



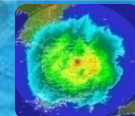
**7<sup>th</sup> World Water Forum**  
**Water for Our Future**

**Vision of Water Resources Assessment**  
**Providing WRA Information**

**KIM HWIRIN**

**Han River Flood Control Office**

**Ministry of Land, Infrastructure and Transport**



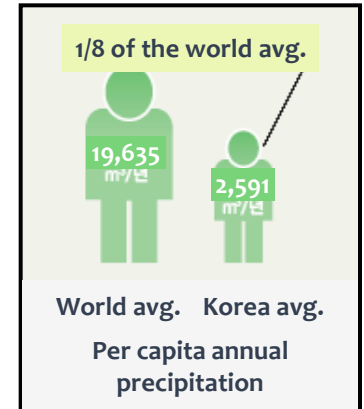
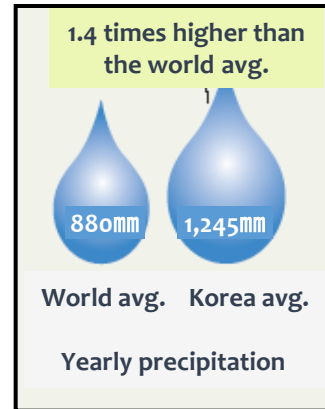
# Contents

1. Introduction
2. Integrated Water Resources Management
3. Water Resources Assessment Information
4. Future Plans for Asia Pacific Region

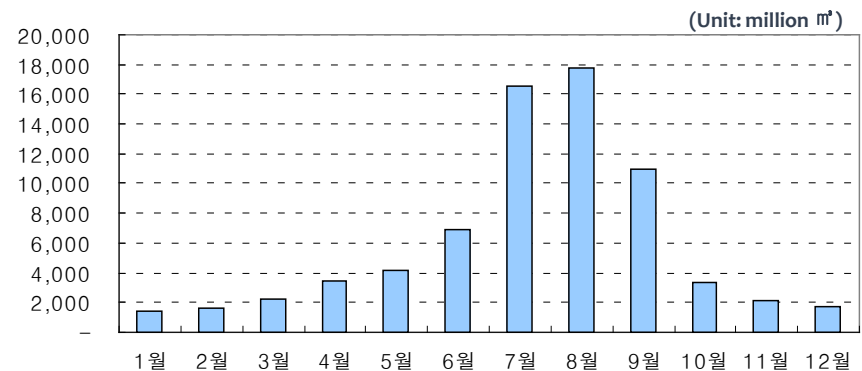
# 1. Introduction

# Water Resources in Korea

- Average yearly precipitation: 1,245 mm (1.4 times higher than the world average)
- Per capita annual precipitation: 2,591 m<sup>3</sup> (1/8 of the world average)



- 75% of precipitation and runoffs are concentrated from Jun. to Sep.
- Precipitation concentrated in Summer → repeated floods and droughts



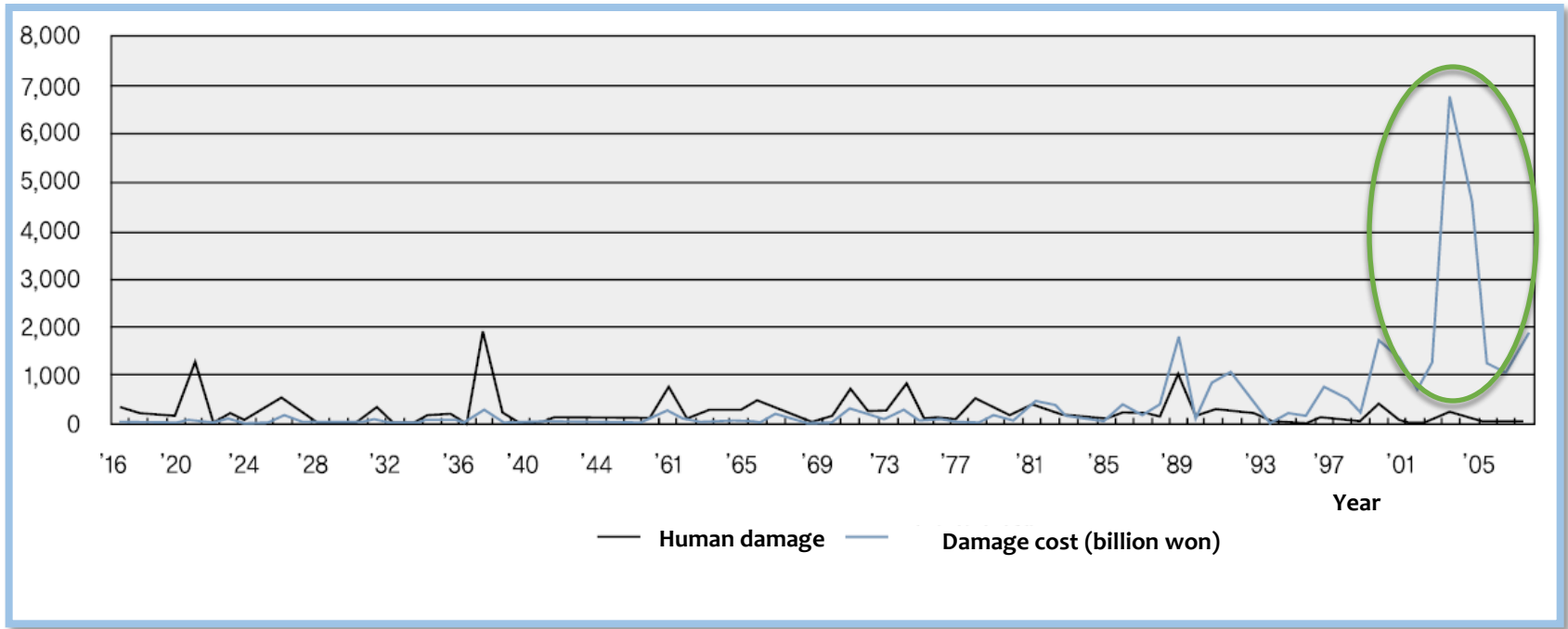
Average monthly runoff





# Annual Trends by water-related disasters

- Increase in economic damages since the last of 1980s



Trend in Damages from in 1916 to in 2007

# Water Resources Management in Korea

- Water Management is Divided into Water Quantity(Flood, Water Shortage Control), Water Supply(Domestic, Industrial, Irrigation), Water Quality and Hydropower Generation
- Each Organization has a Role According to the Functions and Characteristics (Water Quantity and Quality are Managed Separately)



