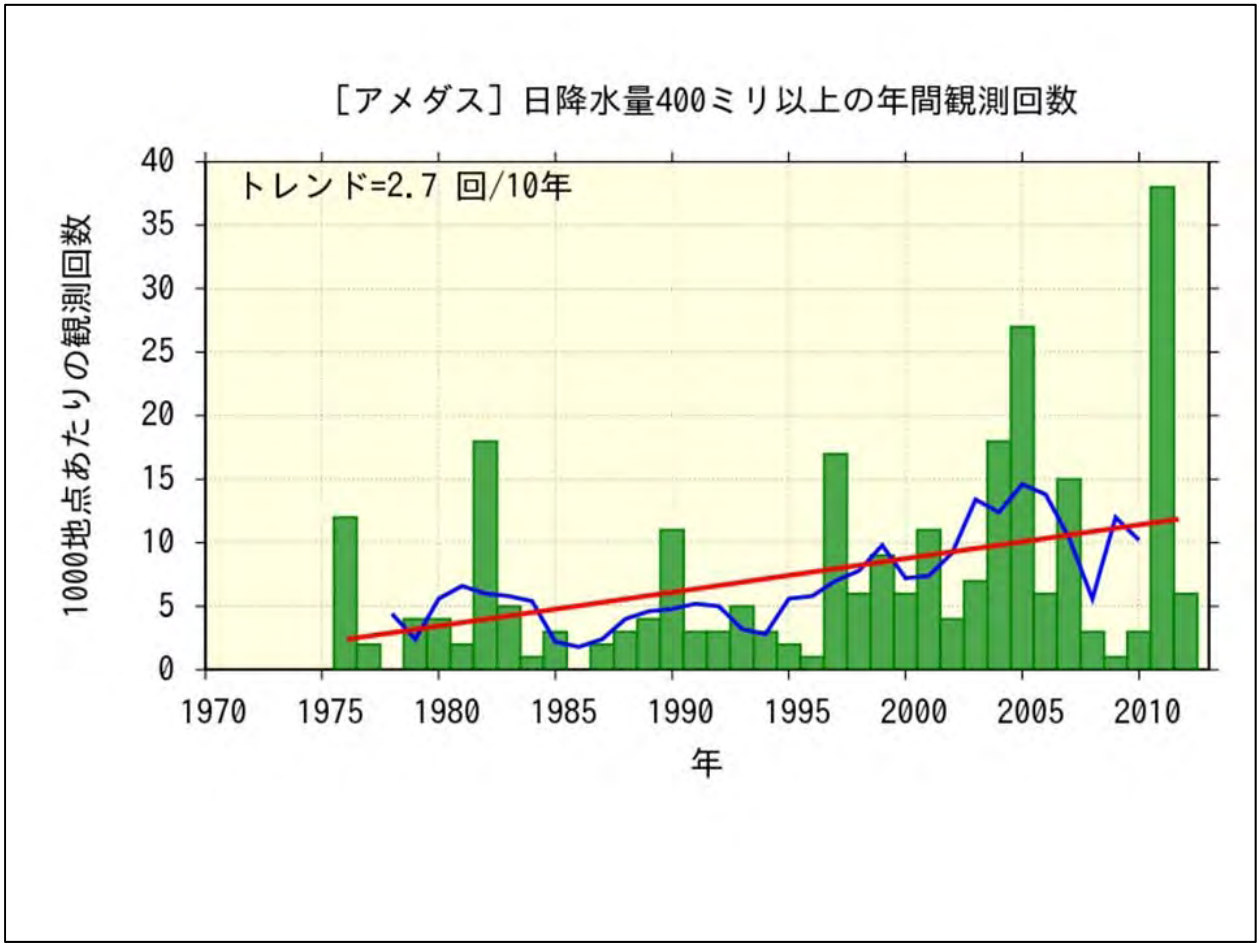

［アメダス］1時間降水量50ミリ以上の年間観測回数
トレンド=21.9 回/10年
1000地点あたりの観測回数
380
330
280
230
180
130
80
1970
1975
1980
1985
1990
1995
2000
2005
2010
年

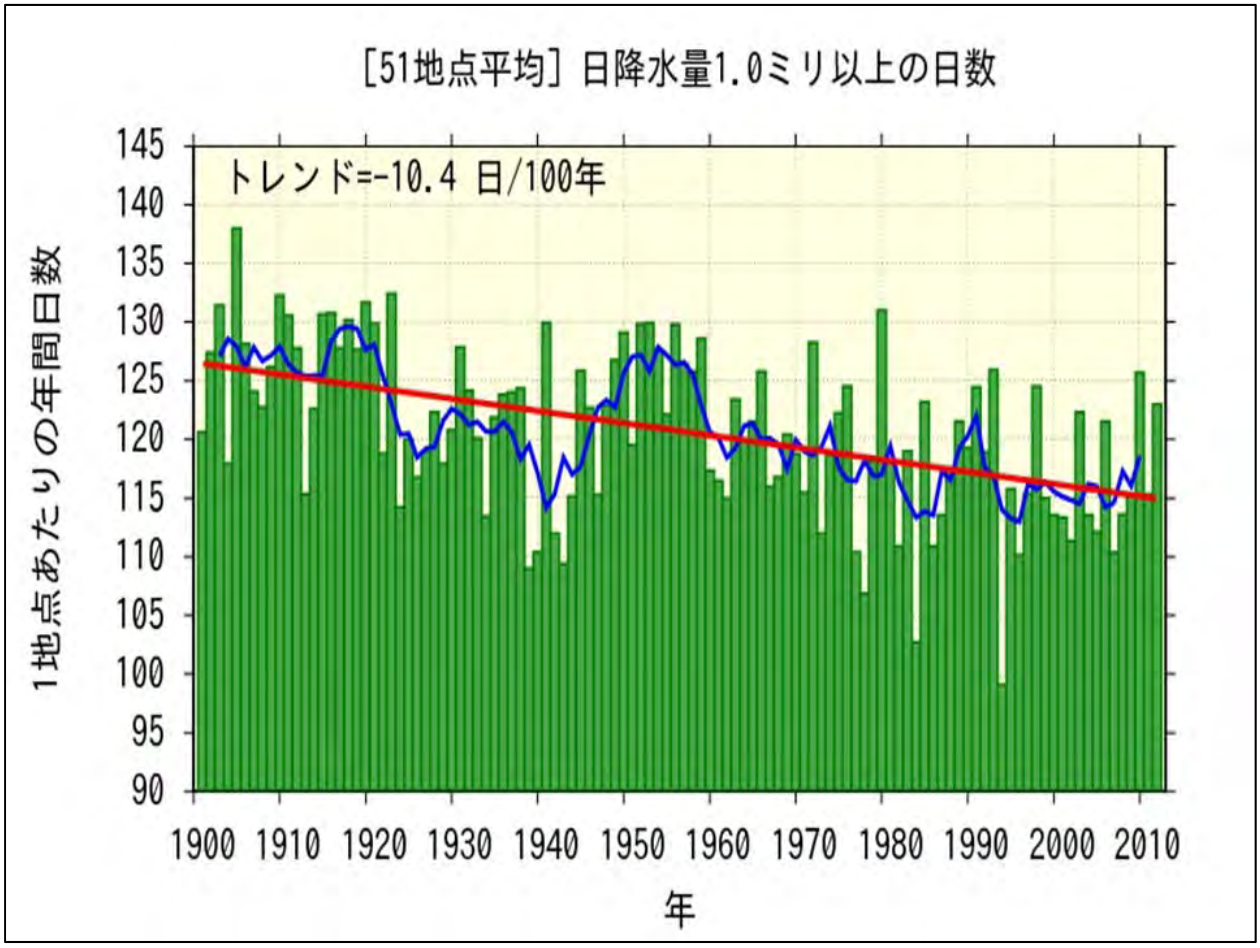

［アメダス］1時間降水量80ミリ以上の年間観測回数
トレンド=2.0 回/10年
1000地点あたりの観測回数
34
29
24
19
14
9
4
1970
1975
1980
1985
1990
1995
2000
2005
2010
年



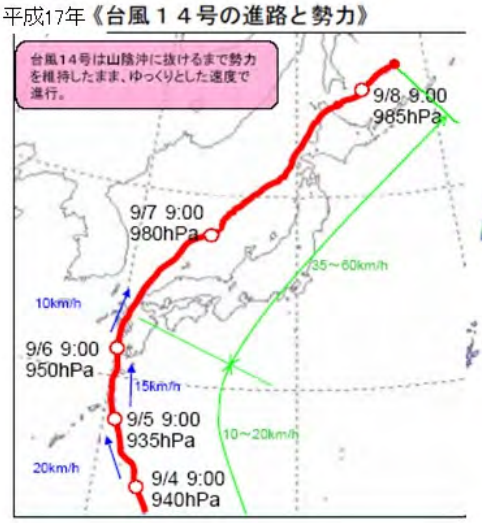


日降水量100mm以上、200mm以上の年間日数の経年変化
折れ線は5年移動平均、直線は期間にわたる変化傾向を示す。

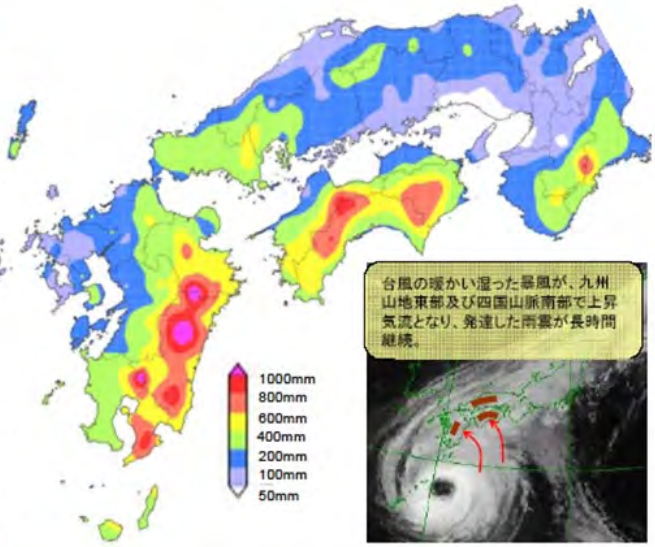

［アメダス］日降水量400ミリ以上の年間観測回数
トレンド=2.7 回/10年
1000地点あたりの観測回数
0
5
10
15
20
25
30
35
40
1970
1975
1980
1985
1990
1995
2000
2005
2010
年


［51地点平均］日降水量1.0ミリ以上の日数
トレンド=-10.4 日/100年
1地点あたりの年間日数
90
95
100
105
110
115
120
125
130
135
140
145
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
年

平成17年《台風１４号の進路と勢力》



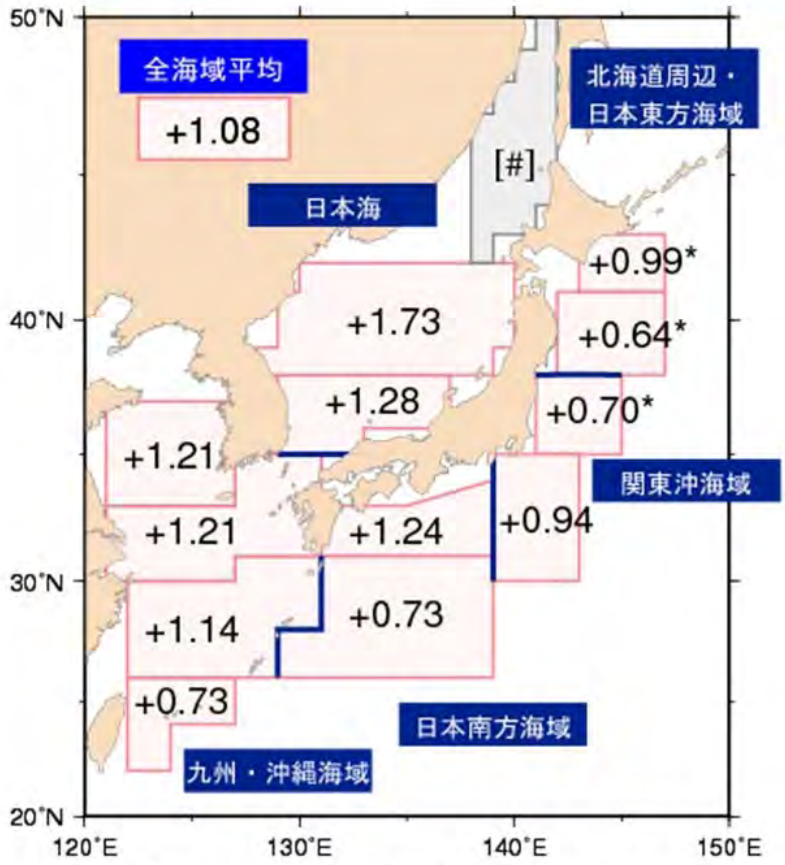
《台風１４号による総雨量の分布》



《被害状況》

【大淀川水系大谷川の越水による浸水状況

【五ヶ瀬川の越水状況（宮崎県延岡市）】

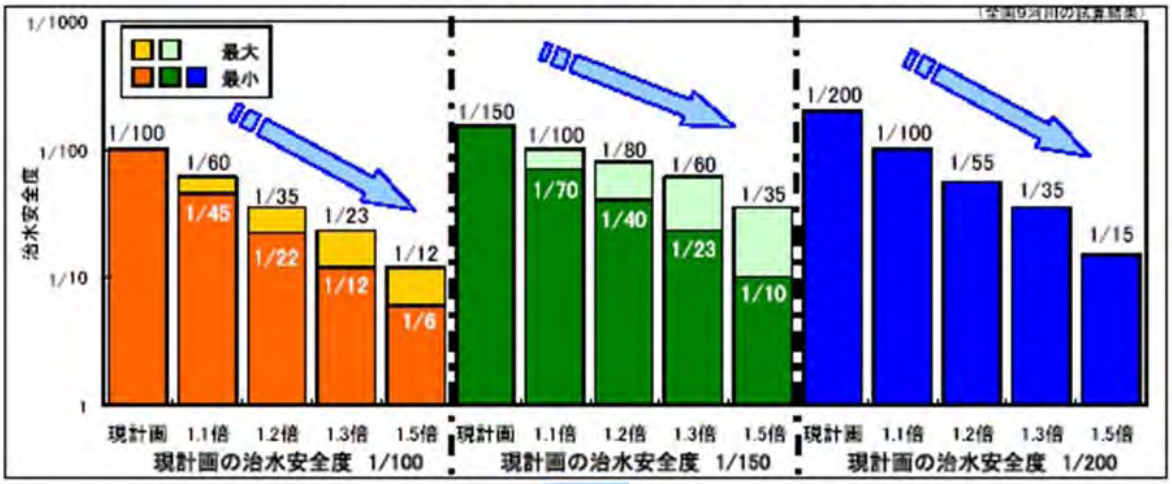


Long-term trends of sea surface temperature（℃/100年）

100年後の降水量の変化が治水安全度に及ぼす影響

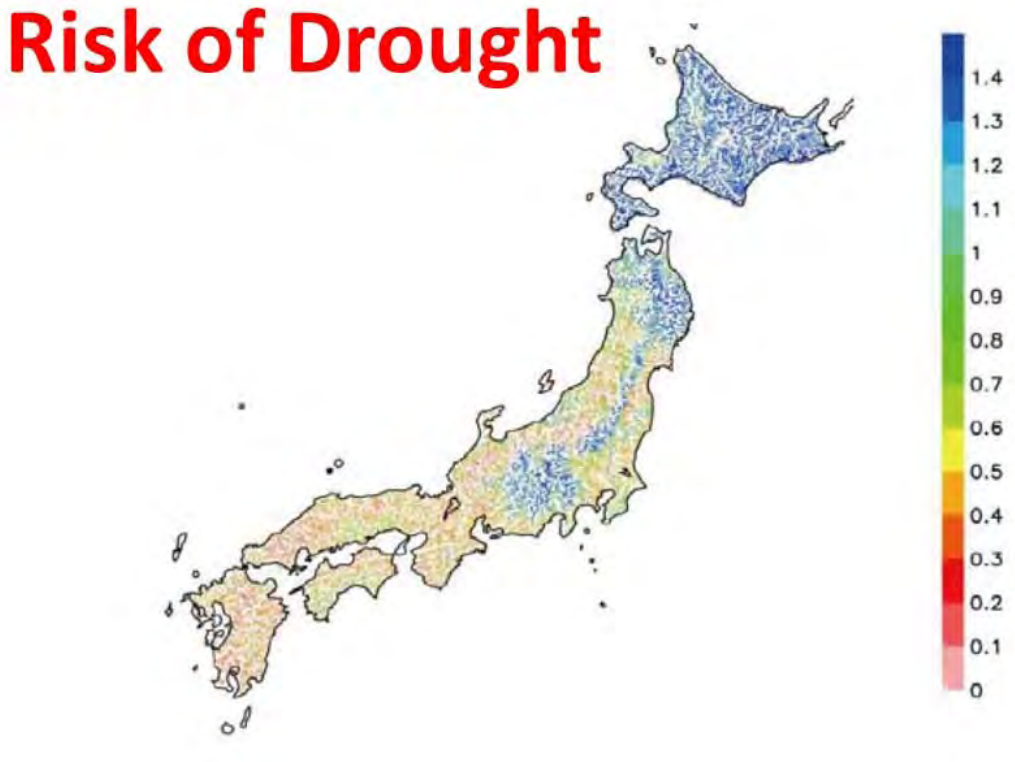
降水量の変化を予測すると、100年後には現在のおおむね1.1～1.3倍、最大で1.5倍程度を見込むことが妥当

