Climate Change and Mitigation Measure in Republic of Korea focused on reservoir operation with high turbid water

Dr. Sangyoung Park

•Executive Director of Korea Water Forum/ Principal Researcher of K-water Institute

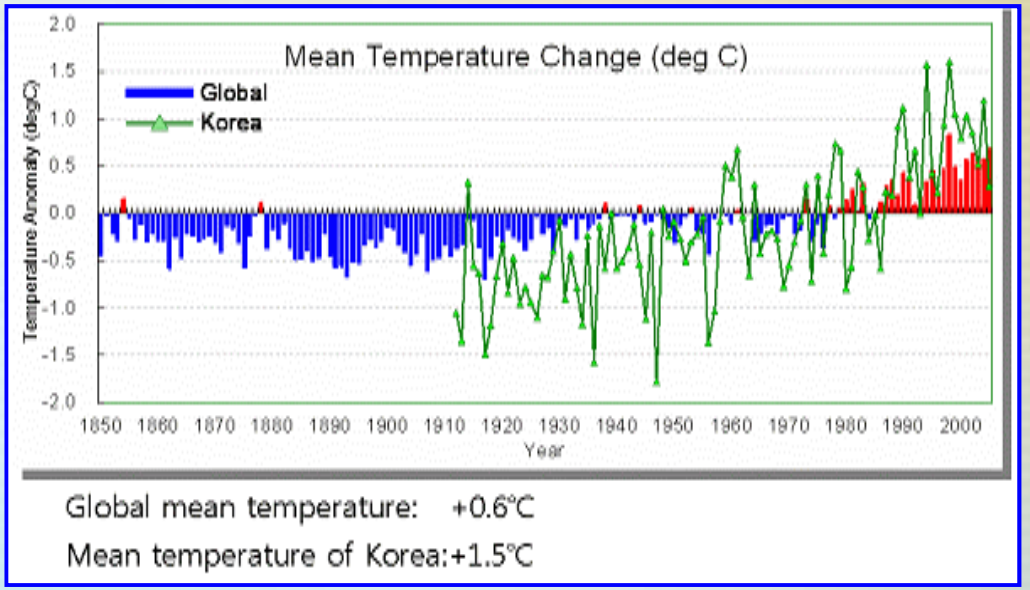
•E-mail: sypark119@kwater.or.kr

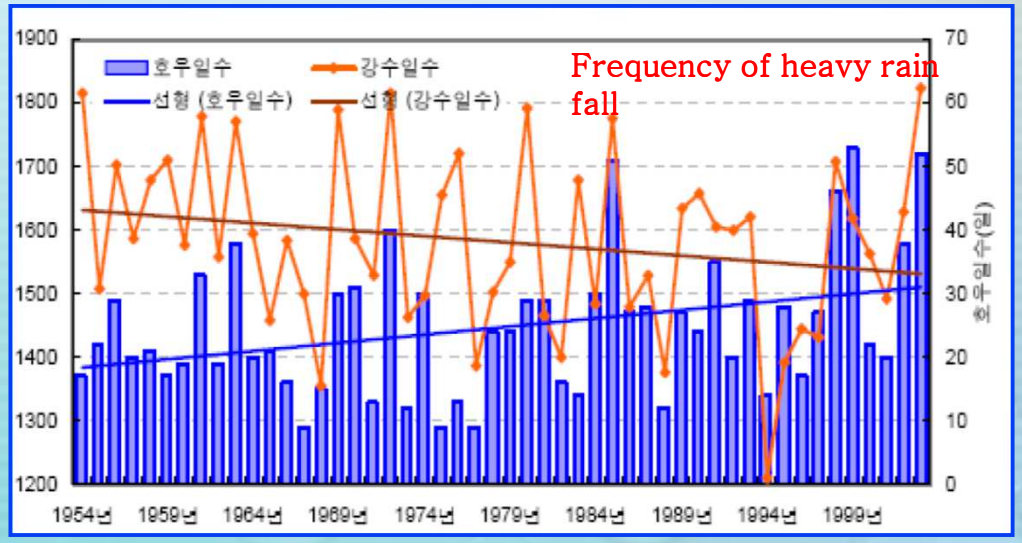
Climate Change of Republic of Korea

Global climate change

- Global warming trend
  - about 0.6℃ increased for century

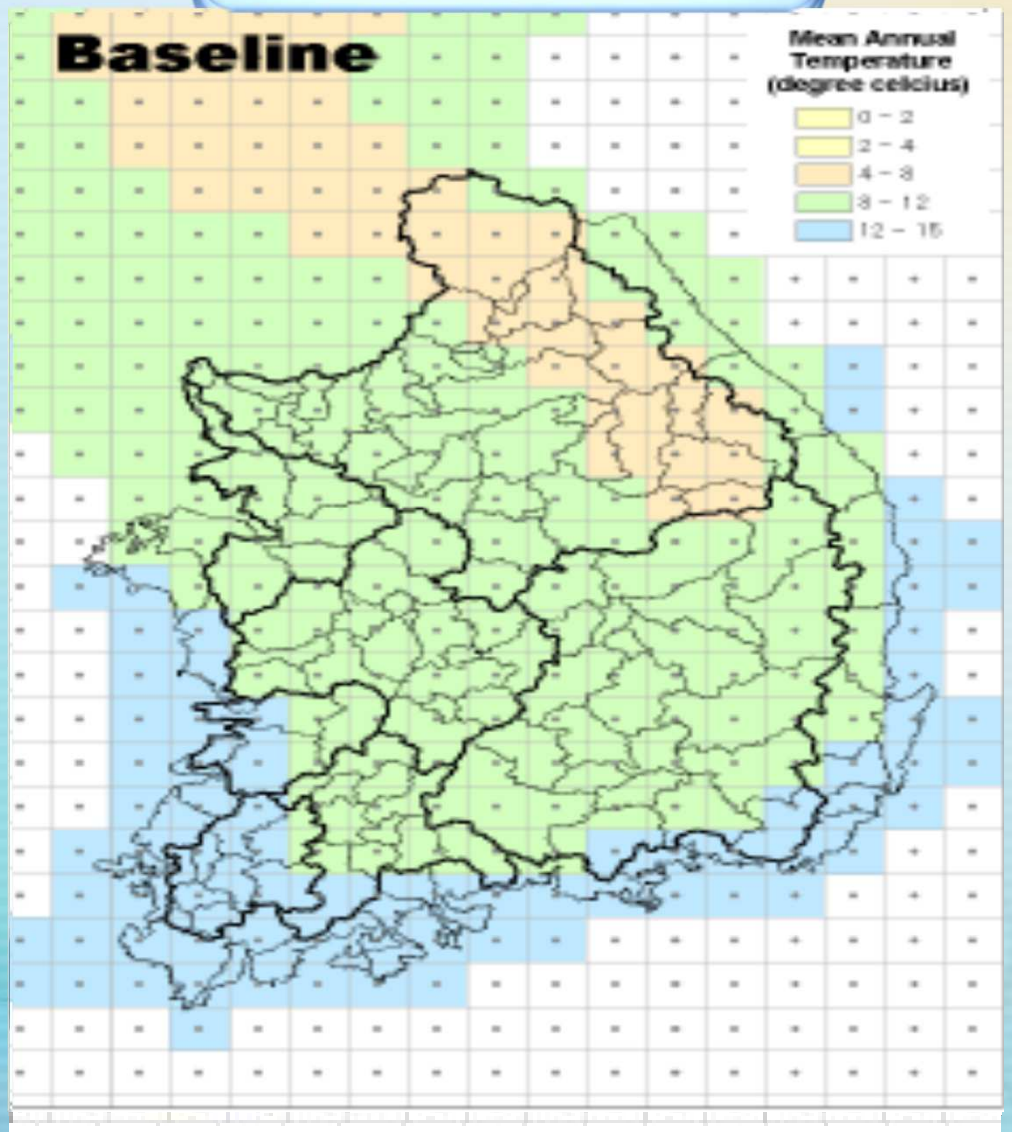
- Average temperature of Korean peninsular has risen up to 1.5 degree during the last century (1906-2005)
- Frequency of heavy rainfall increased to 18%
- Days of rainfall decreased to 14%