- **Water Quantity** (Flood & Water Shortage Control)
- Water Supply
- Mutipurpose Dams, Rivers
- Groundwater Facility
- Multiregional Water Supply



- **Water Quality**
- Regional Water Supply
- Waste Water Treatment Facility



- **Water Supply (Irrigation)**
- Reservoirs for Agricultural Use



- **Electricity Generation**
- Hydropower Generation of Dams



- **Disaster Rescues with Local Government**

**Flood Control Office**

## **2. Integrated Water Resources Management**

# Four Flood Control Offices

Total Basin Area 99,827 km<sup>2</sup>



**Han River FCO**  
Since 1974



**Nakdong River FCO**  
Since 1987



**Geum River FCO**  
Since 1990



**Seomjin River FCO**  
Since 1990  
(Integrated into  
The Yeongsan River  
FCO in 2005)



**Yeongsan River FCO**  
Since 1991





# FCO – Integrated Water Management

Ministry of Land, Infrastructure and Transport

4 Flood Control Office (FCO)

Han River FCO

Nakdong River FCO

Guem River FCO

Yeongsan River FCO

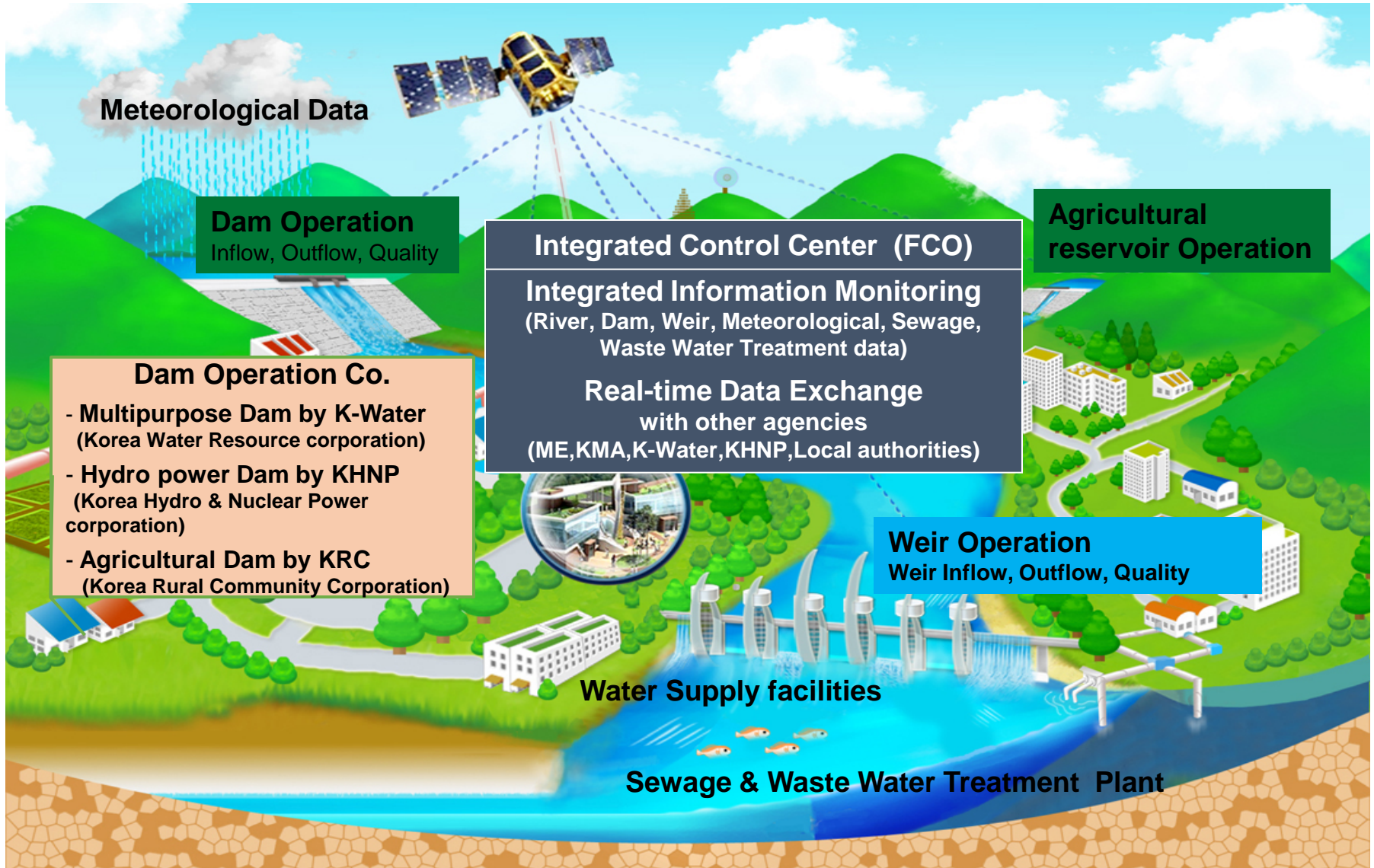
Water Quantity Control

Dam & Weir Operation Control

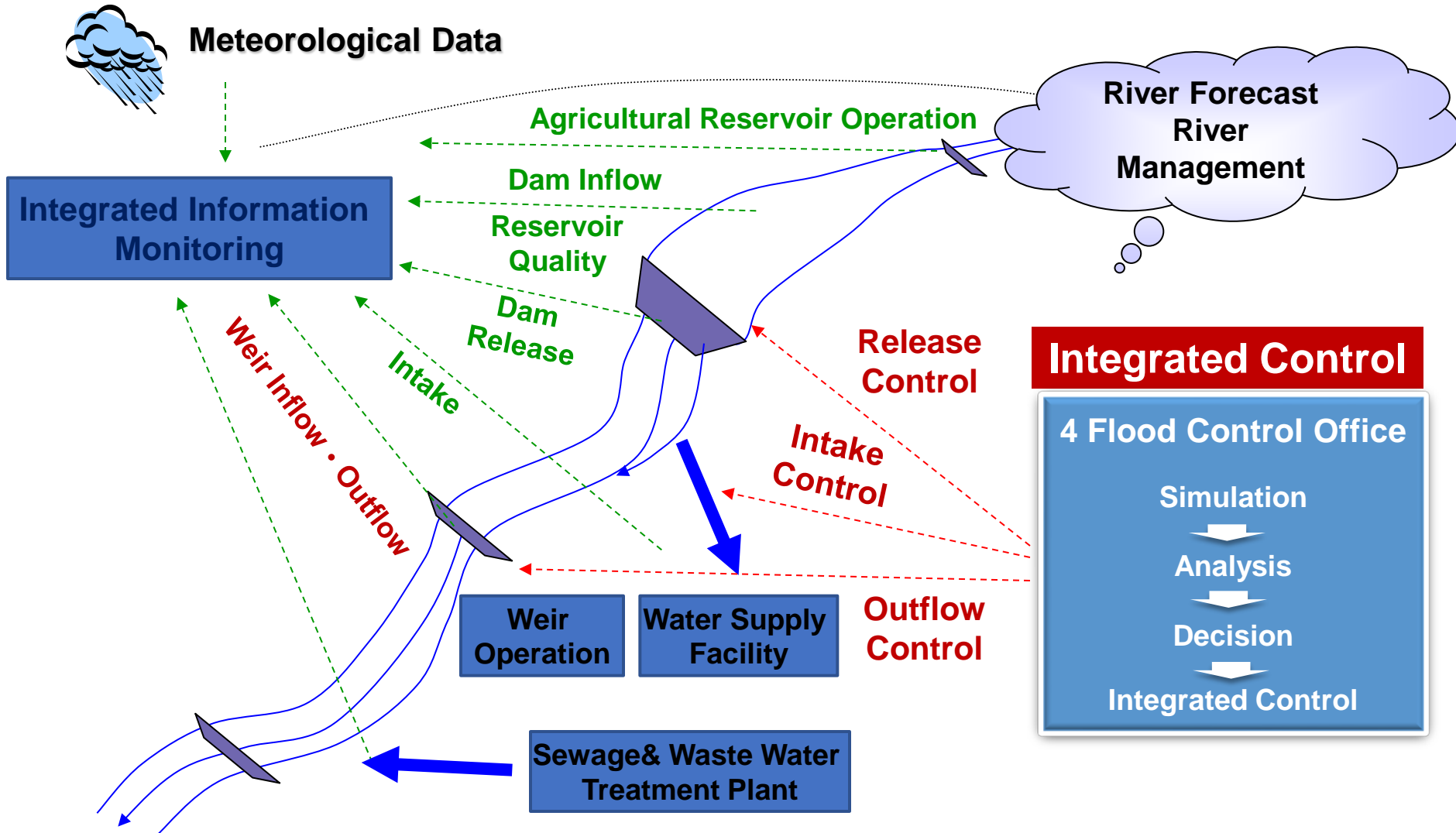
Intake Water Control

Flood & Drought Management

# FCO – Integrated Information Monitoring



# FCO – Integrated Water Management



# FCO – Integrated Water Management

## Real Time River Flow Management (Han River FCO)

- 10 dams at Han river basin (4 dams - flood control capacity)
- FCO approve the Dam release amount & time
  - Comprehensive analysis
  - Upstream + Downstream + Dam Safety + Historical event, etc

### Flood Control Process

Flood Forecasting

Dam Safety

Upstream Analysis

Downstream Analysis

Decision Making

Approve Dam release Amount & Time

Rainfall

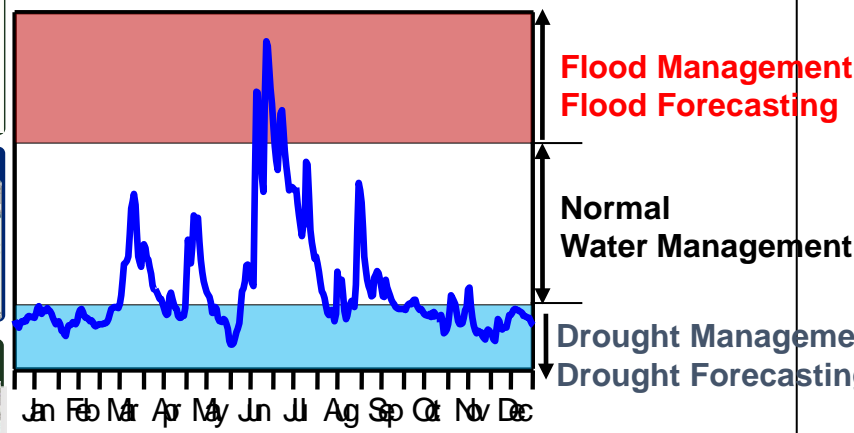
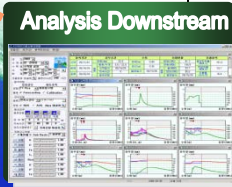
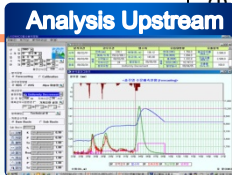
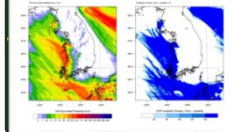
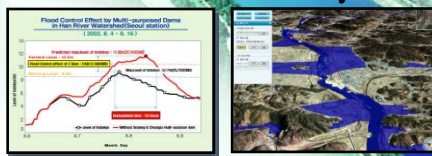
Precipitation Forecasting

