(재) 국제기후환경센터
International Climate & Environment Center

Gwangju's Urban Carbon Management System:

Development and Applications

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(재) 국제기후환경센터
International Climate & Environment Center

1. Development

Gwangju's Urban Carbon Management System

1-1 Background

- **Committed climate response**

Pilot city for climate response

2011 Gwangju UEA Summit

GEO-5 intergovernmental meeting

Rio+20 UNEP session

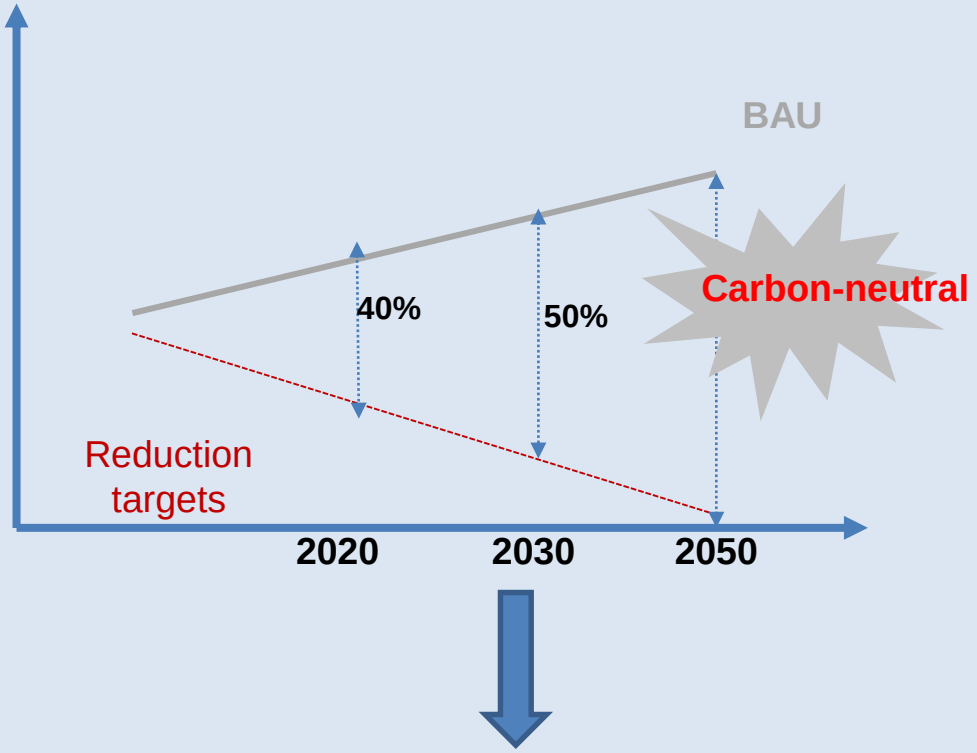
Gwangju positioning itself as
"a global environmental leader"

1. Development

1-1 Background

▪ Gwangju: Carbon-Neural City by 2050

- Gwangju has pledged to reduce GHG emissions by 40% of BAU levels by 2020, 50% by 2030 and become carbon-neutral by 2050



Focus on "cutting down GHG emissions"

▪ Need to identify city-specific GHG emission patterns

- **Need for a base system to continuously monitor progress towards a carbon-neutral city**
  - Systematic management of GHG emissions
  - Monitoring of GHG emissions
- **Need for a comprehensive GHG emissions reduction strategy to**
  - identify Gwangju's emission patterns; and
  - project future emissions and emission reductions

Urban Carbon Management System (UCMS) developed

1. Development

1-2 Objectives and scope

Objectives

- Identify in depth city-specific GHG emission patterns
- Analyze the effects of climate change policies
- Monitor GHG emissions to become carbon-neutral

Action plans

Analyze carbon emission trends and patterns	Analyze the impact of each urban planning element on GHG emissions	Build a system to evaluate progress towards a carbon-neutral city	Establish an UCMS
• Refine the GHG inventory at the city planning level • Identify carbon emission trends • Analyze carbon emission patterns	• Estimate projected GHG emissions • Analyze the impact of each planning element on GHG emissions	• Develop evaluation indicators and an evaluation model to monitor progress towards a carbon-neutral city • Evaluate a carbon-neutral city under each scenario	• Build a comprehensive system to monitor and manage progress towards a carbon-neutral city • Advance the comprehensive management system

Background

Committed climate response at city level

- Gwangju positioning itself as a global environmental leader
- Gwangju: Carbon-Neural City by 2050

Need to identify city-specific GHG emission patterns

- GHG emissions classification system tailored to urban planning
- Refine the GHG inventory at the land plot level

Need for a system that continuously monitors/manages emission trends

- Need for a base system to continuously monitor progress towards a carbon-neutral city
- Evaluate an urban development project based on before/after simulations

2. Key Features

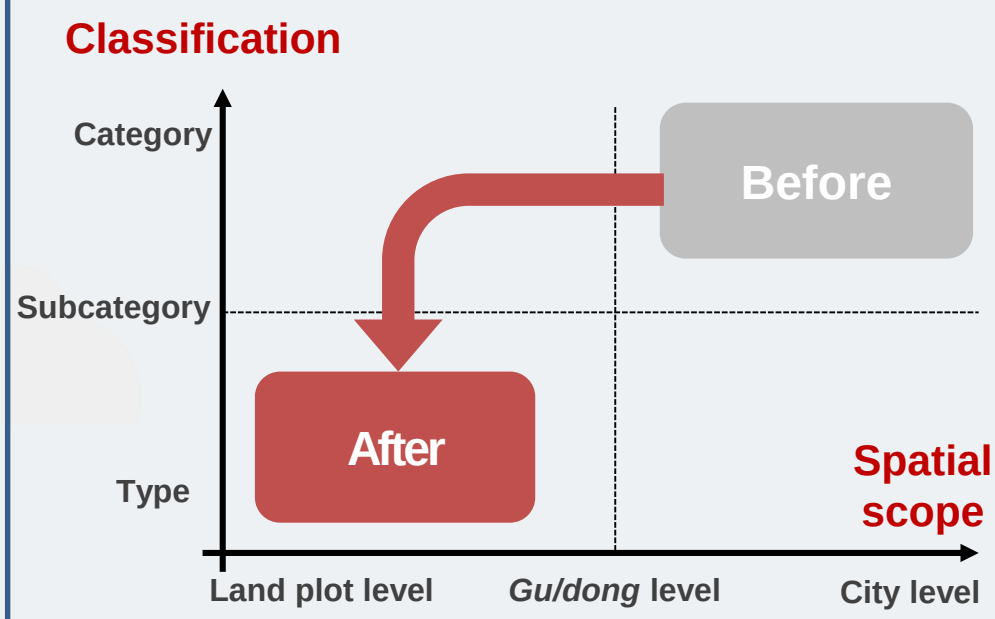
Gwangju's Urban Carbon Management System

2-1 Refined inventory

▪ **GHG emissions classification system tailored to urban planning**

City-level inventory	Areas of urban planning
Residential	Buildings
Public	
Commercial	
Transport	Transport
Waste	
Agriculture/livestock	Parks and green spaces

