**<sup>¶</sup>3<sup>rd</sup>** Asia-Pacific Climate Change Adaptation Forum<sub>J</sub>

### Modelling the impact of climate change on water supply in a complex water allocation system

#### 2013. 3. 19. **Environment Assessment Group** Jin Hee Lee



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### **Contents of the Study**

#### Contents of the Study

#### Construction of Water Allocation Model

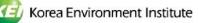
- Survey of domestic and industrial water use
- Estimation of agricultural water demand (consumptive use model)
- Analysis of water resource infrastructures (multiporpose dams, agricultural dams)
- Simulation of natural flow by SWAT model
- Construction of KModSim network (current water right system, reservoir operation practices)

#### • Assessment of Climate Change Vulnerability on Water Resource System

- Downscaling of climate change scenarios by GCM (General Circulation Model)
- Simulation of natural flow by climate change scenarios
- Evaluation of water shortages

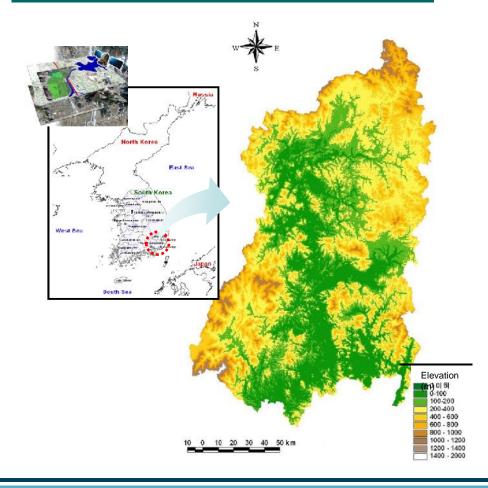
#### • Impact of Four River Restoration Project

- Newly installed water resource infrastructures (including mutlpurpose weirs)
- Agricultural dam raise



#### Study Area – Nakdong River Basin

Characteristics of Nakdong-river basin



#### Geographic Information

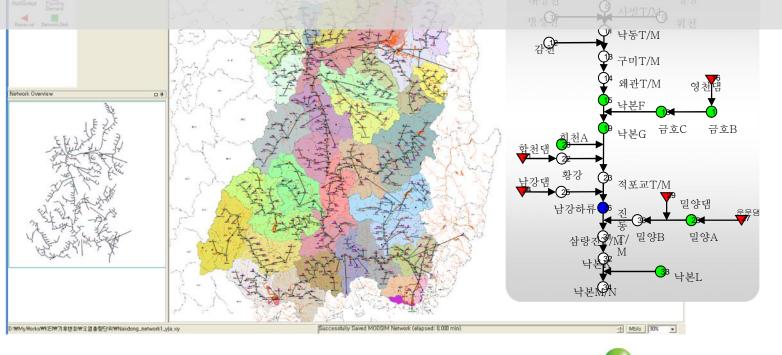
- Location:
  - Latitude 35° 03' to 37° 13' Longitude 127° 29' to 129° 18'
- Watershed Area: 23,384.21 km<sup>2</sup>
- Stream Length: 510.36 km

#### Hydrological Information

 <u>Average Annual Precipitation:</u> 1,255 mm Korean Average 1,274 mm Upstream of Nakdong-river 1,188.7 mm Downstream of Nakdong-river 1,321.0 mm

#### Construction of KModSim Network

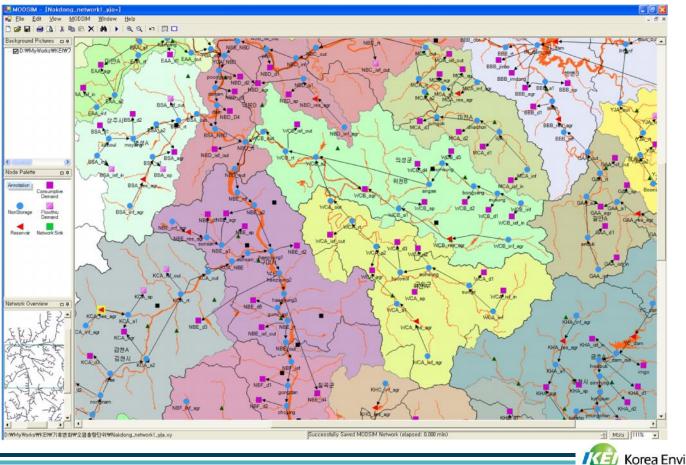
- KModSim Network Structure (41 TMDL unit)
- Complex water allocation model of Nakdong river basin is developed.
- The model simulates complex water right system with reservoir operation.
- Assessment of future water supply security with climate change and the four river restoration project.



