NARBO IWRM Training Courses, 26-30 July 2004 BKK Thailand

Basin Planning

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Contents

Ultimate Truth is composed of: Water and Go

"Water Goes the Way it Goes"

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?

Shifts in Water Management Environment

- 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
- 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 (Global Water Partnership, 2000)

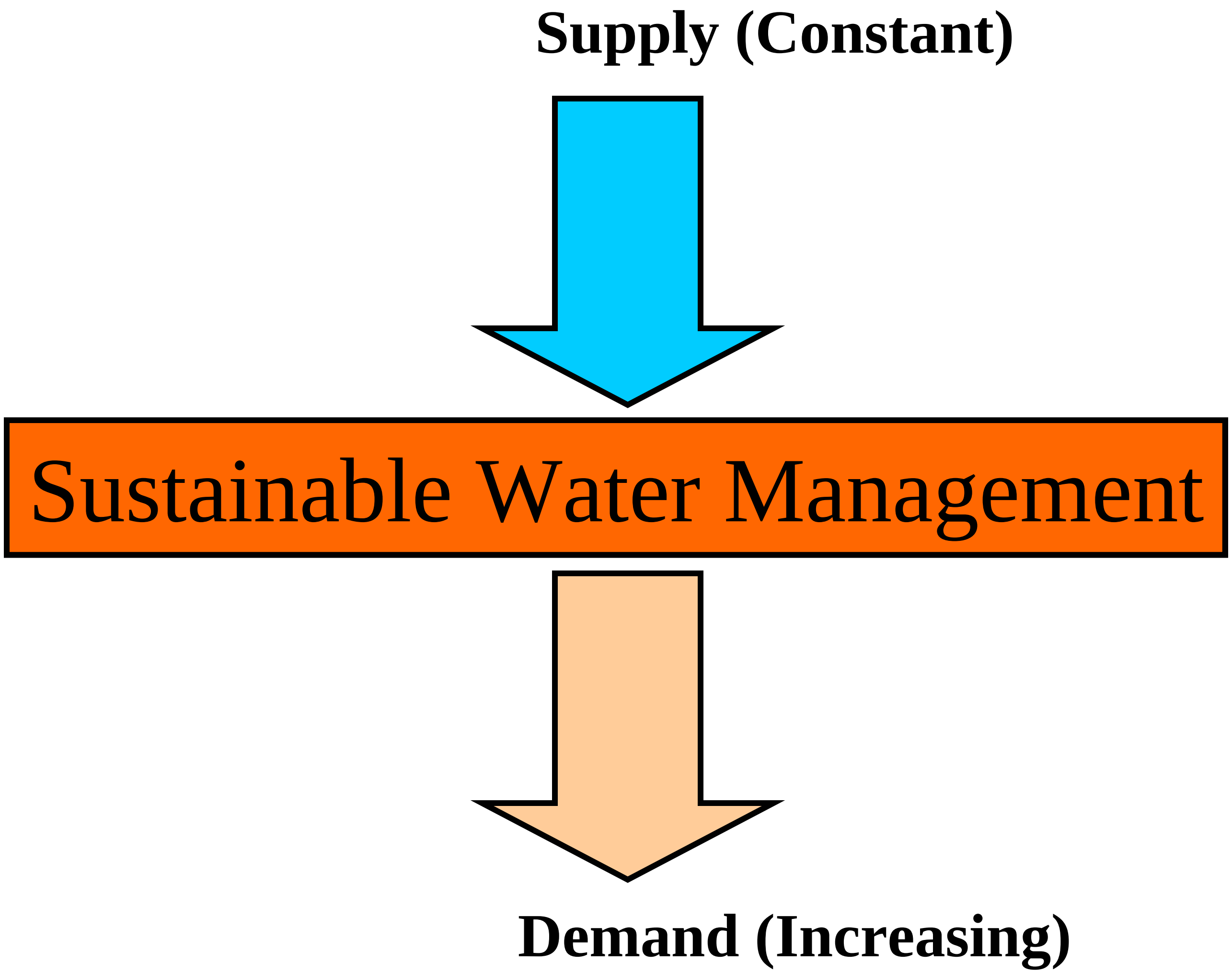
“ A process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems ”

☞ BP viewed as a continuum of **process !!!**

Integrated Water Resources Management

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

↑ Stress ⟹ ↓ Resiliency ⟹ ↑ Catastrophe


Supply (Constant)
Sustainable Water Management
Demand (Increasing)

Integrated Water Resources Management

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

☞ need basinwide multi-sectoral/ multiobjective & multi-disciplinary approach!

Sustainable Development

The development process that meets the needs of the present without compromising our ability to meet those of the future.

Principles:

1. Water use efficiency and conservation
2. Ecological integrity and restoration
3. Clean water
4. Equity and participation in decision making
5. Institutional reform

Water Resources Management

Water resources management is the application of structural and nonstructural measures to control natural and man-made water resources systems for beneficial human and environmental purposes.

The goal is to provide water in the quantity and quality required, when it needed, where it is needed, and with the appropriate level of reliability.

Water Resources Management Scenarios

- Planning and coordination
- Organization
- Water operations management
- Regulation
- Capital investments in facilities
- Policy development

Knowledge Needed by Water Managers

- Water management principles
- Hydro-ecological science
- Water infrastructure
- Planning and decision making
- Organizational theories
- Systems analysis and decision support systems (DSS)
- Water and environmental law
- Financial management

Comprehensive Framework

- Watershed (river basin) focus
- Managed risk for water development and 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

Concepts of River Basin

- 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
  - ☞ RB > Watershed > Catchment

Advantages

- Appeals to water resources planners, engineers & scientists
- Allows a holistic perspective
- Convenient object for modeling
- Can be used to explore basin-wide water management options

Disadvantages

- Does not reflect political boundaries
- Can be difficult to coordinate the large number of stakeholders
- Can be difficult to secure funding for coordinated research and planning activities

☞ main reasons for conflict & difficulty in coordinating (basin) water resources management!

Basin Water Planning

- Planning for water resources facilities that meet economic goals such as hydropower, water supply and others
- Comprehensive basinwide study
- Building national/regional policy

to encourage the conservation, development, and utilization of water

and related land resources of the basin on a comprehensive and coordinated basis

by related communities

Key Factors for Water Planning

- Hydrologic Data
- Present Available Water Amount
- Water Supply Facilities
- Additional Water Sources
- Projected Water Demands
- Future Water Development Plan

☞ Integrated Resources Planning(IRP)

- Investment Assessment and Action Plan

Water Accounting Data

- Streamflow Data
- Water Use data
- Evaporation/Seepage Data
- Water Work Data on the River
- Reservoir & Storage Data
- Aquifer Data
- System Structure Data

Water Sources

- Stream (natural surface water)
- Lake or Reservoir (dam)
- Groundwater (aquifer and spring)
- Reused Water (recycling)
- Renewable Water (return flow)

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

Analysis Tools

- Calculator
- Simulation Model
- Optimization Model
- Network Algorithm
- Optimal Control Theory
- A.I. (Expert System, Fuzzy Logic, Neural Network)

Water Rrsources Systems Analysis

- Purpose : Assure the Availability of Water in the Quantity, Quality and Reliability needed

  (When & Where)

→ by developing a # of alternatives

→ by evaluating the Economic, Environmental, Political, & Social Impacts

Water Resources Systems Analysis

- Economic Efficiency
- "Who pays & Who benefits ?"