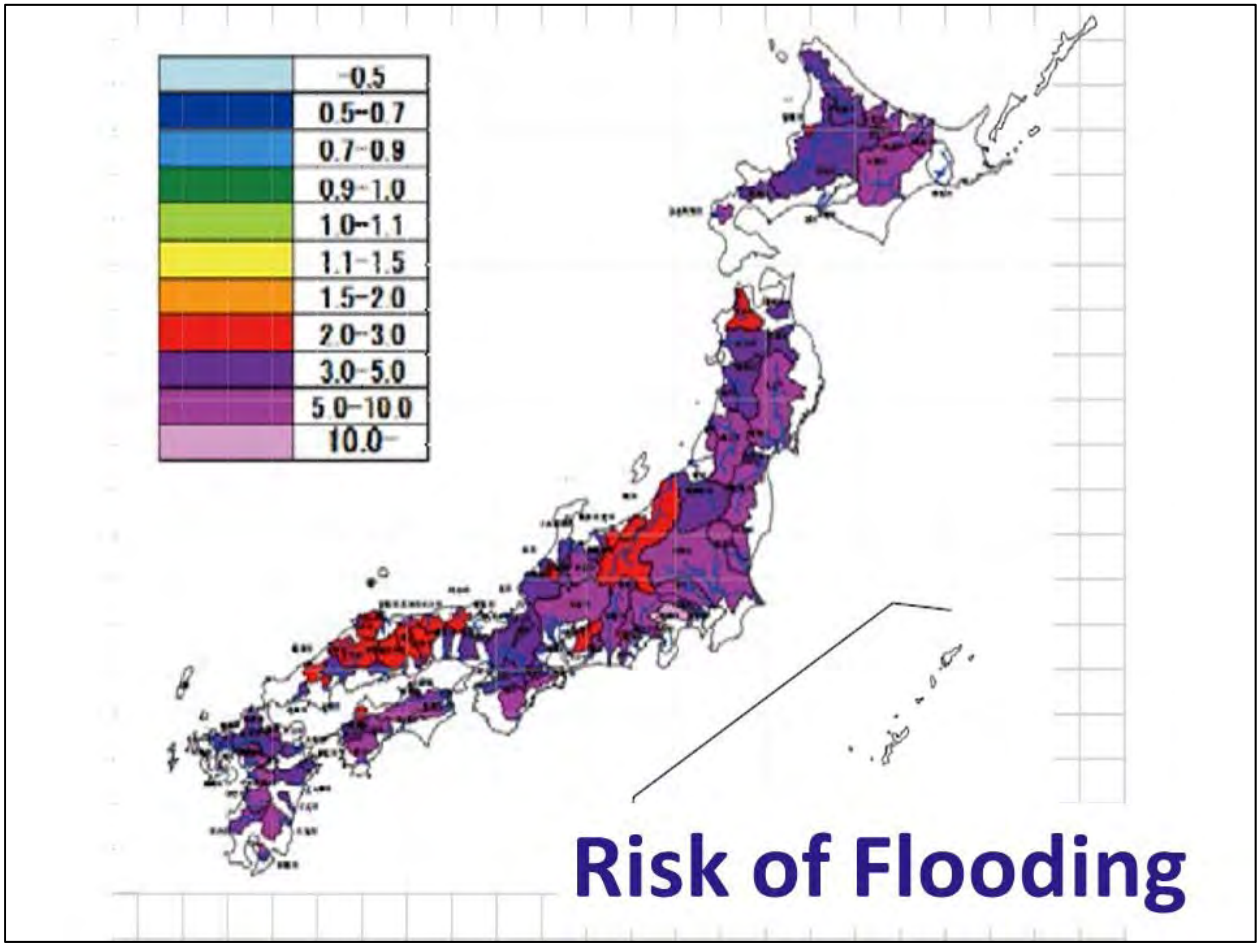
100年後の降水量の変化が治水安全度に及ぼす影響



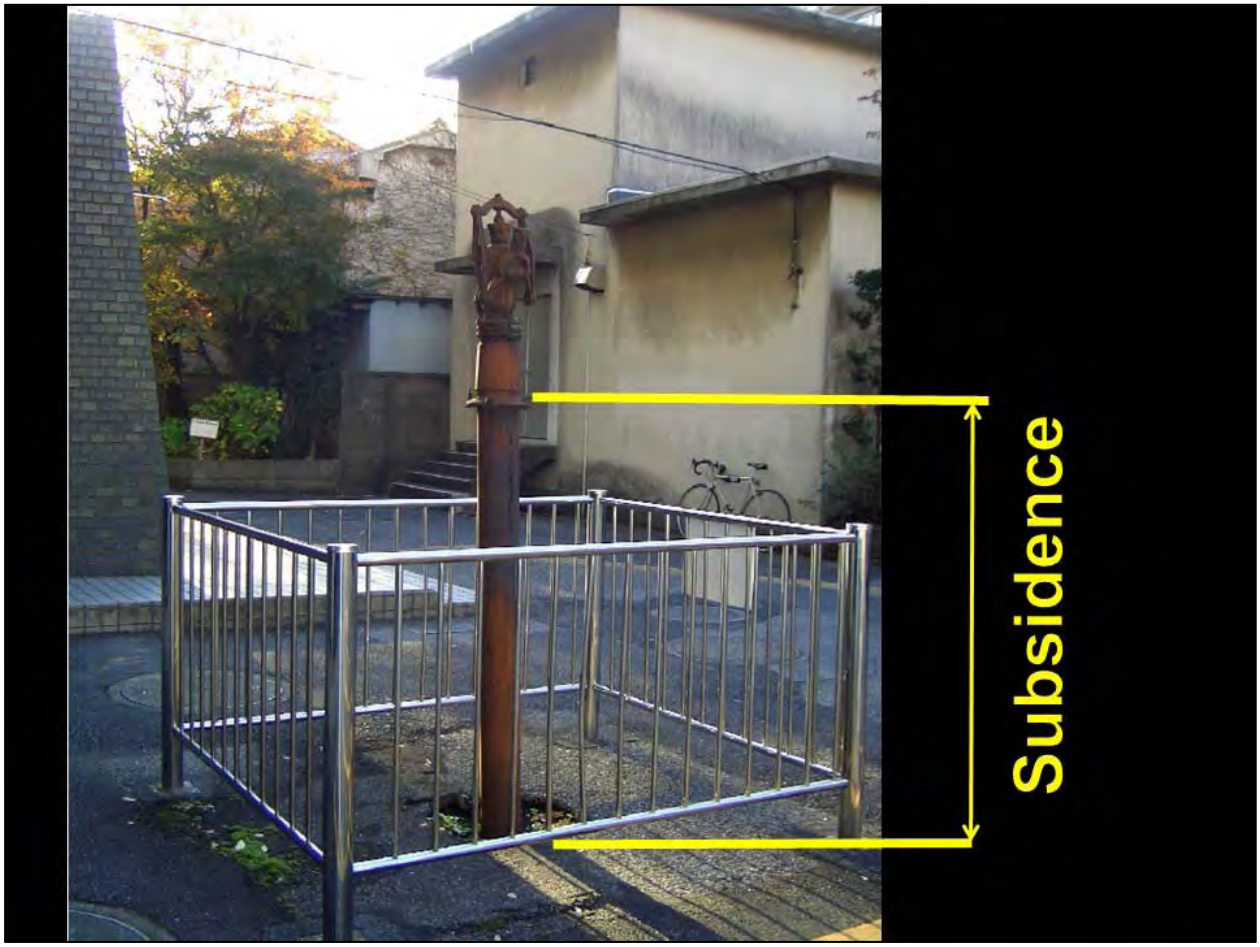
降水量の変化によって、
現計画が目標としている治水安全度は著しく低下していく

国土交通省社会資本整備審議会（2008）

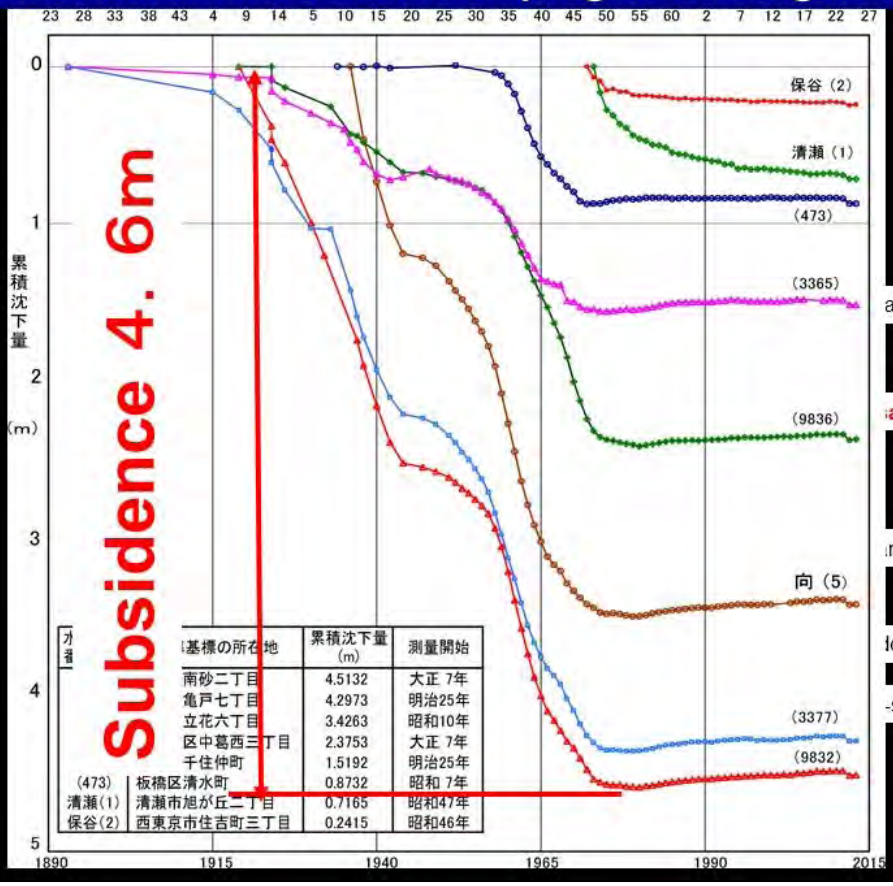




Land subsidence Using too much groundwater



Land Subsidence Due to Pumping of Underground Water



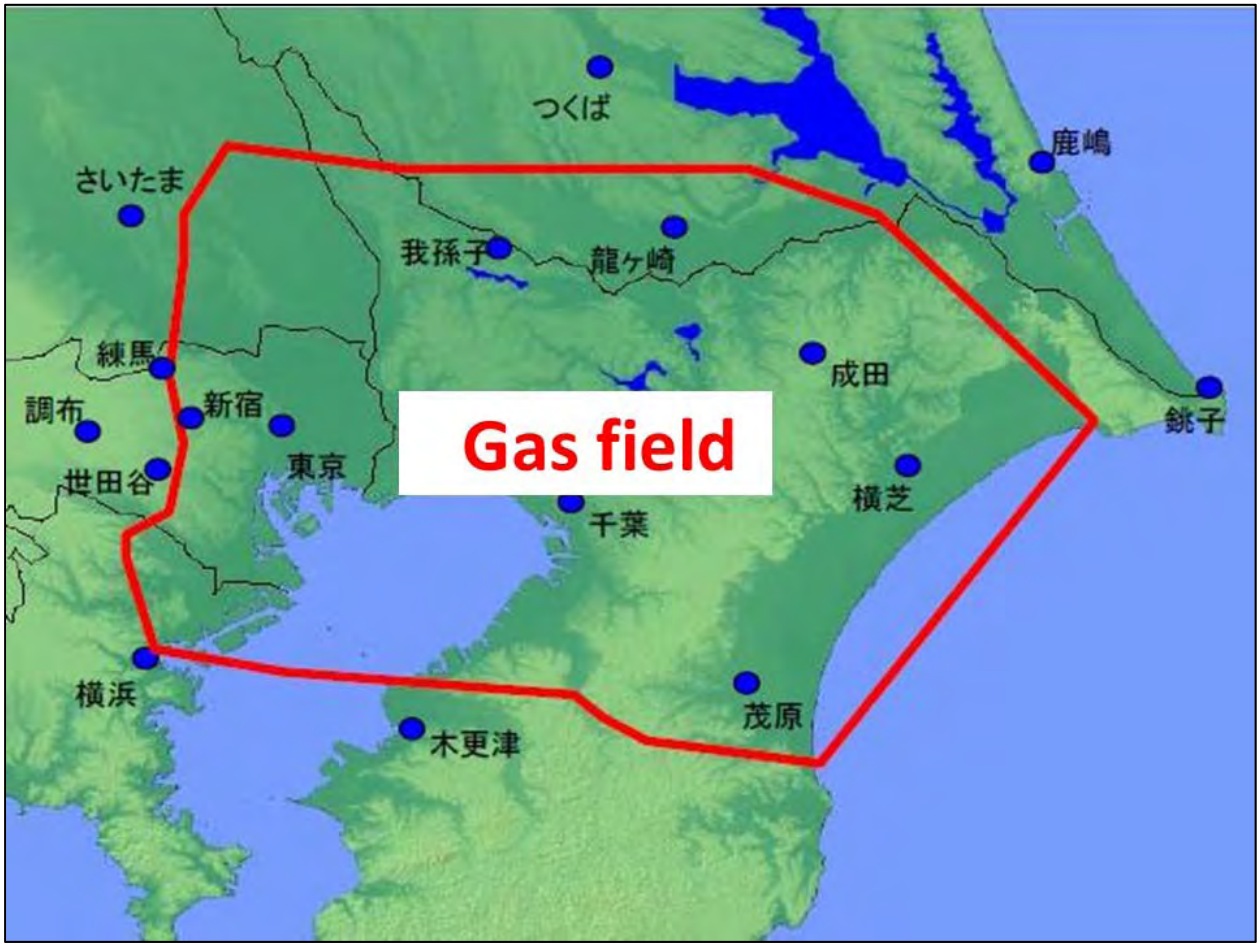
a-cho , Adachi-ku

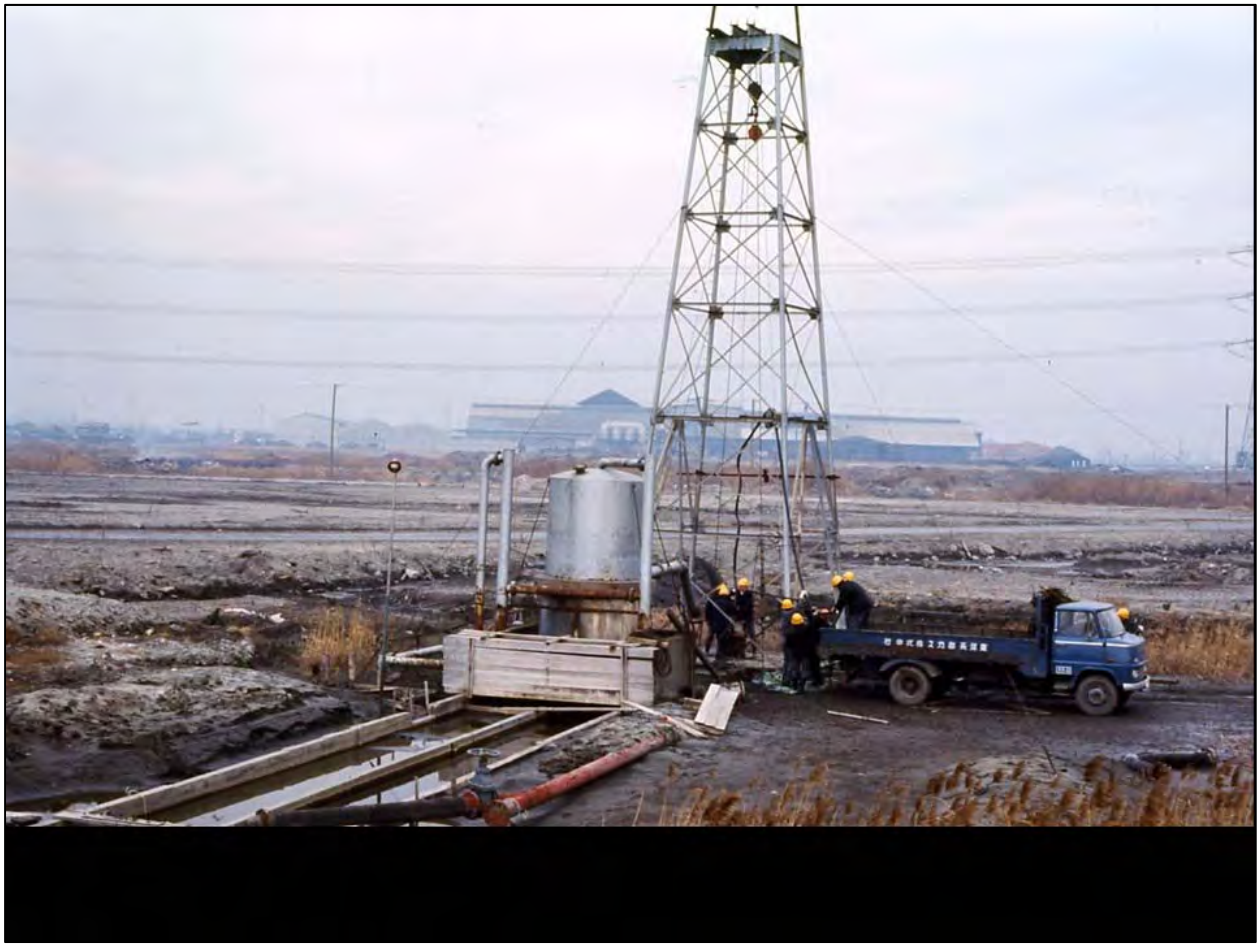
ai, Edogawa-ku

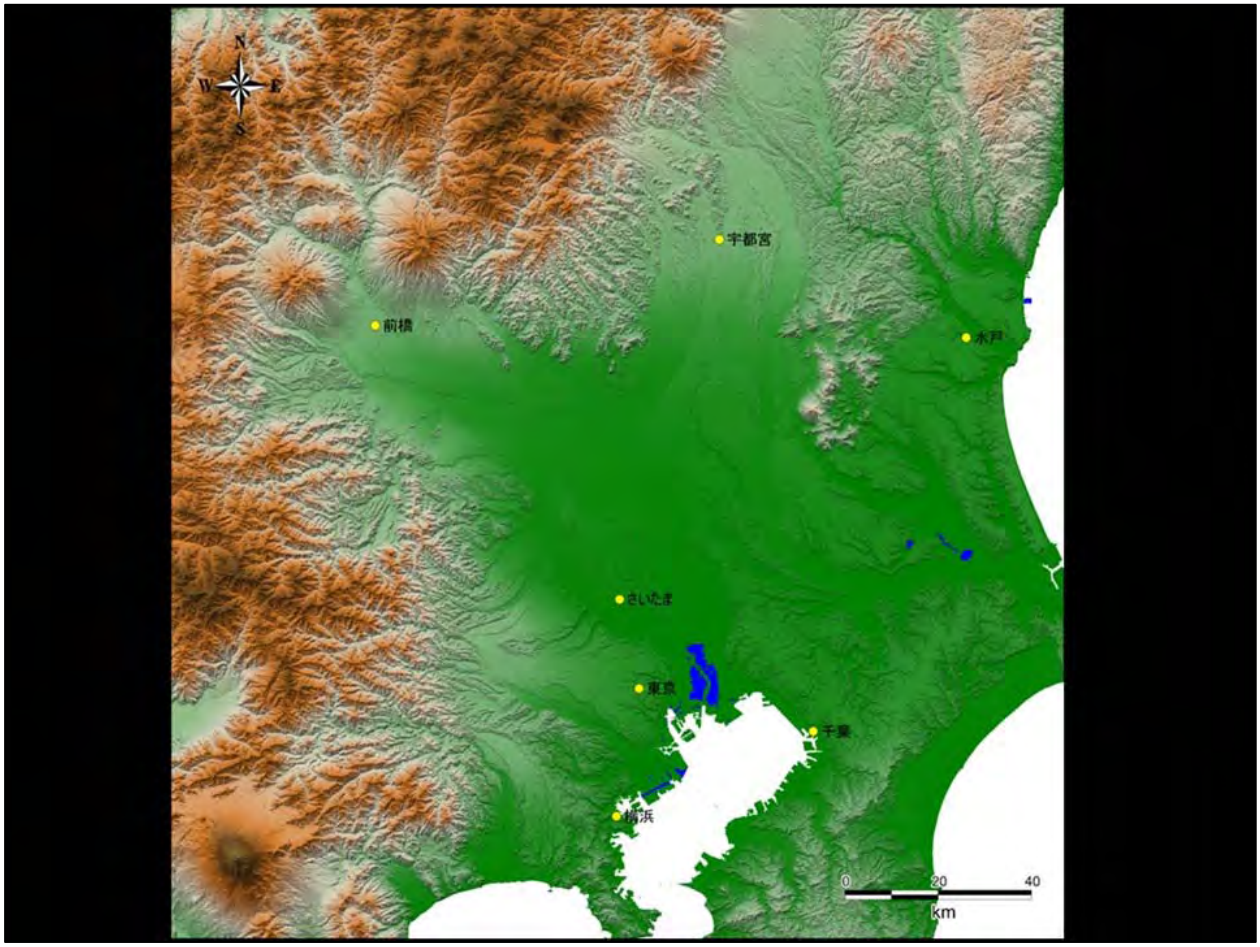
na, Sumida-ku

lo, Koto-ku

-suna, Koto-ku

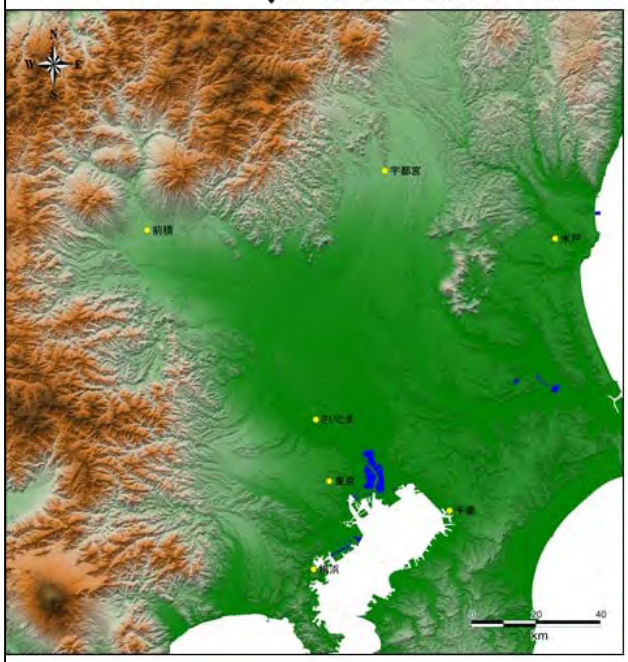

つくば
鹿嶋
さいたま
我孫子
龍ケ崎
練馬
成田
調布
新宿
銚子
Gas field
東京
世田谷
横芝
千葉
横浜
茂原
木更津

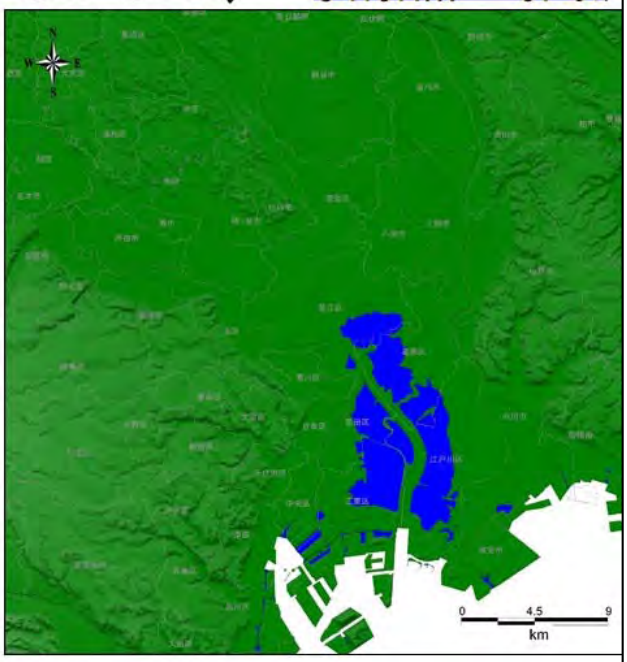




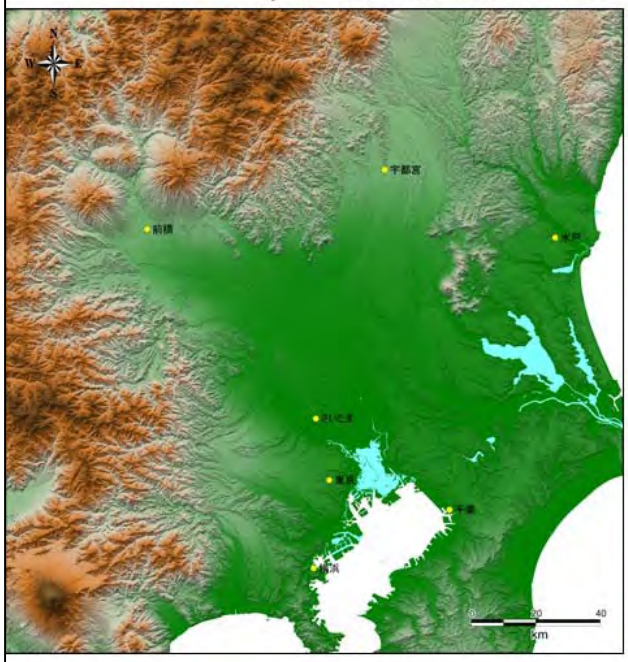
Area under low-tide level
（Arakawa Peil 0m）

