Climate Change, Adaptation and its Implementation for Food and Water Security

- Cases of South Korea -

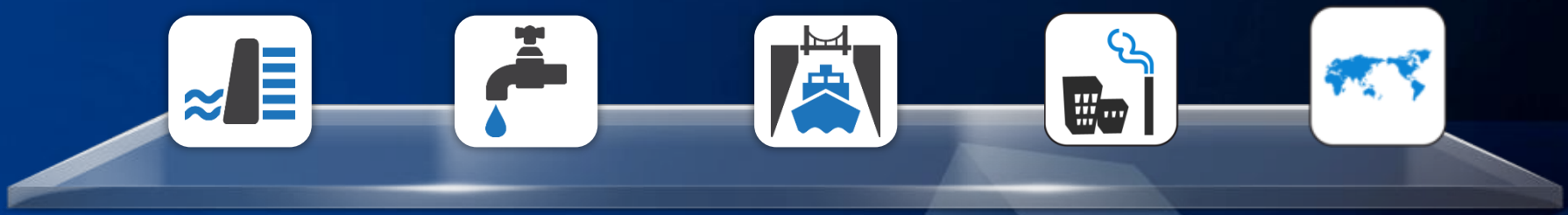
Dr. Han-Goo LEE

K-water

State owned Water Resources Corporation

Total Water Service Provider

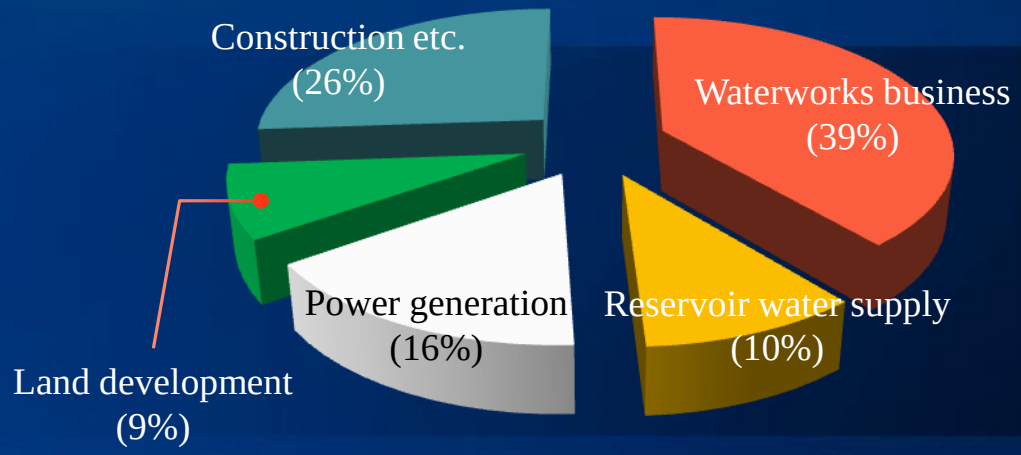
(national level planning ~ construction ~ O&M)



Water resources C & M	Waterworks C & M	River R & M	Land Development	Overseas Business
32 dams in operation 5 under construction Total storage 16 bil. m^3	33 facilities 18 mil. m^3/day 20 mil. customers	River restoration($7.1 bil.) Waterway($2.0 bil.)	7 cities 88,551 km^2 Since 1974($ 21 bil.)	35 projects(20 countries) 17 projects on going Total solution providing

K-water Budgets (2011)

Total $ 2.1 bil.



Capital	: $	9.7 bil.
Net income	: $	262 mil.
R&D expenditure	: $	83 mil.
Credit rating(2010)	: A / A1 / A+	

S&P / Moody's/ R&I

Contents

Ⅰ. Water Resources in Korea

Annual Rainfall & Water per Capita

Annual Rainfall : Global 1.6 times

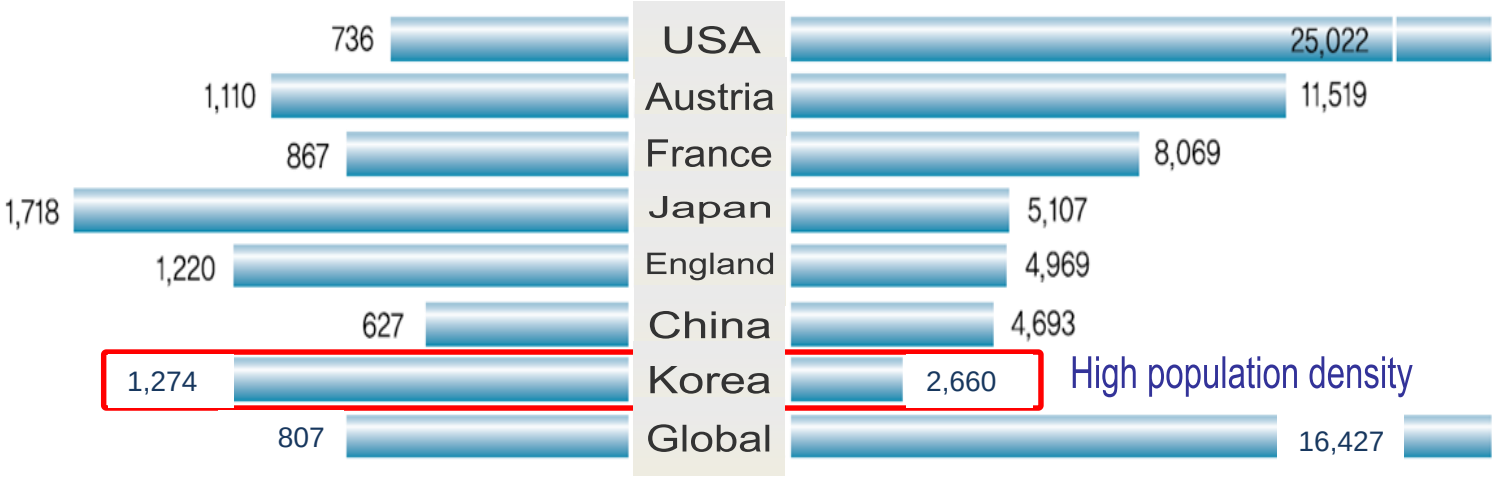
Korea 1,274㎜

Global 807㎜

Water per Capita : Global 1/6 times

Korea 2,660㎥/yr

Global 16,427㎥/yr



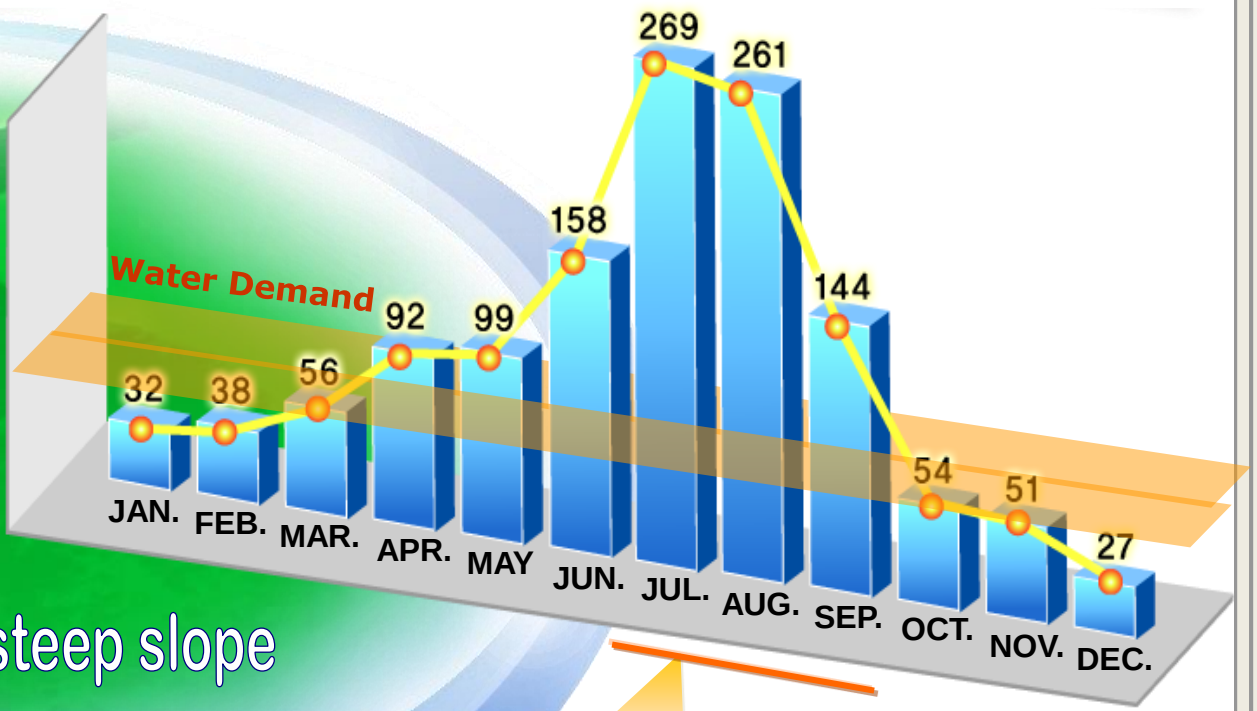
Monthly Rainfall & Geographical Features

Monthly Rain & Geographical Features

KOREA's LAND

65%

mountainous with steep slope



2/3 of annual precipitation : July ~ September

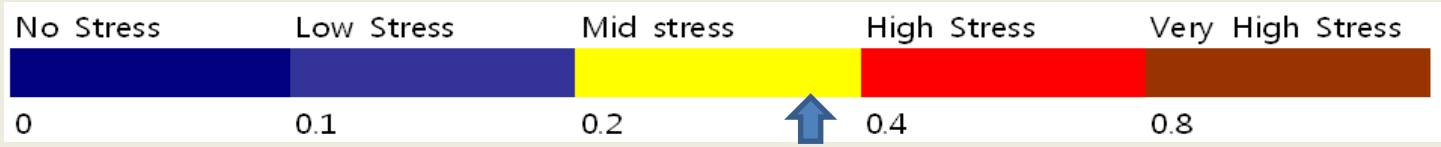
Water Use Conditions

1) Water Res. Available /capita/year (1,493㎥) : 129th in the World

2) Water Poverty Index : 43th in the Worlds

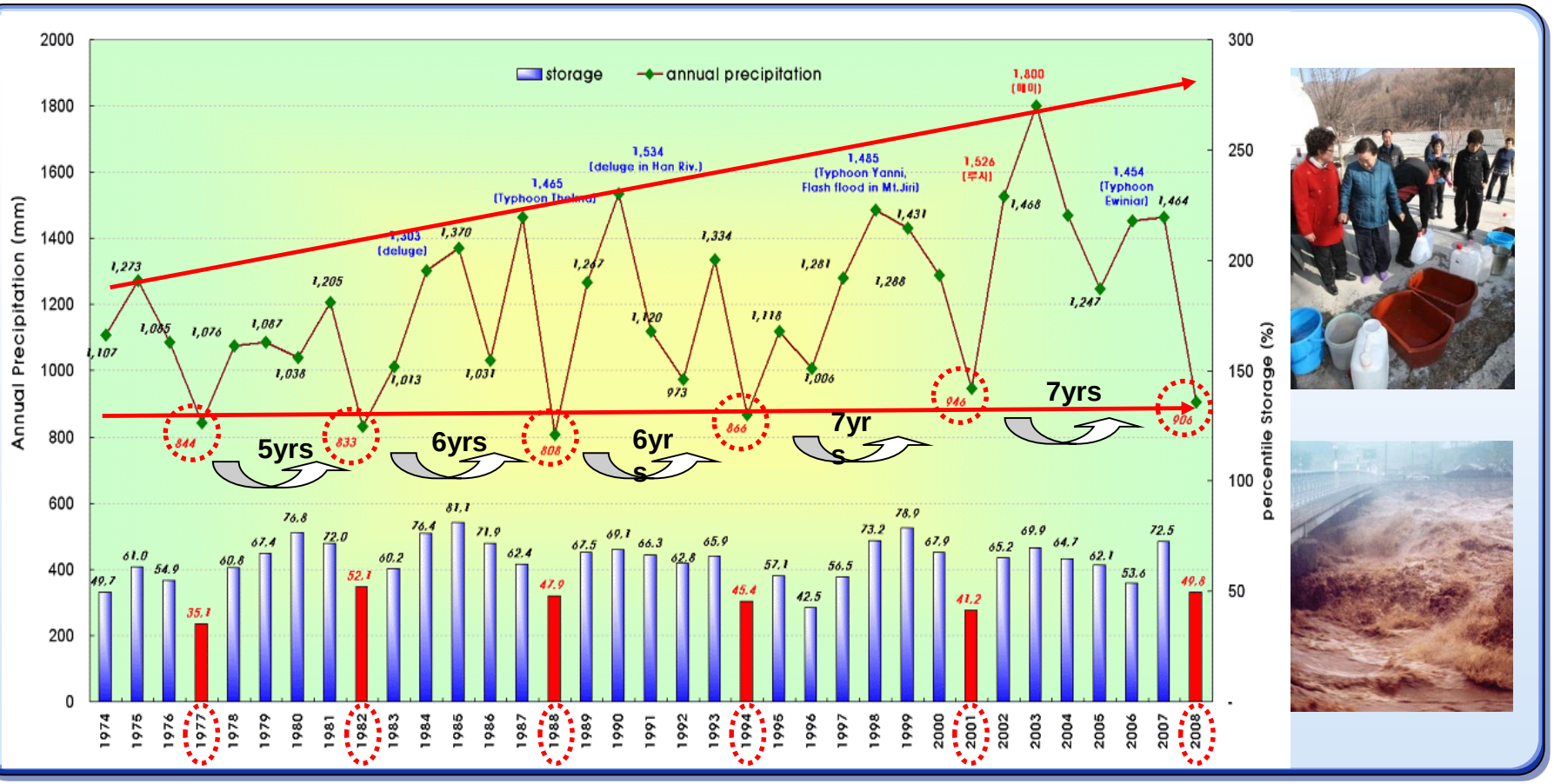
- 5 elements : Wat. Res /capita, Water Consumption, Economy, Environment, Easy Access to Water Use

