

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

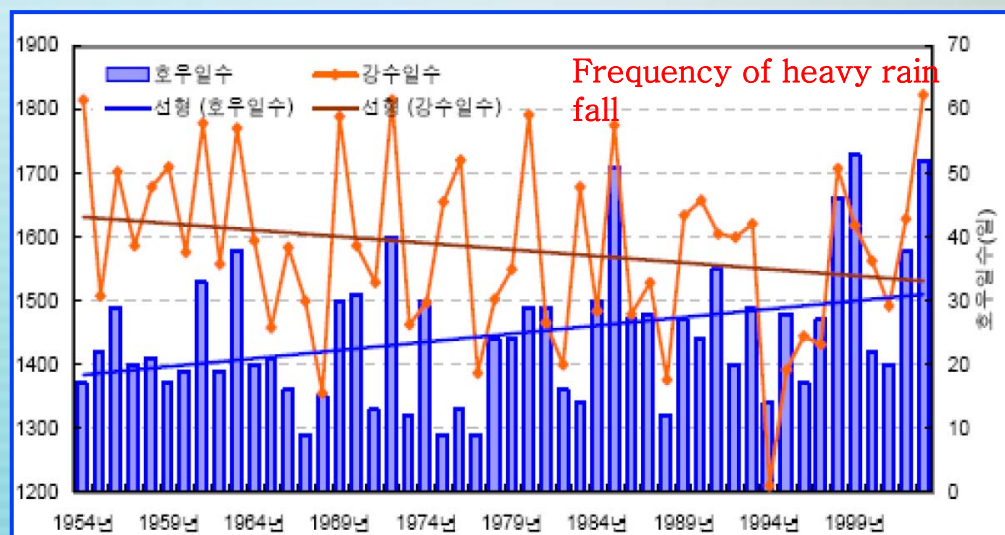
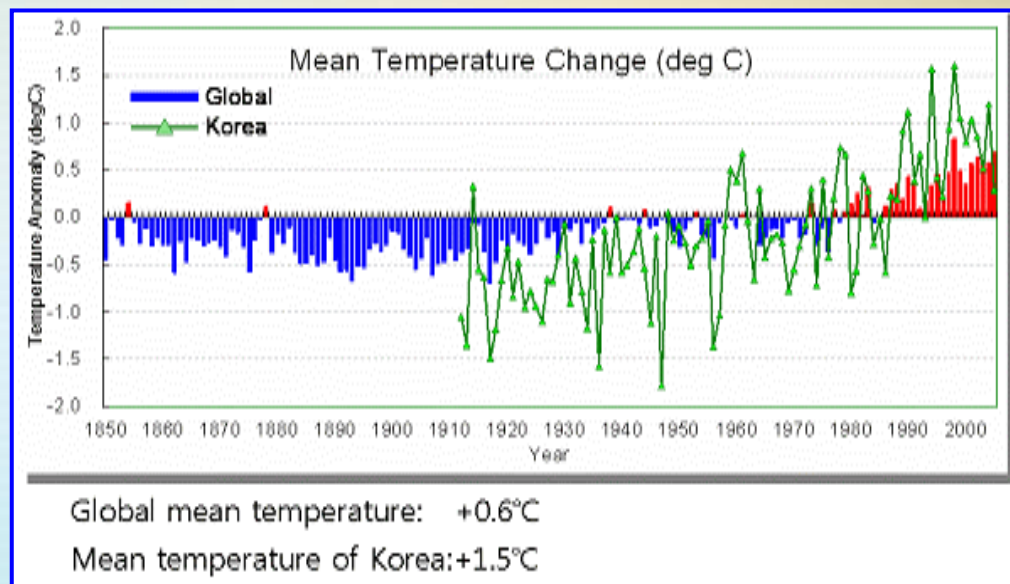
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Climate Change of S. Korea

Global climate change

- Global warming trend
 - about 0.6°C 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%



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



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Background

■ K-water supplies over 16 million m³/d of bulk water

- 16 Multipurpose Dams: 4.4B m³/yr
- 27 Water Supply Systems: 2.8B m³/yr
- Providing 55% of national clean water needs