Analysis Upstream

Analysis Downstream

Flood Forecasting System

Flood control Effect analysis





# 3. Water Resources Assessment

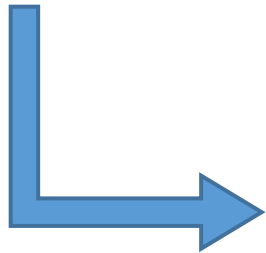
# Water Resources Assessment

## Historic Approach

“Snap-shot” type Assessments

Based on water balance models

Long time-series averages



## Future Approach

Dynamic monitoring of water balance

Based on near real-time information

*(Dr. W. Grabs, 2012)*

## In future water management ...

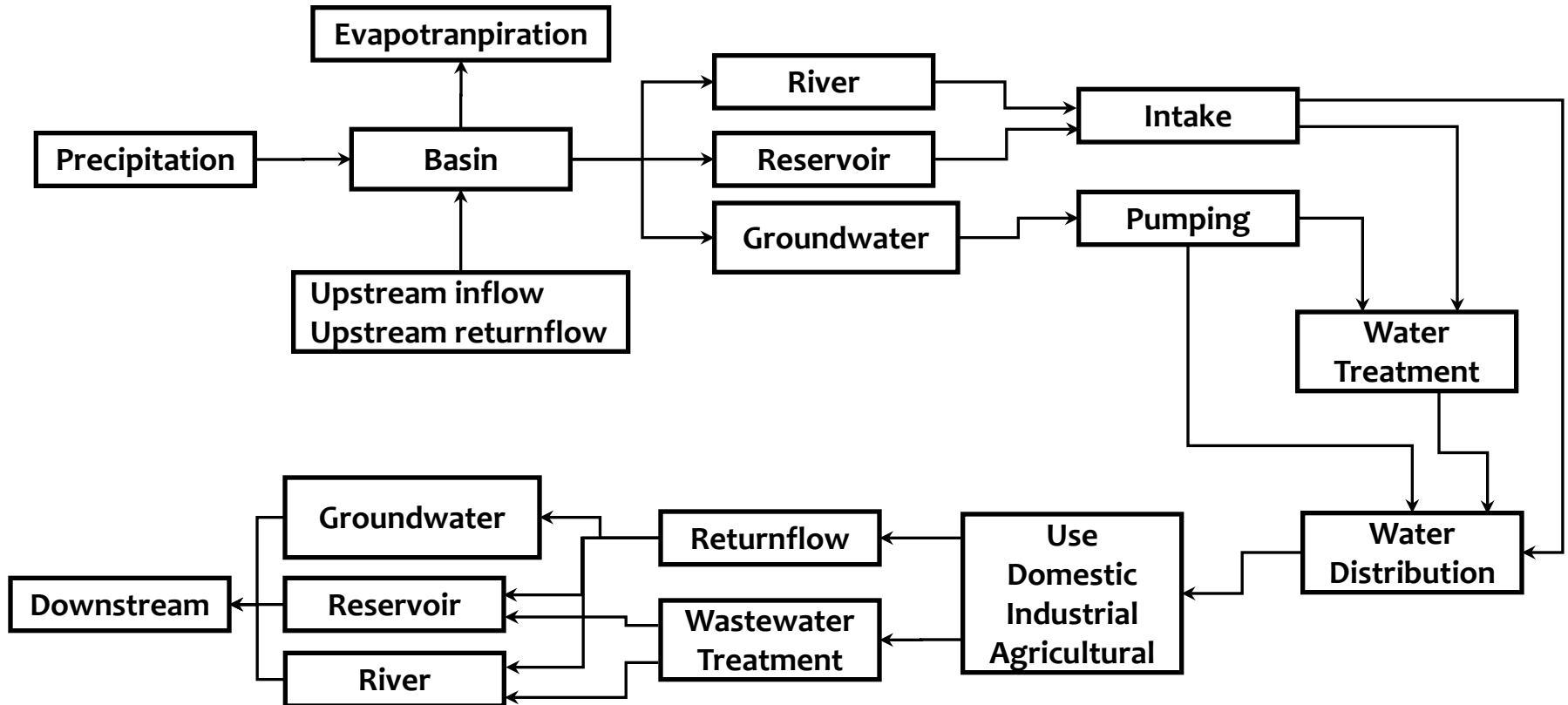
- Increasing role of water storage to buffer (seasonal) variability of water balance
- Increasing role of trans-boundary issues in water demand and supply management and management of conflicts
- Need to solve potential conflicts between model-based Water Resources Management and Consensus-based Water Resources Management involving the social domain

## What we need...

- Improved methodologies and tools (models) for WRA
- Improved methodologies and tools for dynamic adaptation of water management (supply and demand management)
- Action Plans for Adaptive Water Management under climate variability and change, as well as Human factors influencing local and regional water balance (population increase, standards of living, industrialization, agriculture, land- use changes)



# Analysis of water supply and use in river basin



<Major elements of a hydrological system needed for a water budget in Rep. of Korea>



# Dams & Weirs co-operation

## River Act Article 14 (Management Regulations for River Facilities)

(4) The Minister of Land,  
Infrastructure and Transport  
(MOLIT) may, in case where  
necessary  
for prevention of flood damage  
and efficient utilization of water  
resources, formulate  
management regulations for  
systematic linkage operation of  
two or more river  
facilities. <Amended Apr. 1, 2009>



# River Water Adjustment Council

## River Act Article 53 (Adjustment of River Water Use)

**(1) In the case that the state of river water belongs to proper management of river water, the MOLIT may take necessary measures such as limiting the use of river water by the users, adjusting the quantity of permission**

1. It is difficult to secure the flowing water volume for river maintenance at a standard location;
2. There is a possibility to impair public interests unless the permitted quantity of river water is adjusted, due to prolonged drought, etc.;
3. When the user of river water has not used it within the effective period or used a quantity less than permitted, in particular, below the rate determined by Ordinance of the MOLIT; and
4. When it has become difficult to use the permitted river water, etc.

**(3) The MOLIT may organize and operate **the River Water Adjustment Council** as prescribed by the Presidential Decree before adjusting the permitted quantity to reflect the opinions of local residents, etc.**

**(4) The MOLIT, when adjusting the permitted quantity, shall notify thereof to the persons who obtained permission to use river water and the installers of dam, etc.**



# Water Resources Assessment Information

<http://wamis.go.kr>

http://wamis.go.kr/eng/main.aspx#

집(E) 보기(V) 즐겨찾기(A) 도구(T) 도움말(H)

Welcome to Water Management Information S...

Hydro/meteorology Basin River Dam Ground Water Water Use Environment and Ecology Topography Informal Water Resources Media&E

## Water Resources Management Information System

Portal system based on the Internet, built for providing service including water resources information scientifically collected, created, and processed for water related organization.

