3rd NARBO Training Workshop, 14-18 November 2005, Daejon Korea

Technology for IWRM

-River Basin Approach in Korea

14 November 2005

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Contents

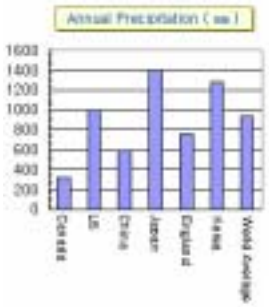
- Key Concept and Issues on IWRM
- IRWMS, Toolkit for Basin Water Management in Korea
- Technical Strategy for Implementing IWRM

3 Fundamental Problems on Water!

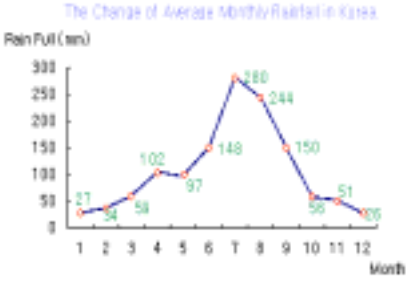
- ✓ Too much water ⇒ **Flooding**
- ✓ Too little water ⇒ **Drought, Water Shortage**
- ✓ Too dirty water ⇒ **Water Quality Deterioration**

River Basins in Korea

General Characteristics



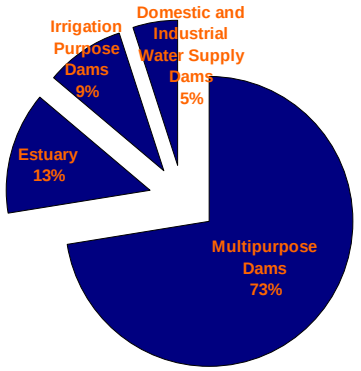
- Rainfall in Korea -



Water Resources Development

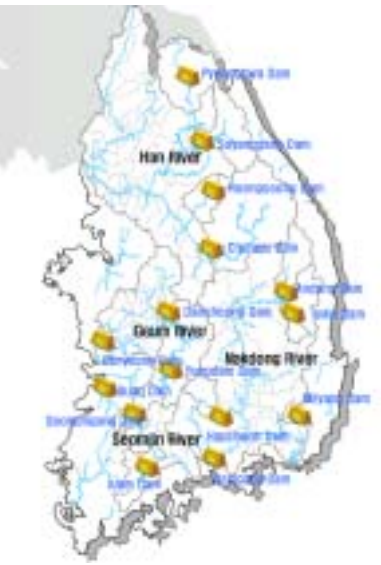
Groups	Total	Multi-Purpose Dams	Hydro Power Generation Dams	Water Supply Purpose Dams	Irrigation Purpose Dams	Small Dams	Estuary Barrage	Natural Lakes
Number	18,803	15	8	15	4	18,750	6	5

Total Storage Capacity : 12.9 billion m^3



Multipurpose Reservoirs in Korea

- **14 Multipurpose Dams**
  - **Total Storage : 12.4 Bil. m^3**
  - **Effective Storage : 8.7 Bil. m^3**
  - **Flood Control : 2.7 Bil. m^3**
- **Water Supply**
  : 11 Billion m^3/yr
- **Hydropower Capacity**
  - **Installed Capacity : 1,010 MW**
  - **Energy Generation : 1.95 GWh/yr**



Historical Perspective

Population ⟹ Demand
Pollution
Use of the Floodplain
Ecosystem Stress

Classic Development Question:

Do we move people to the water or do we move the water to the people?

Water Management Environment in Korea

- Rapid increase in urban water demand
- Strong public interests on environments
- Big increase in cost for water supply expansion
- Competition among various demands on limited water resources
- High cost in water quality control and management
- Uncertain future for water

☞ call **huge increase in social expense** for national/regional water supply

Changing Paradigm and the Needs for IWRM

- **Water resources for economic growth**
- **Construction of water supply facilities**
- **Water treatment facility expansion**
- **Simple engineering problem**
- **Government-led management**

- **Water for sustainable development & Management**
- **Water supply and demand management**
- **Considering environment and ecology**
- **Multi-sectoral problem (social, econo., & env.)**
- **Participation of interested parties(Consensus)**

☞ **Basinwide IWRM considering surface/groundwater, quantity/quality, water and adjacent land (Agenda 21)**

IWRM – Process for better management of water resources

- **encompasses governance, stakeholder participation,**
- **balancing development and conservation for resource sustainability**

IWRM (Global Water Partnership, 2000)

" A Process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems "

☞**A continuum of PROCESS** as a way of **avoiding or resolving conflicts over water** (not as a finished & inviolate set of projects!)

☞as a way of achieving **3 key goals**: **equity**, **efficiency**, **sustainability**!

