글로벌 탄소중립 혁신과 연대를 위한 협력 포럼

International Innovation Forum on Solidarity and Cooperation for Carbon Neutrality

Session 2

IPCC AR6 적응 시나리오 개발과 적용

Developing AR6- based Integrated Scenario Assessment Model and Application

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Global Carbon Neutral technology and Innovation Forum

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Developing AR6- based Integrated Scenario Assessment Model and Application

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Ⅰ Introduction

Ⅱ Method & Result

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Ⅰ.Introduction Background

The 6th Assessment Report of the IPCC (AR6)

- Working Group I (The Physical Science Basis) Report
  Published on August 9, 2021
- Working Group II (Impacts, Adaptation and Vulnerability) Report
  Published on February 28, 2022
- Working Group III (Mitigation of Climate Change) Report
  Published on April 4, 2022
- Synthesis Report of the Sixth Assessment Report
  released on March 20, 2023

	SRES Scenario	RCP Scenario	SSP Scenario
Report	IPCC AR4(2007)	IPCC AR5(2013)	IPCC AR6(2021)
GHG Emission Scenarios	SRESB1/B2/A1B/A1T/A1FI/A2	RCP2.6/4.5/6.0/8.5	SSP1- 1.9/1- 2.6/2- 4.5/ 3- 7.0/5- 8.5
Socio- economic assumptions	Consideration of greenhouse gas emissions due to changes in social structure	Consideration of greenhouse gas concentration depending on whether climate change response policy is implemented	Consideration of socio- economic factors(ex. future population, land use, energy use, and etc.) depending on the level of greenhouse gas reduction and whether climate change adaptation measures are implemented

Ⅰ.Introduction Background

Proposal of technology policy for IPCC AR6 WG2 and guidelines for the government agencies

Based on the last IPCC report, how models or scenarios linked to social, economic, and climate policies in the field of climate adaptation were applied to the region, and the acceptability, utility, and representative performance according to the before and after circumstances of the region to which it was applied were investigated and analyzed. It is necessary to draw implications

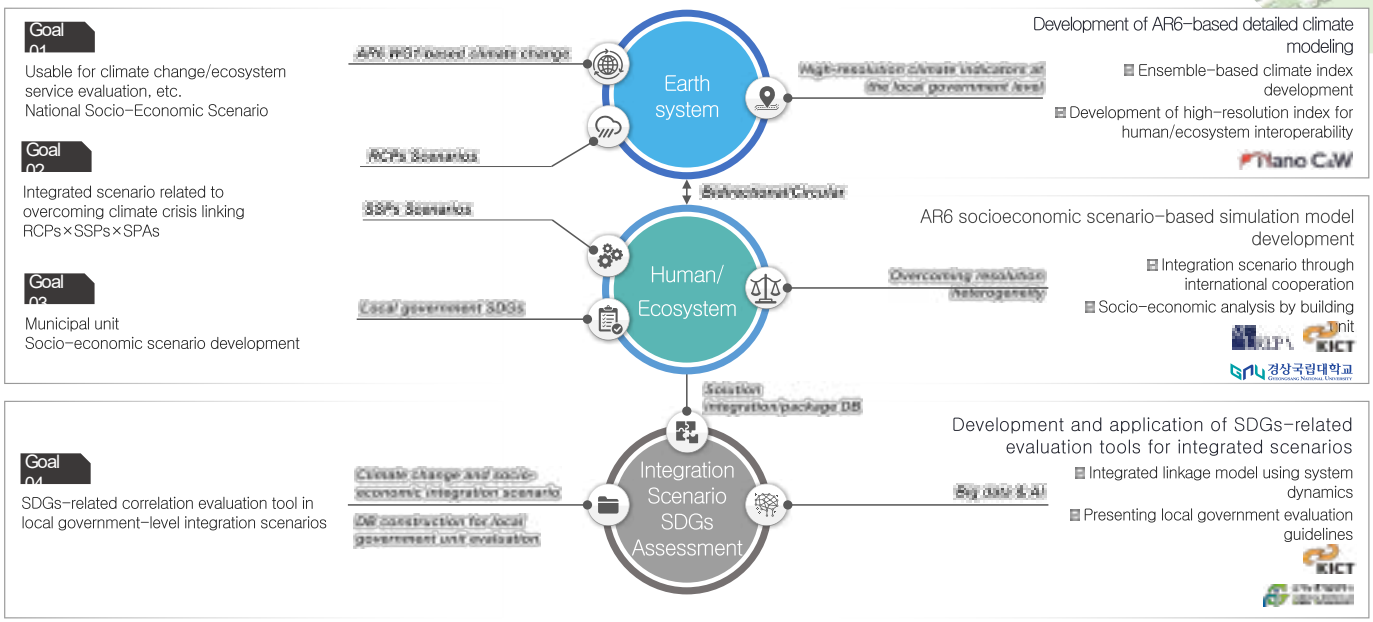
In order to increase global excellence and regional technological effectiveness, we materialize the climate technology application plan in connection with step-by-step scenarios, and use domestic and foreign technology networks and platforms to propose international technology and innovation acceptance and universal technology policy, and develop and spread it as an innovation strategy I need a way to