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#### Construction of KModSim Network

• KModSim Network Structure (41 TMDL unit)

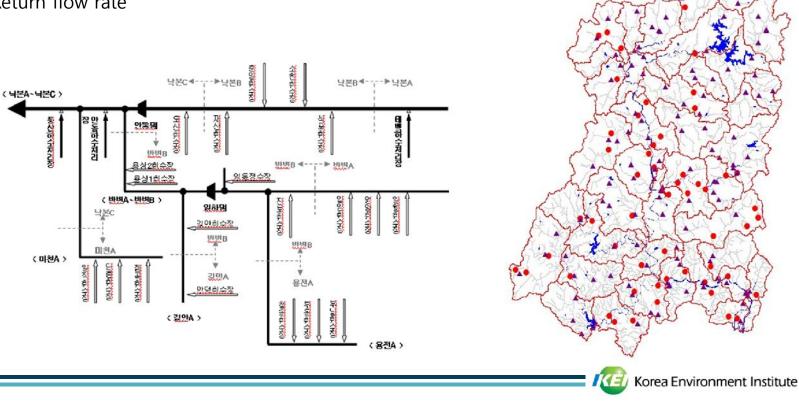


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#### Construction of KModSim Network

- Domestic and Industrial Water Use Data Collection
- Use historical data (2007)
- Return point and amount
- Return flow rate



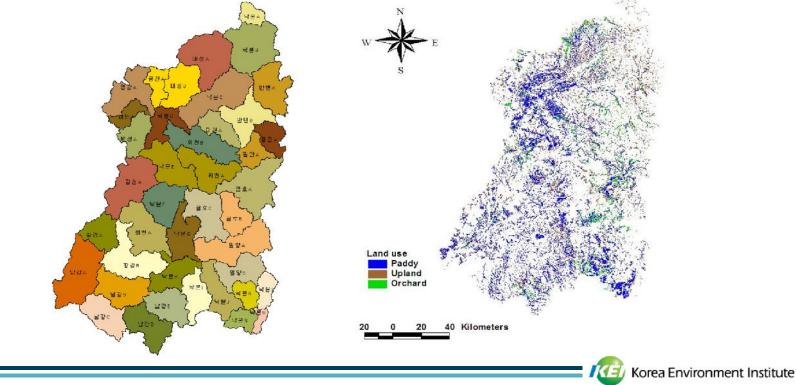
Wastewater treatment plant

Water treatment plan

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#### Construction of KModSim Network

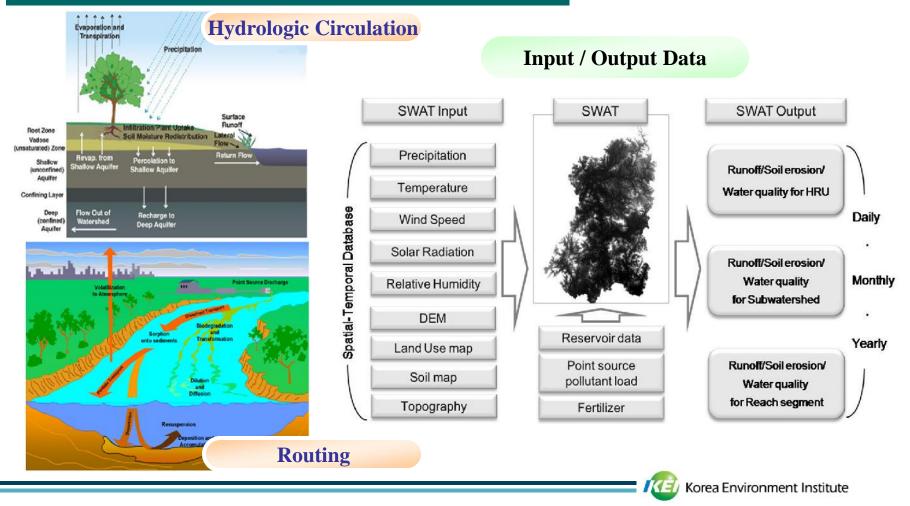
- Estimation of agricultural water use
- No diversion data available
- Consumptive use model (HOMERS) used
- Agricultural area was estimated from 2007 land use gis data



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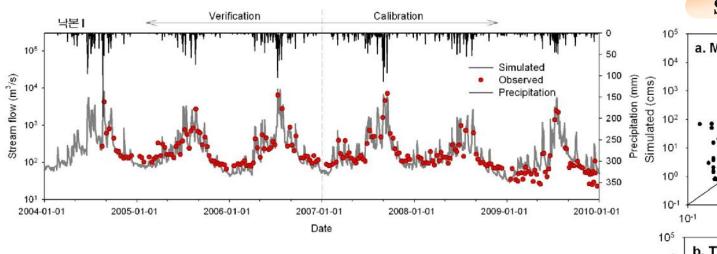
#### Natural Flow Generation

