3rd Session of WMO RA II WGHS

Water for Our Future

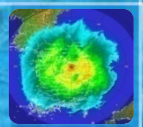
WRA current status and issues in Republic of KOREA

KIM HWIRIN

Han River Flood Control Office

Ministry of Land, Infrastructure and Transport




Changes in Policies for Water Resources

1966~1975(1st)

Multi-purpose dam plans for flood control, irrigation, and energy development in response to increased demand for water resources

1976~1981

Integrated River Basin Development Plan of the four major rivers, Han River, Nakdong River, Geum River, Youngsan River

1981~2001(2nd)

Stable water supply, reduction of natural disasters, improvement of hydropower resources

1991~2001(3rd)

Reasonable development and effective use and management of water resources

1997~2011

Efficient use and management by active demand management and environmentally friendly and sustainable water resource development

2001~2020(4th)

Sound use of water and formulation of friendly and safe water environment

2006~2020

Sustainable water management of people and the natural desire

Status of Water Resources and Prospects

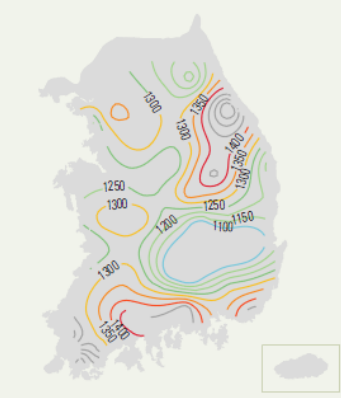
Topography

- 1,300 km long and 300 km wide, is located on the northeastern region of the Asian Continent
- Rivers running to the eastern coast are short in length and steep in their riverbed gradients.
- Long stretching rivers with mild gradient such as the Han River, the Nakdong River, and the Geum River discharge to the southern or western coasts

Topography

Climate

- Korea is in the moderate climate zone of medium latitude, having four definite seasons-spring, summer, fall, and winter
- The average temperature throughout the year is 10~16 ℃ except the central mountainous area
- The hottest month of year is August with 23~27 ℃ ; the coldest month is January with -6 ~ -7 ℃
- Annual precipitation is 1,100~1,400 mm in the central part and 1,000~1,800 ㎜ in the southern area with two-thirds of the annual precipitation occurring in the summer rainy season

