Water Quality Modeling System in IRWMS

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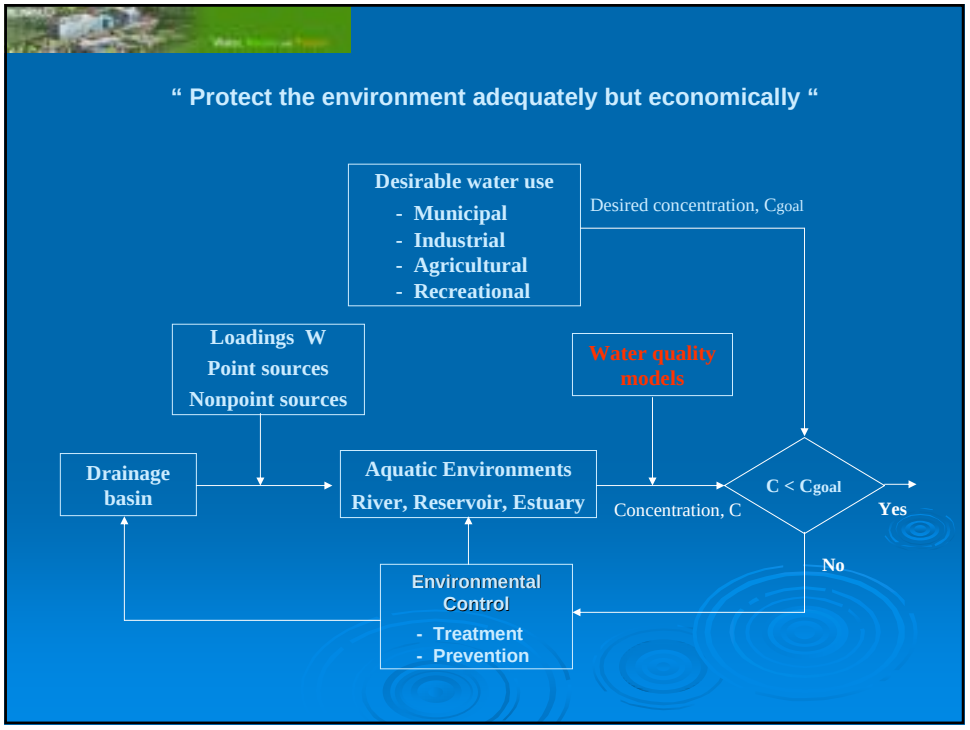
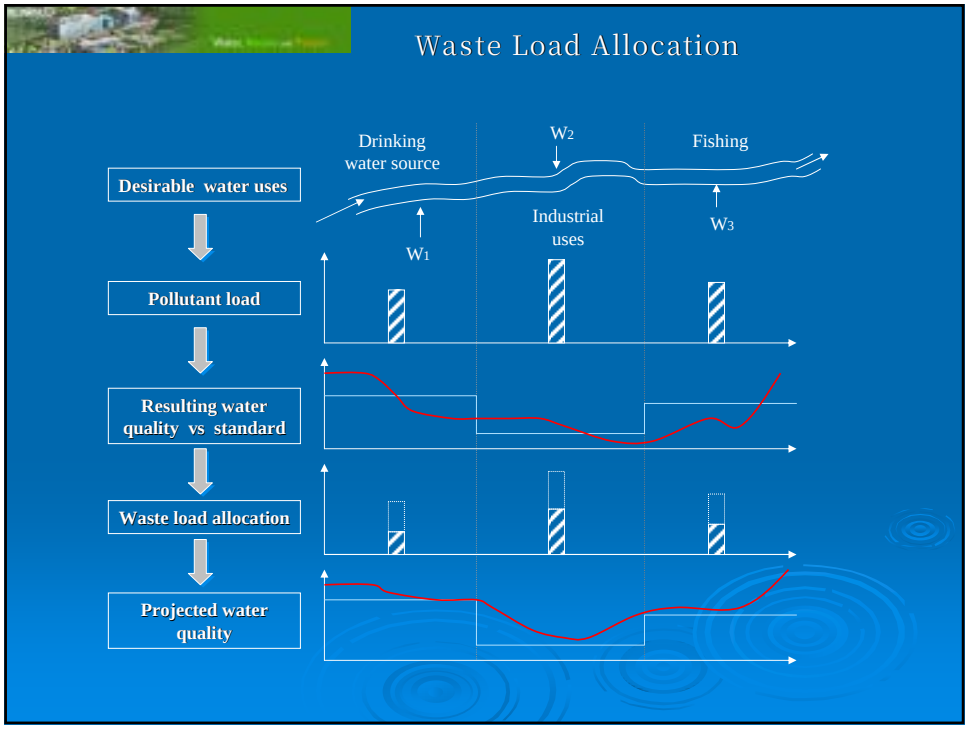

" Protect the environment adequately but economically "
Desirable water use
- Municipal
- Industrial
- Agricultural
- Recreational
Desired concentration, Cgoal
Loadings W
Point sources
Nonpoint sources
Water quality models
Drainage basin
Aquatic Environments
River, Reservoir, Estuary
Concentration, C
C < Cgoal
Yes
No
Environmental Control
- Treatment
- Prevention


Waste Load Allocation
Desirable water uses
Pollutant load
Resulting water quality vs standard
Waste load allocation
Projected water quality
Drinking water source
W2
Fishing
Industrial uses
W1
W3

Water Quality Management in the Geum River Basin

Water Quality Issues in the Geum River Basin

1. Water Quality Problems in Rivers
   - Degradation of W.Q. during low flow season
   - High level of COD, T-N, T-P (BOD has been controlled)
   - Significant level of NH3-N during winter
   - Eutrophication
   - Accidental spills

2. Water Quality Problems in Daechung Dam Reservoir
   - Eutrophication (Algae bloom after summer storms)
   - Turbidity currents during flood season
   - DO depletion in hypolimnion