▪ **GHG inventory refined at the land plot level**



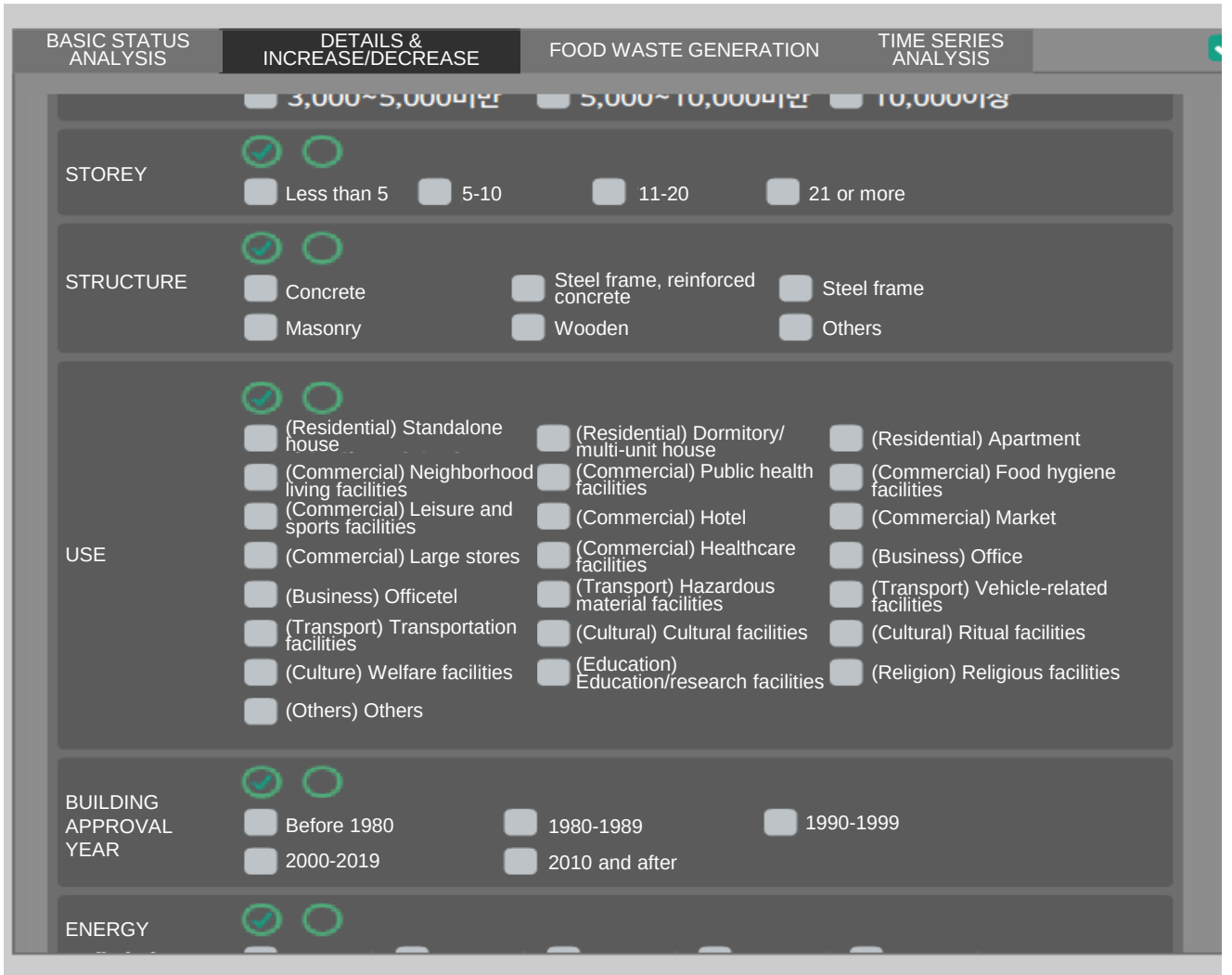
2. Key Features

2-1 Refined inventory

❑ Refined inventory: Buildings

Features/differences (buildings)

1. GHG emission trends (yearly/monthly/use)
2. Emissions tracked at the land plot level
3. Emission units for 103 building uses (Apartments vs. houses)
4. Emissions comparison and energy use evaluation for same type (References for review of energy use plans)
5. Emissions by build year (Buildings built before 2000 vs. after)
6. Factors affecting GHG emissions (Deterioration in buildings, living standards, resident population)



2. Key Features

Gwangju's Urban Carbon Management System

2-1 Refined inventory

❑ Refined inventory: Transport

For the transport sector, the inventory was tracked based on a unit model and trip distribution. For basic unit, emissions from Gwangju's entire transport sector and KOTEMS (Korea Transport Emission Management System) Tier 3 data were considered to estimate emissions for key sections.

Unit model/IPCC Tier2

- **Emissions from road traffic (passenger cars, vans, trucks, special cars) were computed based on a unit model, and those from urban railway (metro) the IPCC**

Unit model

- **Calculation**
  - GHG emissions = Annual distance travelled by vehicle type and fuel type (㎞) X Fuel spent based on distance travelled (L/㎞) X Emission coefficient by fuel type (tCO2)

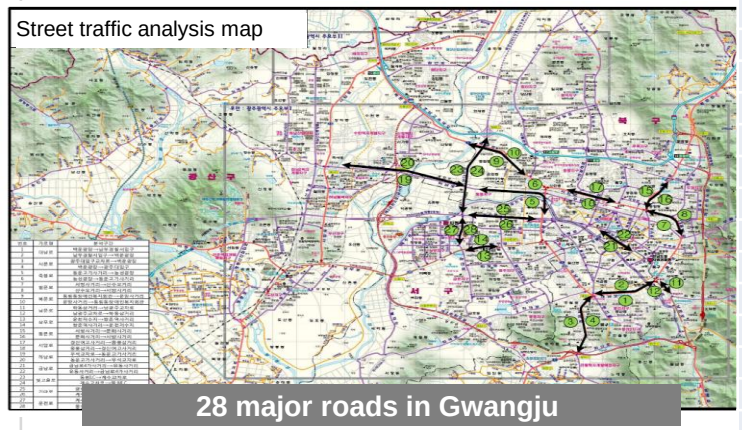
IPCC Tier2

- **Calculation**
  - GHG emissions = Fuel sales by fuel type (㎾) * MOLIT-announced emission coefficient by modal type (CO_2/㎾)

GHG emissions from Gwangju's entire transport sector

KOTEMS Tier 3 data applied

- **Calculation**
  - GHG emissions = Traffic volume in the section by modal type (units) X Section distance (㎞) X Emission coefficient by modal type/speed (tCO_2/㎞-unit)



28 major roads in Gwangju

GHG emissions from key sections

1	Baegun Square – Nambu Police Station entrance
2	Nambu Police Station - Baegun Square
3	Gwangju Univ. Entrance Intersection - Baegun Square
4	Baegun Square – Gwangju Univ. Entrance
5	Dongun Overpass Sageori - Nongseong Square
6	Nongseong Square - Dongun Overpass Sageori
7	Seobang Sageori - Sansu Ogeori
8	Sansu Ogeori - Seobang Sageori
9	Dongrimdong Rehabilitation Center - Unam Sageori
10	Unam Sageori - Dongrimdong Rehabilitation Center
11	Hak-dong Samgeori – Namgwangju Sageori
12	Namgwangju Sageori – Hak-dong Samgeori
13	Uncheon Reservoir – Ssangchon Station Sageori
14	Ssangchon Station Sageori - Uncheon Reservoir
15	Seobang Sageori – Munhwa Sageori
16	Munhwa Sageori - Seobang Sageori
17	Kyungshin Women's High School Sageori – Jungheung Samgeori
18	Jungheung Samgeori - Kyungshin Women's High School Sageori
19	Useok Intersection - Dongun Overpass Sageori
20	Dongun Overpass Sageori - Useok Intersection
21	Geumnamro-4-ga Station Sageori – Yu-dong Sageori
22	Yu-dong Sageori - Geumnamro-4-ga Station Sageori
23	Donglim I.C. – Gyesu Intersection
24	Gyesu Intersection - Donglim I.C.
25	Gwangcheon Sageori - Gyesu Intersection
26	Gyesu Intersection - Gwangcheon Sageori
27	Gyesu Intersection – Punggeum Sageori
28	Punggeum Sageori - Gyesu Intersection

2. Key Features

Gwangju's Urban Carbon Management System

2-1 Refined inventory

❑ Refined inventory: Green spaces

How the existing inventory was developed

- **Initially, absorption volumes were estimated using the IPCC methodological approach**
- **However, the classification is not suitable for cities and cannot be reflected in planning**

IPCC Tier2

- Calculation
  - GHG emission absorptions = Harvest area of perennial woody plants (ha) X Coefficient for woody plant biomass (tC/ha·yr)

Classification Level 1	Classification Level 2	Classification Level 3	Classification Level 4
Non energy	AFOLU	Land	Forest land maintained as forest land
			Land converted to forest land
			Farmland maintained as farmland
			Land converted to farmland
			Land converted to grassland
			Wetland maintained as wetland
			Land converted to wetland
			Loss of biomass carbon stocks due to land use conversion
			Annual change in organic carbon stocks in mineral soils
			Loss of carbon stocks in dead organic matter due to land use conversion

Absorption coefficients by tree type applied

- **Absorption coefficients by tree type, which were developed in Korea, have been applied**
- **Gwangju does not have a forest database sorted by tree type. A database sorted by green space was developed instead**

Absorption coefficients by tree type

- Calculation
  - Forest: Area by forest type × absorption coefficient (kgCO2/ha)
  - Roadside tree : Area by green space type × absorption coefficient (kgCO2/ha)

Category	Subcategory	Type	
Forests	Artificial green spaces	Parks	Neighborhood park
			Theme park
		Green zones	Landscape green zones
			Buffer green zones
			Connecting green zones
Roadside trees	Ginkgo tree		
	Zelkova tree		
	Fringe tree		
	Flowering cherry tree		
	Manshurian fullmoon maple tree		
	Cherry tree		
	Pagoda tree		
	Plane tree		

2. Key Features

2-2 Geospatial mapping

GHG emissions/energy consumption data + Building attributes + geospatial data

- **Emission and energy sources data is linked with building attributes (administrative *dong*, block, land plot, building)**

Inventory where emission sources, energy sources and geospatial data are linked with one another

Emission sources		Energy sources		Geospatial data
• Buildings: Standalone, communal, commercial, business, industrial • Transport: Passenger cars, rail, bus • Parks (absorption sources)	+	Electricity Gas Water Petro District heating and cooling	+	• Topographic data: Administrative district *(gu/dong)*, block/land plot/building, traffic network • Attributes: Building attributes (use, total floor area, deterioration level)