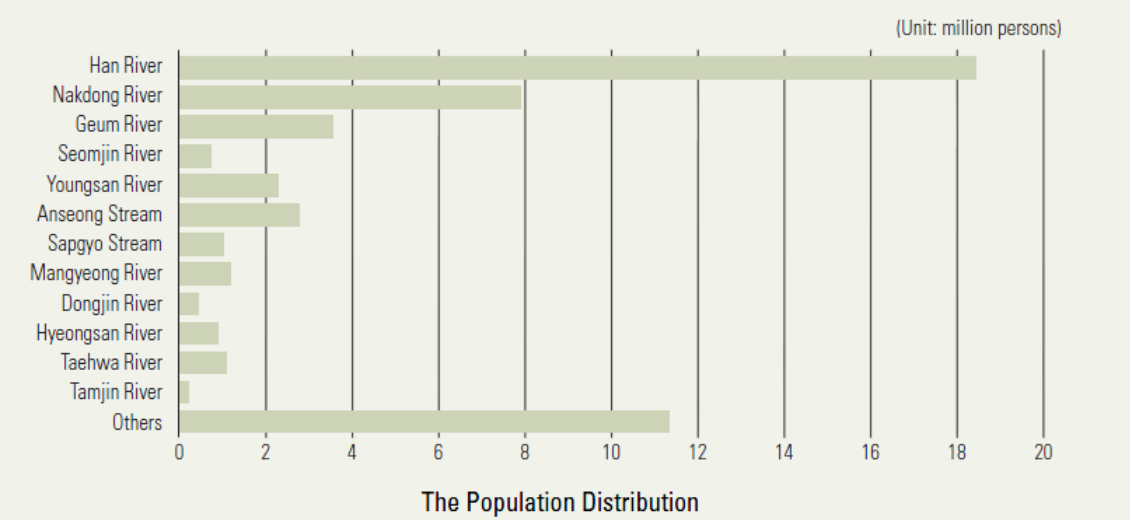


Annual Average Precipitation

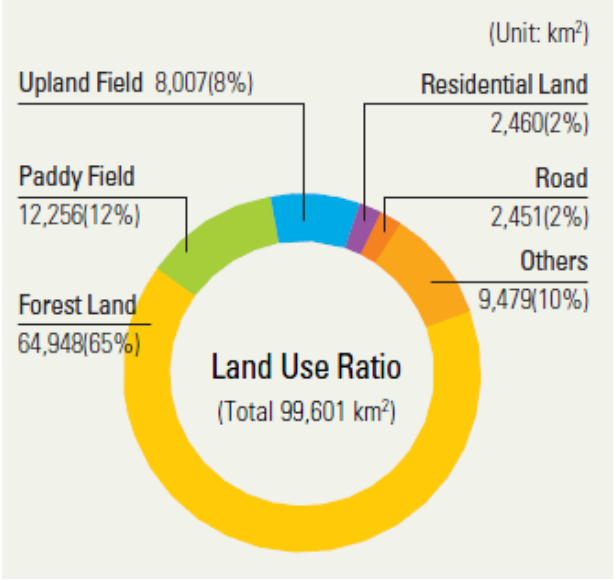
Status of Water Resources and Prospects

Population and Land Use

- As of 2004, the population of Korea was estimated about 47.9 million persons with a population density of 492person/㎢, which ranks as one of the highest in the world along with Bangladesh, the Netherlands, and Belgium
- The total land area is 99,601 ㎢. Farm land constitutes 20,263 ㎢ (20%), while forest covers 64,948 ㎢ (65%). Only 4 percent of the total land area is used for housing, public, and industrial land



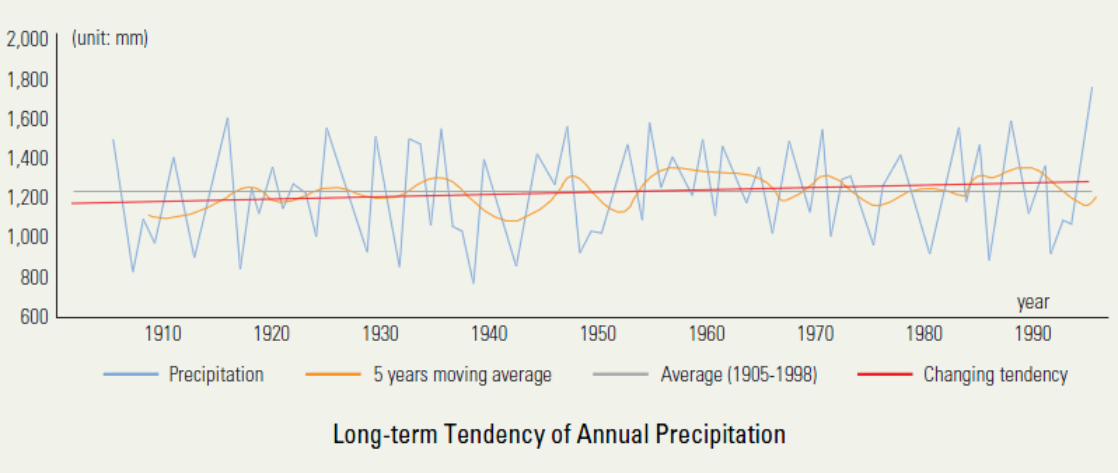
The Population Distribution



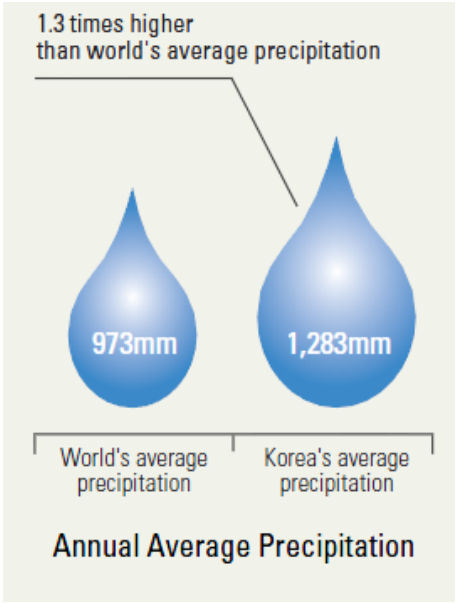
Status of Water Resources and Prospects

Precipitation

- Although the annual precipitation in Korea is 1,283 ㎜, or about 1.3 times larger than the global average of 973 ㎜, the per capita precipitation is about 2,705 ㎥, which is approximately 12 percent of the world's average (approximately 22,096 ㎥)
- The annual precipitation has tended to increase slightly over the past 100 years
- Two-thirds of the annual rainfall is concentrated in the rainy monsoon period from June to September
- The annual average runoff volume is 73.1 billion ㎥, which constitutes 57 % of the annual average volume of precipitation of 127.6 billion ㎥