■ Water quality control is important for drinking water supply

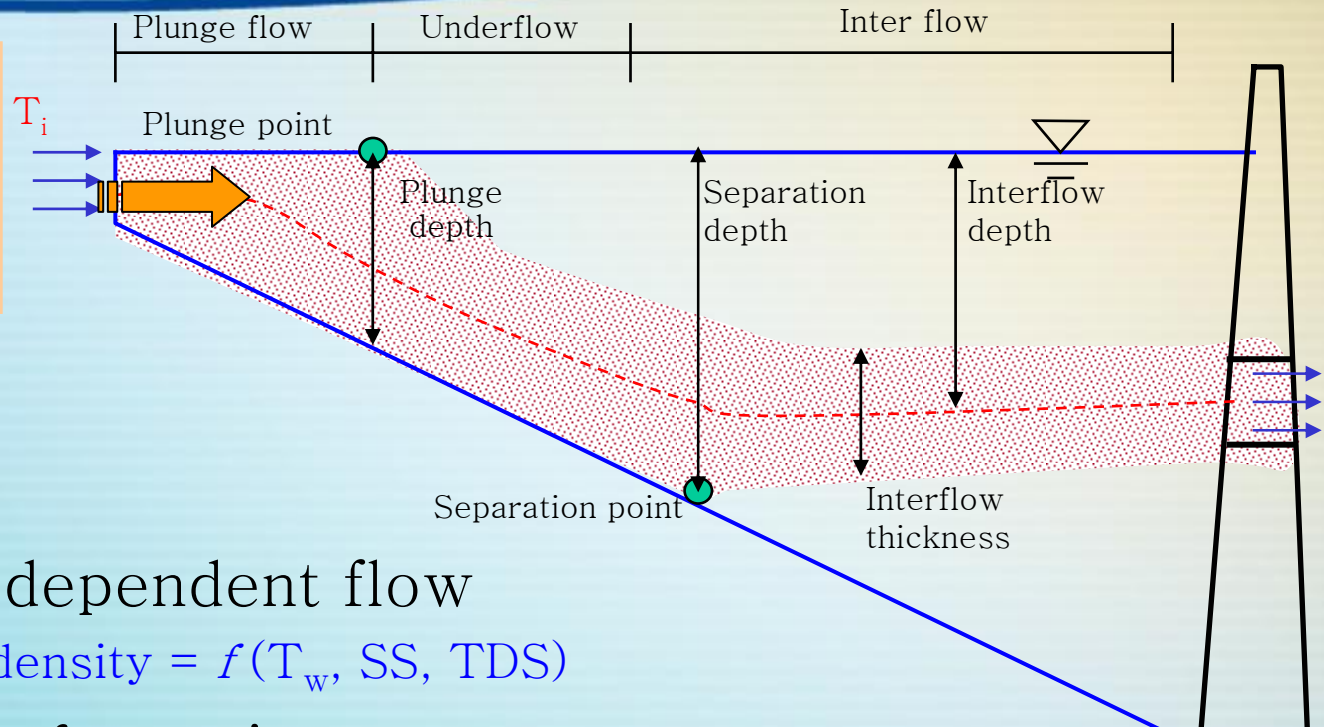
■ Recently, many reservoirs have been suffering from **turbid water**