3) Water Use Stress (= water use / water res. available) : 36%



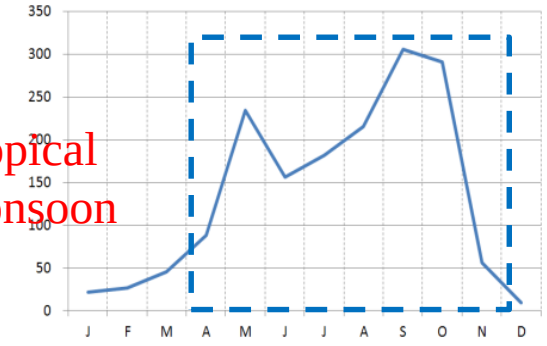
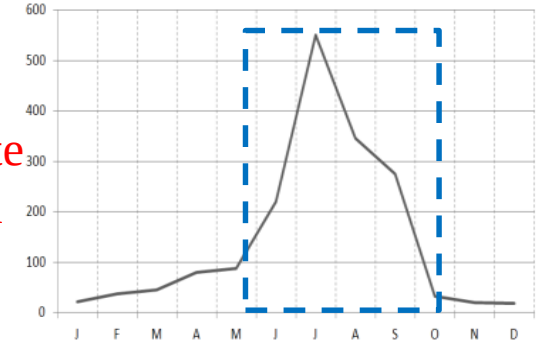
4) Water Budget Analysis : water shortage (1.0 billion m^3 in 2016)

Polarization in water resources



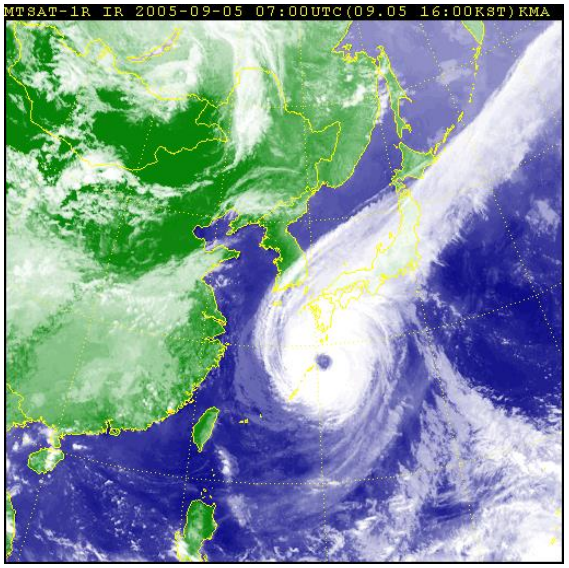
- 5~7 year drought frequency since 1970
- the yearly precipitation clearly increasing

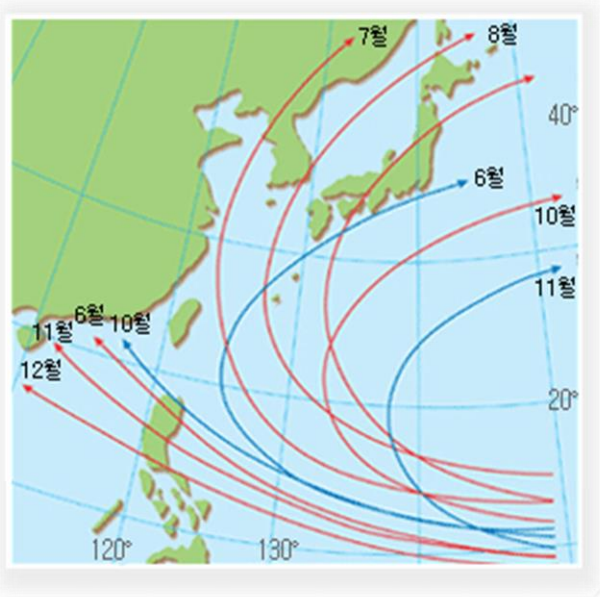
Hydrological Features of Chao Phraya & Han Riv.

Basin Area		Chao Phraya : 157,924 Km^2	Han River : 34,402 Km^2
Climate	Monthly Rain	Tropical Monsoon 	Temperate Monsoon 
	Annual Rain	1,631 mm (1981 ~ 2010)	1,450 mm (1981 ~ 2010)
Daily Max Rainfall		340 mm/day (1965)	332 mm/day (1998)
Coefficient of River Regime (MaxQ/Min Q)		52	250

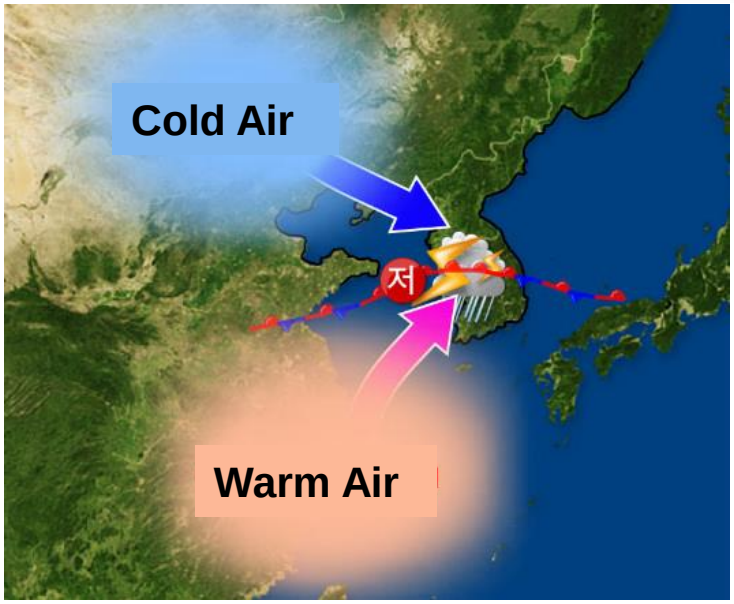
Hydrological Features of Korea

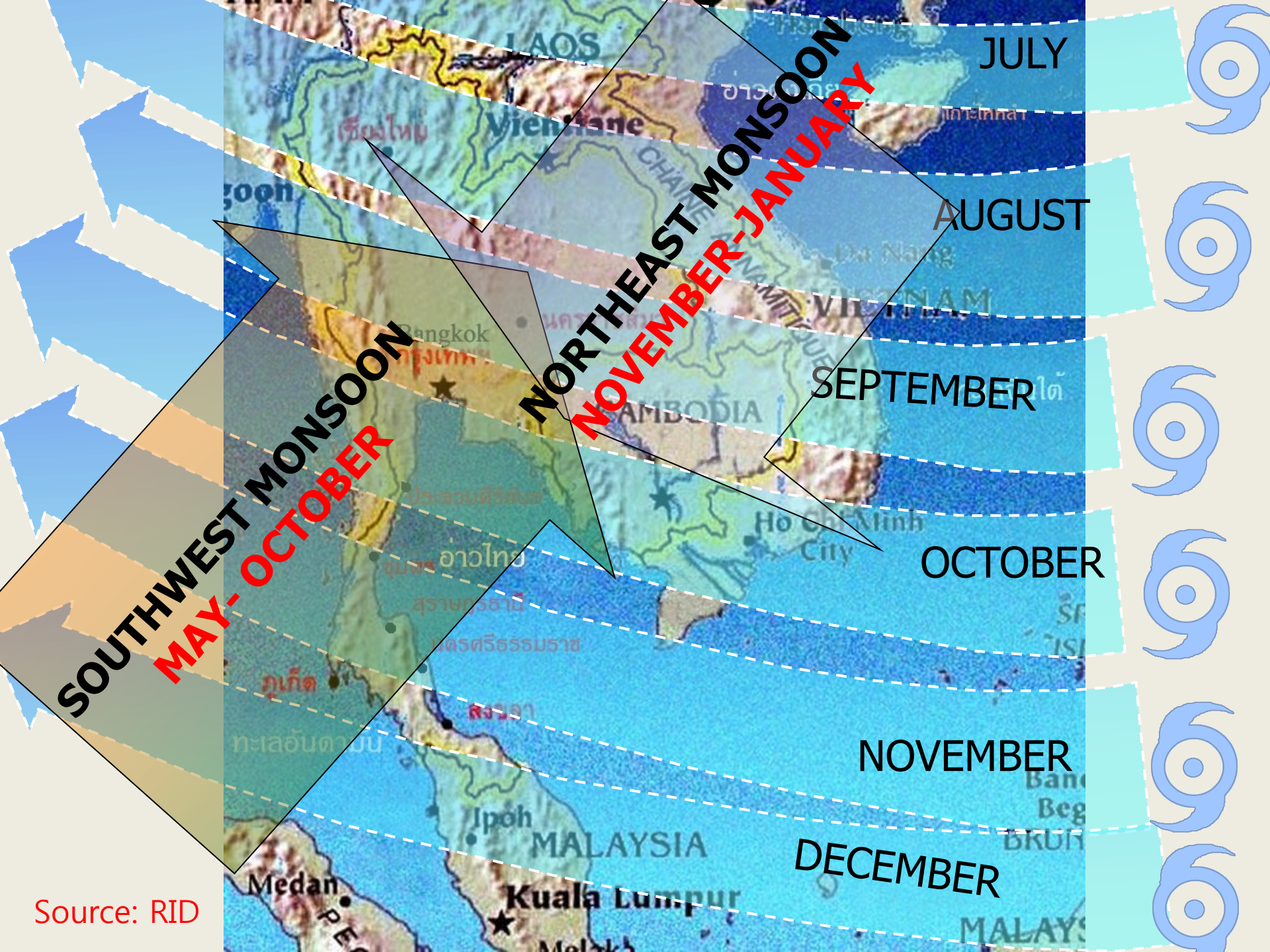
Typhoon





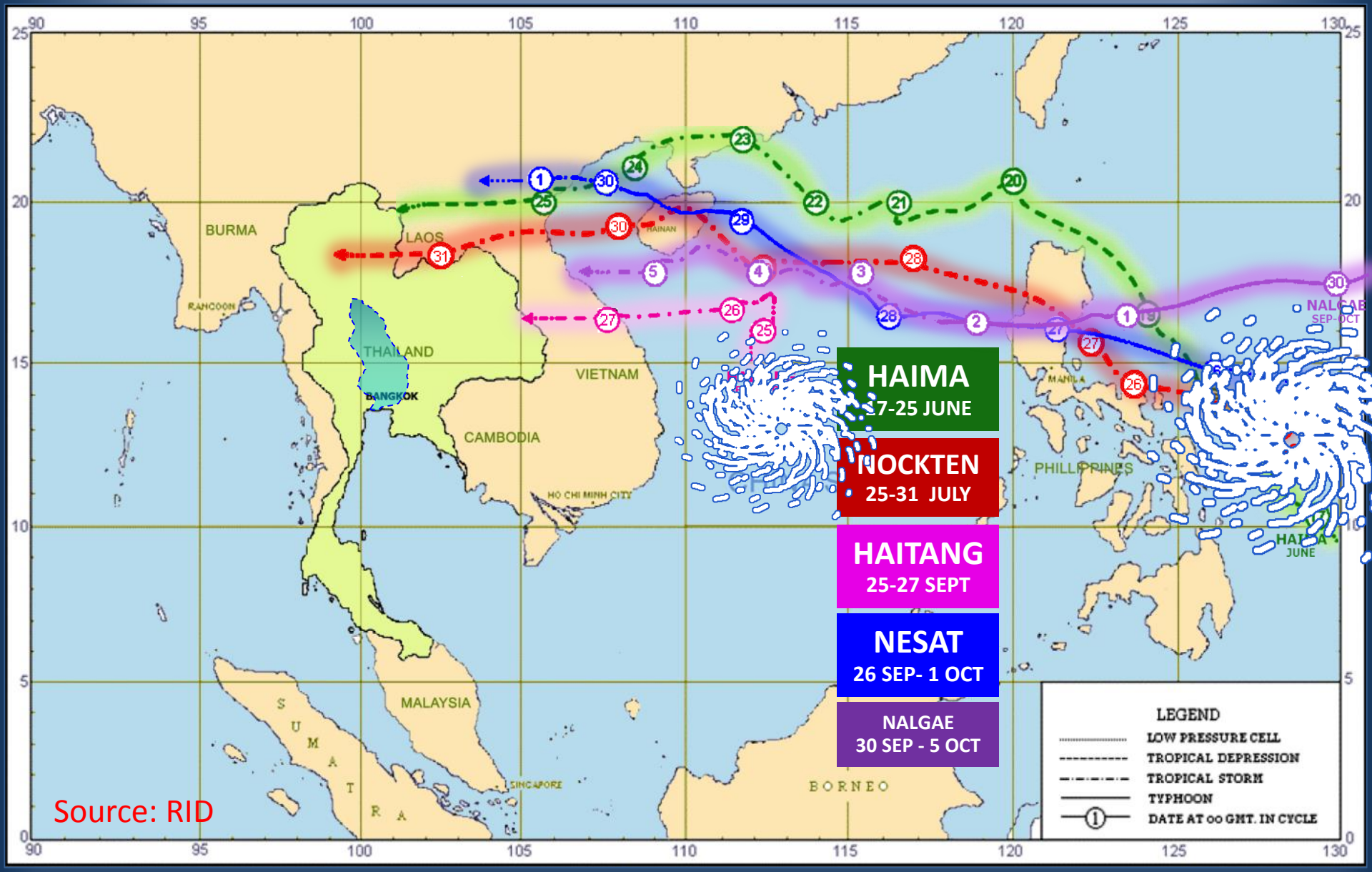
Monsoon Rain Front




SOUTHWEST MONSOON
MAY- OCTOBER
NORTHEAST MONSOON
NOVEMBER-JANUARY
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
LAOS
Vientiane
Bangkok
CAMBODIA
Ho Chi Minh City
Ipoh
MALAYSIA
Medan
Kuala Lumpur