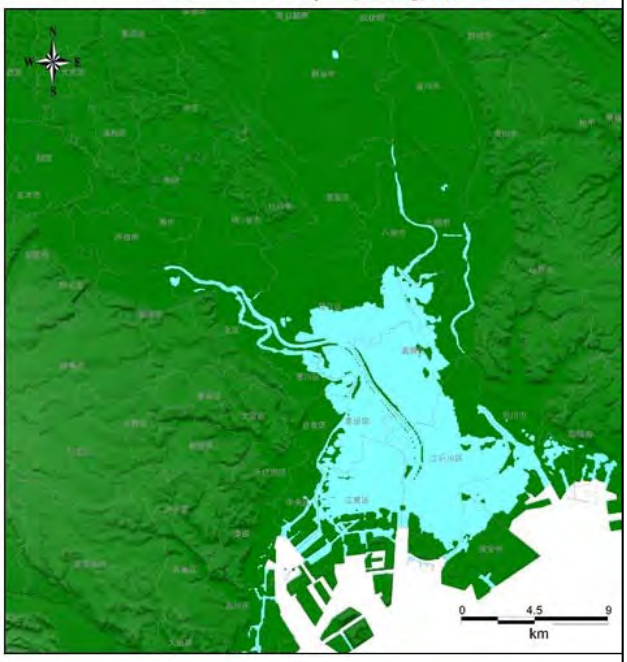
31.5Km² 5.0%



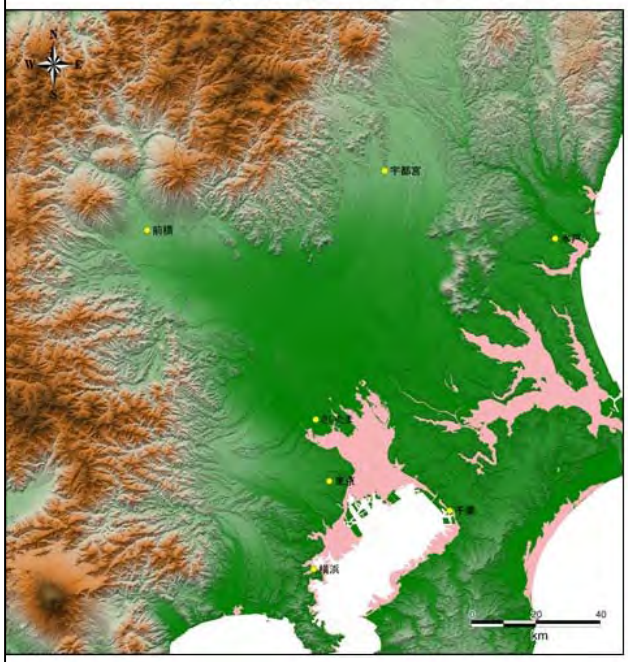


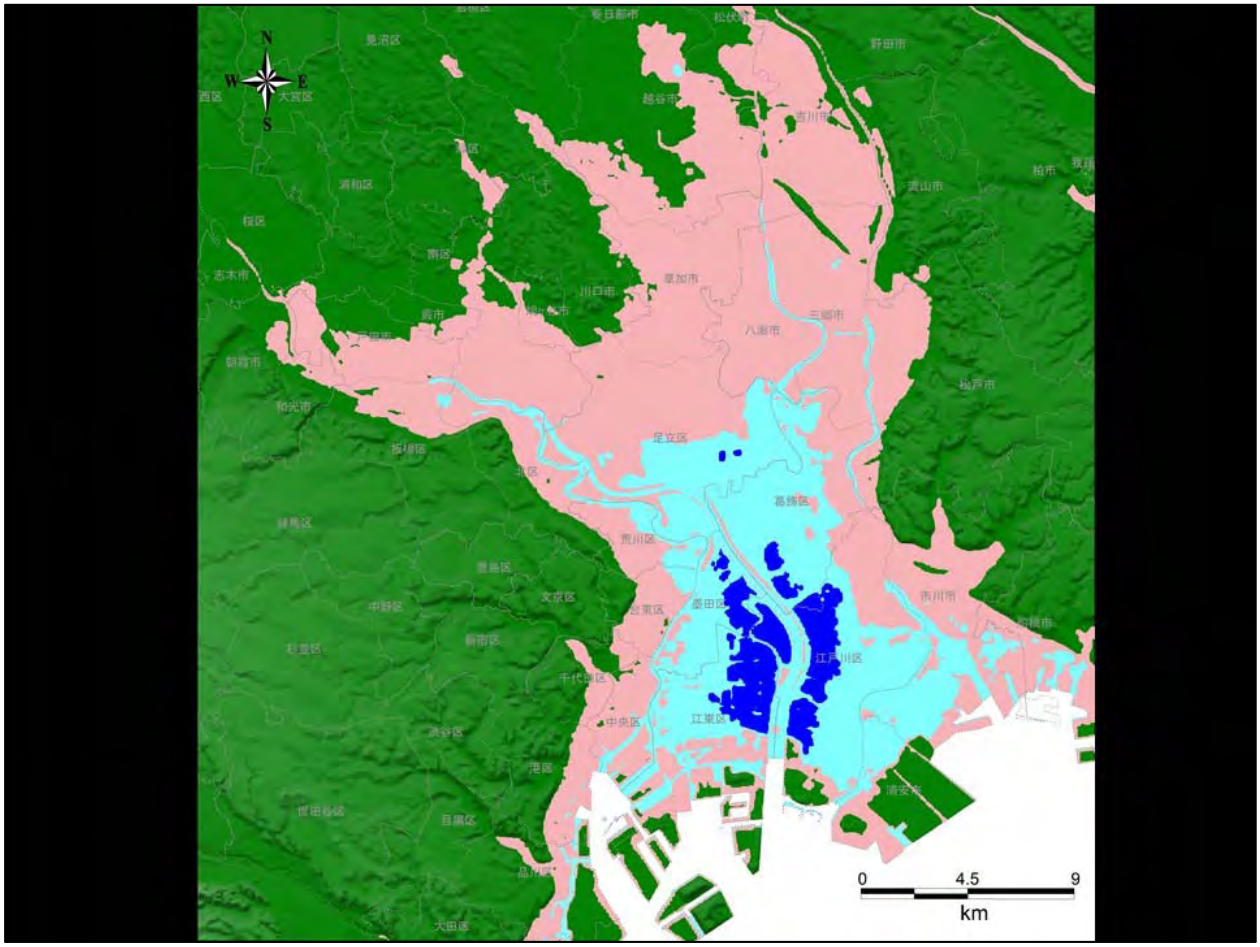
Area under high-tide level
（Arakawa Peil 2.1m）92.8Km² 20%