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

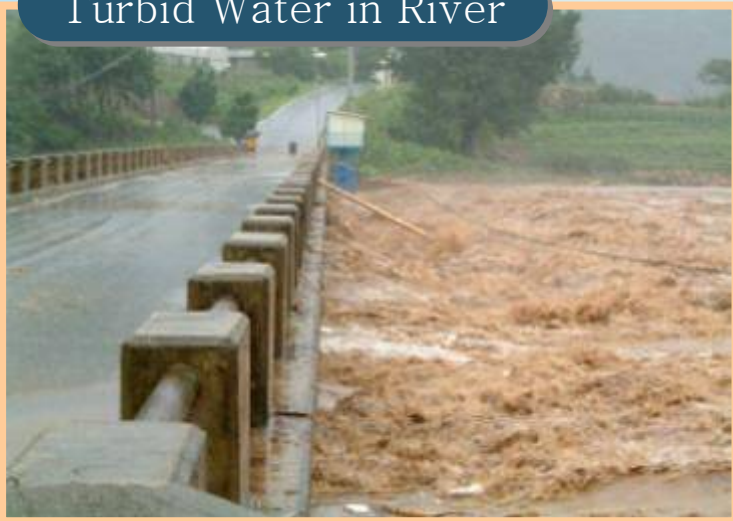
● Water density = $f(T_w, SS, TDS)$

0m 2m 5m 10m 20m 30m 40m 50m 60m 70m 80m 90m 100m

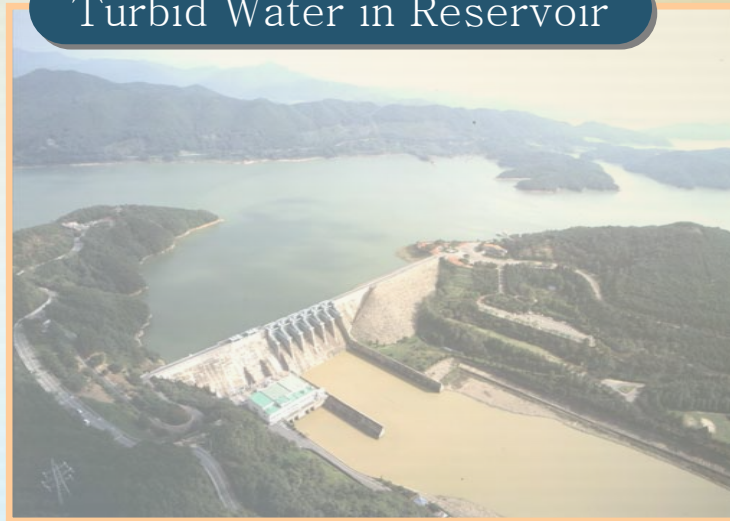


Turbid Water Behavior in Reservoir

Turbid Water in River



Turbid Water in Reservoir



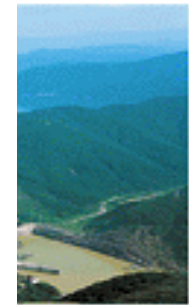
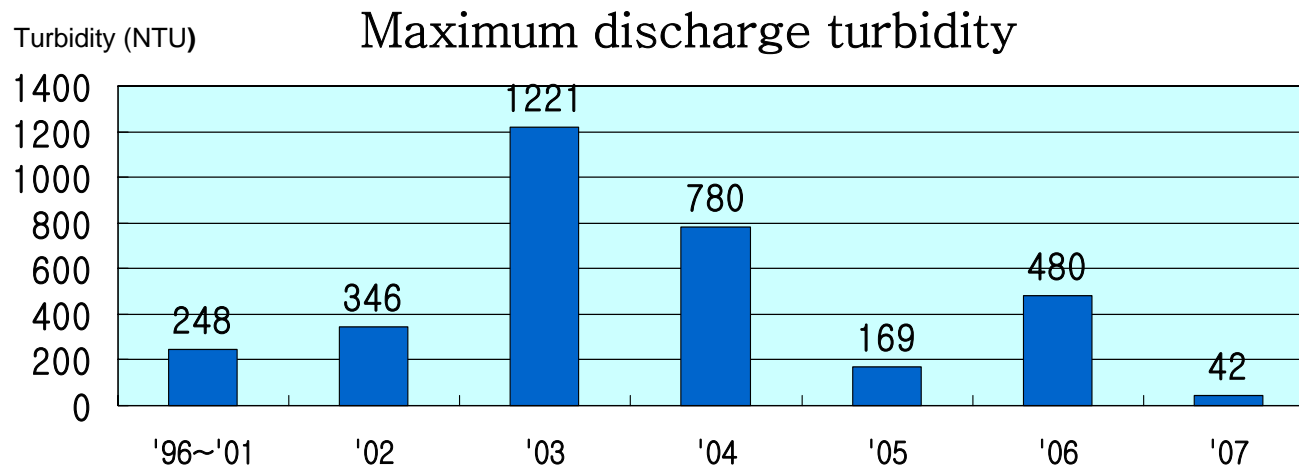
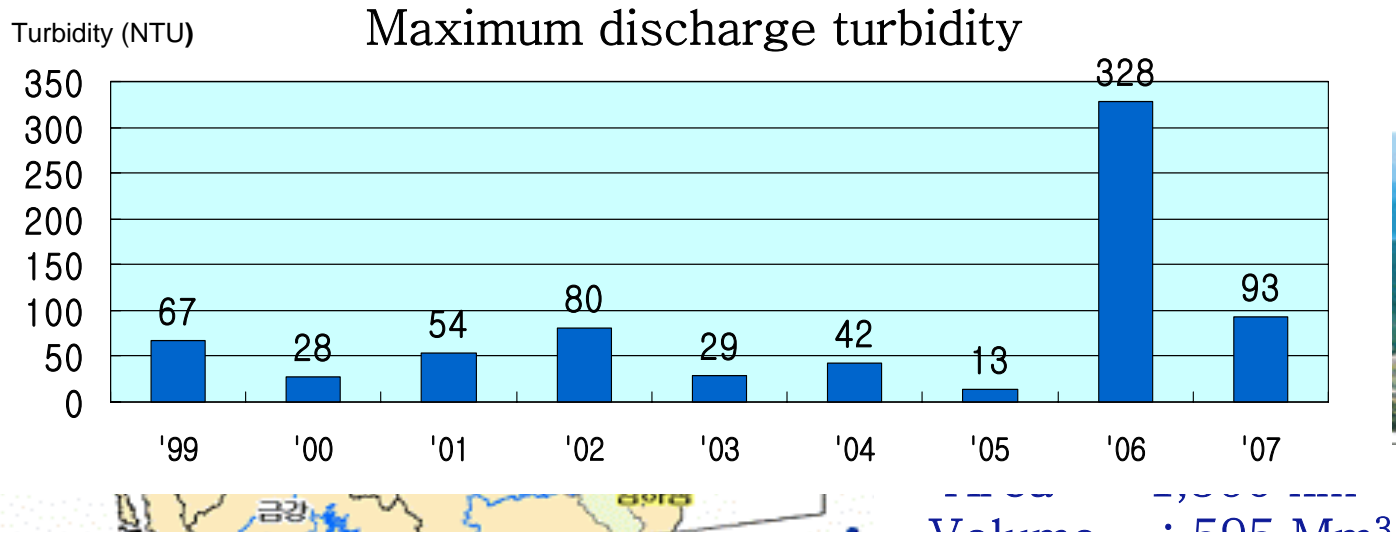
After Turnover



Prolonged Turbid Water Release



Imha and Soyang Case



Major Turbid Water Source of Imha Catchment



Turbid Water Problem in Imha

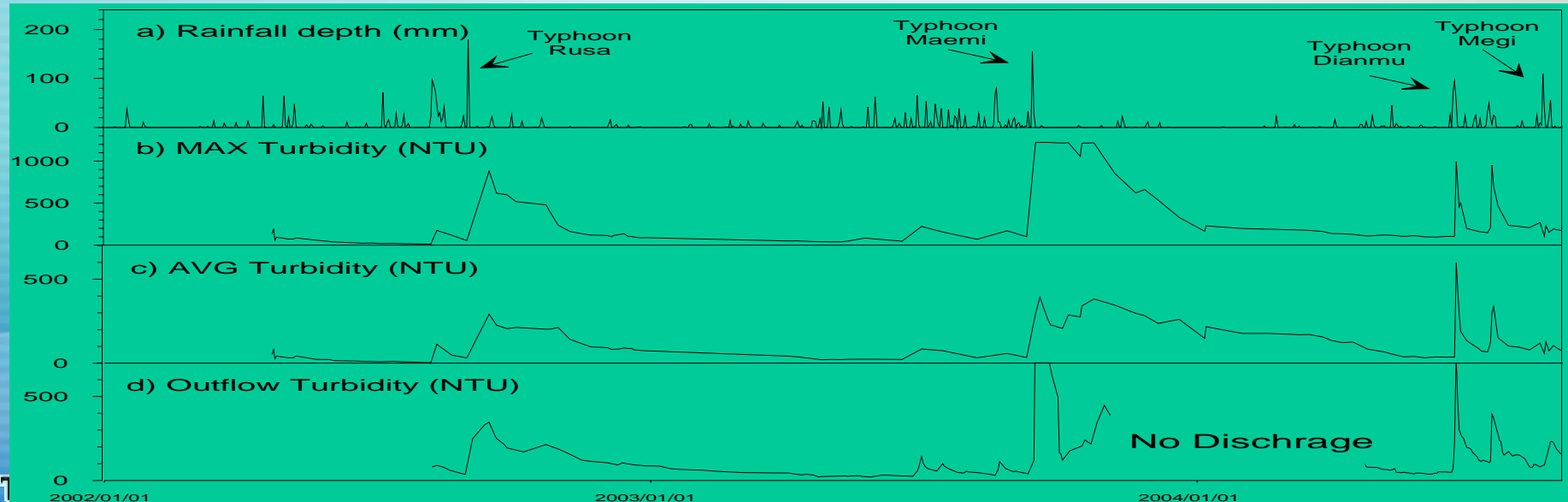
Difficult to operate
water treatment
plants normally



