



A Framework for Ecosystem Functional Group Mapping Based on the IUCN Global Ecosystem Typology

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I. Introduction

II. Datasets and method

III. Label Data Construction

IV. Modeling Approach: Training and Validation Strategy

V. Results and Conclusion



Introduction

01. IUCN GET

02. Research Overview



01. IUCN GET

- **GET (Global Ecosystem Typology)** is developed by the IUCN (International Union for Conservation of Nature)
- GET is organized into a six-level hierarchical structure, where ecosystem types become increasingly detailed from higher to lower levels
- Level 3 represents Ecosystem Functional Groups (EFGs), and the lower levels further refine these groups by reflecting national, regional, and local ecological characteristics
- However, GET was originally developed using global-scale criteria and coarse spatial resolution (1 km), **its application to South Korea result in scale mismatches and limited classification precision, highlighting the need for further refinement.**

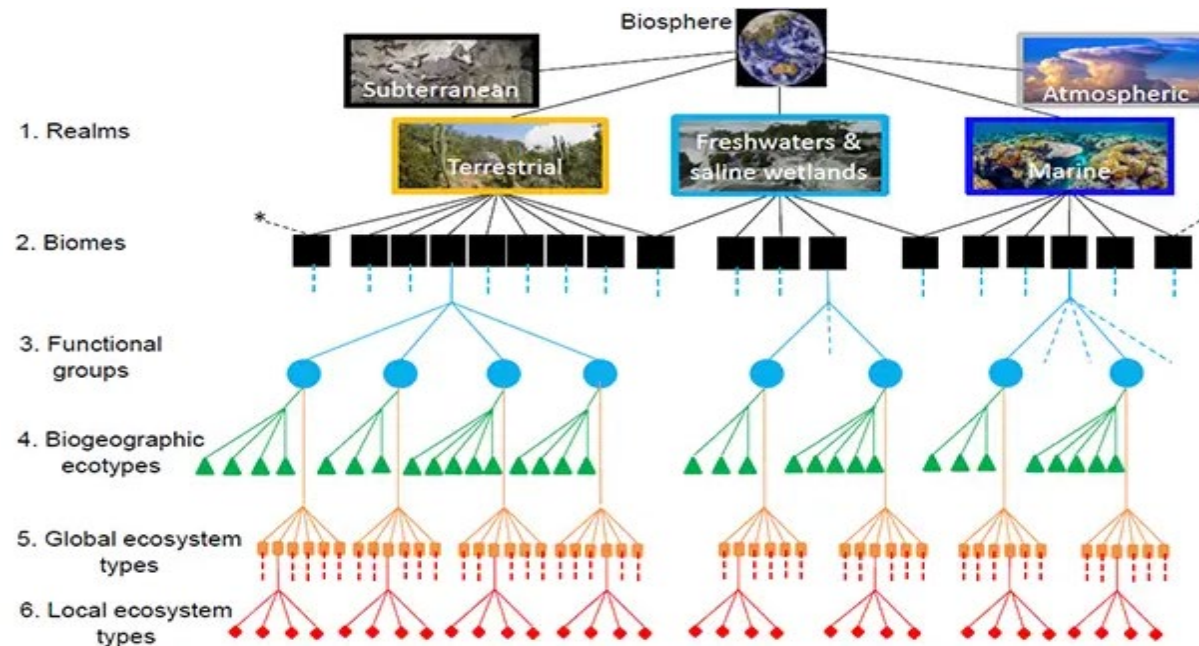


Fig. A six-level hierarchy of GET

01. IUCN GET

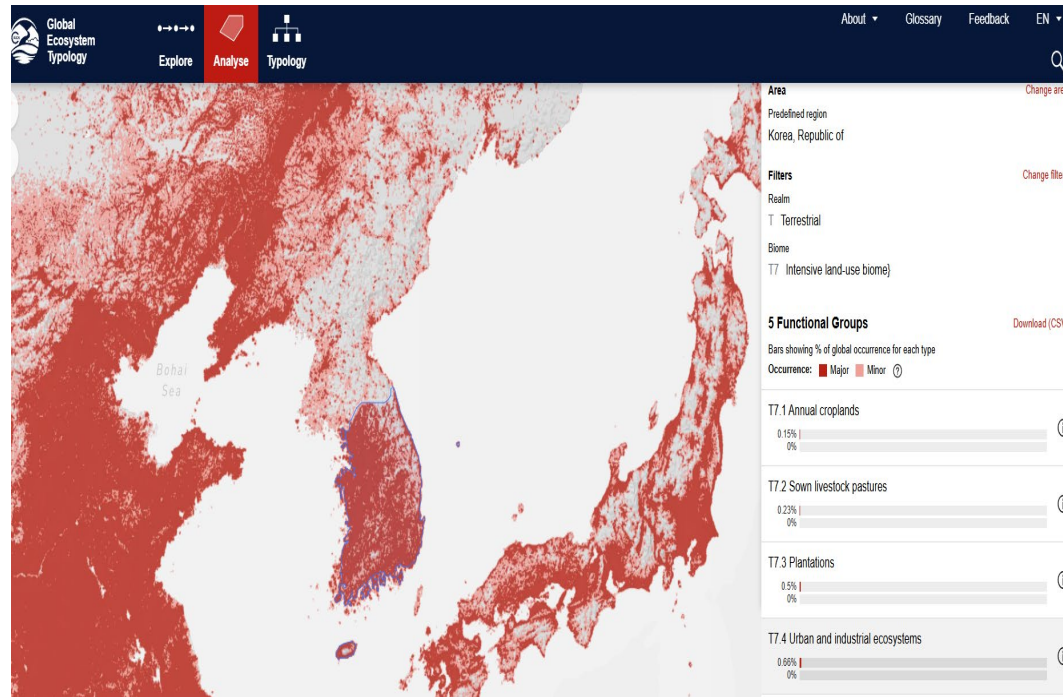


Fig. IUCN GET urban and industrial ecosystems
(1 km or more spatial resolution)