Long-term Tendency of Annual Precipitation

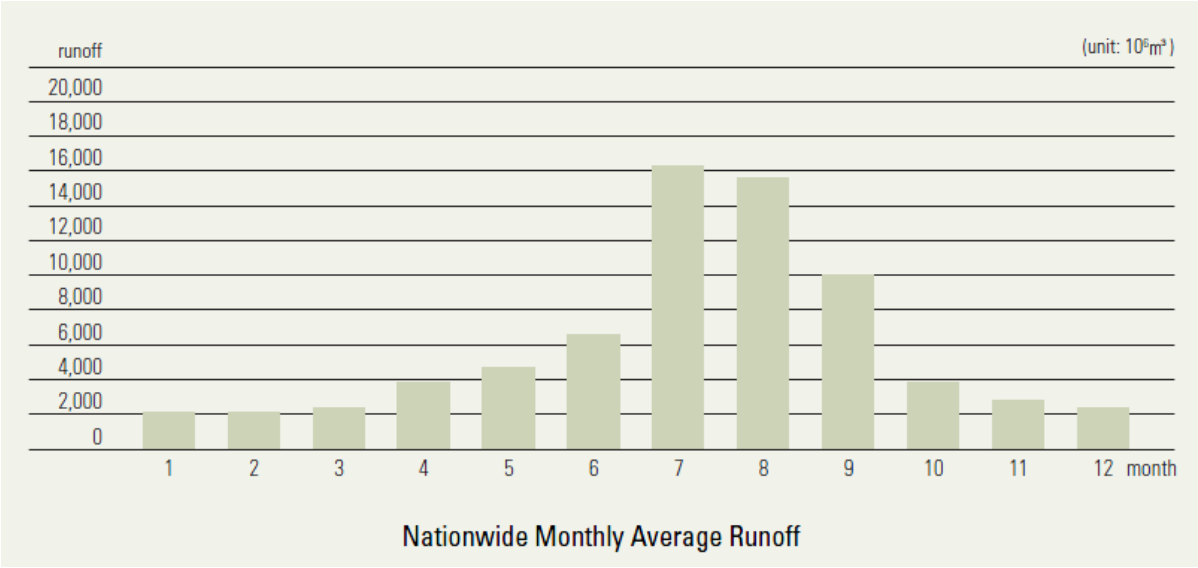


Annual Average Precipitation

Status of Water Resources and Prospects

Runoff

- The runoff ratio of 57% is somewhat large value. Korea's basin area is relatively smaller than that of the United States or Europe, because short river lengths and heavy rainfalls cause large discharge in a short period
- The monthly average runoff volume of June to September, as with precipitation, constitutes 2/3 of the annual volume
- Unlike overseas rivers, the flow of Korea's rivers is unstable due to large seasonal variations in precipitation and discharge