Source: RID

TROPICAL STORMS AFFECTED THAILAND in 2011



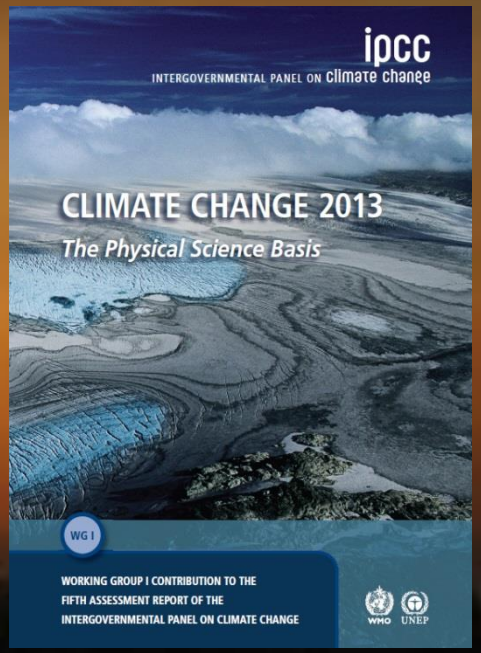
Source: RID

Ⅱ. Climate Change

Climate Change, Projection of IPCC

- **5th Assessment Report(AR5)**

"Climate Change 2013 : The Physical Science Basis"



Global Climate Change

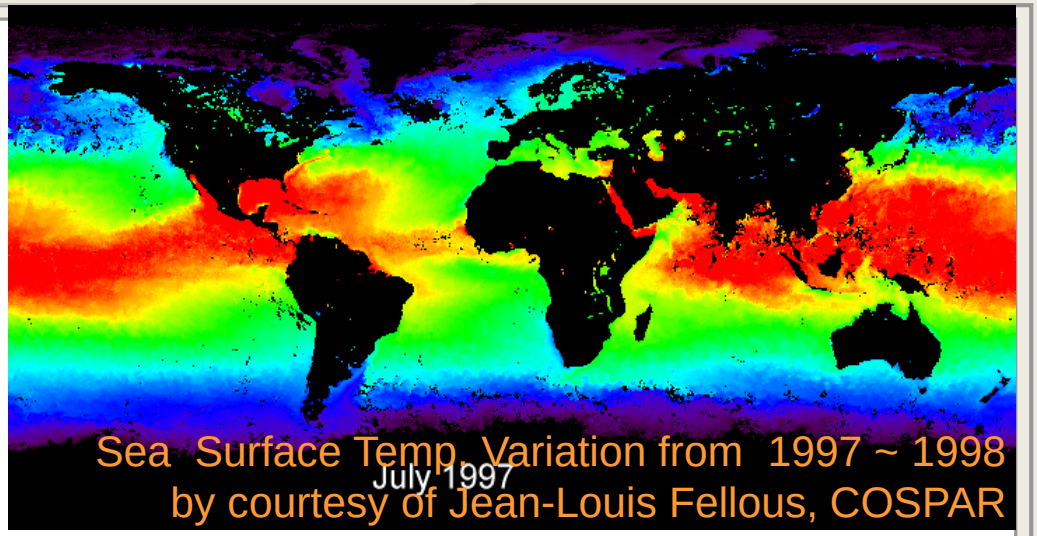
Temperature

Over the last 100 years

Global Mean Temp. (0.85℃↑)

Sea Level

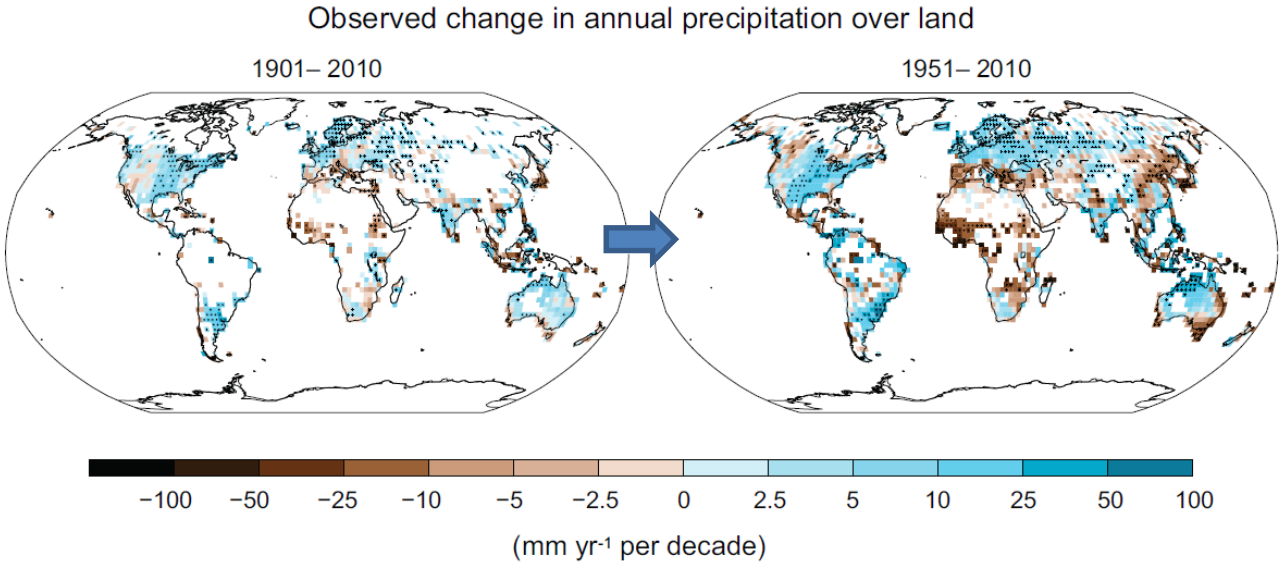
Global Mean Sea level (19cm↑)



Sea Surface Temp. Variation from 1997 ~ 1998
by courtesy of Jean-Louis Fellous, COSPAR

Precipitation

Drought & Flood prone areas: increased



Compare among Global, Thailand, Korea

	Global	Thailand	Korea
Temperature (100 years)	0.85℃	-	1.5℃
Sea Level	0.1cm/yr (observed)	0.3cm/yr (forecast)	0.22cm/yr (observed)

Source: Study on Climate Impact Adaptation and Mitigation in Asian coastal mega cities: Interim Report, JBIC, 2008

In terms of the Sea Level Rise,
The speed of climate change of **Thai : 3 times** higher than the global mean
Korea : 2 times higher than the global mean

Impacts of C.C in the Future in Thai

Change* due to CC in 2050

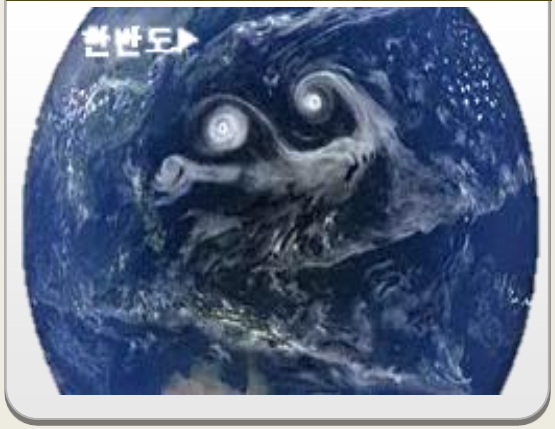
Inundated area (km^2)	+ 175
Inundated area (%)	+ 6.9
Flooded pop. (million)	+ 0.68
Number of flooded residential unit	+ 200,000
Number of flooded commercial unit	+ 48,000
Number of flooded industrial unit	+ 5,000
Number of hospitals/clinics in flood prone area	+ 33
Road (km) in flood prone area	+ 450

	30 year return period			100 year return period		
	2008	A1FI	B1	2008	A1FI	B1
C.2 Gauging Station (Upstream of Bangkok City)						
Flood Volume (MCM)	31,258	32,200	31,965	39,960	41,150	40,839
Factor Increase	**1.00**	**1.03**	**1.02**	1.00	1.03	1.02
Flood Peak (m3/sec)	4,801	5,054	4,976	6,853	7,146	7,065
Factor Increase	**1.00**	**1.05**	**1.04**	1.00	1.04	1.03
C.13 Gauging Station (Downstream of Bangkok City)						
Flood Volume (MCM)	27,756	28,485	28,235	36,997	38,378	38,019
Factor Increase	1.00	1.03	1.02	1.00	1.04	1.03
Flood Peak (m3/sec)	4,484	4,720	4,646	6,399	6,673	6,598
Factor Increase	1.00	1.05	1.04	1.00	1.04	1.03

Source: Dr. Babel, AIT

Impacts of C.C in the Future in Korea

Flood Risk



Torrential rainfall over 100mm/d
2.7 times ↑ after 100 years

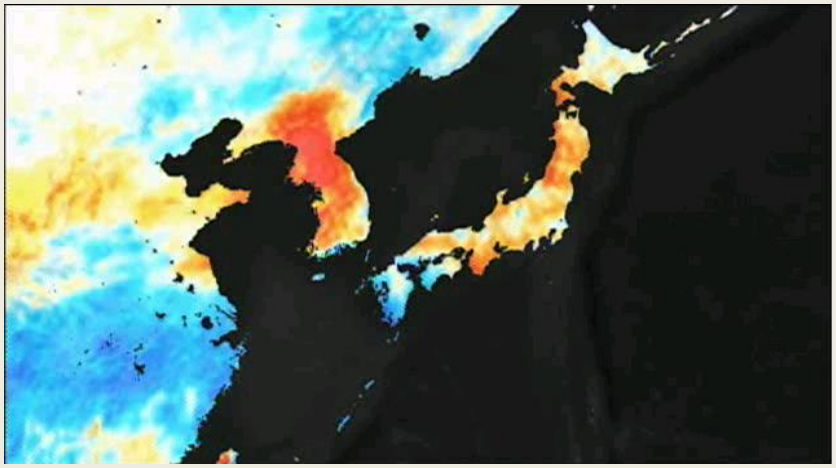
Droughts

Stream discharge ↓ 5.7% during drought season in 2060

3.3billion ㎥ of water shortage
(water budget analysis)

Impacts of C.C in the Future in Korea

- At present, Seasonal rain front moves up and down in normal condition
- But, predicted to stay in southern sea of Korea in the future.

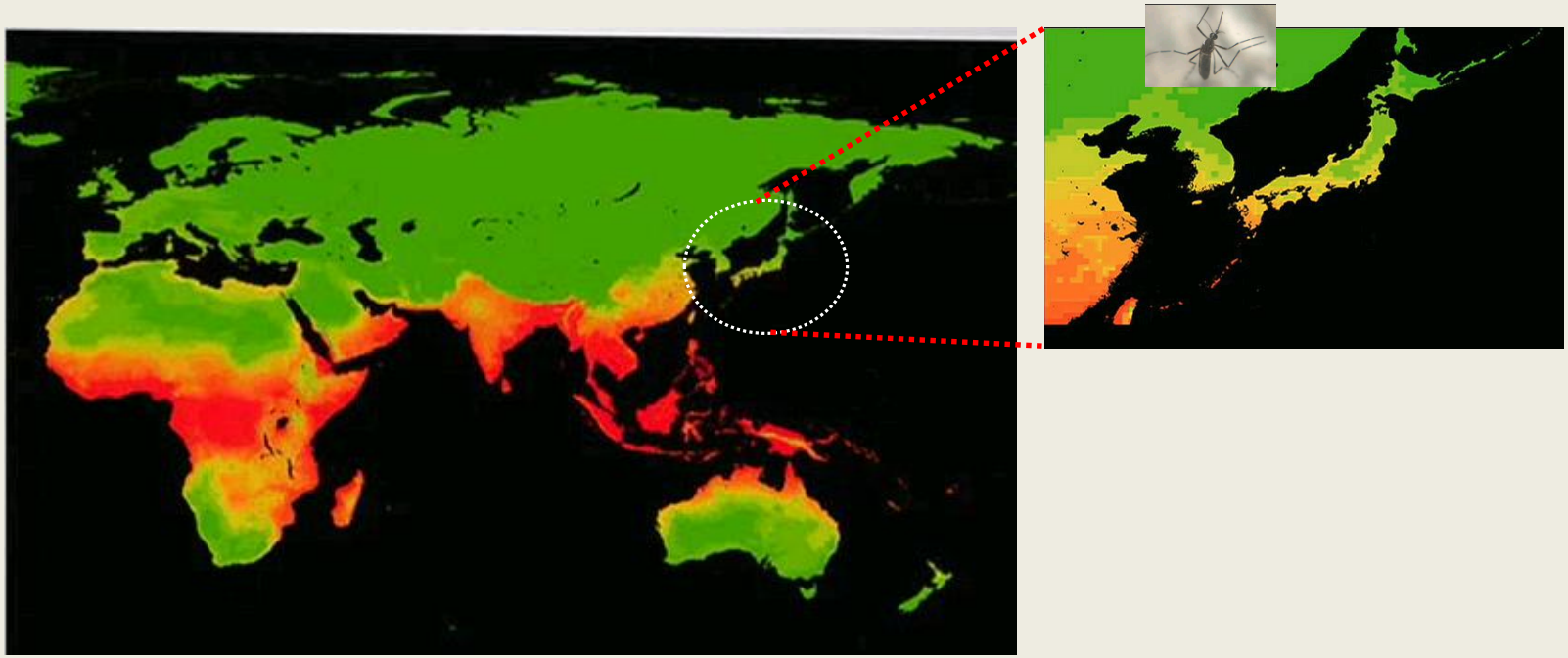


- Droughts getting worse in Korea Peninsula

Impacts of C.C in the Future in Korea

Socio-economic Impact

- Putting people at high risk of dengue fever diseases



Ⅲ. Countermeasures for C.C. in Korea

Strategy and Action plan

- C.C has deteriorated water problems, as a global agenda
- Water Problems should be addressed in Water Security View because of lack of substitution goods