Geum River Basin

- TMDL is set up from 2005
- Identifying Regional Population, Industrial, and Irrigational Waste Load
- Waste Reductions & Allocation
- For Water Quantity & Quality Control Basin Water Resources Management is Important

Objectives of Water Quality Models

• Development of steady state river water quality model

- For normal river & reservoir operation -

To support monthly river & reservoir operation scheduling by providing projected river water quality based on forecasted river flow conditions

• Development of Dynamic river water quality model

- For emergency operation during chemical spill -

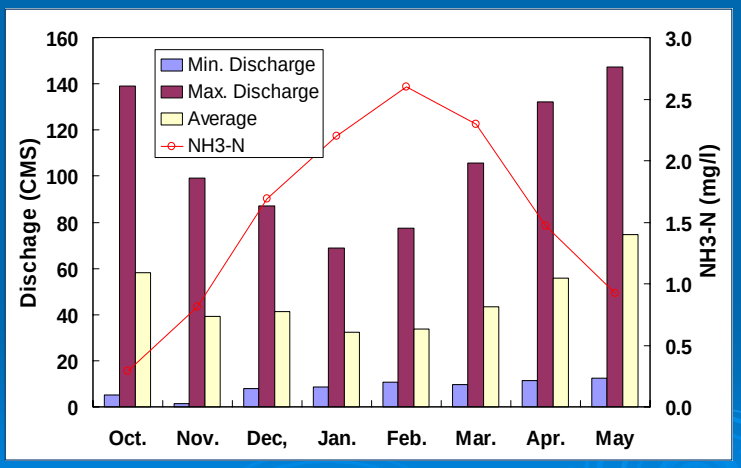
To support a real-time reservoir operation (daily or hourly) by providing projected river water quality based on scheduled reservoir discharge plan upon accidental water quality degradation (travel time and dilution effect)

• Development of reservoir water quality model

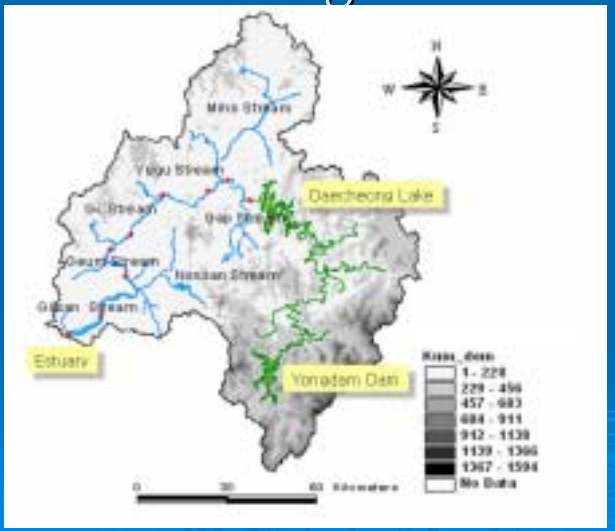
-To assess an adequate reservoir water quality management plan(BMP)

-To support a real-time control of turbidity current during flood season for minimizing the impact of turbidity current on reservoir water quality

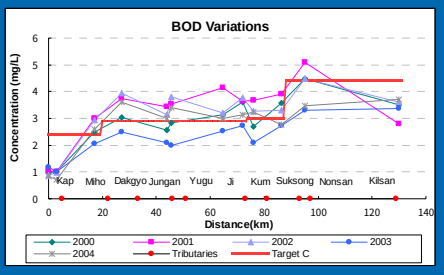
Conventional Reservoir Operations vs. WQ

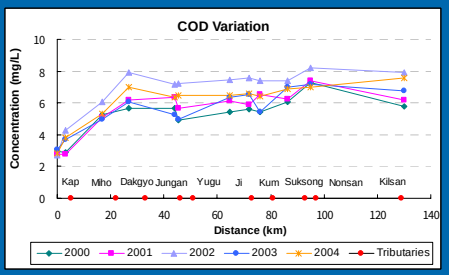


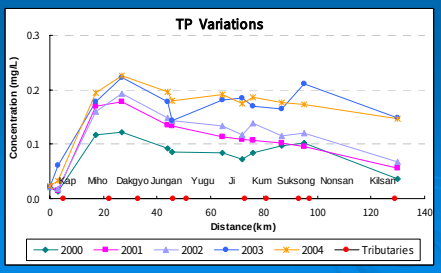
Water Quality Monitoring Sites

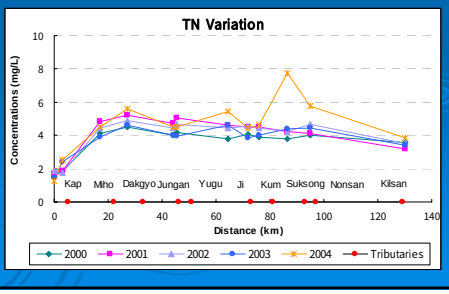


Annual Water Quality Variation









Water Quality Modeling System in IRWMS

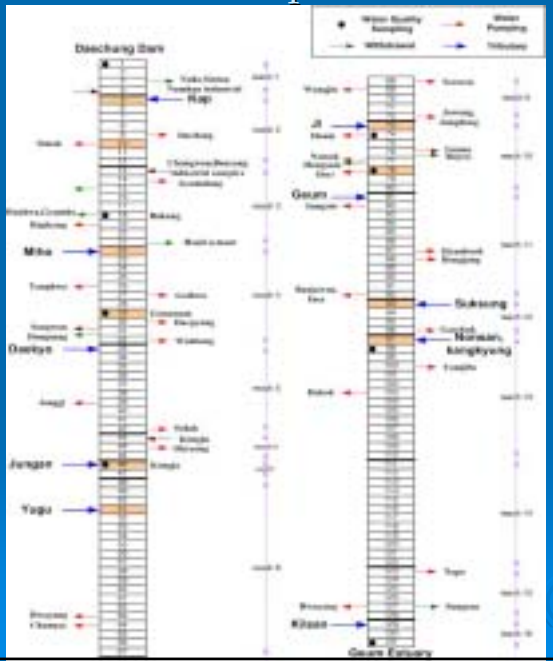
Basin Water Resources Management

- IRWMS is Developed to Support
  - Rainfall-runoff for Reservoir and Watershed Inflow Estimation
  - Reservoir Operational Planning
  - Water Quality Evaluations