Water Now Map on 4.13.2015



# Water Resources Outlook

<http://hrfco.go.kr>

갈수 정보  
제공 현황

단계별  
상황

▶ 관심단계 :

한탄강  
경기도- 포천시 연천군  
강원도- 철원군

▶ 심각단계 :

안성천  
경기도- 평택시 안성시

## Water Shortage Information

▶ 모든 하천에 유량이 적정수준 이상 흐르고 있으며, 기준유량보다 125% 미만인 경우에는 갈수예보가 발표됩니다.

▶ [관심단계] 는 해당하천에 필요한 기준유량의 100~125% 수준으로 하천수 사용에는 문제가 없으나, 유량상황이 악화될 경우에는 [주의단계] 로 변경됩니다.

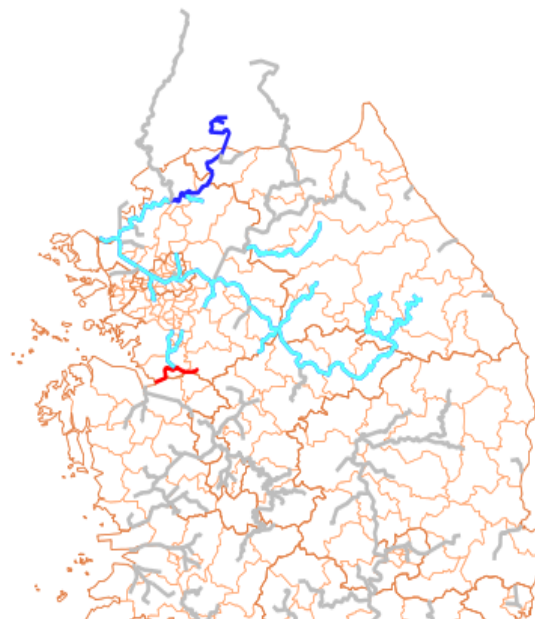
단계

관심

주의

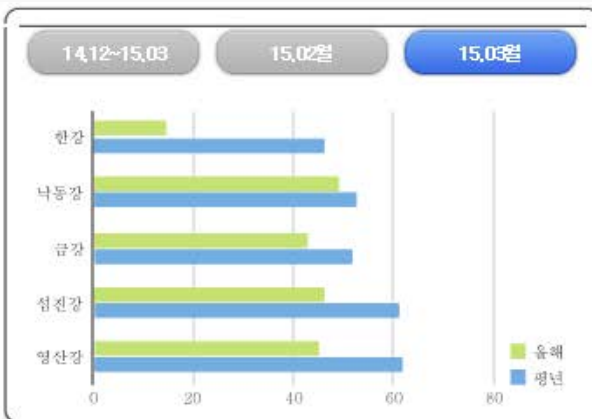
경계

심각



# Water Resources Outlook

<http://hrfco.go.kr>

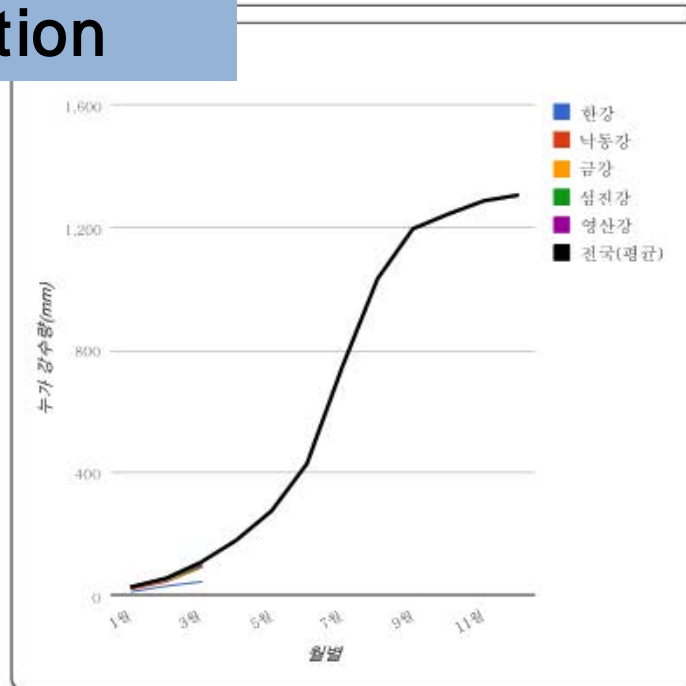
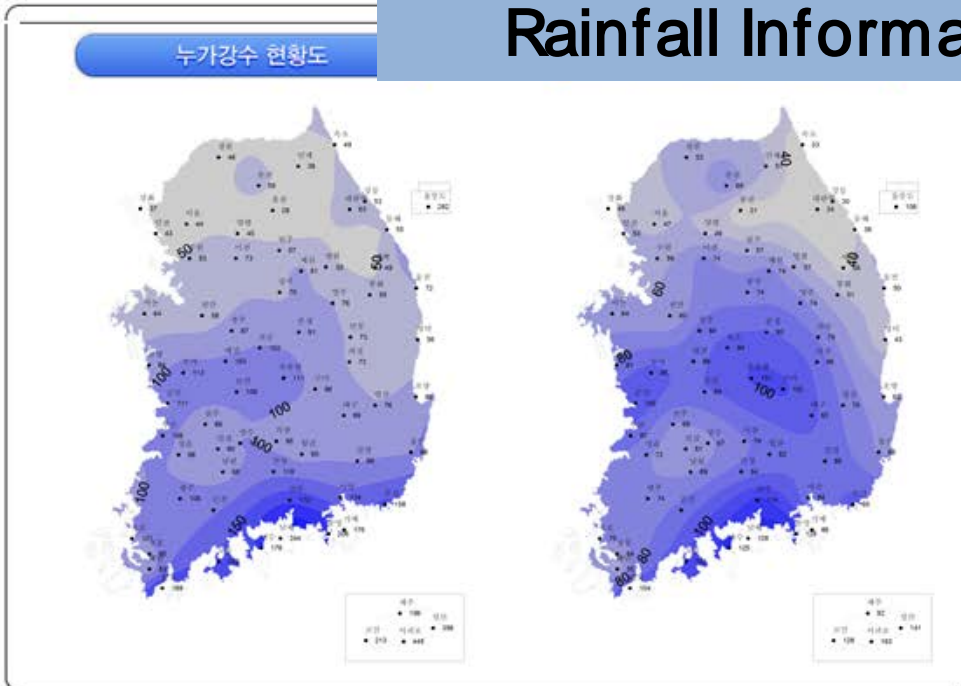