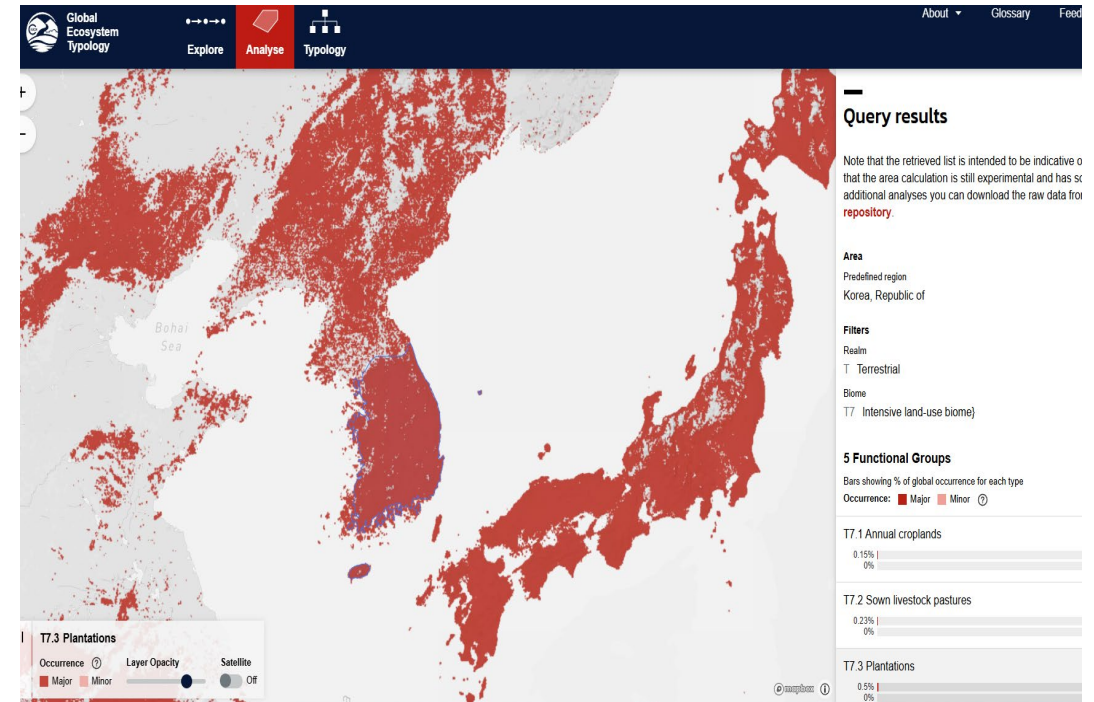


Fig. IUCN GET plantations ecosystems
(1 km or more spatial resolution)

02. Research Overview

Previous Research

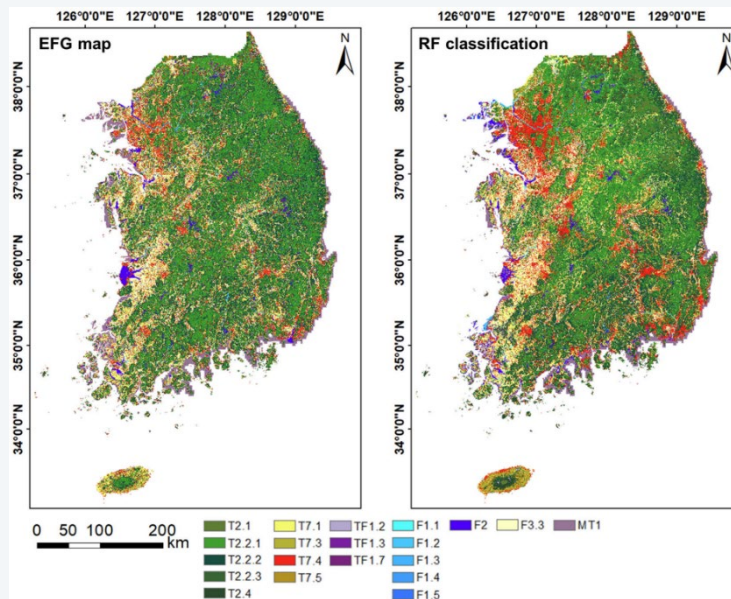
- Development of classification criteria, label map, and Random Forest model for approximately 20 EFG classes distributed across South Korea in 2022.



Article

Mapping Ecosystem Functional Groups in the Republic of Korea Based on the IUCN Global Ecosystem Typology

Kyungil Lee ¹, Haedam Baek ², Chul-Hyun Choi ³, Sang-Hak Han ⁴ and Seonyoung Park ^{2,*}



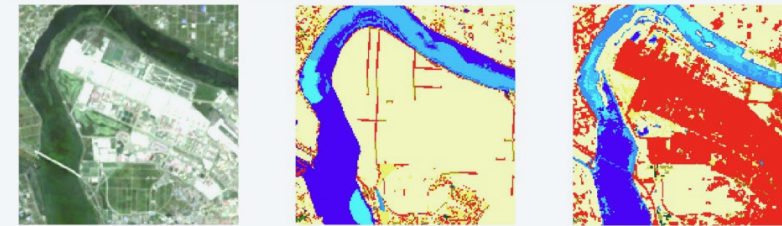
Research Methods

- Landsat-8/9, DEM, MK-PRISM, and spectral indices used as input data
- Google Earth Engine (GEE)-based satellite image preprocessing and mosaicking
- Reference map (Label map) construction using environmental thematic maps and Random Forest (RF)-based classification mapping

True Color

EFG Map

RF Mapping



Findings and Limitations

- South Korea-optimized GET map with improved accuracy over the existing IUCN GET map
- Achieved 80% overall accuracy
- Several GET classes distributed across South Korea were not sufficiently reflected in the classification framework
- Limitation of relying solely on the RF model