Railfall Runoff (RRFS) → Reservoir Operation (SSDP, Comom, Korsim) → Qual2E-Plus (Integrated)

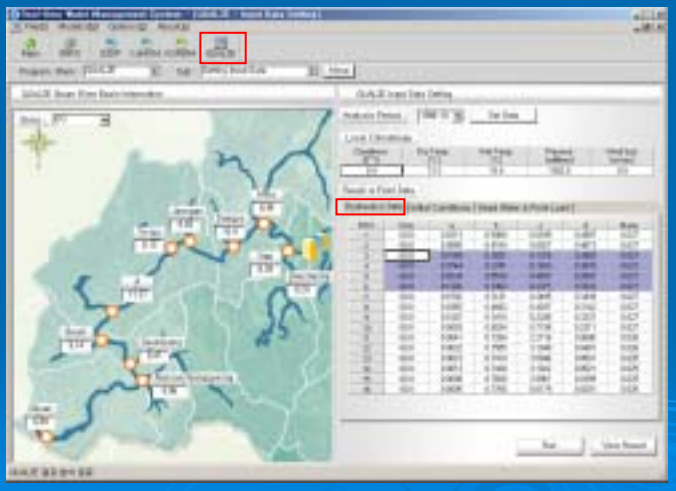
Basin Reservoirs System Operation for Water Quantity & Quality !

Computational Element

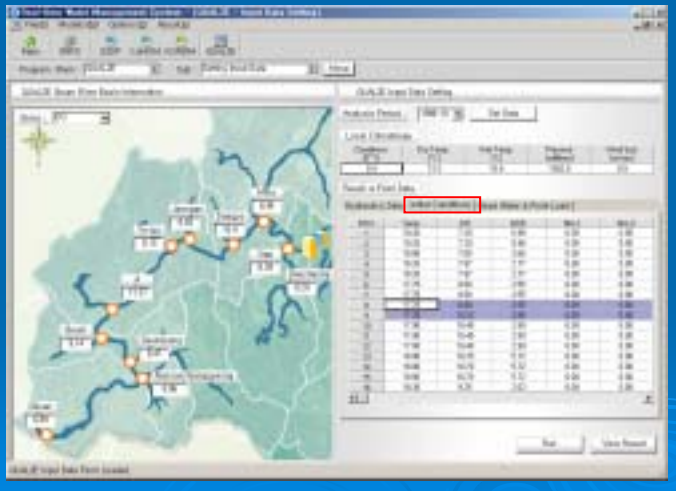


- 16 reaches
- 131 elements
- 10 tributaries
- Water intakes, Pumping
- Water Elevation Stages

