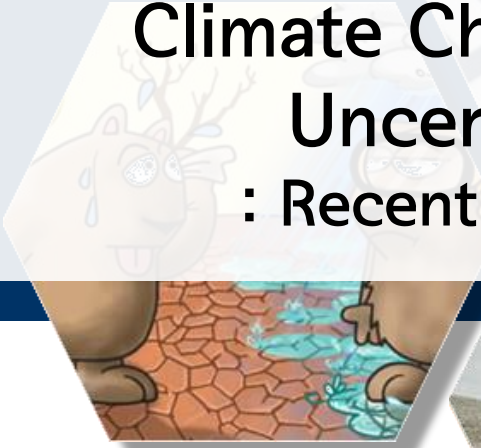




Climate Change Impact Assessment Considering Uncertainties and Integrated Modeling : Recent Research Progress in Republic of Korea



2015. 11. 13.

*Seoul National University

**Korea Environmental Institute

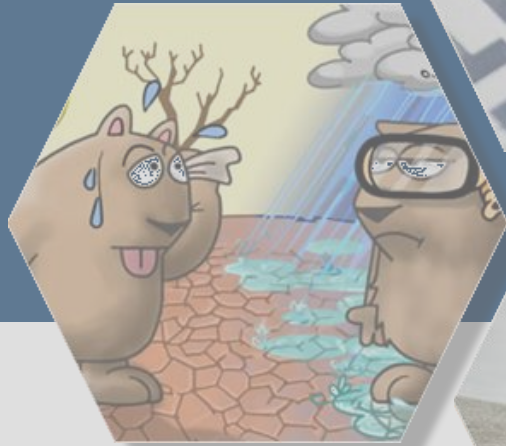
*Sunyong Sung

*Dong-Kun Lee

**Huicheul Jung

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1. Introduction
2. Dealing with Uncertainties
3. Complexity of Climate Change
4. Transboundary Problems of Climate Change
5. Conclusions





Introduction

Backgrounds : Climate Change Impacts in Korea

- In Korea, Frequency and intensity of natural hazard has increased

Heat Wave

Heavy snow

Landslide

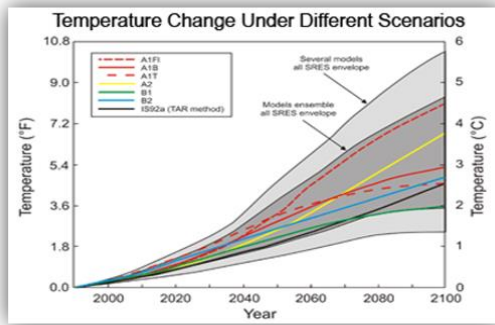
Flooding



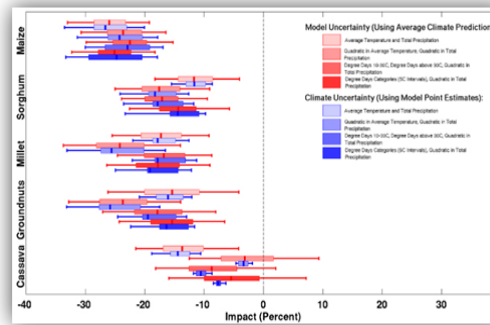
Scientific based Effective, Efficient
Climate Change Adaptation Plans are Needed

Backgrounds : Uncertainties

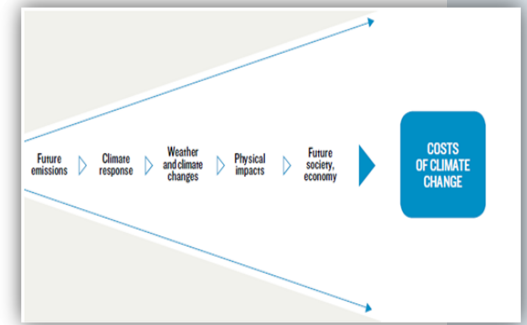
- The range of climate change impact related with “Uncertainties”
 - Policy makers need economic valuation for decision process



Uncertainties from Climate Change Scenarios (IPCC, 2001)



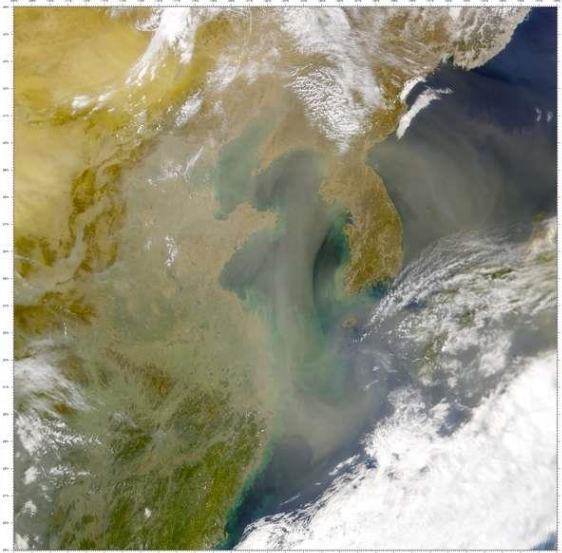
Uncertainties from Impact Assessment Model (Schlenker and Lobell, 2010)



Uncertainties from Economic Assessment Method (Menne et al., 2006)

Backgrounds : Transboundary

- Environmental problems affect on the large scale
 - Ex) Yellow dust, Air Pollutant from China





Key Questions on Climate Change Studies in Korea

How to **reduce uncertainties** in impact assessment?

- Development of Economic Assessment Technique for Climate Change Impact and Adaptation Considering Uncertainties

How to **set the framework** for the integrated impact assessment model on climate change?

- Development of Integrated Model for Climate Change Impact and Vulnerability Assessment

How to take into account **transboundary environmental issues**?