⇩ **Paradigm Shift**

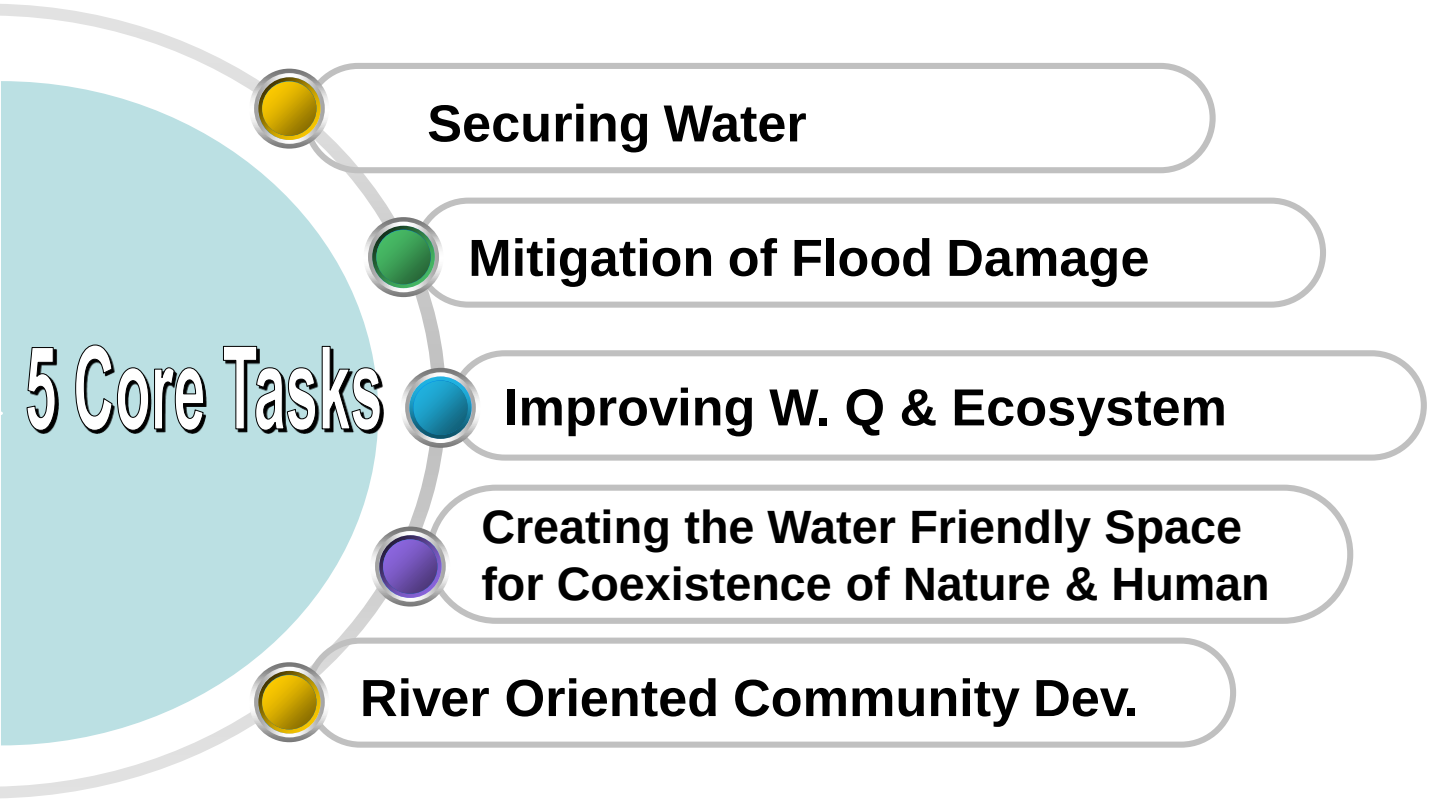
- Shift from the aftermath recovery to prevention in advance
- Water management in multi-disciplinary(consilience) manner with Water Quantity & Quality, Ecology, Water Culture(soft eng.)
- Striking balance in Inter-generation, regional equity in a view of sustainable development
- Creation of jobs and economic growth in a view of the Good Circle betw. Environment & Economy

Motivation of Climate Change Adaption Projects

CASE STUDY (1)

1 4 Major Rivers Restoration Project

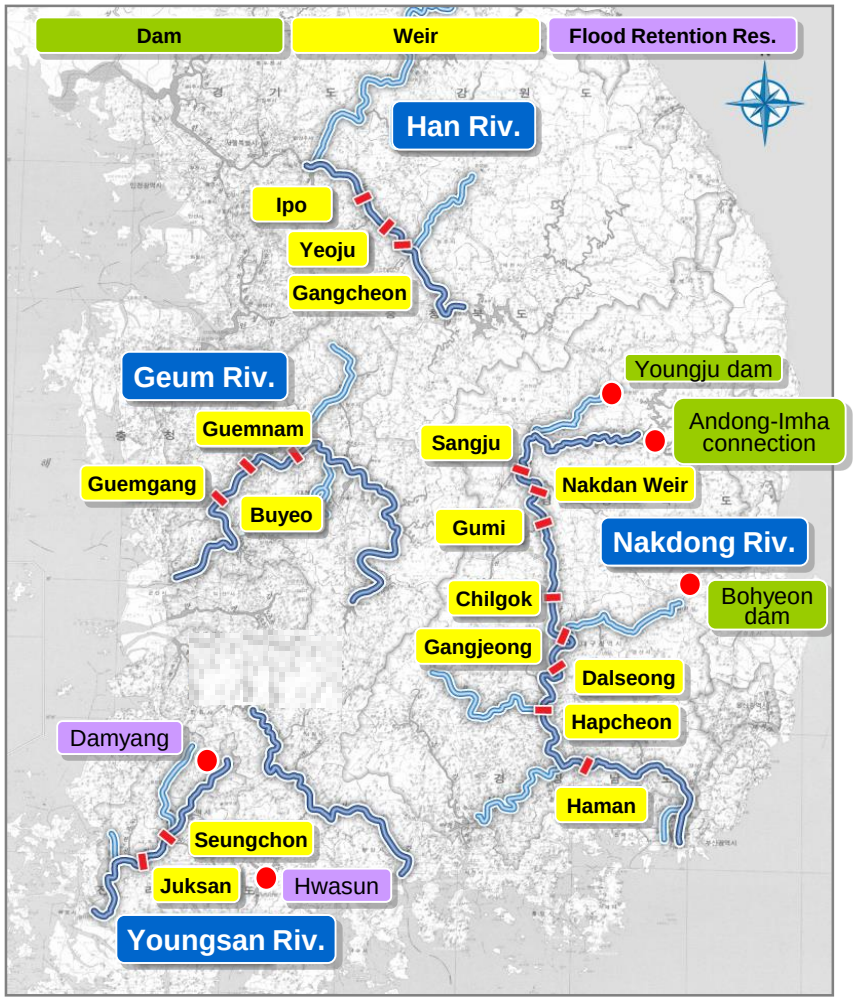
Mission : "Multi-purpose Climate Change Adaptation Project"
Considering Flood, Droughts, Ecosystem, Balanced Regional Dev.



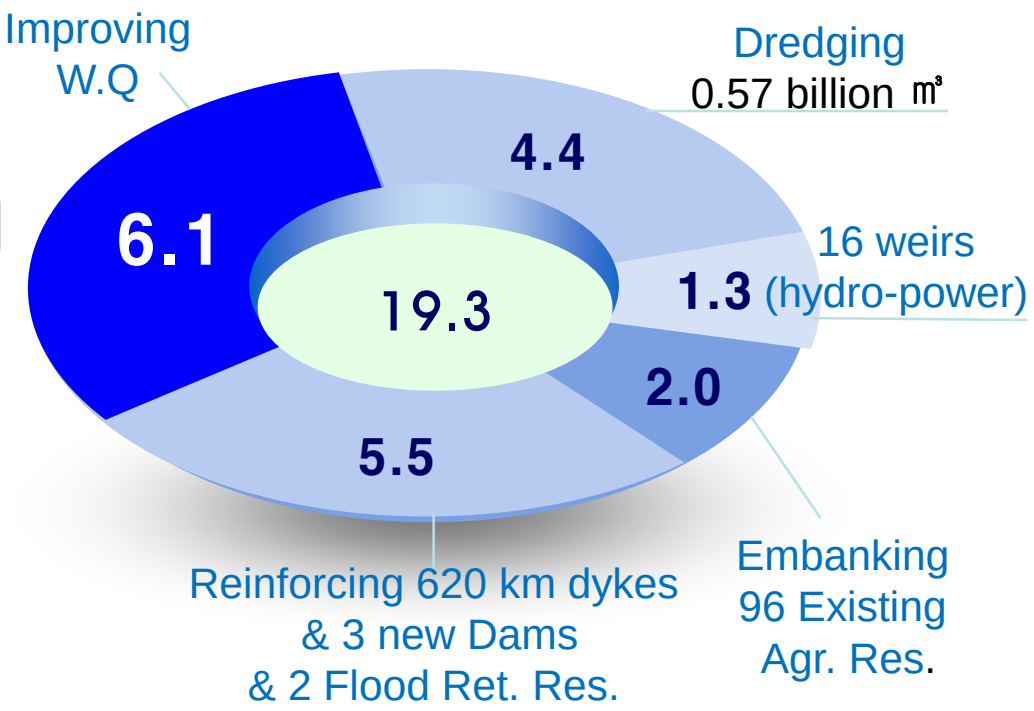
- Very hard to take the large scale structural measures due to social conflicts and environmental impacts
- Shifted to construction of **small scale weirs in rivers** to secure water and to increase flood control volume **by dredging**

Introduction of 4MRRP (Outline of the 4MRRP)

Project period: 2009~2012, **Budget: 20 billion US$**



Work Scope & Budget



(Task 1&2 : Securing water storage for water supply & flood control)

- **1.3 billion m^3 for water supply, 0.92 billion m^3 for flood control**

Constructing 16 weirs and Dredging

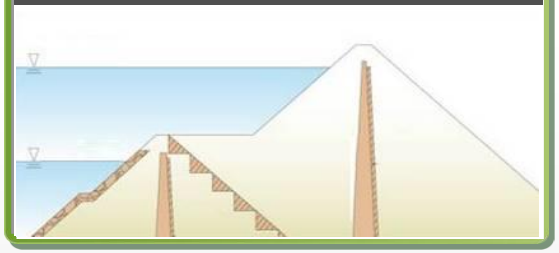
Ipo Weir (The Han River)

Dredging Riverbeds

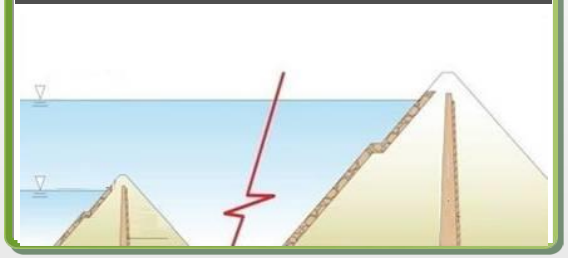
Secure 800 million ton

Embanking the Existing Agricultural Reservoirs (96)

Heightening the River Banks



Reinforcing the River Banks

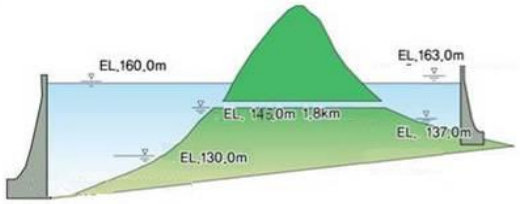


Secure 250 million ton

Constructing New Dams (3)