Formulation of IWRM Concept

Max [Sectoral/Functional/Project base planned & implemented]
Efficiency of Water Res. Management

s.t. [Contraints]

- approach: **holistic** view in an **integrated manner**
- satisfactory req.: **balanced**
  - **economice efficiency**
  - **Social equity**
  - **Env./ecological sustainability**

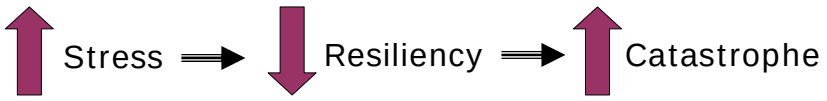
Requirements for IWRM

- Political viewpoint
- Geographic viewpoint
- Functional viewpoint
- Hydro-ecological viewpoint
- Disciplinary viewpoint

☞ Basinwide integrated solution be assembled piece by piece (Key Element in Integration is **COOPRATION**!!!)

I W R M

balances the **views and goals** of political groups, geographic regions, and **purposes** of water mgt.; and **protects** the water supplies for natural and ecological systems.



☞ Resiliency : The ability to return its former shape when pressure is removed (flexibility)

River Basin approach

- A **River Basin** is a natural hydrologic unit for water resources planning & management
- **Focusing on the river basin** provides a holistic point of view
- The **river basin system** can be readily decomposed into smaller watershed units

Basin > Watershed > Catchment

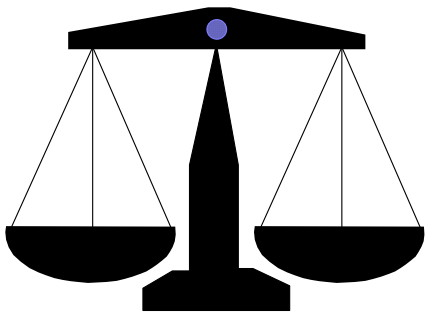
River Basin Management Unit

Management Unit	General Size (km^2)
Catchment	0.15 ~ 1.5
Subwatershed	2.5 ~ 25
Watershed	25 ~ 250
Subbasin	250 ~ 2,500
Basin	2,500 ~ 25,000

Data : Clementis et al., 1996

Three Key Factors to Consider to Attain IWRM Solutions

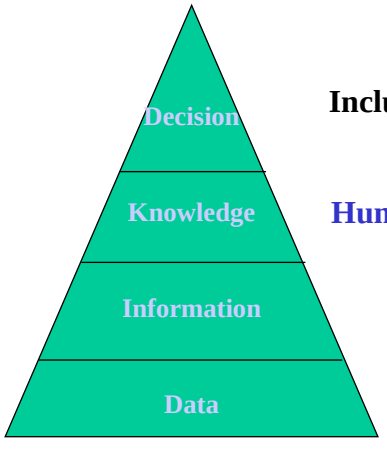
- Legal / political institutional setting
- **Sound technical knowledge base**
- Public involvement and consensus building



Role of Legal/Institutional Setting

- Objective: Institutional Setting for Efficient Water Resources Management
- Function: Establishment of Water Res. Mgt. Strategy at the National Level
- Assignments: Policy/Institution Development, Legislation
- Role: Provision of Participatory Democracy at each stage

Role of Technical Knowledge



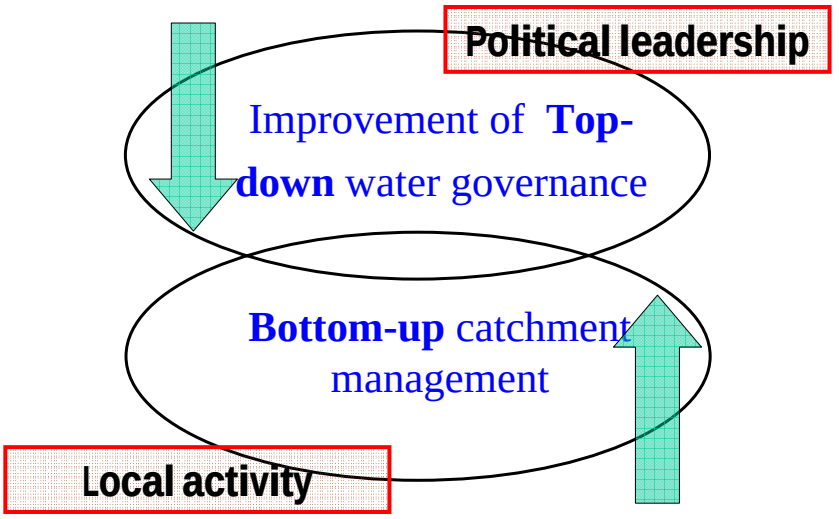
Inclusion with our other factors

Human interpretation and intuition

Data Processing and Analysis

High Quality "raw" data!