Prospect of Climate Change

Temperature change



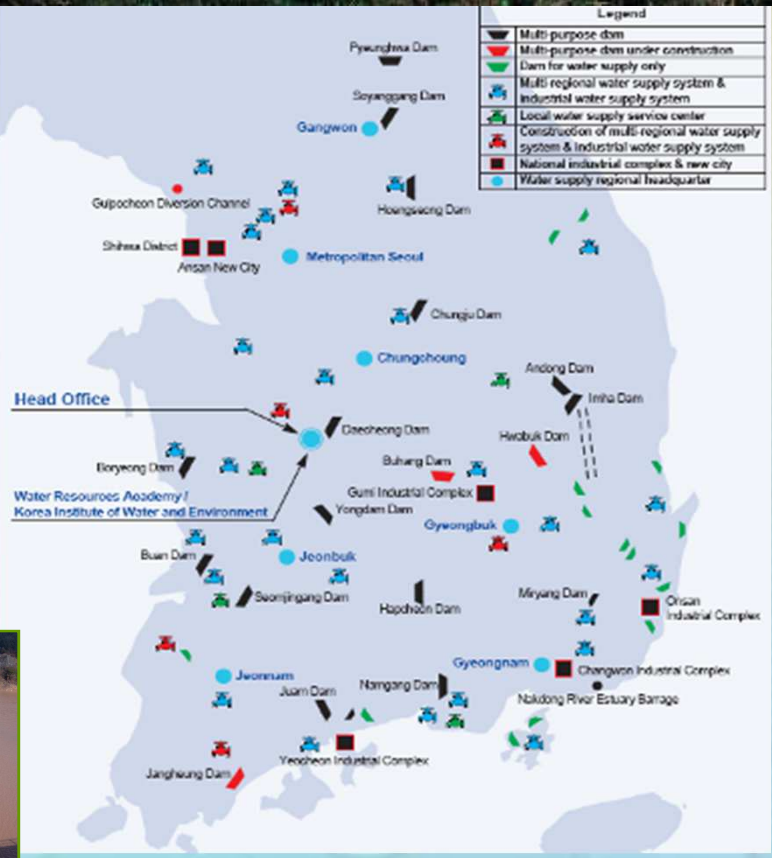
Response of Global Community

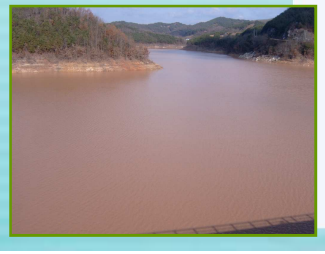
- Economical losses
  - -5~20% of Global GDP (Stern review, '06)
- **Mitigation & C.C Adaptation Program**
  - -World Bank 1 trillion$, EU 6,400$ investment plan
  - -Development of National level mitigation plan of climate change: USA, Japan, U. K., Canada

Contents

Background

- K-water supplies over 16 million m^3/d of bulk water
  - 16 Multipurpose Dams: 4.4B m^3/yr
  - 27 Water Supply Systems: 2.8B m^3/yr
  - Providing 55% of national clean water needs
- Water quality control is important for drinking water supply
- Recently, many reservoirs have been suffering from turbid water

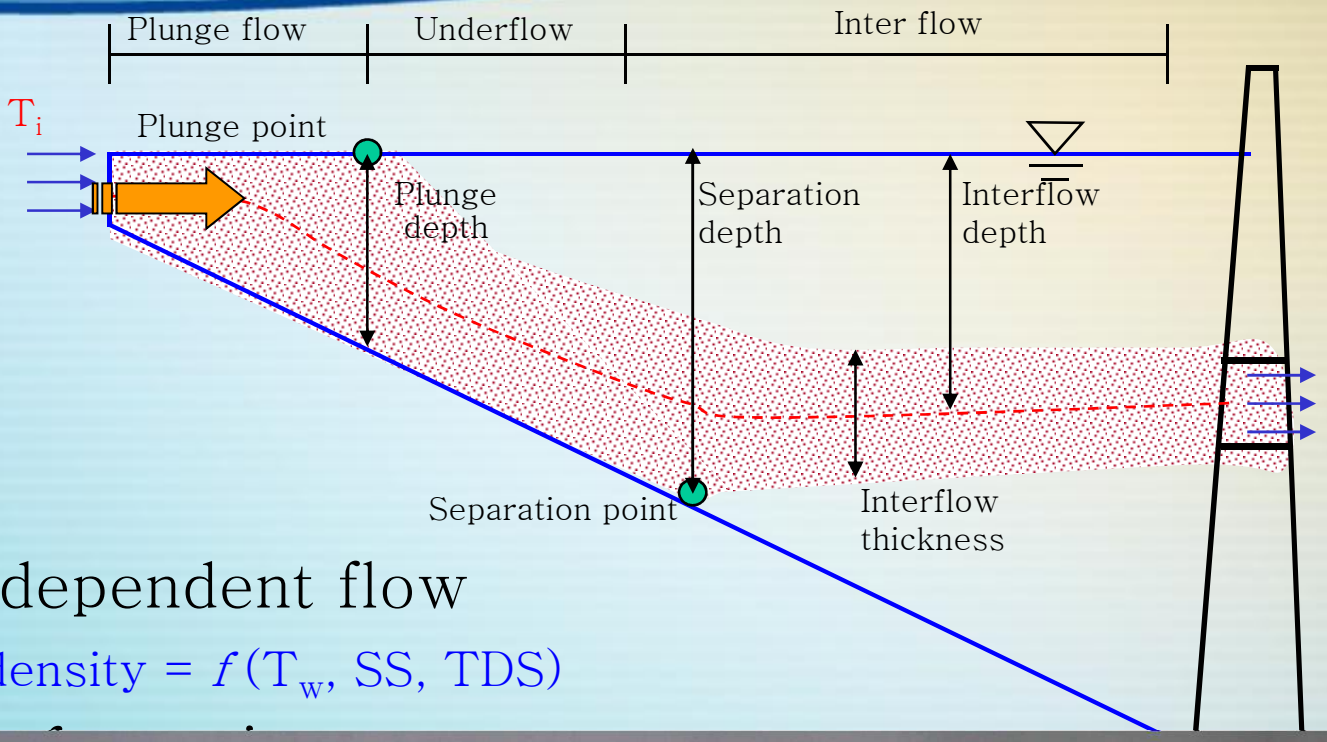




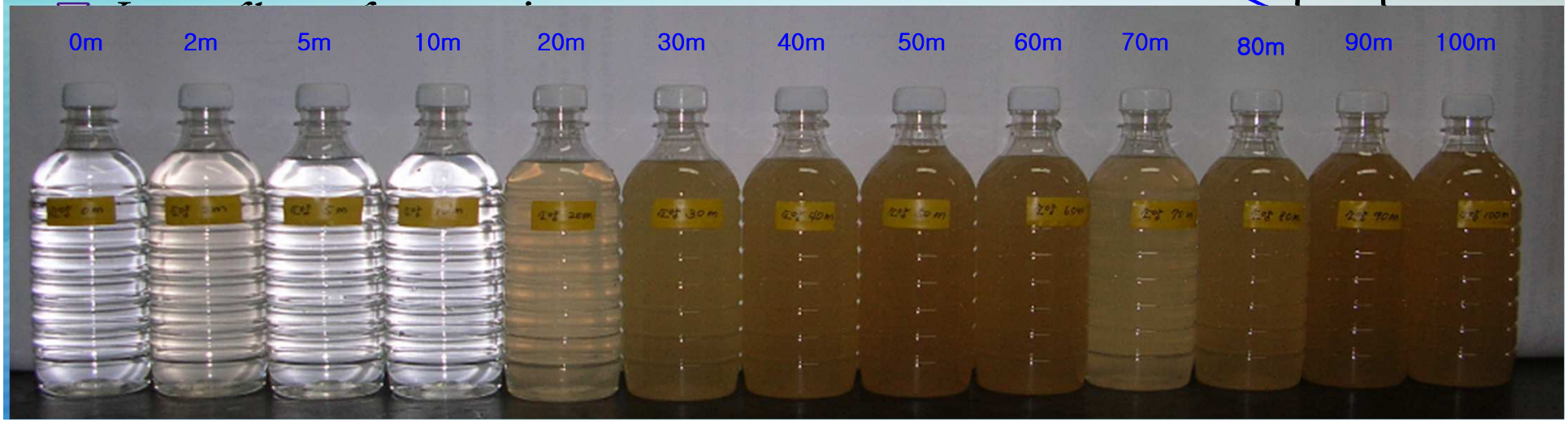
Turbid Water and Problems

- Turbid water is dirty water with suspended solids and other harmful materials
  - Organic materials, P and N are attached to suspended solids
- High turbidity affects drinking water source quality
- Increasing drinking water treatment costs
- Drinking water standard is < 0.5 NTU
  - NTU: Nephelometry Turbidity Unit