New Dam Const. (Yeongju Dam

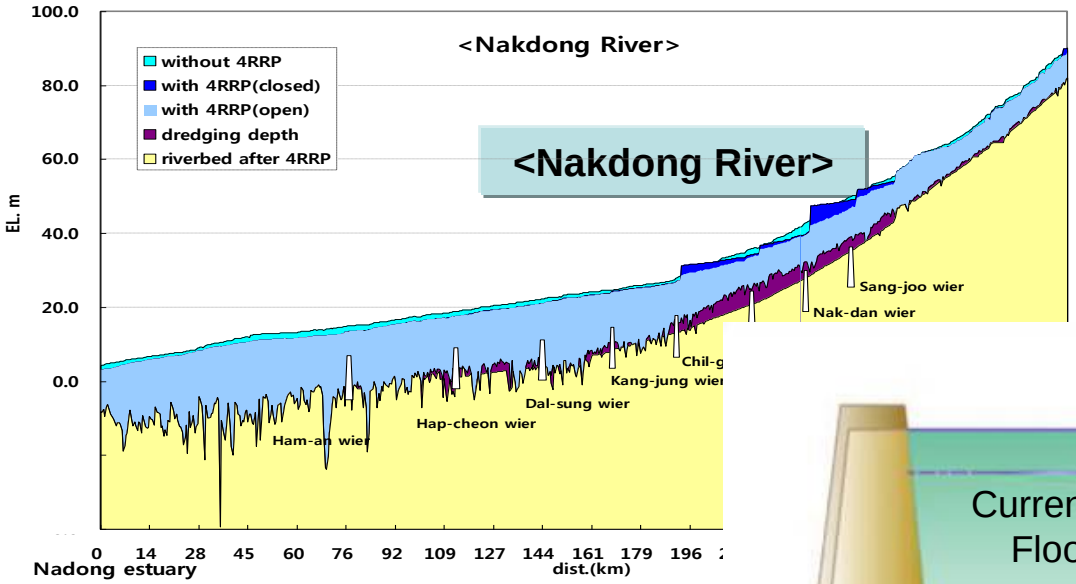
Connecting Andong and Imha Dams

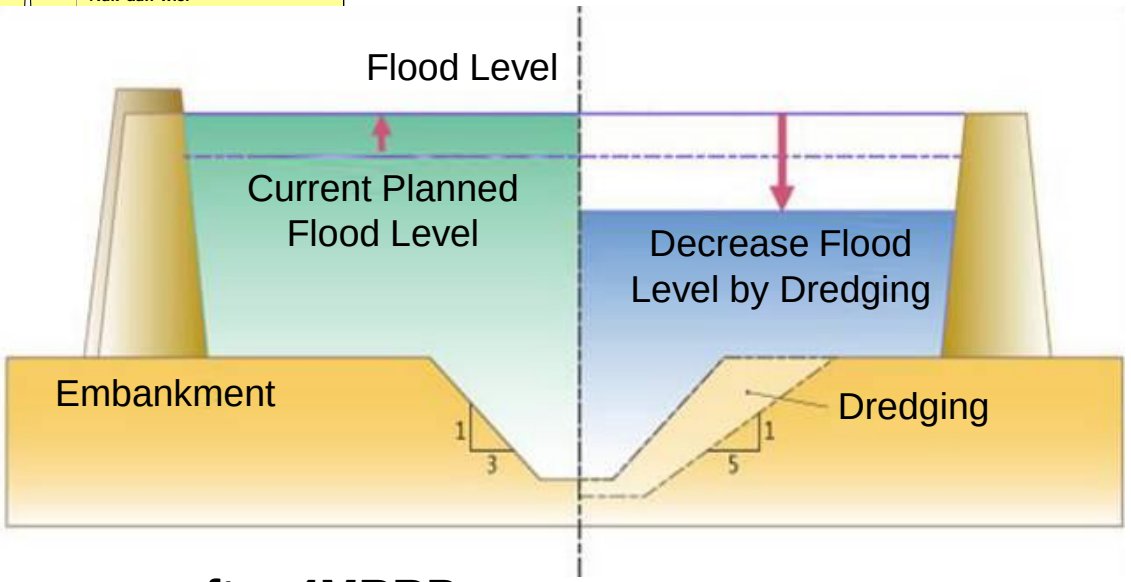


Secure 250 million ton

Effects of the Project (lowering flood water level)

- **Decrease in the Design Flood W.L by Dredging**





- **Range of Design Flood W.L Decrease after 4MRRP**

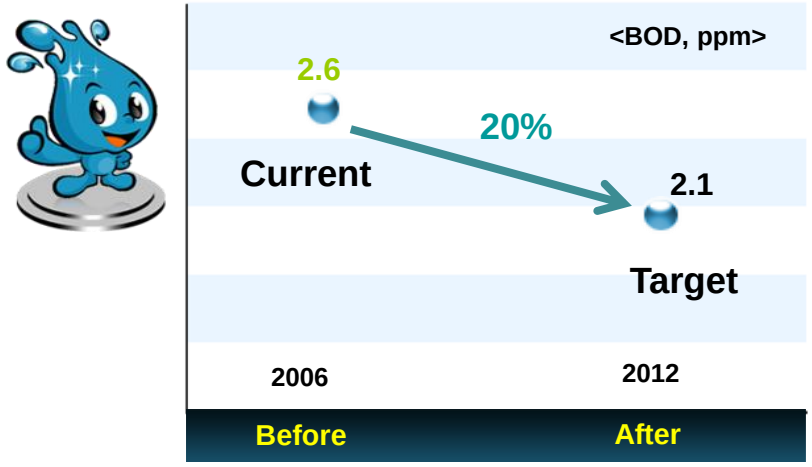
  - Han Riv. 1.0~2.6m ▼
  - Nakdong Riv. 0.9~3.9m ▼
  - Geum Riv. 0.7~0.9m ▼
  - Youngsan Riv. 0.4~1.5m ▼

Effects of the Project (green energy production)

- Creating Green Energy
  - Capacity : 57,000 kw (16 weirs),
  - Power Generation : 280*10^6 kwh/yr → supply to 58,000 houses

(Task 3 : Water Quality & Eco-system Improvement)

BOD & TP Improvement

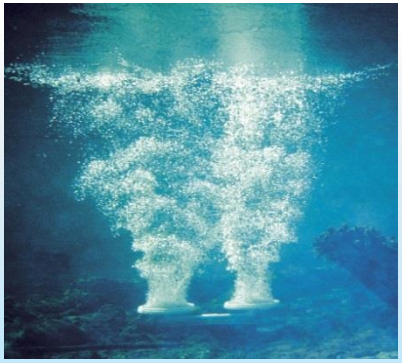


- Point Pollution Trtmt. Facil. : over 1,100
  (Sewage 644, Livestock Manure 19,
  T-P 237, Industrial W.W 37, etc.)

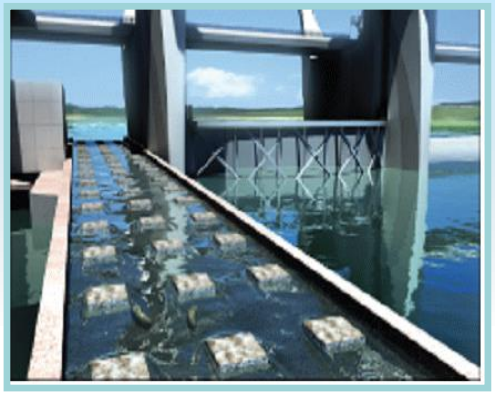
- Non-point pollution treatment facility: 21

Air Diffusing System

- 10% reduction of algae

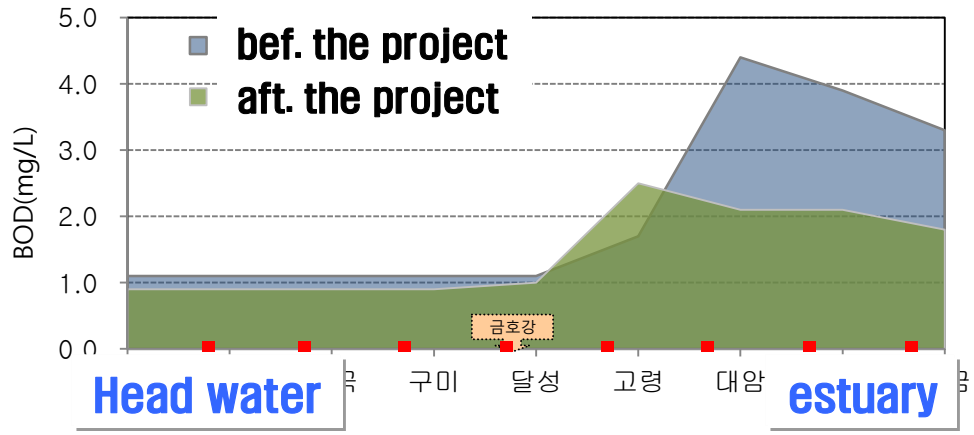


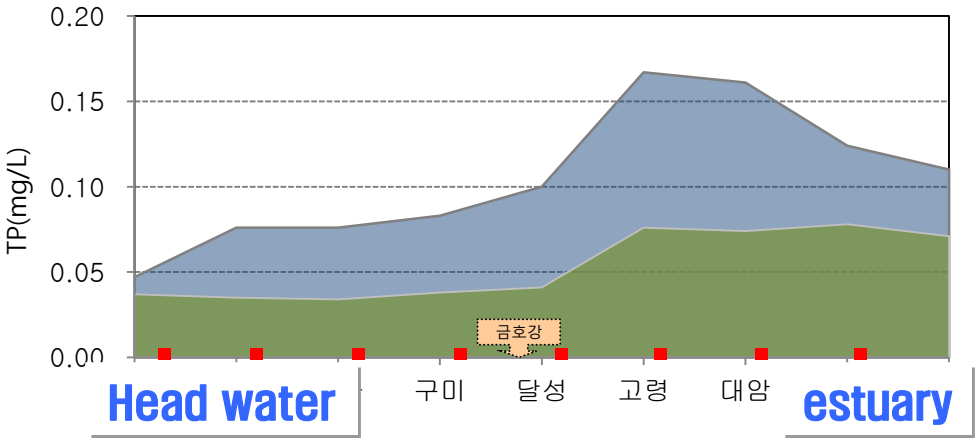
Installing ecological wetlands and nature-friendly fish-ways

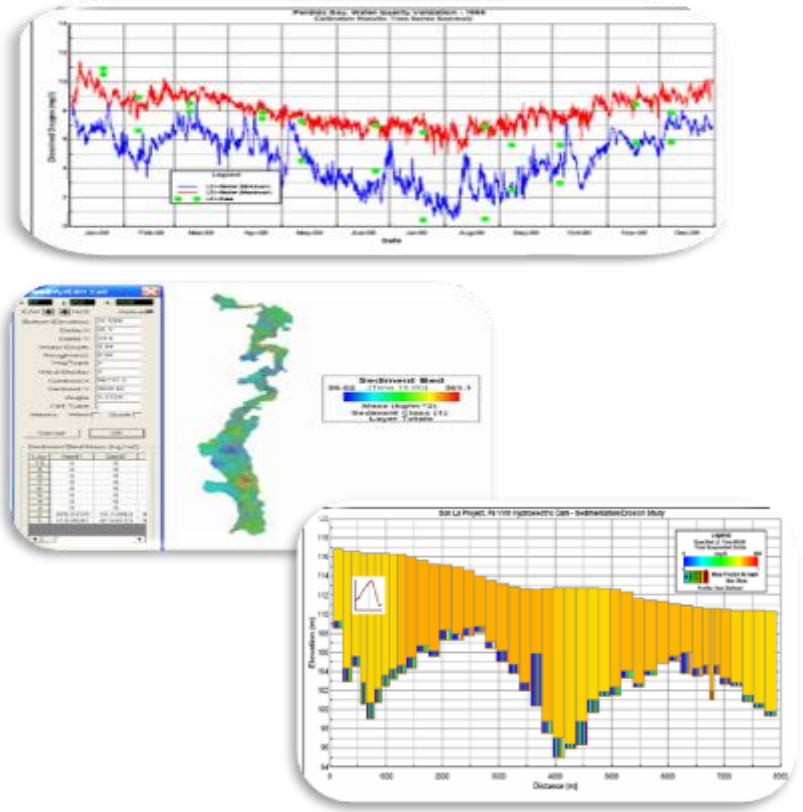


Effects of the Project (water quality improvement)

- Improvement of W.Q (BOD, TP) along the 4 rivers (scientific modeling)





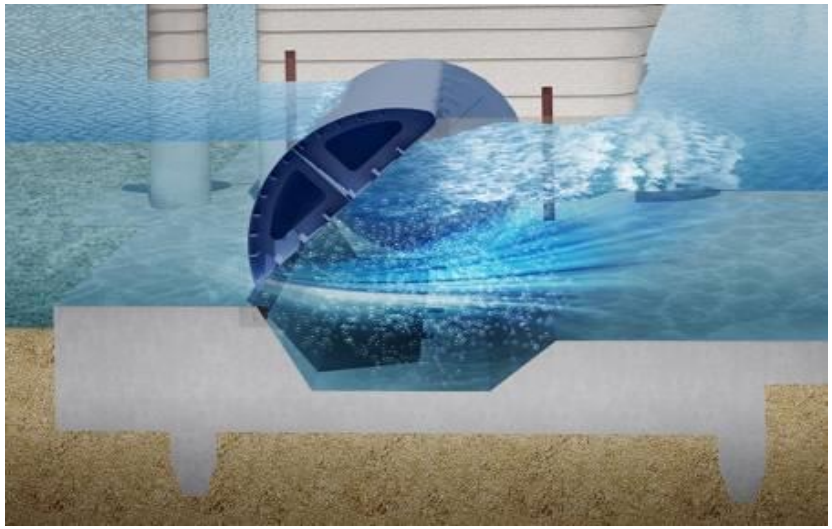


Water Quality Computer Modeling

Effects of the Project (prompt reaction to toxic spill accidents)

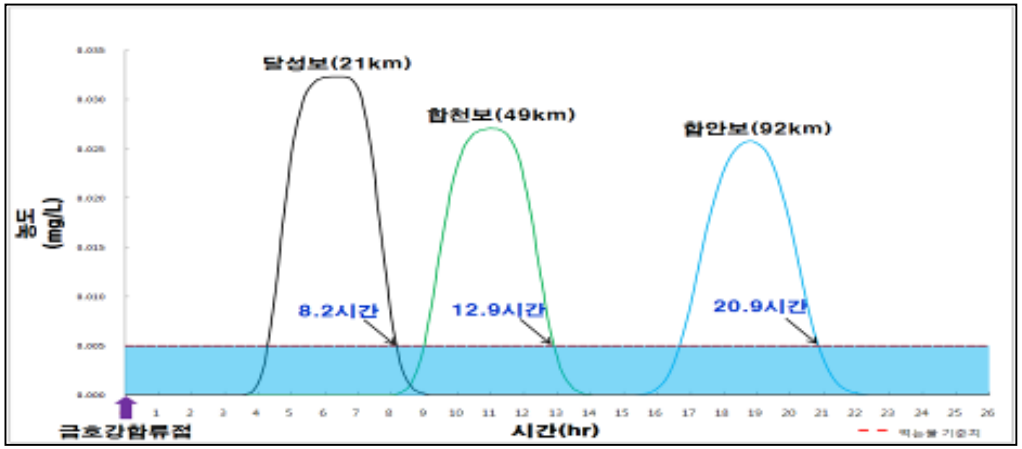
- (bef. Proj.) only depending on increase in release from dams
- (aft. Proj.) flushing promptly by releasing the water into weirs

- recovering to the normal condition about 3 times faster than bef. Proj.