Role of Public Involvement



- **No general blueprint suitable for each river basin and every country!!!**
- **Rather, the IWRM process has to be formulated and adjusted according to the socio-economic, political and cultural conditions of each country**

Integrated Real-time basin Water Management System

IRWMS, Toolkit for Basin Water Management in Korea

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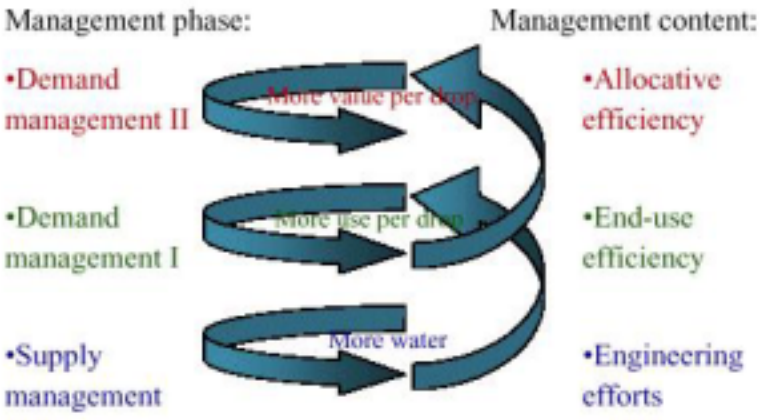
General Trend of Change in Water Resources Management



Challenges in Water Resources Management in Korea

- **Facing Severe Water Shortage in 2025-2030**
- **Difficulties in Water Quality Management**
  - **point sources → non-point sources control**
- **Need for Environmental/ Recreation Water**
  - **conflict against the existing water rights**
- **Efficient and Equitable Water Allocation**
  - **policy option in the era of water resources mgt.**
  - **water transfer & adaptive water management**
- **Prepare for Global Warming/Climate Change**
  - **Flooding, Drought disaster**

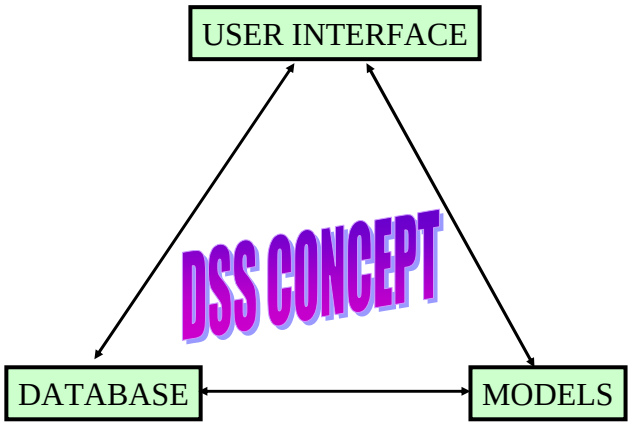
Need for Computer-based Analysis Tools

- Size, Complexity of River Basin Management
- Administrative, Legal Constraints; Water Rights, Compacts, Inter-State Agreements
- Interdependence of Surface and Groundwater Resources
- Environmental and Ecological Impacts
- Resolving Conflicts among Urban, Agricultural, Environmental Concerns

DSS Definitions

An integrated computing framework, consisting of a database, model base and user interface/dialogue facility, that facilitates the development and evaluation of alternative courses of action. It is used to transform data to information to support the decision process. (Fontane)

A computer-based advisory system for management, that uses databases, models, and communication/dialog systems to provide decision makers with management information (Grigg)



River Basin DSS: Interface

- Access the models and database
- Display information from the database
- Create model input files
- Run models
- Save model results to the database
- Create and manage reports
- Communicate with organizational elements
- Monitor the system
- Link and post to the web