  - Issues of Equity
- Sustainability

  - Env. Quality & Social Welfare

  ↳ Public Involvement in WRPM

  (Shift of responsibility for making choices)

Reasons for Analysis

- In Planning

  - to provide hydrologic and economic information for the formulation and evaluation of alternative plans

- In Design

  - to provide hydrologic and economic information for the design of water resources facilities

- In Operations

  - to provide information for the operation and management of water resource systems

System Engineering

- The ART and SCIENCE of selecting from a large number of feasible alternatives, the set of actions which BEST accomplish the overall objectives of the decision makers.

  (Warren A. Hall)

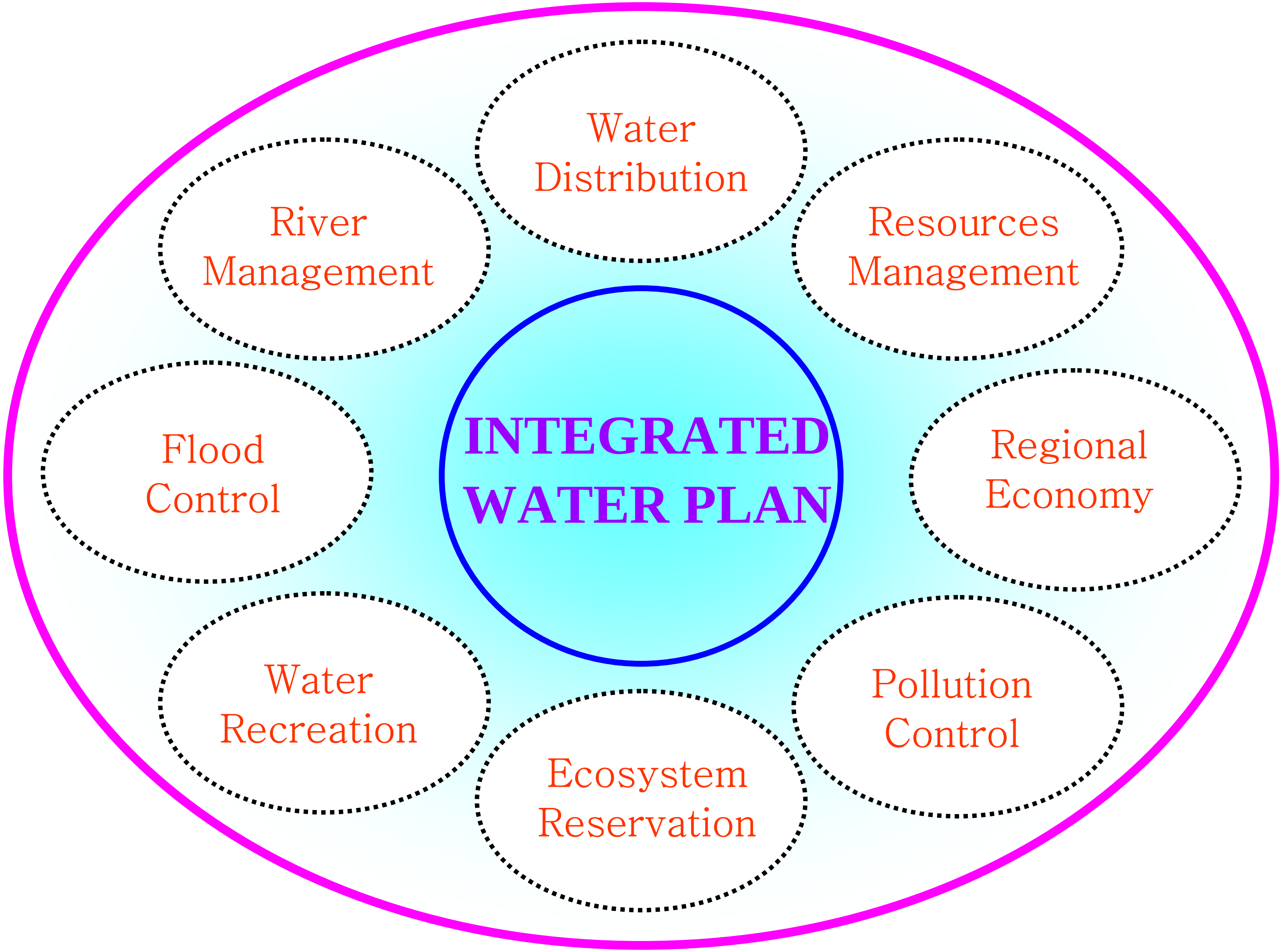
- The BEST decision is important whenever we have :

  LIMITED RESOURCES

Risk Assessments

- Water Safe Yield
- Water Supply Reliability
- Water Shortage
- Understanding Drought