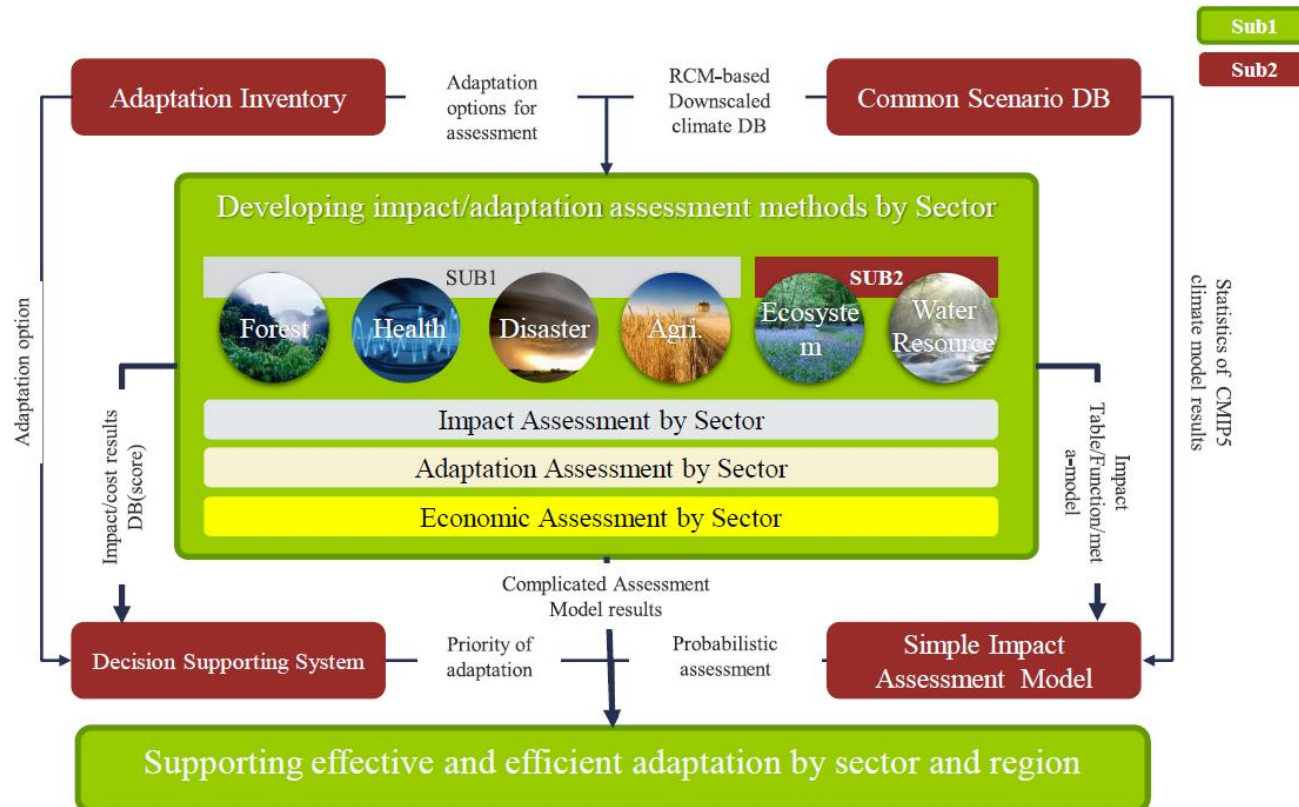
- Impact Assessment of SLCP/LLCP in East-Asia Considering Cost of Mitigation and Adaptation



Dealing with Uncertainties

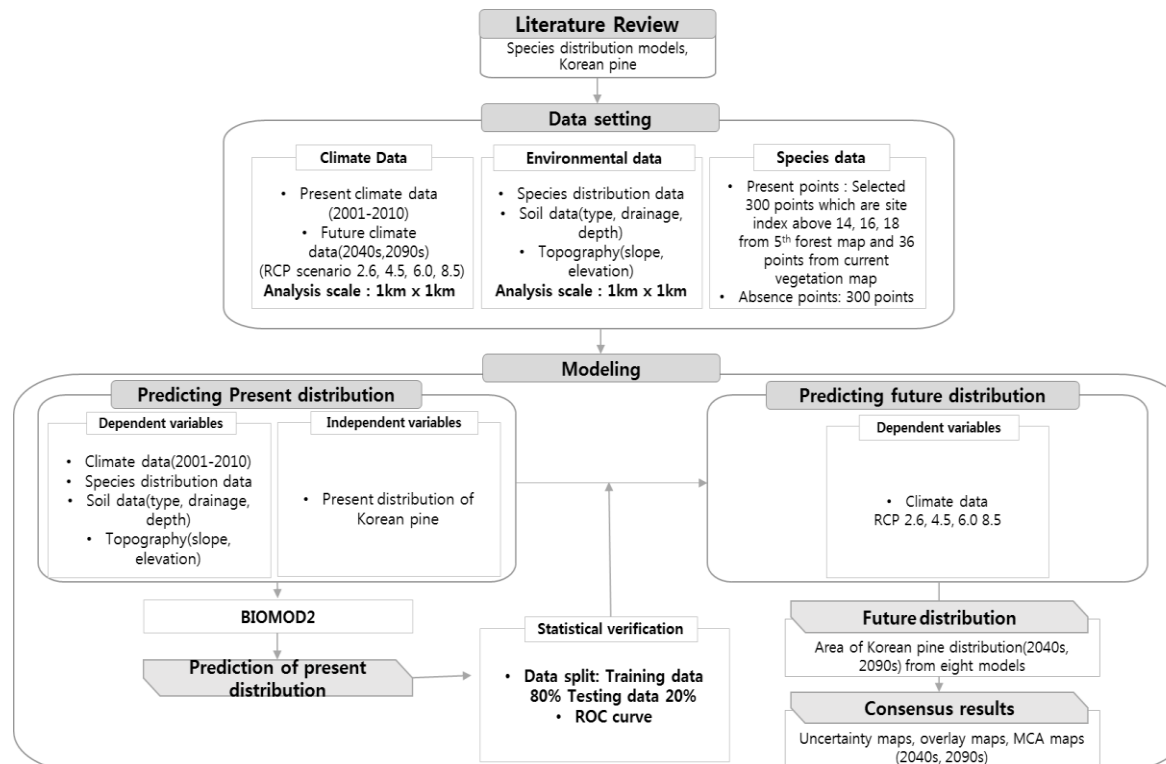
Project Overview

- to support the national and local adaptation planning considering uncertainty of projection
- Three types of uncertainties considered in 6 individual sectors