02. Research Overview

- **In further study**, 36 EFGs classification was conducted based on GET framework, which classifies ecosystems sharing specific ecological characteristics and functions within each biome
- Preparation of input datasets and label construction for 36 EFG classes based on the 2022 reference year
- Application of satellite remote sensing-based AI algorithm using the constructed EFG label dataset for time-series mapping
- **Main analysis:** Development of CNN-based classification models using 2022 Landsat satellite imagery at 30 m spatial resolution and application to EFG mapping for 2020 and 2024
- **Additional analysis:** Development of a higher resolution (10 m) EFG mapping model through the integration of Sentinel-2 and Landsat satellite imagery based on the 2022 reference year



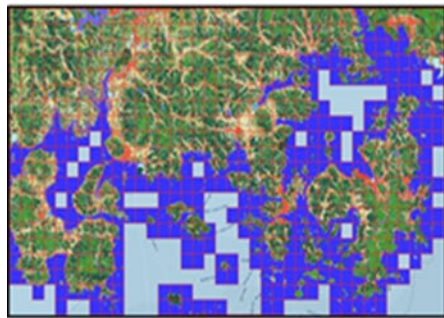
Datasets

01. Data Sources and Acquisition

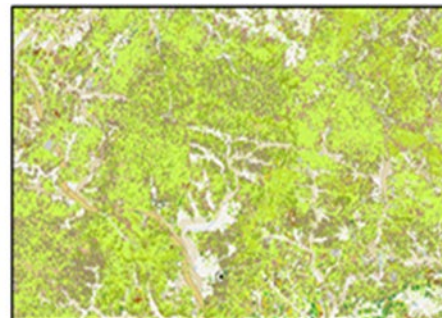
02. Dataset Details

01. Data Sources and Acquisition: Datasets for macro classification

Data	Providers	For use	Datasets
Land Cover Map	<ul style="list-style-type: none"> ● Environmental Geographic Information Service (EGIS) 	Baseline data for macro-scale ecosystem and land cover classification	<ul style="list-style-type: none"> ● 2022 Sub-classified (level-3) Land Cover Map
Tree Type Map	<ul style="list-style-type: none"> ● Forest Geographic Information Service (FGIS) 		<ul style="list-style-type: none"> ● 2022 Large-scale Forest Type Map
Farm Map	<ul style="list-style-type: none"> ● Ministry of Agriculture, Food and Rural Affairs (MAFRA) 		<ul style="list-style-type: none"> ● 2022 Nationwide Farm Map data
Wetland Inventory	<ul style="list-style-type: none"> ● National Institute of Ecology (NIE) of South Korea 		<ul style="list-style-type: none"> ● Wetland Inventory Provided by NIE



Land Cover Map



Tree Type Map



Farm map

01. Data Sources and Acquisition: Datasets for functional classification

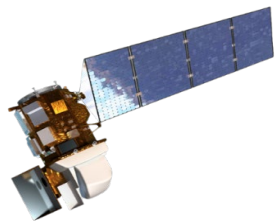
Providers	For use	Datasets
<ul style="list-style-type: none"> ● Public Data Portal (data.go.kr) ● Korea Meteorological Administration (KMA) ● Ministry of Oceans and Fisheries (MOF) ● Global Surface Water Explorer ● National Geographic Information Institute (NGII) ● National Institute of Environmental Research (NIER) ● Korea Institute of Geoscience and Mineral Resources (KIGAM) 	Ecosystem functional classification	<ul style="list-style-type: none"> ● 2021 JRC Global Surface Water ● HydroRIVERS ● 2020 coastal substrate (sediment) distribution map ● MK-PRISM ● Continuous Digital Topographic Map ● DEM ● Biota Monitoring Network (Water Environment Information System) ● Digital Geological Map

01. Data Sources and Acquisition: Datasets for Modeling

Data	Providers	Characteristics
Landsat	USGS	<ul style="list-style-type: none"> ● 11 spectral bands in total ● 30 m spatial resolution with a 16-day revisit (temporal resolution) for imagery and derived products ● 2020, 2022, 2024
Sentinel-2	ESA	<ul style="list-style-type: none"> ● 13 spectral bands in total (VIS–SWIR) ● 10 m, 20 m, and 60 m spatial resolution depending on the band, with a 5-day revisit (temporal resolution, combined Sentinel-2A/2B) for imagery and derived products ● 2022

Common strategy for preprocessing and obtaining

- Obtaining: Cloud cover < 20%
- Preprocessing: Seasonal composites were constructed for each band by applying cloud masking (using the QA_PIXEL band for Landsat and the SCL band for Sentinel-2) and median mosaicking on images acquired during the corresponding seasonal periods



Landsat Series
(USGS)



Sentinel-2
(ESA)

02. Dataset Details

① Land Cover Map: Hierarchical Classification

- The Land Cover Map is a thematic map that represents the state of the Earth's surface by analyzing data acquired from satellite or aerial imagery.
- It distinguishes among various land-use types such as forest, agricultural land, and urbanized areas.
- In this study, Level-3 Land Cover Map for 2022 produced by the Ministry of Environment was used to identify land-use types across the Korean Peninsula
- Basis for preliminary ecosystem type classification and sub-type labeling