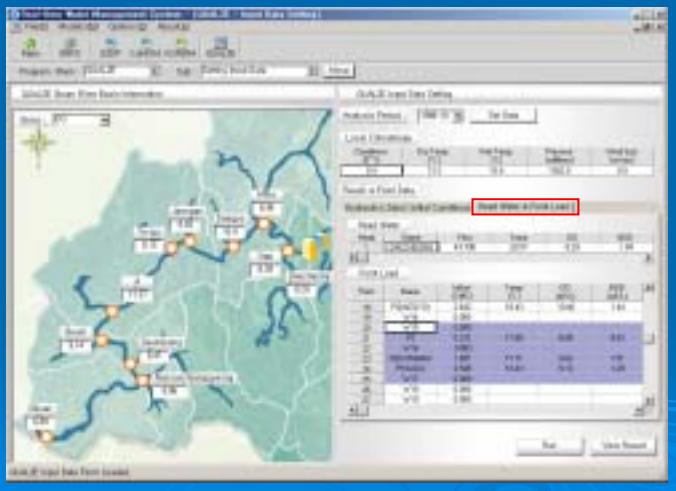
Hydraulic Data



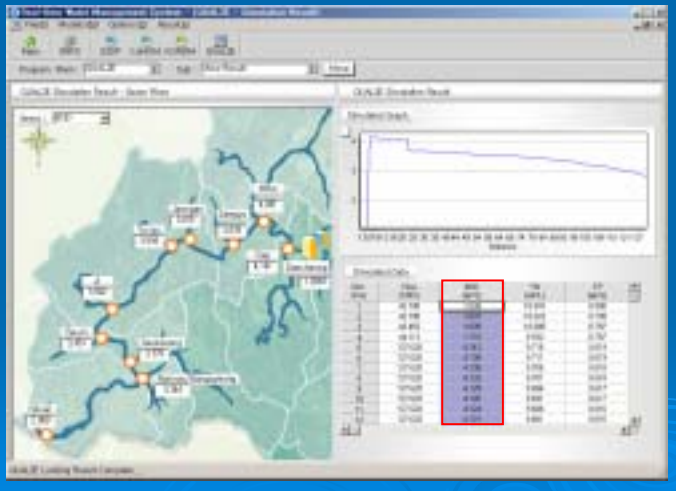
Initial Conditions

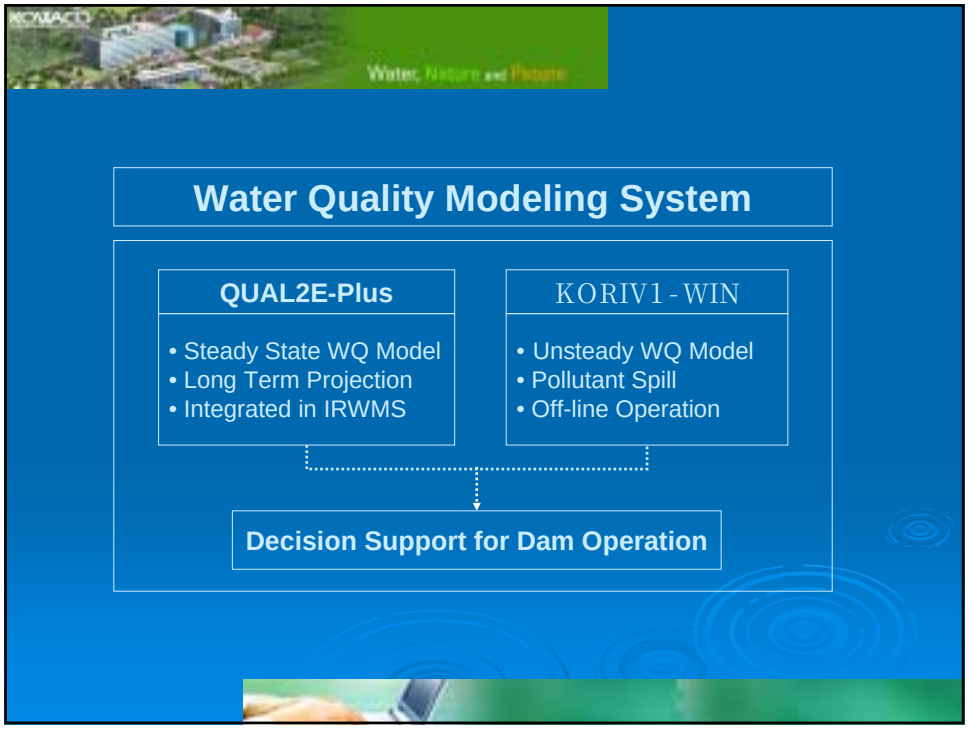


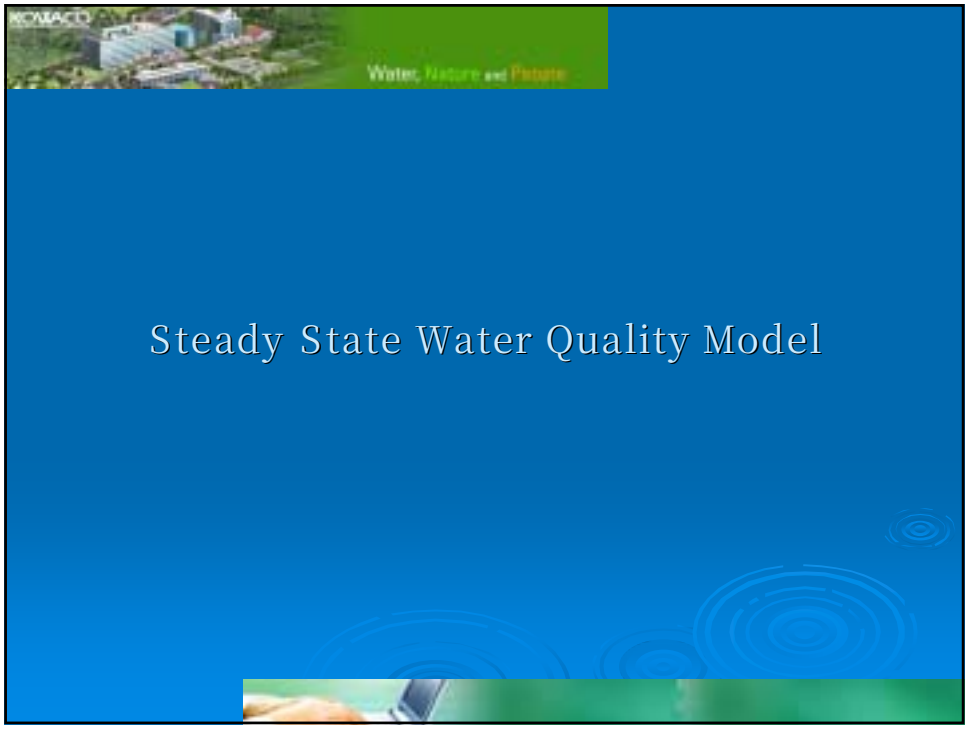
Head Water & Point Load



Output Results



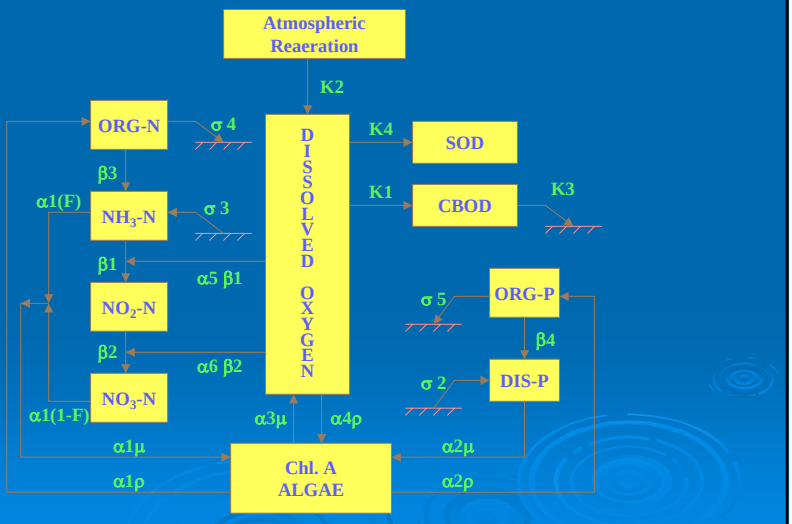

Water Quality Modeling System
QUAL2E-Plus
• Steady State WQ Model
• Long Term Projection
• Integrated in IRWMS
KORIV1-WIN
• Unsteady WQ Model
• Pollutant Spill
• Off-line Operation
Decision Support for Dam Operation