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

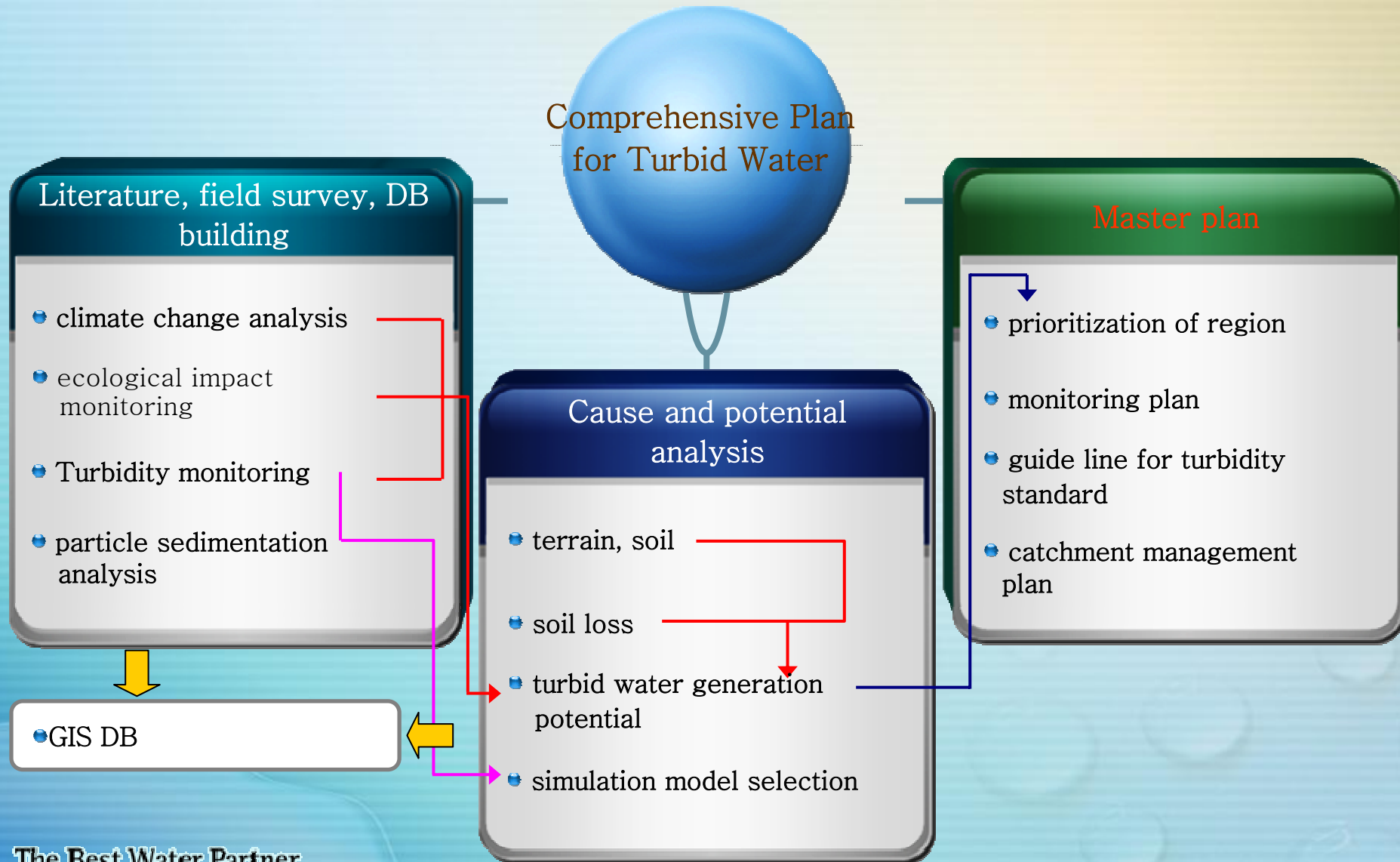
Four-river Restoration Project

Min. of Public Admin.