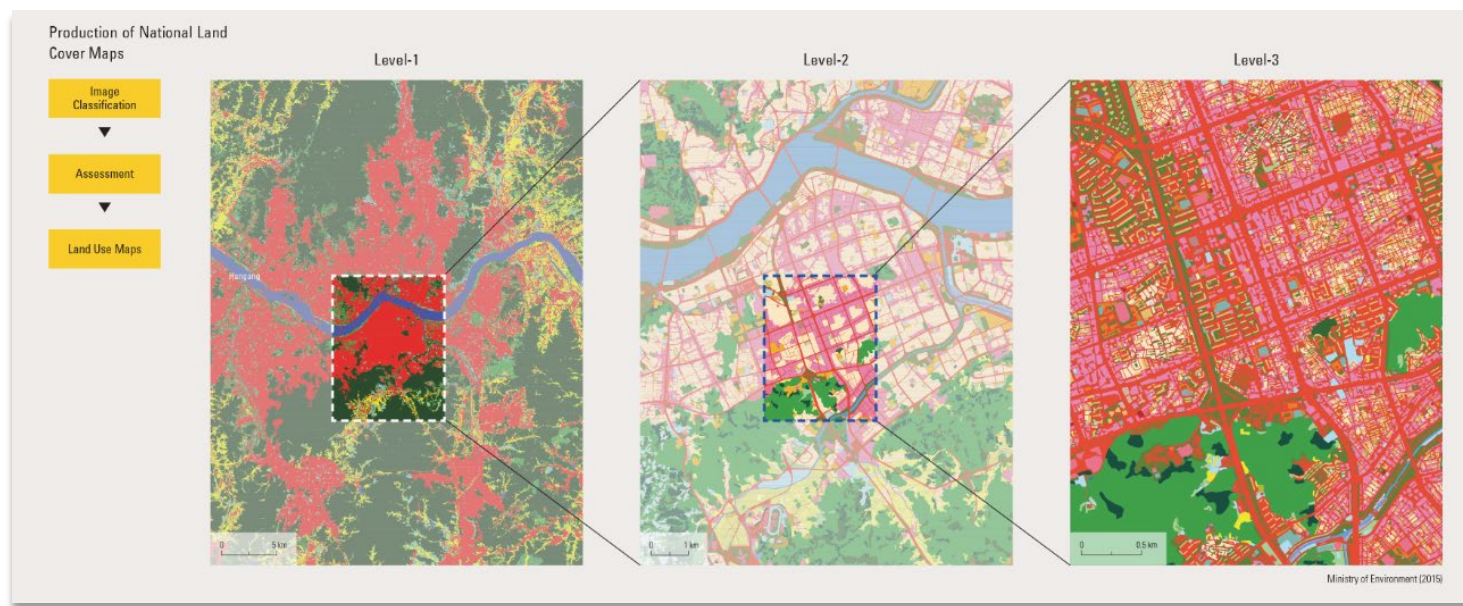
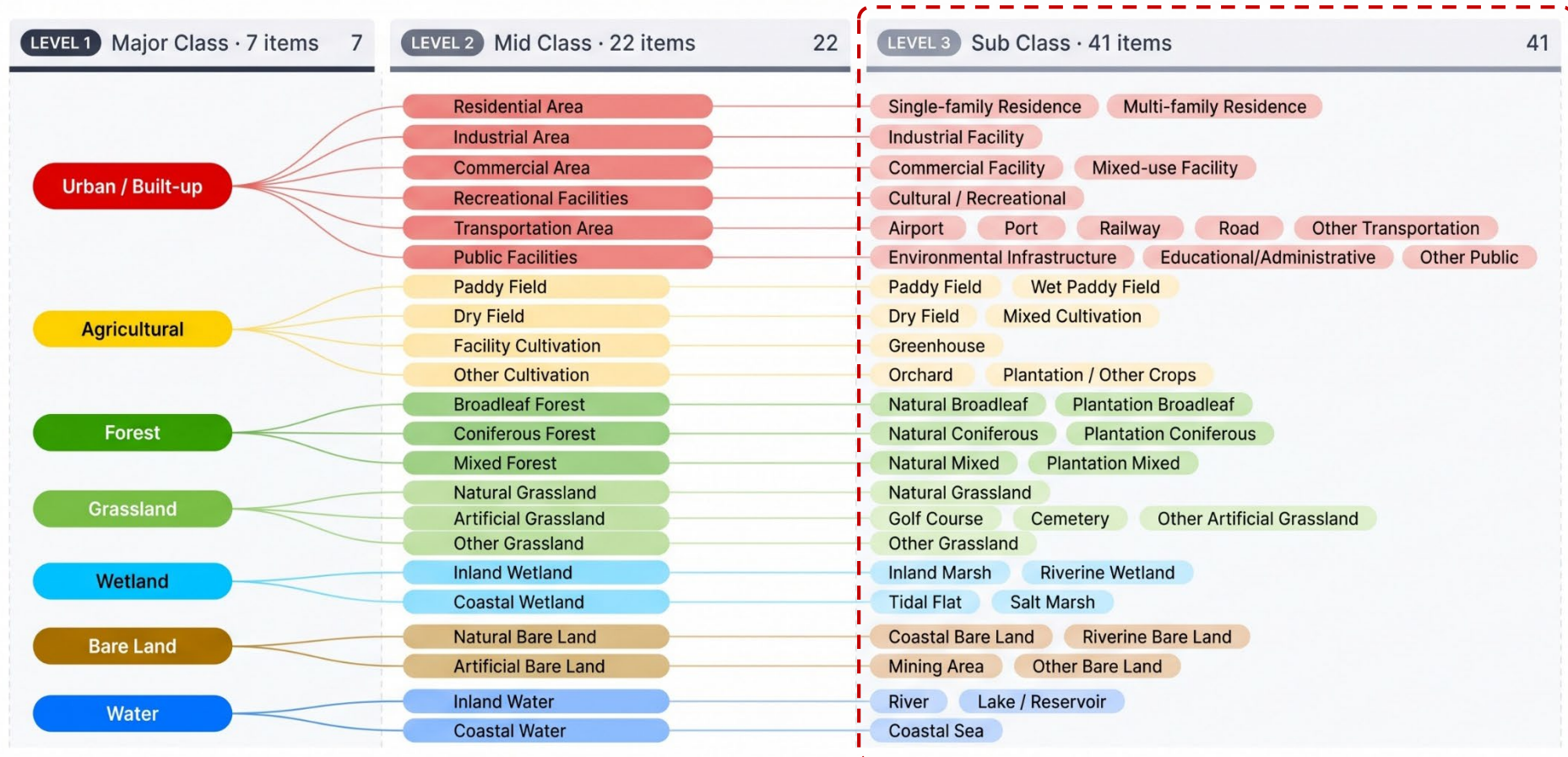


Fig. Example of Land Cover Map by classified to level-3 from level-1

02. Dataset Details

① Land Cover Map: Hierarchical Classification

7 Level-1 classes → 22 Level-2 classes → 41 Level-3 classes



02. Dataset Details

② Forest Type Map

- The Forest Type Map is a forestry thematic map depicting the distribution of forests and species composition across the Korean territory, and it reflects the ecological characteristics of forests in relatively fine detail.
- In this work, the 2022 nationwide Large -scale Forest Type Map produced by the Korea Forest Service (KFS) was used to delineate forest ecosystem types within the Korean Peninsula.