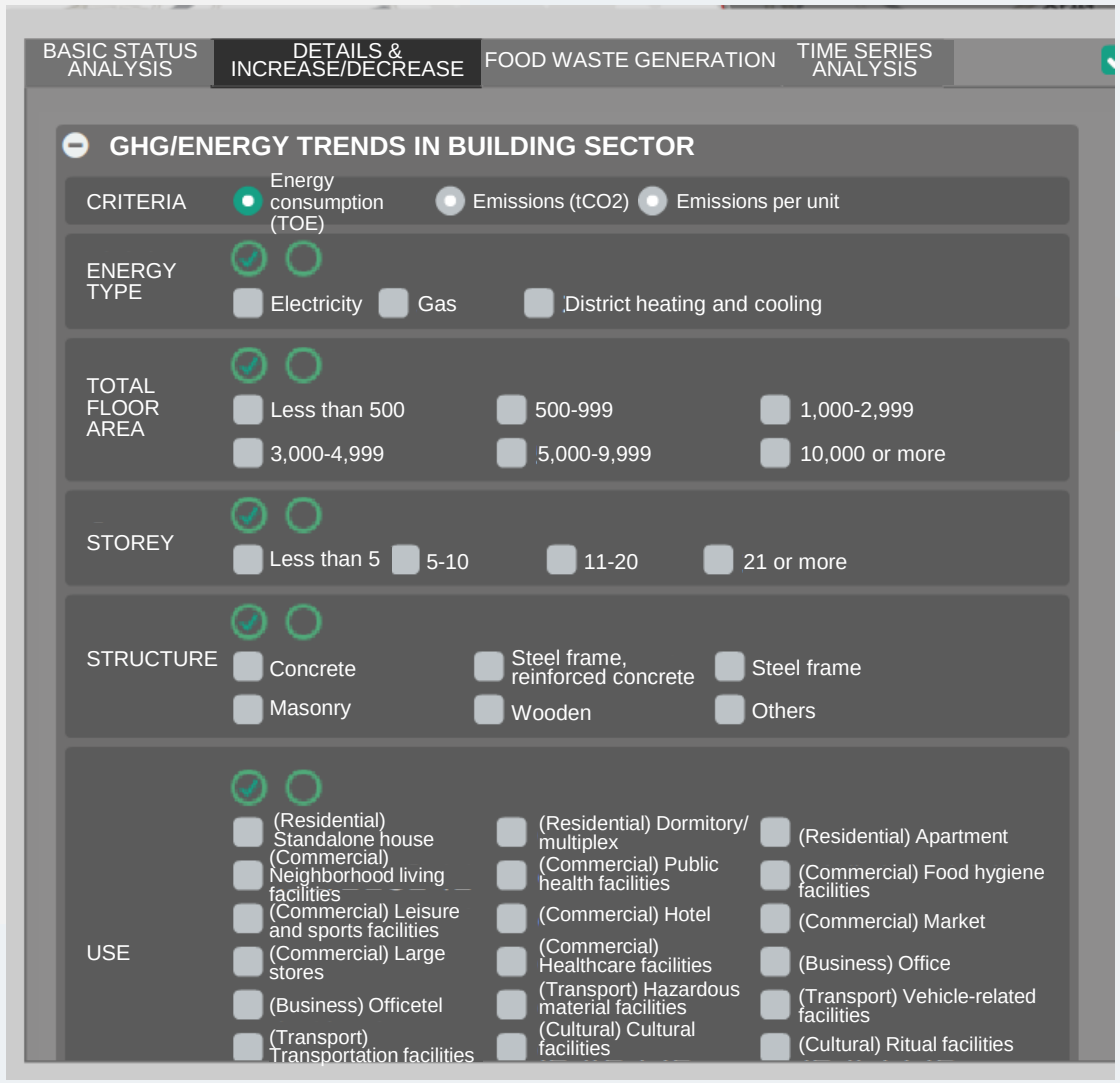
2. Key Features

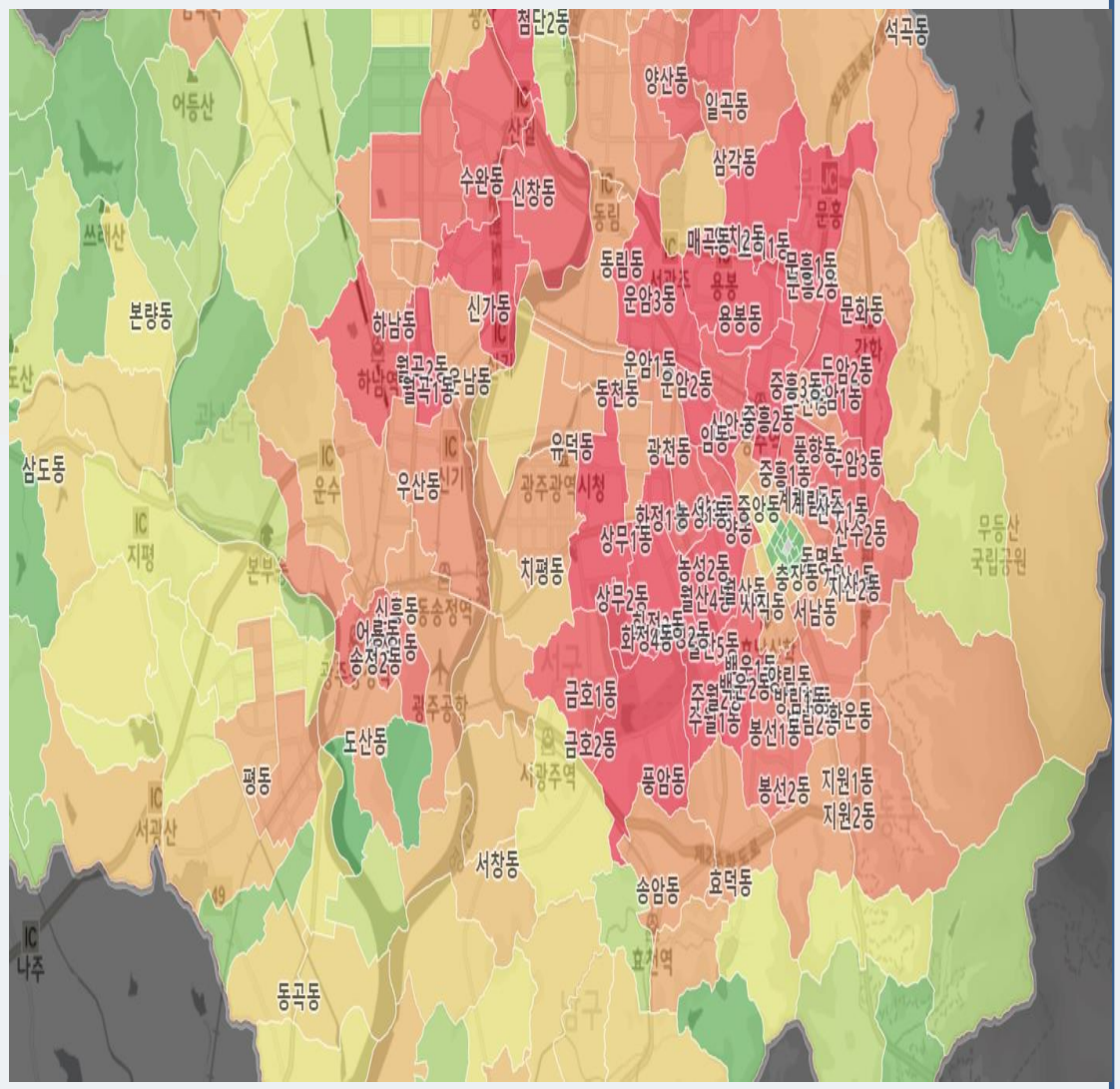
Gwangju's Urban Carbon Management System

2-2 Geospatial mapping

GHG emissions/energy consumption data
+ Building attributes + geospatial data

- **Emission and energy sources data is linked with building attributes (administrative *dong*, block, land plot, building)**





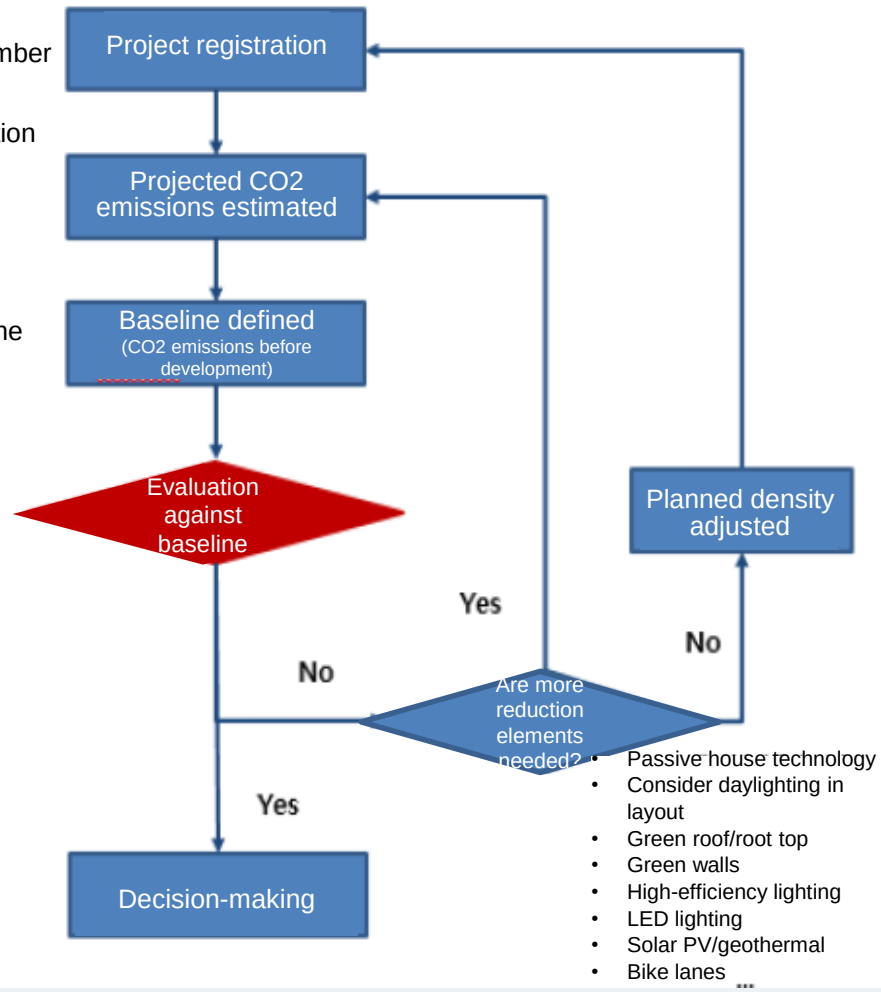
2. Key Features

2-3 Carbon-neutral evaluation system

Carbon-neutral city evaluation system

Emissions evaluation model for policy

- Projected population (current population/number of households)
- Area by use
- GHG emissions reduction plan



- Select area similar to the target area as baseline

- Total emissions
- Emissions per capita
- Emissions per household

- Passive house technology
- Consider daylighting in layout
- Green roof/root top
- Green walls
- High-efficiency lighting
- LED lighting
- Solar PV/geothermal
- Bike lanes ...