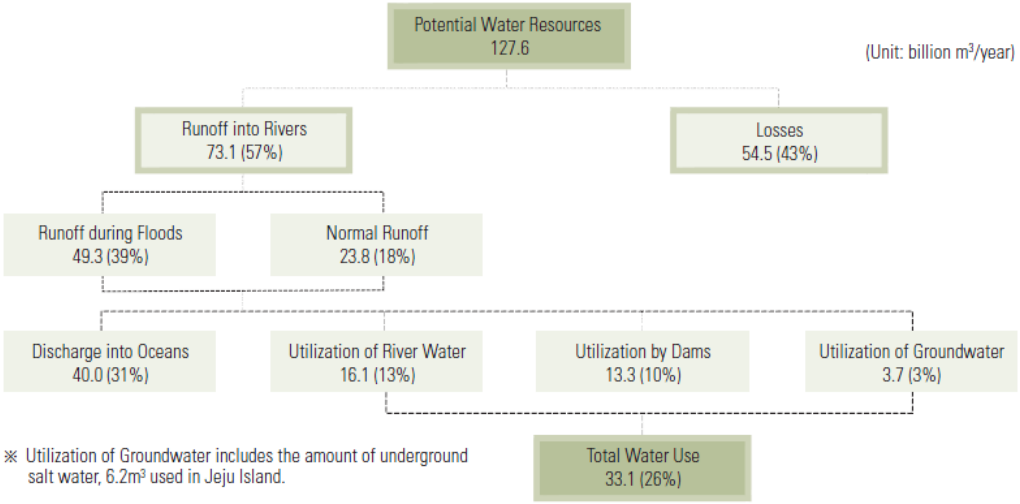


Nationwide Monthly Average Runoff

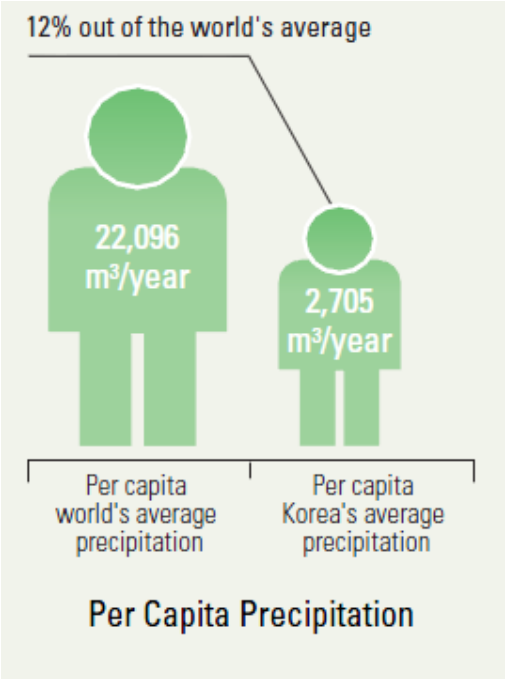
Status of Water Resources and Prospects

Water Resources Utilization

- **Annual average volume of water resources is 73.1 billion ㎥, which constitutes 57 % of the annual average precipitation of 127.6 billion ㎥ and per capita available water resources is 1,500 ㎥**



Status of Water Resources Utilization

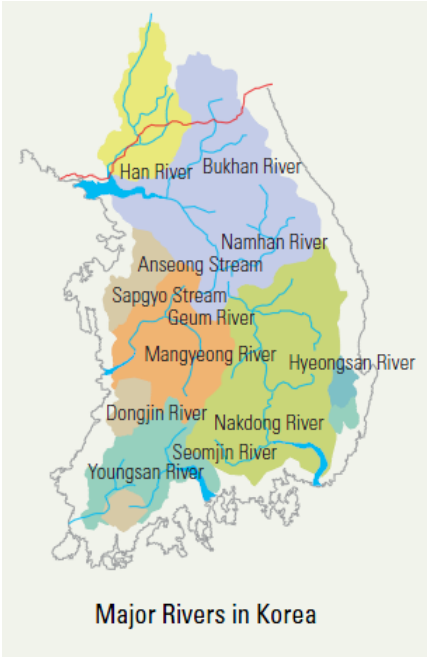


Per Capita Precipitation

Status of Water Resources and Prospects

Characteristics of Rivers

- **The largest river in South Korea from the viewpoint of basin area and annual discharge is the Han River, while the longest river is the Nakdong River**
- **Among the ten major rivers, the Seomjin River has the highest precipitation per unit area in the basin**



Major Rivers in Korea

Status of Major Rivers

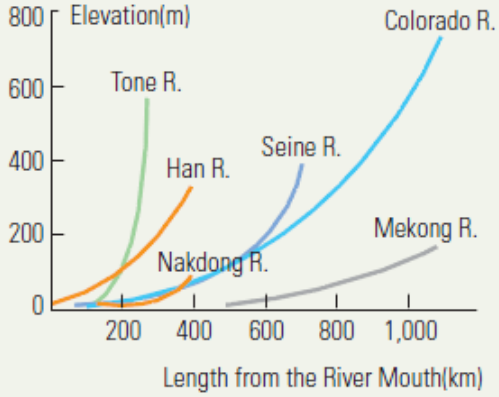
Name	Basin Area (km^2)	Length (km)	Mean Annual Runoff (100 million m^3)	Mean Annual Precipitation (mm)
Han River	25,954(35,770)※	494	189	1,301
Nakdong River	23,384	510	138	1,186
Geum River	9,912	398	66	1,272
Seomjin River	4,960	224	39	1,412
Youngsan River	3,468	137	27	1,318
Anseong Stream	1,656	76	13	1,269
Sapgyo Stream	1,650	59	10	1,235
Mangyeong River	1,504	81	10	1,254
Hyeongsan River	1,133	63	6	1,138
Dongjin River	1,124	51	8	1,278

※ ( ) represents total area of the Han River included North Korea's part.

Status of Water Resources and Prospects

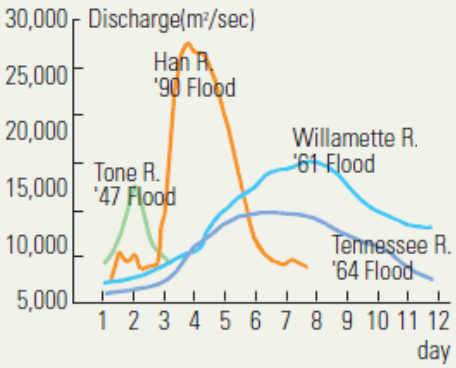
Characteristics of Rivers

- **The river lengths are relatively short and channel slopes are steep**
- **Flooding occurs quickly and peak flood discharges are great**
- **Flow variations are large**
  - The coefficients of the river regime, expressed by maximum discharge over minimum discharge, for five major rivers in Korea are an average of over 300 in natural river condition due to fluctuant annual precipitation