Steady State Water Quality Model

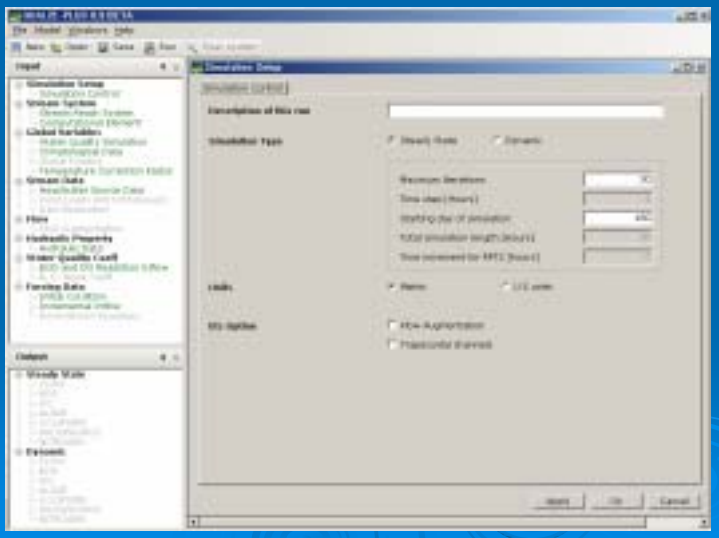
Qual2E-Plus Model

- **Improve Qual2E**
  - **Most widely used river water quality model**
  - **15 Water quality parameters are simulated**
  - **Reach, Element, Sources & Sinks**
  - **Steady state model**
  - **Flat-file data format**
  - **Embedded in watershed model (BASIN)**
  - **Does not support windows environment**

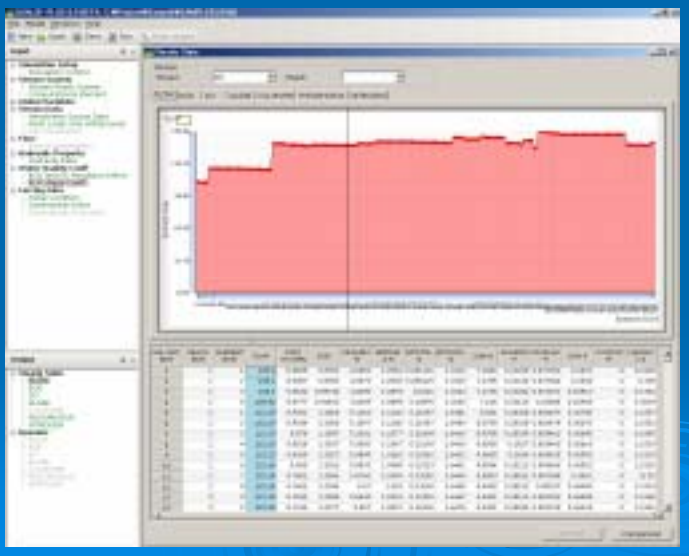
Qual2E-Plus Kinetics



Simulation Setup Screen



Simulation Result Screen

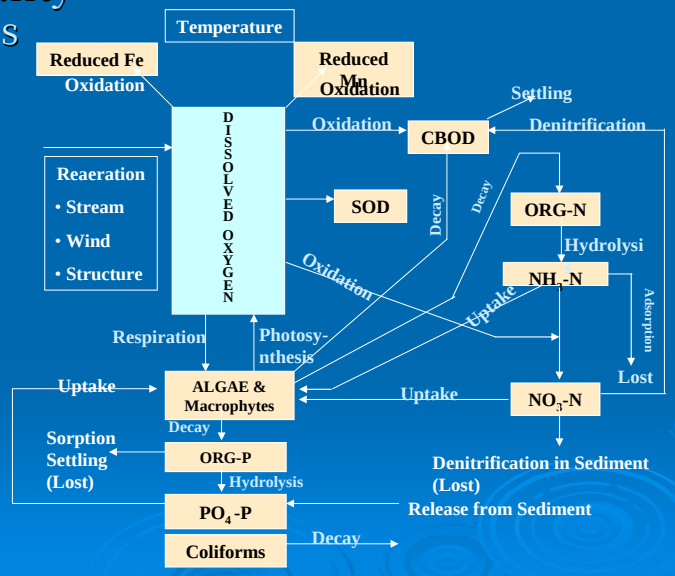


Dynamic Water Quality Model

KORiv1 Model

- **Unsteady WQ model**
  - Independent Model Run
  - Determine flushing discharge for contaminant spills
- **Based on CE-Qual-Riv1**
- **Hydraulic module**
  - Full dynamic equation (St. Venant eqns)
  - Continuity & momentum equation
  - 4-point implicit Preissman scheme
- **Water quality module**
  - Holly-Preissman for convection term
  - Similar kinetics to QUAL2E
  - Modeling of 12 WQ parameters (DO, CBOD, N groups, P groups, Mn, Fe, Algae, etc)

Water Quality Kinetics



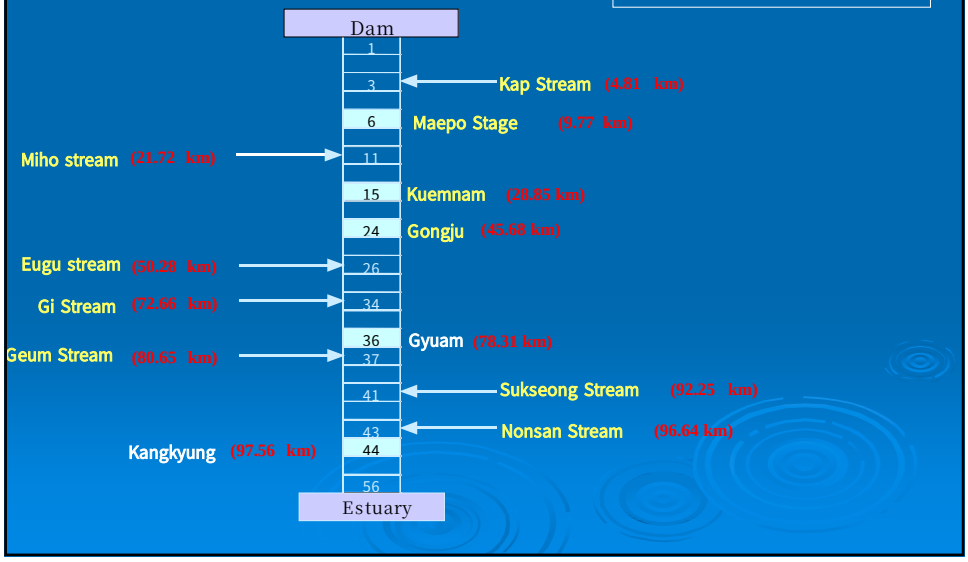
Schematic of Modeling

1. **Data Preparation**
2. **Hydrodynamic Input file generation and model run**
3. **Check out the result of hydrodynamic module**
4. **Water quality file generation and model run**
5. **Check out the results of water quality model**