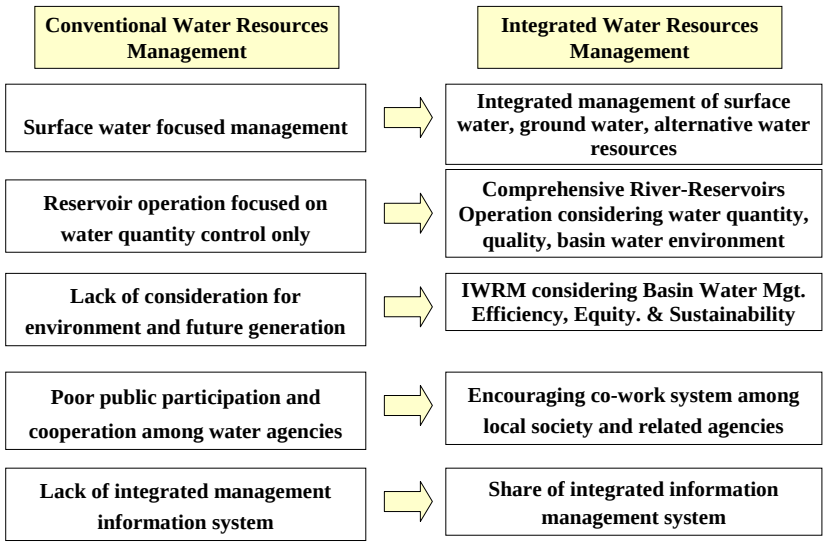
River Basin DSS: Data

- Real-time hydro-met data (flows, precip, etc.)
- Historical hydro-met data
- Spatial information & GIS maps
- Physical system information
- Operational policies
- Operational Information
- Forecast information
- Computed information from model runs
- Institutional information

River Basin DSS: Models

- Reservoir simulation – long term
- Reservoir simulation (routing) – short term
- Reservoir optimization – long term
- River simulation – long term
- River routing
- River water quality simulation
- Reservoir water quality simulation
- Water rights accounting
- Water demand estimation
- Decision analysis

Directions for IWRM in Korea



General Objectives for IWRM

- **Stable water supply for municipal, industrial, and irrigation uses**
- **Flood mitigation**
- **Water quality management (rivers, reservoirs)**
- **Management of river & lake environment, ecology (habitats, bio-diversity)**
- **Hydropower Generation**
- **Recreation**

Technology for IWRM

(21C Frontier R&D Program)

- Hydrologic Data Acquisition and Monitoring
- Effective Use of Temporal and Spatial Data in a River Basin
- Water Resources Application of Short and Long Term Weather Forecast System
- Integrated Basinwide Water Budget Analysis and Water Resources Planning
- Integrated Real Time River Basin Water Management System (IRWMS)
- Water Resources Policy for Sustainable Water Resource Development

Research Cluster for IRWMS Project

- **Lead Organization :**

  KOWACO Hydrosystems Engineering Center

- **Co-workers :**

  6 Universities, 2 Industrial Ventures

- **International Collaboration :**

  CSU(US), eWater CRC (Austrailia)

- **2nd Phase Fund : 4 Million US $**

- **Participants : 80 Researchers/yr**

Main Objectives of IRWMS

❖ **Development & Implementation of Web/GIS-based Decision Support System for integrated basin water resources management**

1st Stage ('01-'04) : Fundamental Technology Development (Integrating surface water)

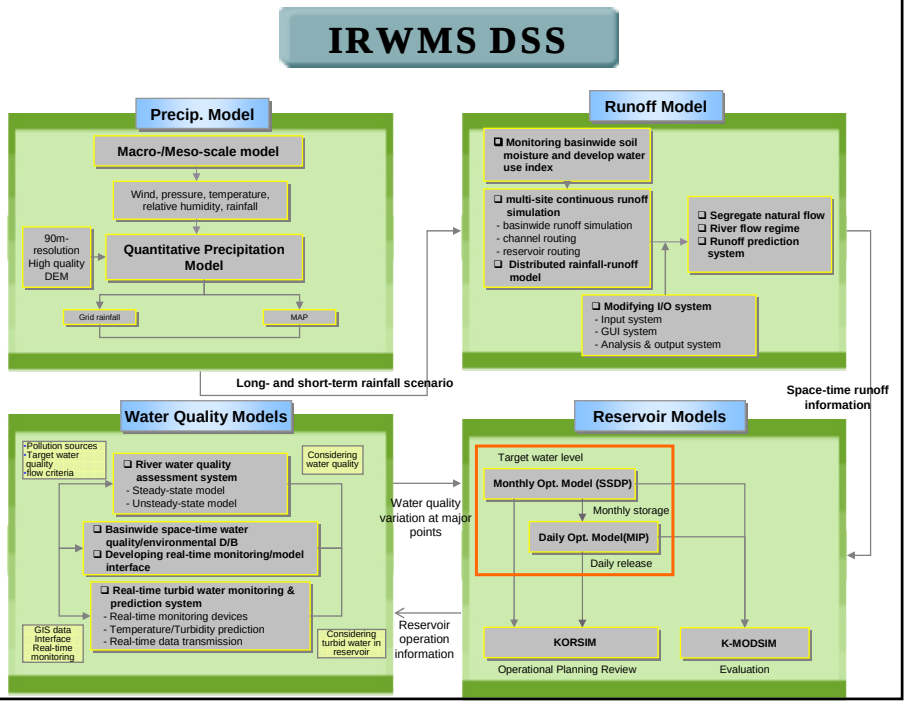
- **Develop basin rainfall-runoff simulation technology**
- **Develop simulation and optimization models for multi-reservoirs system operation**
- **Develop streamflow water quality prediction models**
- **Build integrated real-time water information system**