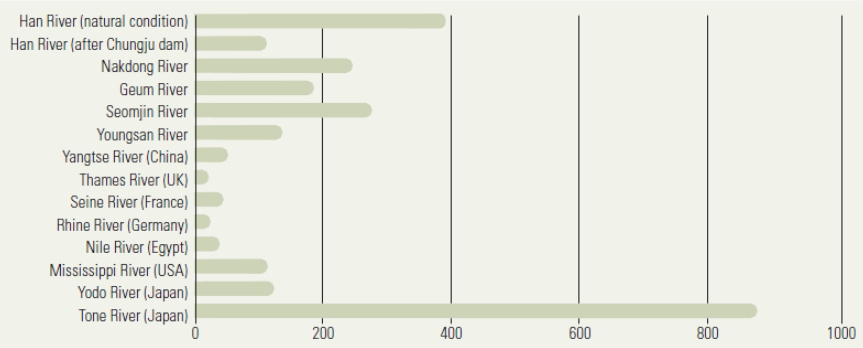
Channel Slopes

* Tone R.(Japan), Seine R.(France), Colorado R. (USA),



Flood Hydrographs

* Tone R.(Japan), Willamette R. & Tennessee R. (USA)



The Coefficients of the River Regime of Five Korean Major Rivers and Foreign Major Rivers

Vision and Policy Objectives

Sound use of water and formulation of friendly and safe water environment

Stable supply of clean water

Advancement of water resources management and technology

Formulation of flood resistant land

Formulation of eco-friendly water environment

Stable supply of clean water

Establishment of Mid and Long-term Water Supply Plan

- Regarding long-term plans for water resources, Korea has Long-term Comprehensive Water Resources Plan, Long-term Plan for Dam Construction, and Waterworks Management Plan
- These plans are established every decades, and revised or added to every five years or when needed. In order to reach a societal agreement on water resources policies, a council is formed with related administrations, water experts, and NGO, consulting every process of making policies

Comprehensive Long-term Water Resources Plan

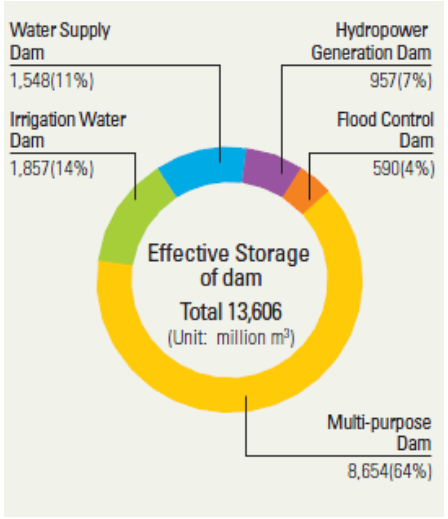
- This is the nation's highest plan for water resources utilization, development, and conservation
- Main contents of the plan are as follows: ① Projection on water demand and supply, ②Water use plan, ③Flood control plan, ④River environment plan, ⑤Water resources investigation, assessment, research, and development plan

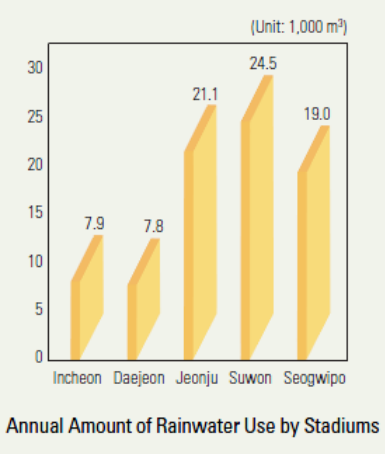
Waterworks Management Plan

- This is the nation's basic plan on multi-regional and industrial water supply

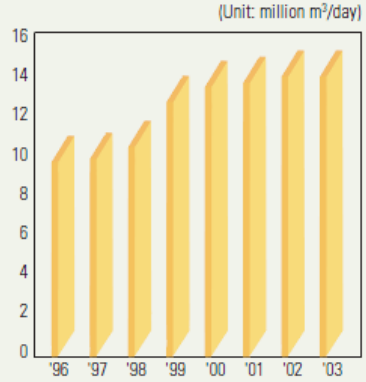
Stable supply of clean water

- Construction of Dams harmonized with Local Areas
- Formulation of Multi-regional Water Supply
- Systematic Management of Groundwater
- Development of Supplementary Water Resources to Diversify Water Sources