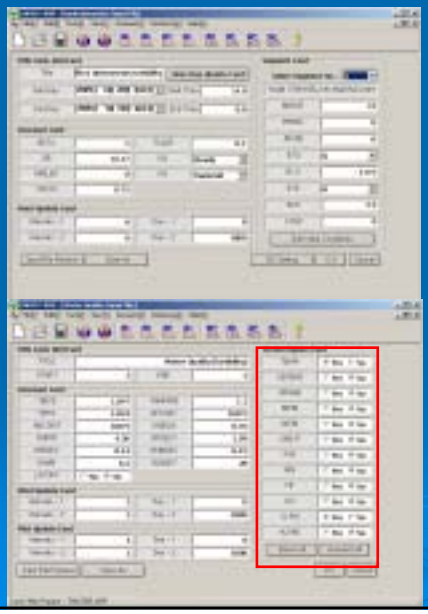
Data Preparation	Run Hydrodynamics	Run Water Quality	Output Display
• Model grid and node • Geometric data • Hydro parameters • Kinetic parameters • Initial conditions • Boundary conditions	• Hydro input *.INP • Lateral flow *.LAQ • Cross section *.XSF	• Water quality *.INP • Hydro output *.HYD • Lateral load *.LAC • Meteorological *.MET	• Water level, flow, velocity • Concentration • By node display • By time display • Graph & Table

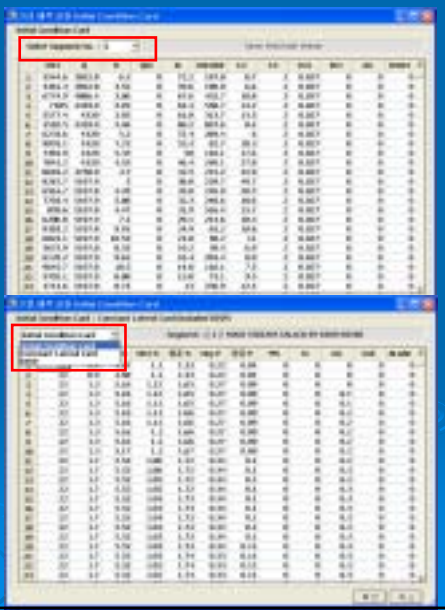
Diagram

- 1 main reach and
- 7 tributaries (8 segments)
- 2 nodes for each tributary
- Total 70 nodes

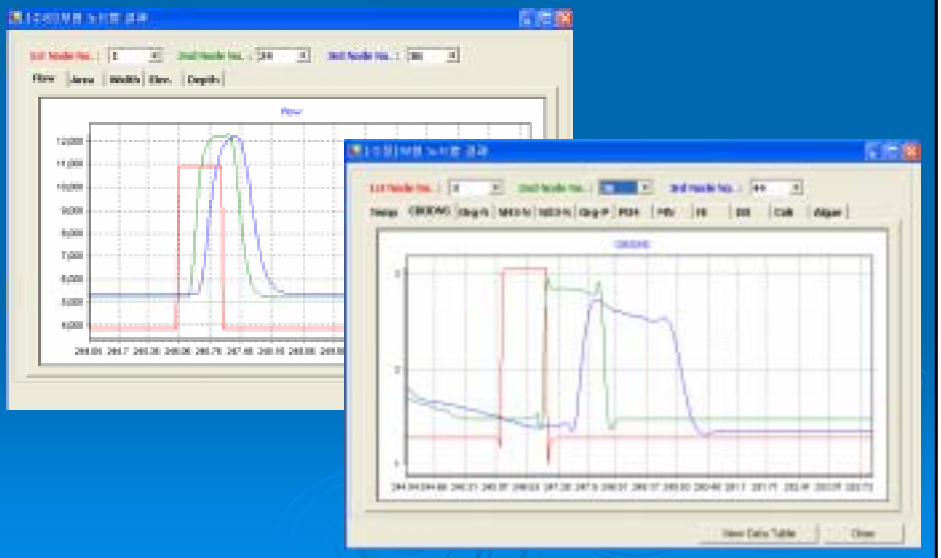


Data Preparation



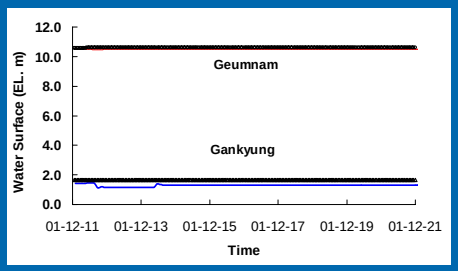


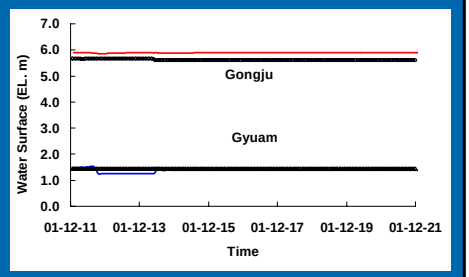
Output Results



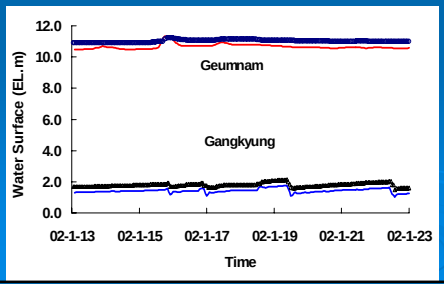
Riv1H Calibration

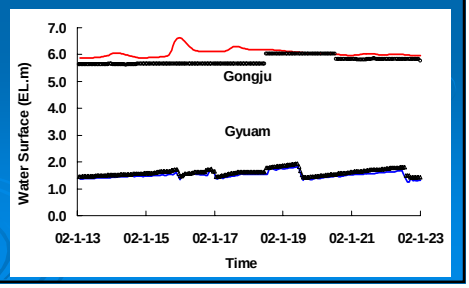
- 2001.12.11~12.21(Dry Season)