Local Government

- TMDL policy
- NPS control plan
- Urban development plan

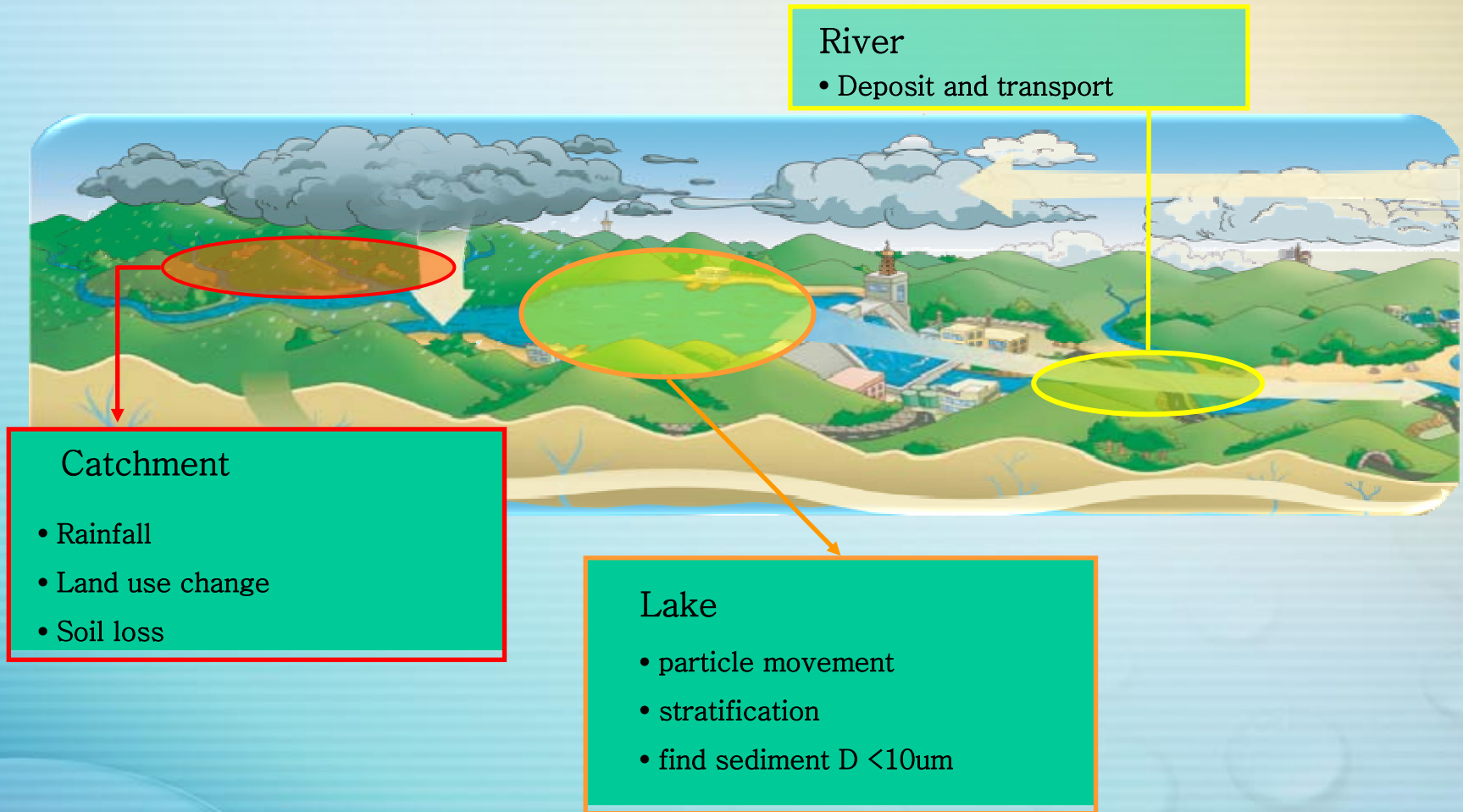
Comprehensive Plan for Turbid Water



Major outputs of master plan

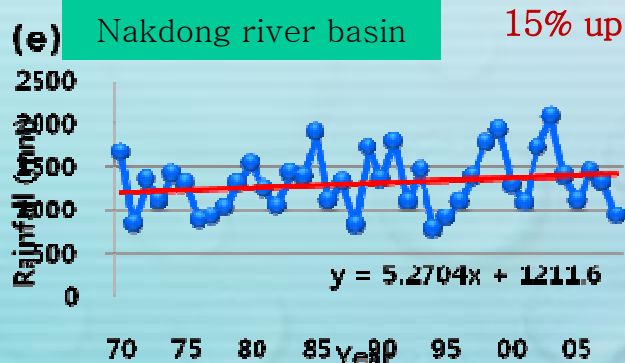
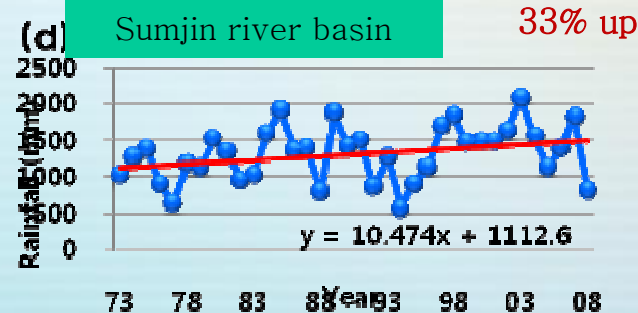
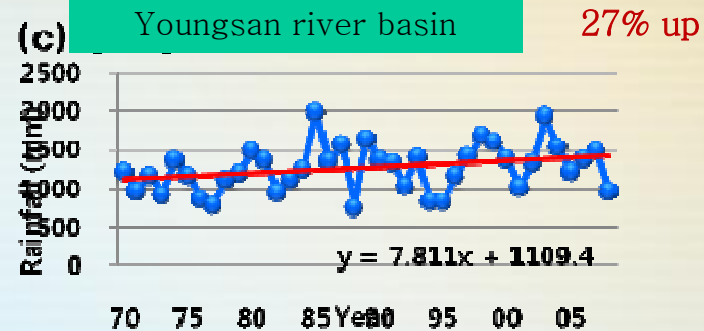
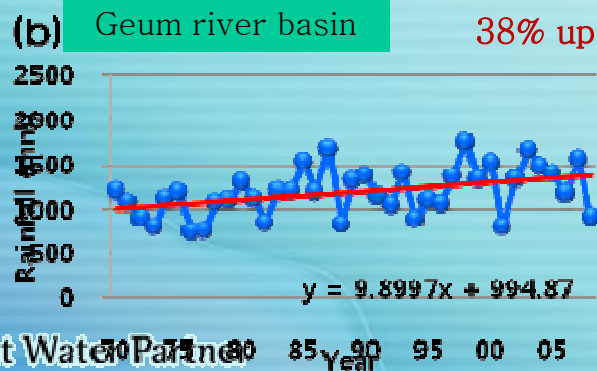
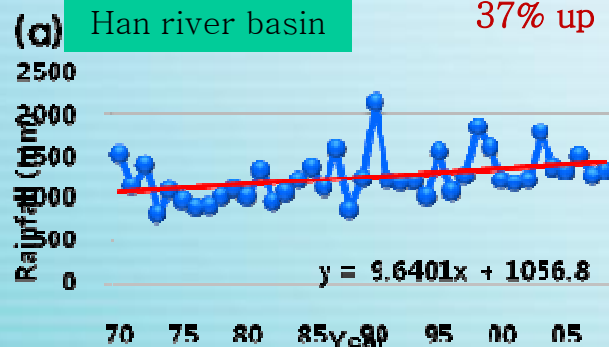
- ✚ Climate change analysis
- ✚ Turbid water mechanism
- ✚ Cause analysis
- ✚ Soil loss analysis
- ✚ Turbid water potential analysis
- ✚ Risk Map and DB management
- ✚ Technical guide line for turbid water management