(Flushing chemical toxic)

< Recovering Time (hours) of Water Quality Standard of Drinking Water >



(Scenario : Phenol Spill Accident in Nakdong River)

(Task 4 : Creating Water-friendly Space for the Residents)

Removal of Agricultural Lands on the Riverside foreland

- Relocation of agricultural lands
- Removal of vinyl greenhouses

Creating Public Spaces

- Bike ways

- Auto Camping

- Sport Facilities

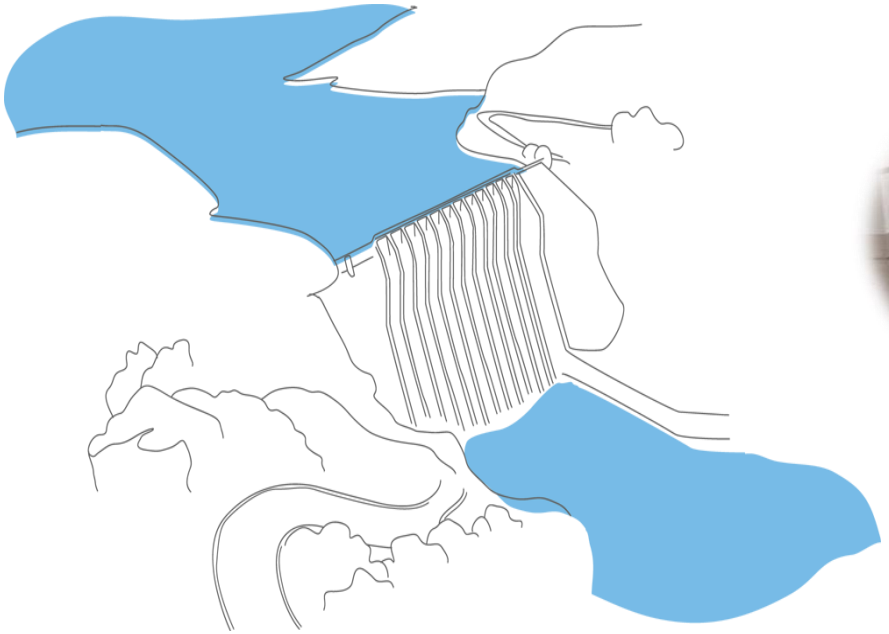
- Scenic Places

(Task 5 : River Oriented Community Development)

- Utilizing riverside as multipurpose space
- Creating the new areas for leisure activities
- Promoting cultural tourism

CASE STUDY (2)

2 Integrated Water Resources Management (IWRM)



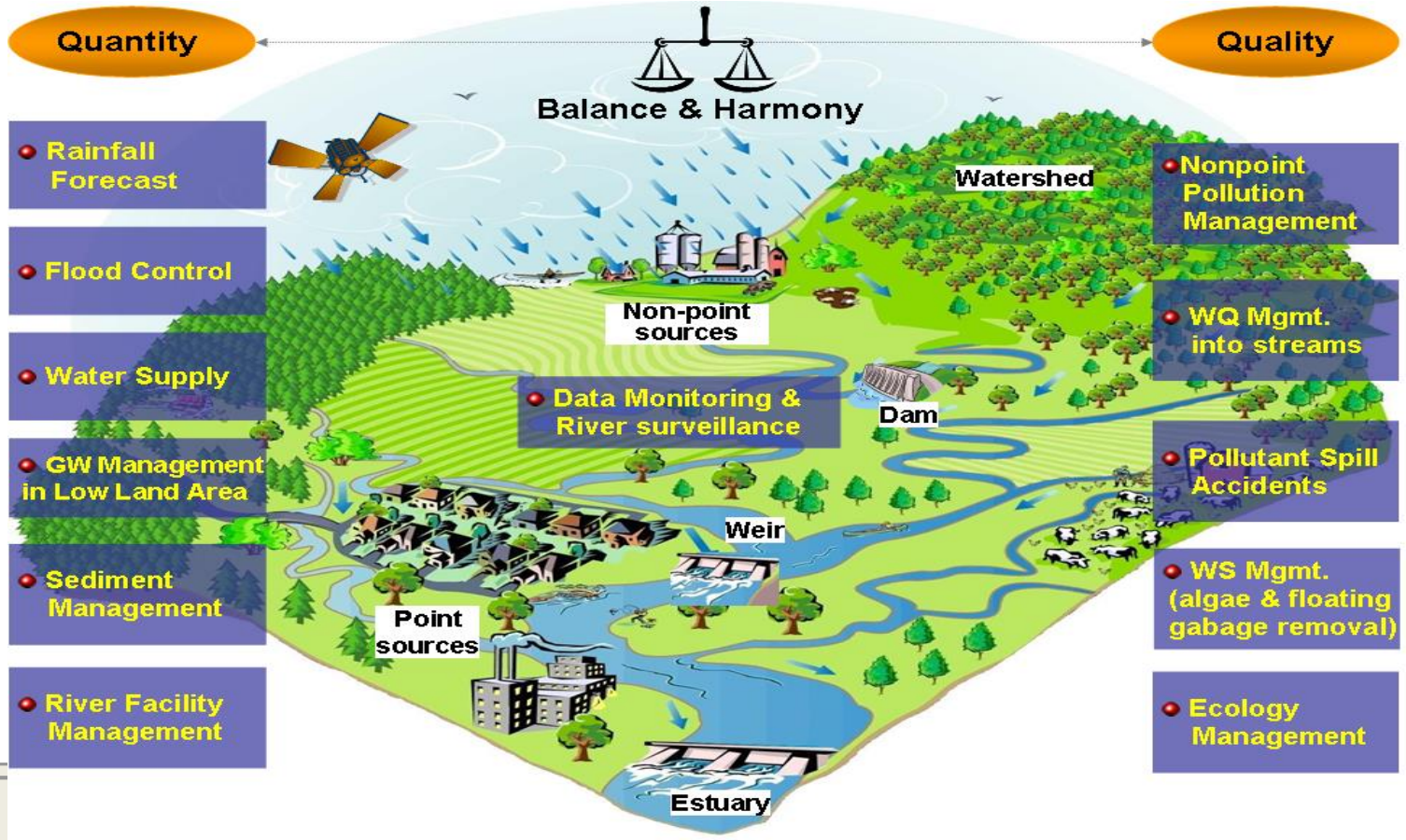
IWRM ?

1. Integration of Water Management Functions

- **Maximizing** the Economic and Social Welfare by **Integrating Water Quantity & Quality, Ecosystem, Land and Related Resources**

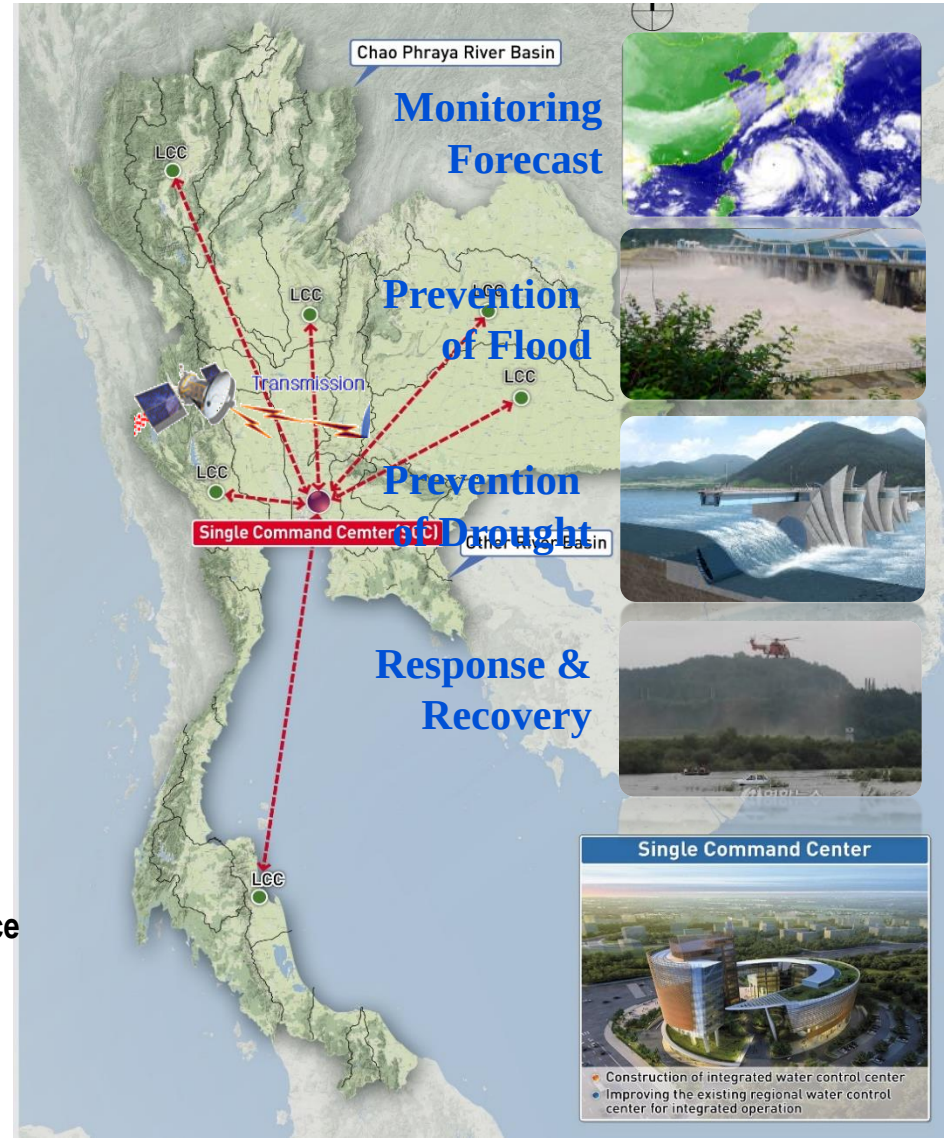
2. Integration of Water Agencies in Cooperative Manner

- **Maximizing** the Efficiency by Water Agency Cooperation centering on **SCA**



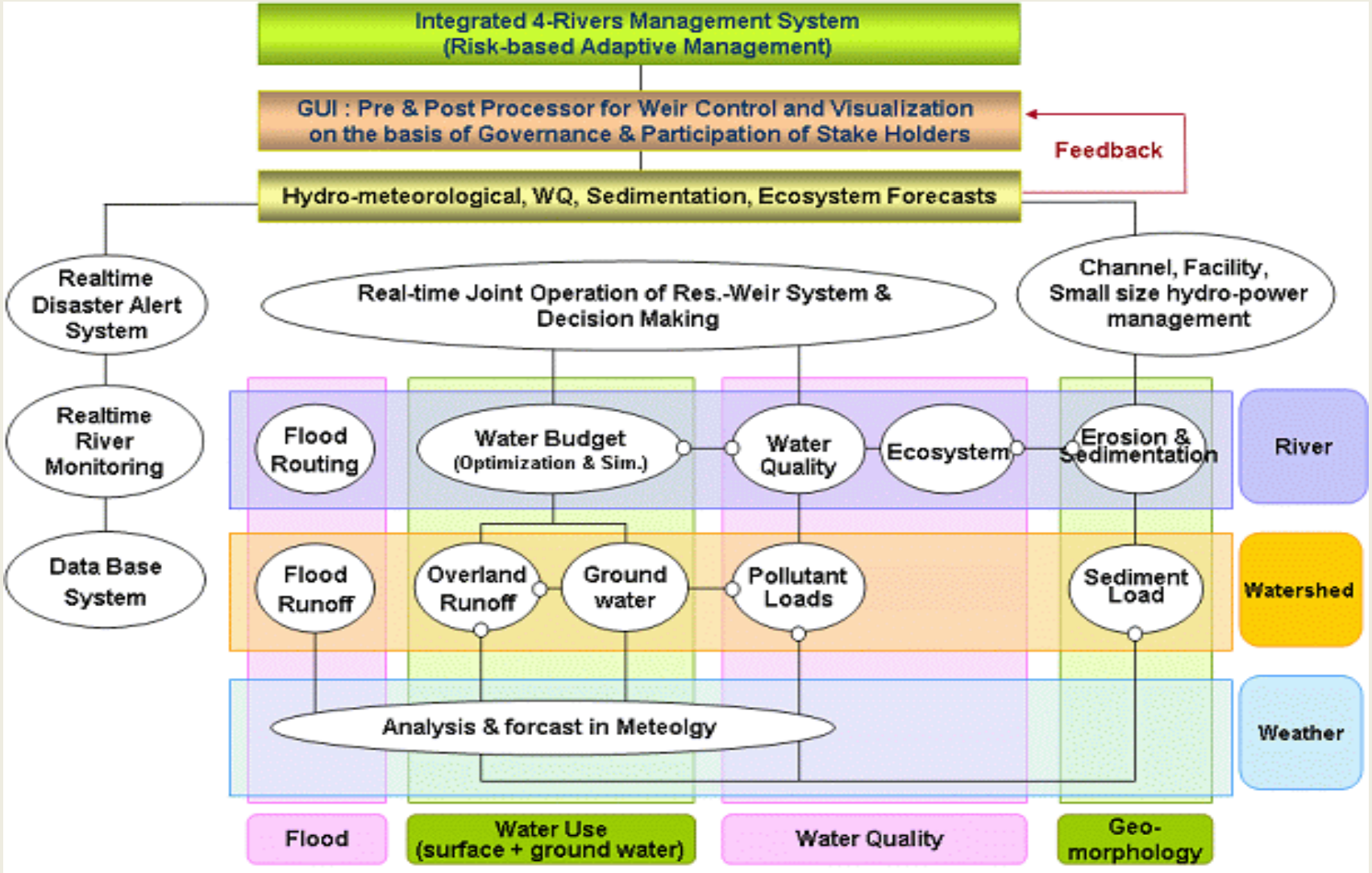
Development ICT-based IWRM System to Realize IWRM

- **IWRM System on the basis on the Risk(2P) & Crisis(2R) Management**
- **Managing in Cooperative Manner by SCA**



Risk-based IWRM System: Flood Ctrl + Water Supply + W.Q Mang.
Land Use Mang. + Sed.Ctrl. + G.W Mang. + Water Culture, etc.