2nd Stage ('04-'08): Application Technology Development (Linkage to weather forecast)

- **Develop linkages to weather forecast and processing system for hydrologic analysis**
- **Validate and upgrade real-time basin-wide runoff simulation model**
- **Validate and upgrade long- and short-term joint reservoirs system operation models**
- **Validate and upgrade river water quality models**
- **Web/GIS-based basin water management DSS**

Project output

A **decision support tool** for river and reservoirs system operation to meet the temporal and spatial water demands for diverse water users through monitoring long-term and near real-time water accounting between supply and demand based on **forecasted streamflow** and **water demand information** at key stations and sub-system

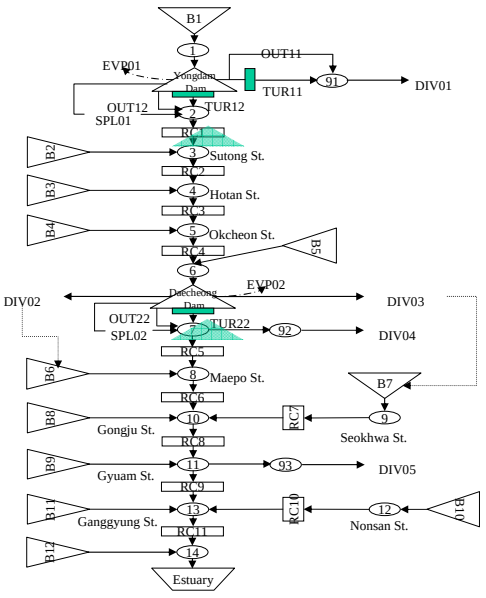


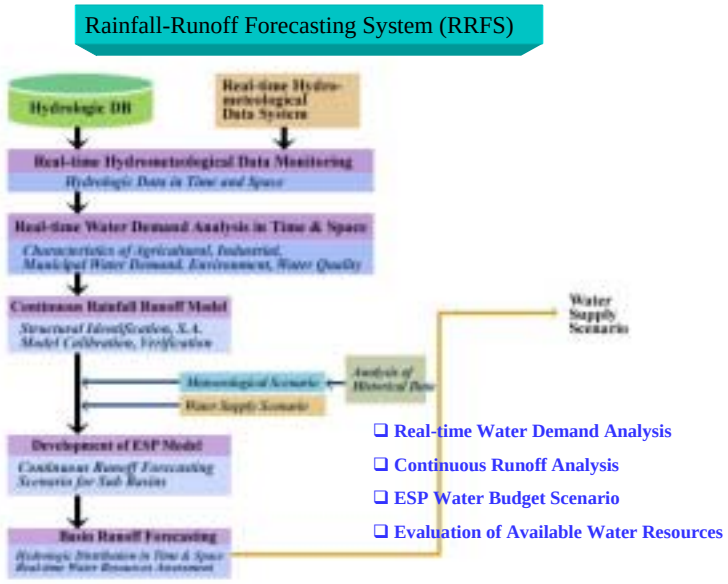
1. Basinwide Rainfall Runoff Model

❑ Objectives

- To analyze monthly and daily hydrologic runoff components
  - including surface runoff, subsurface runoff and return flow at key operation stations in the basin.
- To develop short-term water demand forecasting technology
  - taking into account the patterns of municipal, industrial and agricultural water uses