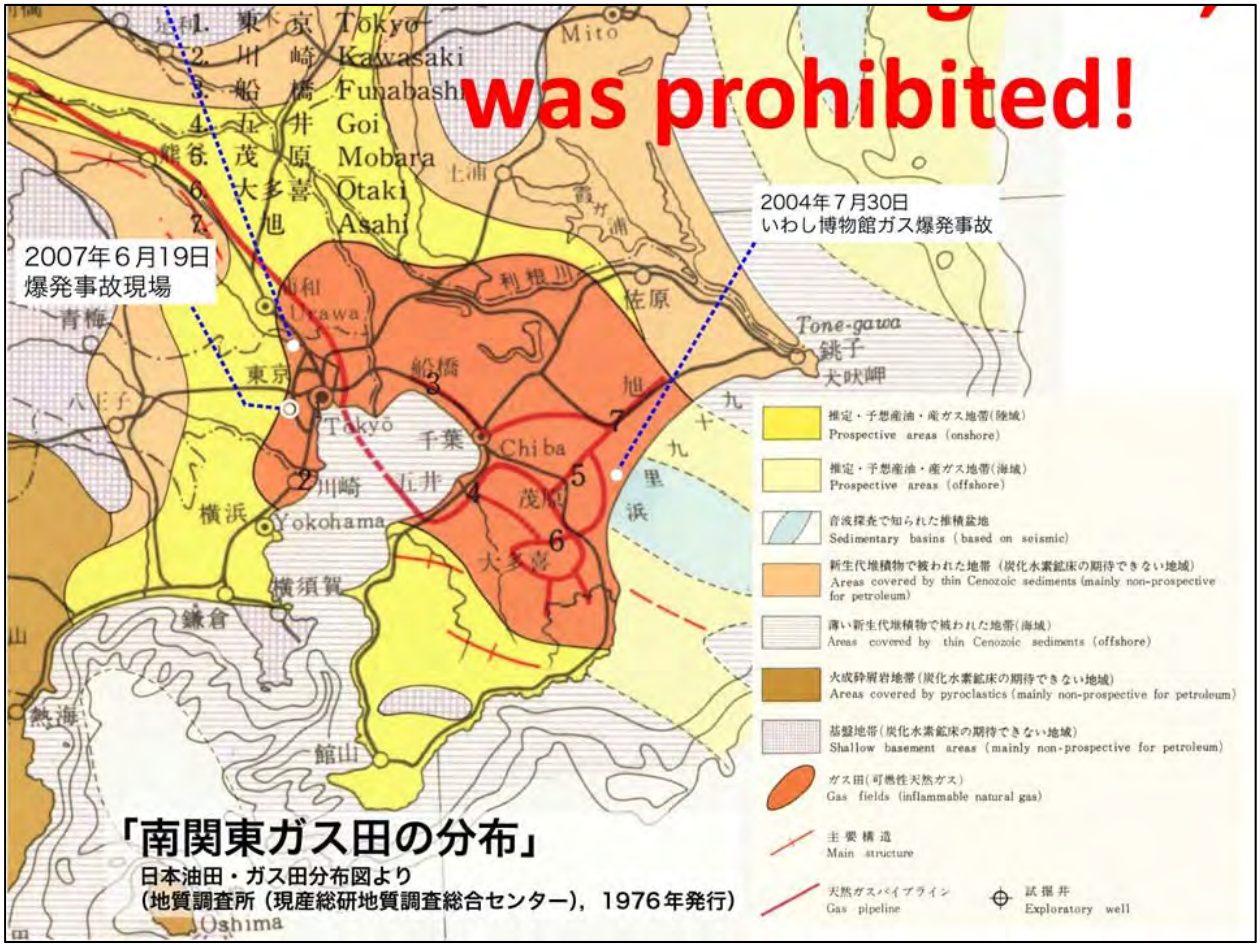




Area at risk of damage by flood tides
（Arakawa Peil 5.1m）254.6Km² 41%







「南関東ガス田の分布」
日本油田・ガス田分布図より
（地質調査所（現産総研地質調査総合センター），1976年発行）

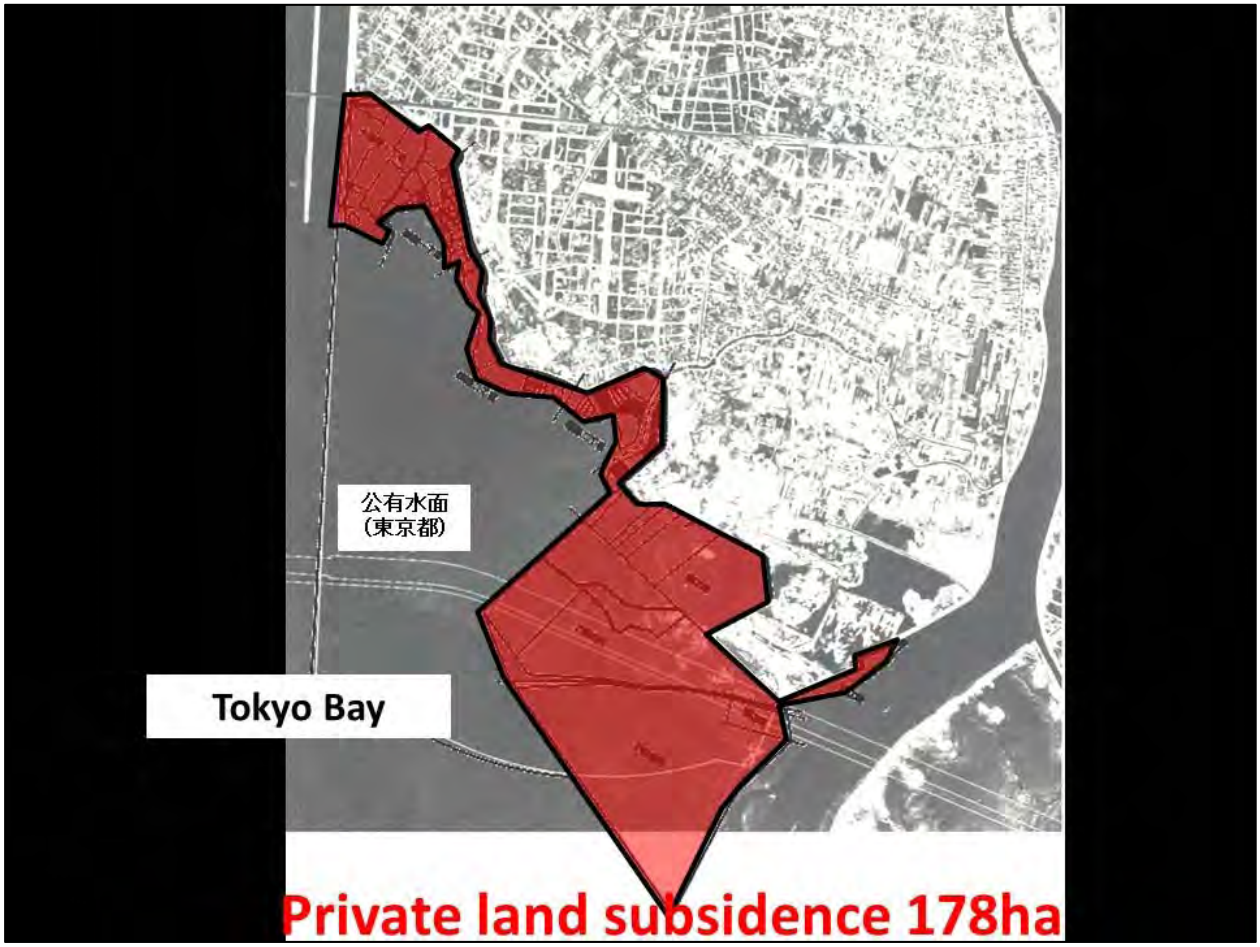
Adaptation to the challenges

Construction of

The defense line

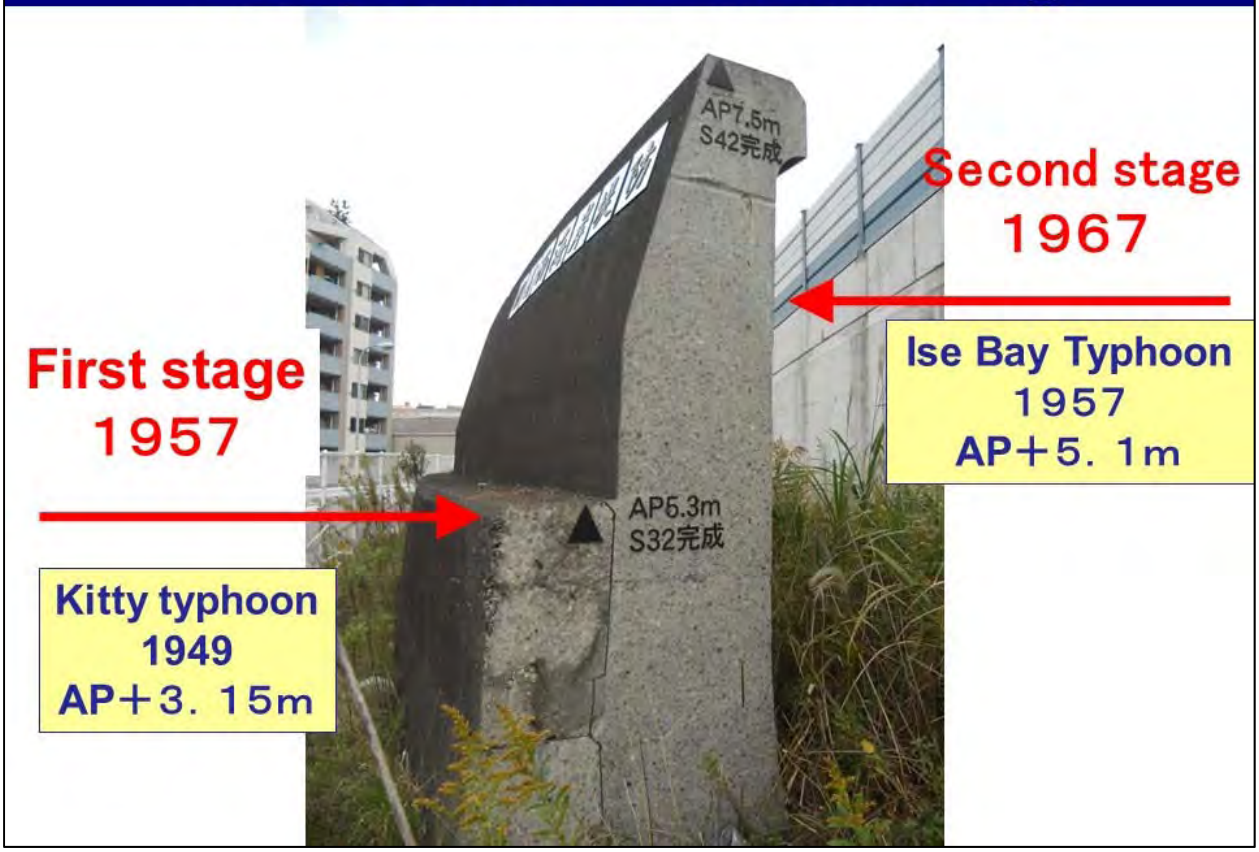

1905 (subsidence coastline)
0

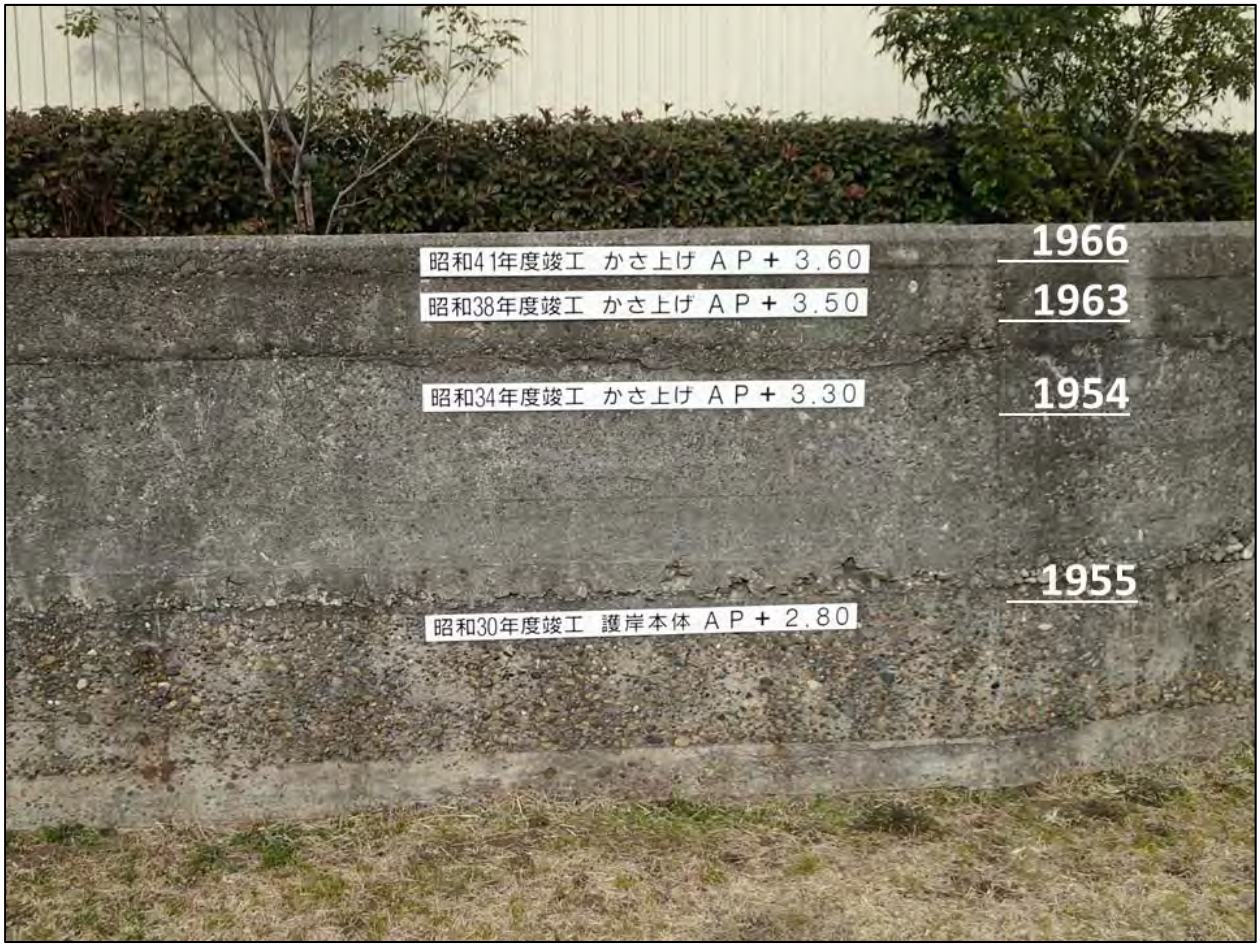

1972 (subsidence coastline)
0


公有水面
(東京都)
Tokyo Bay
Private land subsidence 178ha

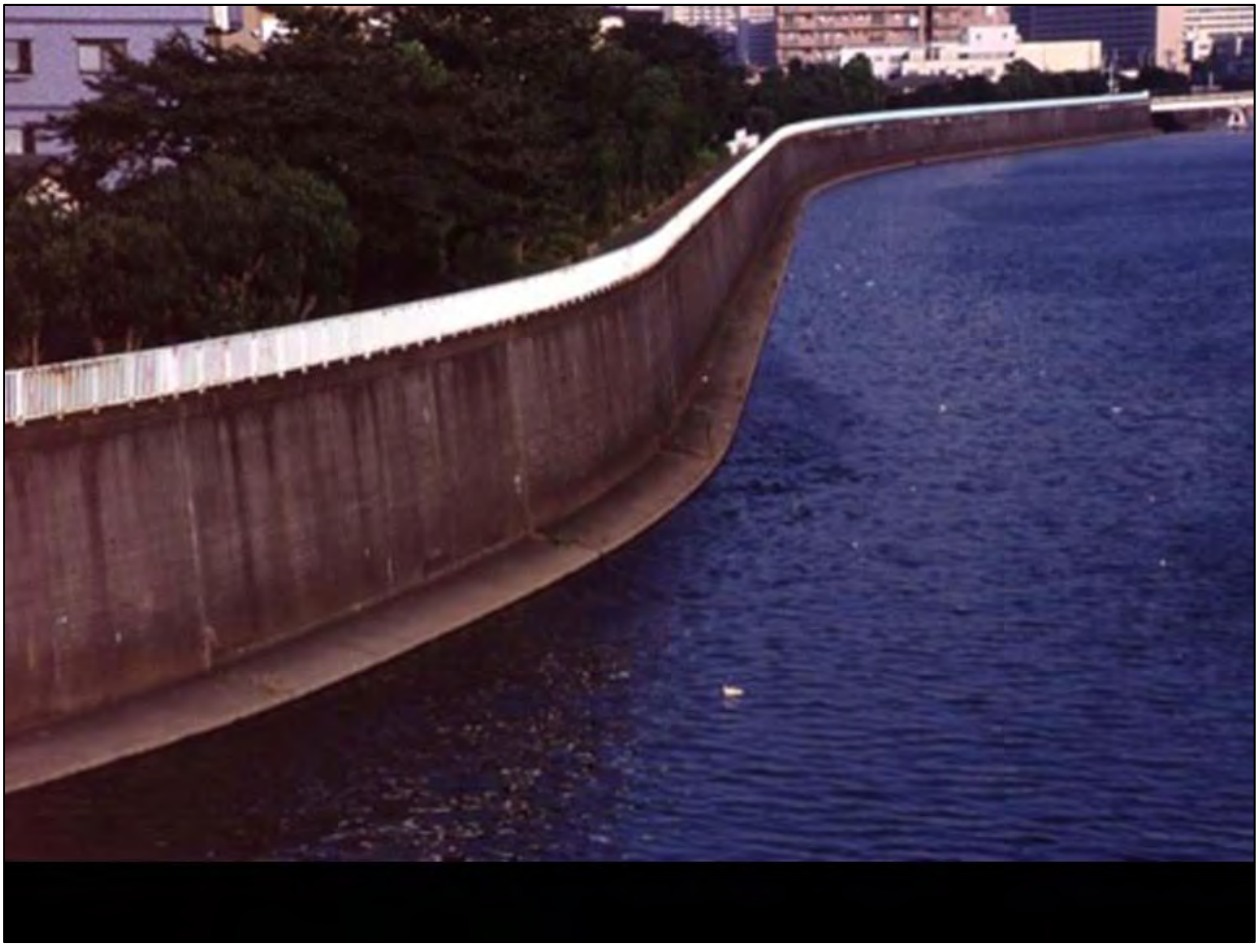

Storm surge dike construction project
1957
江戸川区政50年史

Traces of the seawall raising



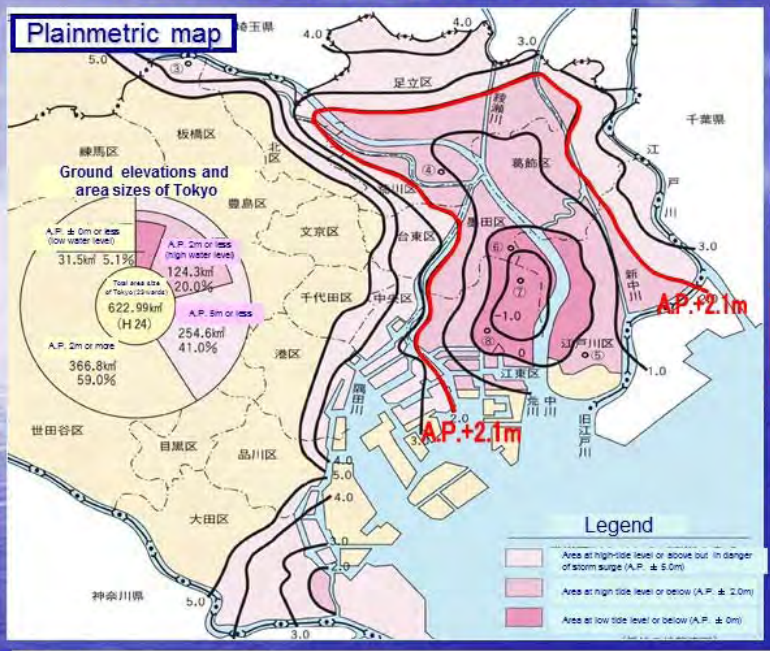

昭和41年度竣工 かさ上げ AP + 3.60
1966
昭和38年度竣工 かさ上げ AP + 3.50
1963
昭和34年度竣工 かさ上げ AP + 3.30
1954
1955
昭和30年度竣工 護岸本体 AP + 2.80


凡例
外郭防潮堤
堤外地防潮堤
内部護岸
水門
排水機場
高潮対策センター



Tide Level Markings on School Wall
(Komatsugawa Elementary School)

Ground elevations of lowlands in Tokyo

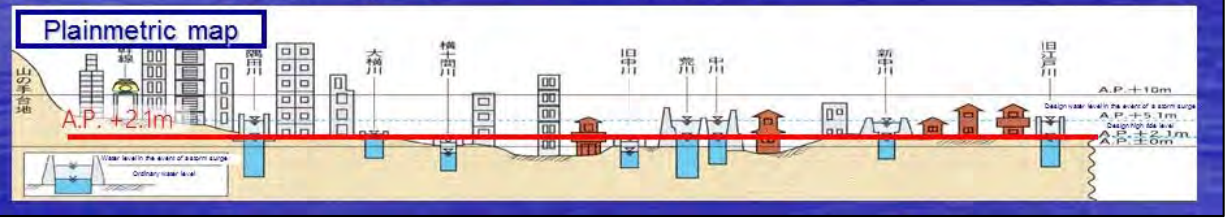


The areas on the map are located below high tide area (A.P. + 2.1m)

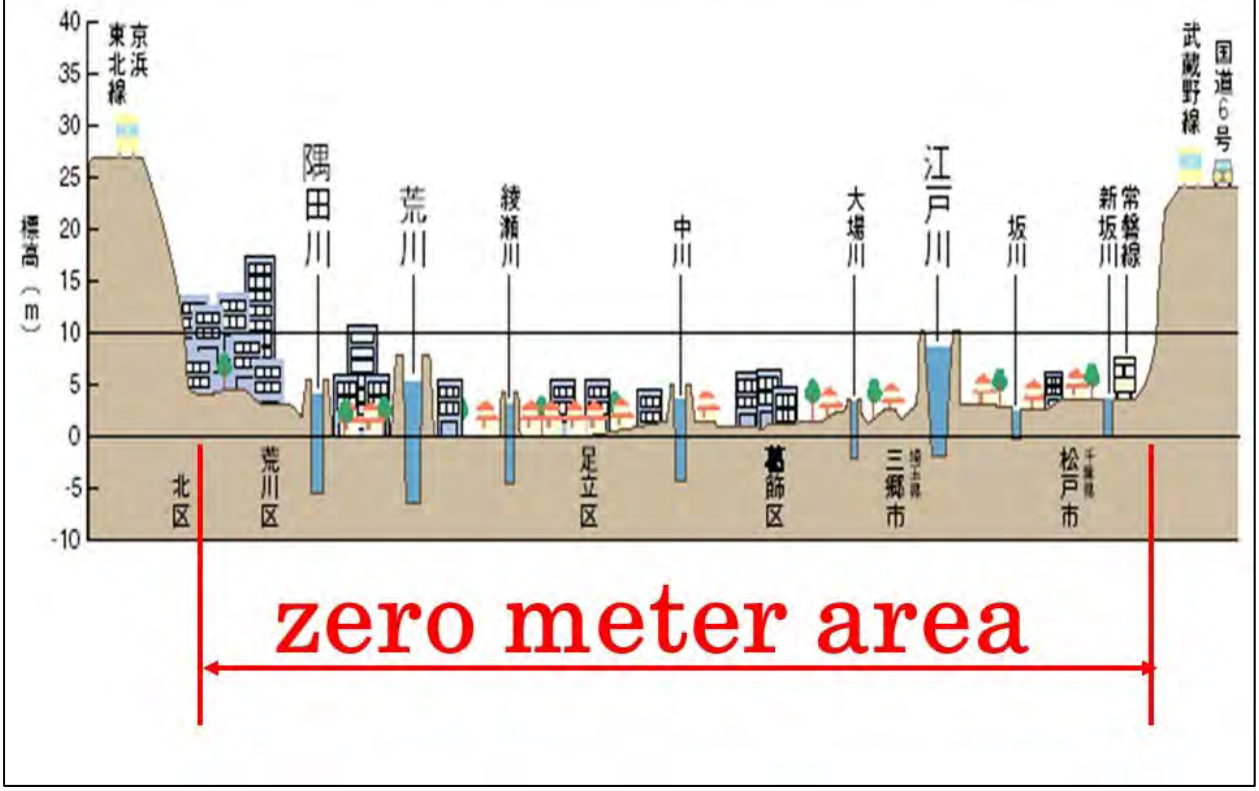
Area size: 124 km2
Population: about 1.5 million

It is expected that extremely sever damage will be inflicted in the event of a flood disaster.

※Mean spring tide low water A.P.±0.0m
Mean spring tide high water A.P. + 2.1m



Cross-view of the Tokyo eastern lowlands

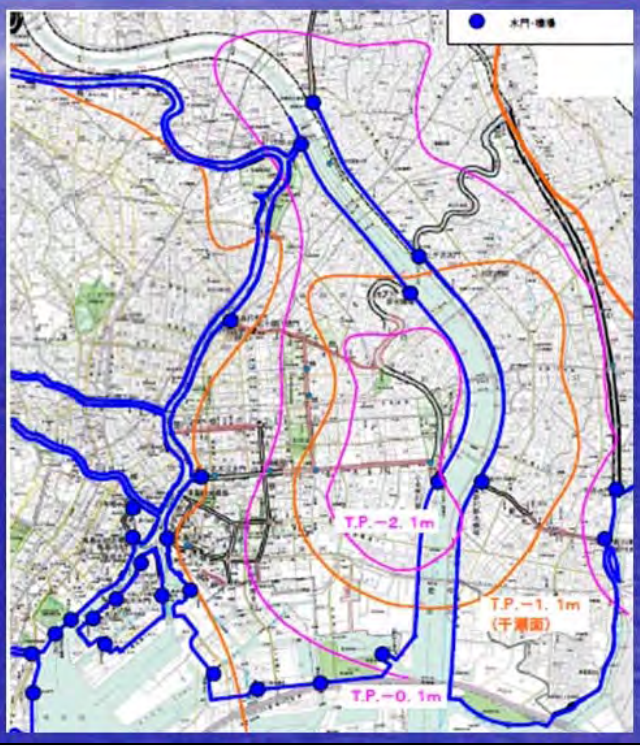


Improvements of coastal defense facilities against storm surge

In order to protect lowlands in the eastern part of Tokyo from flooding caused by a storm surge event, similar in scale to the storm surge event caused by the Typhoon Vera or so-called the Typhoon Isewan Bay, river tidal defenses and water gate are improved and the improvement works have been almost completed.

River Tidal Defense (the Sumidagawa River)

Water Gate (Imai Water Gate)