Turbid Water Behavior in Reservoir

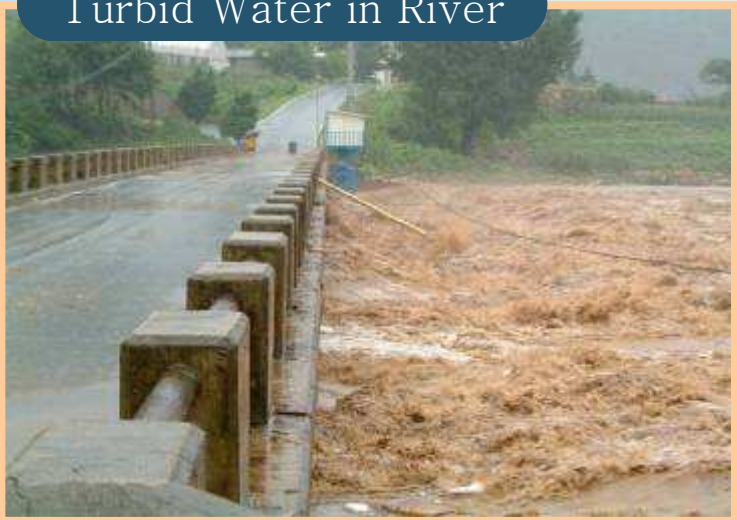


- Density dependent flow
  - Water density = $f(T_w, SS, TDS)$



Turbid Water Behavior in Reservoir

Turbid Water in River

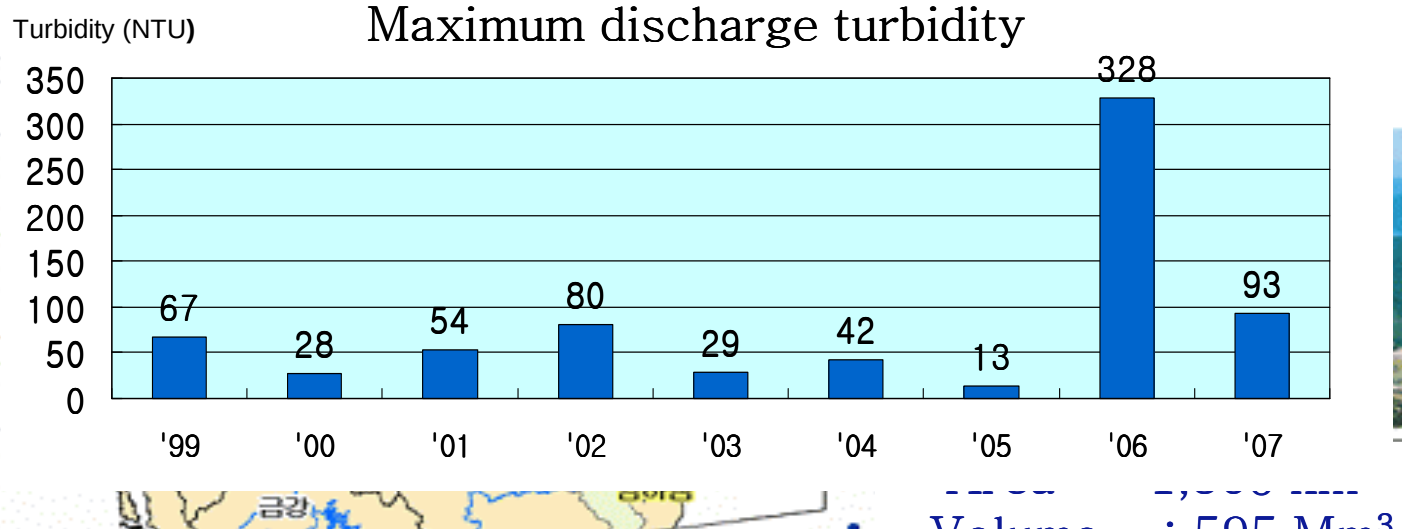


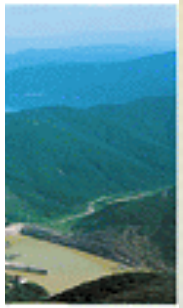
Turbid Water in Reservoir

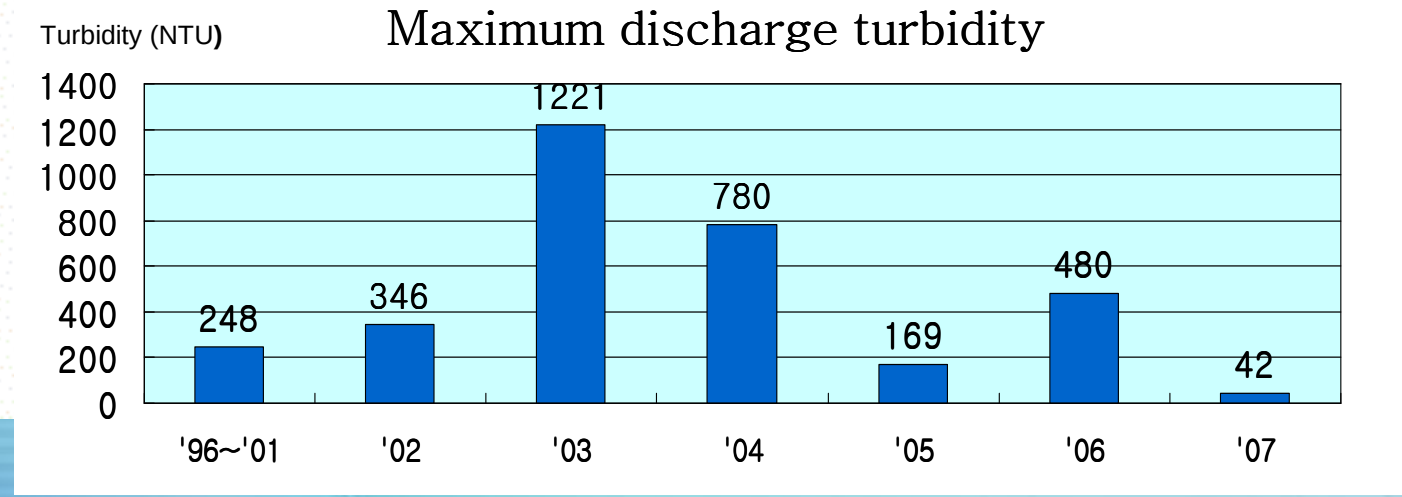
After Turnover

Prolonged Turbid Water Release

Imha and Soyang Case







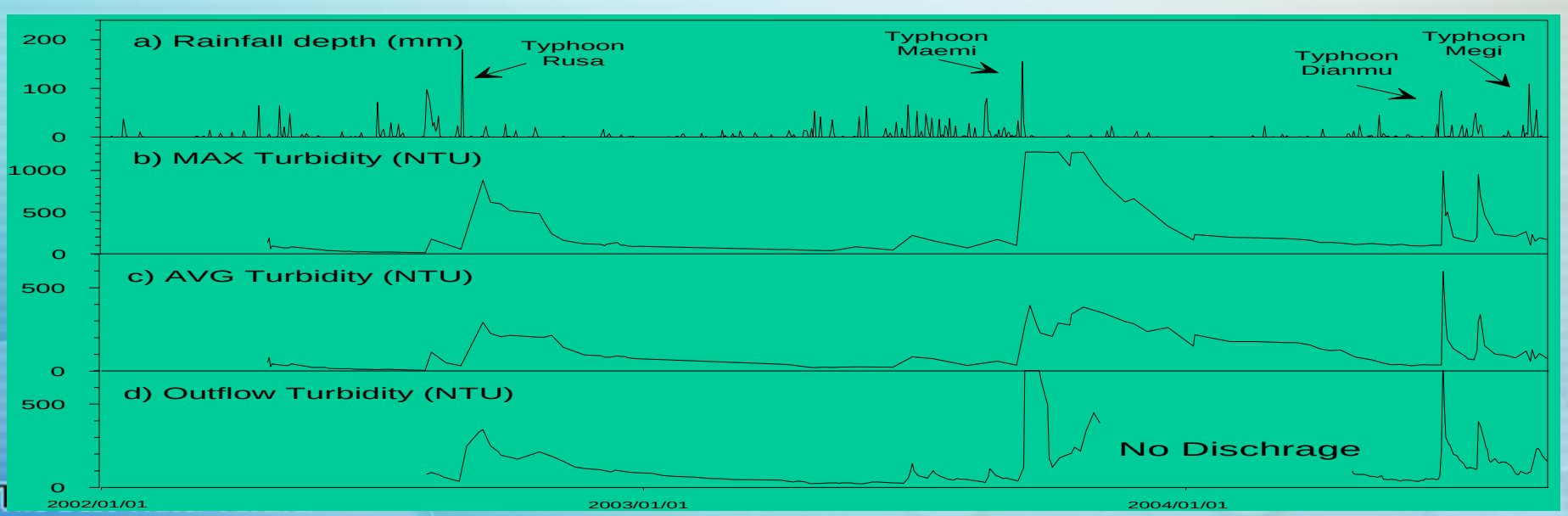
Major Turbid Water Source of Imha Catchment