❑ Schematic Diagram for Geum River System



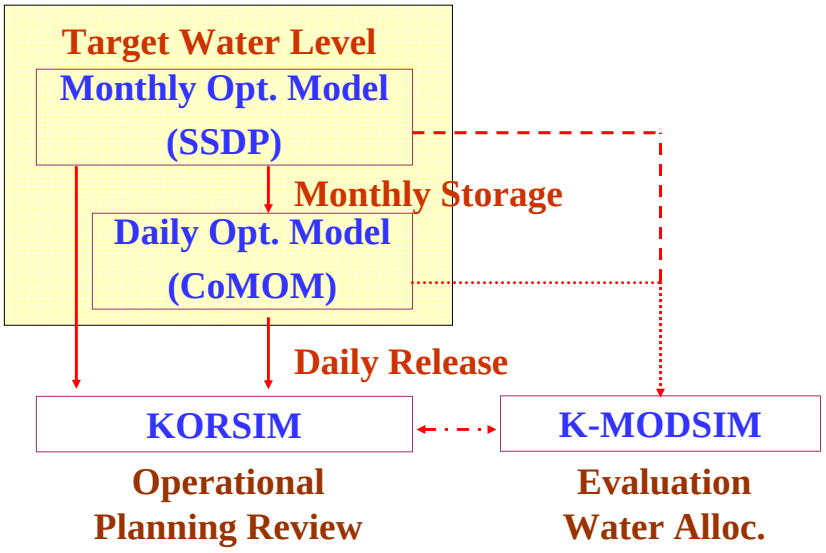


2. Reservoirs System Simulation/Opt. Models

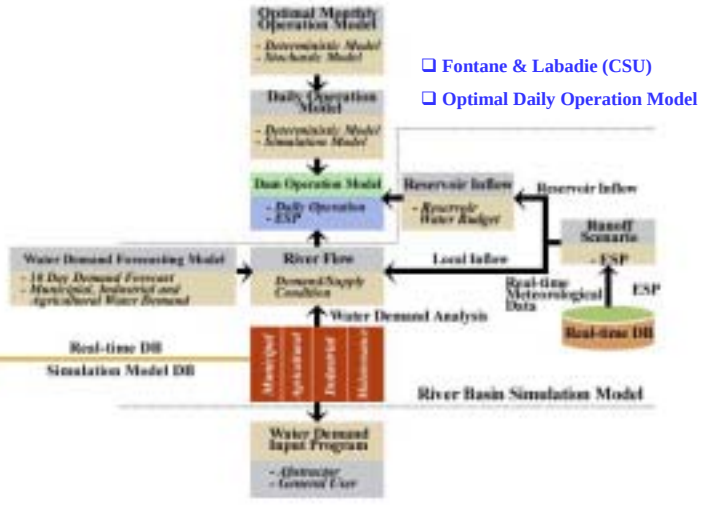
❑ Objectives

- To develop reservoirs system operation models based on simulations and optimization techniques.
- Long-term (monthly) and short-term (daily) hydro-scheduling
  - taking into consideration of sub-basin water balance and downstream water quality

❑ Reservoirs Operational Planning Procedure



Reservoirs System Operation Models



❑ Fontane & Labadie (CSU)

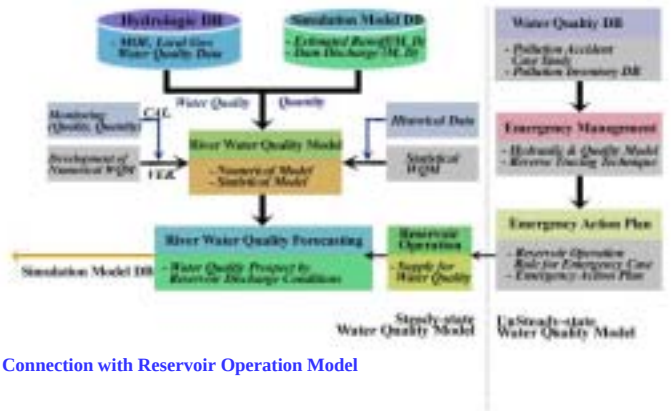
❑ Optimal Daily Operation Model

3. Water Quality Simulation Model

❑ Objectives

- Steady state River Water Quality Model(Qual2E-Plus)
  - to project monthly river water quality
  - to determine the amount of river maintenance flow
- Unsteady state River Water Quality Model(KORIV1-Plus)
  - to determine the amount of discharge from u/s reservoirs and the time to mitigate the degradation of d/s water quality during emergency spill and severe drought conditions