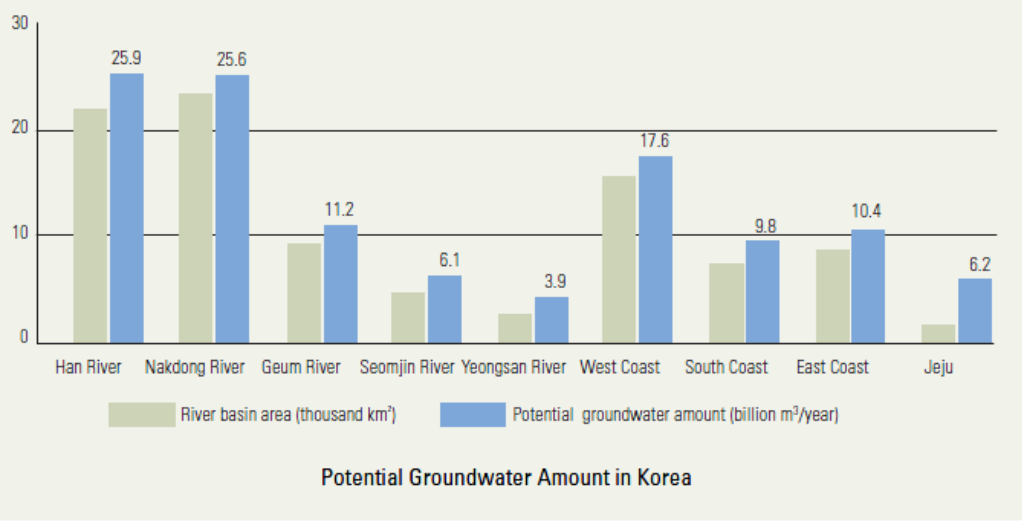




Annual Amount of Rainwater Use by Stadiums



Mult-regional Water Supply Facility Capacity



Potential Groundwater Amount in Korea

Formulation of flood resistant land

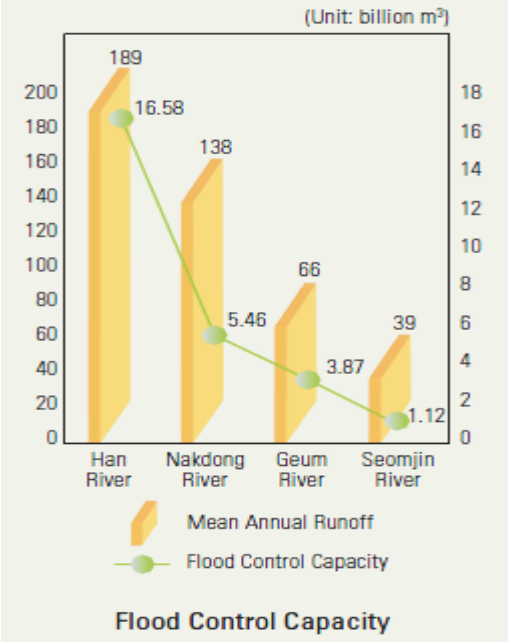
- **Permanent Measures of Flood Damage**

  - Dam, Levee, Comprehensive River Basin Flood Control Plan, Systematic Expansion of Investment on River Improvement Project, Strengthening Government-led River Management

- **Increasing Current Dams' Flood Control Capacity**

- **Improvement of Flood Forecasting System**

- **Cooperation of Water Resources Shared by South and North Korea**



Flood Control Capacity

Major Rivers Shared by South and North Korea

Formulation of eco-friendly water environment

- **Close-to-Nature River Improvement Projects**

  - Establishment of Environment Friendly River
  - Maintenance Plan; Residential Participation Plans, River Management Plan by Area, Environment Friendly Flood Control Method

- **Formulation of Environment Friendly**

- **New Water Culture Along the River**

* Gyeongan River (Gyeonggi-do)

* Yangjae River (Seoul)

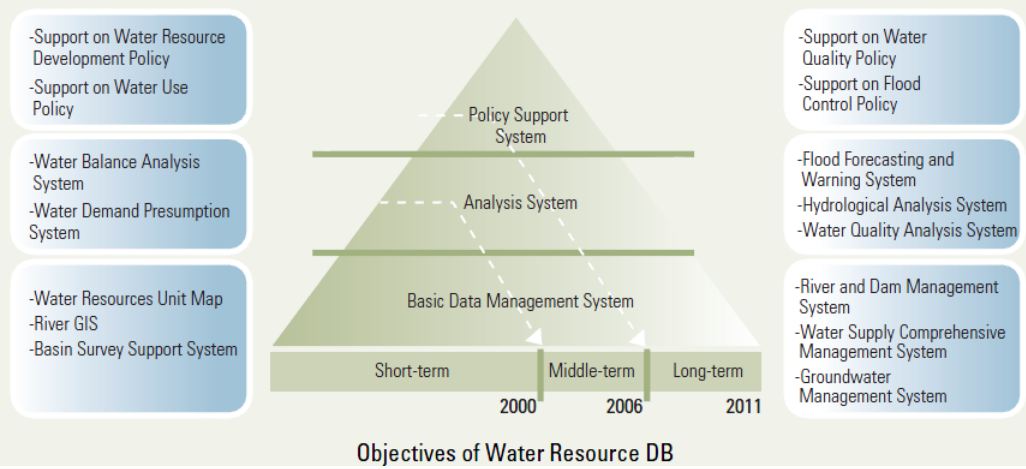
* Taehwa River (Ulsan)