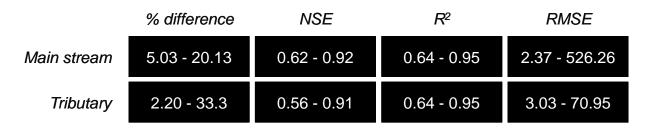
#### • Runoff Simulation by climate change (SWAT model)

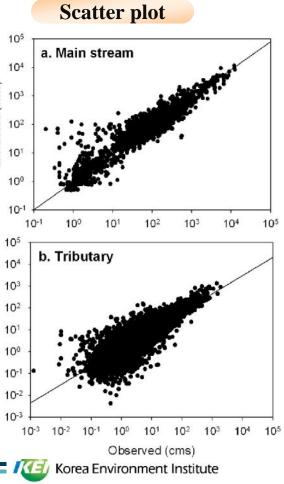


#### Natural Flow Generation

• Runoff simulation by climate change (SWAT model)



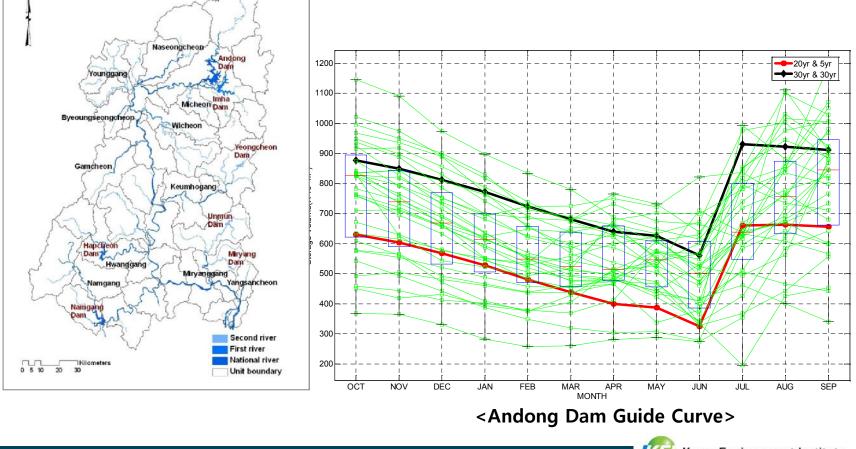




Simulated (cms)

#### Construction of KModSim Network

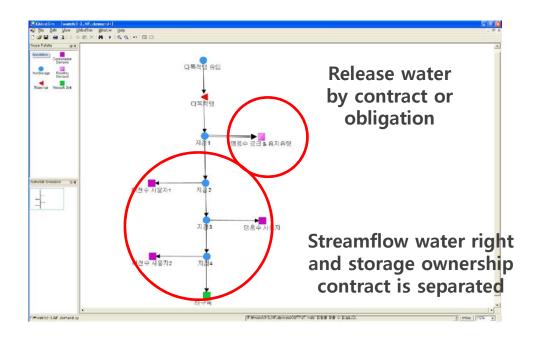
• Reservoir Operations (Zone based guide curve)



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#### Construction of KModSim Network

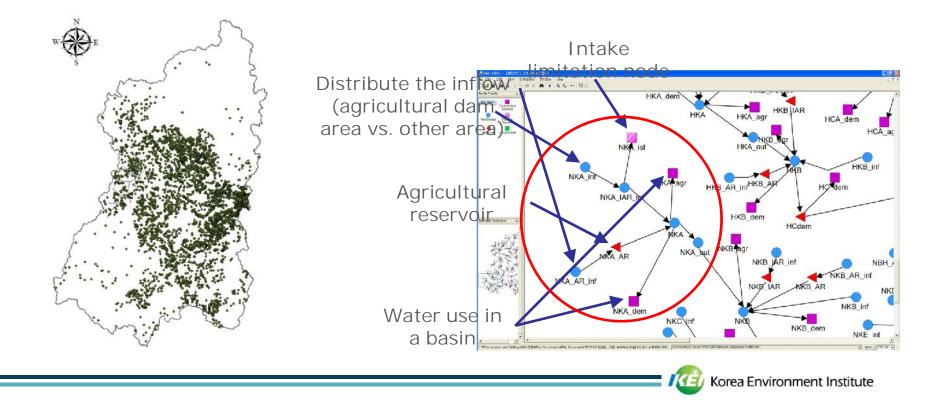
- Water Right System and Allocation of Water
- Priority of natural flow is upstream to downstream
- Storage water is protected from natural flow demand usage