To select representative climate-vulnerable areas and climate innovation areas among basic local governments in Korea, establish a cooperative system with regional local governments, apply policies based on two-way demand and two-way communication between local residents and administrative authorities, and develop network construction and step-by-step application methodologies for this purpose. It is important to try to materialize

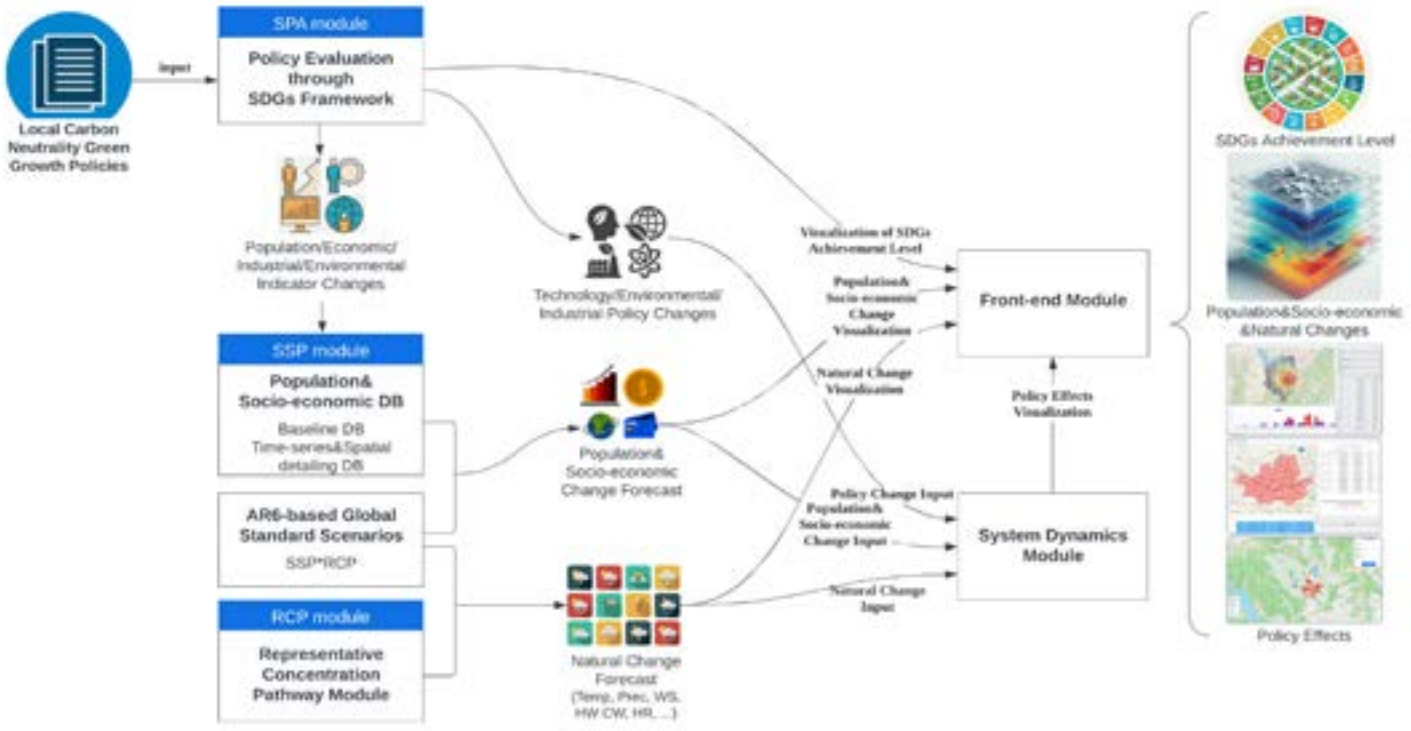
As a climate technology research institute, GTC supports the provision of guidelines for establishing climate adaptation technology policies applicable to local governments at the international level based on its knowledge and know-how, and supports local government-centered carbon-neutral scenario optimization plans based on simulation results.