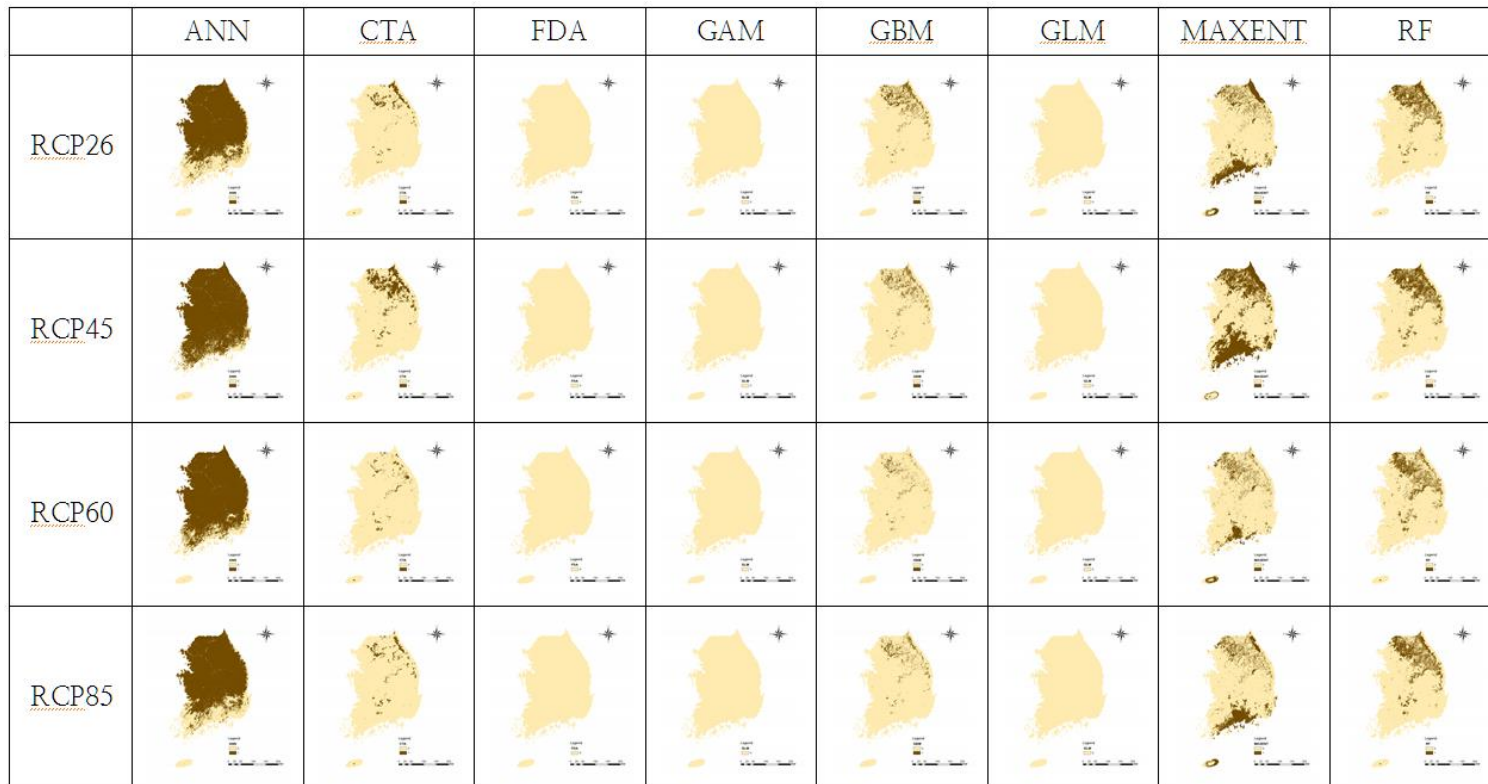
Dealing With Uncertainties: Forestry Sector

- Uncertainties have been considered in species distribution modeling
 - 8 different species distribution models
 - 4 different climate change scenarios



Dealing With Uncertainties: Forestry Sector

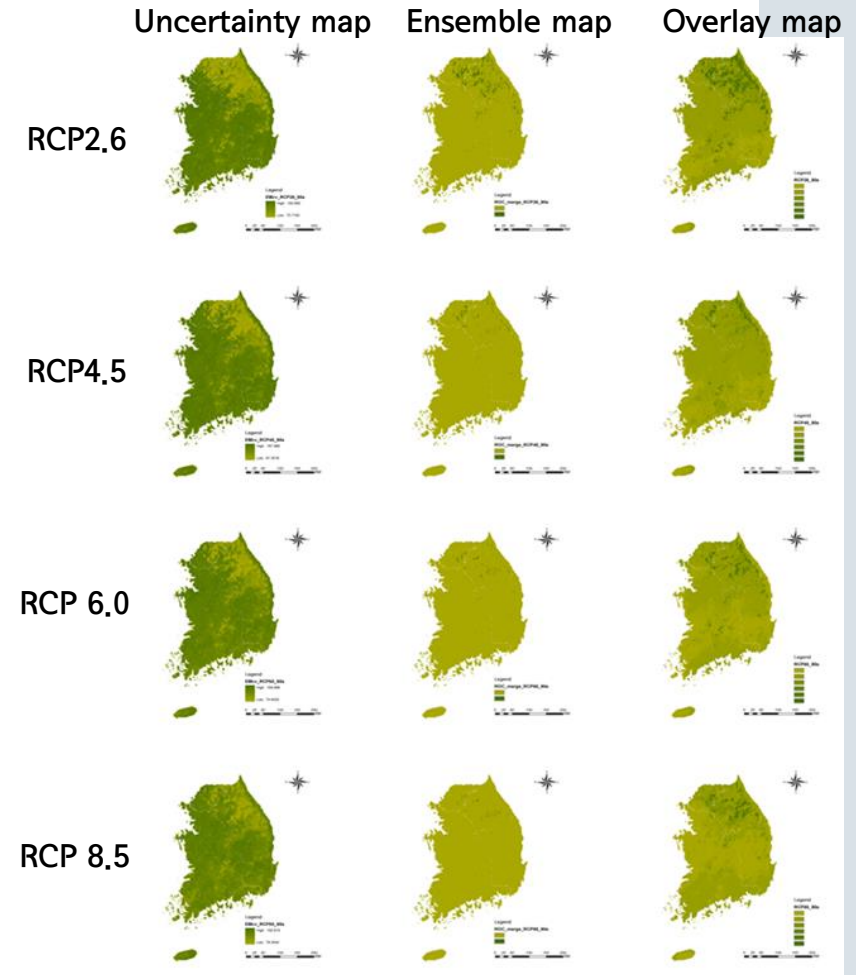
- Considerable differences among the species distribution models caused by algorithms, verification methodology



Distribution of Korean pine in 2040

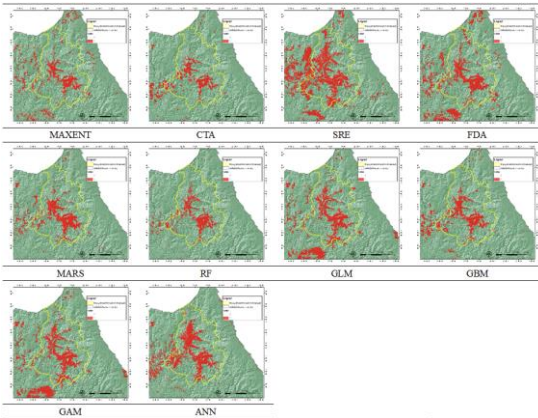
Dealing With Uncertainties: Forestry Sector

- Ensemble modeling reduces uncertainties
- Results from individual model showed high uncertainty. But ensemble model derive reliable result