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#### Construction of KModSim Network

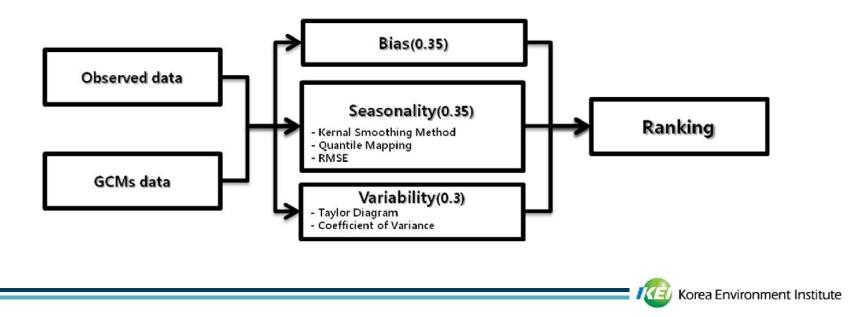
- Agricultural dam operation
- Over 7,000 agricultural dam (2007)
- Aggrigate agricultural reservoir according to the TMDL unit



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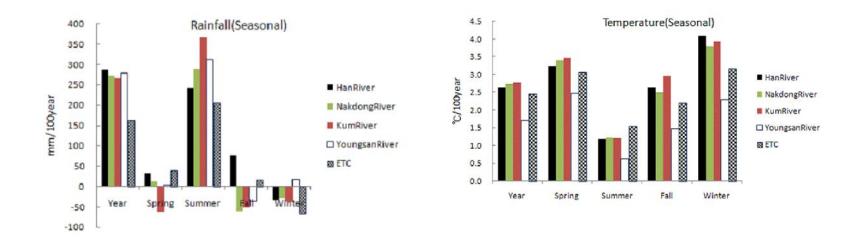
#### **Climate Change Scenarios**

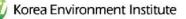
- GCMs selection and simulation for future climate changes scenarios
- Used IPCC AR4 17 out of 23 GCMs simulation
- Using CNCM, CSMK, CT63, MPEH model which are well reproduced Climate characteristics of the Korean Peninsula, rainfall and temperature changes are predicted.
- Catchment-scale impacts from the potential change of climatic conditions in the region are identified in the study according to the IPCC SRES A2, A1B and B2 change scenarios.



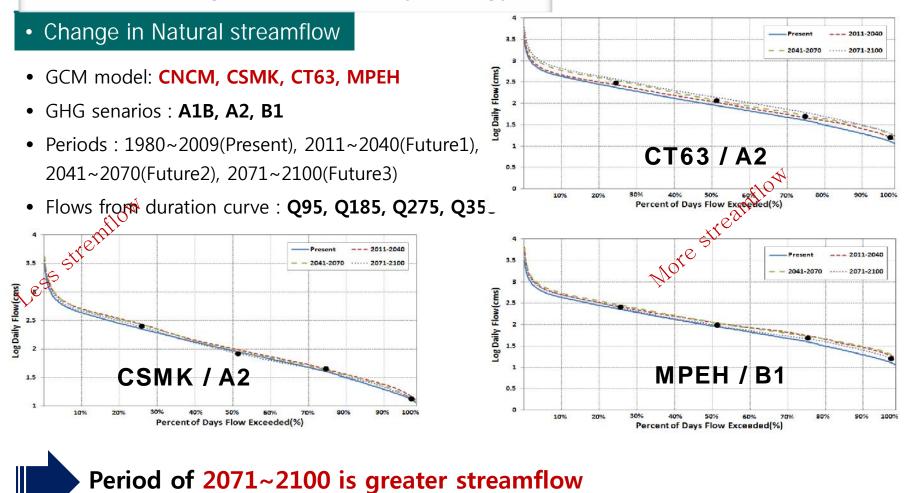
#### Climate Change Impact on hydrology

- Change in annual and seasonal precipitation by 2100
- The annual mean precipitation and temperature were expected to increase
- · The seasonal mean precipitation were expected to increase in spring and summer
- The levels of flooding and drought are expected to worsen