Necessary to establish guidelines for the use of climate adaptation scenarios tailored to the region at the international level.

Ⅰ.Introduction Research Purpose



Ⅰ.Introduction Research Framework



II. Method & Result SSP Module

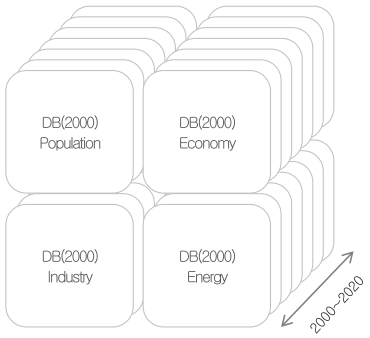
Establishment of socio-economic DB by region

- Collection of socioeconomic data from 2000 to 2020

Type	Variables
Economy (2000~2020)	Real GRDP
	Real GRDP by economic activity
	Nominal GRDP by economic activity
	Trade import/export amount
	Number of businesses & employees by industry
	Final consumption expenditure
	Disposable income
Industry and Energy (2000~2020)	Renewable energy detailed energy source production
	Renewable energy detailed energy source power generation
	Renewable energy detailed energy source supply
	Electricity usage by contract type
	Electrical energy consumption by district number
	Gas consumption by district number

Collection of socioeconomic data at city/province level(2000~2020)

- Population: total population, population by age, birth rate, etc.
- Economy: Real GRDP, number of businesses, number of employees, etc.l
- ndustry and energy: power usage, oil consumption, etc.



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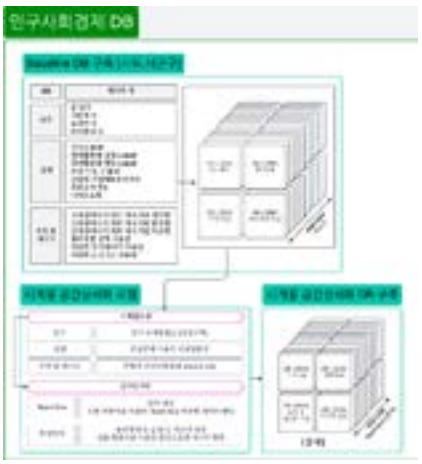
II. Method & Result SSP Module (continued)

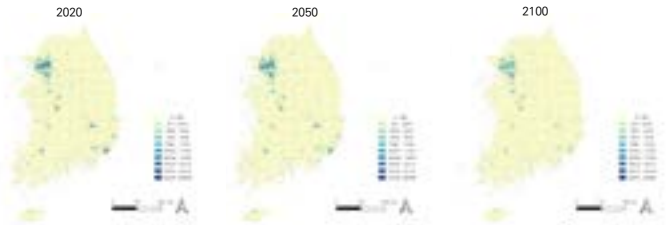
Variables and methodologies for building data

SSP based spatial interpolation model

✓ Presentation of time series spatial detailing by applying spatial detailing model based on time series model data



✓ (National Level) Gridded SSP 1~5 Populations (2020-2100)



✓ (3 regions) Building based interpolation (2020 - 2100_SSP2)

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II. Method & Result SSP Module (continued)