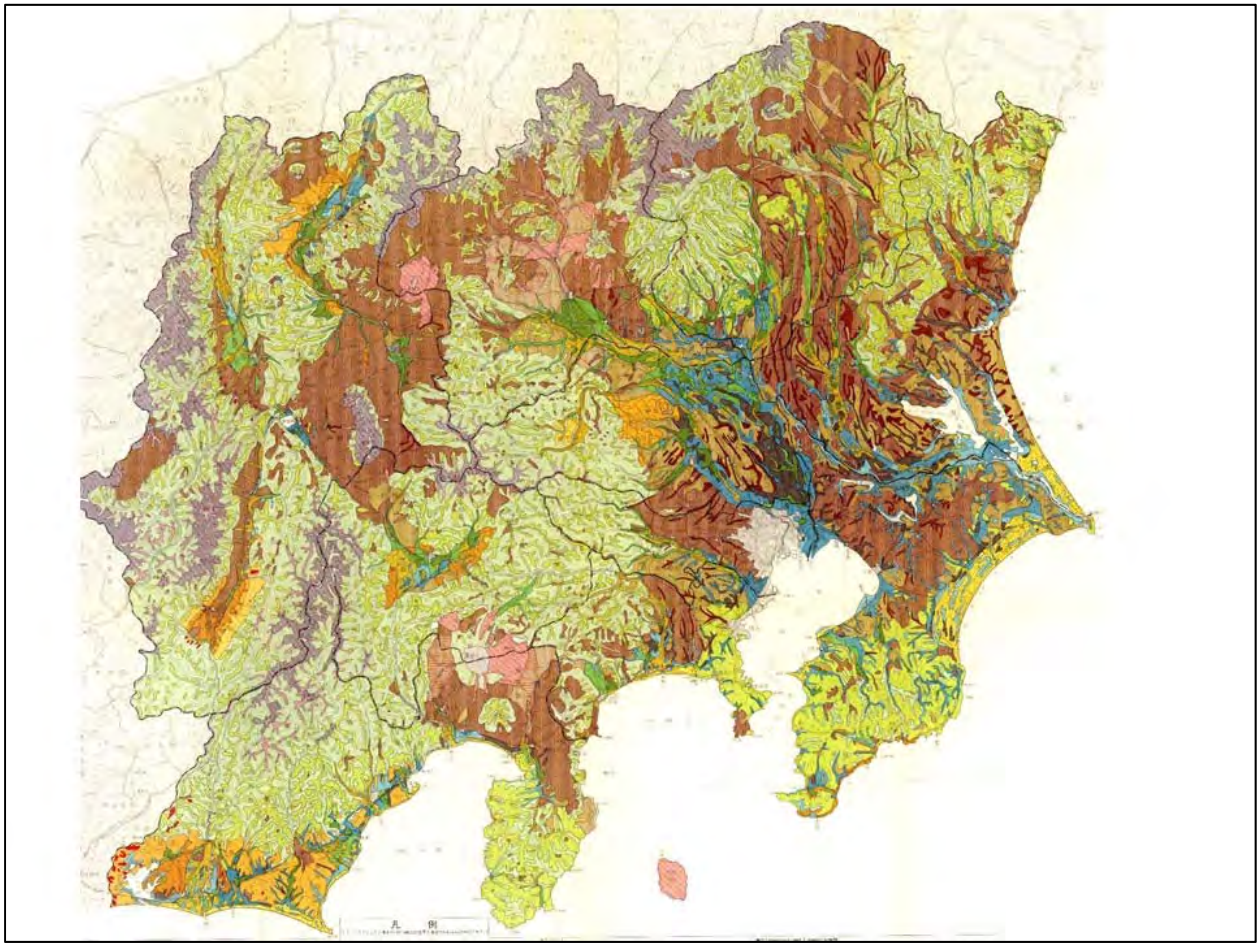


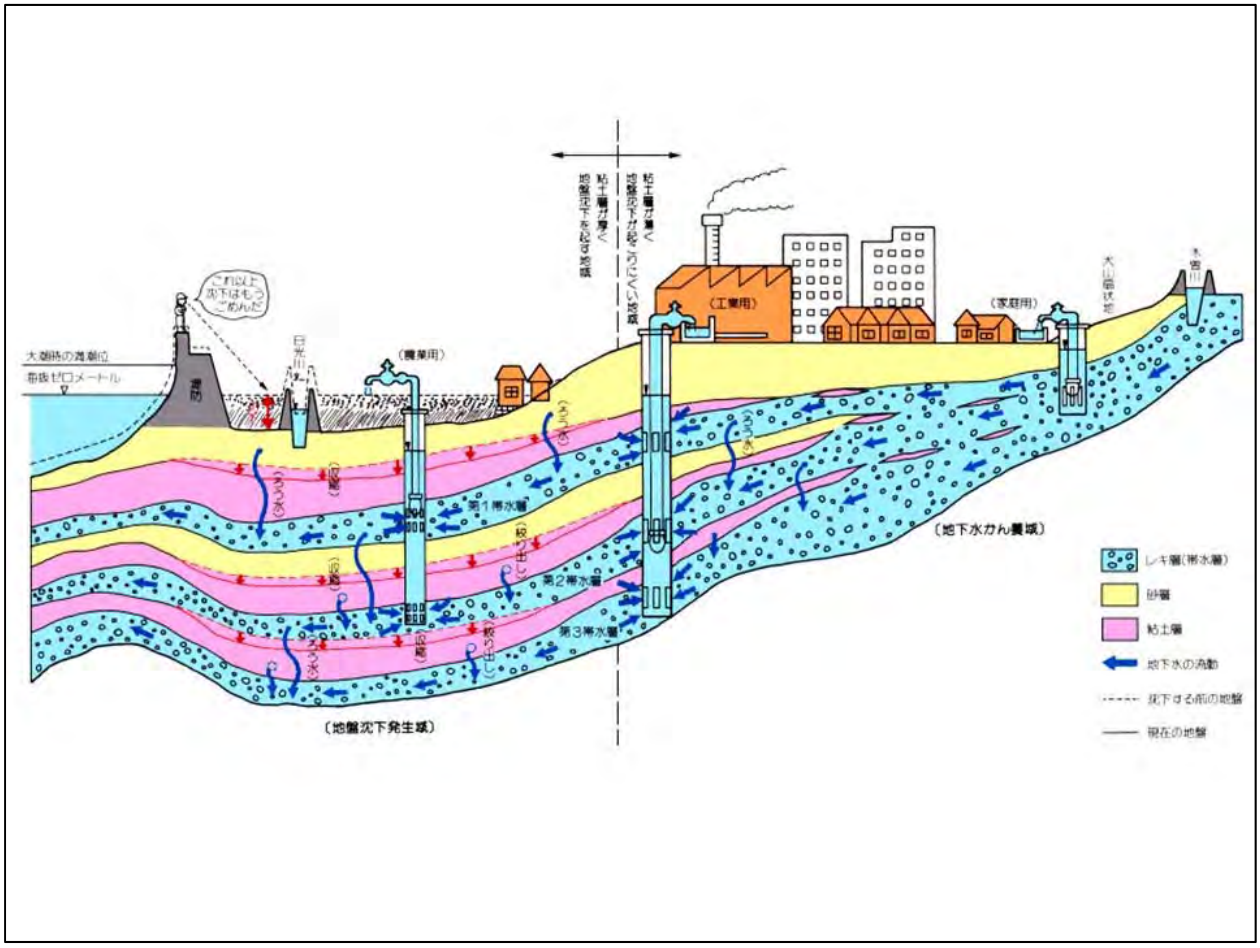
Recovery of lost land

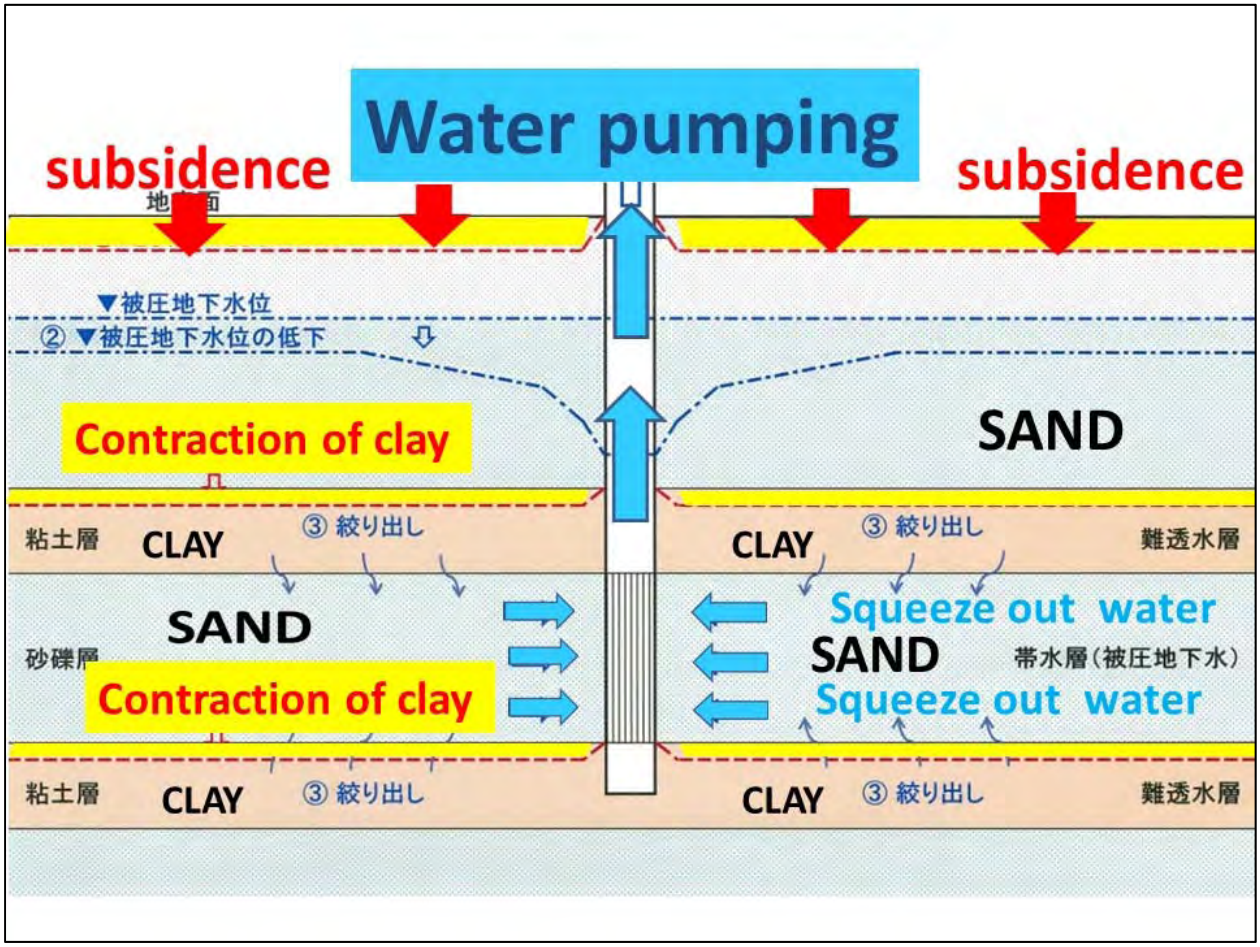
61

Construction of industrial water,

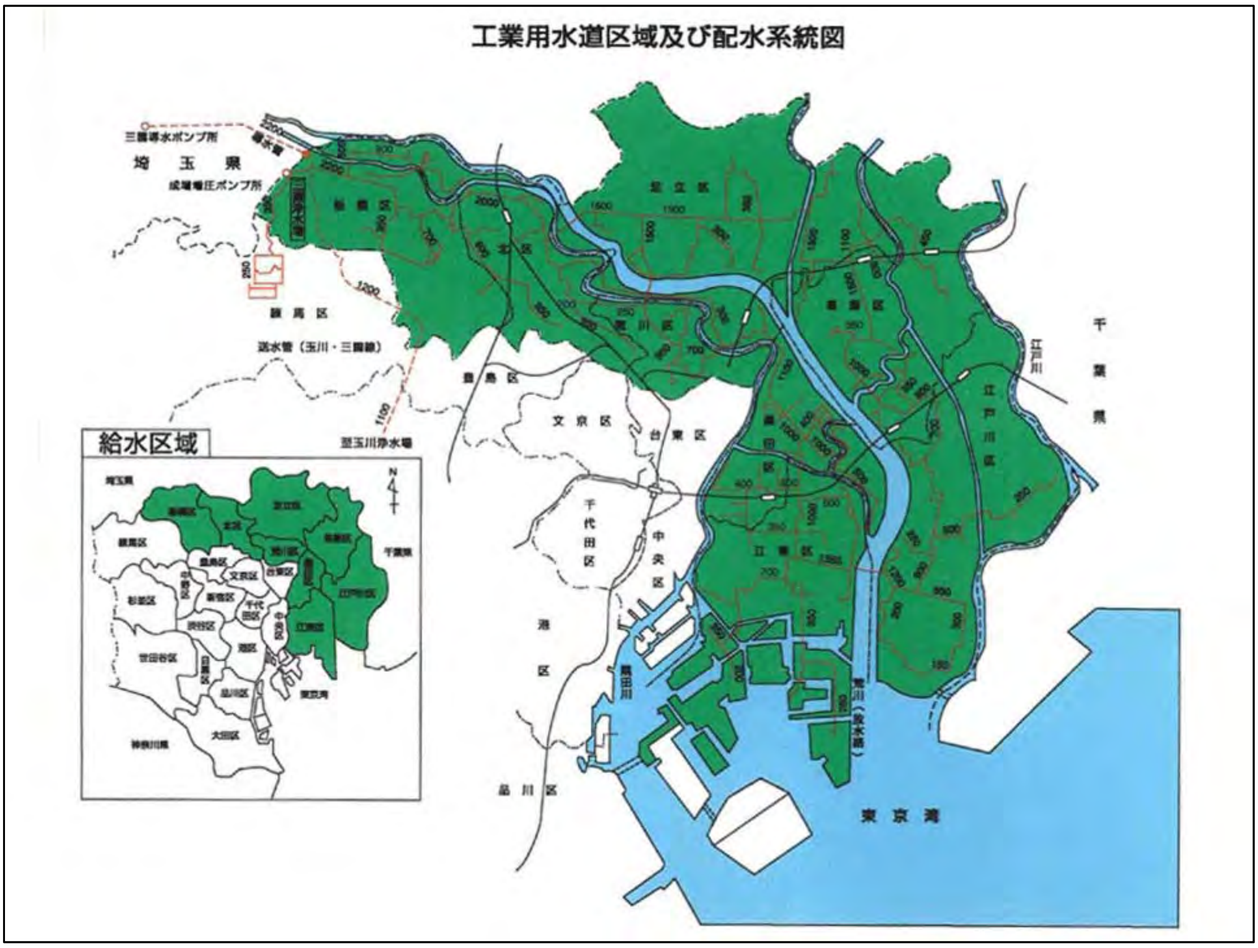
prohibited of pumped groundwater



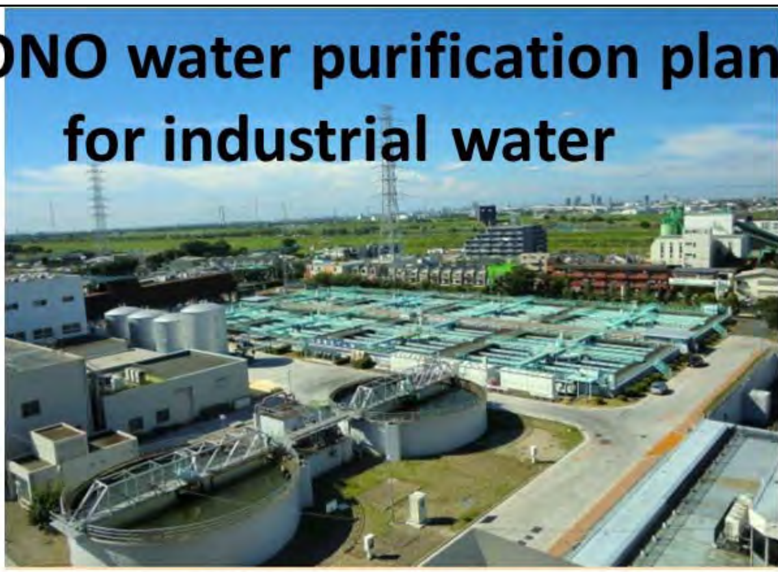

これ以上沈下はもうごめんだ
大潮時の満潮位
基準ゼロメートル
堤防
(農業用)
(工業用)
(家庭用)
粘土層が厚く地盤沈下を起す地域
粘土層が薄く地盤沈下が起こりにくい地域
第1帯水層
第2帯水層
第3帯水層
(地盤沈下発生域)
(地下水かん養域)
レキ層(帯水層)
砂層
粘土層
地下水の流動
沈下する前の地盤
現在の地盤

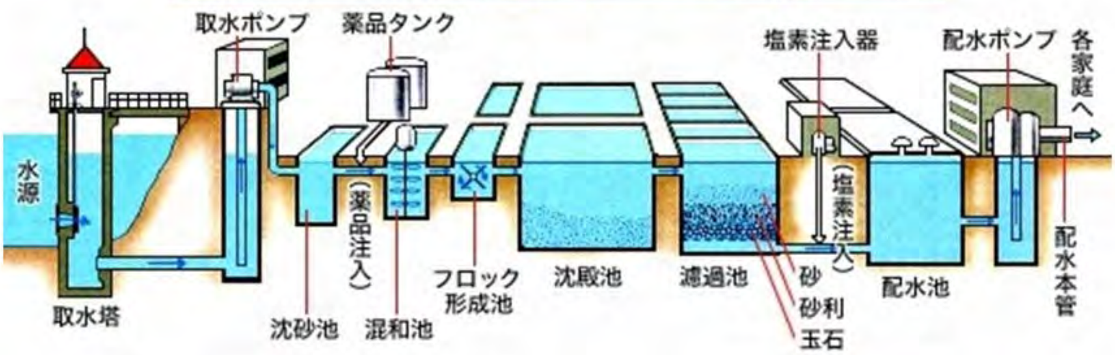

Water pumping
subsidence
subsidence
地盤面
▼被圧地下水位
② ▼被圧地下水位の低下
Contraction of clay
SAND
粘土層
CLAY
③ 絞り出し
CLAY
③ 絞り出し
難透水層
Squeeze out water
SAND
砂礫層
帯水層（被圧地下水）
Contraction of clay
Squeeze out water
粘土層
CLAY
③ 絞り出し
CLAY
③ 絞り出し
難透水層

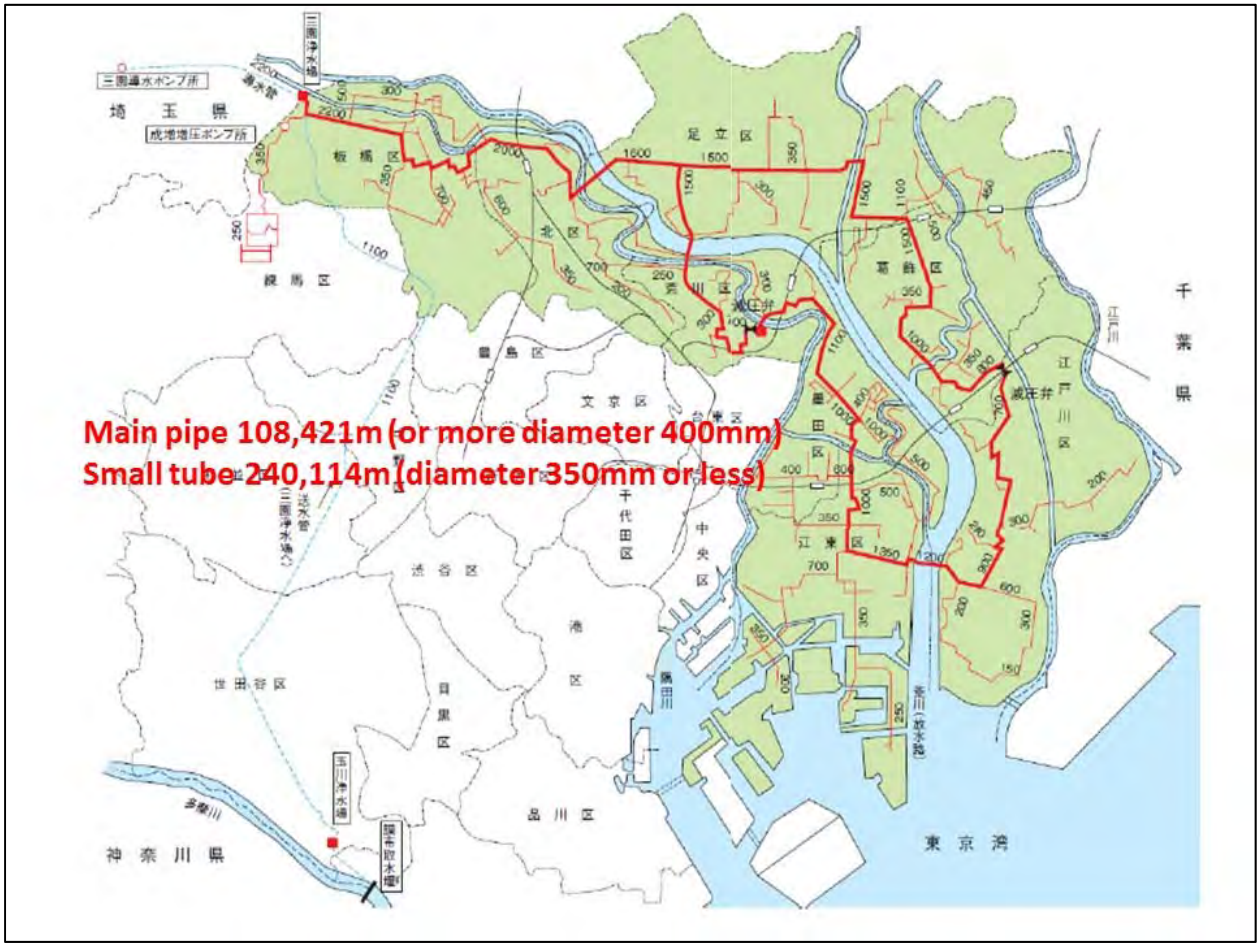

東京の地形
洪積台地
下末吉面（S）
武蔵野Ⅰ面（M₁）
武蔵野Ⅱ面（M₂）
武蔵野Ⅲ面（M₃）
立川面（Tc₁,₂）
青柳面（Tc₃）
拝島面以下（H）
山地
丘陵地
沖積平野
谷底低地
扇状地・後背湿地・三角州性低地
埋立地
河川・河川敷
N

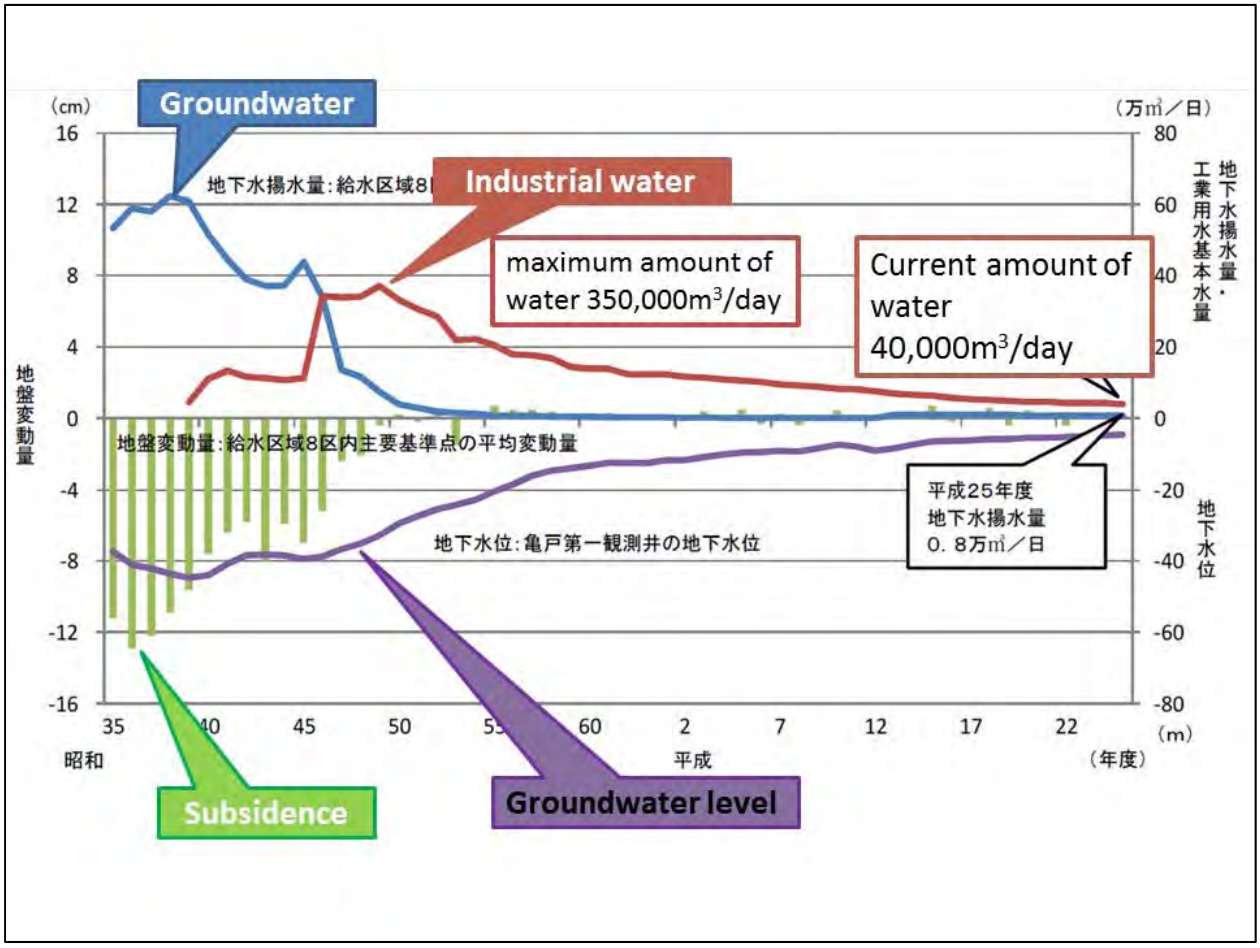


MISONO water purification plant for industrial water






Main pipe 108,421m (or more diameter 400mm)
Small tube 240,114m (diameter 350mm or less)
埼 玉 県
千 葉 県
神 奈 川 県
東 京 湾


Groundwater
Industrial water
maximum amount of water 350,000m³/day
Current amount of water 40,000m³/day
地下水揚水量:給水区域8
地盤変動量:給水区域8区内主要基準点の平均変動量
地下水位:亀戸第一観測井の地下水位
平成25年度 地下水揚水量 0.8万m³/日
Subsidence
Groundwater level
(cm)
(万m³/日)
地盤変動量
地下水揚水量・工業用水基本水量
地下水位
(m)
昭和
平成
(年度)

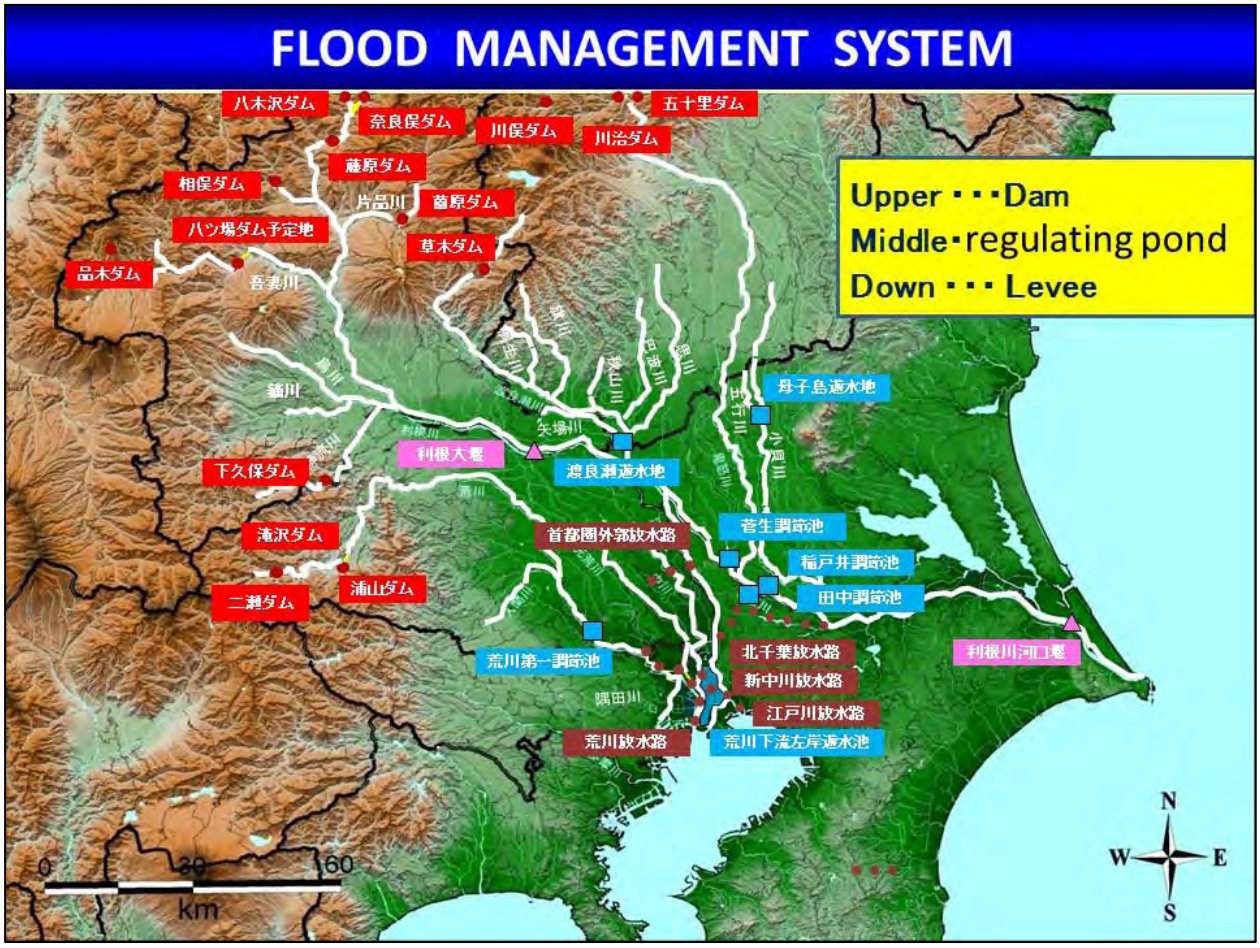
Tap water source adjustment system

Yunishigawa dam 72 million m^3

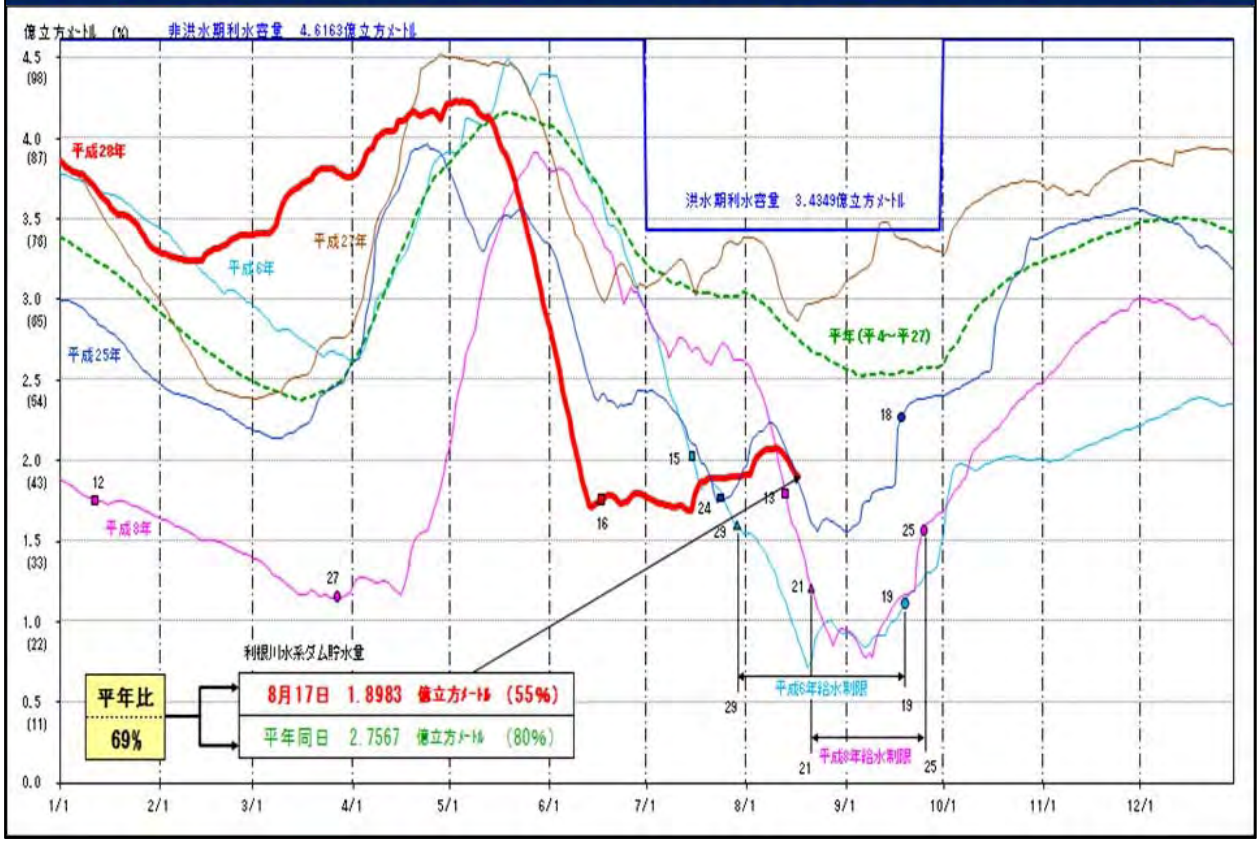
Yagisawa Dam 175 million m^3

76

Watarase reservoir and regulating



Tokyo accumulation amount 6.3 million m³/d



Lost river due to amount of water has decreased

Deterioration of River Environment (pollution, garbage)