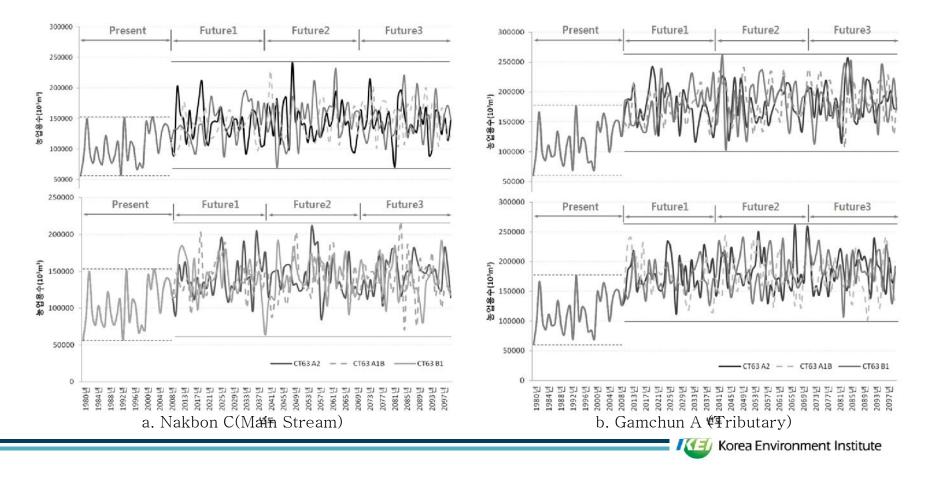
#### Climate Change Impact on hydrology



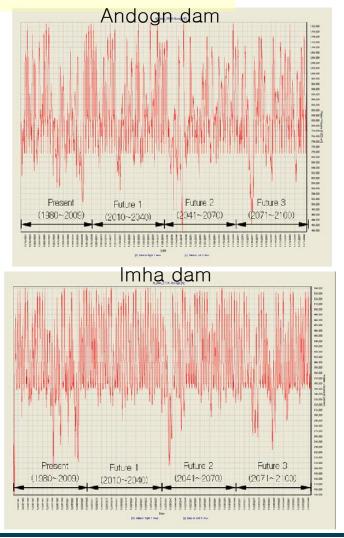
15

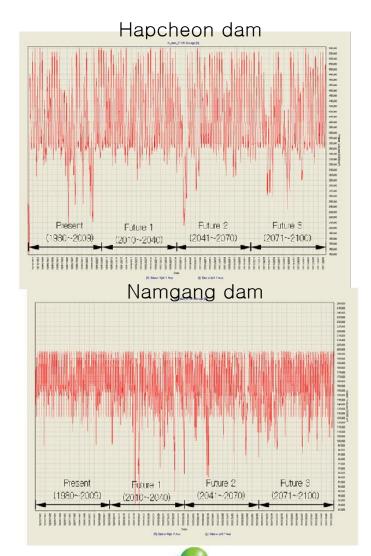
#### Climate Change Impact on Agriculture Water Demand