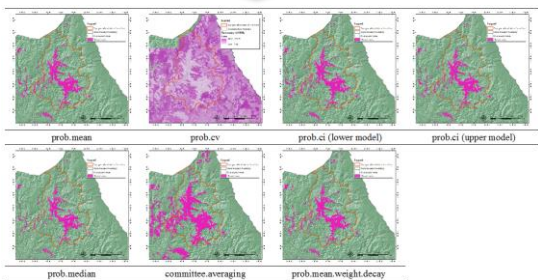


Dealing With Uncertainties: Landslide Risk

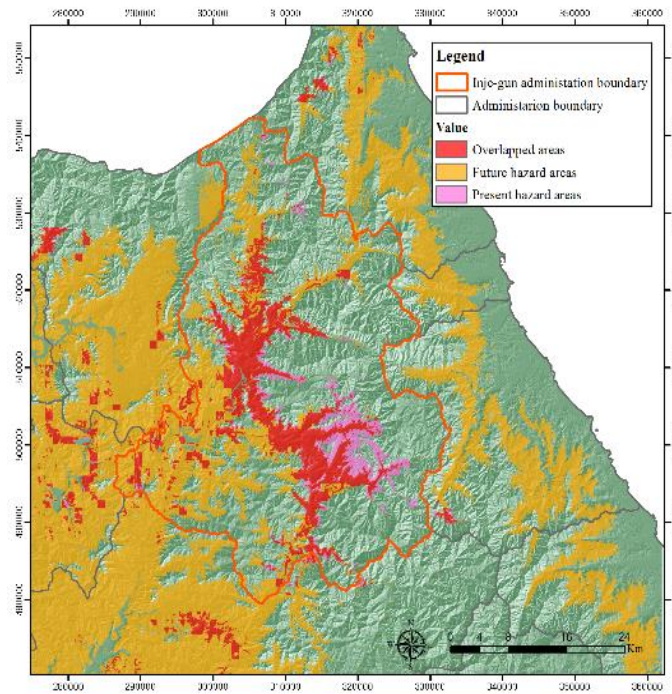
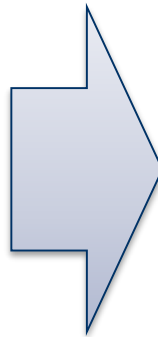
- 10 spatial distribution models applied for landslide risk area
 - Ensemble methods applied for ensure the validity of models



Result from Individual Models



Result from Ensemble Models

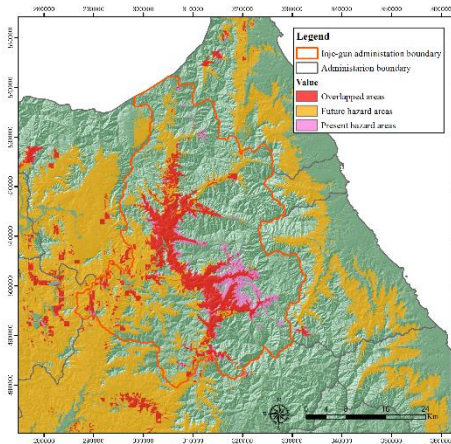


Result Selection Considering Validity and Uncertainties of Models

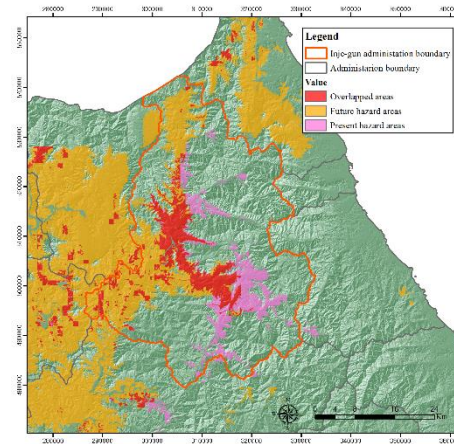
Dealing With Uncertainties: Landslide Risk

- Precipitation differences in climate scenarios cause uncertainties on impact assessment

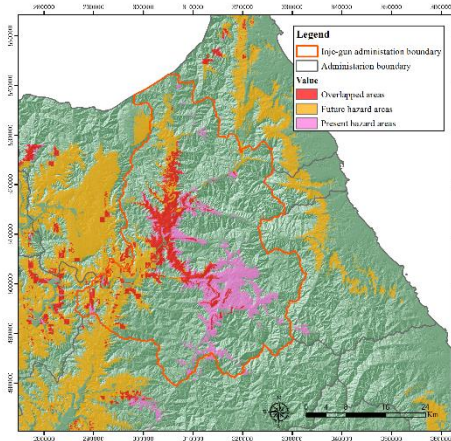
RCP 4.5 (2040s)



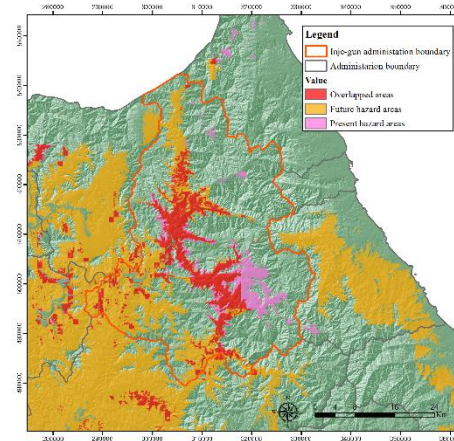
RCP 4.5 (2090s)



RCP 8.5 (2040s)



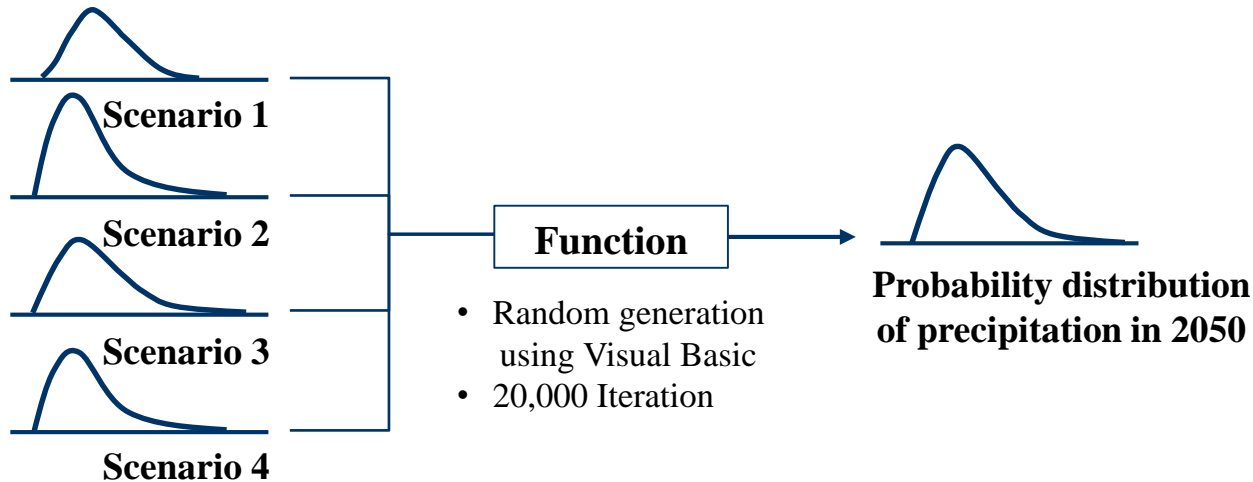
RCP 8.5 (2090s)



Dealing With Uncertainties: Flood Risk

- Monte Carlo simulation for scenario ensemble

- Ensemble of RCP scenarios from a range of future precipitation
- **Probability distribution of extreme rainfall of each scenarios with 20,000 iterations**