5대강 전체		한강		낙동강	
올해	32.5	올해	14.6	올해	49.3
평년	50.8	평년	46.4	평년	52.9
평년대비	64 %	평년대비	31 %	평년대비	93 %

금강		영산강		섬진강	
올해	43.0	올해	46.4	올해	45.4
평년	51.8	평년	61.2	평년	61.7
평년대비	83 %	평년대비	76 %	평년대비	74 %

## Rainfall Information



# Water Resources Outlook

<http://hrfco.go.kr>

월간 저수현황

Search 2015 년 03 월 검색

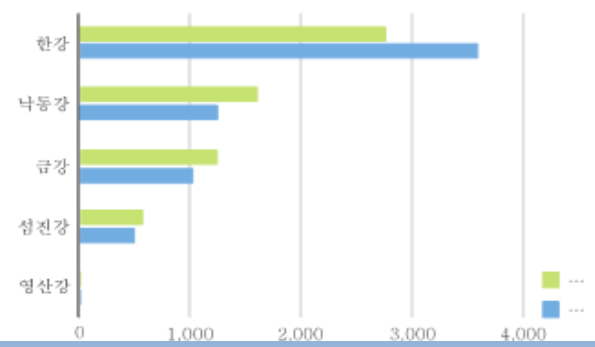
2015년 03월

댐 저수량 **6.252** 백만<sup>3</sup>m<sup>3</sup>  
평년대비 **97 %**

보 저수량 **621** 백만<sup>3</sup>m<sup>3</sup>  
평년대비 **- %**

농업용 저수지 **1.387** 백만<sup>3</sup>m<sup>3</sup>  
평년대비 **103 %**

댐 보 농업용 저수지



5대강 저수량

올해 **6,252**  
예년 **6,456**  
예년대비 **97 %**

한강

올해 **2,780**  
예년 **3,601**  
예년대비 **77 %**

낙동강

올해 **1,617**  
예년 **1,279**  
예년대비 **126 %**

금강

올해 **1,254**  
예년 **1,051**  
예년대비 **119 %**

영산강

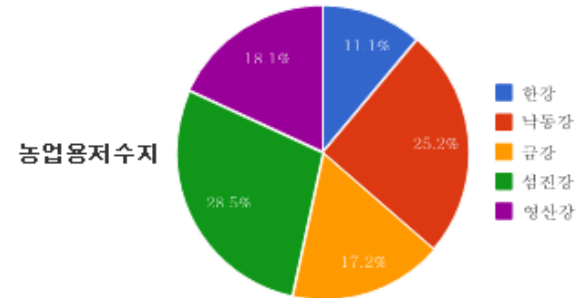
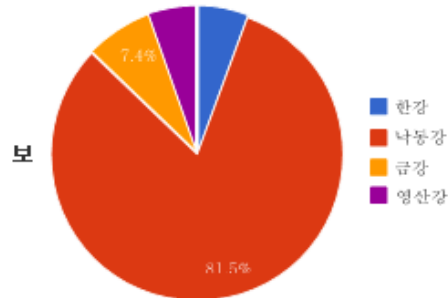
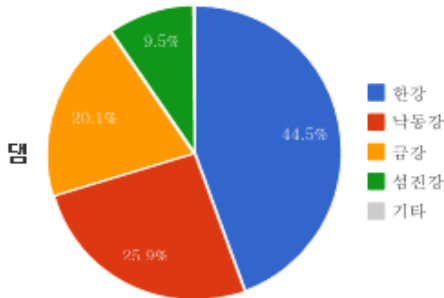
올해 **594**  
예년 **519**  
예년대비 **114 %**

섬진강

올해 **7**  
예년 **6**  
예년대비 **113 %**

수계별 분포도

## Dam, Weir & Reservoir Information



댐 저수현황

구분	댐			보			농업용 저수지		
	예년	올해	비율 (%)	예년	올해	비율 (%)	예년	올해	비율 (%)
합계	6,456	6,252	97	-	621	-	1,352	1,387	103

# Water Resources Outlook

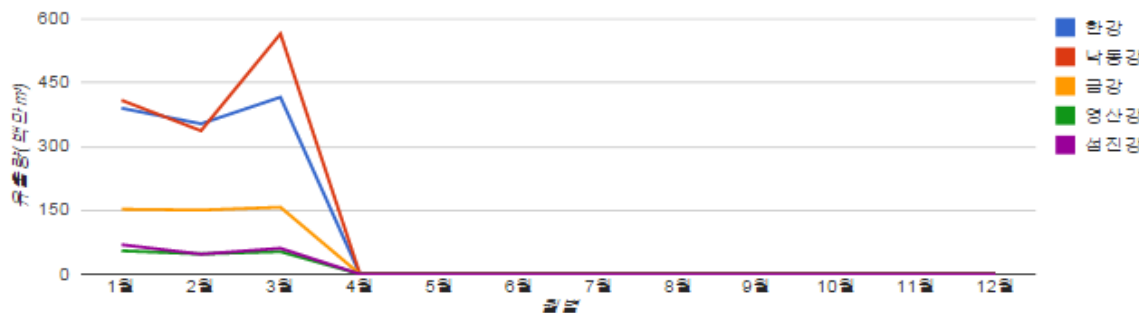
<http://hrfco.go.kr>

2015년 03월 유출현황 (단위:백만㎥)