(Goal) Maximization of the Functional Benefits & Minimization of Water Disasters



K-water Water Management Center

HUB of Water Management of Korea

Facilities

- 32 dams
- 16 weirs
- 55 hydropower plants
  * 121 generators(1,331MW)
- 1,300 gauging stations

Organization

- Weather forecasting Team
- Water management Team
- Water ICT Team
- Hydropower generation Team

70 Experts composed with 4 Teams including 5 member of weather forecasters

K-water Water Management Center

HUB of Water Management of Korea

Major works

- Data acquisition & monitoring
- Hydro-met. Forecast
- Res. Operation
  - Water supply
  - Flood Control
  - Hydropower Gen.
  - W.Q Improvement
- Technology R&D

A year, 365 days, 24 hours, Constant Duty System

K-water IWRM System Structure

Real-time Data Acquisition System

(HDAPS)

Hydrological Forecast System

(PFS)

Real-time Basin & River Hydrodynamic Models

- Basin Analysis: Runoff, pollution & sediment load
- River Analysis:
  - ✓ Flood Routing
  - ✓ Water Quality Analysis
  - ✓ Sedimentation Analysis

Optimal Joint Reservoir & Weir Operation System For Water Supply

- Water Budget Analysis

(Optimization & Simulation)

(RWSS)

Real-time Gate & Hydro-Power Operation System in Remote Control

(GIOS)

Reservoir & Weir Operation System For Flood Control

- Decision Support System

(Simulation, partly Optimization)

(FAS)

Real-time Disaster Surveillance System

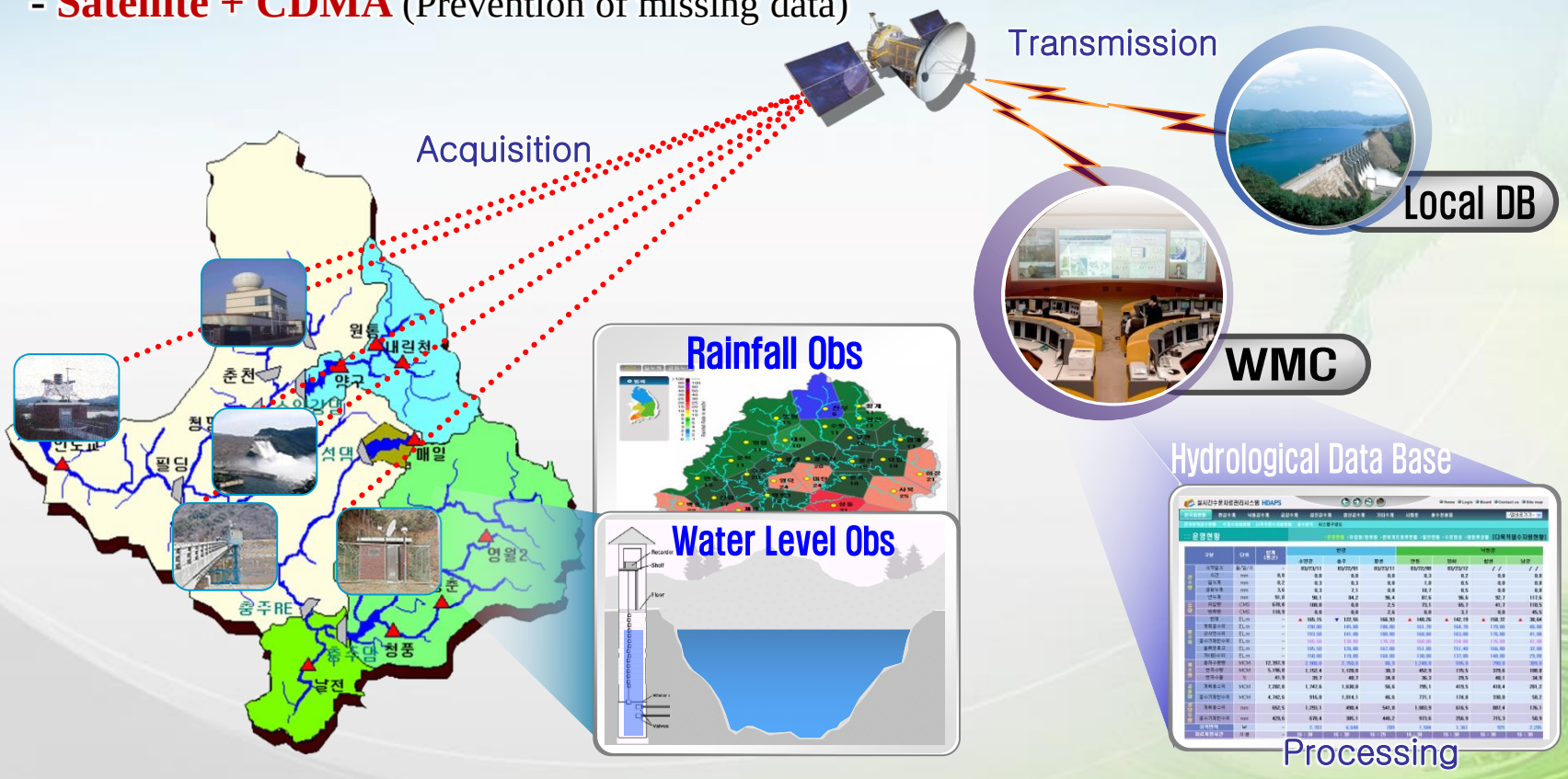
Drought Season

Both in Common

Flood Season

(1) Real-time Hydrological Data Acquisition & DB Management System (HDAPS)

- ✓ **Hydrological data acquisition from more than 1,300 gauging station**
  - Rainfall, water level, inflow etc
  - **1 minute real time base**
  - **Satellite + CDMA** (Prevention of missing data)

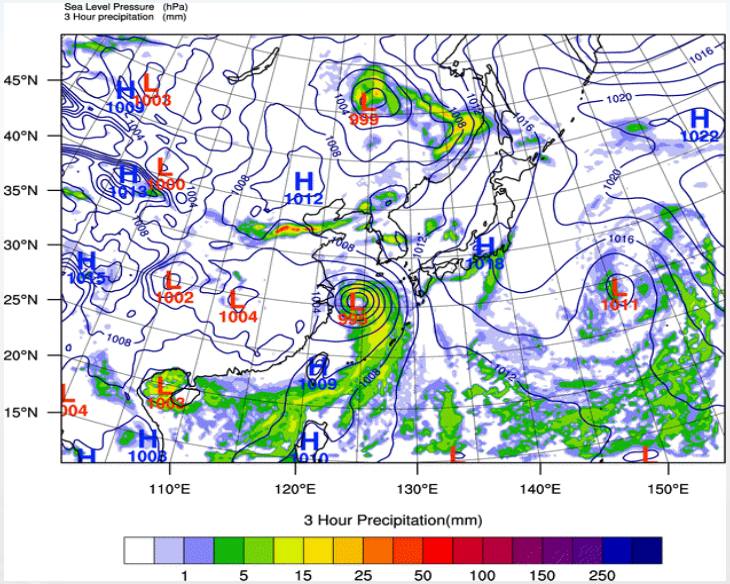


(2) Precipitation Forecast System (PFS)

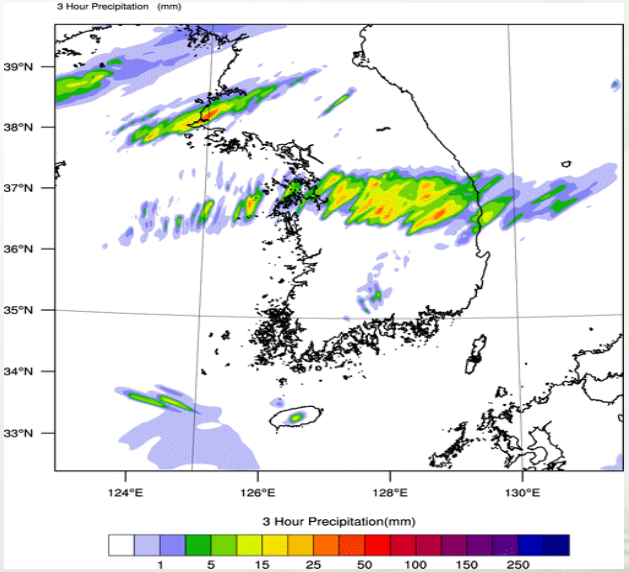
✓ **Self-developed high-resolution precipitation forecasting system**

- **Super computer based numerical analysis**
- **Forecast 5 days' rainfall & typhoon in 58 sites, and update 4 times a day**
- **10 ensemble members** ← **KMA, JMA, NOAA, etc**

Weather chart



Basin wide QPF



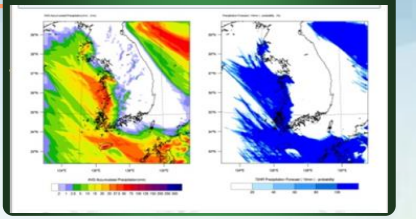
Quantitative Precipitation Forecasting

(3) Flood Analysis System (FAS) & Flood Early Warning System (FEWS)

- Rainfall forecasting
- Runoff analysis
- Reservoir simulation
- Downstream routing
- Release amount decision making
- Gate operation

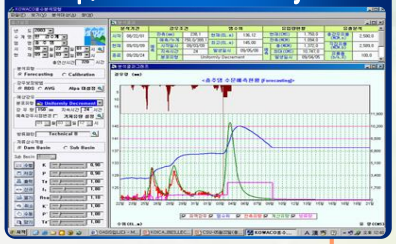
PFS

Precipitation Forecasting



FAS

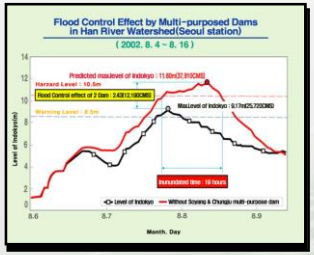
Up/downstream Analysis



FEWS

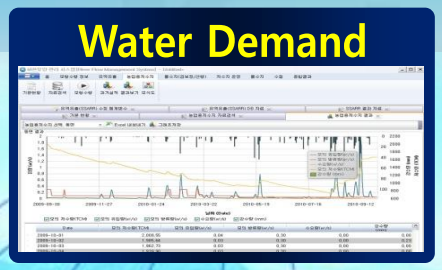
Water Disaster Warning

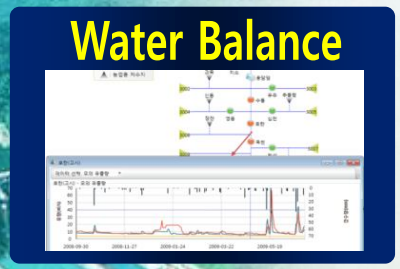
Flood control effect analysis



(4) Reservoir Water Supply System (RWSS) & Power Generation Integrated Operation System (GIOS)

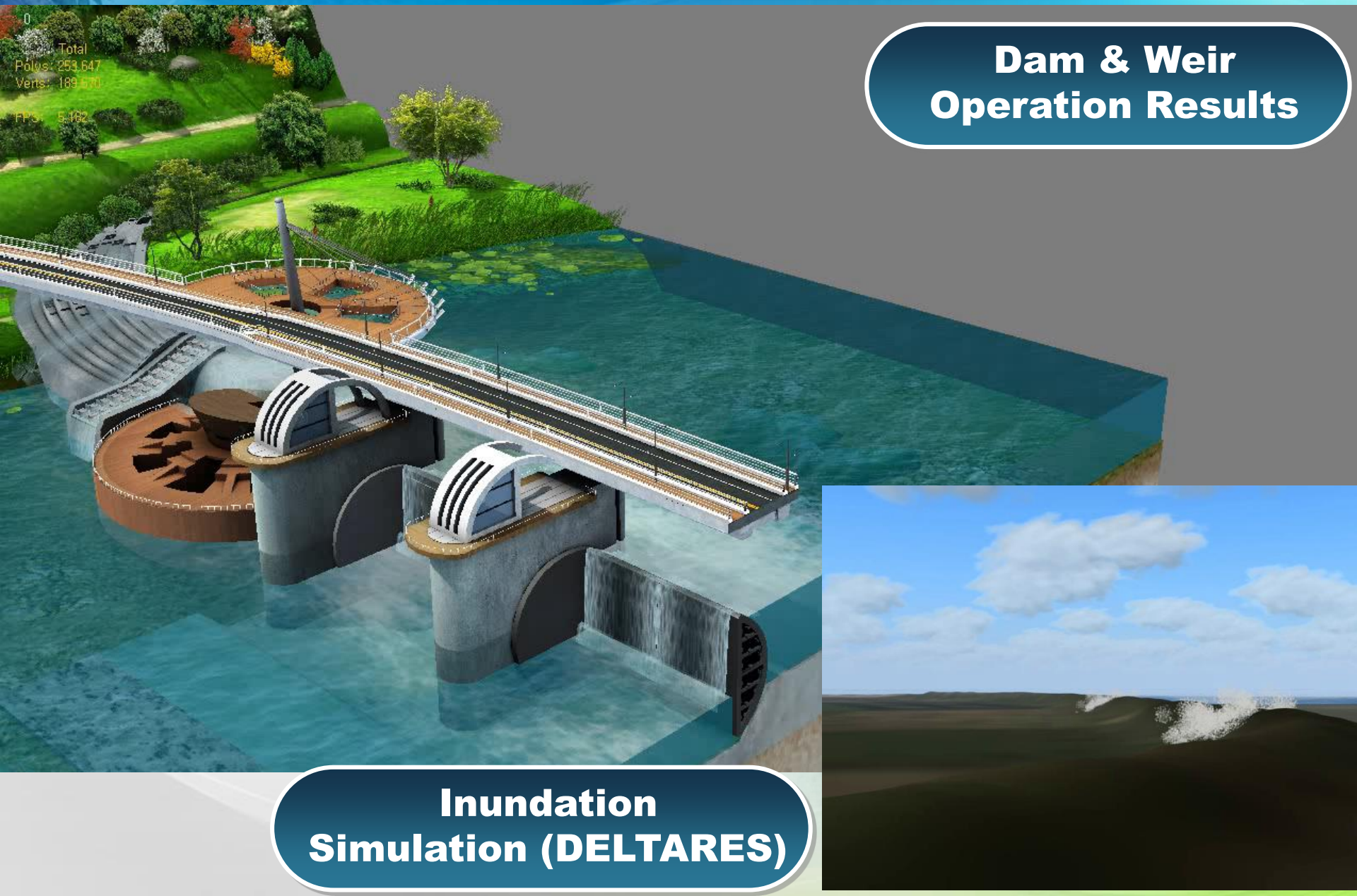
- Water Demand Forecast
- Long-Mid Term Runoff Analysis
- Water Balance (Res. Operation)
- Water Quality Analysis
- Hydro-Power Generation Plan