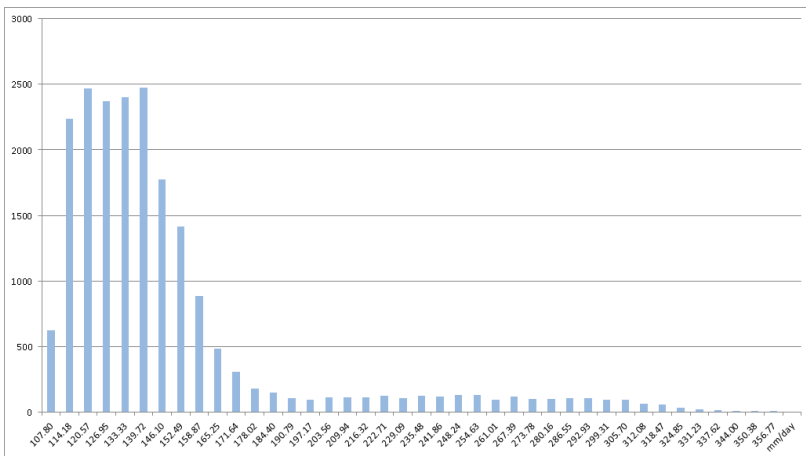
- MaxEnt model with probability distribution of flood depth

- **Probability distribution of flood depth by 10,000 iterations** to indicate possibility of flood occurrence
- The average and maximum possibility in 95% confidence of the outputs

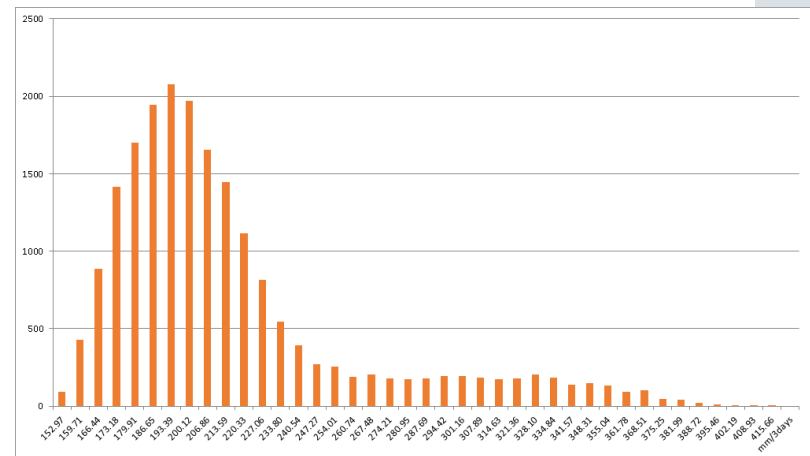
Dealing With Uncertainties: Flood Risk

- Monte Carlo simulation generates **the range of uncertainties**

		Minimum	Average	Maximum
2050 rainfall	daily precipitation (mm)	101.41	133.10	356.76
	accumulated precipitation (mm)	146.24	198.20	415.66
Current rainfall	daily precipitation (mm)	90.00	137.96	250.00
	accumulated precipitation (mm)	141.5	197.04	360



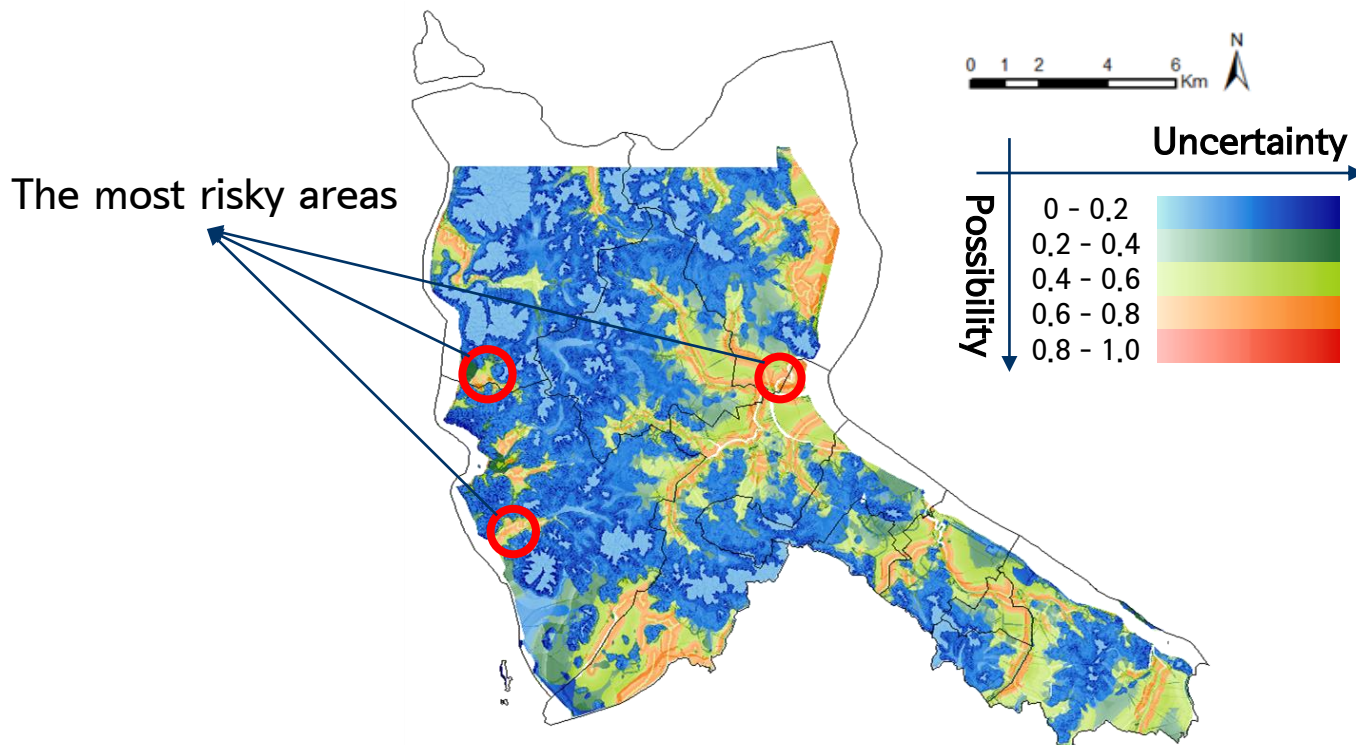
Frequency of daily precipitation in ensemble



Frequency of three-day accumulated precipitation in ensemble

Dealing With Uncertainties: Flood Risk

- MaxEnt with probability distribution of precipitation
 - **Standard deviation of 10,000 outputs** indicating uncertainty
 - Matrix of possibility and uncertainty showing most risky areas, with high possibility and low uncertainty