Building a time series spatial interpolation model

- Building a time series spatial detail model to build a baseline DB

Time series Spatial Interpolation Model

- Spatial unit : 1kmX1km (National level)
  Building unit(Ulsan, Seosan, Suncheon)
- Time Series model: Industrial Relations Weighted Time Series Model (Economy)Flexible industry linkage model (industry and energy)

Time series spatial regression analysis

Building a carbon indicator model by deriving relationships between sectors

GHG=f(D, Ec, I, En, etc)

D : population I : Industry En : Energy
Ec : Economy etc : Macro-level control variables

Spatial Interpolation

1km X 1km
- Unit: National level
- Data allocation for each 1kmX1km grid using the total floor area of the building
- Apply weights according to regional industry and population characteristics

Building level
- Target: 3 local governments (Ulsan Metropolitan City, Suncheon City, Seosan City)
- Data allocation by building level using building total floor area
- Apply weights according to building use

Time Series Estimation Model

Economy
- Methodology: Industry relationship weighted time series analysis

Industry
- Methodology: FLEX-IO

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II. Method & Result SSP Module (continued)

Baseline DB 구축

- Establishment of socio- economic baseline database from 2025 to 2100
- Establishment of K- SSPXRCP standard scenario using socioeconomic indicators

Spatial Interpolation DB (2025~2100, 5year interval)

- Integration of socio-economic indicators K-SSP 1~5 Construction of detailed socio-economic spatial future database by scenario (2020-2100)

DB(2020) Population 1kmX1km grid & building level

DB(2020) Economy 1kmX1km grid & building level

DB(2020) Industry 1kmX1km grid & building level

DB(2020) Energy 1kmX1km grid & building level

2020~2100

Building K- SSP standard scenario data

- Integration of socio-economic indicators K-SSP 1~5
- Construction of detailed socio-economic spatial future database by scenario (2020-2100)

K- SSPXRCP urbanization by region (2020~2100)

- Socio-economic indicator integration
- Establishment of future urbanization degree database

K- SSPXRCP Standard scenarios

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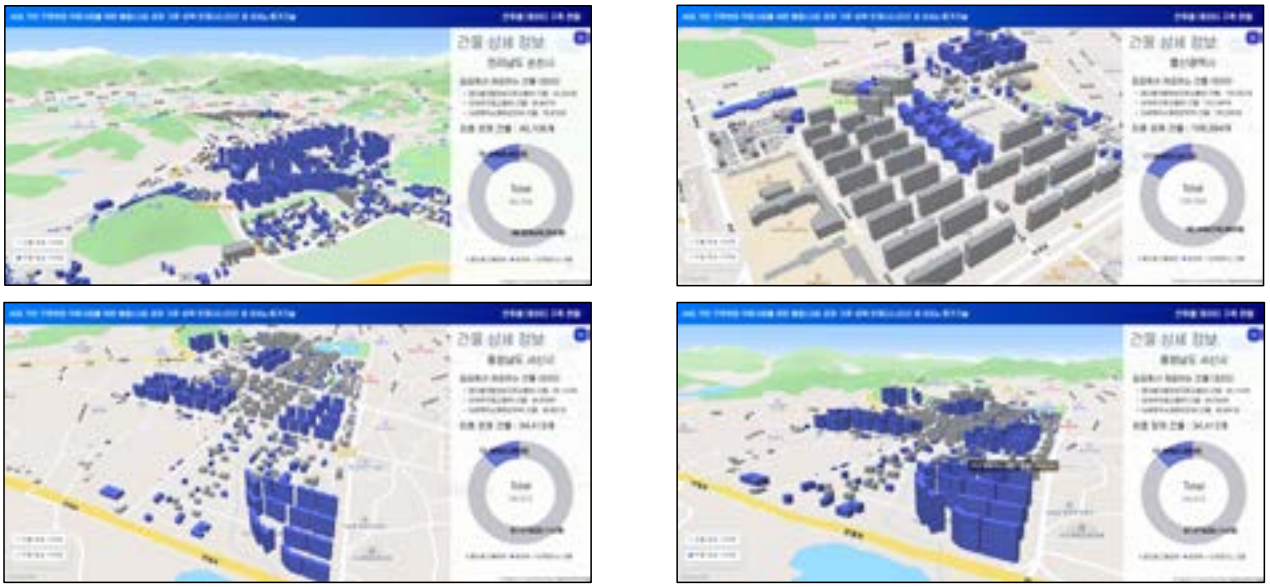
II. Method & Result SSP Module (continued)