Evaluation indicators for urban carbon management

- Regional characteristics considered
- GHG emission and reduction patterns considered
- Easy-to-obtain/apply data
- Easy-to-understand indicators for all

Criteria	Pressure indicators	Response indicators
Gwangju Metropolitan City	City's GHG emissions (buildings + transport - emissions absorbed)	• GHG emissions per capita • GHG emissions per GRDP
Buildings	GHG emissions from buildings	• GHG emissions per area • GHG emissions per household
Transport	GHG emissions from transport	• GHG emissions per capita • GHG emissions per number of registered vehicles
Parks and green spaces	GHG emissions absorbed by parks and green spaces	• GHG emissions per capita • Area ratio of sources absorbing GHG emissions

2. Key Features

2-3 Carbon-neutral evaluation system

City maintenance project

- **Development plans on notifications for target maintenance areas used for effects analysis**
  - Projects that are beyond the target area selection stage were considered
  - Project plans on notifications for target areas used to estimate projected emissions
  - Effects analysis was carried out based on area by lot, area by use and green spaces area
- **Analysis of 23 target areas for redevelopment and 5 target areas for reconstruction showed an emissions increase of 152% for redevelopment projects and 178% for reconstruction projects**
  - In case emission levels before the project were unknown, emission unit by building deterioration level was considered as emission unit by use.
    (emission unit before 1990 for before the project and emission unit after 2005 for after the project)

Criteria	Area name
Redevelopment	Kyerim 5-3
	Sansu 2
	Yang-dong 3
	Gwangcheon-dong
	Jiwon 1
	Wolsan 2
	Punghyang
	Kyerim 4
	Kyerim 8
	Sansu 1
	Jiwon 2-1
	Hak-dong 4
	Kyerim 2 (Pungyang 3)
	Wolsan 1
	Im-dong 2
	Usan
	Shinga-dong
	Kyerim 5-2
	Kyerim 7
	Punghyang 2
	Gakwha, Munhwa-dong
	Hak-dong 3
Reconstruction	Mareuk Chipyeong Ssangchon, Ssangchon-dong
	Yeomju Jugong, Hwajeong-dong
	Juwol Jangmi
	Songjeong Jugong
	Hwajeong Jugong

How to estimate projected emissions from urban development project

GHG emissions = Number of households X Net area per household (㎡) X Emission unit by use (tCO2/㎡)

Area name	Area before (㎡)	Area after (㎡)	Emissions before (tCO2)	Emissions after (tCO2)	Emissions increase (tCO2)	Rate of emissions increase (%)
Hak-dong 3	9,148,650	18,175,318	749,274	1,437,668	688,393	191.9

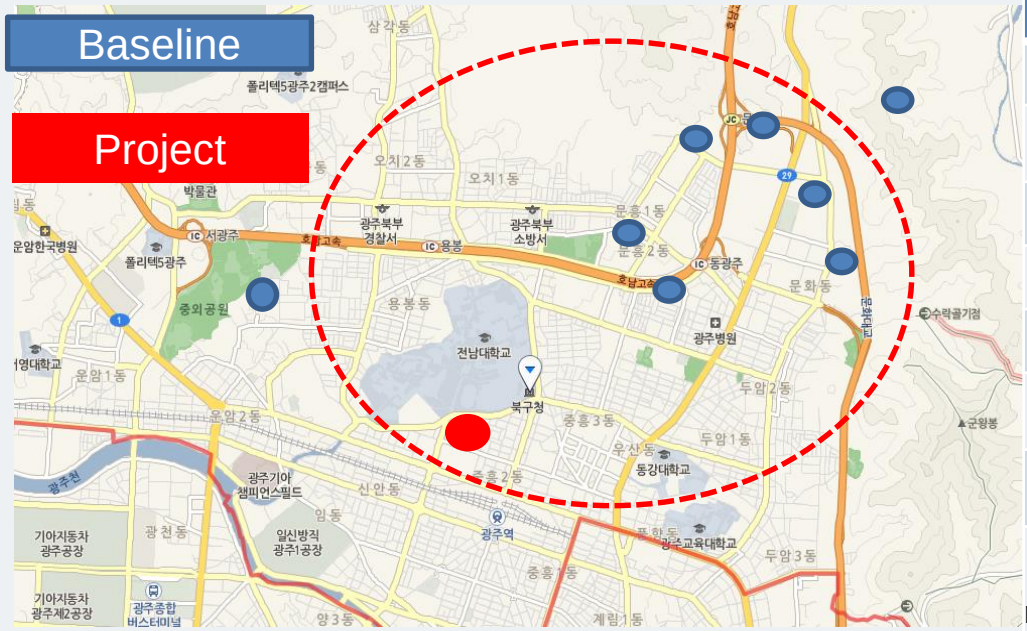
2. Key Features

2-3 Carbon-neutral evaluation system

Evaluation system for urban carbon management

assesses the impact of Gwangju's projects on emissions

Evaluation of GHG emissions from Gwangju Green Apartment



Criteria	Project		Baseline
Location	Sinan-dong, Buk-gu	VS	Unam-dong, Buk-gu
Building use	Multi-unit house (apartment)		Multi-unit house (apartment)
Net area	84㎡		84㎡~124㎡
Build year	Oct. 1991		Aug. 1989
Income	1.2 mil won/㎡		1.4 mil won/㎡
Target area			16,670.52 m2
Emission unit	54 $kgCO_2$/㎡		116 $kgCO_2$/㎡
Estimated reductions	62 $kgCO_2$/㎡ * 16,670.52㎡ = 1,033,572.24 $kgCO_2$ = 1,033 tCO_2		

3. System Overview

Gwangju's Urban Carbon Management System

3-1 Elements

International Climate and Environment Center (ICEC)
builds, operates and manages Gwangju's UCMS

Gwangju Metropolitan City

Ministry of Land, Infrastructure and Transport

Korea Appraisal Board

Korea Electric Power Corporation

Korea Transportation Safety Authority

National Institute of Forest Science

Haeyang Energy Co.

Statistics provided

Emissions estimation

GHG emissions/energy consumption in the building, transport and green space sectors are estimated

Urban Carbon Management System (UCMS)

GIS mapping

Emission sources and energy data linked with GIS to offer spatial information

Wooridongne Greenhouse Gas Information Center

Data made available to citizens

3. System Overview

Gwangju's Urban Carbon Management System

3-1 Elements

3. System Overview

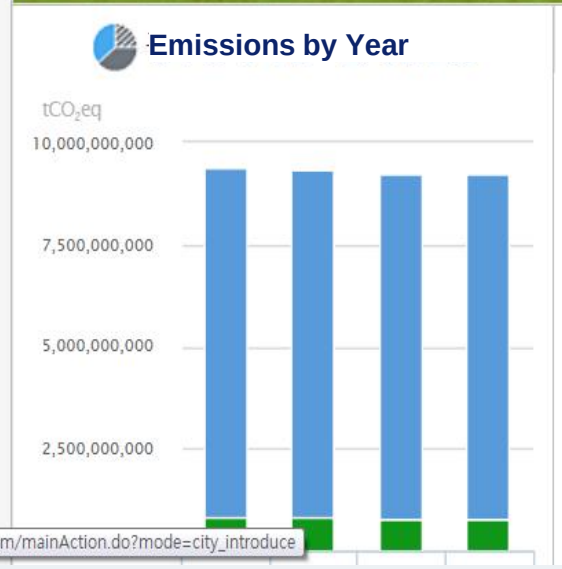
Gwangju's Urban Carbon Management System

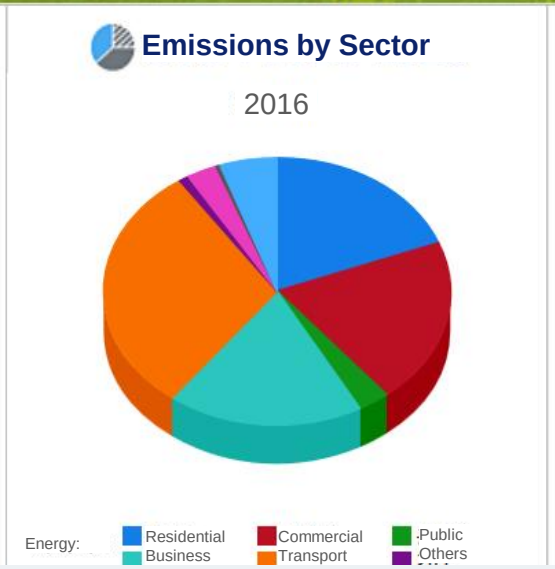
3-1 Elements

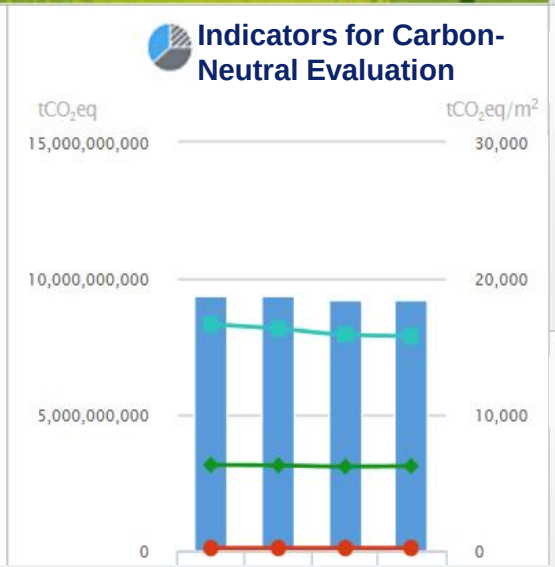
Urban Carbon Management System (GUCMS)