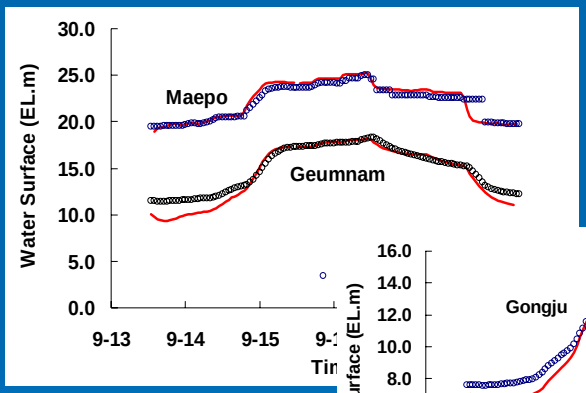


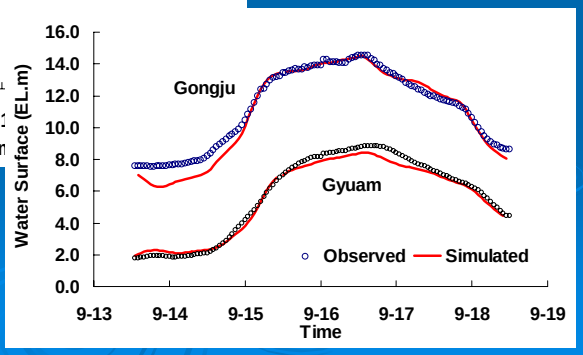
- 2002.1.13~1.23(Dry Season)





▪ 2000.9.13 ~ 9.18 (Typhoon Saomi)



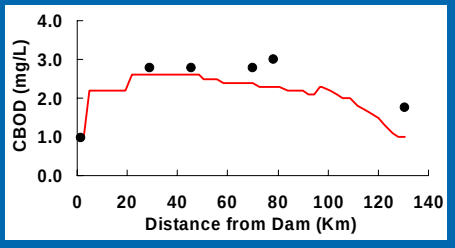


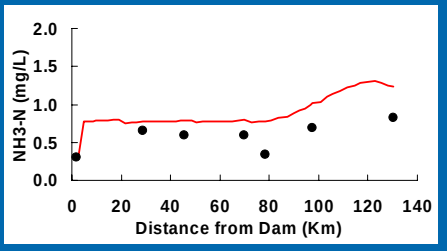
Discharge Increase for WQ Improvement

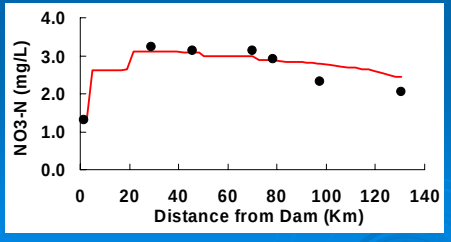
Bridge

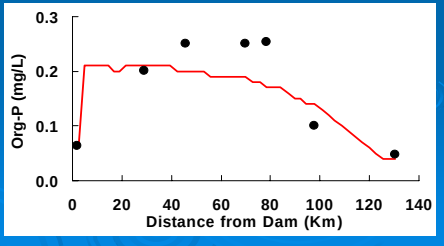
EL Gauge

▪ Model Verification





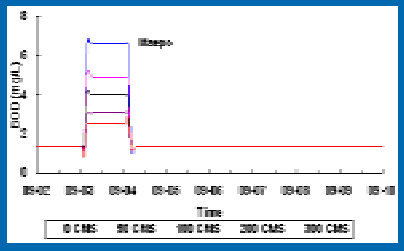


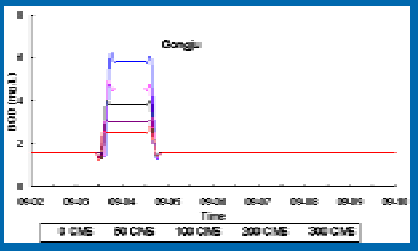


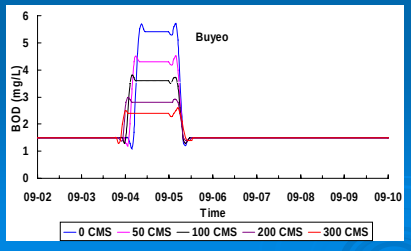
Application Examples

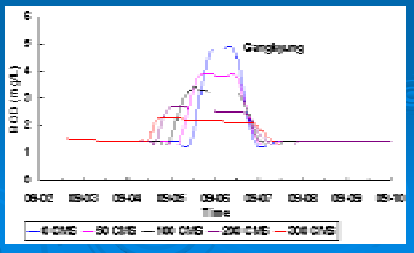
- Scenario Setup
  - Maintenance of Water treatment plant in the Kap stream
  - Releasing BOD 100 ppm, 620,000 ton/day
  - Estimate discharge release to maintain BOD concentration below 3 ppm
  - Inform water intake system at Downstream