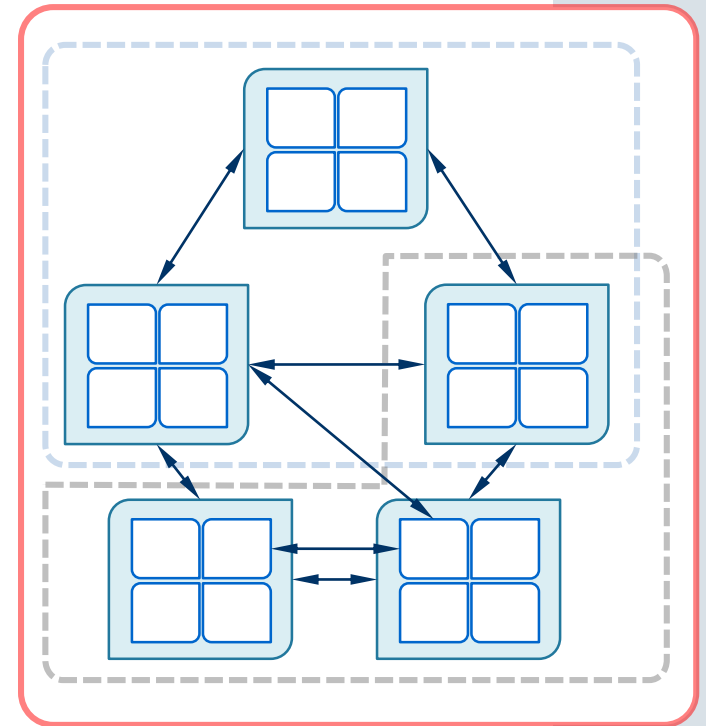
Complexity of Climate Impact Assessment



Integrated Impact Assessment Model Structure

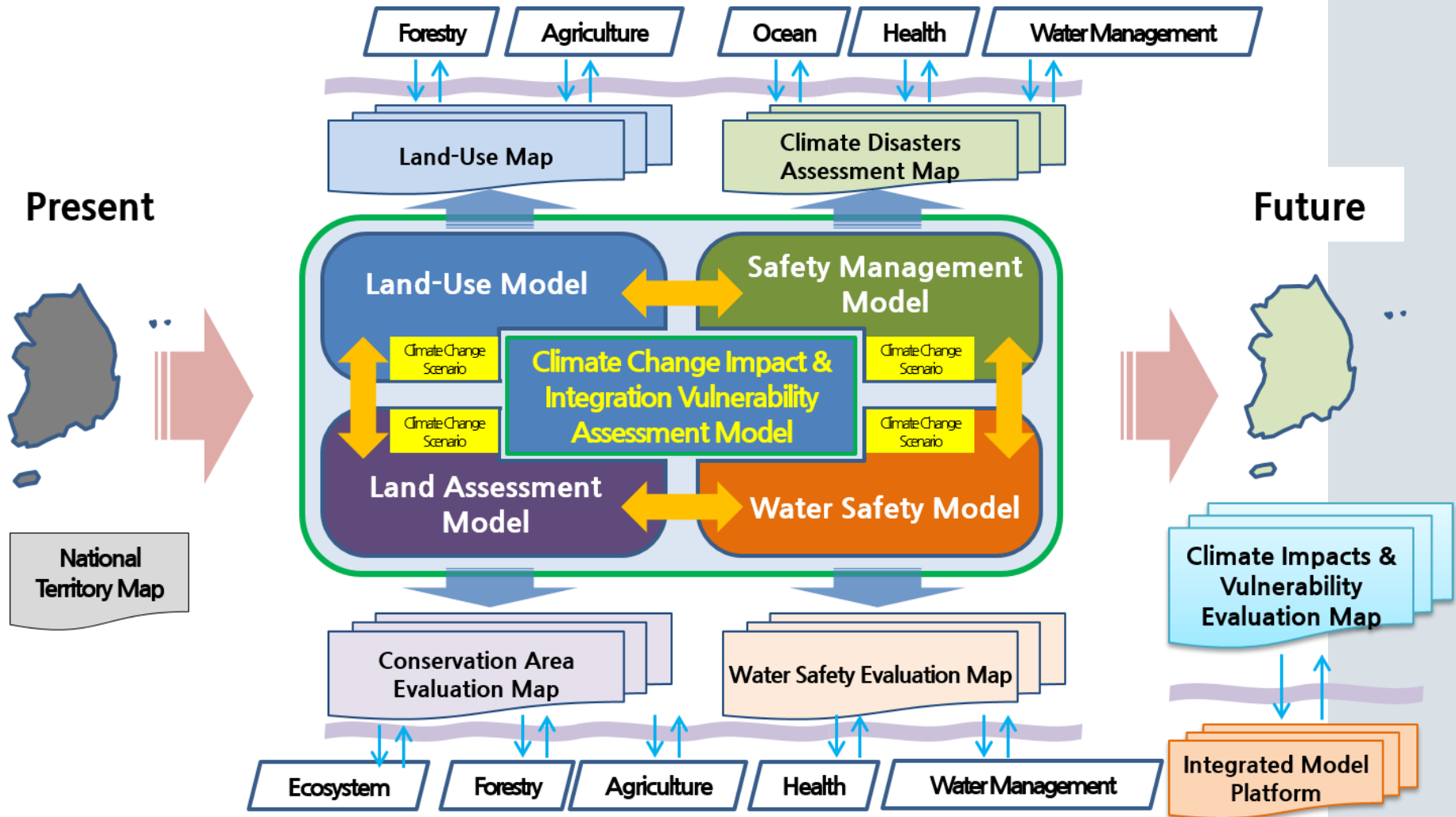
- Integrated models consist with four main strategies

- Individual sector model
 - : (ex) Water quality
- Cross-Sectoral model
 - : (ex) Water sector model
(Water quality, Water quantity, Aquatic ecosystem)
- Integrated impact model
 - : (ex) Expending conservation area
(Ecosystem, Agriculture, Forestry, Water)
- Synthetic impact model
 - : Risk assessment