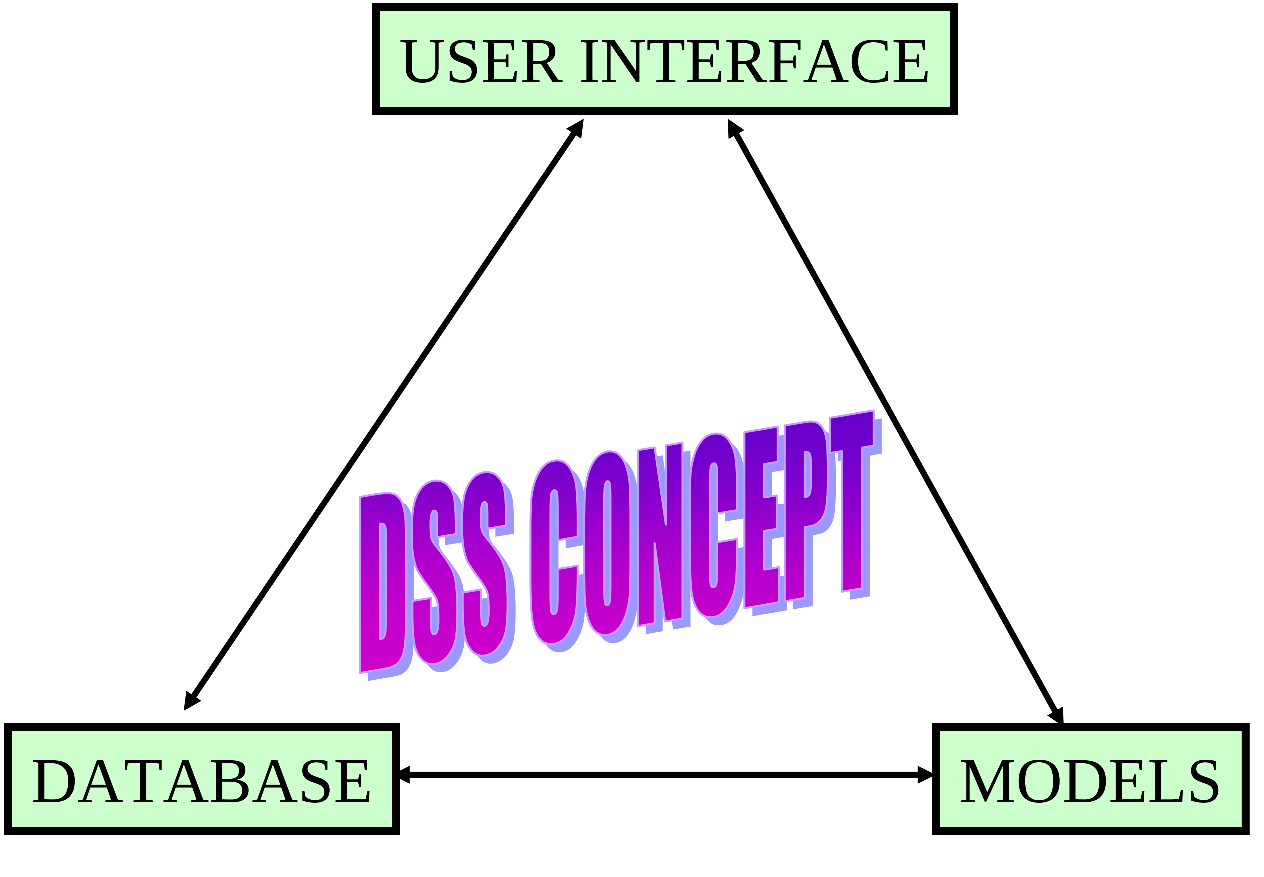
  Magnitude, Length, Drought Index
- Drought Water Management


Water
Distribution
River
Management
Resources
Management
INTEGRATED
WATER PLAN
Flood
Control
Regional
Economy
Water
Recreation
Pollution
Control
Ecosystem
Reservation

DSS Definitions

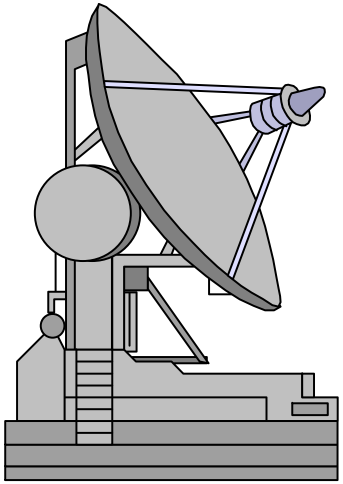
An integrated computing framework, consisting of a database, model base and user interface/dialogue facility, that facilitates the development and evaluation of alternative courses of action. It is used to transform data to information to support the decision process. (Fontane)

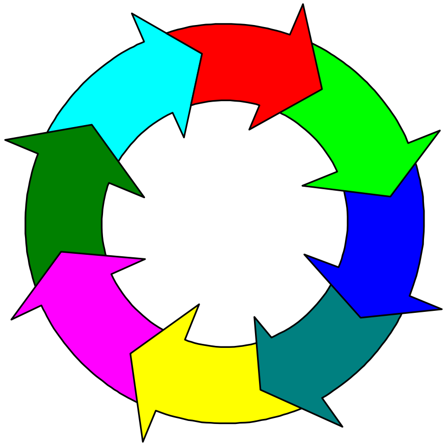
A computer-based advisory system for management, that
Uses databases, models, and communication/dialog systems
To provide decision makers with management information (Grigg)


USER INTERFACE
DSS CONCEPT
DATABASE
MODELS

Computer Analysis

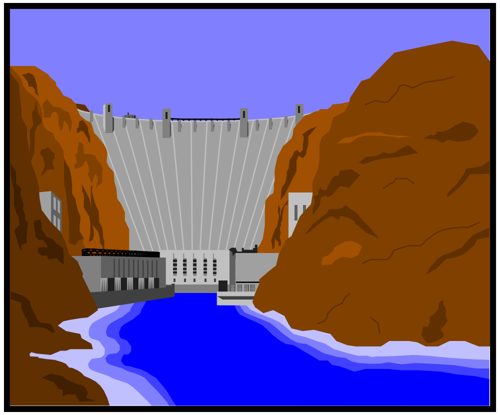
Communications



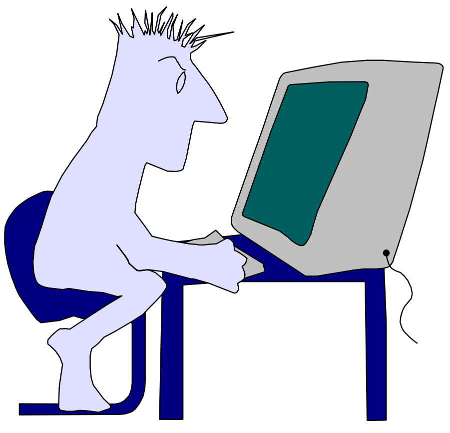


Decision Makers

Engineering



Steps in DSS Development



- Identify Potential Users
- Identify Decisions
- Identify Information Needs
- Identify Data Requirements
- Identify Model Attributes

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

Model

Conceptualization of a system that retains the essential characteristics of that system for a specific purpose

Building Your Own Model

Advantages:

- Complete knowledge of the model
- Customized to the exact needs
- Customized to work with other models and databases

Disadvantages:

- Expensive and time consuming
- Must be thoroughly tested
- May not have all the features of other models

Using Someone Else's Model

Advantages:

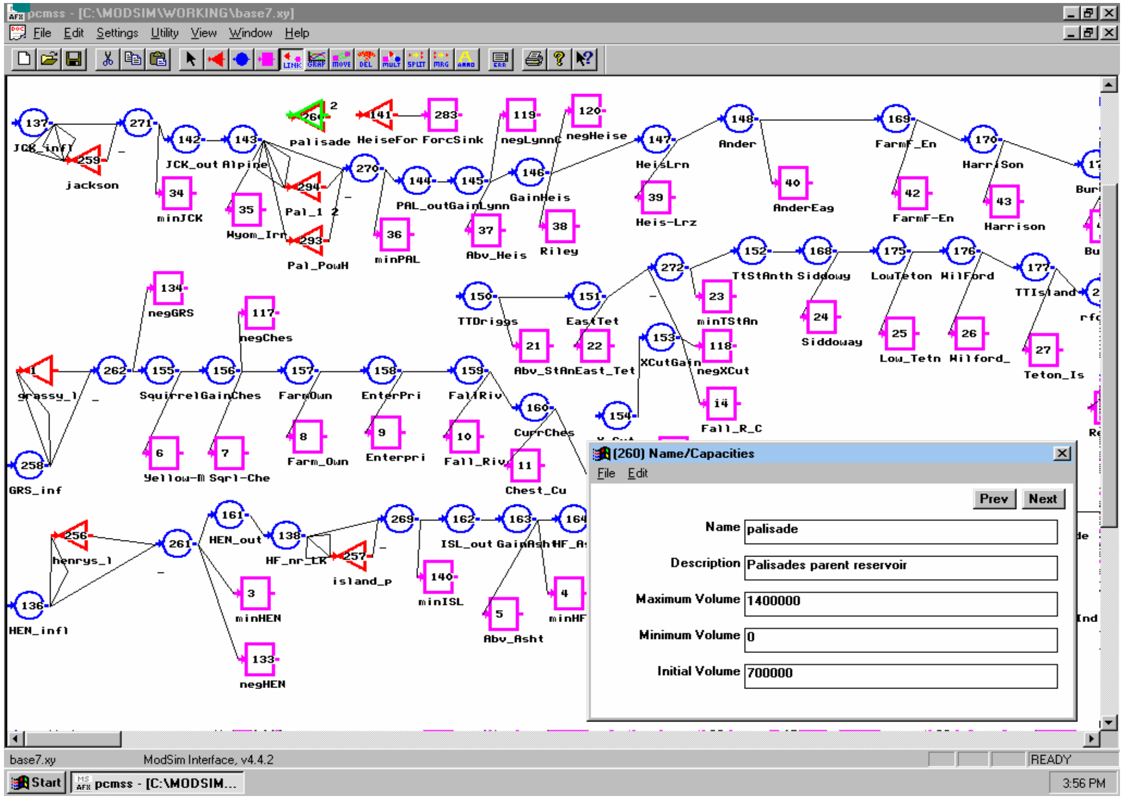
- May save time & money (some models may still be costly)
- Model may be tested & documented
- Support services may be available (training)

Disadvantages:

- Incomplete knowledge of the model
- Must be adapted for the desired application and database
- May not have all the features desired

Generalized Models

- MODSIM
- RiverWare
- HEC5



Integrated Water Resources Planning - Case Study

Development of
a Decision Support System
for River Basin Planning

Eureka EU 487

Development of a Decision-Support System for River-Basin Planning

The Eureka EU 487 Project

Participants…

- University of Bologna, Italy
- University College, Cork, Ireland
- University of Newcastle-upon-Tyne, England
- International Institute for Applied Systems Analysis, Austria
- Ansaldo Industria Spa, Italy
- Thames Water International, England

Timescales…

- Commenced January 1992
- 5-Year Duration
- Base System Within 3 Years

Development of a Decision-Support System for Integrated River Basin Planning

Aims

- To develop a comprehensive, easy to use DSS

  - **Waterware**

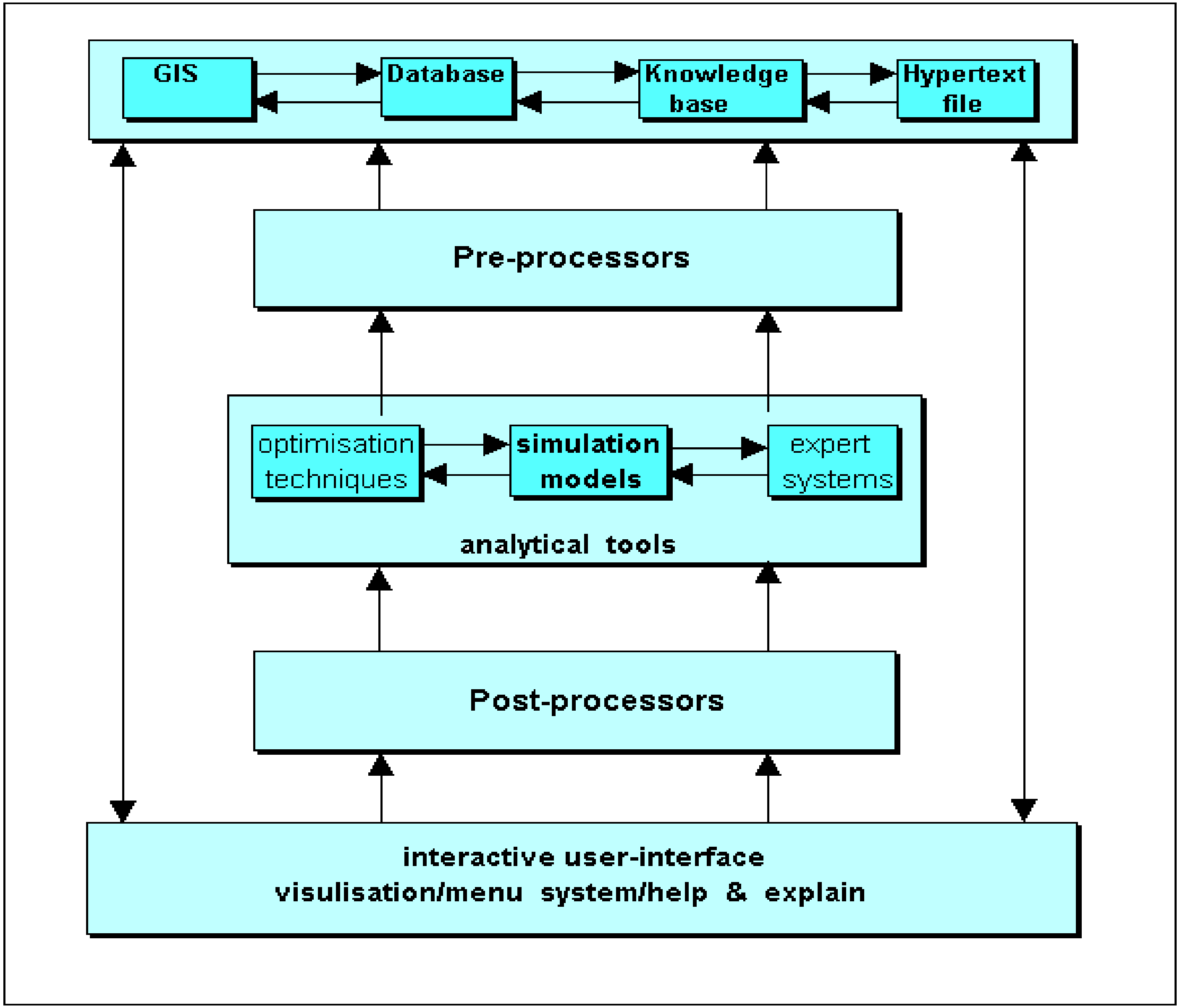
  (**5th Generation Hydroinformatics System**)
- Scope to include aquifers, rivers, lakes, reservoirs, estuaries and coastal water
- Covering both water quantity and quality
- Integrated environmental assessment
- Complexity transparent to user

Development of a Decision-Support System for River-Basin Planning

Integrated River-Basin Planning

- Exercise in conflict management
- Allocating scarce resources between competing interests
- Minimizing impacts between non-compatible interests