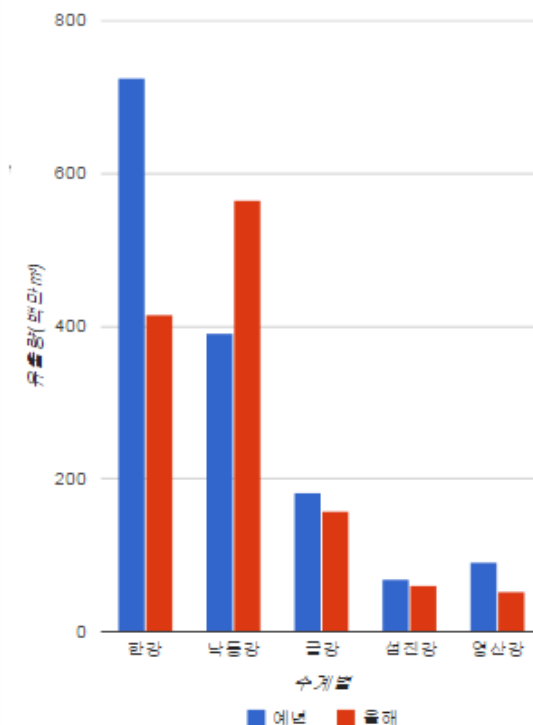
구분	계	한강	낙동강	금강	영산강
올해	1,252	416	565	157	61
예년	1,459	726	390	183	69
예년대비	86 %	57 %	145 %	86 %	88 %

## Outflow Information

월간 유출



수계별 유출량 (단위:백만㎥)



유출현황

구분	2015년 01월 ~ 2015년 03월			2015년 02월			2015년 03월		
	예년	올해	비율(%)	예년	올해	비율(%)	예년	올해	비율(%)
합계	3,681	3,262	89	1,039	935	90	1,459	1,252	86
한강 (한강대교)	1,823	1,159	64	529	353	67	726	416	57
낙동강 (진동)	839	1,310	156	233	337	144	390	565	145
금강 (공주)	602	460	76	132	151	114	183	157	86
섬진강 (송정)	185	177	96	65	47	72	69	61	88
영산강 (나주)	232	155	67	79	47	60	91	53	58




## 4. Future Plans for Asia Pacific Region

# Future Plans



▶ **Water Resources Assessment System**

▶ **Water Resources Assessment Manual**



▶ **Technical Report**  
- Evaluation, Optimization and  
Design of Hydrological Networks



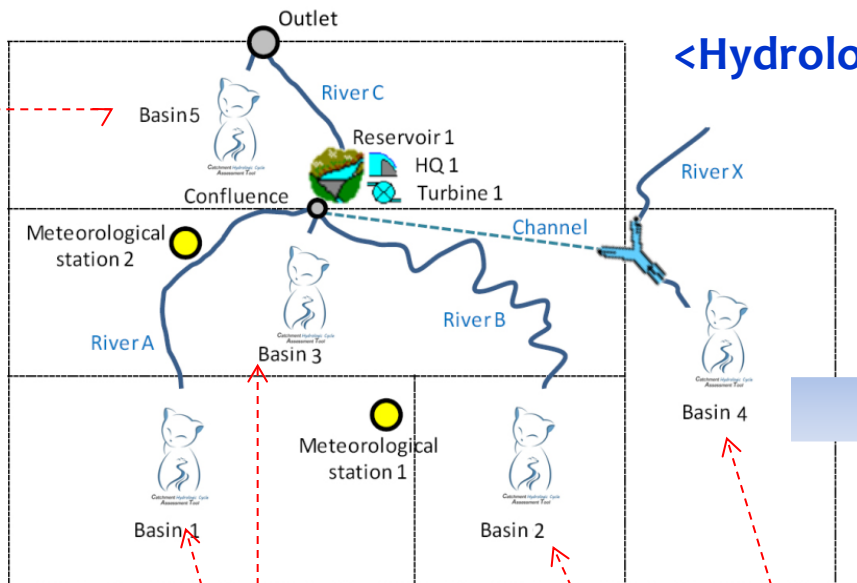
# Development of WMO WRA System

- **Collaboration**
  - Korea / WMO CHy (Commission for Hydrology)/ WMO RA-II (Asia Pacific Region) WGH (Working Group Hydrology) members
- **Period: 2014-2018**
- **After the individual studies, pursue combined analysis lead by RA-II WGHS**
- **Organize “Workshop on Development of Water Resources Assessment Methodologies and System” at 2016 in Rep. of Korea**

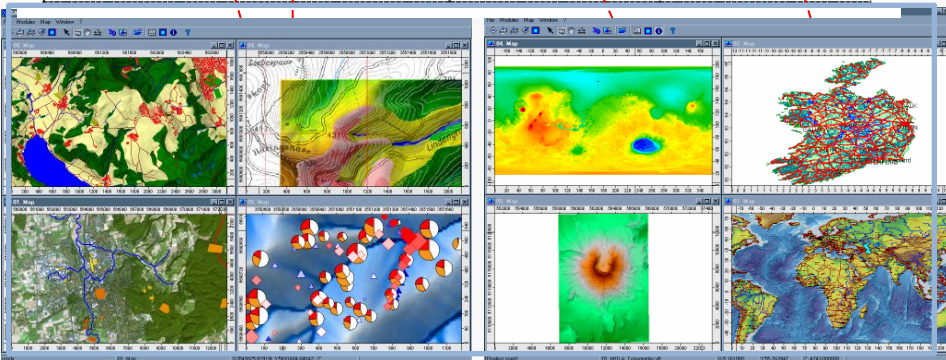
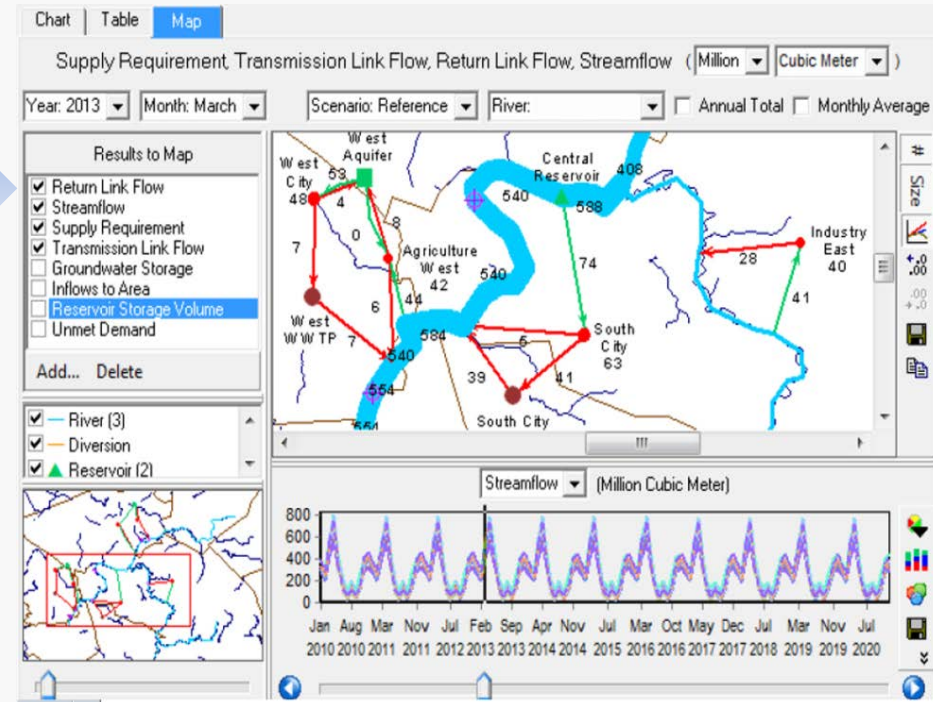