Turbid Water Mechanism Analysis



Cause analysis-rainfall pattern change

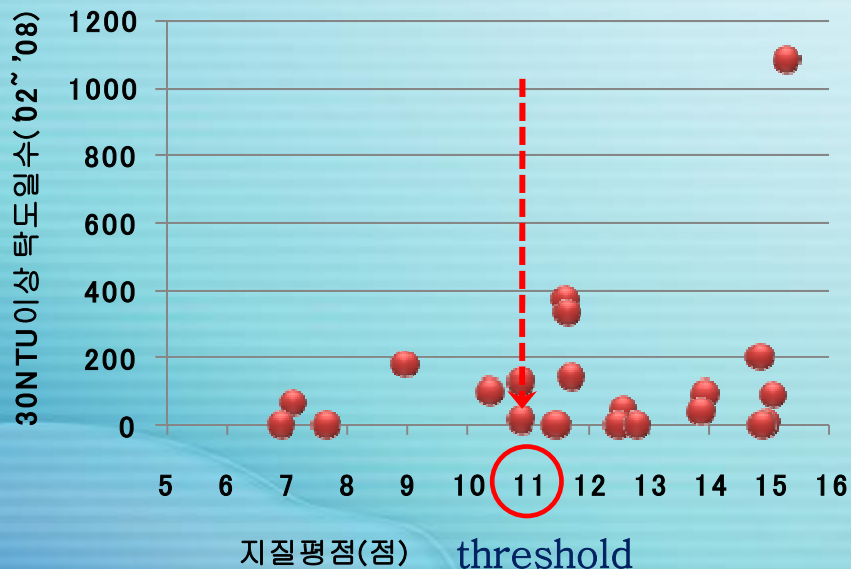
Mean annual rainfall



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)