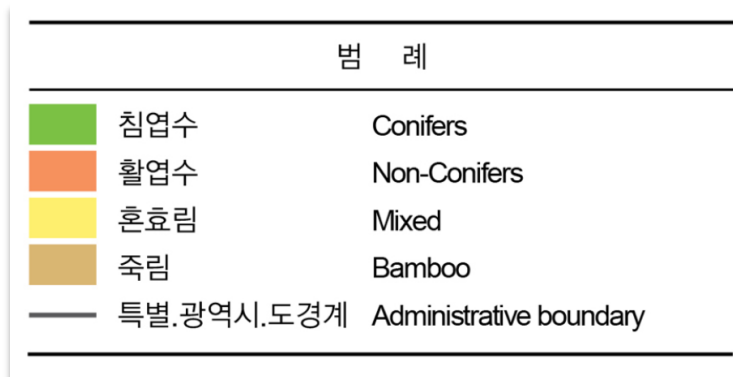
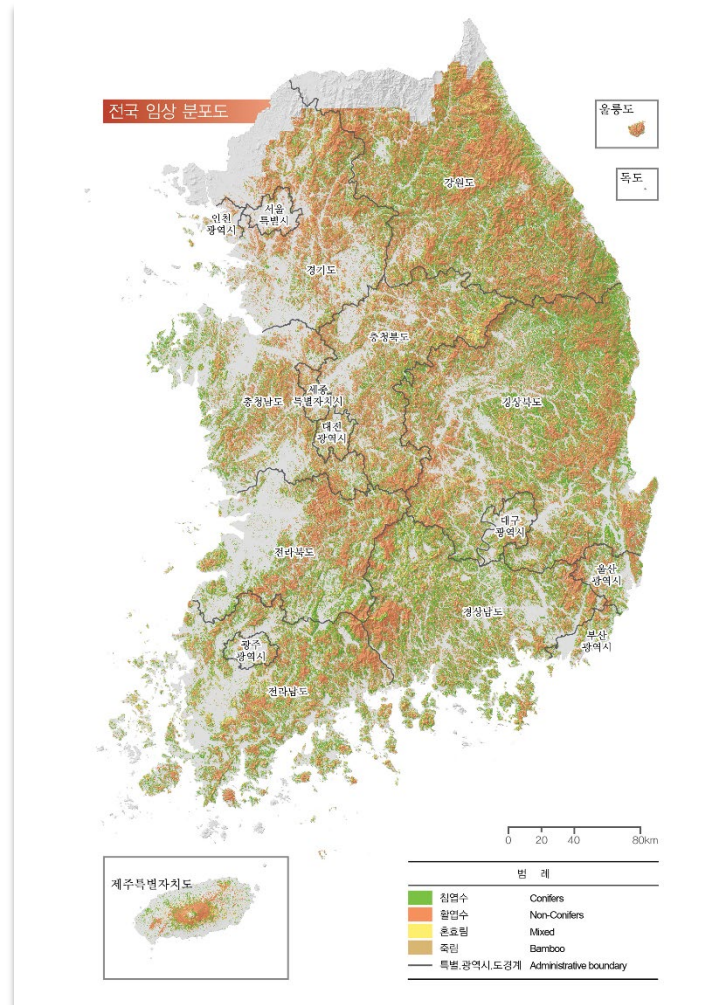


Fig. Example of Forest Type Map from KFS



02. Dataset Details

③ Coastal Substrate Distribution Map

- The Coastal Substrate Distribution Map is a polygon -based map that represents the substrate distribution of Korean coastal waters.
- It can be used to distinguish types associated with the marine environment, such as tidal flats and shorelines.
- In this work, the Coastal Substrate Distribution Map was used to classify coastal types related to the marine environment and to construct the corresponding label data.