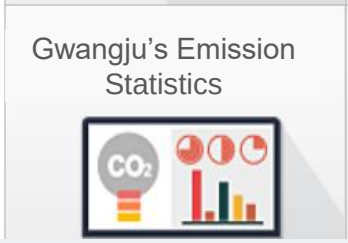
| ADMIN | CHANGE PASSWORD | LOGOUT

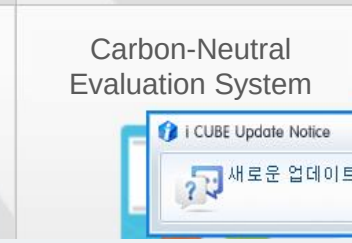
UCMS	EMISSIONS FROM URBAN PLANNING	URBAN PLANNING EMISSION UNIT	CARBON-NEURAL EVALUATION SYSTEM	GWANGJU'S EMISSION STATISTICS	ARCHIVES
What is UCMS	Emissions from urban planning	Urban planning emission unit	Evaluate city maintenance projects	Emissions trends	Education materials
Urban planning classification	Emissions by building region	Emission unit by building use	Indicators for carbon-neutral evaluation	Emissions by sector	Related policies
	Emissions by building use	Emission unit by building deterioration level (area)		Emissions projections by year	Sources
	Emissions by building energy source	Emission unit by building deterioration level (use)		Emissions projections by sector	Manage users
	Emission by transport area	Emission unit by number of registered vehicles			
	Emissions by transport energy sources	Emission unit by distance travelled			
	Absorption by green spaces	Absorption per green space area			
	Advanced search				









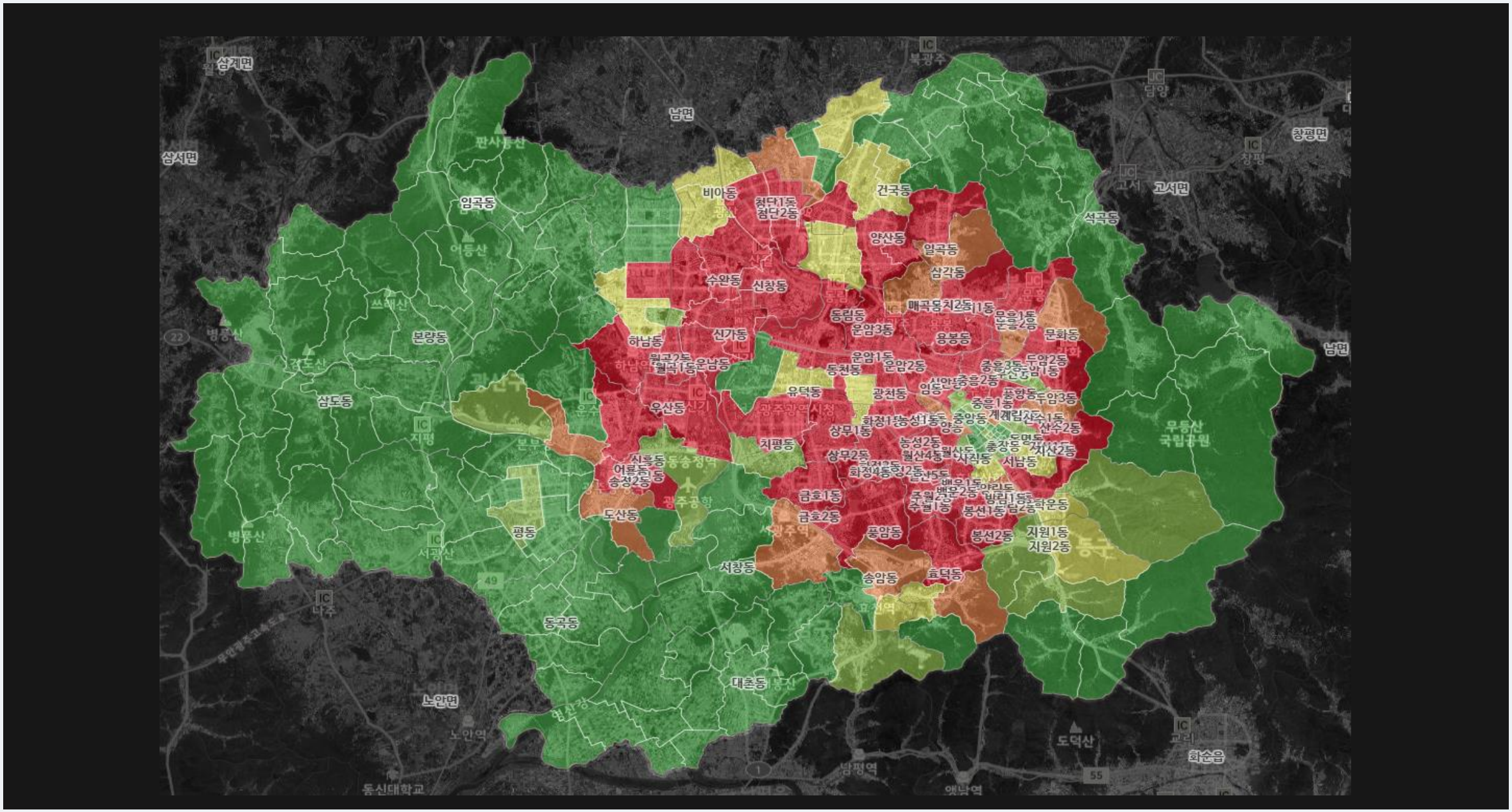


3. System Overview

Gwangju's Urban Carbon Management System

3-1 Elements

❑ Basic analysis (GHG emissions from the building sector in 2017)

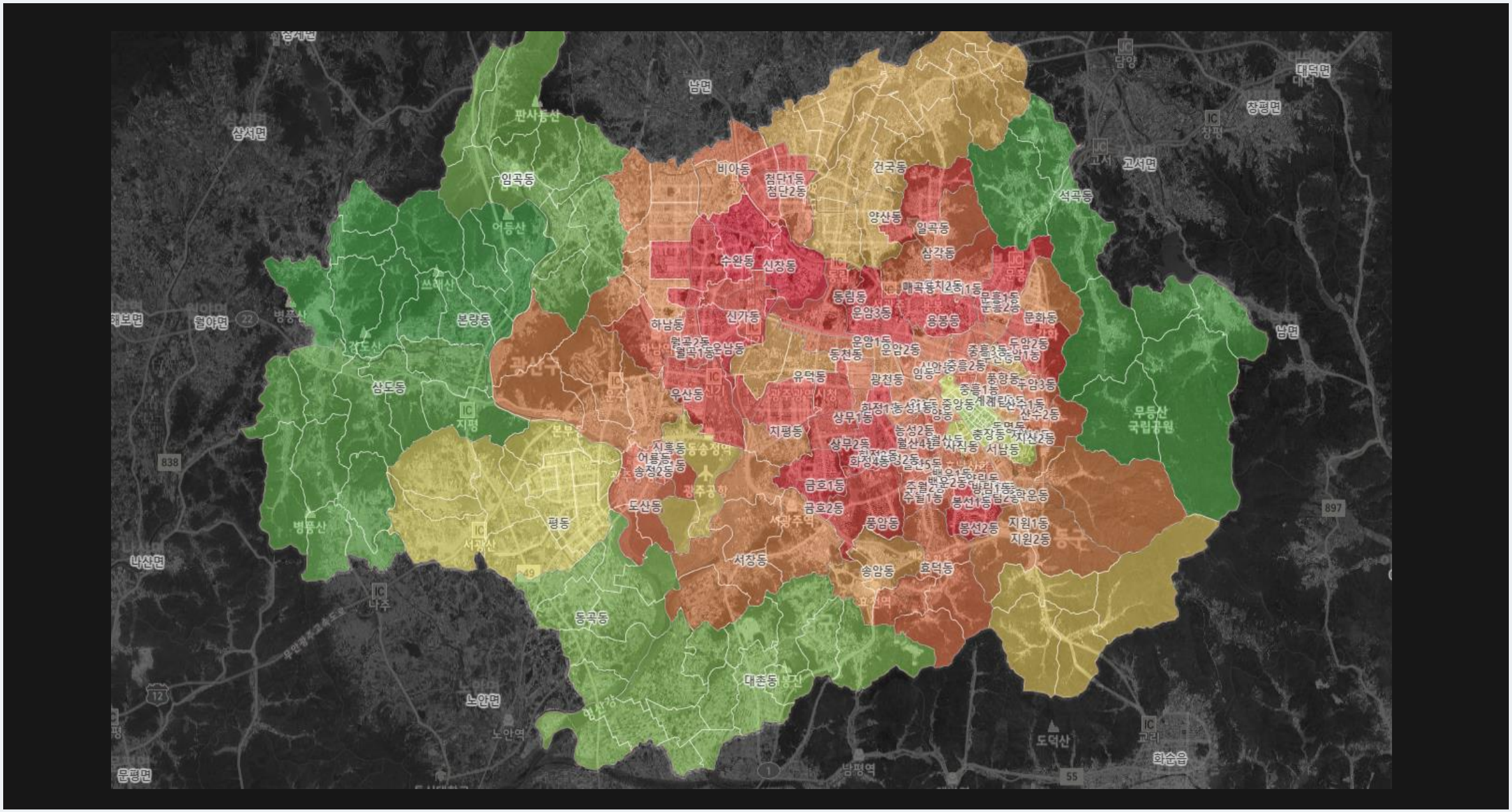


3. System Overview

Gwangju's Urban Carbon Management System

3-1 Elements

❑ Basic analysis (GHG emissions from the transport sector in 2017)