Turbid Water Problem in Imha

Difficult to operate water treatment plants normally

Negative Impact on Downstream

Difficult to operate reservoir normally



Turbid Water in Soyang Watershed

- Severe storm in Inje area in '06.7
- 7.11~20, total 600mm, Hourly Max. 88mm/hr

Landslide(125), River bank breaks(121), Massive soil loss in upstream watershed

Declared as "Special Disaster Area('06.7.18)"
Government spent 675 bn. won

Response

Imha-dam

- Fishery loss compensation('04~'07.7) : 3.2 bn. won
- Move water purification plant : 14.4 bn. won
- Total budget of government ('05 – '15) : 23.31 bn. won

Demonstration of local fisherman ('07.2~3)

Response

Yongdam-dam

- Cleaning riverbed (about 19km): 0.16 bn. won
- Selective withdrawal facility: 50 bn. won

Current Counter Measures for Turbid Water Problems

Catchment

- source control (short term effect)
  - soil loss control
  - tributary and farm land refurbishment
  - improve cultivation method
  - debris barrier

Reservoir

- dam facility improvement
  - tunnel type spill way
  - selective withdrawal facility
  - automatic monitoring system

Downstream River

- reduce the impact of downstream
  - construction of wetland
  - monitoring ecological condition

Governance

- short term counter measure
  - low performance or outcome
  - lack of integrated approach

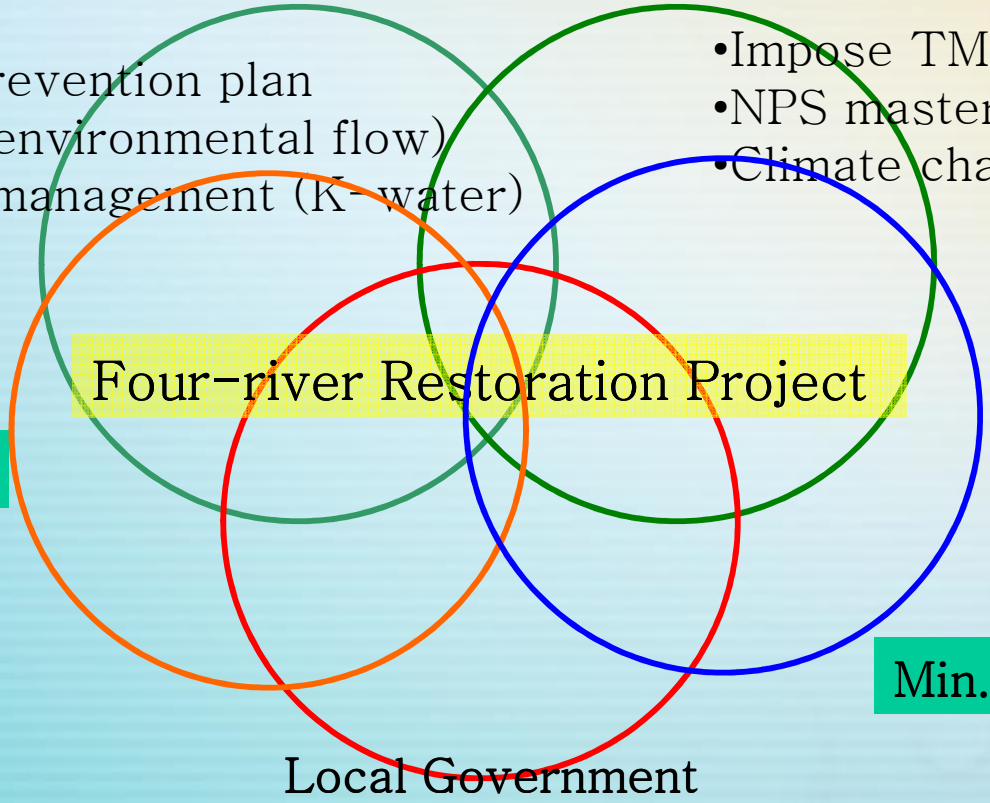
Governance for Turbid Water Management

Min. of LTM

- Turbid water prevention plan
- Instream flow (environmental flow)
- Dam reservoir management (K-water)

Min. of Environment

- Impose TMDL policy
- NPS master plan
- Climate change master plan



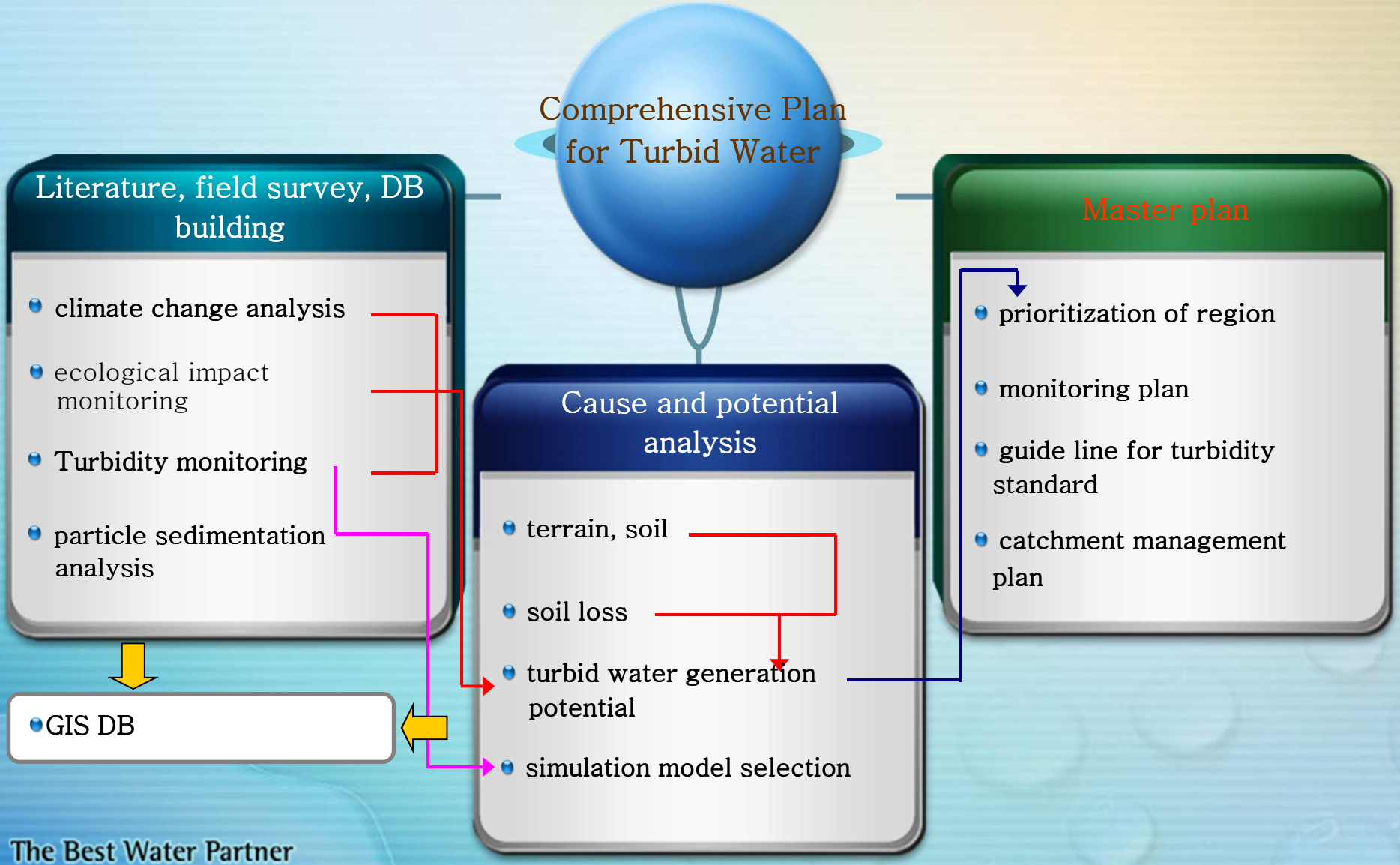
Min. of Forest

Min. of Public Admin.