82p

Sumida river, 1967東京、隅田川

Source: Annual visual report on environment in Japan, 1982

83p

Bubble at the Tama river東京、多摩川

Source: Bureau of Environment, Tokyo Metropolitan Government, 1970

84p

渋谷川

Garbage around the river mouth of Shibuya River (Furu River), 1970

Source: Tokyo Metropolitan Government 's homepage


85p

Furukawa before Construction

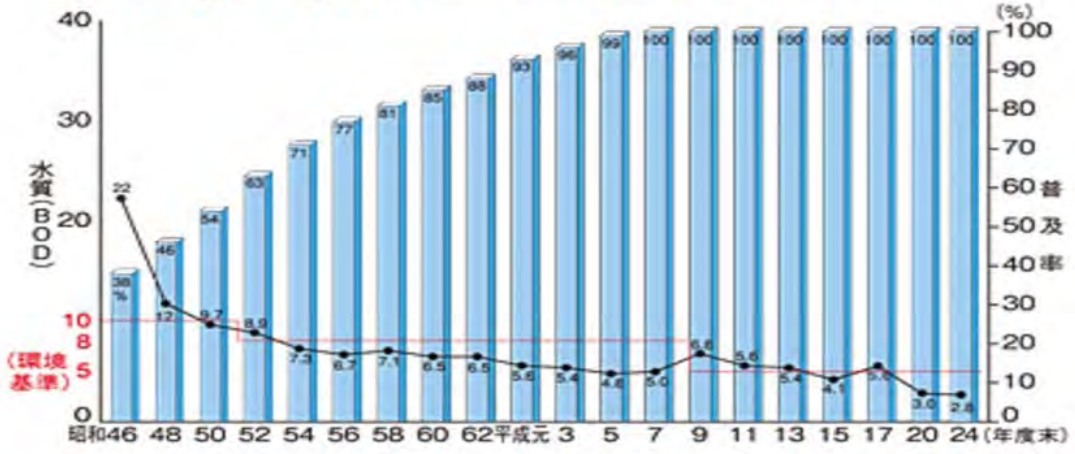

Furukawa Shinsui Park
—the first Shinsui Park in Japan—


Komatsugawa Sakaigawa Shinsui
River Park
before Construction


「Komatsugawa Sakaigawa Shinsui River
Park」

sewerage was completed 100% in 1995

Water quality and sewage system diffusion rate

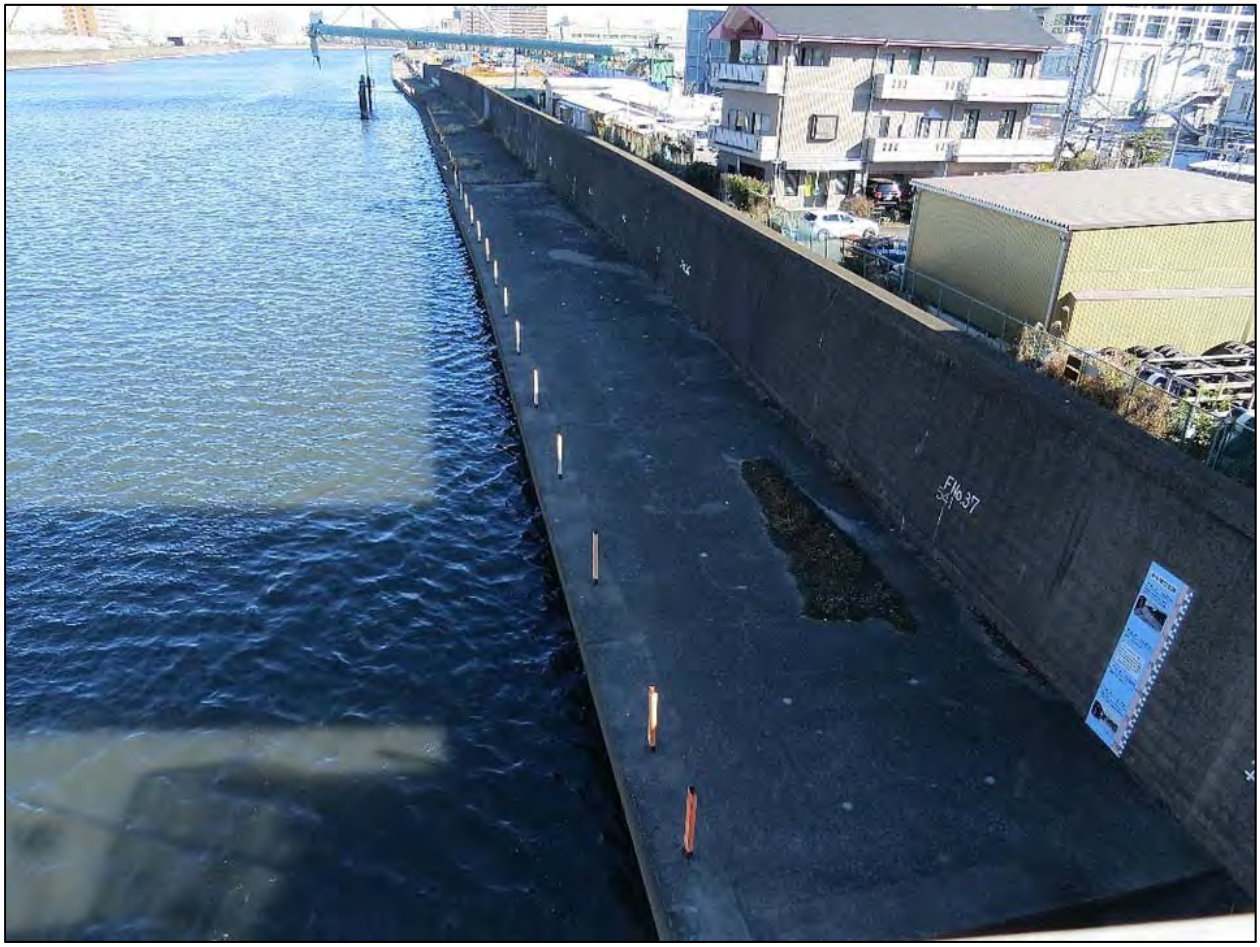


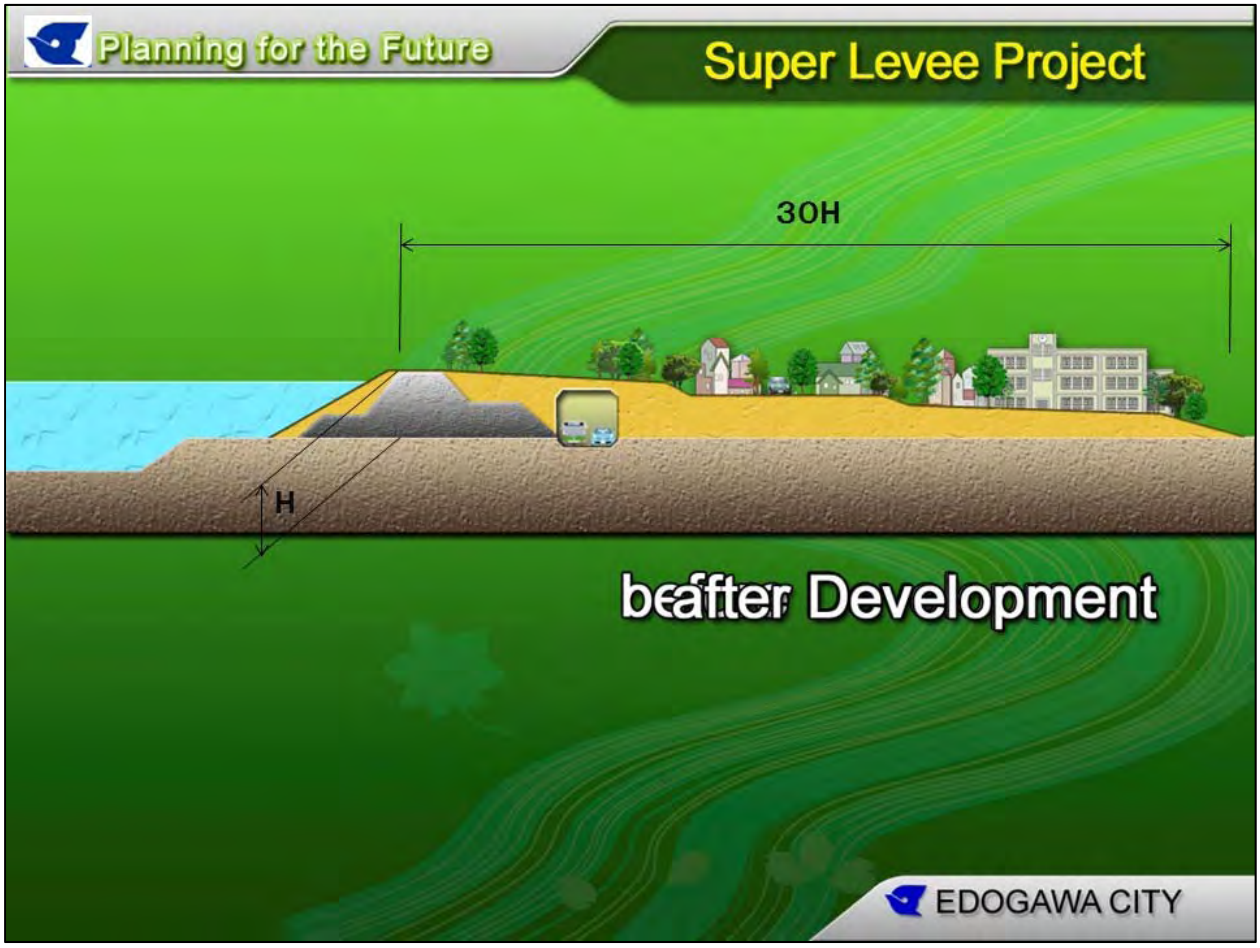

篠田堀親水緑道


小松川境川親水公園


「Shinodabori Shinsui Green Path」


Cleanup activities by
“Group of Lovers”




Planning for the Future
Super Levee Project
30H
H
beafter Development
EDOGAWA CITY


Enhancement of the Landscape
Area 65.6ha
Period 1980～2007
Plan population 26,000
Land Readjustment Project
in Komatsugawa Area
EDOGAWA CITY


109p
Thank you for your kind attention

New technical perspectives to break a positive path for the activities of river restoration in Korea

NEW TECHNICAL PERSPECTIVES TO BREAK A POSITIVE PATH FOR THE ACTIVITIES OF RIVER RESTORATION IN KOREA

KYUHO KIM (1)
(1): Director of the Green River Research Center

River Restoration has been become the center of public interest since early 1980s in the most of developed or developing countries and also Asian countries. It would certainly be helpful to improve our quality of life and earth environment damaged or deteriorated by the river development for economic activities during last 100 years. It's destined to restore the river and its ecosystem for biodiversity and sustainable environment in this lonely planet to hand down our next generations.

There have so far been implemented a number of river restoration projects in Korea, i.e., upgraded and changed revetments with bio- or natural materials, reach or channel scale restorations, a few river spatially restoration projects, and some removal of weir or dam for fish passage, etc. It's, however, not sure to say that how many projects have been accomplished in success compared to the basic river restoration principles and goals, objectives in detail.

Therefore, It would be a good opportunity to discuss and talk about our status and situations of river restoration works in Korea, whether it goes to more desirable ways, its effectiveness and realistic results, what we have done or not for the better or best river environments as we have intended or goaled, what we have really learned or not in the view of scientific and technological approaches or implementations, or what kinds of science and technology are necessary, etc..

New technical perspectives to break a positive path for the activities of river restoration in Korea

August 24, 2016

Kyuho Kim, Ph.D.
Director of the Green River Research Center
Advanced Water Management Program supported by KAIA and MOLIT
Korea Institute of Civil Engineering and Building Technology

1

Contents

I Introduction
II Status of River Restoration in Korea
III Technical Perspectives
IV New Approaches
V Suggestions

2

I. Introduction

I. The River Projects over the past 100 years

1. Public profitability by science, engineering, or developing activities

- Water use, flood control, hydropower generation, river improvement(nearly channelization in Asia), hydraulic structures such as dam and levee, revetment, weir, crossing structures, water intakes, etc.
- Inland navigation, channelization, land use occupied by riverfront parks

2. Reductions or damages of inherent river functions

- Disconnection of ecological passage or connectivity by barriers such as dam, culvert, levee, etc.
- Reduction of riverine habitat caused by floodplain & river improvement and development
- Deterioration of aquatic habitat & stream health by water detention and pollution
- Damage or disturbance of aquatic ecosystem and biodiversity by impoundment and channelization
- Decrease of river aesthetics, natural characters, active recreations, and amenity
- Increase the opportunity to approach and enjoy the river parks for passive reports or recreations

I. River Restoration Researches and Projects in Korea

Late 1980s	Introduction and public concerns of the river environment
1989 – 1994	International cooperation with Europe, America, or Japan
1991 – 1996	Introduction to overseas' river-environment techniques
1996 - 2001	Guidelines of stream restoration or close-to-nature river works
Aug. 1999	Amendment of river act (additional clause: river environment)
2000 - 2004	Guidelines for eco-friendly river management
2006 - Present	Restoration projects for ecological habitat, flood damage reduction, systematic river connectivity(primarily fishway)

- River improvement project for recreations
- Demonstration project (Gyeong stream)
- Cheonggye-cheon restoration project
- Four major rivers project

- Ecological urban river project
- Close-to-nature river improvement project
- Stream rehabilitation project

5

I. Basic Directions of River Restoration

- To make sure a naturally diverse and productive river basin system that is sustainable by natural ecological processes and managed to provide for compatible social, economic and cultural activities;
- To develop and promote a consecutive and successive science and technology to understand and predict the river system and its revolution processes according to the policy towards coexistence between nature and human;
- To make a general and diverse framework for river restoration based on the river basin scale including hierarchical structure and habitat, socioeconomic benefits to achieve economically and environmentally sustainable floodplain management.

6

I. Restoration of River and Ecosystem

- Consideration of river ecosystem (structure and function not only target species but also biodiversity)
- Longitudinal, lateral, and vertical connectivity based on river continuum concept for flow, habitat, movement, and physical dynamics in basin
- Dynamics and diversity of river and its floodplains / adaptation to climate change for flood mitigation and biodiversity
- Spatial and temporal river system in the river basin (not defined some area or some reaches)
- Multiple functions of river system (not single objective, cost-effective based socioeconomic decision-making processes)
- Take time to plan river restoration and monitoring(keep self-sustaining)

II. Status of River Restoration in Korea

II. Status of River Restoration in Korea

Turning point of river function to be considered in the mid-1990s

→ Before: focus on water use and flood control, floodplain development and land use

→ After: river environment to be harmonized with water use and flood control issues

Nature-friendly river environment, technique, and application

1991 - 1996	1998 - 2001	2001 - 2004
• Basic survey or test-bed, monitoring for river environment by KICT, etc.	• G7 Research Program • Nature-friendly river environment • Successful operation of test bed on reach scale	• Next generation core environmental tech. • Nature-friendly method based on previous study • Verification by experiment, monitoring

II. Status of River Restoration in Korea

2004 - 2008	2006 - 2011	2012 - 2018
• Stream connectivity and water quality by weir removal with out of function(Hantan, Gongnung stream etc.) • Change the artificial revetments by natural materials to enhance the river environments • Test-bed projects for close-to-nature river(Gyeongan stream)	• Ecoriver21 Research Program • Channel restoration considering ecological function • Basic approaches to restore the abandoned channel • Fish habitat survey, analysis, assessment, and restoration • Socioeconomic assessment or evaluation of the stream restoration projects	• Green River Research Program(now) • Basin restoration framework on channel-floodplain for flood, ecological, cultural, and socioeconomic studies to climate change • River environmental assessment and ecosystem connectivity • Improvement of ecological function and connectivity over the hydraulic structures

II. Status of River Restoration in Korea

First Mover?

Fast Followers

Considerations of Korean river styles and patterns

The introduction of technology from overseas

[Collapse of movable weir]

[River-bed degradation at Mankyunggyo]

[Ecological river project & damage and loss]

[Failure of grade control structure]

II. Status of River Restoration in Korea

First Mover?

Fast Followers

User-friendly river restoration

Guidelines of river restoration

Development of Korean river styles and patterns

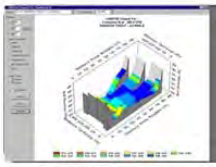
The introduction of technology

[Typical urban streams to be enhanced]

[Channelized tributary to be connected with main]

III. Technical Perspectives

III. Scientific and Technical Progress and Promotion

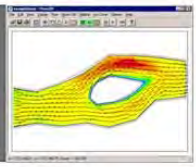


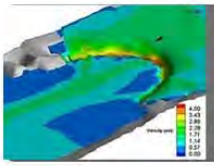
1D (Quasi 2D)

PHABSIM, HEC-RAS, SIMHAB
Abundant application case
Non-reflection of Microhabitat

2D

RIVER-2D, CASiMiR, CDG2D, RMA-2, CCHE2D
Depth Average Model
Reflection of Microhabitat





3D

CFX, FLUENT, FLOW-3D
Limitation of Spatial range
Calculation of Z-axis (direction of water depth)

1D Schematic & Basic design
Macrohabitat / Mesohabitat

2D Basic & Working design
Mesohabitat / Microhabitat

3D Construction design
Mesohabitat / Microhabitat

The answer for what

III. Technical Perspectives

Context of National Policy for River Basin

- Major government projects
- National midterm fiscal policy
- Science and technology basic plan
- Future of science and technology 2040
- Water vision 2020
- Long-term plan of MOLIT
- International cooperation for global improvement of environmental quality

Future technology for river restoration

- Creation technology of sustainable ecological river
- Rehabilitation of river area and application of riverfront
- Creation of river amenity
- Ecological river convergence technology for management

Realization of sustainable ecological river system towards coexistence between nature and human in local, national, regional, and international connections

III. Technical Perspectives

Research fields	Global, national-level technologies to be needed	Technologies to be likely converged
Survey of river environment & Evaluation	▪ River-environment information acquisition and management system for the river basin scale	▪ High resolution image analysis on ecotopes or habitat along the river corridor and floodplain
River restoration planning and technical design	▪ River restoration framework ▪ Ecological restoration planning ▪ Prediction of river ecosystem considering climate change	▪ Selection of target species or community in consideration of historical changes and revolutions of each rivers
Improvement of water quality	▪ Water purification in impounded channel or riverine wetlands	▪ Wetland restoration for water quality improvement or pesticide mitigation
Management and monitoring	▪ Monitoring and evaluation of river restoration project in systematic approaches ▪ Adaptive management of river restoration project	▪ Adaptive management to be more natural processes and evolutions
Humanities and social sciences	▪ Ecological concept and design with public and experts ▪ Evaluation of social impacts and contributions	▪ River history, culture conservation, public welfare, well-being ▪ Coexistence between human and riverine nature

III. Technical Perspectives

Research fields		Global, national-level technologies to be needed	Technologies to be likely converged
Integrated River Basin Management	Control of sediment runoff or delivery	▪ Prediction of sediment in watershed ▪ Stable channel design of small and medium-sized stream and river	▪ Channel restoration degraded riverbed after dredging and blocking sediment and flow
	Restoration of habitat function to extend from channel to floodplain	▪ Improvement related with biological habitat and water quality ▪ Restoration of river habitat at backwater area in large-scale river	▪ To make sure the positive roles of prosperous vegetation covered along the river
	Connection between aquatic and terrestrial ecosystem (lateral connectivity)	▪ Management of hyporheic zone ▪ Middle dam removal and channel restoration for barrier-free ▪ Secure of ecological passage	▪ Connectivity in the degrading river-bed between main and tributary channels
	Recovery of endangered and migratory species	▪ Habitat restoration for intercontinental migratory birds or related species	▪ North-East migratory birds in the river and tidal flats for coastal and estuarine ecosystems
	Channel or hydraulic structure enhancement of ecological function	▪ Bio-material for hydraulic structures ▪ Eco-friendly bank protection ▪ Grade control structure ▪ Fish or vertebrates' screening facilities	▪ River experiment and development of numerical simulation ▪ Biomaterial instead for artificial or natural stone or gravel from river

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IV. New Approaches

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IV. New Approaches

Application of international goals, standards, protocols, and agendas with the respective differences having been considered

- Agenda21 and others (UNCED, 1992; WHO, 2010; OECD, 2005, 2012)
- To cooperate with practical information about environmental assessment, objective and reliable environmental policies

International cooperation

- Unified appraisal standards, frameworks, and programs for river basin management
- Water Vision 2020: Green infrastructure and river restoration through international cooperation with human resources, national or international issues

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IV. New Approaches

Life-cycle management of river restoration sciences and technologies merged with high technology by the scientific evidences and verifications

- Emerging technology with ICT
- Application of such as an UAV (unmanned aerial vehicle) for river basin changes, and its ecological responses monitoring and evaluation, etc.