Construction DB visualization platform design sample images



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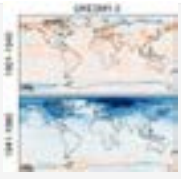
II. Method & Result RCP module: Input data

Characteristics of climate change scenarios : Global, East Asia, and South Korea

Climate change scenarios : Global(135km)

- ✓ IPCC 6th assessment report SSP 4 scenarios
- ✓ Ensemble of global climate models(K-ACE, UKESM1)
- ✓ Region : global(resolution:135km)



▲ Figure 4. (Mulcahy, Jane, et al. 2022) DOI:10.5194/gmd-16-1569-2023

Climate change scenarios : East Asia(25km)

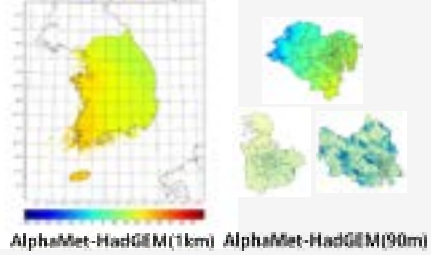
- ✓ Dynamical downscaling using global climate model(UKESM1)
- ✓ Ensemble of regional climate models(HadGEM3-RA, WRF, CCLM, GRIMs, RegCM4)
- ✓ Region : East Asia(resolution : 25km)

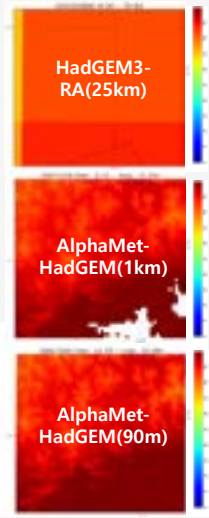
▲ Figure 1. (Xiaojin Xu, 2023) DOI:10.1016/j.catena.2022.106763

Climate change scenarios : South Korea (1km/90m)

- ✓ Downscaling using regional climate model(HadGEM3-RA)
- ✓ Using Diagnostic model, AlphaMet, core technology of Nano C&W
- ✓ Region :
  - South Korea(Resolution : 1km)
  - Ulsan, Seosan, Suncheon(Resolution : 90m)

▼ Model outputs for Suncheon area





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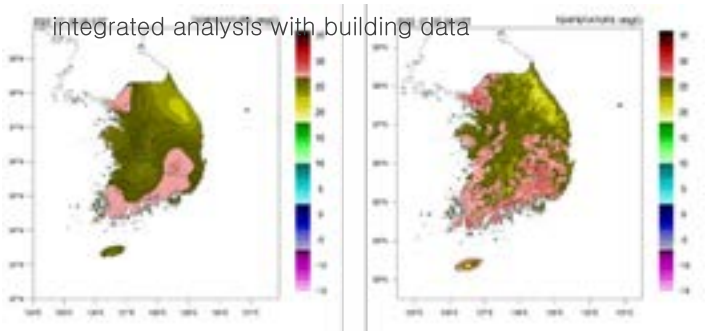
II. Method & Result RCP module: Downscaling

Method of producing high-resolution downscaled climate data for Ulsan, Seosan, and Suncheon : AlphaMet

Characteristics

- ✓ Diagnostic model → fast computational speed
- ✓ Topography reflecting detailed terrain characteristics
- ✓ 100m or higher horizontal resolution
- ✓ Vertical downscaling → expected to enable integrated analysis with building data



AlphaMet

3D Weather/Climate Data Platform, AlphaMet

- Restoring of meteorological data for unobserved location(1km~ 10m)
- Production of 3D temperature, precipitation, and wind
- Patented and trademark registered

『Device and method for back calculation daily max/min temperature using daily mean temperature』 (application, 10-2023-0152293)

Description : Using observation data-based temperature to estimate daily max/min temperature from scenario model data-based daily average temperature

Expected effect

- ✓ Effective reduction of computational resources and time during the downscaling climate scenario model data