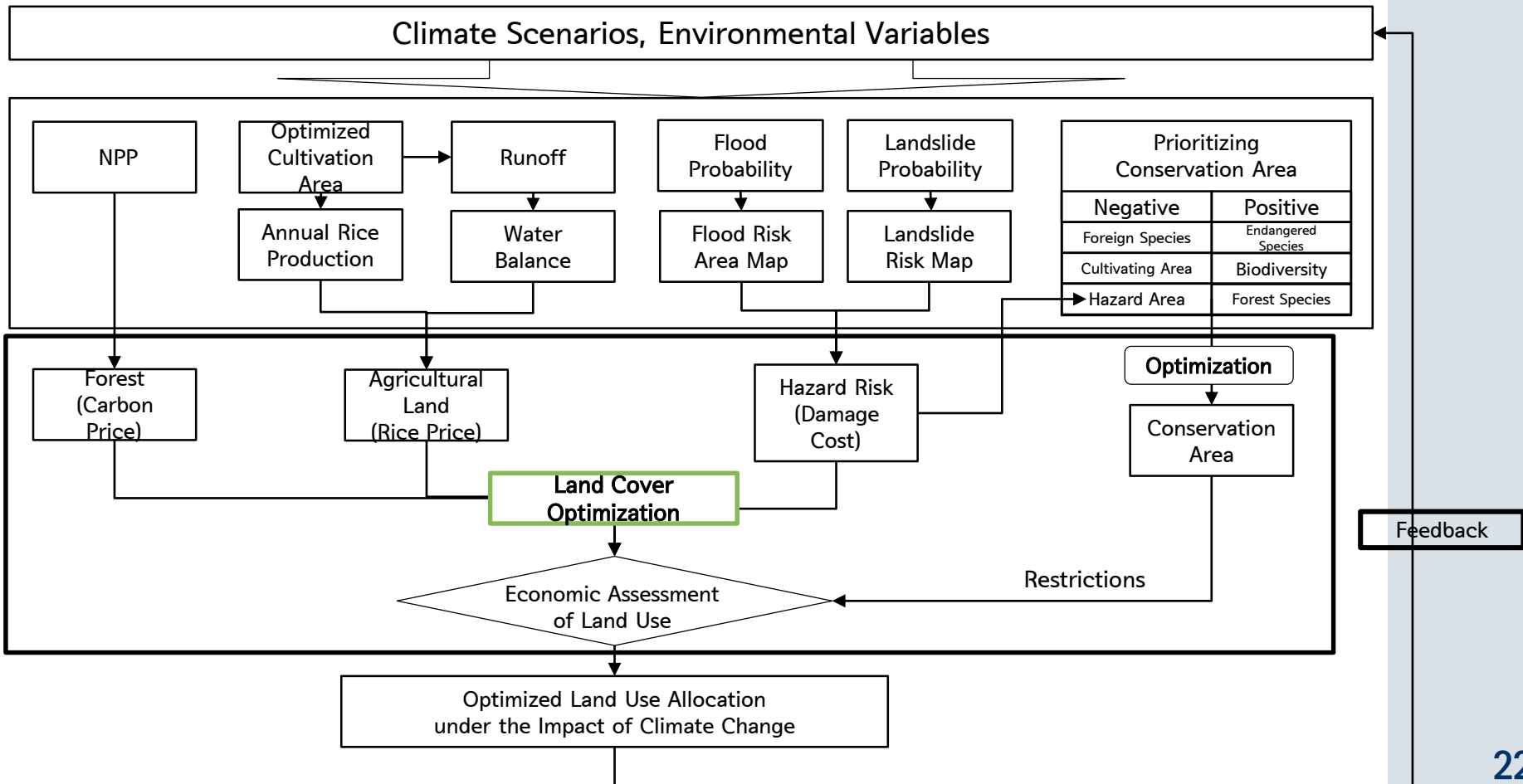
Conceptual diagram for Integrated Impact Assessment Model

Integrated Impact Assessment Model Structure



Integrated Impact Assessment Model : Land Use Optimization

- Land use allocation by each policy goal
 - Feedback roof considering economic valuation