Local Government

- TMDL policy
- NPS control plan
- Urban development plan

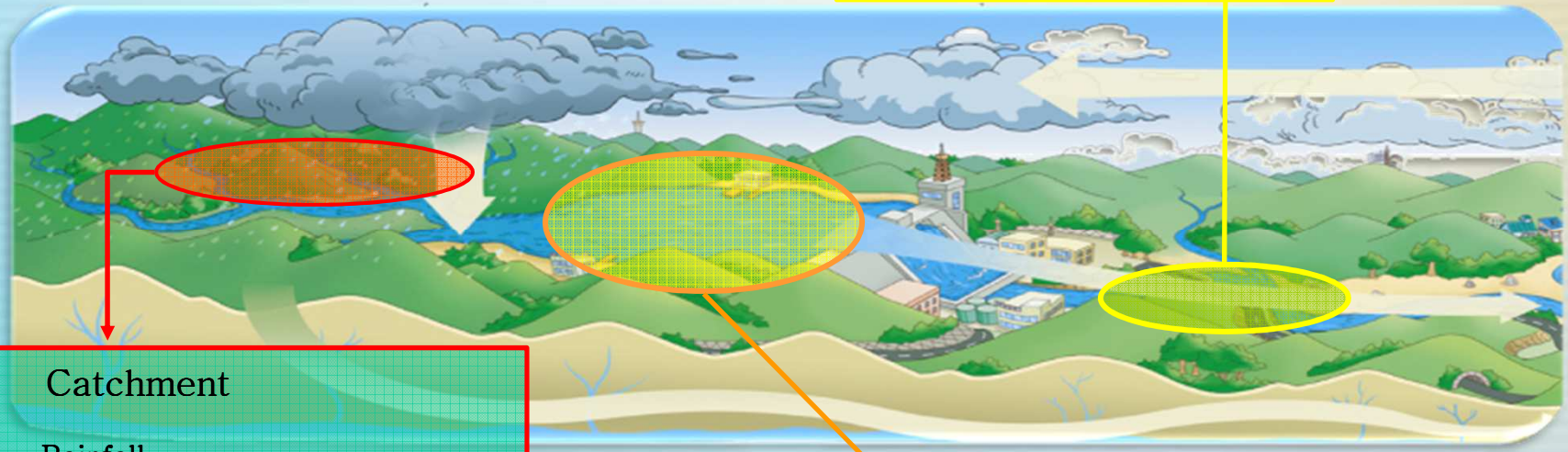
Comprehensive Plan for Turbid Water



Major outputs of master plan

- Climate change analysis
- Turbid water mechanism
- Cause analysis
- Soil loss analysis
- Turbid water potential analysis
- Risk Map and DB management
- Technical guide line for turbid water management

Turbid Water Mechanism Analysis



River
- Deposit and transport

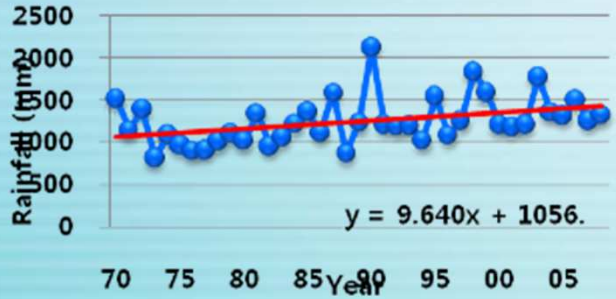
Catchment
- Rainfall
- Land use change
- Soil loss

Lake
- particle movement
- stratification
- find sediment D <10um

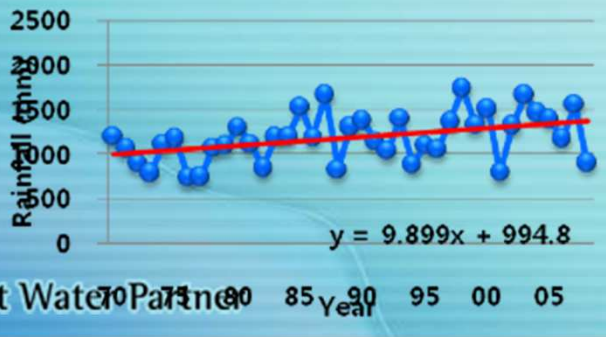
Cause analysis-rainfall pattern change

Mean annual rainfall

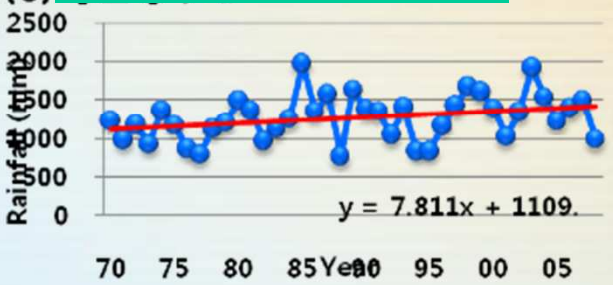
(a) Han river basin 37% up



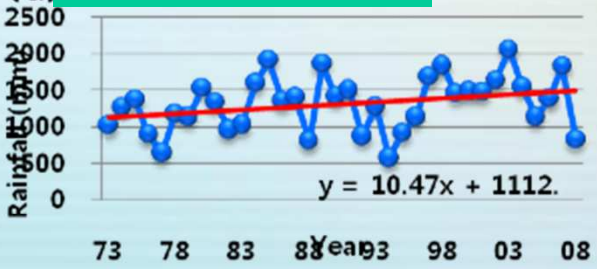
(b) Geum river basin 38% up



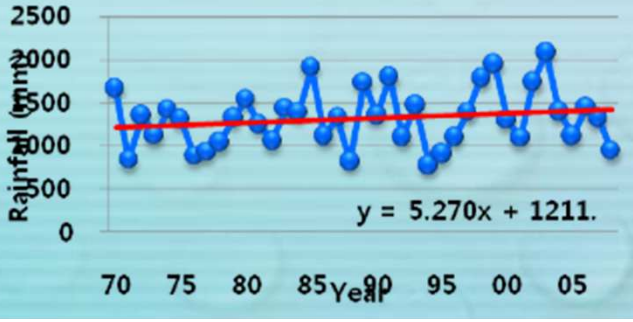
(c) Youngsan river basin 27% up



(d) Sumjin river basin 33% up



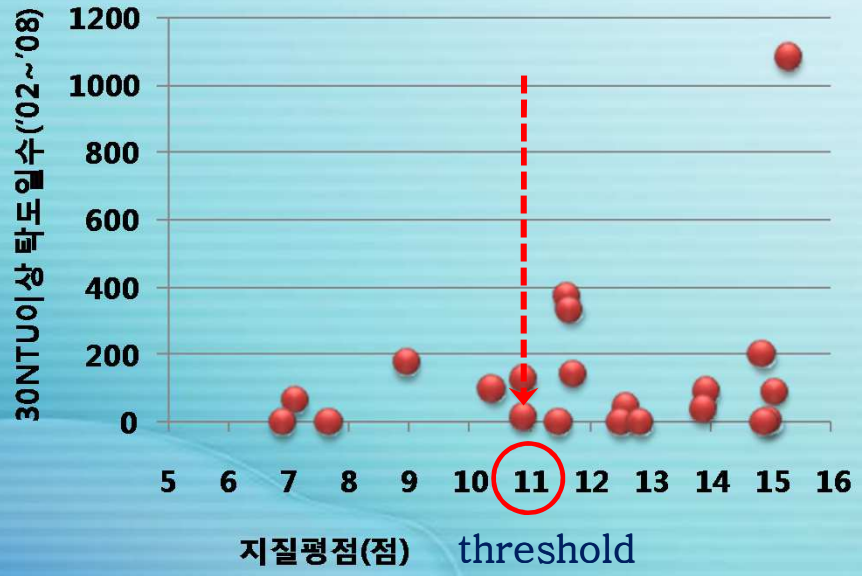
(e) Nakdong river basin 15% up



Cause analysis- soil characteristic

Soil analysis for potential risk of high turbidity

- categorization and coding of soil characteristic
- weighting of soil code
- estimate the threshold value: above 11= high risk area
- Nakdong river basin has high risk area in terms of soil characteristic