River Water Quality Prediction Models

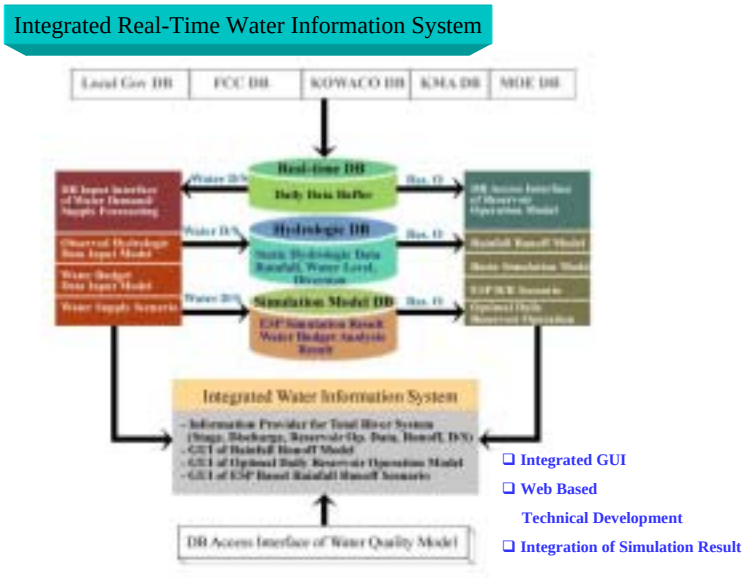


❑ Connection with Reservoir Operation Model

4. Integrated Real Time Water Information System

❑ Objectives

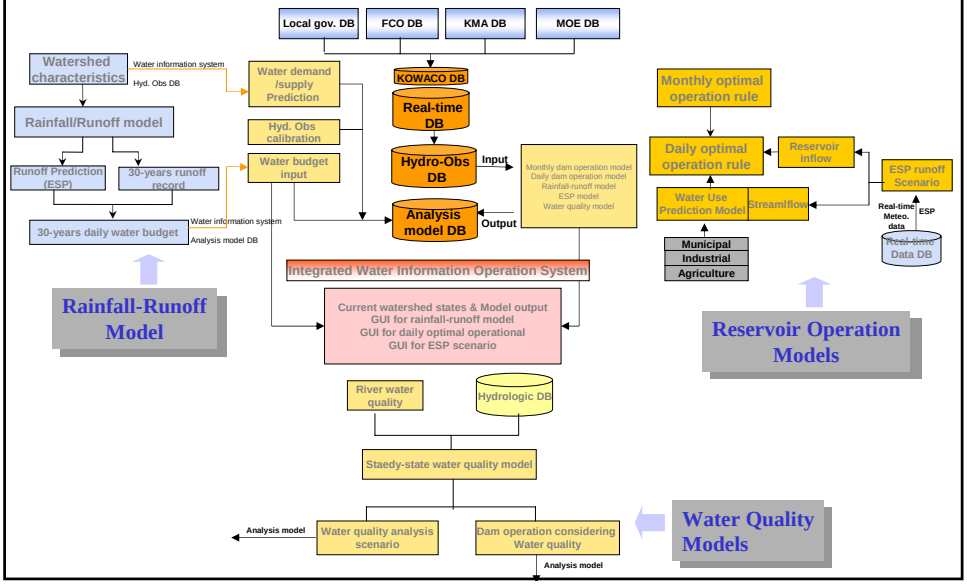
- Realization of each models with Web-GUI
- A Portal data base management system (DBMS)
  - to exchange basinwide water information
  - to provide operational information to the basin water manager and the public



Real Time Decision Making Process in Basin Reservoirs System Operation

1. **Nowcasting** : Streamflow information at the key gages in the basin
2. **Forecasting** : Continuous (Sub) basin runoff forecasting with short term water demand prediction/ hydrometeorological forecasting
3. **Decision making** :
   - ✓ Long/Short Term Multiple Reservoir System Operational Planning
   - ✓ Considering Basin Water Quantity/Quality
   - ✓ Deficit Supply Mode

Integrated real-time basin Water Management System (IRWMS)



Conclusions

- Need for advanced technology for basinwide WRPM
  - supported by holistic legal, institutional measures
  - in terms of **IWRM approach**
- Introduction to the technical framework for an Integrated River Basin Water Management
- Examples of DSS for Basin Water Management in Korea
  - Long-term & Short-term Basin Reservoirs System Operational Planning

Application For

- Long-term National/Regional Water Planning
- Basinwide Real-time Water Mgt. (Operational DSS)
- Overseas Technical Assistance in IWRPM

2nd Stage Upgrade(04-07)

- Hydro-meteorological Forecasting Technique
- Surface Water + Ground Water (Conjunctive Use model)
- Water Quantity + Quality with more consideration for Environment/Ecology
- Economic Water Valuation

Current and Future Works (2005-2011)

- **Implementation and Operation of the System in KOWACO Water Res. Operation Center(WROC)**
  - **Test and validation for the Geum River basin**
  - **Technology Transfer to other major river basins in Korea**
- **Important Role for Long-term Planning**
- **Final goal**
  - **To develop generalized system and contribute for Integrated River Basin WRPM Practice**
- **Needs for International Research Networking**
  - National/International Advisory Panel
  - **Operation of End-Users Group**
  - **International Collaboration**
    (US, Austrailian eWater CRC, **Asian Society, NARBO**)

Comprehensive Framework of Basinwide IWRM

- **River basin focus**
- **Managed risk** for water dev. & operation
- **Coordinated actions** between water agencies in a regulated environment
- **Capacity building** to encourage local responsibility
- **Local responsibility** to the maximum extent appropriate
- **Voluntary and cooperative actions**
- Maximum use of market mechanisms to allocate and price water resources

Questions

Integrated Water Resources Management

Technical Strategy for Implementing IWRM

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Challenges in IWRM

- **Lack of understanding of IWRM**
- **Resource mobilization**
- **Effective coordination and stakeholders′ participation**
- **Lack of appropriate toolkit for efficient and sustainable dev. & mgt. of water**