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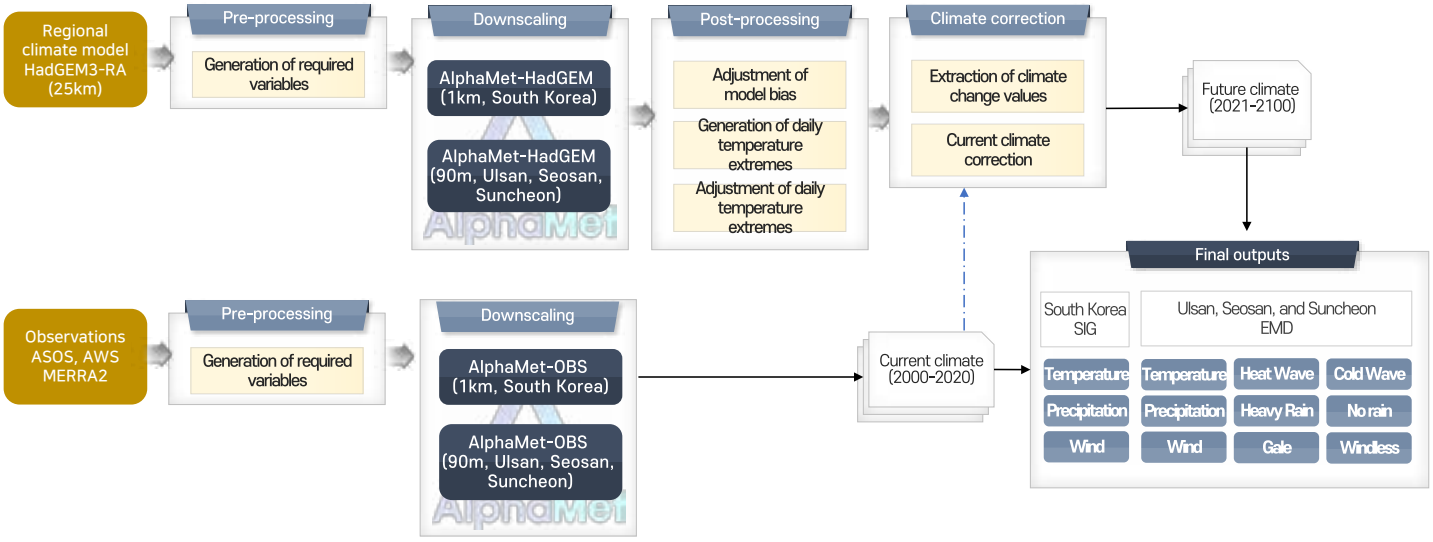
II. Method & Result RCP module: Process

Producing the current climate data based on observation data & the future data based on climate change scenarios



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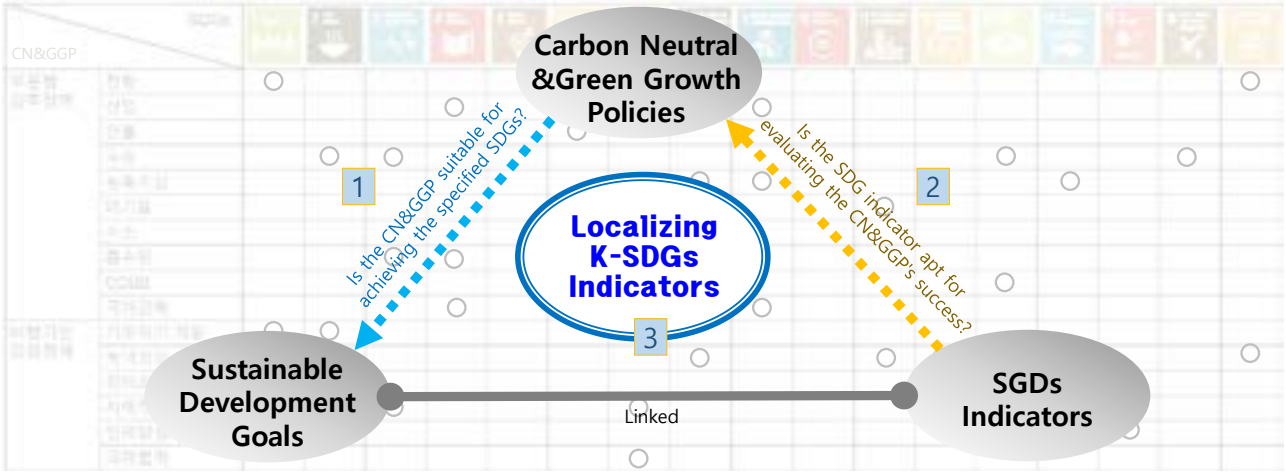
II. Method & Result SPA module