System Architecture



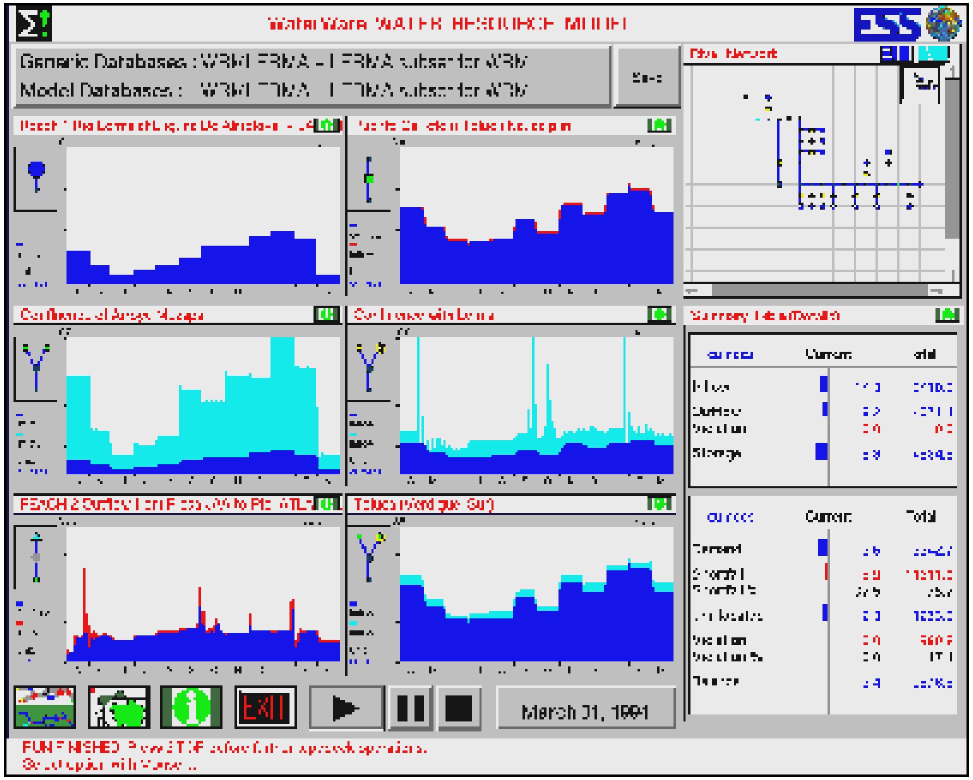
(iii) Water Resources Planning

*Generic model on a daily time-step, representing the system dynamics.

*The output summarizes

-the balance between supply and demand, indicating the frequency and extent of shortfalls,

-enabling the reliability of the water-resource system to be assessed.



Development of a Decision-Support System for River Basin Planning

Application of Waterware

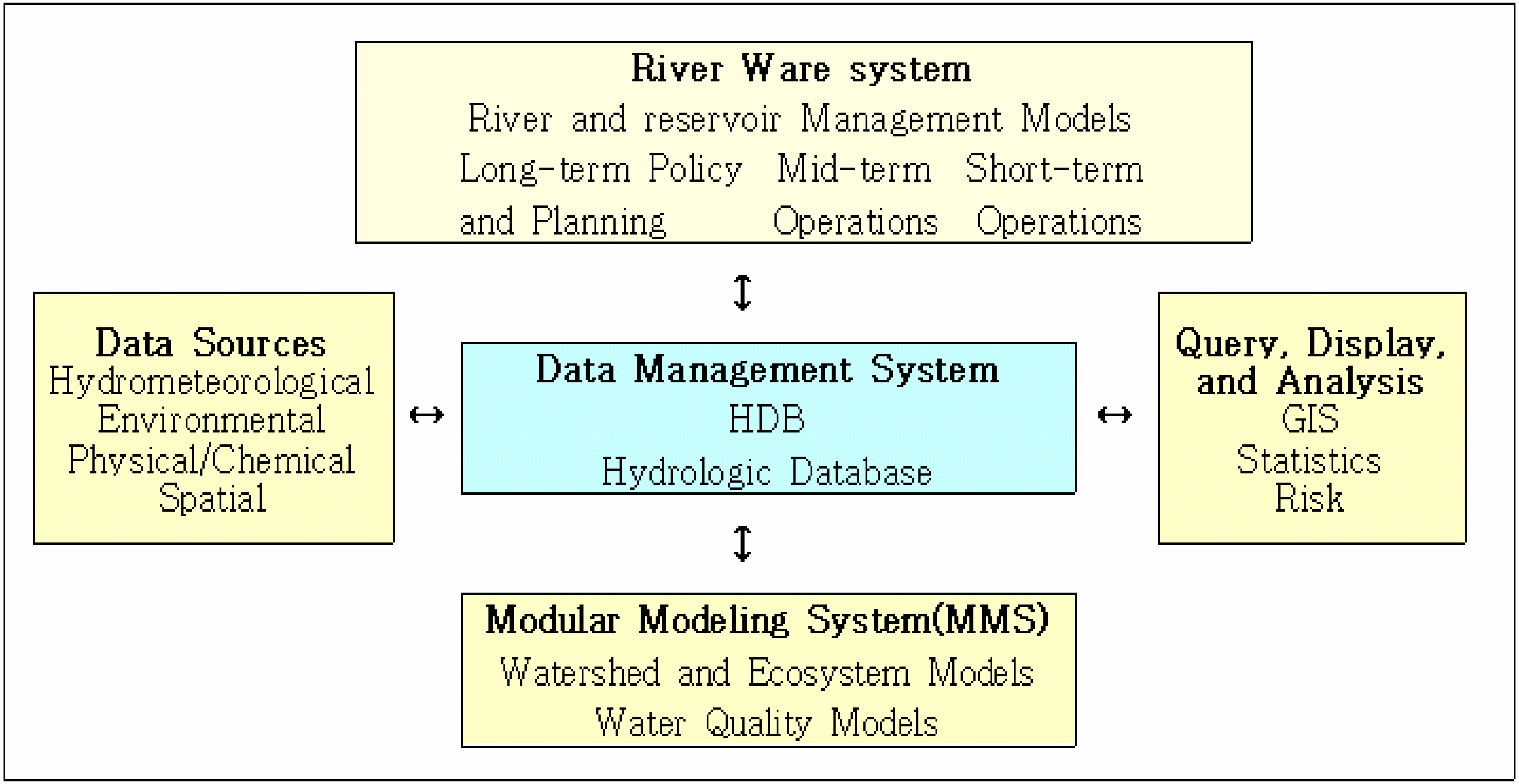
- Thames River Basin, U.K.
- Rio Lerma River Basin/ Lake Chapala, Mexico
- Palestine
- Further Development for Integrated EU RBs?