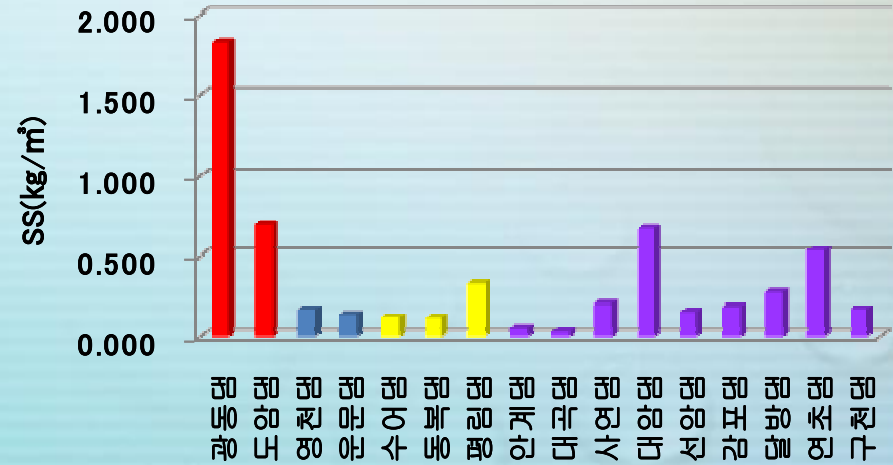
Cause analysis- soil loss

- ✚ 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



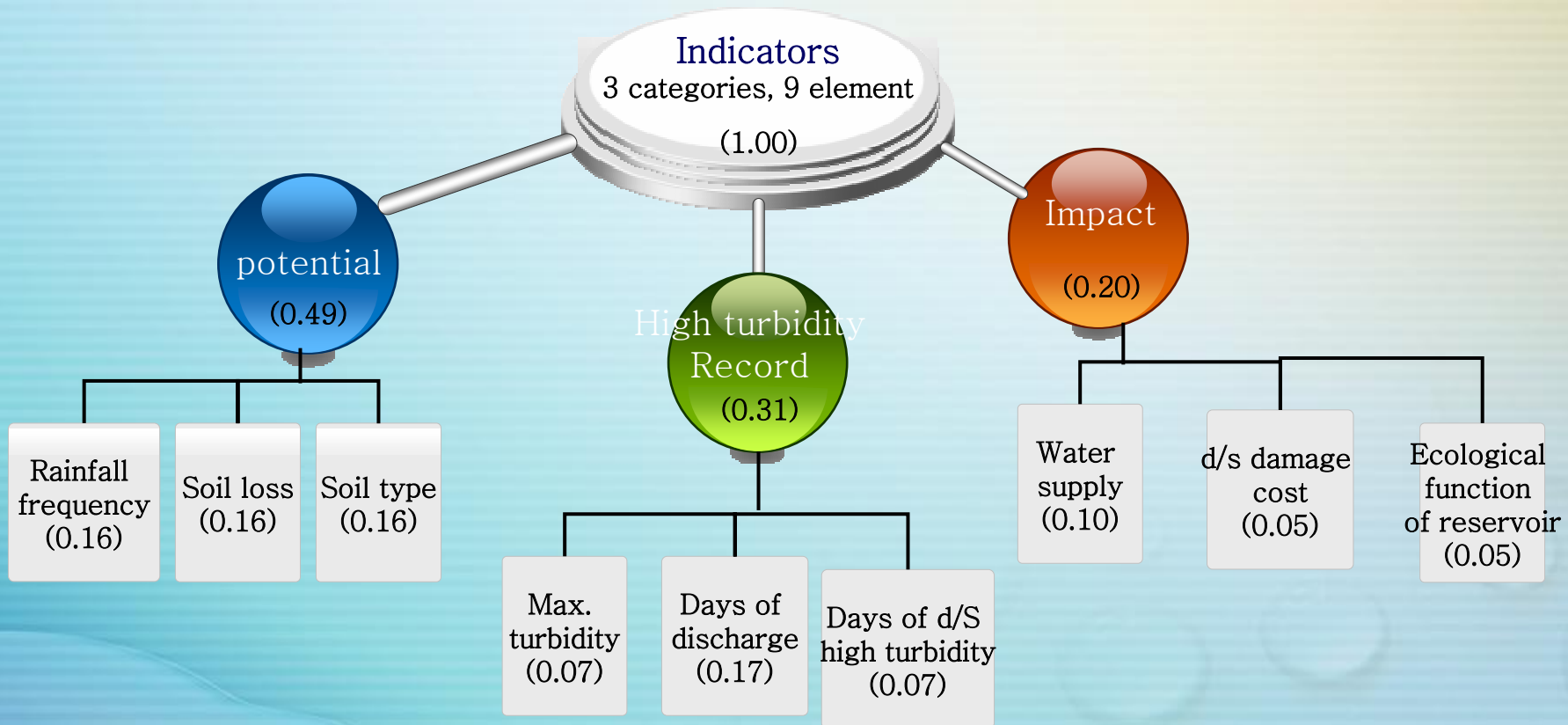
Water supply dam



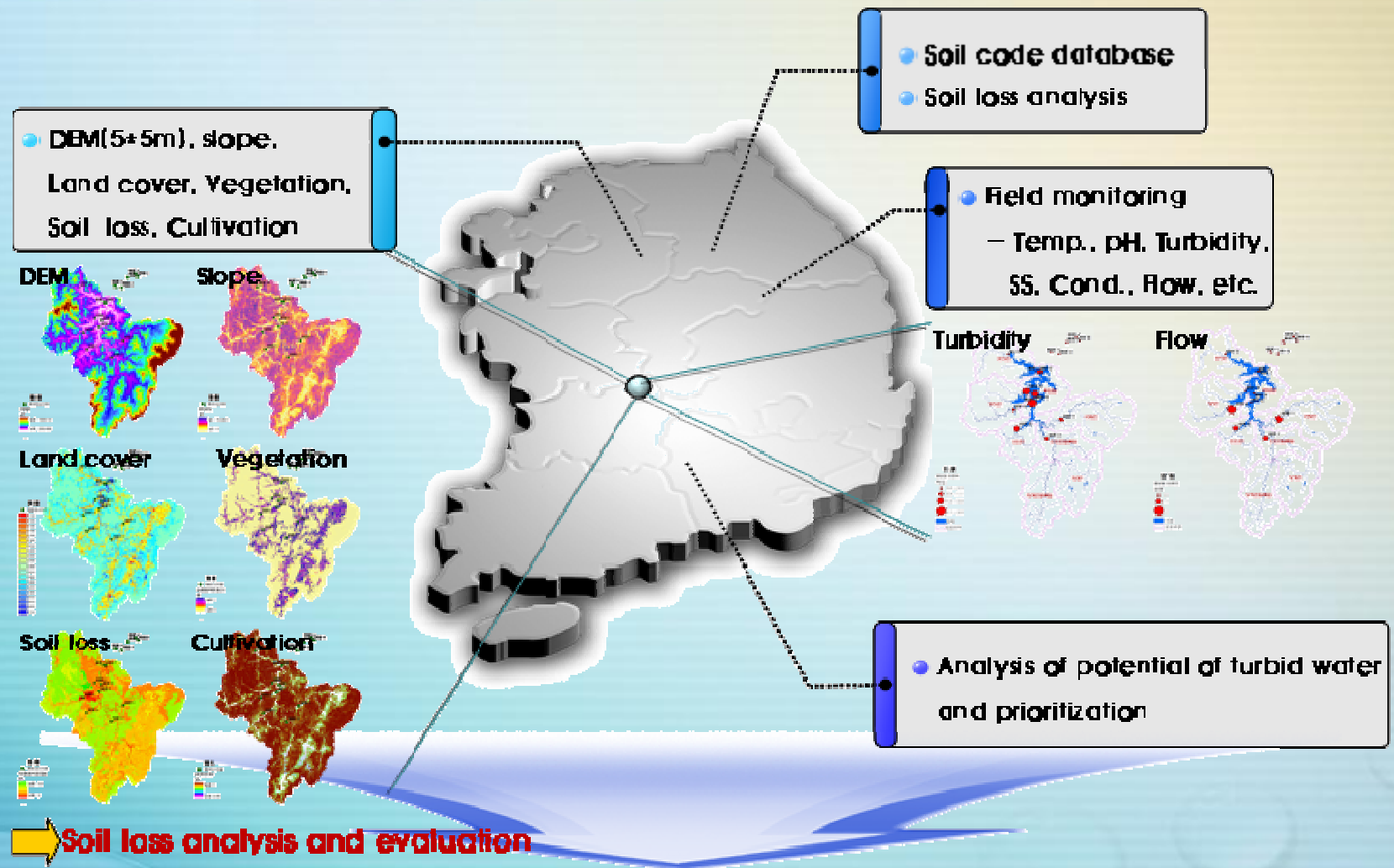
Turbid water potential analysis–indicator development