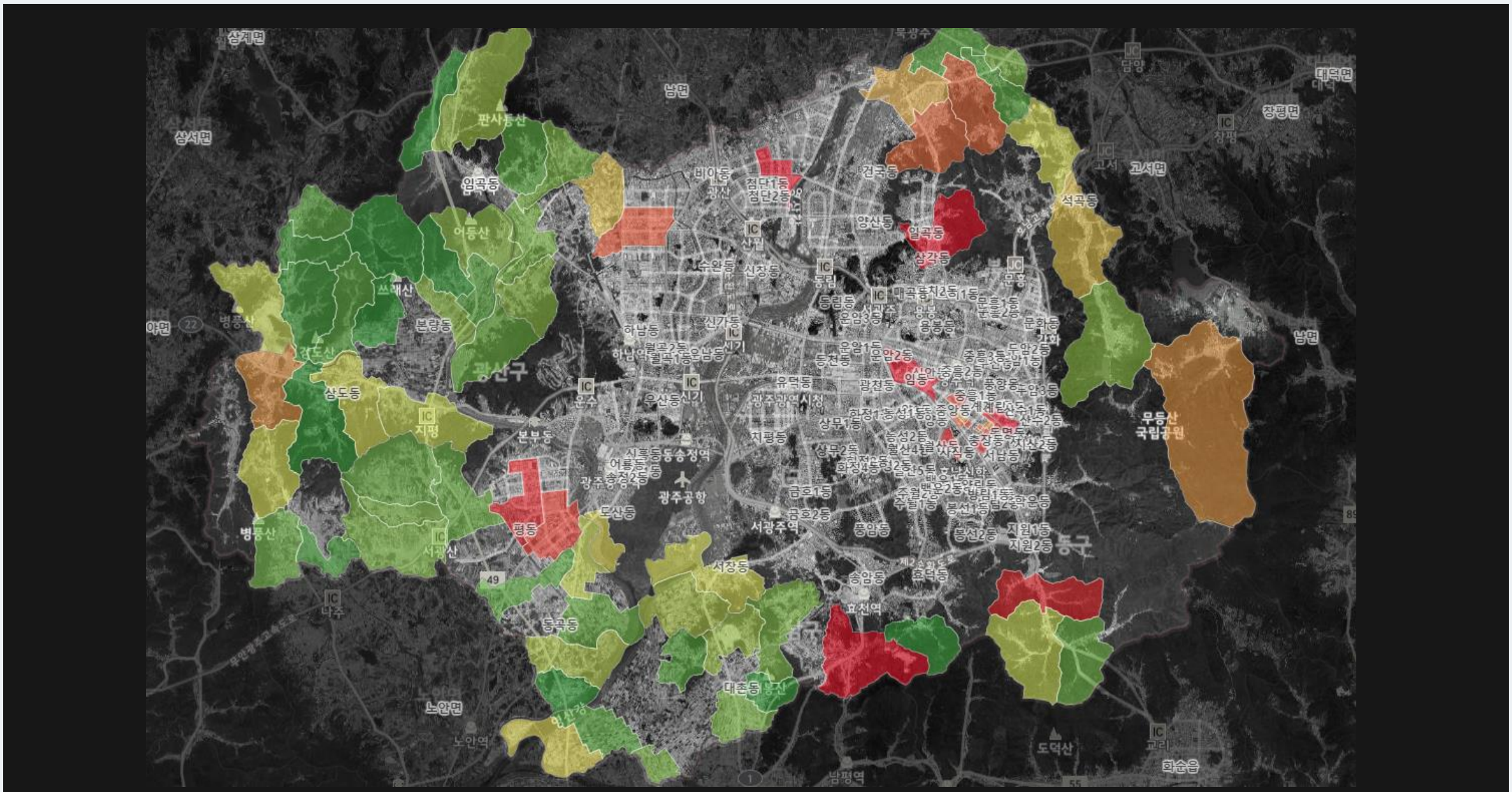


3. System Overview

Gwangju's Urban Carbon Management System

3-1 Elements

❑ Basic analysis (Areas with a GHG emissions increase from the previous year in the building sector)

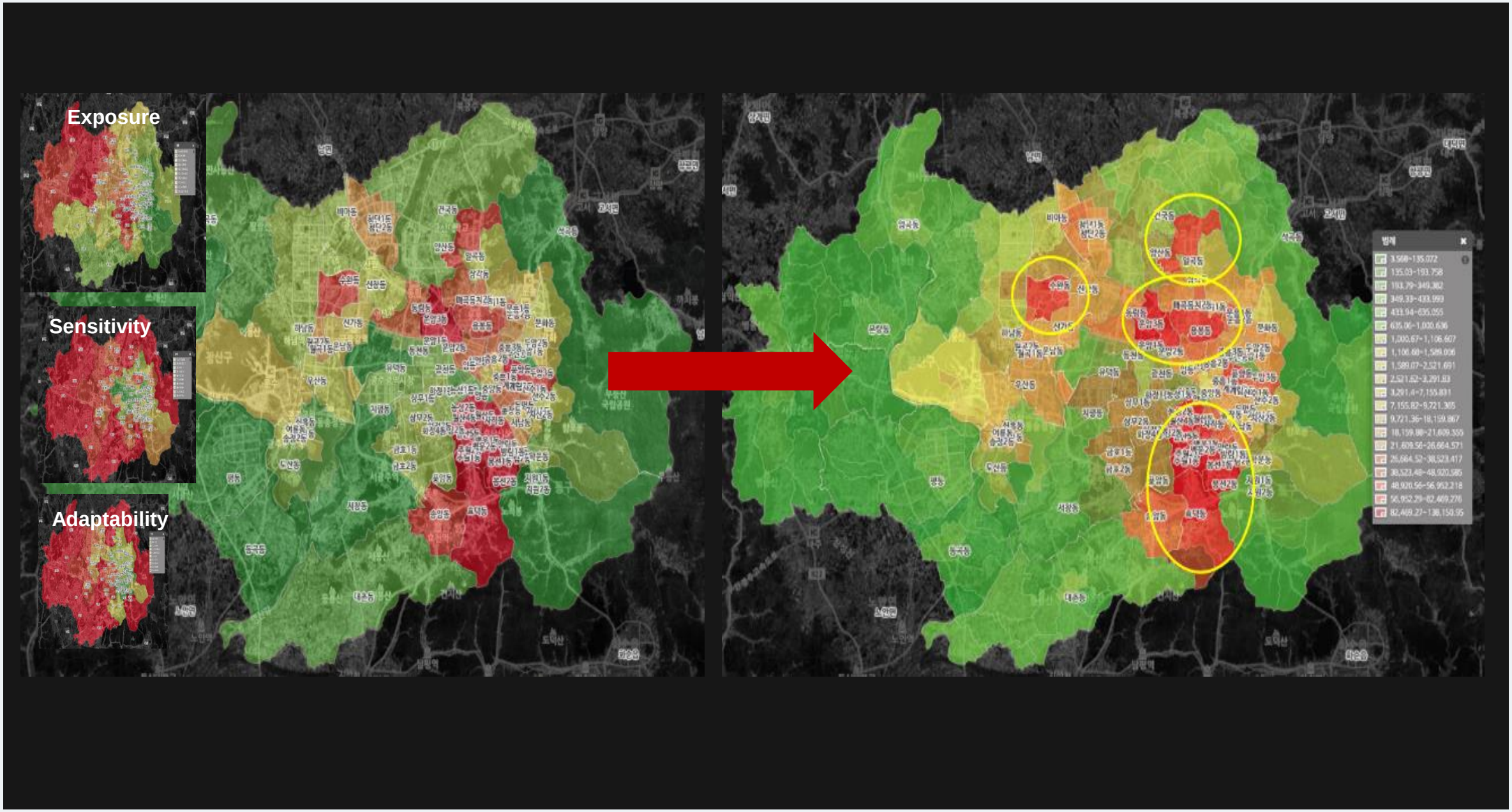


3. System Overview

Gwangju's Urban Carbon Management System

3-1 Elements

❑ Applied analysis (VRI)



3. System Overview

Gwangju's Urban Carbon Management System

3-1 Structure

❑ Applied analysis (Food waste generated from multi-unit houses)

BASIC STATUS ANALYSIS | DETAILS & INCREASE/DECREASE | FOOD WASTE GENERATION | TIME SERIES ANALYSIS

WASTE GENERATION TRENDS

CRITERIA: Total generation / General generation / Generation through volume-based waste fee system