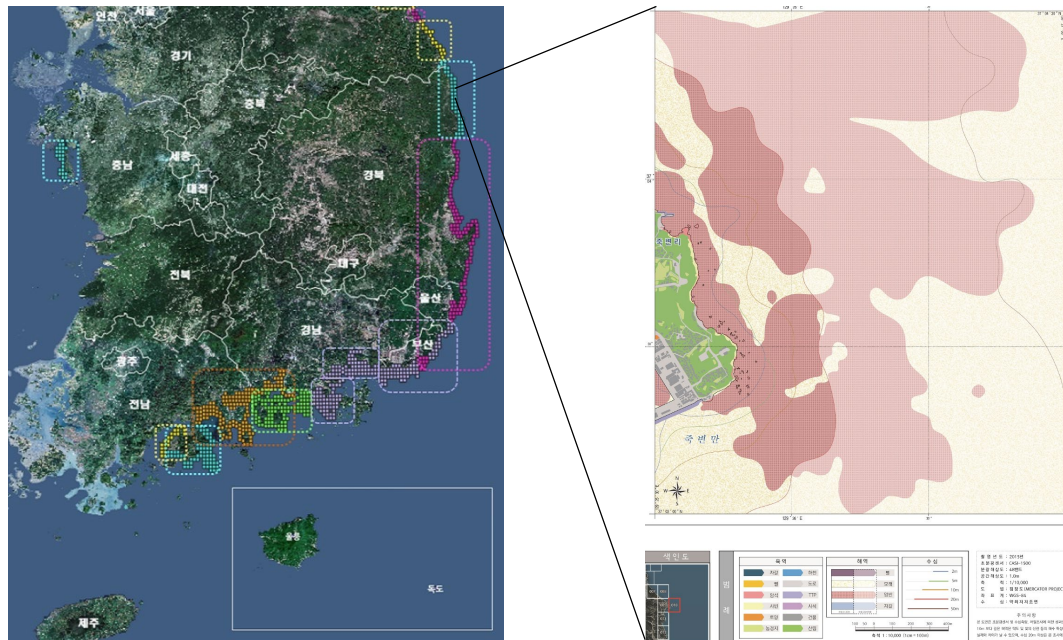


Fig. Example of Coastal Substrate Distribution Map

02. Dataset Details

④ River-related Spatial Data

- For river type classification, the **JRC Global Surface Water**, **HydroRIVERS**, etc.
- A. **JRC Global Surface Water** is a dataset that captures the distribution and dynamics of water resources at a global scale, providing information on major water bodies such as rivers and lakes.
- B. **HydroRIVERS** is a spatial database that defines the hydrological characteristics of river networks, including flow, connectivity, stream order, and contains information on the position and length of each river reach.
- C. **KRF (Korean Reach File)** is a standardized spatial database developed for the management of domestic river networks in Korea, providing information applicable to river flow analysis as well as hydrological and water -quality modeling.
- D. Actual-width river information from the Continuous Digital Topographic Map was additionally used.
 - This dataset consolidates river information that is otherwise separated by map sheets and reflects the actual river width, thereby providing clearer river boundaries than other datasets.

02. Dataset Details

⑤ Farm Map

- For agricultural land type classification, the Farm Map constructed by the Ministry of Agriculture, Food and Rural Affairs (MAFRA) was used.
- The Farm Map is a thematic map based on aerial imagery that delineates actively cultivated land, providing area and attribute information (e.g., paddy field, dry field, facility cultivation, orchard).
- It contains detailed agricultural information that is not sufficiently represented in the Land Cover Map.
- In this study, the attribute information of the Farm Map was used to classify agricultural land into paddy fields, dry fields, orchards, and other categories, which were then used to build the label data for agricultural ecosystem types.



Fig. Example of Farm Map distribution in Gyeongju-si

02. Dataset Details

⑥ MK-PRISM

- MK-PRISM (Modified Korean Parameter-elevation Regressions on Independent Slopes Model) is a Korean-adapted version of the PRISM (Parameter-elevation Regression on Independent Slopes Model), modified to fit a 1 km grid over South Korea.
- It generates high-resolution gridded climate data by accounting for DEM (Digital Elevation Model) elevation, distance, aspect-facing slopes, and coastal proximity, all of which are important factors in climate formation.
- In this work, MK-PRISM was used to construct seasonal climate information across the Korean Peninsula.
- The MK-PRISM data are provided through the Climate Information Portal, and monthly climate data from 2015 to 2019 were collected for this work.
- The collected data were preprocessed on a seasonal basis and used for constructing both model input data and label data.
- You can refer it here:
https://github.com/alienatiz/process_MK-PRISM.git

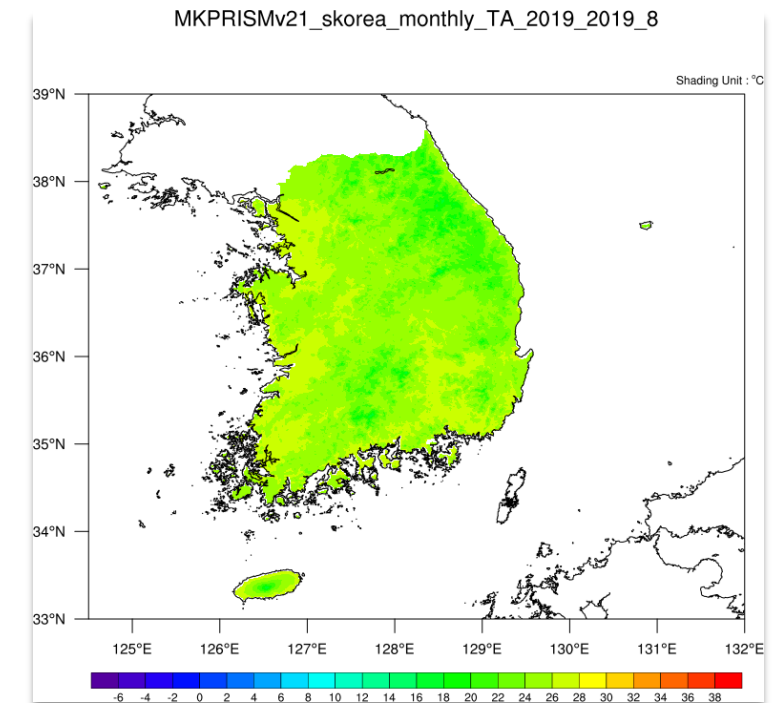


Fig. Example of MK-PRISM climate data
(August 2019)

02. Dataset Details

⑦ Wetland Inventory

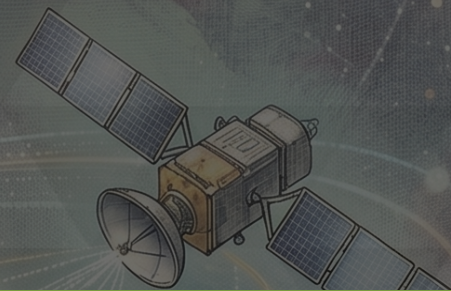
- The Wetland Inventory is a dataset compiled by the Ministry of Environment and the National Institute of Environmental Research (NIER), containing spatial and geographic information (e.g., parcel numbers and coordinates), wetland types, and area statistics for various wetlands identified through nationwide inland wetland surveys conducted since 2000.
- Based on this dataset, the spatial distribution of wetland ecosystem types was analyzed, and the inventory was used as a foundational reference for constructing the wetland type classification scheme.

⑧ Biota Monitoring Network (Water Environment Information System)

- This dataset, operated by the National Institute of Environmental Research (NIER) under the Ministry of Environment, is part of the water environment monitoring network.
- Specifically, it provides information on vegetation species and their occurrence from the riparian vegetation component of the Biota Monitoring Network for river environments (weir -segment biota monitoring).

⑨ Digital Geological Map

- The Digital Geological Map, produced by the Korea Institute of Geoscience and Mineral Resources (KIGAM), is a map in which the distribution of exposed rocks, geological structures, and stratigraphic conditions at the surface is converted into a digital format that can be analyzed and edited on a computer.