Indicator selection and standardization

Weight selection by expert panel analysis using AHP and ANP

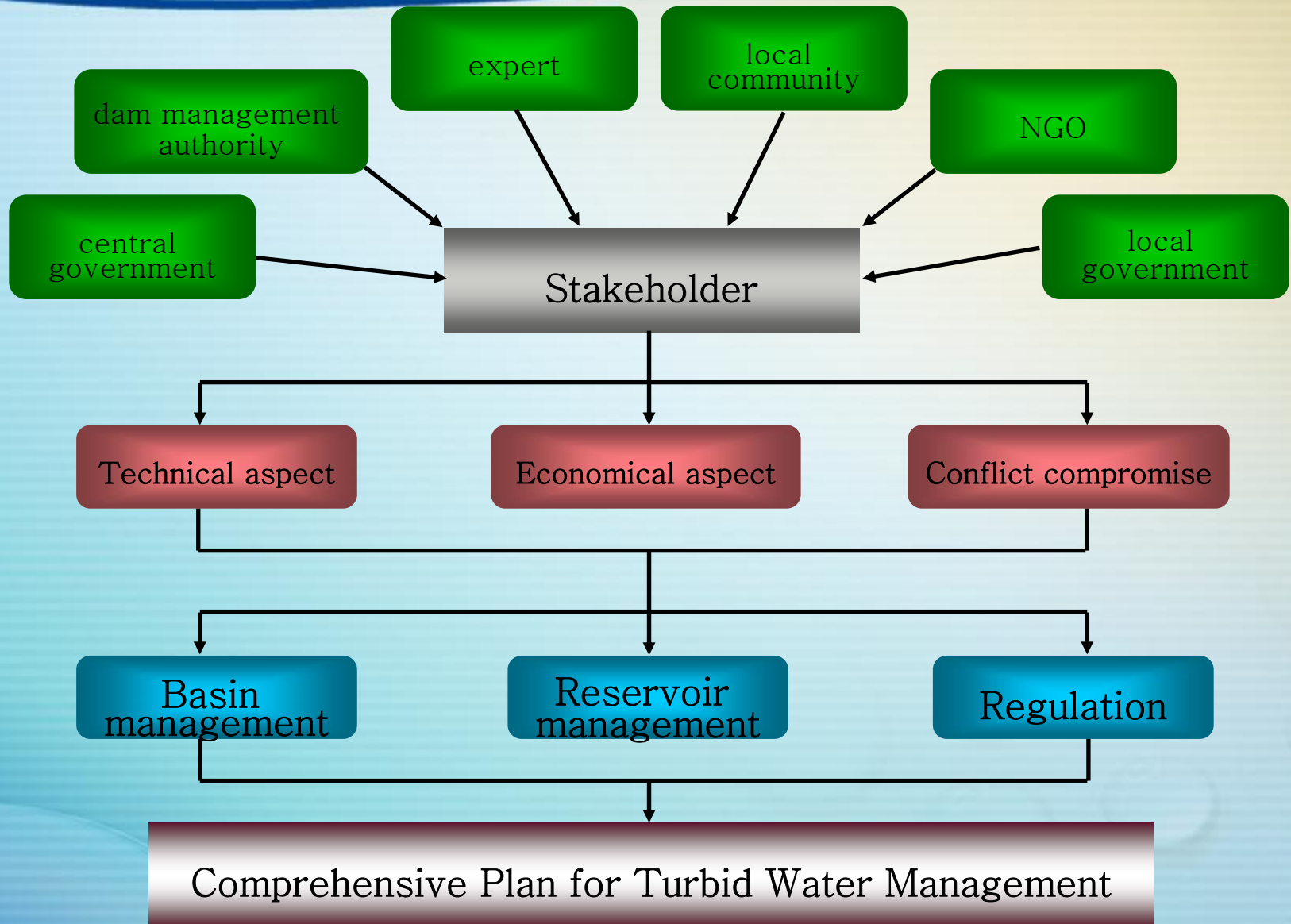


Risk Map development and DB management



Basin Scale GIS Database for High Turbidity Management

Governance for Turbid Water Management



Questions