Application of Water quality accident

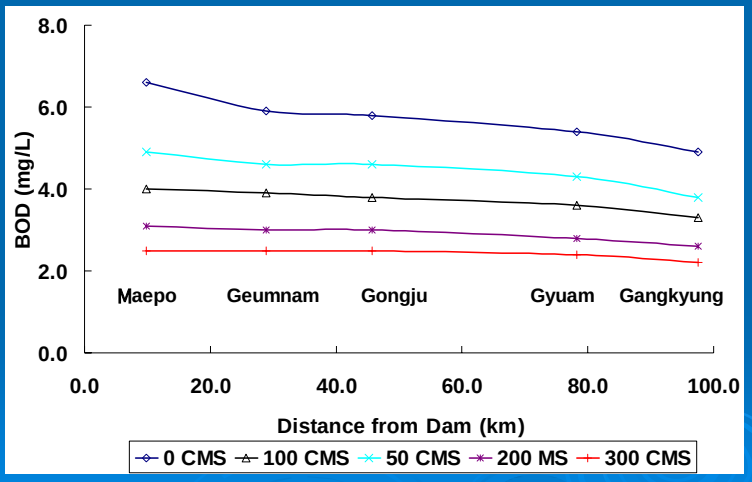


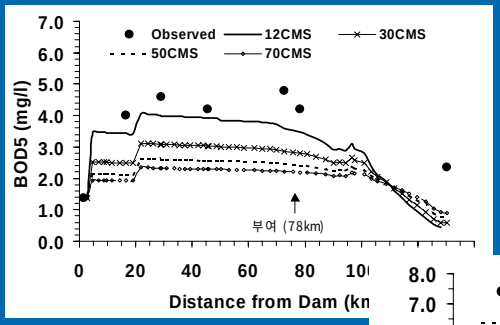




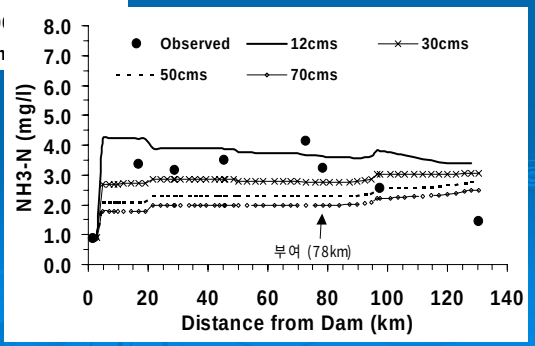


- Maximum Concentration Variation



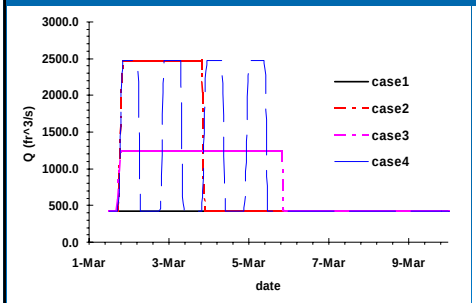


NH3-N Simulation

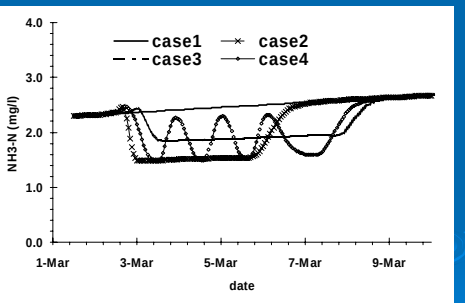


Flushing Effects
Release Pattern Change to Evaluate Downstream Water Quality

Flushing Scenario



NH3-N Concentration



Koriv1 - Plus

- Updated Version of Koriv1
- Enhanced Visual Description
  - Channel Visualization
  - Cross Sectional Shapes, Depth
- Coloring Index of WQ Concentration
- Animated Result Output

Model Summary

- **Qual2E-Plus & KORiv1 Model**
  - Steady and unsteady water quality model
  - In the steady state, the results are very similar
  - Both are developed under window environment
- **KORiv1**
  - Useful for the accidental spill at downstream
  - Determine adequate discharge for flushing
  - Effect of water quality improvement
  - Compute channel maintenance flow

Further Development

- **Integration with basin runoff system**
  - RRFS System
  - Reservoir operation system
- **Estimate channel flow maintenance discharge**
- **Environmental flow Estimation**
- **Use TMDL Support Tool**
- **Real-time turbidity current modeling in Reservoir & Downstream**

Water Quality & Environmental Flow Analysis System

Emergency Spill

- Hydraulic Analysis (Riv1H)
- Discharge Decision for Emergency case (Riv1Q)
- Flushing effect / Travel Time

Long-Term WQ

- Identify Watershed Pollutant source
- Discharge to meet WQ Criteria
- Projecting long term water Quality (Steady)

KoRiv1 ⟷ Qual2E-PLUS

Integrated Water Quality & Environmental Flow Analysis System

PHABSIM, RAP

Environmental Flow

- Monitoring & Assessment
- Impact Analysis on Discharge Variation

Reservoir Water Quality Model

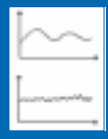
R T M M S

Real-time Monitoring | **Real-time Prediction**

Turbidity, Temp, DO, pH, Conductivity

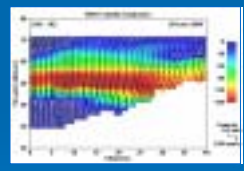
CDMA wireless Internet Network

Server



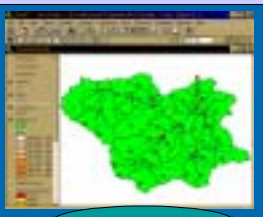
Temp & Turbidity Forecasting

Input Data Preparations



2D Simulations

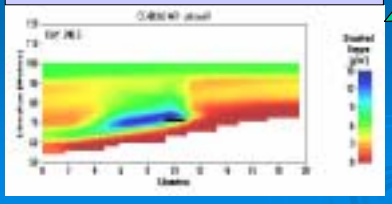
Reservoir contaminant influx computation module



GIS based
Basin water quality
Temporal spatial DB

River water quality evaluation system
for reservoir operation

Realtime turbidity flux prediction system



Thank you

감사합니다