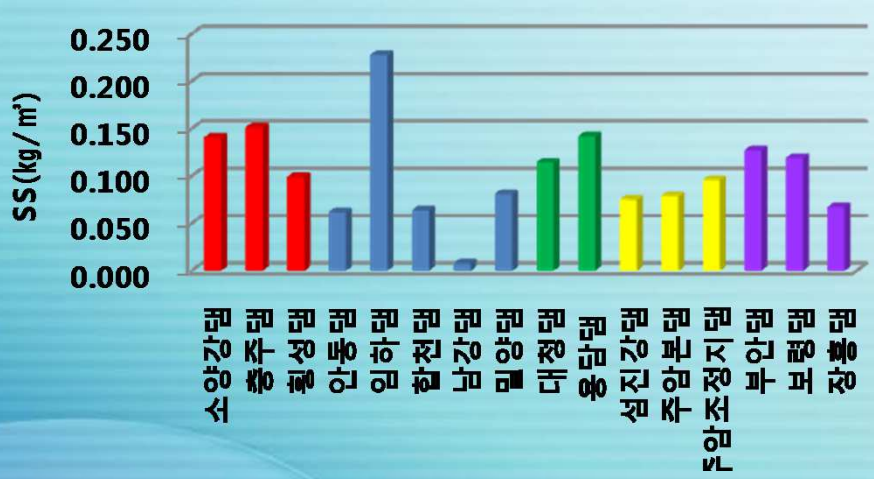


River	Num. of dams above threshold	High score
Han	3	14.84(Gwangdong)
Nakdong	4	15.29(Imha)
Geum	1	13.86(Youngdam)
Sumjin, Youngsan	4	15.06(Suo)

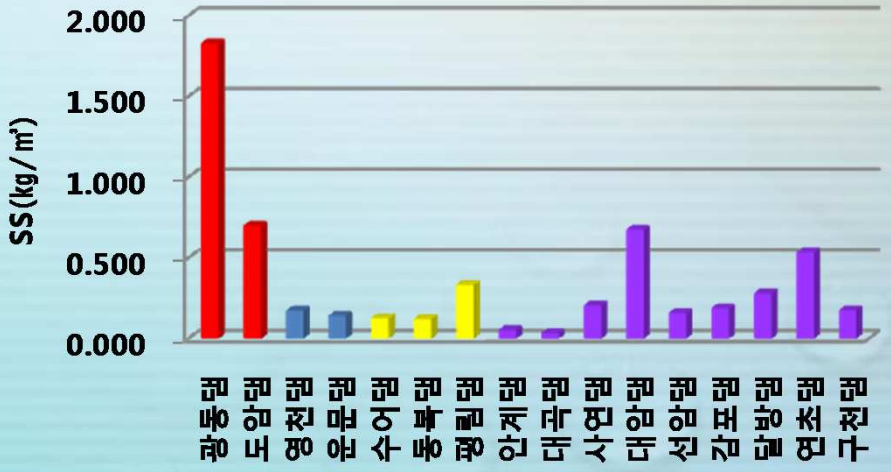
Cause analysis- soil loss

- Soil loss comparing with storage volume of dam reservoir
  - ✓ Multi-purpose dam : Imha>Chungju>Soyang>Youngdam
  - ✓ Water supply dam : Gwangdong>Doam>Daeam>Yeoncho
- Han and Nakdong river basin has relatively high soil loss potential

Multi-purpose dam



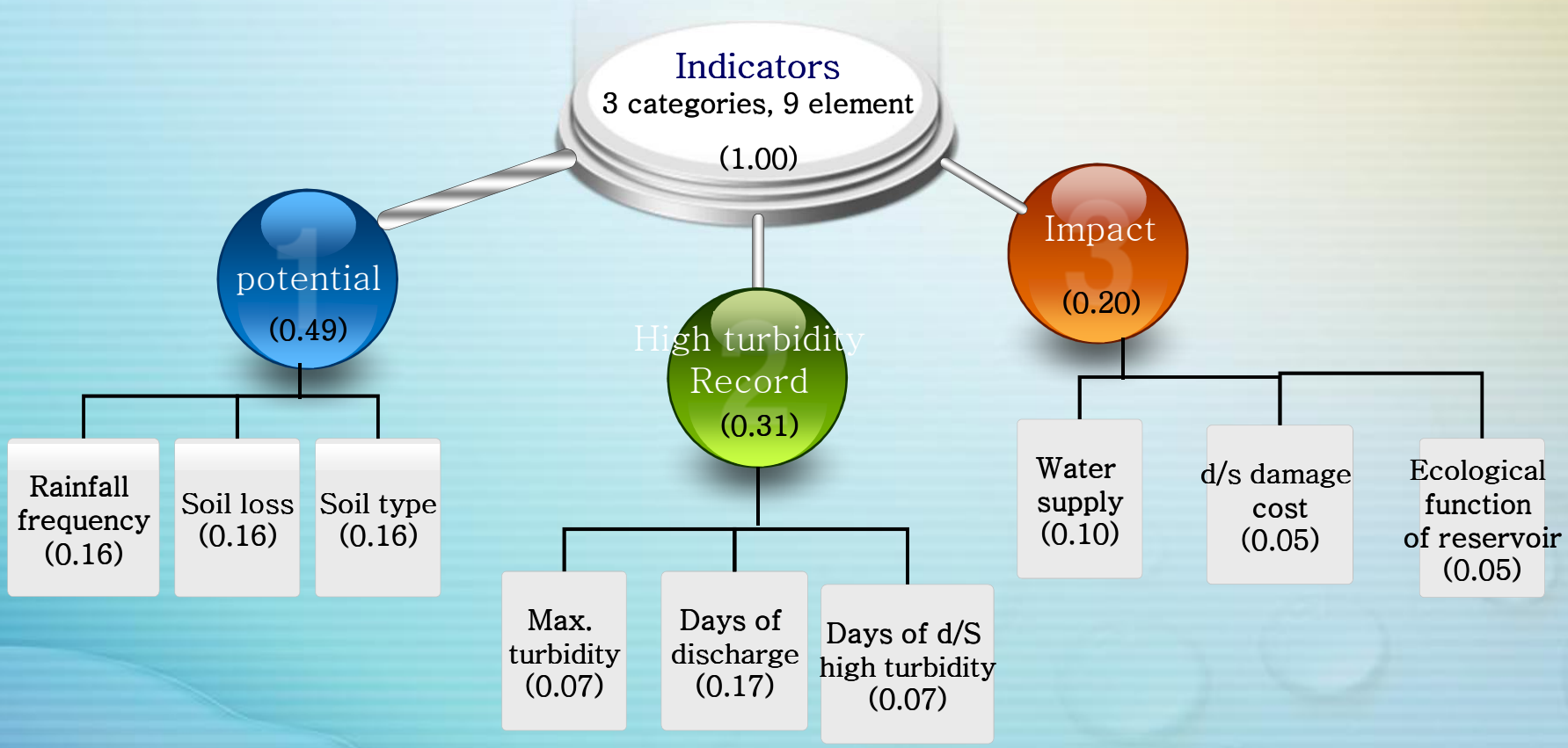
Water supply dam



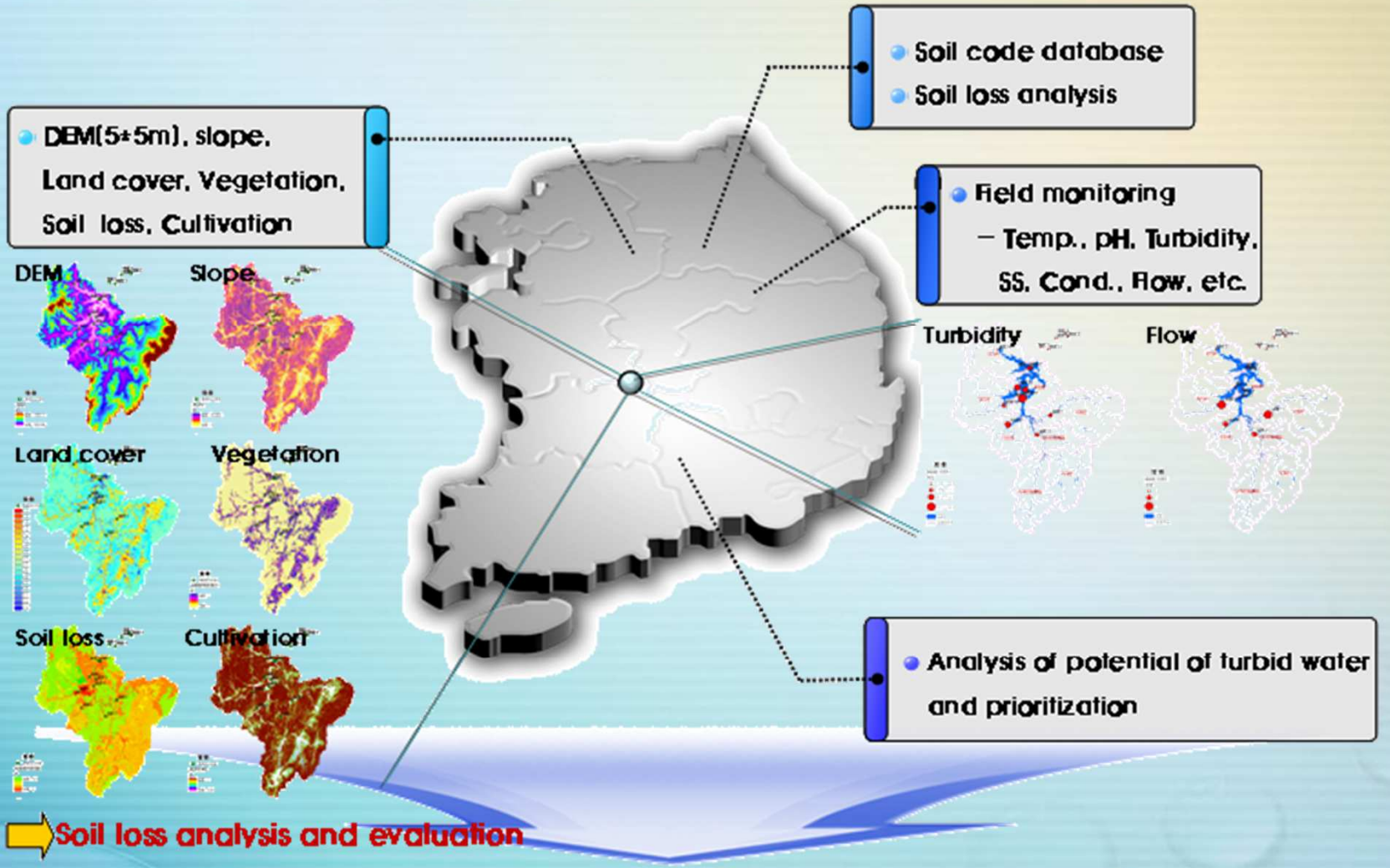
Turbid water potential analysis-indicator development