Evaluate the local CN&GGP through the lens of the SDGs



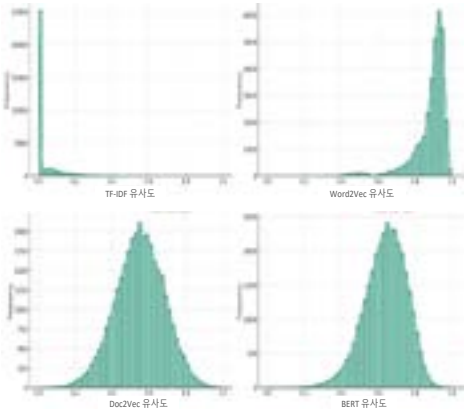
II. Method & Result SPA module (continued)

National Carbon Neutral & Green Growth Policy Evaluation through SDGs Framwork

Sector	Subsector	Policy content	SDGs	SDGs_target	SDG indicator
Buildings	Improving the energy efficiency of buildings	• Innovation in building energy use equipment and management systems • Strengthening the foundation for building energy efficiency assessment and management, and improving efficiency	Environmentally friendly production and consumption of energy	Save energy and improve energy efficiency	• National energy efficiency indicators • Building energy efficiency indicators
		• Strengthening the public sector's leadership in reducing greenhouse gas emissions	Sustainable production and consumption	Promote sustainable green consumption through the expansion of green product certification and green purchasing.	• The green product purchase rate in the public sector (local government)
	Planning and spatial arrangement for carbon neutrality	• Energy transition and expansion of renewable energy in the building sector	Environmentally friendly production and consumption of energy	Save energy and improve energy efficiency	• National energy efficiency indicators • Building energy efficiency indicators
		• Promoting climate change impact assessments to internalize carbon neutrality in planning and development projects	Climate change and response	Efforts are made to incorporate action plans for climate change into local policies and initiatives.	• Proportion of local governments with established basic plans for climate change response • Proportion of local governments with dedicated agencies for climate and energy
		• Consideration of carbon neutrality values in the National Spatial Plan for carbon neutrality at the national level.	Conservation of terrestrial ecosystems	Efforts are made to restore land degraded by drought, floods, and development.	• The proportion of degraded land area to total land area
				Efforts are made to restore ecological corridors disrupted by human activities such as development projects and to maintain and manage ecological networks.	• The area of forest restoration including Baekdu Daegan and others
				Strengthen sustainable forest management by halting deforestation and restoring degraded forests.	• Expansion of national forest management indicators
				Protect endangered species to prevent biodiversity loss.	• Mountainous area green cover index
				Activate conservation and restoration activities to diversify terrestrial and inland freshwater ecosystems.	• The proportion of designated protected areas for terrestrial and freshwater biodiversity to total land area • The proportion of forest area to total land area
				Take measures to prevent the introduction of invasive alien species and reduce their impact on terrestrial and aquatic ecosystems.	• Annual forest damage area caused by forest pests
			Conservation of marine ecosystems	Actively manage marine ecosystems and habitats for fisheries resources.	• Restored tidal flat area • Cumulative area of created sea forests
				Expand the designated areas of marine protected areas for systematic conservation and sustainable use of marine ecosystems.	• Area designated as marine protected areas
		• Introducing carbon neutrality elements into urban planning for carbon neutrality at the city level.	Conservation of terrestrial ecosystems	Efforts are made to restore ecological corridors disrupted by human activities such as development projects and to maintain and manage ecological networks.	• Urban/regional restoration

II. Method & Result SPA module (continued)

1. Linking CN&GGPs to SDGs



2. Appropriateness of SDGs indicators for evaluating CN&GGPs

Evaluation using GPT API from the perspective of experts in 10 fields.