- 6th EU Framework Programme(02-06)
- EU Conference (11-13 Nov., 2002)

USBR’s Integrated Water Resource Management

- Irrigation, Domestic and Industrial Water Supply
- Hydroelectric Power Generation
- Environmental Protection and Restoration
- Recreation
- Flood Control
- Drought Management
- Water Recycling and Reuse

USBR's Database-centered decision support system



Optimization

- Pre-emptive Linear Goal Programming
  - Multi-objectives without user-defined penalties
  - Policies (Goals) are Prioritized
  - Minimized infeasibilities
- Goals/constraints formulated in Editor
- Variables automatically linearized
  user controls linearization methods
- Economic (hydropower) objective Thermal Object
- Physical constraints generated by objects
- CPLEX solver
  - Can “tune” parameters
  - Informational diagnostics
- Post-optimization Simulation

Directions for Integrated Water Resources Management in Korea

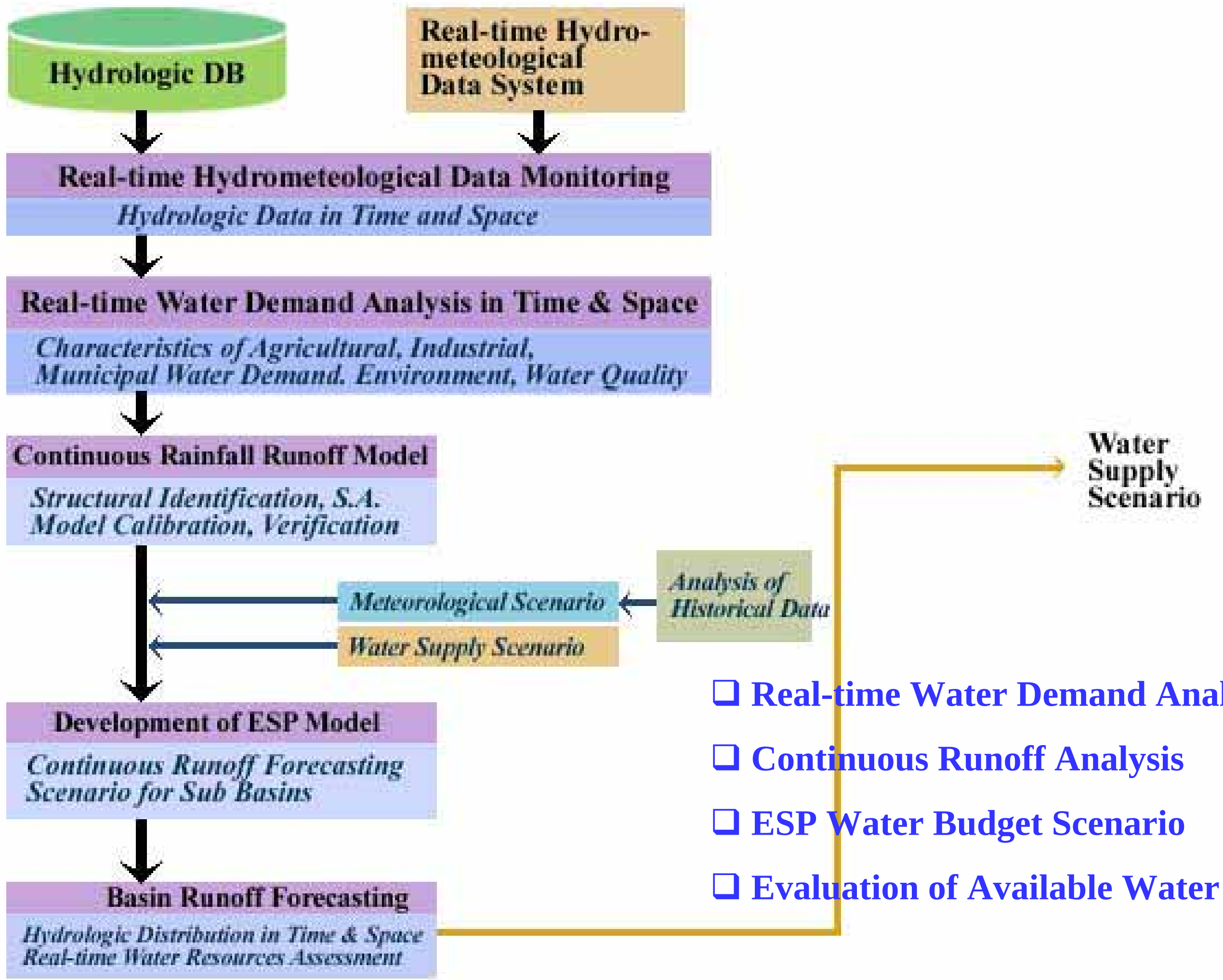
Conventional Water Resources Management	Integrated Water Resources Management
Surface water focused management	Integrated management of surface water, ground water, alternative water resources
Reservoir operation focused on water quantity control only	Comprehension River-Reservoir Operation considering water quantity, quality, basin water environment
Lack of consideration for environment and future generation	IWRM considering Basin Water Mgt. Efficiency, Equity. & Sustainability
Poor public participation and cooperation among water agencies	Encouraging co- work system among local society and related agencies
Lack of integrated management information system	Share of integrated information management system

21st Century New Frontier Research Project(2001-2011)