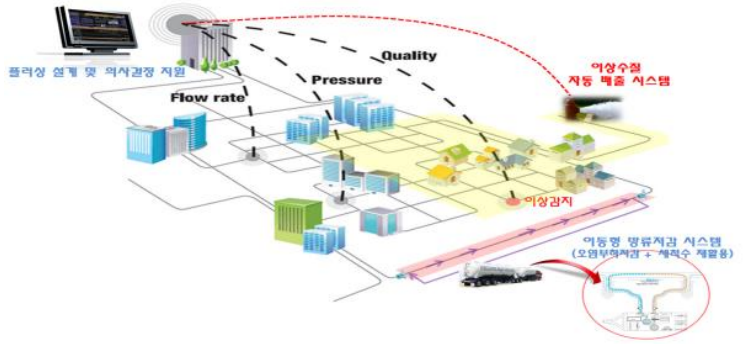
Optimal Reservoir Operation Plan

(5) GIS based 3D Visualization System



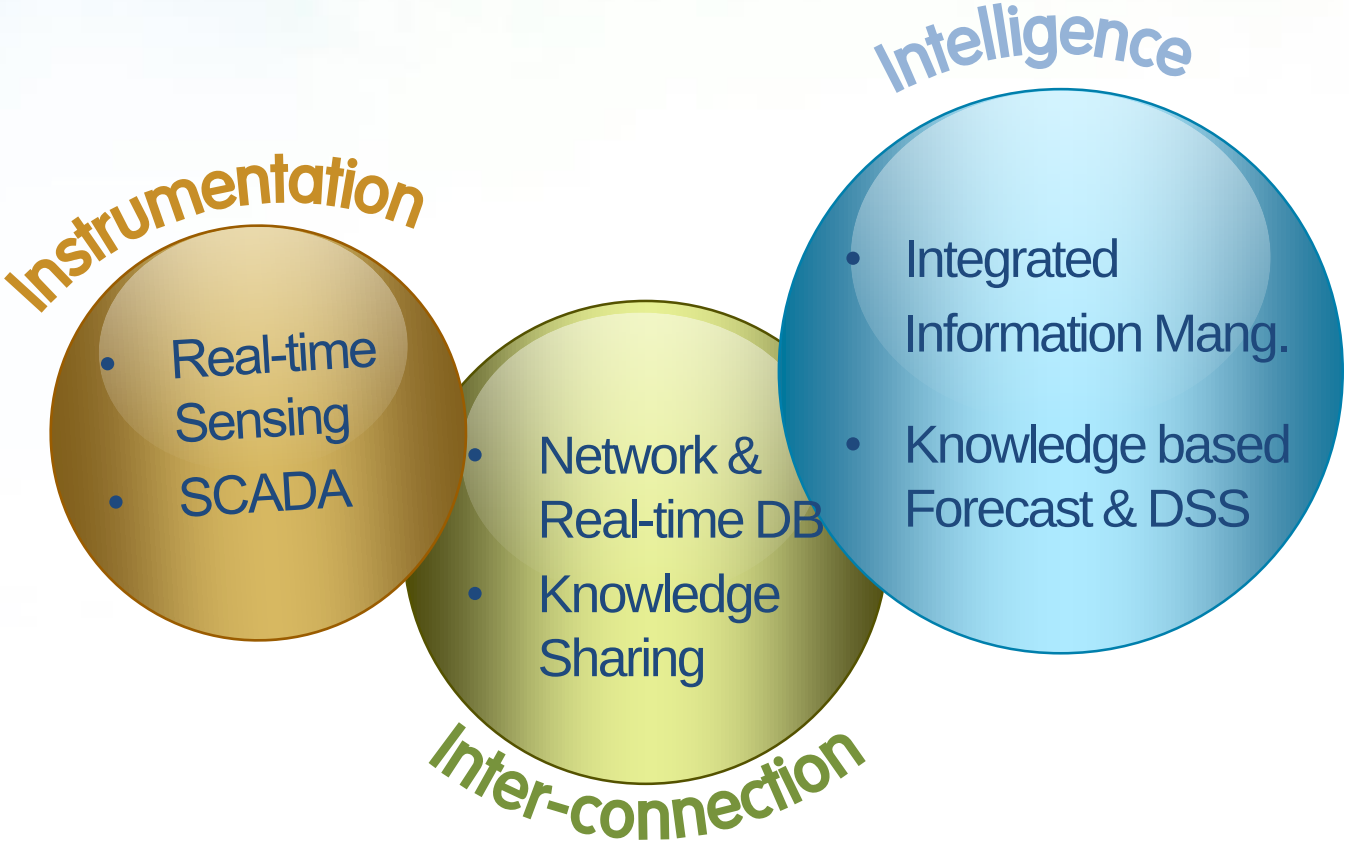
CASE STUDY

3 Smart Water Grid



02

Features of Smart Grid Tech.



Infra

- Traffic
- Energy
- Education
- Medical
- Environment

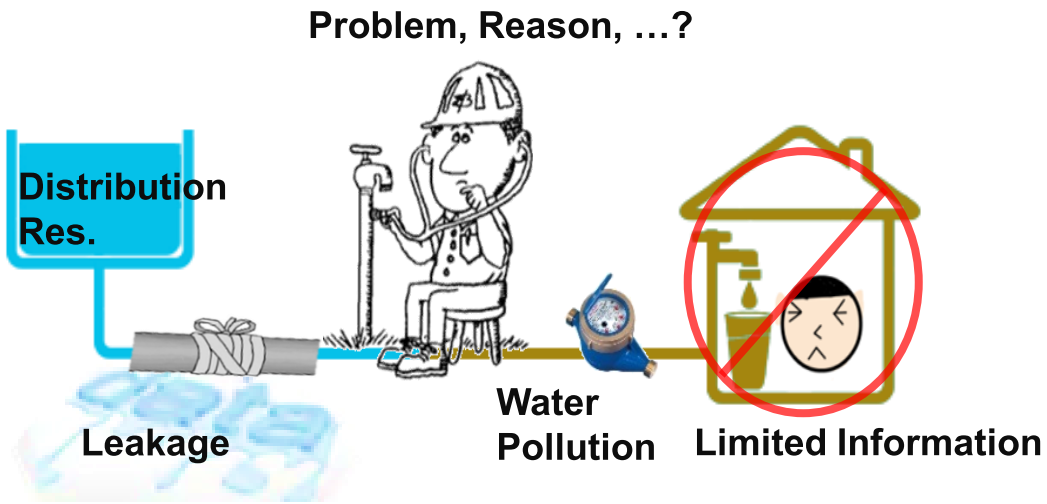
SWG Concept

Optimal Water Supply Network Operation Tech.
to Enhance the Safety, Stability, Efficiency
by Combining ICT to the Existing Water Supply System

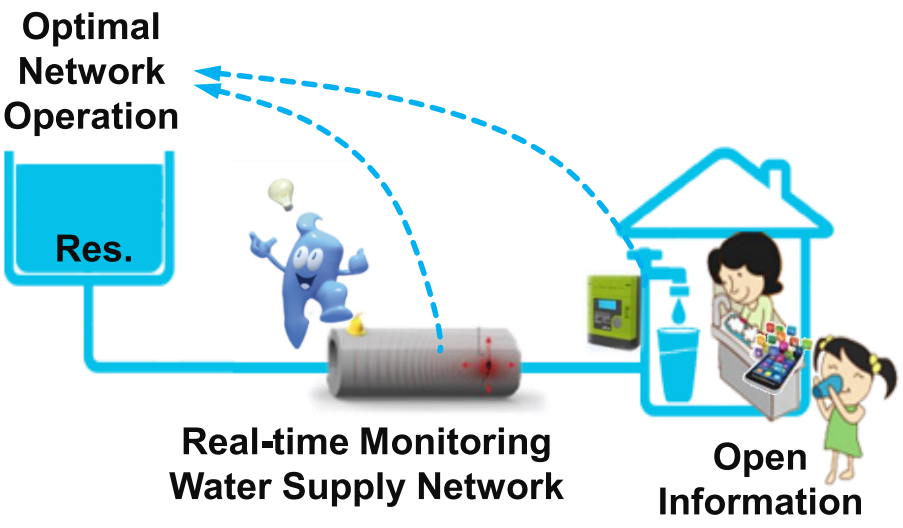
(Raw Water Intake – Water Treatment – Distribution Res. – Water Conveyance)

Traditional Water Grid		ICT Tech. Smart		Smart Water Grid (SWG)
• Supply Control in one-way (Supplier View) • Loss of Water & Energy	+	• Real-time Sensing (water pressure, W.Q, demand,..) • Controlling Water Supply Considering Demand in 2-ways by bringing down to the Customer Level	=	• High Efficiency (by decreasing water loss in conveyance, and saving water by supply & demand control) • High Stability (by integrating the raw water source) • High Safety (by checking W.Q in all processes)

SWG of Concept



To be Smart



SWG at Government Level

Ministry of Land, Infrastructure and Transport

Integrated Management of water resources
As a Raw Water Suppler

- Research Center for River Operation and Mang. to Cope with C.C (’11~’16)
- SWG Research Center (’12~’16) : Development of Practical Tech.

Ministry of Environment

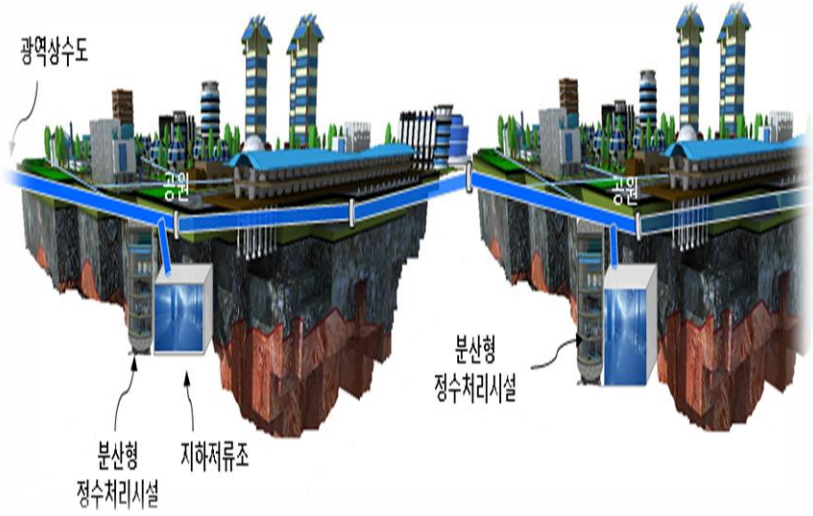
Integrated Operation of the Water Supply
Network at the Customer Level

- Research Center for Eco-Smart Water Works System (’11 ~ ’16)
- Center for Intelligent Water Conveyance Network (’11 ~ ’16)

SWG of K-water

K-water

- Reallocating Water Supply Network System for the Balanced Regional Water Supply
- ICT-based Integrated Water Supply Network Operation Center



< Distributed Water Supply System >

< Integrated Operating Center>

SWG of K-water

SWG – Stable
Water Supply

- Integrating the distributed water intake sources
- Connecting the water supply net. of water agencies
- Replacing the old pipe net.
- Decreasing the water loss using leakage surveillance censor

SWG – Efficient
Water Supply

- Saving Water by controlling water supply using the optimal water net. operation with real-time censoring (water pressure, water use, etc.)

SWG – Safe
Water Supply

- Keeping water clean from intake to home by checking W.Q in real-time

IV . Conclusion

C.C is inevitable.

- 3 Case Studies for C.C Adaption Measures in Korea
  - ✓ 4MRRP: 4 Major River Restoration Project (finished)
  - ✓ IWRM (on-going)
  - ✓ SWG (on-going)
- Monitoring the effects of 4MRRP, Complementing the unexpected problems in adaptive manner

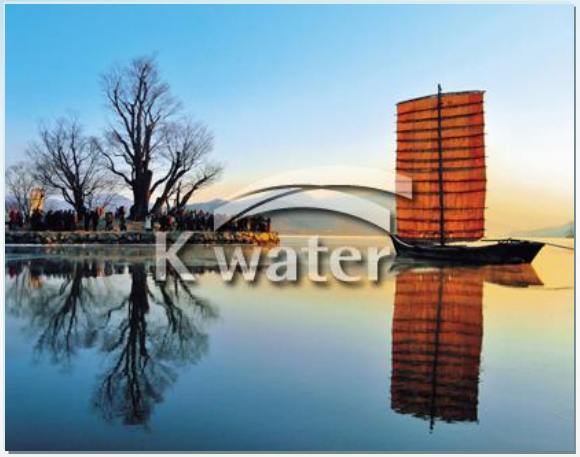
Thailand has an external and internal drivers of flood & drought

- **heavy rainfall, sea level rise, land subsidence**
- **insufficient land-use plan & IWRM**

The success at the on-going water project will lead to the solution to water & food securities for the next generation, so that they are proud of water strong country.

To make the happier world….

Water, Nature and People



Thank You