- Higher fluctuation and higher water demand
- More changes in tributary



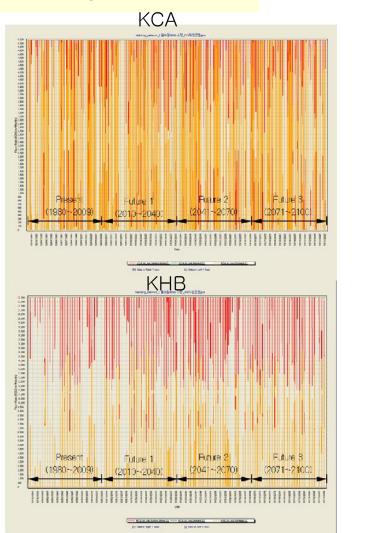
#### • Result of reservoir operation

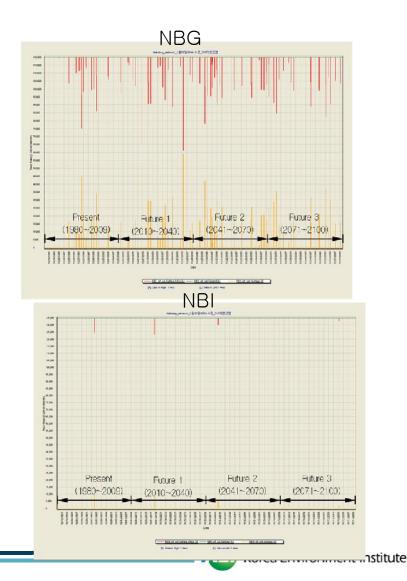




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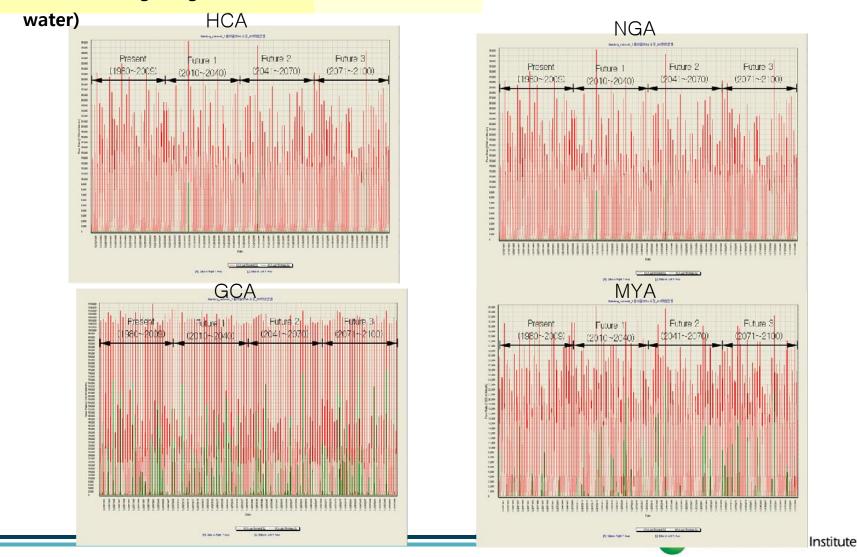
#### • Water Shortage (instremflow)



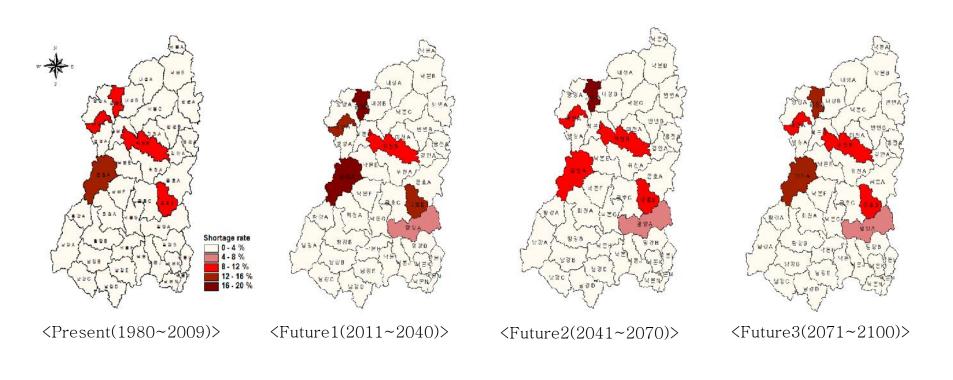


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• Water shortage (Agricultural



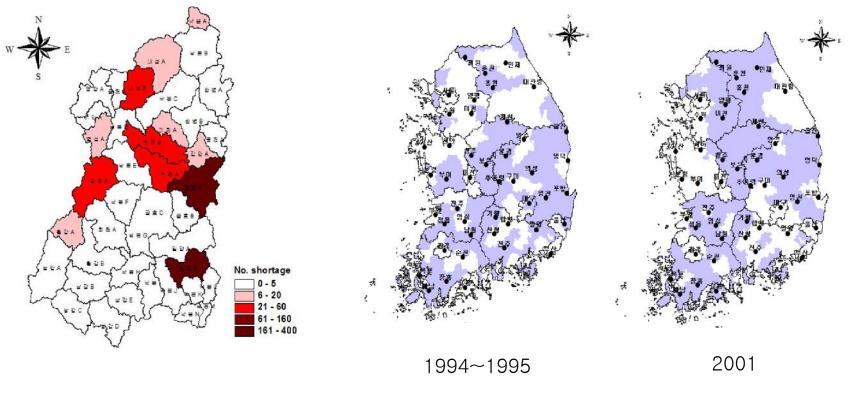
Water shortage (Agricultural water)



Groundwater usage is accounted after simulation



Water shortage (Domestic and Industrial water)