Indicator selection and standardization

Weight selection by expert panel analysis using AHP and ANP

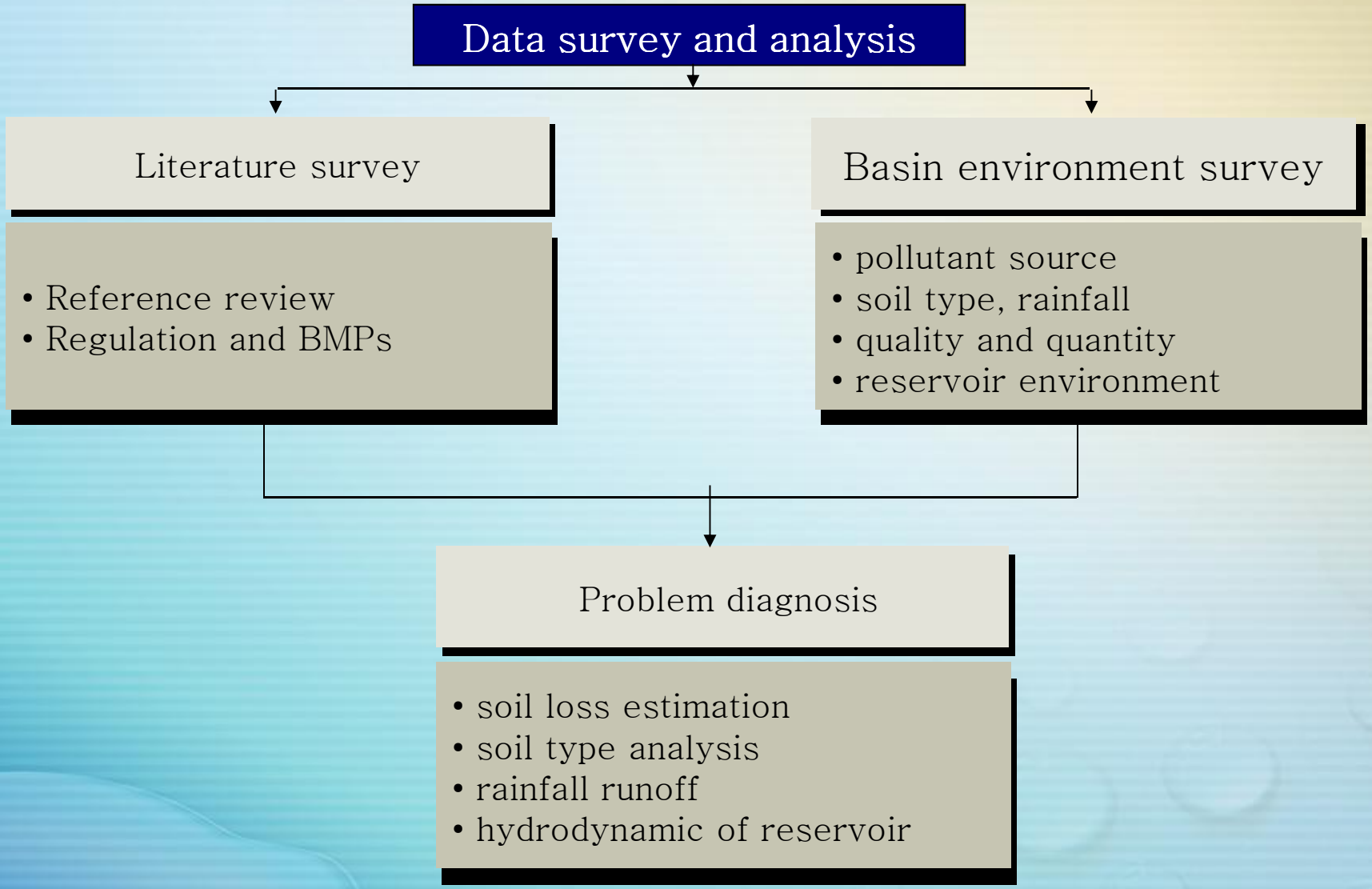


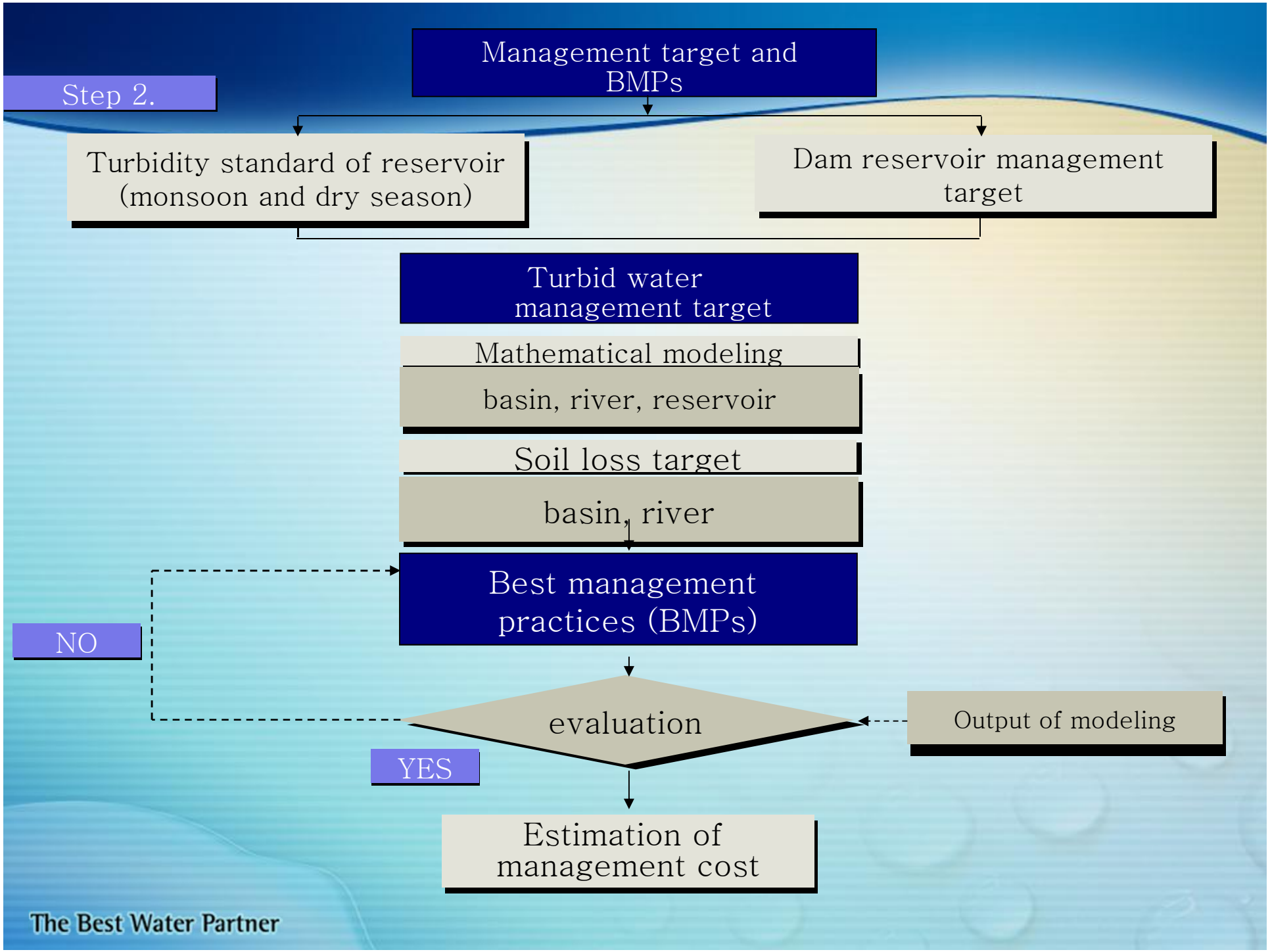
Risk Map development and DB management



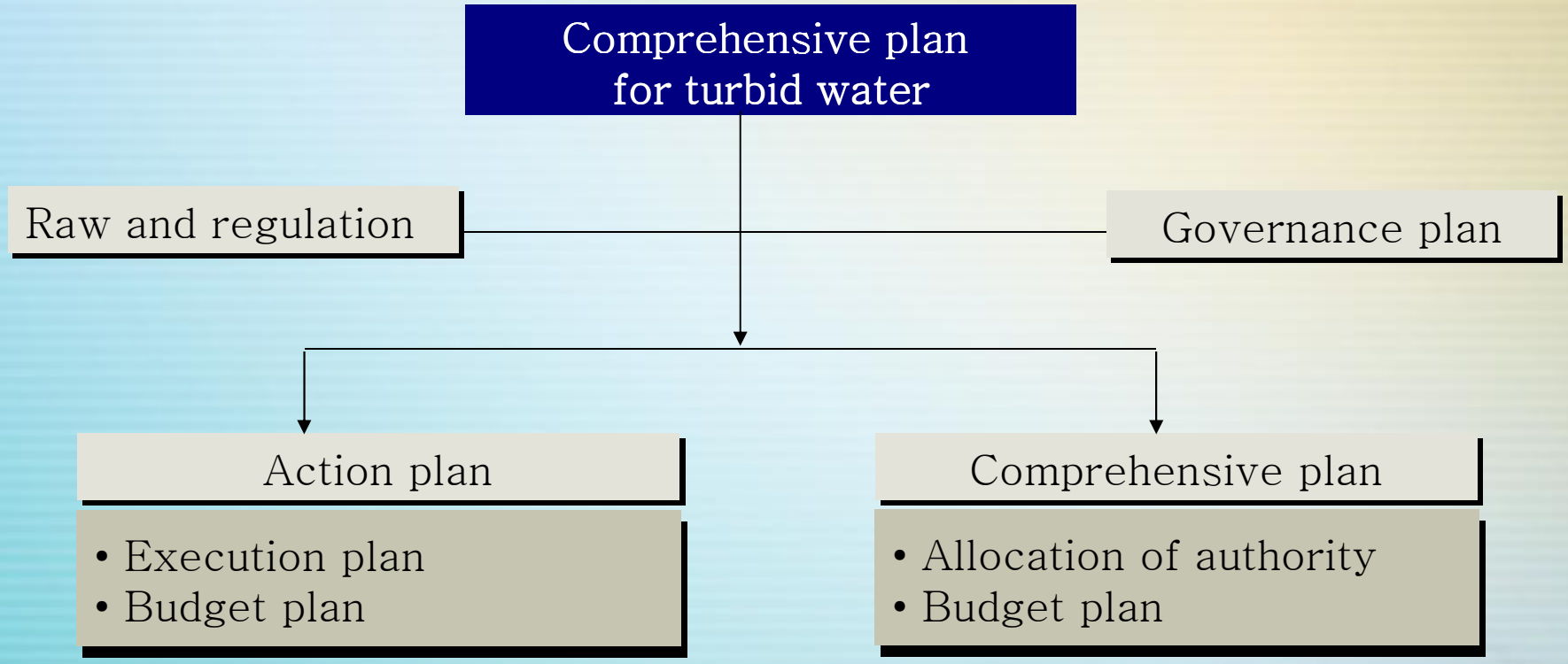
Technical Guide Line for Turbid Water Management

Step 1.

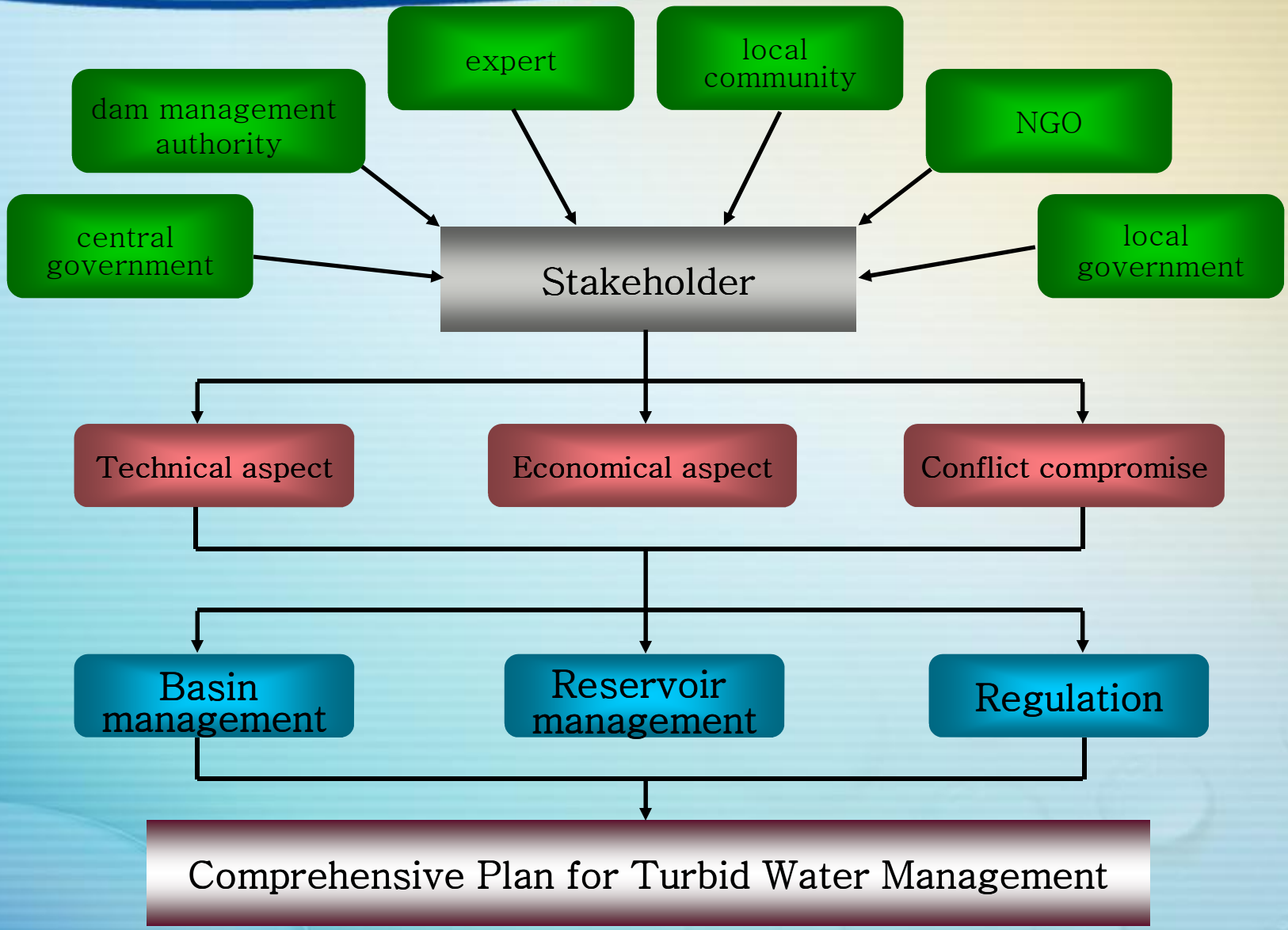



Step 2.
Management target and BMPs
Turbidity standard of reservoir (monsoon and dry season)
Dam reservoir management target
Turbid water management target
Mathematical modeling
basin, river, reservoir
Soil loss target
basin, river
Best management practices (BMPs)
NO
evaluation
Output of modeling
YES
Estimation of management cost
The Best Water Partner

Step 3.


Comprehensive plan for turbid water
Raw and regulation
Governance plan
Action plan
• Execution plan
• Budget plan
Comprehensive plan
• Allocation of authority
• Budget plan

Governance for Turbid Water Management



Questions