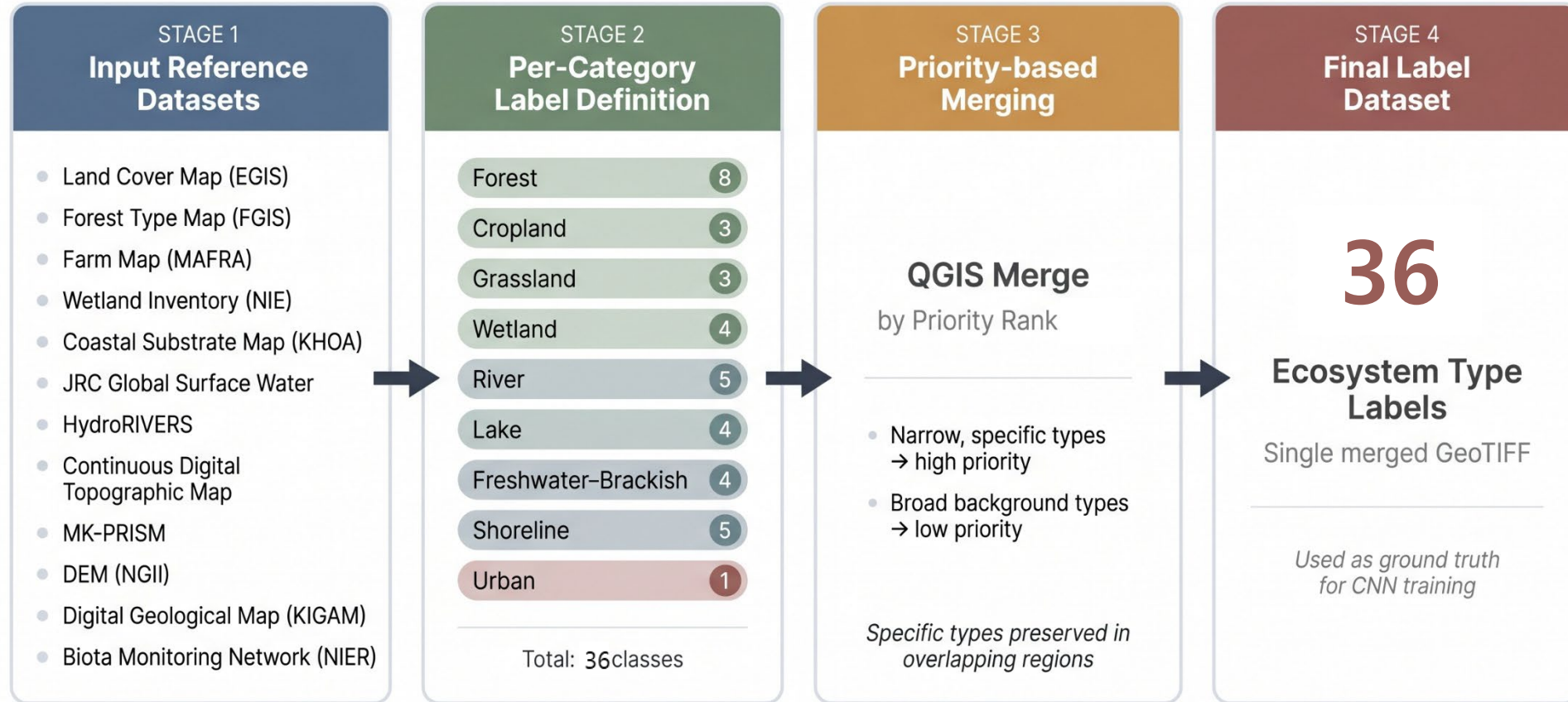


Label Data Construction

01. Used Datasets and Methods

01. Used Datasets and Methods

● Workflow for Ecosystem Type Label Construction



Multi-source reference data → per-category labeling → priority merge → unified label dataset

01. Used Datasets and Methods

No.	Type	Map	Datasets	Classifying Method
-	Base Map	Land Cover Map – GET-based revision	—	—
1	Urban	Urban Area	Land Cover Map (level-3)	Urban area (100), Artificial bare land (620)
2	Shoreline	Tidal Flat Shoreline	Substrate Distribution Map; Land Cover Map (level-3)	Mud (Substrate Map); Tidal flat (Land Cover Map)
3	Shoreline	Rocky Shoreline	Substrate Distribution Map	Rock
4	Shoreline	Sandy Shoreline	Substrate Distribution Map	Sand
5	Shoreline	Boulder/Gravel Shoreline	Substrate Distribution Map	Gravel
6	Shoreline	Artificial Shoreline	Substrate Distribution Map; Land Cover Map (level-3)	Port (Substrate Map); Tetrapod (Land Cover Map)
7	Grassland	Semi-natural Secondary Grassland & Fallow Land	Farm Map; Land Cover Map (level-3); Forest Type Map; Eco-friendly Livestock Grazing Farms	Visual inspection (manual cross-check)
8	Grassland	Intensive Pastureland	Farm Map; Land Cover Map (level-3); Forest Type Map; Eco-friendly Livestock Grazing Farms	Visual inspection (manual cross-check)

01. Used Datasets and Methods

No.	Type	Map	Datasets	Classifying Method
9	River	Freeze–Thaw River	Continuous Digital Topographic Map; Land Cover Map (level-3); MK-PRISM	Level-3 river class (711); Winter (Dec–Feb) mean temperature $\leq -2^{\circ}\text{C}$
10	River	Seasonal River (Downstream)	Continuous Digital Topographic Map; JRC Global Surface Water; Land Cover Map (level-3)	Level-3 river class (711); Actual-width river; Stream order 5–9; Seasonal (flow variability present)
11	River	Seasonal River (Upstream)		Level-3 river class (711); Actual-width river; Stream order 1–4; Seasonal (flow variability present)
12	River	Permanent River (Downstream)		Level-3 river class (711); Actual-width river; Stream order 4–9; Permanent (no flow variability)
13	River	Permanent River (Upstream)		Level-3 river class (711); Actual-width river; Stream order 1–3; Permanent (no flow variability)