- **No general blueprint suitable for each river basin and every country!!!**
- **Rather, the IWRM process has to be formulated and adjusted according to the socio-economic, political and cultural conditions of each country**
- **An IWRM strategy can therefore be interpreted as preparing a roadmap or action plan to put IWRM into practice in the basin**

- **Technology for IWRM can be implemented through a step-by-step process**

- **In the preparation of river basin mgt., the application of IWRM process is far more important than having a plan *per se***

- **Public awareness and multi-stakeholder participation is a must to ensure acceptance by public and the government**
  -> Buttom Up + Top Down

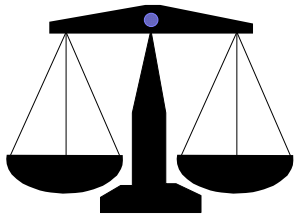
What are the Equitable Solutions in Basin Water Management?

- Solutions that are arrived at by treating each objective (and stakeholder) in a fair manner

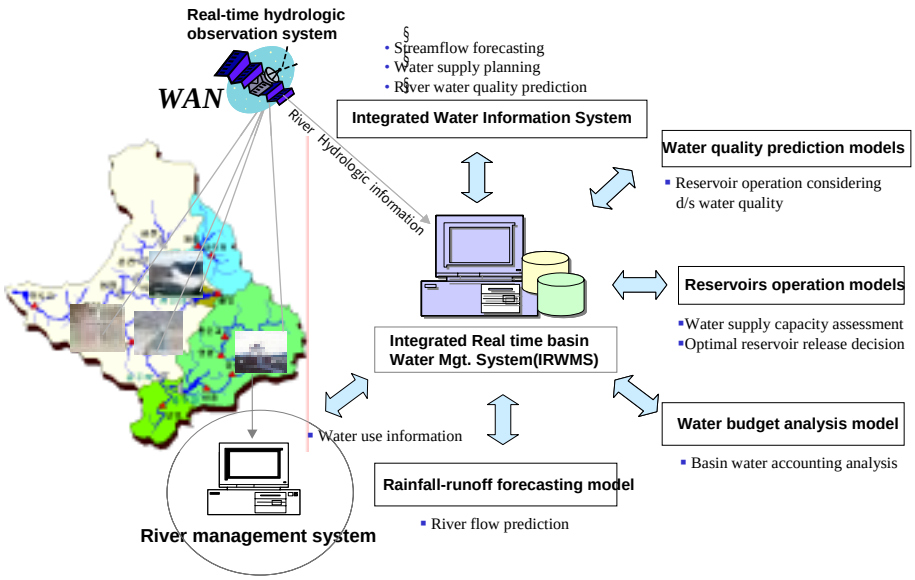
- Solutions that can be accepted by all

Three Key Factors to Attain IWRM Solutions

- Legal and political constraints
- **Sound technical knowledge**
- Public involvement and consensus



Integrated Real-time Water Mgt. System



How to promote the IWRM Process?

Open & Transparent Process	Functions
• **Common Assumptions** & **Estimates** of Management Strategies • **Common Data** • **Common Analytical Tools**	• National/Regional Water Planning • Water-related Conflict Resolution • Various Trade-off Analysis

☞ **Final Goal : Mutual Trust & Consensus Building**

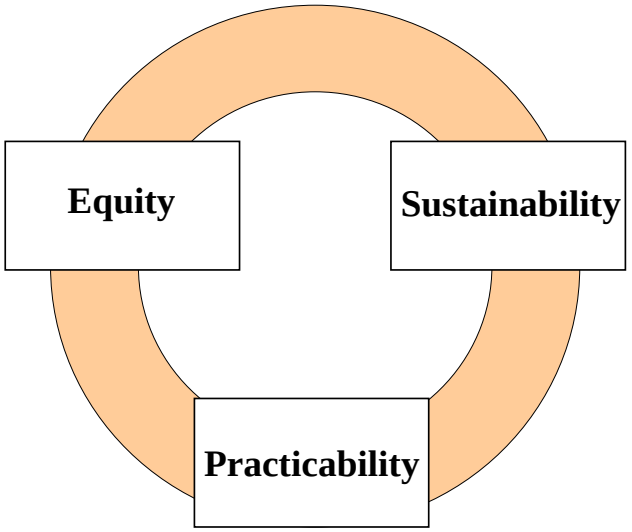
How to promote IWRM Process? (Need for Collaborative Leadership)

- If you bring the appropriate people together in constructive ways with good information, they will create authentic visions and strategies for addressing the shared vision and concerns of the community or river basin.

Improving Water governance

- River Basin level
- Capacity building
- Information ability
- Enabling environment
- Equitable allocation
- Challenge in the 21st Century
  Linking Water Mgt. Technology + Policy for Technical Advancement in IWRM

Water for life – Human Society with Healthy Nature



Questions

Thank You