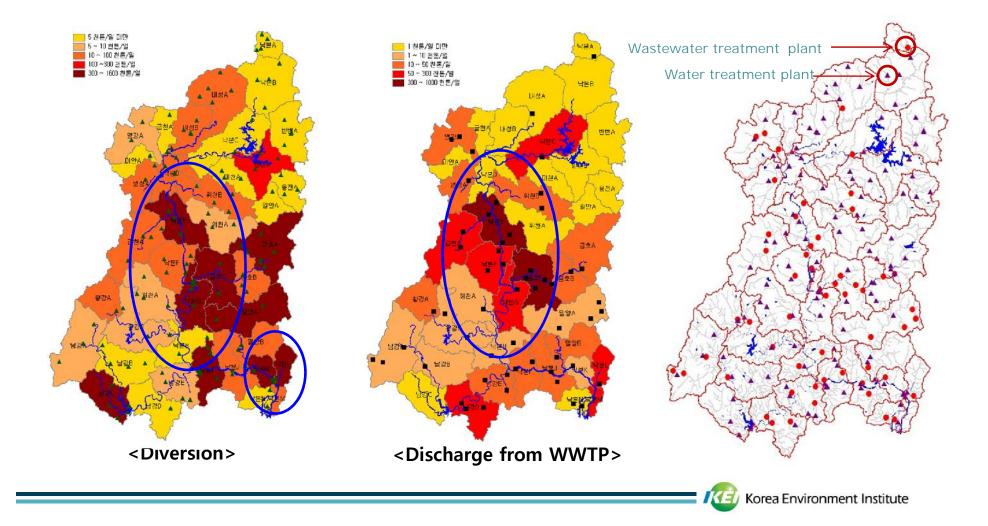


Frequency of D&I Water shortage (1980~2100)

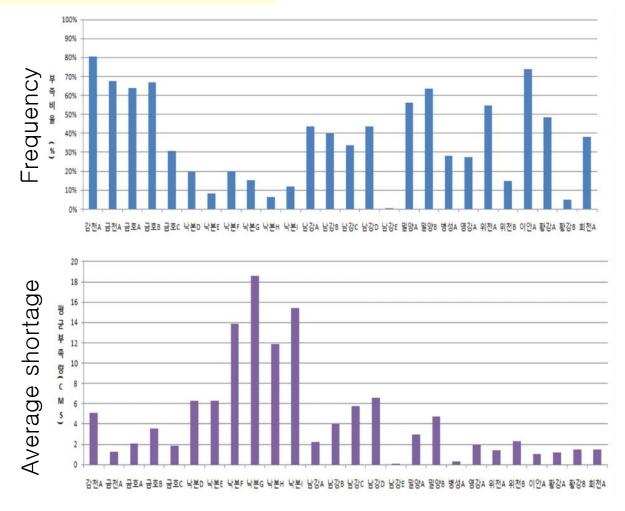
Historical domestic water shortage area

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• Vulnerability of drinking water intake



Frequency of instreamflow shortage and



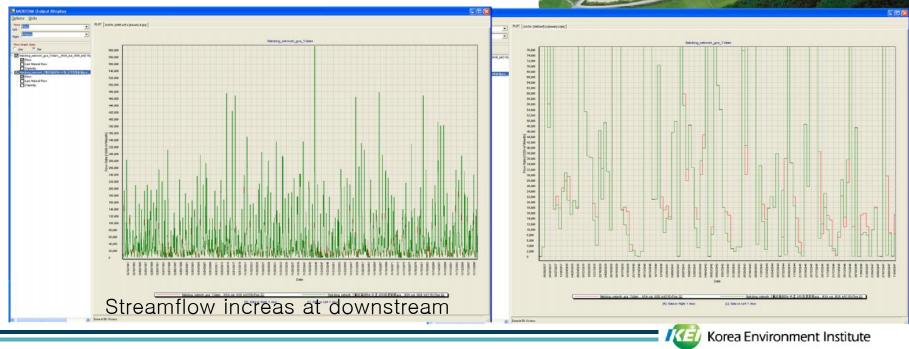
amount

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#### New Dam Built (Youngju dam)

- Objective: Provide instream flow
  - in main stem of Nakdong river
- Result: Increase downstream flow