* Dorim River (Seoul)

* Hwamyeong River (Busan)

Advancement of water resources management and technology

- **Water Resources Investigation**
- **Water Resources Information**
  - Water Information Management
  - Groundwater Information Management System
  - Multi-regional Water Supply Integrated Management System
- **Development for Water Resources Assessment Methodologies**



Objectives of Water Resource DB

* Paldang Multi-Purpose Dam

Technology Development for Water Resources Assessment

Background

- Water resources assessment (WRA) is a tool to evaluate water resources in relation to a reference frame, or evaluate the dynamics of the water resource in relation to human impacts or demand
- It is part of the IWRM approach, linking social and economic factors to the sustainability of water resources
- Depending on the objective of the assessment, WRA may look at a range of physical features in assessing the dynamics of the resource
- Assessments for large or long-term projects need to include examination of changes in land use and possible soil degradation as well as climate variability and change

Establishment of WRA System

- Effective water resource policy and planning requires comprehensive, consistent and robust information on water generation, distribution, storage, availability and use
- To meet this need, We want to provide crucial information for managers, planners and policy makers
- We developed the **Dynamic Water resources Assessment Tool (DWAT)**
- This continental-to-regional scale water balance modelling system supports reporting and assessment of water flows and stores on a daily time scale

Technology Development for Water Resources Assessment

Development of DWAT System

- The DWAT system has a landscape model component and a river model component that were developed and validated against a range of data sources
- For the first time, we have a tool that can consistently account for important aspects of water resources, including runoff and river flow, soil water storage, groundwater recharge for some area in KOREA

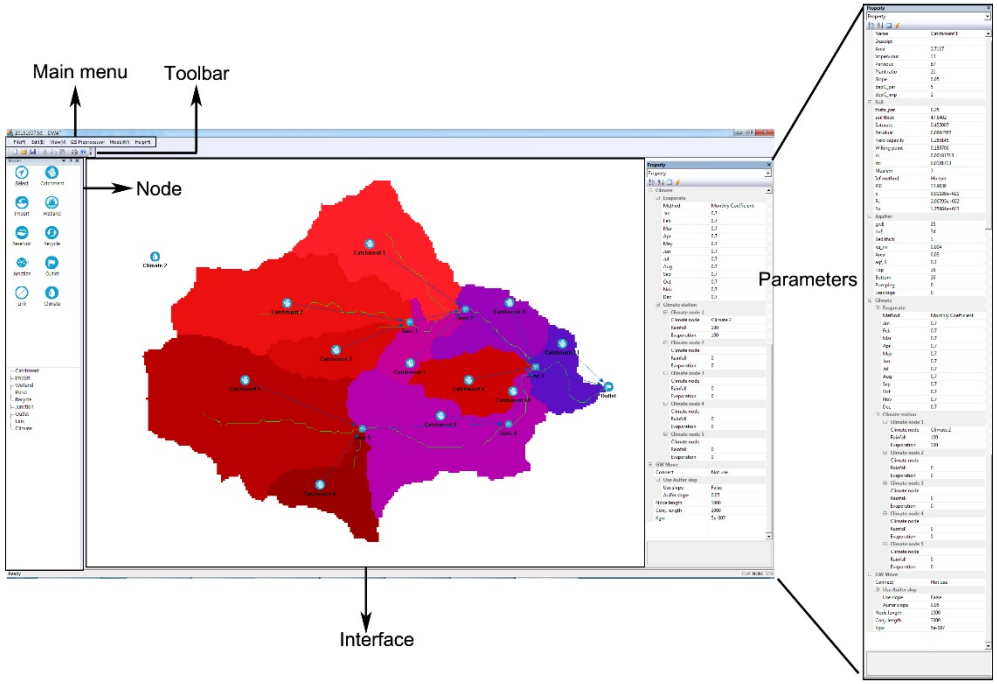
DWAT Overview

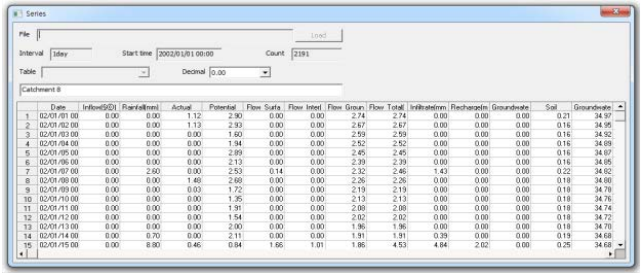
- DWAT has basic hydrological functions and is consisted of pre-process and water balance process
- DWAT is a continuous, long-term, and physical parameter model designed to simulate the runoff of pervious and impervious zones separately
- Hydrologic components such as infiltration, groundwater flow, evapotranspiration, channel routing, etc.