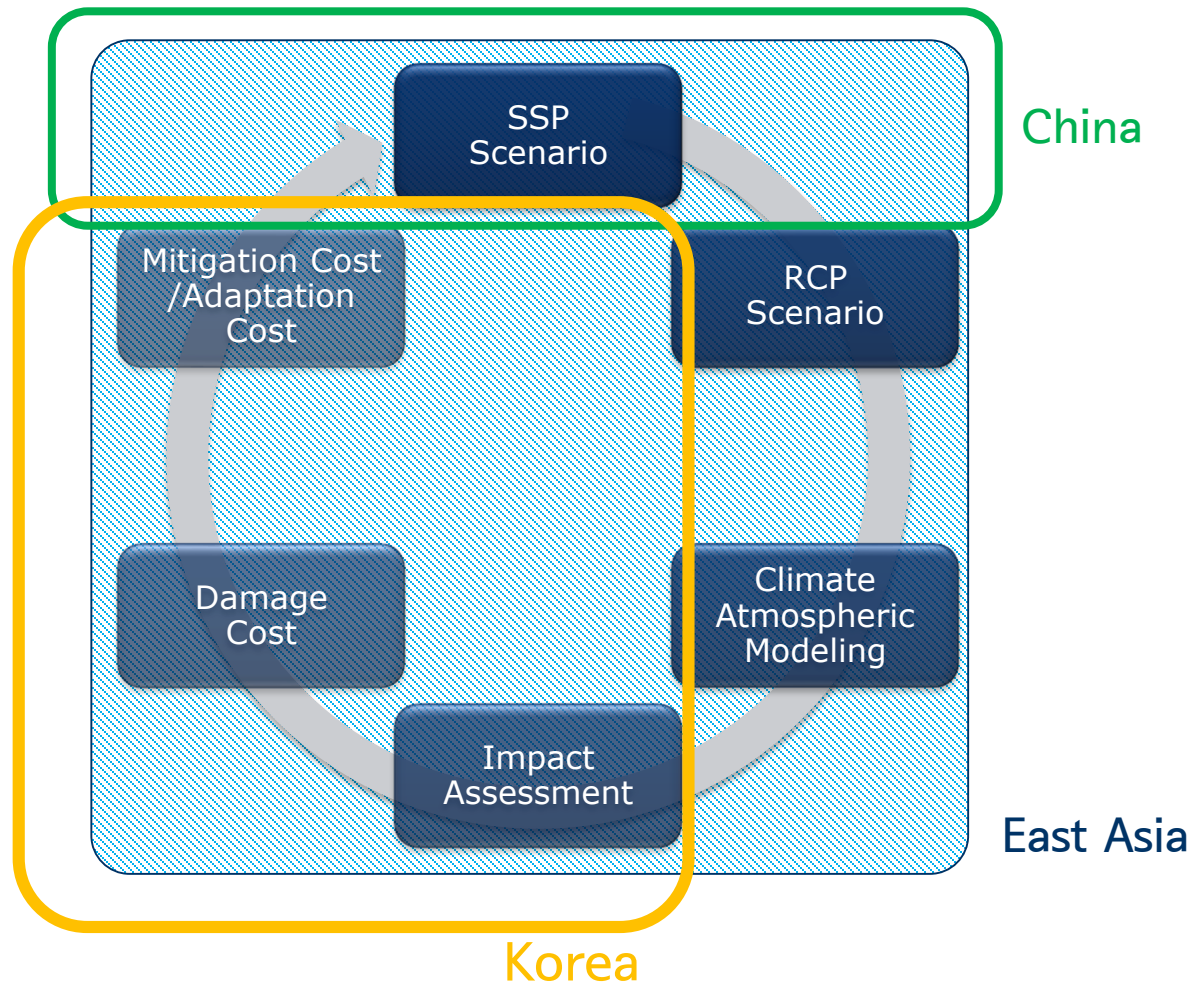




Transboundary Problems of Climate Change

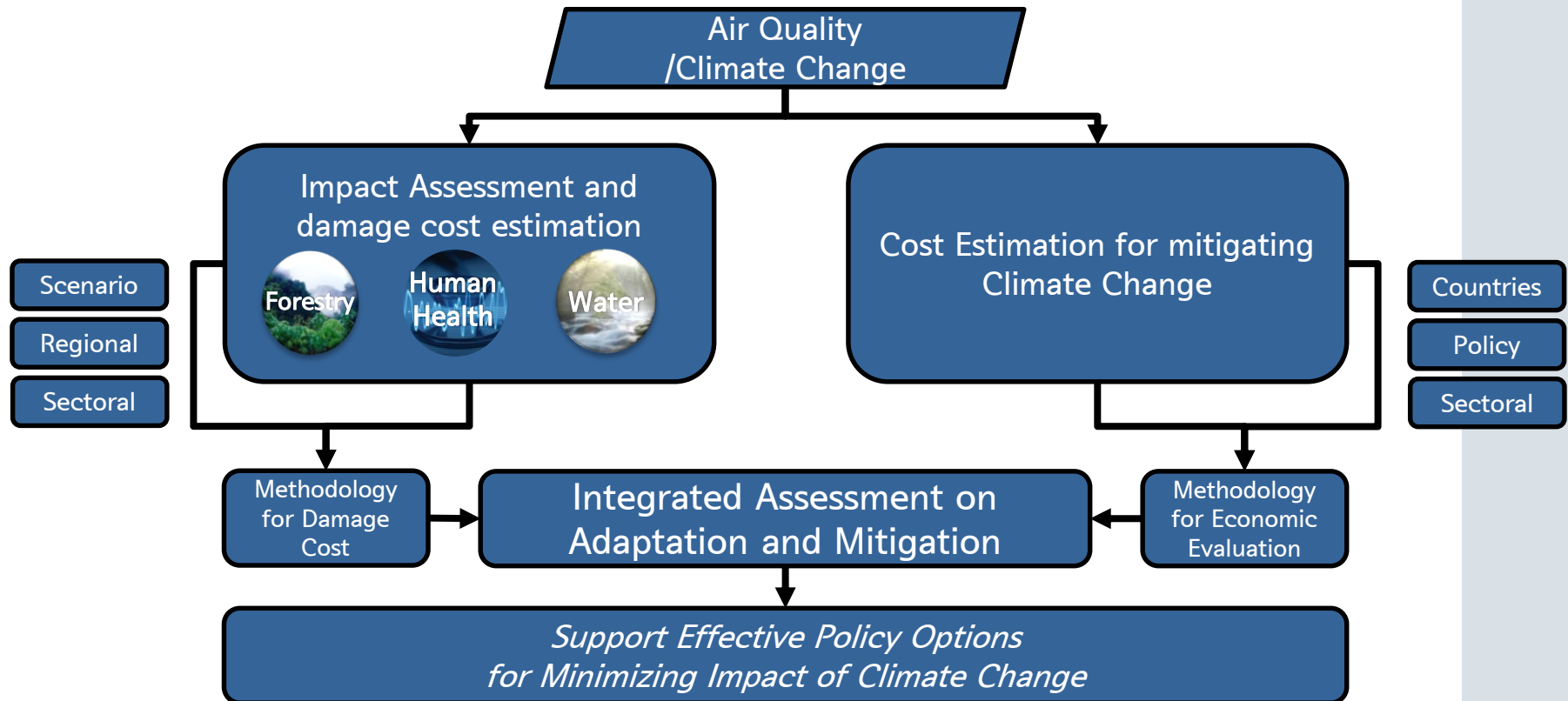
Transboundary Issues in East Asia

- Impact assessment of climate change is under discussion at international scale



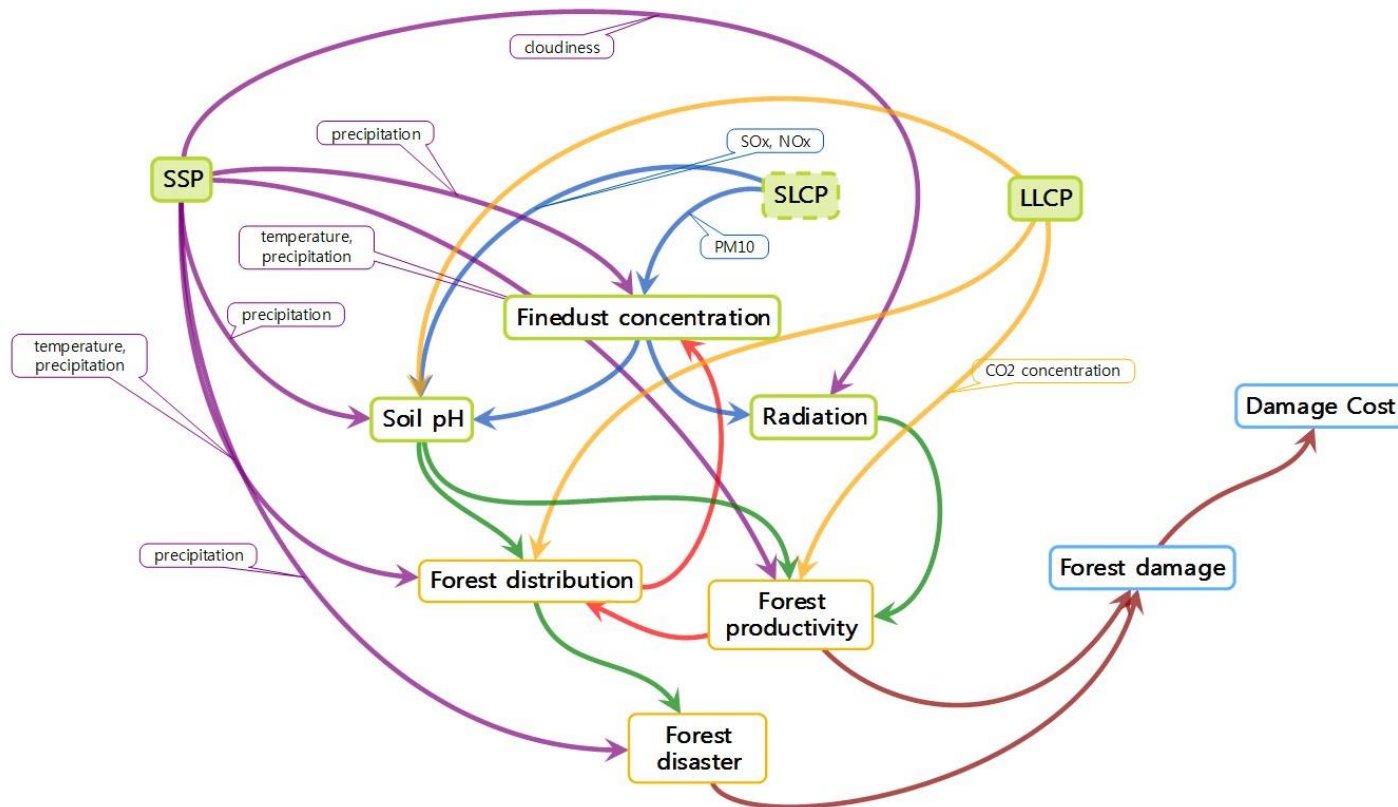
Transboundary Issues in East Asia

- Air quality map from each climate change scenario provides transboundary environmental issues



Transboundary Issues in East Asia

- Casual relationship between air quality and forest productivity
 - Damage and its cost will be calculated by process based model in forestry sector





Conclusions



Conclusions

To evaluate the impact of climate change in Korea

1. Consideration on uncertainties

- Ensemble model
- Multi climate change scenarios
- Probabilistic approach

2. Complexity of climate change impact assessment

- Land use based optimization: economic evaluation of land use

3. Transboundary Problems of Climate Change

- Transboundary problems: process based model



Thank You for Your Attention

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