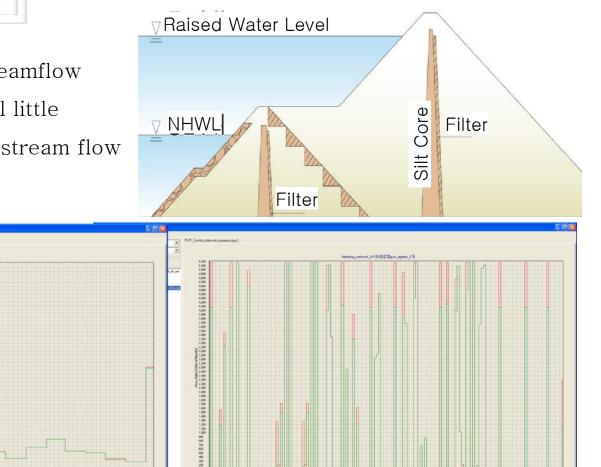


#### Irrigation Dam Raise

- Objective: Increase instreamflow
- Result: No protection will little

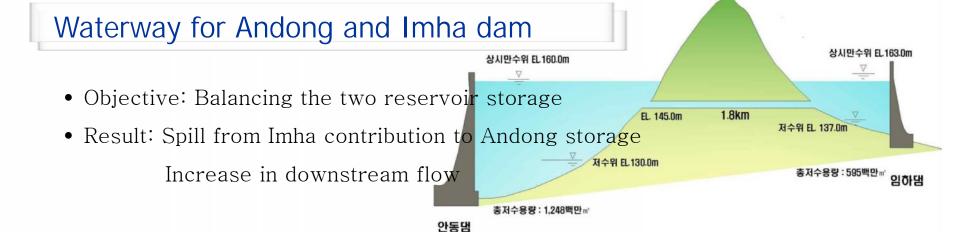
Increase in downstream flow

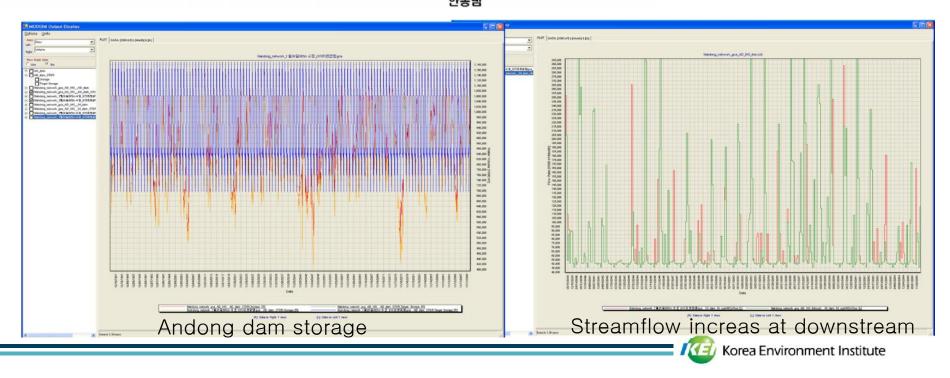
Case1: without augmented flow protection



Case2: with augmented flow protection

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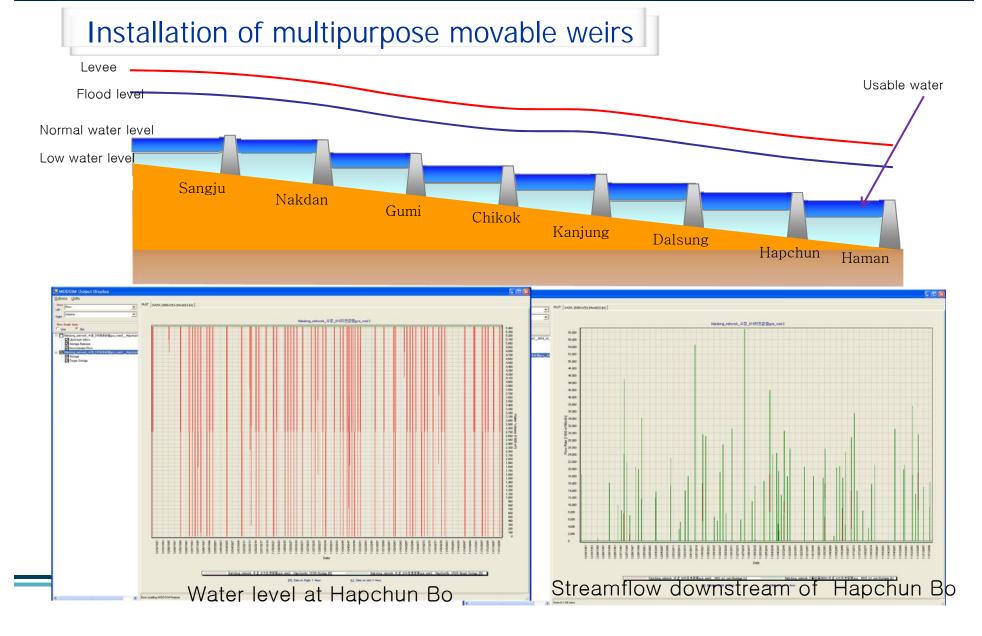




Installation of multipurpose movable weirs







# Conclusion

- Climate change assessment can include the following source of uncertainty
  - Climate change projections (emissions scenarios, GCMs, downscaling techniques)
  - Inability of models to represent future conditions perfectly (future water demand and land use etc.)
- Climate change has implications for many aspects of water management
  - The water availability in river basin, the future level of demand, the design and operation of hydrologic structure
- Water resources planning should be modified to incorporate not only the drought events from long historical records but also the full range of climate variability by GHG emission scenarios
- Climate change adaptation as well as construction of basin-wide water allocation
  model need integrated watershed-scale collaborations
- Advanced technologies and new setting of institutional frameworks policies for reallocation of water needed after four river restoration project completed





# Thank You !!