YEAR: 2016 2017

MONTH: Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

SHOW AS: *Si*(city)/*gun/gu* / Legal *dong* / Points

INCREASE/DECREASE

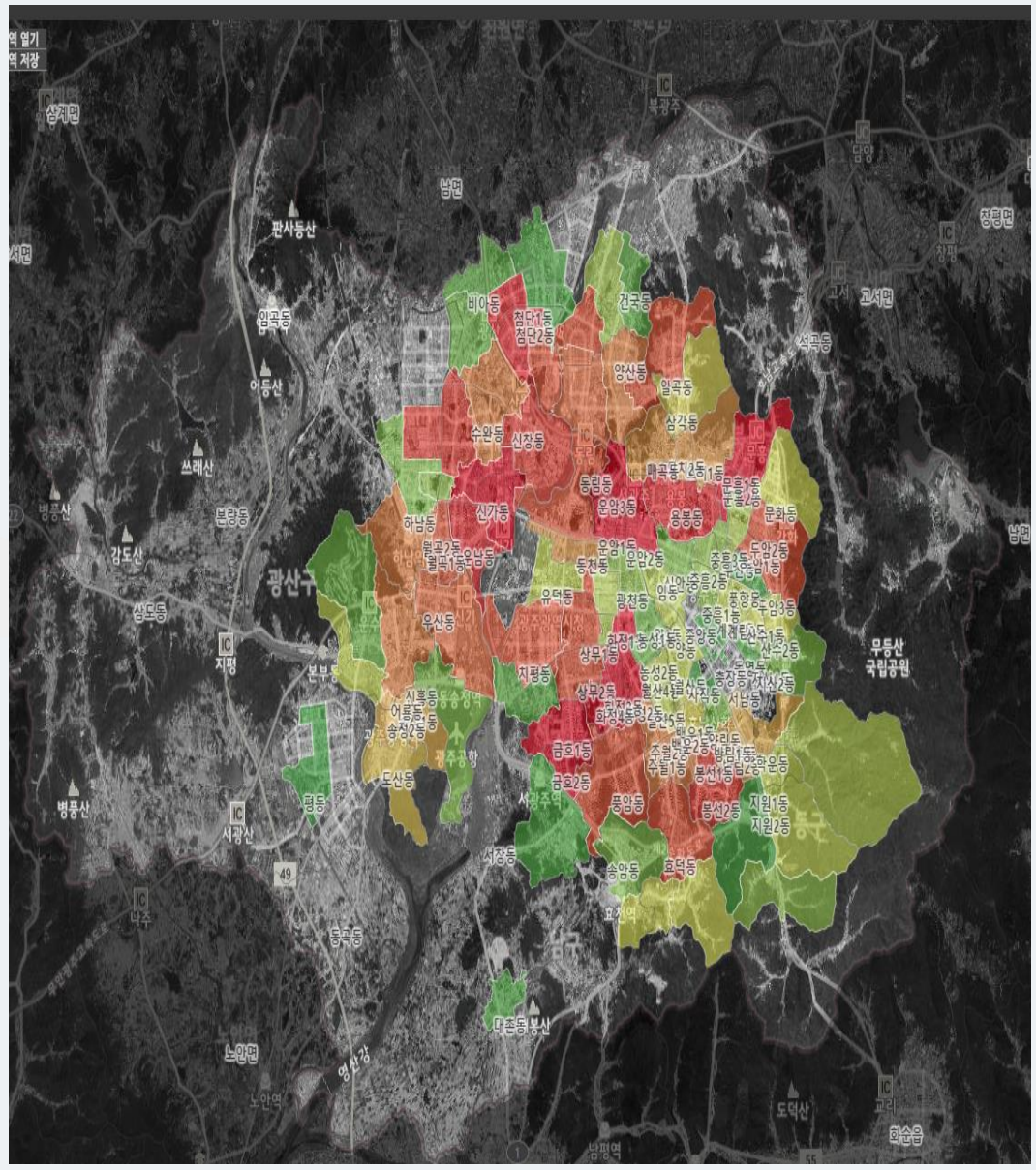
CRITERIA: Total generation / General generation / Generation through volume-based waste fee system

SELECT TIME PERIDO TO COMPARE: Jan 2016 ~ Dec 2016

SELECT TIME PERIDO TO COMPARE: Jan 2017 ~ Dec 2017

FILTER BY: None

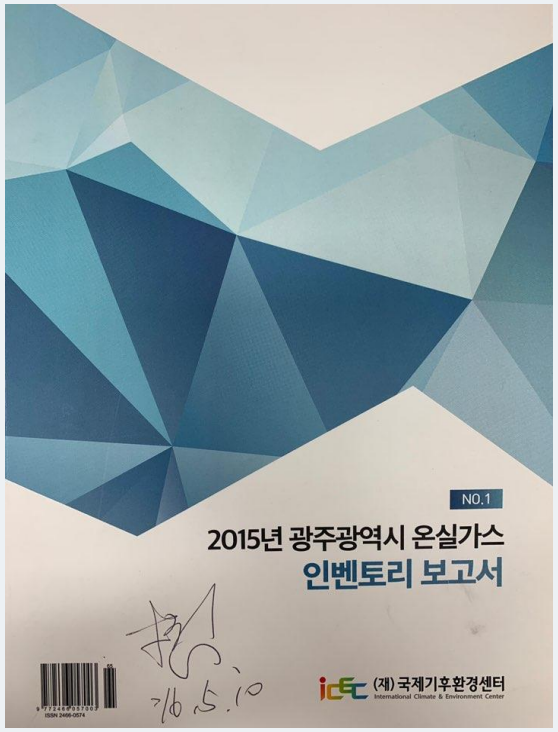
SHOW AS: *Si*(city)/*gun/gu* / Legal *dong* / Points

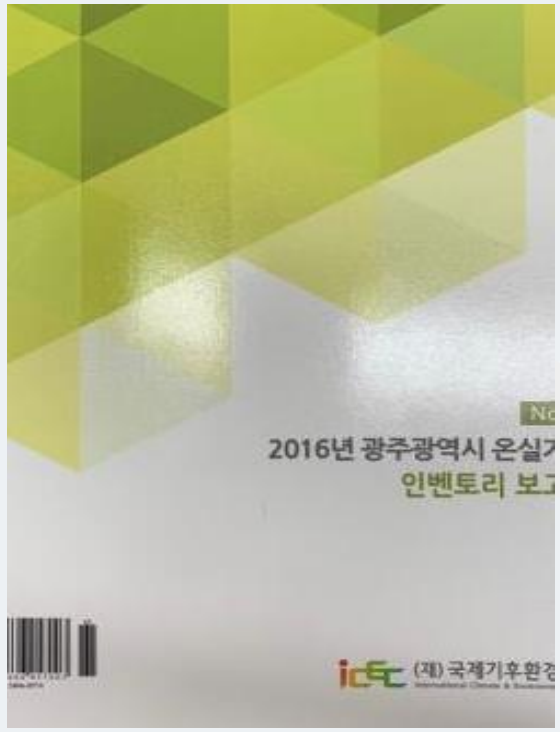


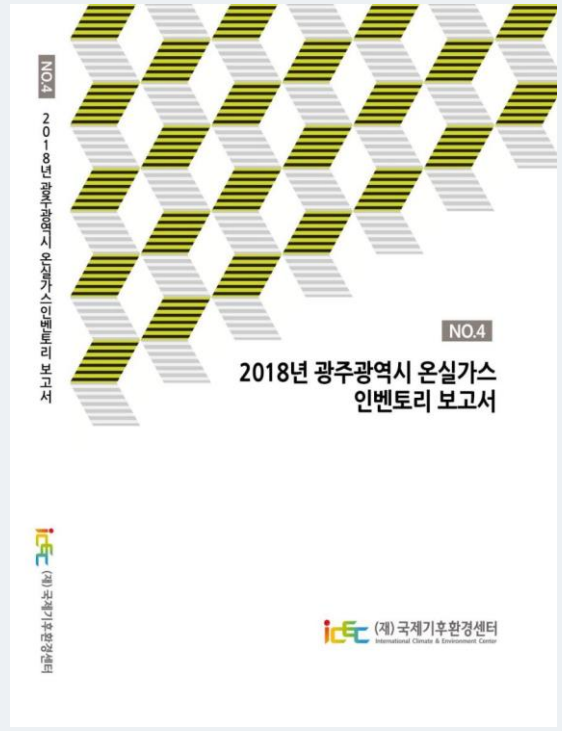
3. System Overview

3-2 Applications

❑ Example of system application (GHG Emissions Inventory Report)