- Expert fields: Energy, Transportation, Industry, Agriculture, Land Use, Construction, Finance, Education and Research, Policy and Regulations, Waste
- Prompt for evaluation:
  = gpt("As an expert in the field of "&D3&", how appropriate do you think the "&$C4& " indicator is for evaluating "&$B4&" policy? Summarize your points in 50 tokens")
  = gpt("Based on "&D4:M4&", how appropriate do you think the "&$C4&" indicator is fo r evaluating "&$B4&" policy? Evaluating on a scale of 1 to 10 ")

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II. Method & Result SPA module (continued)

3. SDGs Evaluation Indicator Matrix(CN&GGPs · SDGs Targets)

SDGs \ CN&GGP Sectors	Buildings	International Reduction	International Cooperation	Climate Crisis Adaptation	Green Growth	Agriculture And Fisheries	Industry	Hydrogen	Transpor-tation	HR Development and Awareness Enhancement	Transition	Just Transition	Local-led	Waste	Carbon Sink	CCUS
Healthy and safe water management	3			3	3	3	3			3	3	2	5	3		
Ensuring healthy and happy lives				3												
Climate change response	2		3	3	1							2	2			
Quality education for all				1	3					26		1				
Resolution of all forms of inequality			5	5			1			4		1	4		4	
Reduction of poverty and strengthening of social safety nets				5			2					2				
Activation of industrial growth and innovation, and construction of social infrastructure		2	2	5	11		11	5		4	6	11	4	3	2	7
Ensuring gender equality			1	3	2		2			5		3	3			
Food security and sustainable agriculture enhancement				4									3			
Environmentally friendly production and consumption of energy	5			2	5	5	1				4	1	4	2		
Conservation of terrestrial ecosystems	2	3		1						2			4		11	
Expansion of decent work and economic growth				2						2						
Strengthening global cooperation		5	8		5					6		3	7			
Sustainable production and consumption				6	4	3	5	2		5		2	2	1		2
Peace, justice, and inclusivity		4	4	1	3		1			1		7	5			1
Creating inclusive, safe, resilient, and sustainable cities and communities	3			15	4		8		3	8		2	12		5	
Conservation of marine ecosystems		1		3	2					1			2		7	

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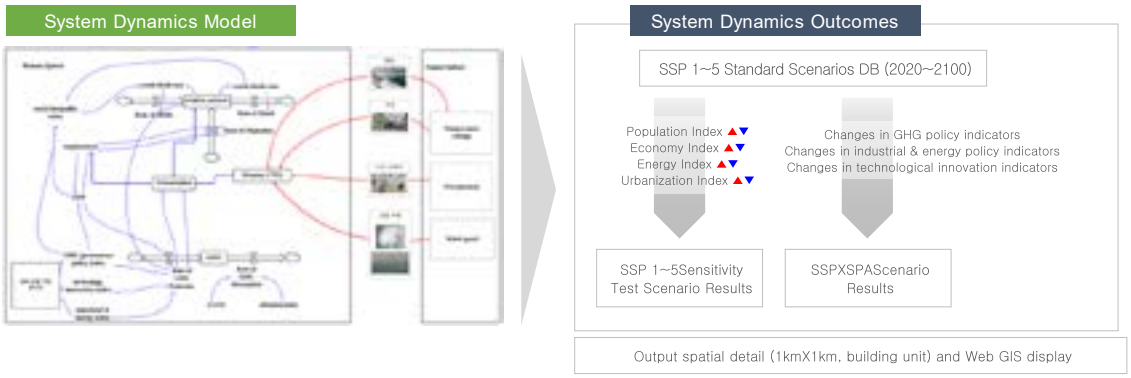
II. Method & Result Human/Ecology: Integrated Framework

Derivation of system dynamics model

- Application of System Dynamics simulation for each indicator (SSPXRCPXSPA)
- System Dynamics uses trial data to construct relations
- System Dynamics simulation output (Sensitivity Test) spatial detail application and WebGIS display



III. Research Plan Integrated Scenario Development Framework