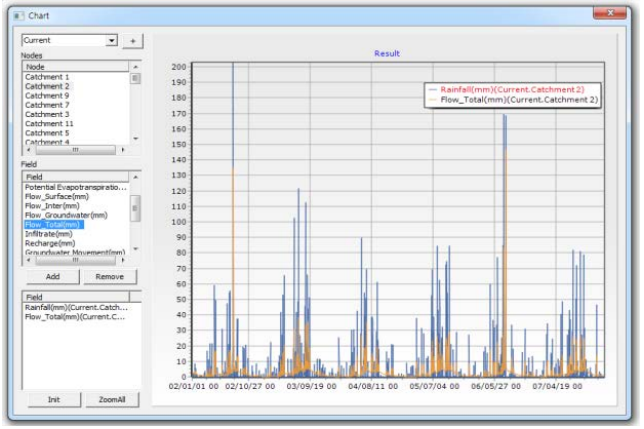
Technology Development for Water Resources Assessment

Characteristics of DWAT

- Physical parameter-based link-node type model
- Quantitative assessment of the characteristics of the short/long-term changes in water cycles
- Simple, practical and easily accessible
- Guaranteed satisfactory results with minimal data and efforts
- Easy user convenience system (GUI)
- Provision of results through diverse tables and figures







Technology Development for Water Resources Assessment

- **2016. 11: pilot study in Korea**

  - After the individual studies, pursue combined analysis lead by RA-II WGHS

- **2016. 12: Pilot study for the volunteer countries including WMO RA-II members**

- **2016. 12: Providing the DWAT System & Manual**

- **Organize "Training Course & Workshop on DWAT System" in 2017**

- **Collaboration**

  - Korea / WMO CHy (Commission for Hydrology) / WMO RA-II (Asia Pacific Region) WGHS (Working Group on Hydrological Services) members

  - We will reflect your needs and requirements for the DWAT system

WORKPLAN: Water Resource Assessment

Review of Work Programme in Gyeongju, Republic of Korea

- The overall objective of work on water resources assessment is to provide useful and accurate information to facilitate decision making by a variety of users
- Improvements on capabilities to assess water resources will focus on two aspects; The first is regarding the technological aspects of assessing the availability of basin-wide water resources, including climate predictions, the second is to assist in furthering the implementation of water resources assessment
- The main task of the work plan is to improve approaches and models of water resources assessment
- These will be used to analyze basin-wide water resource surpluses and deficits in real time and to consider climate prediction and climate change scenarios of potential future states
- Training courses and workshops will be conducted for capacity improvement of RA II members
- To expand the abilities of the water resources assessment approaches and their application, it is desirable for the WGHS members to apply the tools in their countries and provide feedback to the theme leader

WORKPLAN: Water Resource Assessment

Review of Work Programme in Gyeongju, Republic of Korea

Deliverables	Activities	Outputs	Resources	Milestones	Linkage
1. Assessment of basin-wide water resources availability, including use of climate Predictions (3.3.2)	Prepare assessment and outlook of basin-wide availability water surplus and deficits on a national level in a regional context including the use of climate scenarios. (Priority C)		-RAII		RAII, CHy
2. Assessment of basin-wide water resources availability, including use of climate predictions (3.3.2)	Set up knowledge base to adapt to changes in water resources availability. (trends, outlook) (Priority A)	Report related to the case studies	- RA II - Research Documents	- collection case studies in Nov.2015 - summary the achievements in Oct. 2015 - Final report in Dec. 2015	RAII, AWG
3.3.3 Implementation of Water Resources Assessment (WRA)	Provide guidance materials for WRA linking to Climate prediction - downscaling - monthly and seasonally prediction WRA models - WRA (Priority B)	Guidance for WRA	- China - Korea	. - Provided manual in Dec. 2016	RAII, CHy
3.3.4 Development of national and regional capacity building programmes and related training activities for hydrological services	Organize a training course related to the advancements of WRA : - Downscaling methods; - Data collection; - WRA methods; - WRA Information system (Priority B or C)	Training Course	WMO Regional Training Center in Nanjing	Training Course in Jun. 2016	

Key Message :

We need to share and provide the water resources assessment technology!

hydro@korea.kr