Development of Basin Water Management System

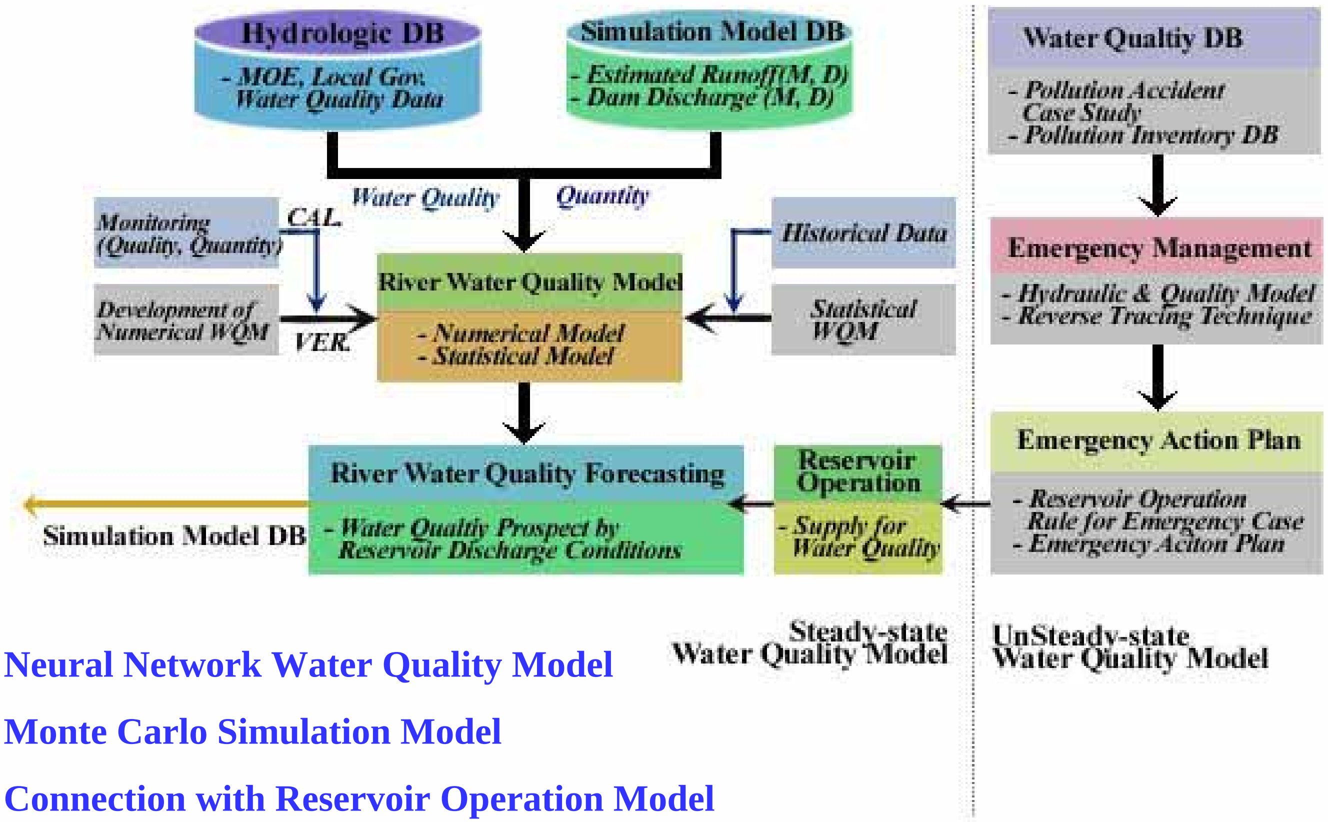
- **Long/s**hort term water use/supply forecasting system
- Reservoirs system optimization & simulation models
- River/reservoirs water quality prediction models
- Integrated basin water information system

Short-term Water Demand/Supply Forecasting System



- Real-time Water Demand Analysis
- Continuous Runoff Analysis
- ESP Water Budget Scenario
- Evaluation of Available Water Resources