Systematic approaches to climate change, geomorphological, physical, biological, chemical, and cultural attributes in the basin scale

Convergence science and technology between human culture and river functions according to the past, present, and future needs

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IV. New Approaches

Multi-Dimensional River Basin Restoration(Temporal, Spatial, and Functional Interactions)

Past

- To evaluate and utilize areas for multi-dimensional function of natural river system and its function along the hydromorphic active-river area

Present

- Geomorphological, hydrological, and biological changes through river development/channelizati
- Abandoned, isolated floodplains and land use changes through hydrmorphological barriers

Future

- Hydrological recovery after regulated rivers and streams
- Hydromorphological reconnection of channe and floodplains for bio-safe policies

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V. Suggestions

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IV. Suggestions

- Social and scientific prediction of socioeconomic impacts, and values, services of river environments between nature and human in the river (or basin) restoration project by following more cost-effective policies and self-sustaining river processes.
- Make a river basin restoration framework considering of multi-functional analysis and planning processes for flood damage mitigation, ecosystem and its habitat recovery, water quality improvement, and historical cultures and amenities, etc. (i.e., IRBM)
- Analysis and assessment to give a priority of habitable area, such as biotope, ecotope or habitat before and after hydromorphological alteration to recover the geomorphological structure of physical and biological interacting between channel and floodplain or inland wetlands.

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IV. Suggestions

- Removal or improvement the lateral or longitudinal barrier of ecosystem and its connectivity by barrier-free analysis and assessment, planning, design, and implementation for migratory species(fish or bird) of aquatic organisms in the river basin
- Estimation and management of environmental flow or natural flow in regulated rivers related with dam operation by hydrological and biological processes or connectivity in the spatial and temporal nature's variations
- Upgrading the ecological roles and functions of riverine infrastructure or hydraulic structures through the physical, biological, cultural and hydromorphological improvements

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KICT KOREA INSTITUTE of CIVIL ENGINEERING and BIOMECHANICS

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생태하천 조성기술개발 연구단

Thank you for your attention.

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Adaptive management for ecosystems restoration in Haihe Basin

ADAPTIVE MANAGEMENT FOR ECOSYSTEMS RESTORATION IN HAIHE BASIN

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Climate change will affect ecosystems through a number of mechanisms, involve a spectrum of human–climate–environment interactions, so policy and management for ecosystems conservation and restoration should be adapted to mitigate the impacts. As uncertainties are associated with specific areas vulnerable to climate change, a comprehensive study is necessary to clarify the linkages between ecosystems and climate, to improve understanding of the responses of ecosystems to climate change, which is the basis of management adaptation. Based on the background of Haihe basin, a complex system consists of mountain area, plain rivers, wetlands and estuary in the north of China, a regional scales study is carried out for the formulation of adaptive management strategies on the resilience of ecosystems under scenarios of climate change. The study closely linked with ecological water quantity and quality of seasonal rivers.

Through data analysis and models verification, environmental changes, trends and their effects on ecosystems are introduced, vulnerability analysis to climate change is done to identify future priorities, a brief overview of regional restoration planning efforts is given and restoration needs and techniques in the design, planning, and regulatory operation are discussed. The preliminary research results have been applied to the planning and management of water resources and flood control practice to reflect the impacts assessment of climate change.

Adaptive Management for Ecosystems Restoration in Haihe Basin

Institute of Water Resources and Hydropower Research

(IWHR)

2016.8

Background

Based on the background of Haihe basin, a complex system consists of mountain area, plain rivers, wetlands and estuary in the north of China, a regional scales study is carried out for the formulation of adaptive management strategies on the resilience of ecosystems under scenarios of climate change. The study closely linked with ecological water quantity and quality of seasonal rivers.

Background

As uncertainties are associated with specific areas vulnerable to climate change, a comprehensive study is done to clarify the linkages between ecosystems and climate, to improve understanding of the responses of ecosystems to climate change.

A brief overview of regional restoration planning efforts is given and restoration needs and techniques in the design, planning, and regulatory operation are discussed.

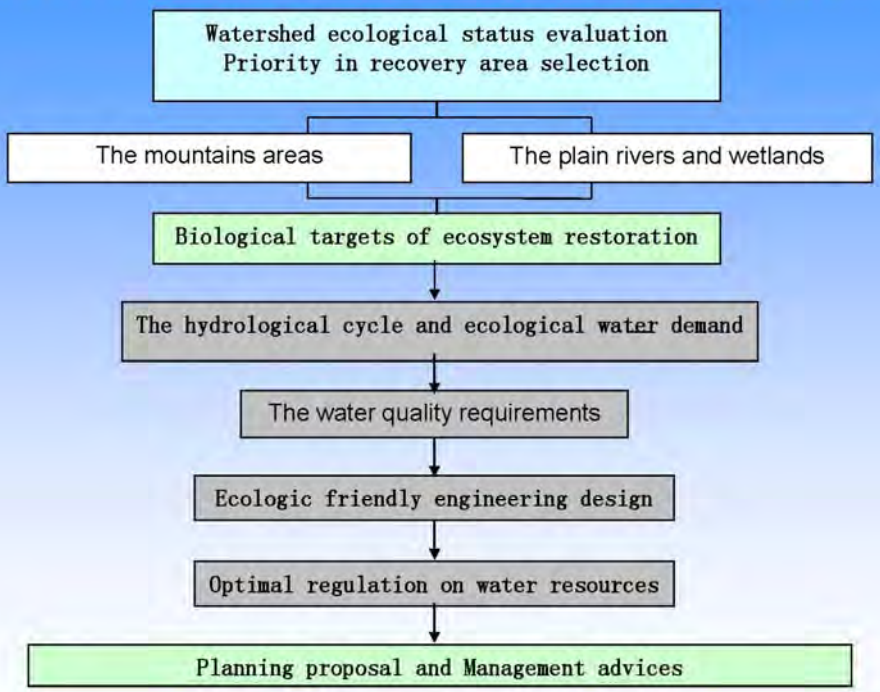
Objects

1. Basin scale investigation and evaluation of present ecological situation
2. Ecological-functional zone division
3. Ecological restoration objectives under the restriction of water supply
4. Ecological water demand estimation
5. Restoration technology
6. Formulating the strategies and adaptive management

Contents

- Ecological system structure analysis and function evaluation
- Water ecosystem restoration priority sequence
- Urban river ecological restoration technology
- Estuarine wetland ecological restoration technology
- Groundwater recharge technology
- Water pollution treatment technology
- Reservoir eutrophication control technology
- Impulse ecological water supply
- Ecological benefits review
- Possible ways of adaptive management and feasibility

Technical Route

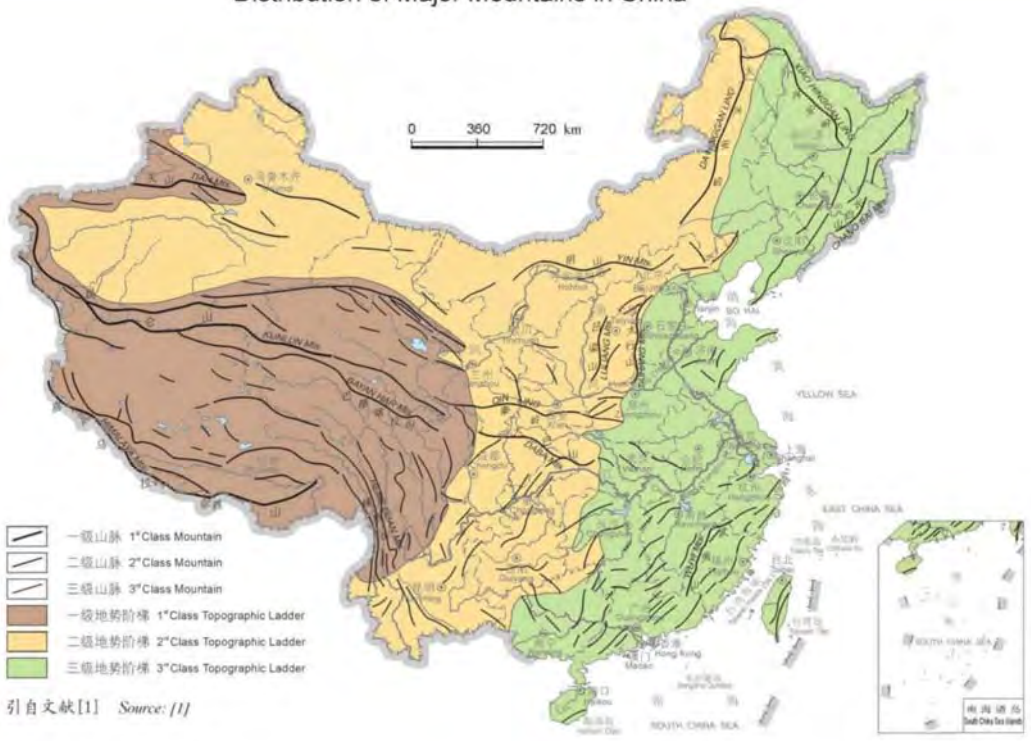


北方农牧交错带在中国的位置
Position of Farming-pastoral Zone of Northern China

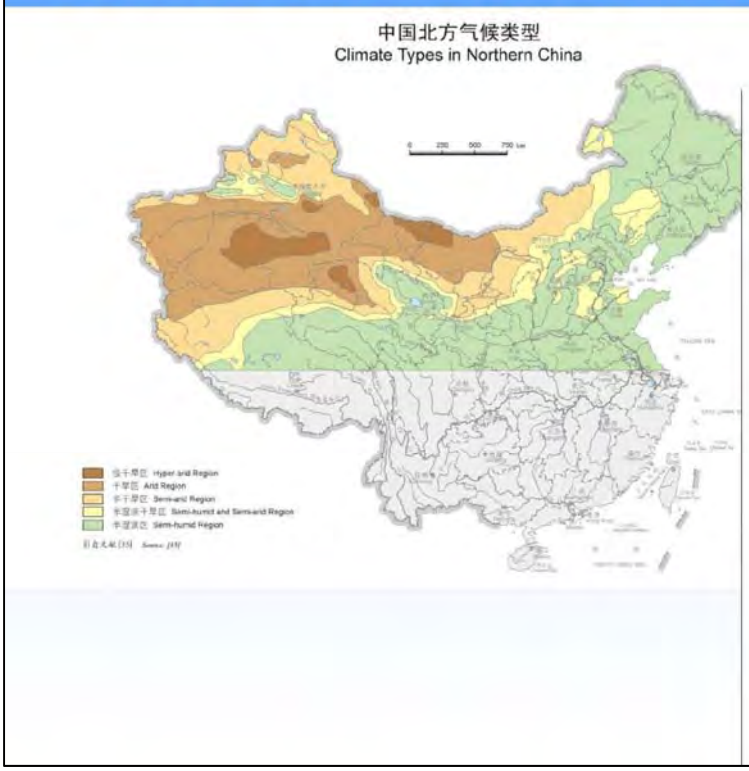
Ecological background analysis

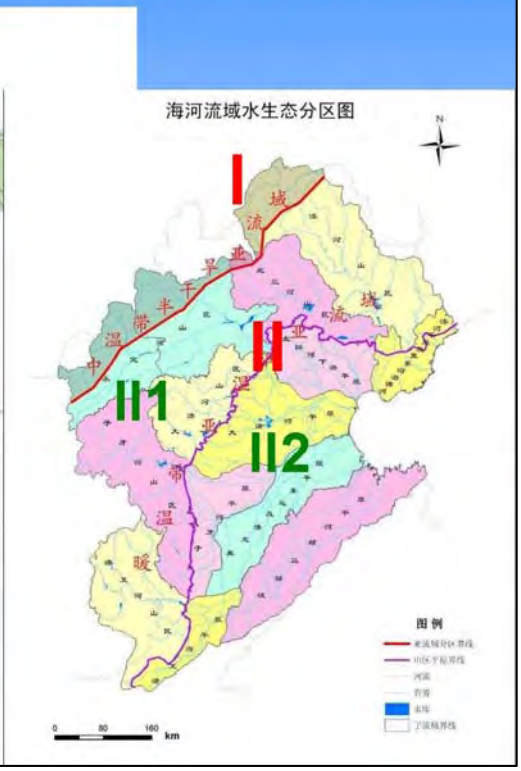
Division and rivers classification

中国山地分布
Distribution of Major Mountains in China



Ecological background analysis
Division and rivers classification

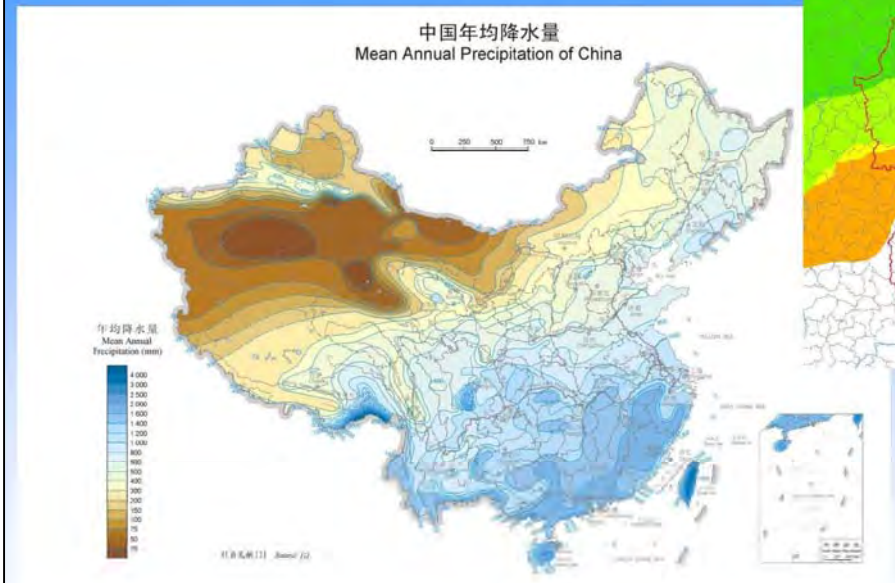


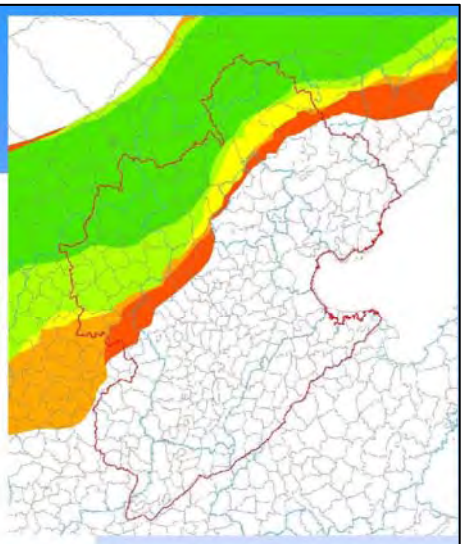


Ecological background analysis
Division and rivers classification

- According to the hydro-thermal factors，The Haihe river basin is divided into two biome
  - I Mid temperate zone semi-arid grassland biome
  - II Warm temperate zone sub-humid broadleaved deciduous forest biome
- According to the topography，Warm temperate zone II is divided into 2 ecological subregions
  - II1 Mountain ecological subregions
  - II2 Plain ecological subregions

Climate change

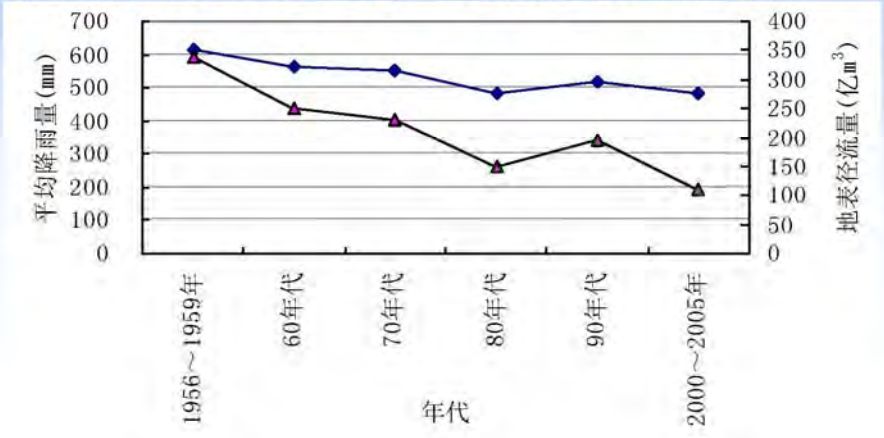




Through data analysis and models verification, environmental changes, trends and their effects on ecosystems are clarified.

Climate change

- Over the past 40 years, 450 mm rainfall isoline moved 45km-200km to the southeast,
- Area of region less than 450 mm of precipitation increased by 1.3 times, one third of the basin area
- Total precipitation decrease 21%, volume of runoff decrease 67%。

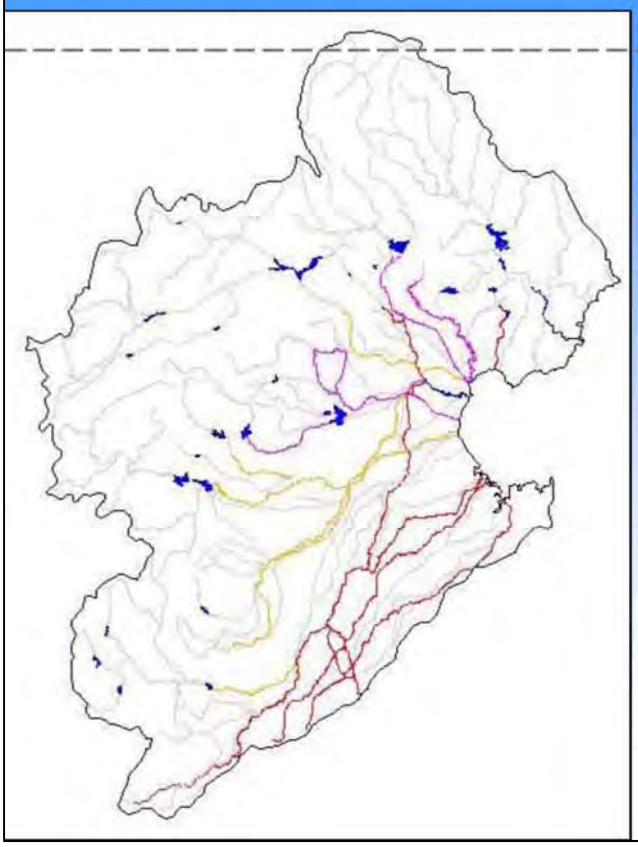


Rivers Classification

Sub basin type of Haihe basin

No	Originated in leeward slope	No	Originated in windward slope or plain
1	ZangweiRiver	1	Tuhaimajia River
2	Zhiya River	2	Heilong Harbor Channel
3	Yongding River	3	Daqint River
4	Luan River	4	North Three River

Plain river divided into three kinds of sewage, block and drying



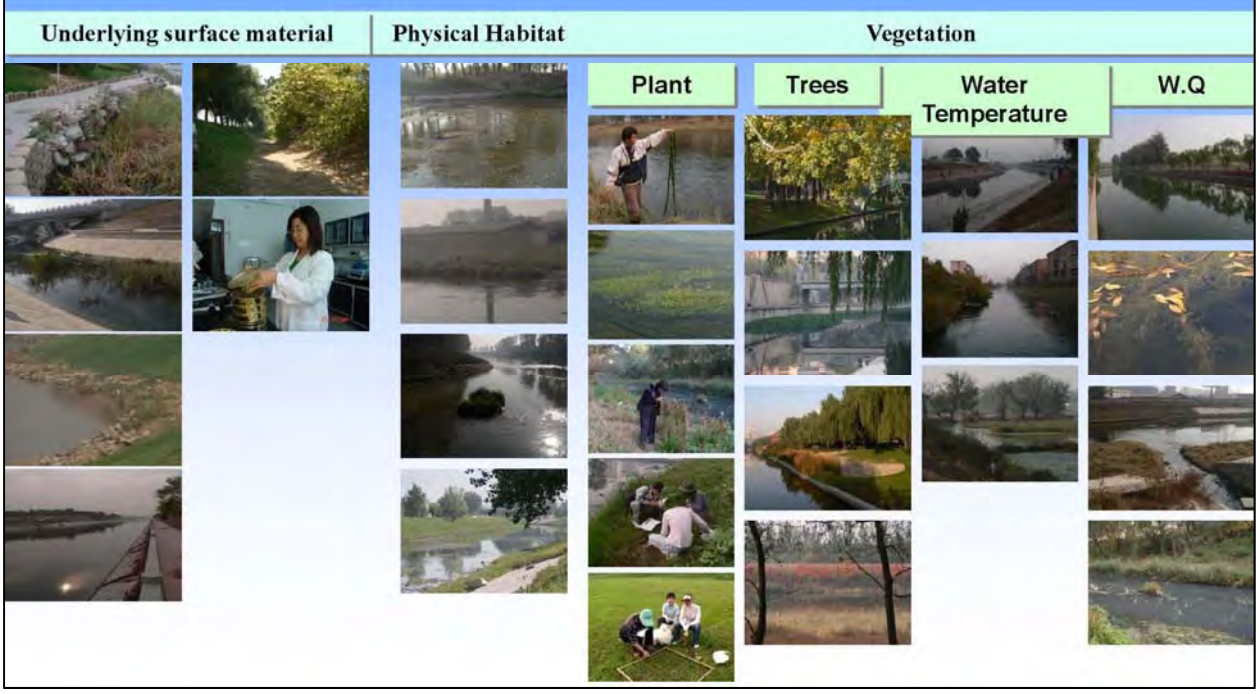
海河流域平原重点河流分类

序号	河流名称	现状	控制站	年平均流量 (m3/s)	水质
1	漳河	全年有水	漳县	89.3	III
2	海河干流	全年有水	耳闸		>V
3	陡河	全年有污水	陡河水库	1.86	>V
4	北运河	全年有污水	通州	15.1	>V
5	卫河	全年有污水	元村	22.5	>V
6	卫运河	全年有污水	北河店	6.79	>V
7	漳卫新河	全年有污水	四女寺	4.14	>V
8	马颊河	全年有污水	大道王	6.44	>V
9	徒骇河	全年有污水	二十里铺	17.9	>V
10	唐河	断流，汛期、灌期有水	西大洋	11.4	III, >V
11	潮白河	断流，汛期有水	苏庄	3.59	III, >V
12	黄运河	断流，汛期有水	九王庄	18.9	>V
13	南拒马河	断流，汛期有水	北河店	1.47	III, >V
14	白沟河	断流，汛期有水	东茨村	2.93	>V
15	南运河	干涸	四女寺		
16	子牙河	干涸	献县		
17	滹龙河	干涸	北郭村		
18	溢阳河	干涸	艾辛庄		
19	滹河	干涸	观台	风沙	
20	永定河	干涸	卢沟桥	风沙	
21	滹沱河	干涸	黄壁庄水库	风沙	