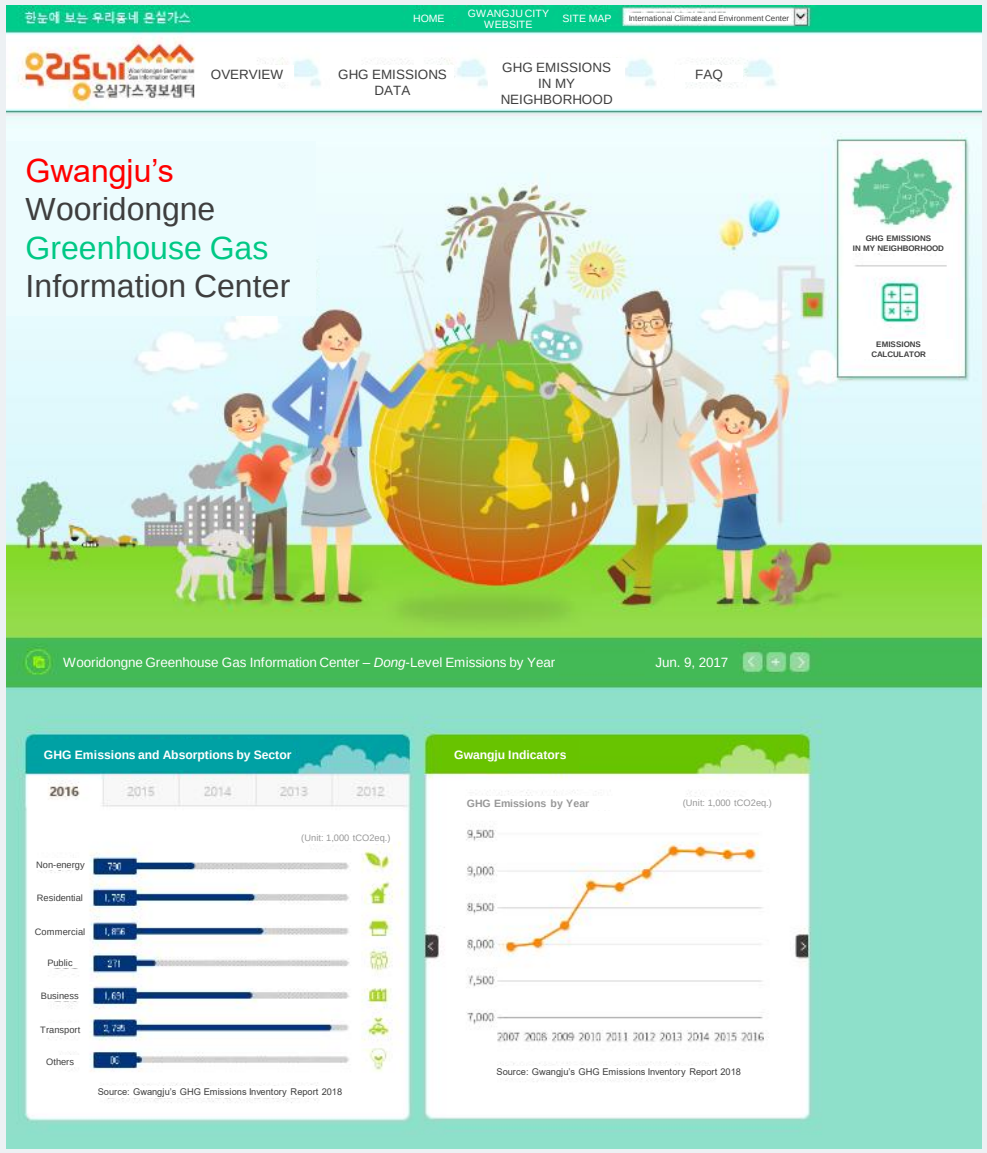


3. System Overview

Gwangju's Urban Carbon Management System

3-2 Applications

❑ Example of system application (Wooridongne Greenhouse Gas Information Center)



Wooridongne Greenhouse Gas Information Center

OVERVIEW

The Wooridongne Greenhouse Gas Information Center is a website that provides a wealth of information about Gwangju's GHG emissions and energy use

Weather abnormalities arising from global warming are affecting our everyday lives.

Governments around the world have strengthened their GHG emissions regulations, and emission reduction efforts at the city level have become more important than ever.

The Wooridongne Greenhouse Gas Information Center provides Gwangju's GHG emission levels and other useful information to encourage public interest and participation in GHG reduction and energy saving efforts.

UNDERSTANDING GHG EMISSIONS

- Definition
- Effects
- Ways to reduce emissions

GHG EMISSIONS AND PROJECTIONS

- Emissions at national level
- Emissions and projections at city level
- Emissions at *gu/dong* level

DATA SOURCE

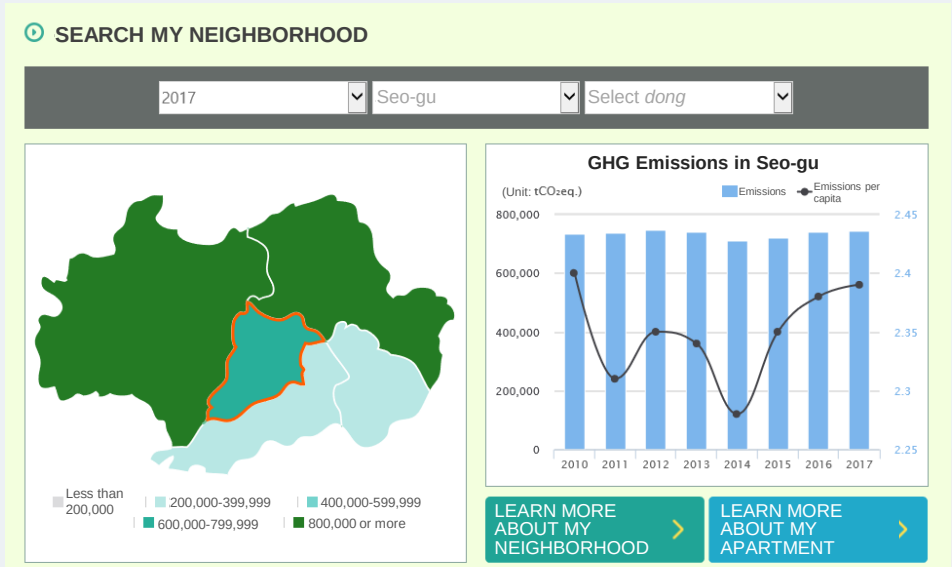
- Emissions database for Gwangju and user's neighborhood
- Gwangju's GHG Emissions Inventory Report
- Gwangju's emission maps
- Emissions calculator

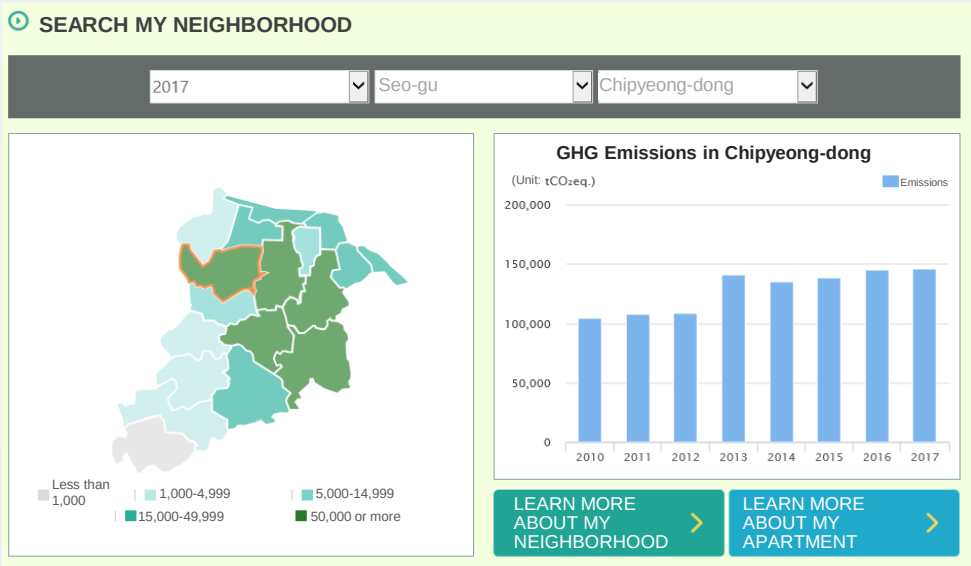
3. System Overview

Gwangju's Urban Carbon Management System

3-2 Applications

❑ Example of system application (Wooridongne Greenhouse Gas Information Center)





SEO-GU'S RANKING IN 2017

(Unit: $tCO_2eq.$)

Rank	*Gu*	Total emissions	Emissions per capita	Graph
1	Buk-gu	996,400	2.24	
2	Gwangsan-gu	877,600	2.12	
3	**Seo-gu**	**742,500**	**2.39**	
4	Nam-gu	366,100	1.66	
5	Dong-gu	325,700	3.36	

Total emissions **Emissions per capita**

CHIPYEONG-DONG'S RANKING IN 2017

(Unit: $tCO_2eq.$)

Rank	Legal *dong*	Total emissions	Graph
1	**Chipyeong-dong**	**145,663**	
2	Yongbong-dong	123,966	
3	Ssangchon-dong	109,147	
199	Dogeum-dong	99	
200	Deokeui-dong	43	
201	Doho-dong	2	

Total emissions

3. System Overview

3-2 Applications

❑ Example of system application (base data for R&D and policy development)

- Gwangju's Master Plan on Climate Change
- Gwangju's Climate Change Adaptation Plan
- Seo-gu/Nam-gu's Climate Change Adaptation Plans
- Gwangju's Climate Action Plan
- 2030 Gwangju GHG emissions reduction roadmap
- Making Gwangju 1℃ Cooler Project
- Gwangju's Environmental Conservation Plan
- Research Report on Urban Heat Environment

Used as objective and scientific statistic data for a wide range of R&D activities and policy response on climate change

Used as base data for policy development, planning and budgeting

Future Challenges

- ❑ **Continuous database update to ensure stable system performance and system improvement**
  - MOU with the Korea Appraisal Board to secure a stable database on buildings
  - Strengthen linkage to climate information and renewables to drive advanced projects
- ❑ **Gwangju's GHG Emissions Inventory Report (every year)**
- ❑ **Wider use of UCMS**
  - Use as reference materials for annual user training targeting civil servants and as policy materials
  - Encourage the use by experts through database information-sharing programs
  - To develop potential emission rights projects in the non-industrial sectors
- ❑ **Refinements to monitor emissions reduction projects and evaluate their results**

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THANK YOU
FOR WATCHING