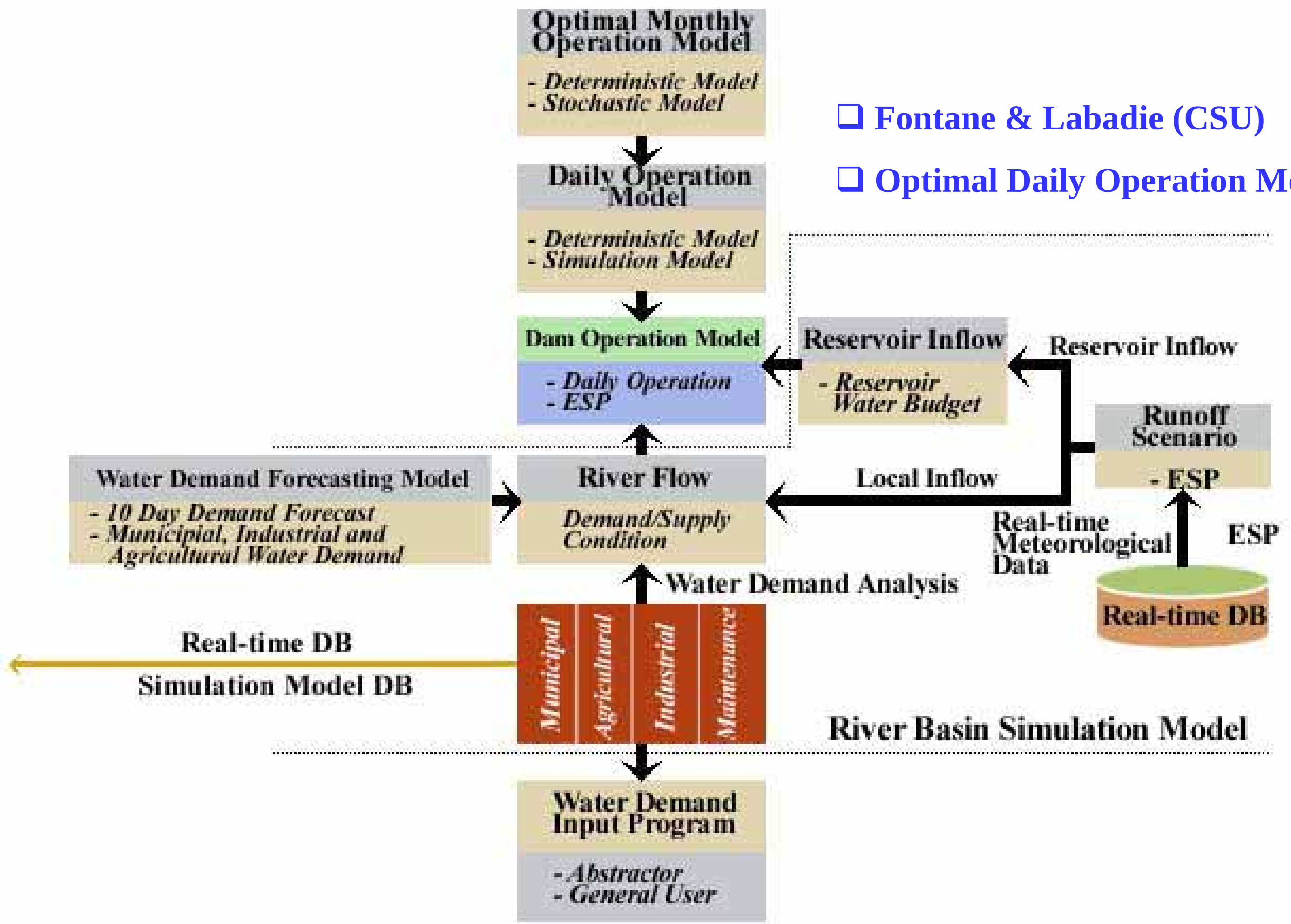
Basin Wide River Water Quality Model



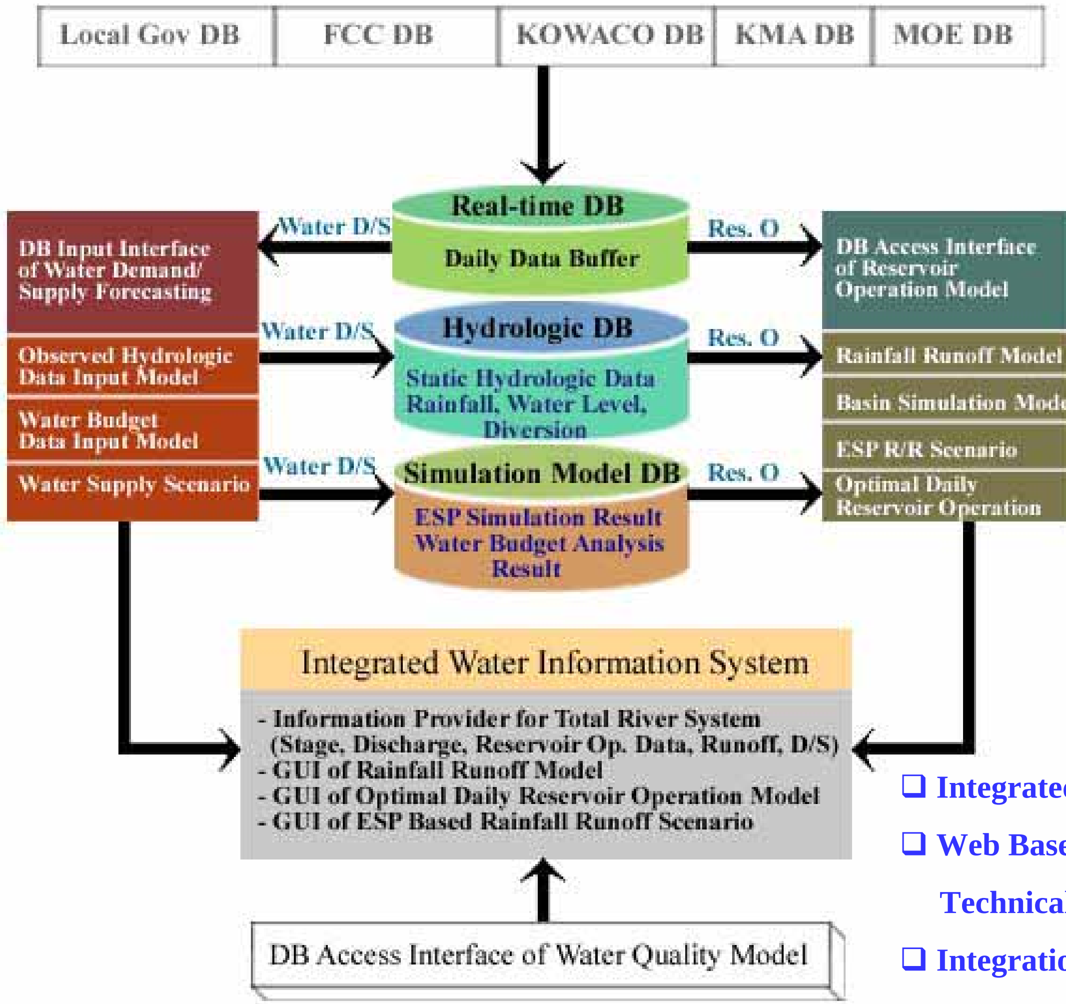
- ❑ **Neural Network Water Quality Model**
- ❑ **Monte Carlo Simulation Model**
- ❑ **Connection with Reservoir Operation Model**

Real-time Reservoirs System of Operation Model

- **Fontane & Labadie (CSU)**
- **Optimal Daily Operation Model**



Development of Integrated Real-Time Water Information System



❑ **Integrated GUI**

❑ **Web Based Technical Development**

❑ **Integration of Simulation Result**

Application For

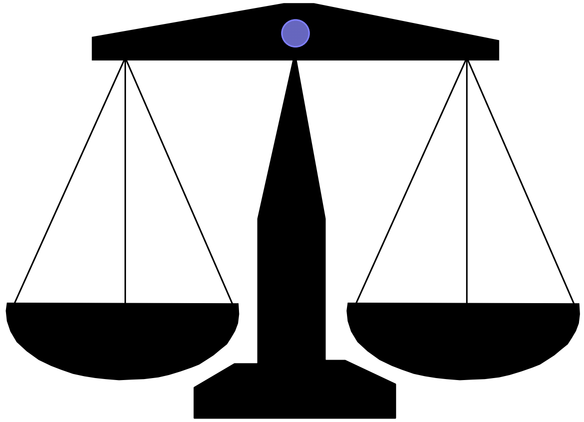
- Long-term National/Regional Water Planning
- Basinwide Real-time Water Mgt.(Operational DSS)
- Overseas Technical Assistance in IWRPM

2nd Stage Upgrade(04-07)

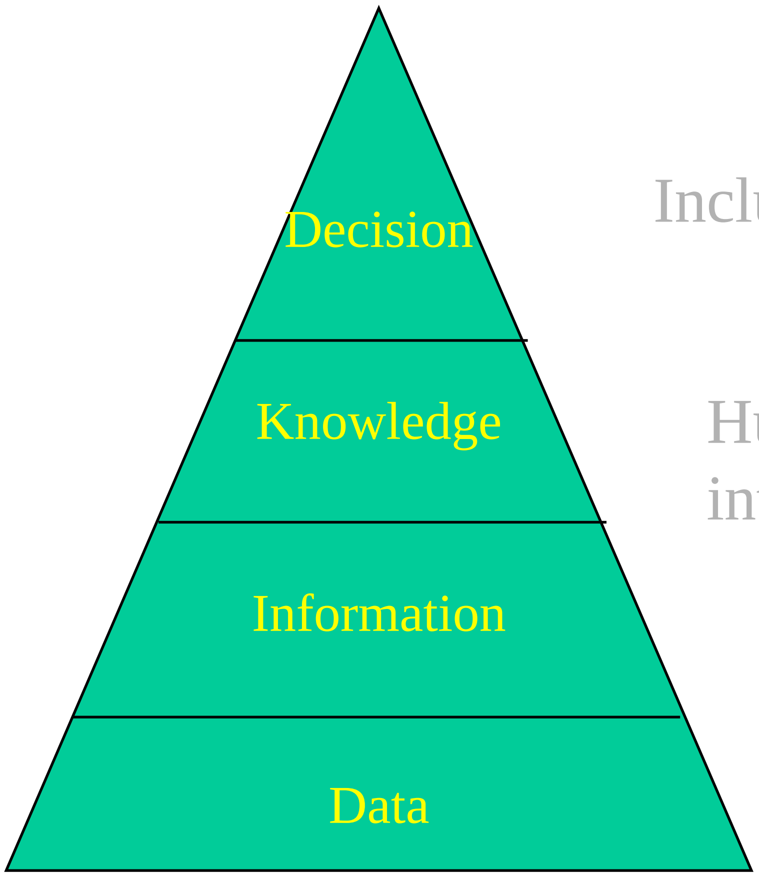
- Hydro-meteorological Forecasting Technique
- Surface Water + Ground Water (Conjunctive Use model)
- Water Quantity + Quality with more consideration for Environment/Ecology
- Economic Water Valuation

Key Factors to Consider to Attain Equitable Solutions

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



Role of Technical Knowledge



Inclusion with our other factors

Human interpretation and intuition

Data Processing and Analysis

High Quality "raw" data

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 Planning Studies
- Examples of DSS for Basin Water Management
  - Long-term Development Planning (Europe)
  - Long-term & Short-term Operational Planning (US, Korea)

Main Functions of the Developed Systems

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**

Thank You

Questions