Reach scale ecological classification - Indicator

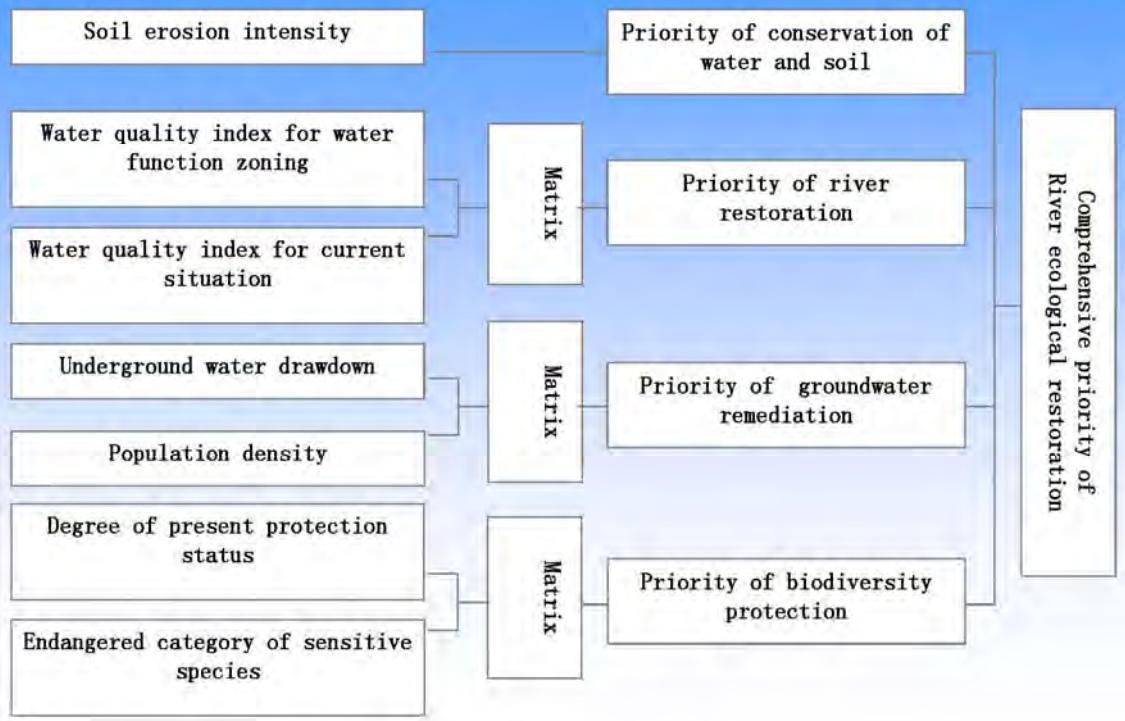
Underlying surface material	Physical Habitat	Vegetation
Streambed substrate Particle size index	Index of flow regime	Riparian vegetation structural index
Fixed Bed Sample percentage	Dominant flow pattern	总树分
Bank substrate Particle size index	Number of nature forms Bank	总树特征分
Fixed Banks Sample percentage	Ratio of nature forms bank	Number of River vegetation type
Ratio of bank protection	Number of artificial riverbank	Dominant vegetation type
Ratio of biodegradable bank	Ratio of artificial riverbank	Average coverage of River vegetation
Ratio of bare substrate bank	Number of natural habitat Type	总污染分
Ratio of fixedbank		Number of sewage pipe
Degree of bank protection and durability		Number of Drop points
		Water temperature

Rivers Classification



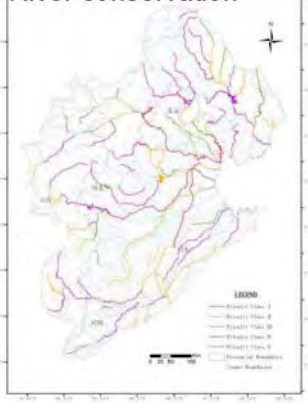
Ecological classification of urban river in Beijing

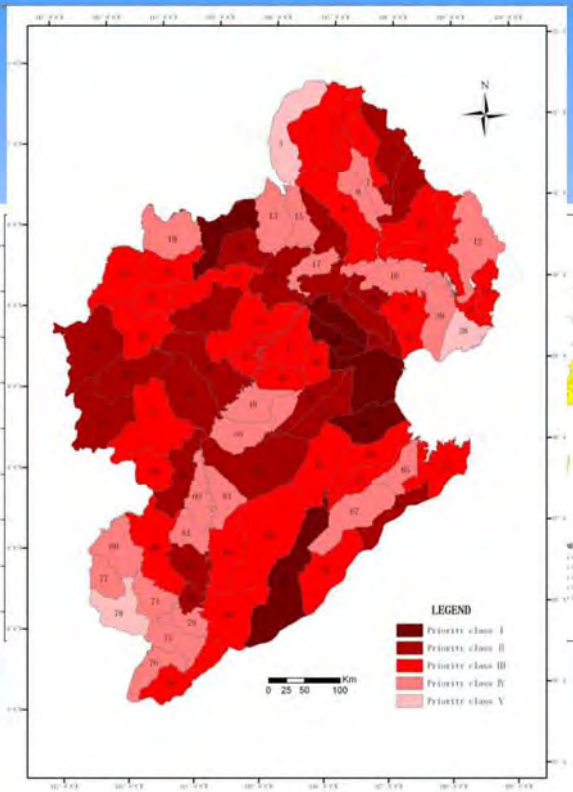
Priority sequence determination



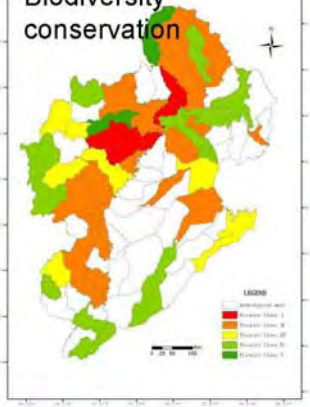
Priority sequence determination

River conservation





Biodiversity conservation



Rivers Classification

海河流域重点保护的河流湿地

序号	名称	保护对象	保护级别	序号	名称	保护对象	保护级别
京1	密云水库湿地保护区		申报国家级	冀1	白洋淀	湿地生态系统 丹顶鹤、大鸨、金雕等	省级
京2	野鸭湖湿地保护区	湿地候鸟及湿地生态系统	争取国家级	冀2	大浪淀	鸟类	市级
京3	潮白河湿地保护区		争取国家级	冀3	海兴县湿地	鸟类	市级
京4	杨植苇塘湿地保护区		市级	冀4	黄骅市湿地	鸟类	市级
京5	三家店湿地保护区		市级	冀5	沧州市白洋淀	鸟类	市级
京6	金海湖湿地保护区		市级	冀6	南大港	白鹤、黑鹤、丹顶鹤、白肩雕，湿地生态系统、鸟类	省级
京7	鹰沟湿地保护区	候鸟	市级	冀7	衡水湖	湿地生态系统及鸟类	国家级
京8	拒马河湿地保护区（十渡）	大鲵	市级	冀8	闪电河湿地自然保护区	湿地生态系统	国家级
京9	怀沙怀九河湿地保护区	大鲵	市级	冀9	滦渡河自然保护区	野生动物、湿地、水源涵养	国家级
京10	白河堡水库湿地保护区		县级	冀10	官厅水库水源涵养林及湿地保护区	湿地、水源涵养林	国家级
京11	金牛湖湿地保护区	鸟类及其生境	县级	冀11	西大洋-王快水资源保护区	水源涵养林	国家级
京12	龙庆峡湿地保护区		县级	冀12	滦河河口湿地自然保护区	湿地、迁徙鸟类	国家级
京13	永定河湿地保护区			冀13	北戴河海底鸟类	候鸟 丹顶鹤、大鸨、天鹅等	县级
津4	北大港	古泥湖湿地生态系统、珍稀候鸟	市级	冀14	廊海湿地自然保护区	湿地生态系统	国家级
津5	古海岸与湿地	贝壳堤、牡蛎滩古海岸遗迹及渤海湿地生态系	国家级	冀15	黄骅市湿地与鸟类自然保护区	湿地生态系统	国家级
津6	东丽湖	水生生态及水生生物	市级	冀16	隆化茅荨钢	湿地珍禽候鸟及水生野生动植物，森林生态系统	省级
晋1	桑干河	迁徙水禽及其生境	省级	鲁	霸王河	水域生态系统及水源	县级
晋2	恢复河源头	森林生态系统、景源	省级				

Focus on rare species habitat and zone of abundant biodiversity, total of 38 important rivers, wetlands having protection value：
Beijing 13,
Tianjin 3,
Hebei 16,
Shanxi 2,
Inner Mongolia 1

Ecological Restoration Objectives

Principles for the determination of ecological restoration objectives based on :

- The present condition of the precipitation and trend
- Ecological water supply capacity
- Integration of biology, water quantity, water quality, and hydrological cycle water power

Biological object

Reduce sources of pollution ,Groundwater recharge standard reach Class **III.**
Restore shore land vegetation and submerged plants, Build the foundation of river ecological system, Plants and invertebrates shift from the stain resistance into a common species.

- In the near future，replace water with green plant to cover the riverbed.
- Mid-Term，Local forming marsh wetland，flood and drought resistance grass be the dominated species,
- Forward， trickle form in the river, and emergent aquatic plants be the dominated species, invertebrates appear

Water quality target

Ecological water demand estimation

River ecological water demand = Ecological base flow + Evaporation loss + Seepage loss

Wetland ecological water demand = Evaporation loss + Seepage loss

The total amount of ecological river base flow : Dry year runoff in 70s

Inter-monthly allocation proportion of Ecological river base flow

— IHA method were adopted for the 17 rivers with fully data

— Tennant method were adopted for the 4 rivers without fully data

Inter-monthly evaporation loss: remote sensing

River seepage quantity: empirical formula for channel leakage recharge of groundwater

The seepage quantity of wetland: 3mm/d

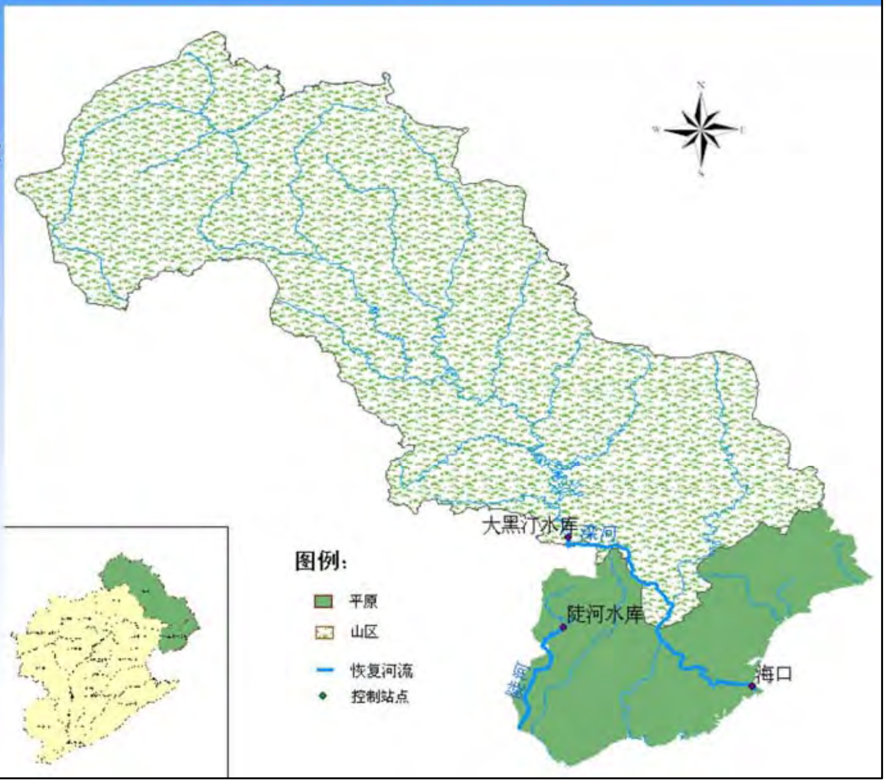
Ecological water demand

Luan River and coastal rivers system

Ecological water demand: 0.971billion m3/yr

River loss:: 0.17 billion m3/yr

Sea outflow : 0.80 billion m3/yr



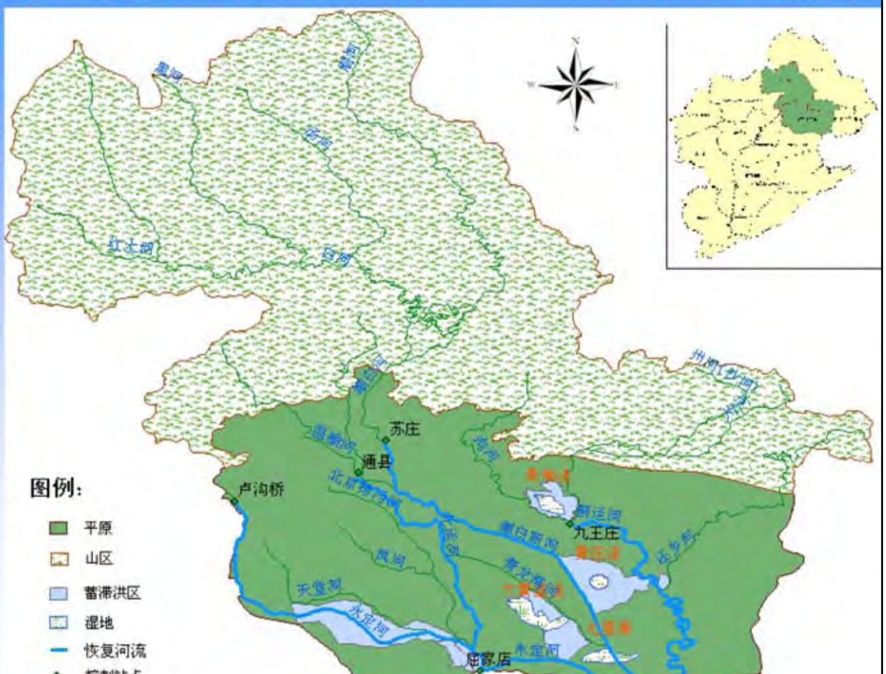
Ecological water demand

The North Four River

Ecological water demand: 1.5 billion m3/yr

River loss: 0.34 billion m3/yr

Sea outflow : 0.74 billion m3/yr



Ecological water demand

Daqing River

Ecological water demand:
0.76 billion m3/yr

River loss:
0.13 billion m3/yr

Wetlands water demand:
(Baiyangdian etc.)
0.72 billion m3/yr

No sea outflow

Ecological water demand

Zhiya River

Ecological water demand:
0.81 billion m3/yr

River loss:
0.37 billion m3/yr

Wetlands water demand:
0.12 billion m3/yr

Sea outflow :
0.32 billion m3/yr

Ecological water demand

Zhangweinan channel system

Ecological water demand:
1.2 billion m3/yr

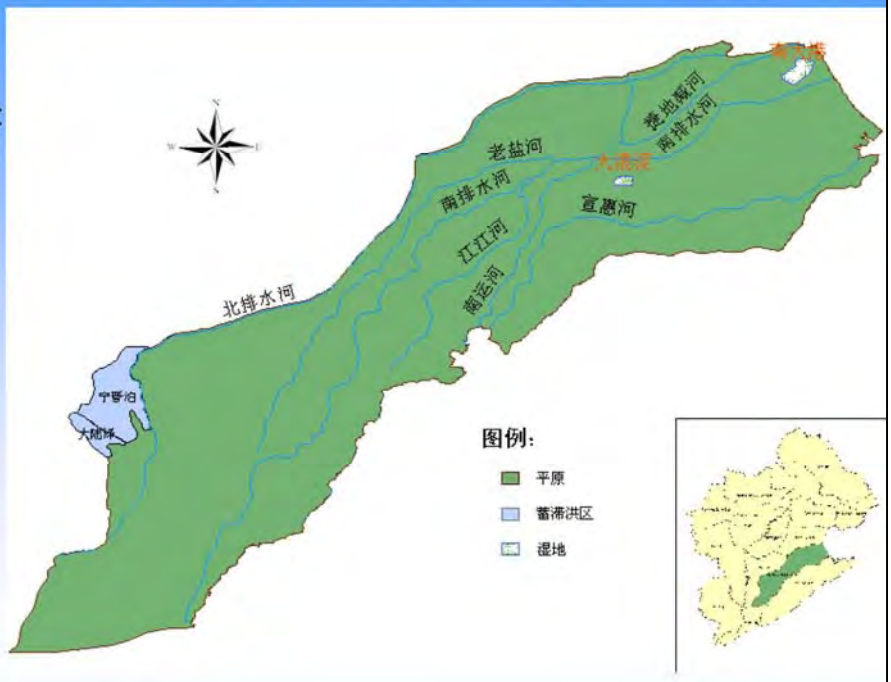
River loss:
0.61 billion m3/yr

Sea outflow :
0.58 billion m3/yr

Ecological water demand

Heilong harbor wetland

Ecological water demand:
0.13 billion m3/yr



Ecological water demand

Tuhaimajia River

Ecological water demand:
0.33 billion m3/yr

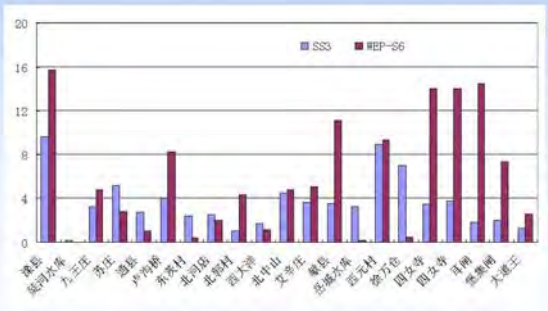
River loss :
0.22 billion m3/yr

Wetlands water demand:
0.07 billion m3/yr

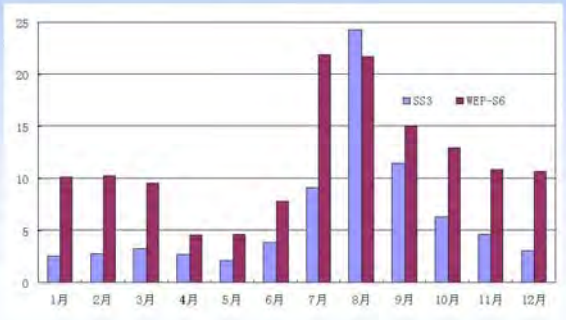
Sea outflow :
0.10 billion m3/yr

Water allocation

Ecological water demand for Haihe basin is 5.61billion m3/yr, Under present condition, only three rivers have enough runoff ,
A water deficit of additional 2.95 billion cubic meter is needed to satisfy the ecological water demand on basin scale.

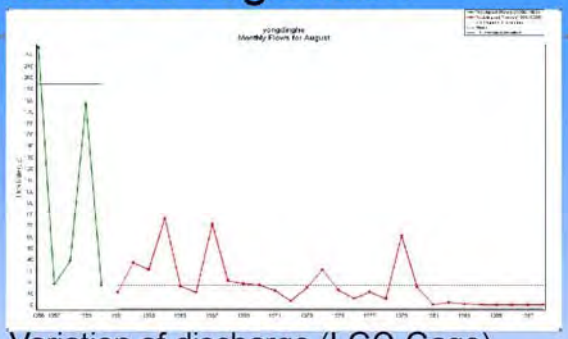


2020a 13 river YES， 8 river NO

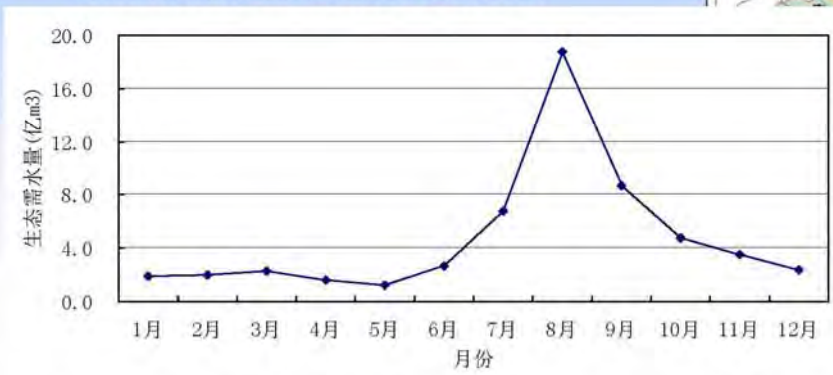


Monthly compare

Reservoir regulation



Variation of discharge (LGQ Gage) before and after dam construction



Recommended regulation schedull of Guanting reservoir in Yongding River

Ecologic Regulation

Maintain stable base flow in springtime,

Increase the flood frequency in summer.

Qing River 23km, 9 regulating sluices

Ecological Restoration Technology

Qing River 2006

Qing River 2009

Liangshui River 2005

Liangshui River 2008

Ecological Restoration Technology

Construct artificial bifurcation, connected by-pass wetland

Main Conclusions

1. The decrease of precipitation caused by global climate change and rapid development in Haihe Basin have leads to the shortage of water resources, deterioration of water quality and ecological degradation, enforced strict management is the key strategy.
2. Stage ecological restoration targets are proposed for different water body,include water quality targets and biological object.

Main Conclusions

3. Ecological water demand including environmental flow, evaporation loss and seepage loss. To implement the ecological restoration and achieve the long-term goals ,runoff should recover to the dry years in 70s.
4. 5.61 billion cubic meter water is demanded for the 21 rivers and 12 wetlands ecological restoration, 2.95 billion cubic meter deficit.
5. The deficit of whole basin ecological demand water can only be satisfied by optimum operation of hyudraulic projects and spatio-temporal optimum allocation of distributable resource.

Main Conclusions

6. Climate change will affect ecosystems through a number of mechanisms, policy and management for ecosystems conservation and restoration should be adapted to mitigate the impacts.
7. Constrainted by water supply, a single purpose approach can not confront the challenge of ecological crisis.
8. For management and policy making, an intergrated step by step solution to reach the target of restoration is an reasonable alternative.

THANKS For YOUR ATTENTION