# Development of WMO WRA System

- 2015~2016 : Development of WMO Water Resources Assessment System using the module of Korea Water Cycle Analysis Model (CAT, Catchment hydrologic cycle Assessment Tool)



## <Water Supply & Demand Estimation>

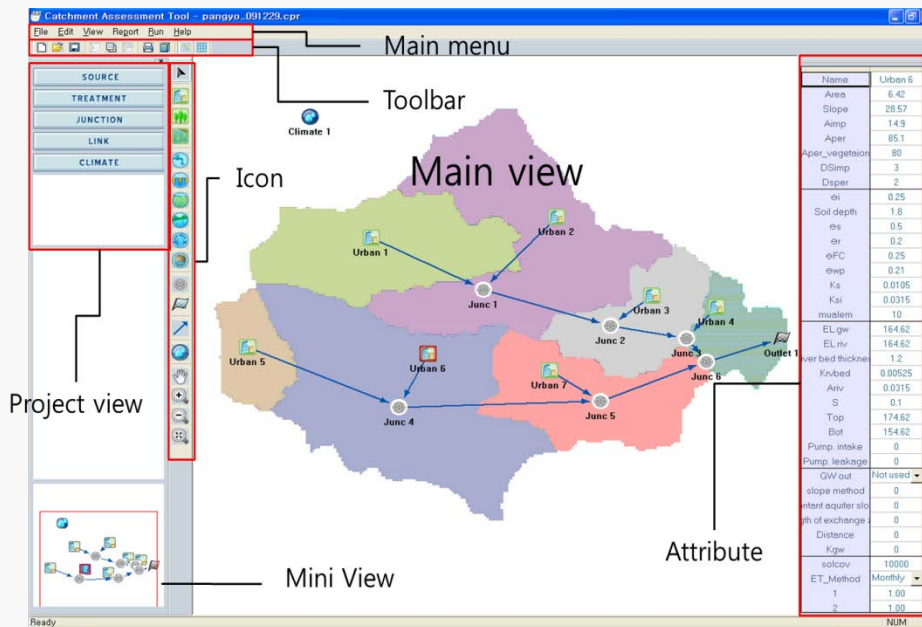


<Using Open GIS Tool for the parameters>



# Development of WMO WRA System

- 2015 : 1<sup>st</sup> pilot study in Korea
- 2016 ~ : Training Course & Pilot study for the volunteer countries including WMO RA-II (Asia Pacific) members
- 2016~ : Providing the WRA System & Manual



<WMO WRA System Example>

## ❖ WMO WRA Manuals Review

- **Water Resource Assessment Activities – Handbook for National Evaluation (1988, WMO & UNESCO)**
  - Apply to Australia, Germany, Ghana, Malaysia, Panama, Rumania, Sweden
- **Water Resources Assessment – Handbook for Review of National Capabilities(1997, WMO & UNESCO)**
  - Revision in 1988
  - Comprehensive Freshwater Assessment
- **Technical Material for Water Resources Assessment (2012, WMO CHy)**
  - Revision 2004 ~ 2012 (8 years)
  - Application of Geological Information by Remote Sensing
  - Manual Process 2013 ~ 2016 (Korea & Brazil)

# WMO Water Resources Assessment Manual

- Review the WMO WRA Handbook & Technical Material
- WMO Experts Opinon

WRA Handbook (WMO/UNESCO, 1997)	Technical Material for WRA (WMO, 2012)	WRA Manual (WMO, 2016)
Review of national capabilities	Improved guidance how to quantify sustainable long-term WR	Guidance to generate information needed for decision making processes in WR management
Basic WRA	Basic WRA + (e-flow, climate change, alternative water, etc.)	Basic WRA + (e-flow, climate change, alternative water, etc.) + Decision making process of WR management
Long-term WRA (WR planning)	Long-term WRA (WR planning)	Long/short-term WRA (WR planning/operation)

# WMO Water Resources Assessment Manual

- Sep 2014 WMO consultant drafting contents
- Oct 2014 Experts Teleconference
- 2015 Compose the Experts team
- 2015 Draft and Review a WRA Manual
- 2016 Complete WRA Manual





# WMO Technical Report

## WMO Evaluation, Optimization and Design of Hydrological Networks (Title)

### 1. Importance of optimal hydrological networks

- Hydrological processes and their different behaviors
- Long-memory and short-memory processes
- Different spatial and temporal scales
- Basic concept of sampling network design
- Additional considerations required for hydrological network design

### 2. History of hydrological network design

- Precipitation
- Runoff (and water stage)
- Soil moisture
- Evaporation and Transpiration
- Groundwater
- Etc.

### 3. Design practices of hydrological network design

- Precipitation
- Runoff (and water stage)
- Soil moisture
- Evaporation and Transpiration
- Groundwater
- Etc.

### 4. Evaluation and optimization of hydrological network design

- Precipitation
- Runoff (and water stage)
- Soil moisture
- Evaporation and Transpiration
- Groundwater
- Etc.

### 5. Multi-sensor networks for Monitoring hydrological processes



# WMO Evaluation, Optimization and Design of Hydrological Networks (Title)

- 2014 Decide the Contents
- 2014 Draft the Technical Report
- 2015 Review and Modify the Technical Report by Experts
- 2015 Submit the final Technical Report (English Version)

Thanks for your attention  
[hydro@korea.kr](mailto:hydro@korea.kr)