01. Used Datasets and Methods

No.	Type	Map	Datasets	Classifying Method
14	Lake	Freeze–Thaw Freshwater Lake	Continuous Digital Topographic Map; Land Cover Map (level-3); MK-PRISM	Lake/Reservoir; Level-3 lake class (712); Winter (Dec–Feb) mean temperature $\leq -2^{\circ}\text{C}$
15	Lake	Temporary Freshwater Lake	Continuous Digital Topographic Map; Land Cover Map (level-3); JRC Global Surface Water	Lake/Reservoir; Level-3 lake class (712); Ephemeral
16	Lake	Large Reservoir	Continuous Digital Topographic Map; Land Cover Map (level-3)	Lake/Reservoir; Level-3 lake class (712); ≥ 8 ha
17	Lake	Permanent Small Freshwater Lake		Lake/Reservoir; Level-3 lake class (712); ≤ 90 km ²

01. Used Datasets and Methods

No.	Type	Map	Datasets	Classifying Method
18	Wetland	Artificial Lake Wetland	Wetland Inventory	Artificial wetland
19	Wetland	Marsh		Lake/river wetlands (≤ 8 ha)
20	Wetland	Forested Wetland		Mountain wetland (High-moor M1, Low-lying wetland M3, Swamp M4)
21	Wetland	Grass Wetland		Low-moor (M2)

01. Used Datasets and Methods

No.	Type	Map	Datasets	Classifying Method
22	Freshwater –Brackish	Permanent Estuary & Bay	Biota Monitoring Network (Water Environment Information System); Wetland Inventory	Open-estuary selection; e.g., Anseong-cheon, Geomdan-cheon, Gongchon-cheon
23	Freshwater –Brackish	Salt Marsh & Reed Wetland		Open estuary & reed community; Estuarine salt marsh
24	Freshwater –Brackish	Periodically Opening/Closing Brackish Lake	Wetland Inventory	Lagoon wetland
25	Freshwater –Brackish	Coastal Delta		Estuarine delta wetland (R2)

01. Used Datasets and Methods

No.	Type	Map	Datasets	Classifying Method
26	Forest	Temperate Coniferous Forest	Forest Type Map (pine, larch, cedar, and all other species used); DEM; MK-PRISM	$\leq 1,000$ m; Winter mean temperature < 1 °C; Summer (Jun–Aug) mean temperature ≤ 22 °C
27	Forest	Temperate Mixed Forest	Forest Type Map (mixed forest and all other species used); DEM; MK-PRISM	$\leq 1,000$ m; Winter mean temperature < 1 °C; Summer (Jun–Aug) mean temperature ≤ 22 °C
28	Forest	Temperate Broadleaf Forest	Forest Type Map (broadleaf forest); DEM; MK-PRISM	$\leq 1,000$ m; Winter mean temperature < 1 °C; Summer (Jun–Aug) mean temperature ≤ 22 °C
29	Forest	Warm-temperate Evergreen Broadleaf Forest	Forest Type Map (<i>Quercus myrsinifolia</i> , <i>Cinnamomum</i> , <i>Daphniphyllum</i> , and all other species used); DEM; MK-PRISM	≤ 600 m; 5-year mean annual precipitation 1,200–2,500 mm

01. Used Datasets and Methods

No.	Type	Map	Datasets	Classifying Method
30	Forest	Subalpine Mixed Forest	Forest Type Map (mixed forest and all other species used); DEM; MK-PRISM	Mixed forest other than evergreen broadleaf (Forest Type Map); $DEM \geq 1,000 \text{ m}$
31	Forest	Subalpine Coniferous Forest	Forest Type Map (pine, larch, cedar, and all other species used); DEM; MK-PRISM	Coniferous forest (Forest Type Map); $DEM \geq 1,000 \text{ m}$
32	Forest	Plantation Forest	Forest Type Map (artificial forest and all other species used); DEM; MK-PRISM	$\leq 1,000 \text{ m}$; Winter mean temperature $< 1 \text{ }^{\circ}\text{C}$; Summer (Jun–Aug) mean temperature $\leq 22 \text{ }^{\circ}\text{C}$
33	Forest	Limestone Area	Digital Geological Map (stratigraphic name)	Upper Great Limestone Group; Limestone; Yeongwol-type Joseon Supergroup; Jeongseon-type Joseon Supergroup; Joseon Supergroup Yeongdeok Formation; Joseon Supergroup Middle Great Limestone Group; Joseon Supergroup Great Limestone Formation – Limestone Group; Pyeongchang-type Joseon Supergroup; Lower Great Limestone Group

01. Used Datasets and Methods

No.	Type	Map	Datasets	Classifying Method
34	Cropland	Paddy Field	Farm Map	Paddy field
35	Cropland	Dry Field		Dry field, Facility cultivation, Ginseng, Non-cultivated land
36	Cropland	Orchard		Fruit tree

01. Used Datasets and Methods

❖ Tool

- QGIS Merge function — integrates individual per -type GeoTIFF files into a single label dataset

❖ Priority Rule

- Low priority (broad extent, clearly defined in source maps):
 - Temperate coniferous forest, broadleaf forest, urban areas, etc.
- High priority (narrow extent, prone to overlap):
 - Coastal delta, plantation forest, salt marsh & reed wetland, etc.

❖ Rationale

- Most ecosystem types rarely overlap spatially
- Priority setting ensures narrow, specific types are preserved over broader background types in overlapping regions

❖ Final Output

- A single merged label dataset containing **36 ecosystem types**

```
priority_files = [
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Fig. The priority for merging labeled data



Artificial Intelligence for Biodiversity Mapping
and Conservation Decision-Making

Modeling Approach: Training and Validation Strategy

01. Satellite Data Configuration for Model Input
02. Inputs for Classification
03. Model Architecture

01. Satellite Data Configuration for Model Input

① Satellite Data Construction Using Google Earth Engine

- **Primary Inputs (Landsat -8/9)**
 - Surface Reflectance (SR)
 - Land Surface Temperature (LST)
- **Study Area & Period**
 - Study area: entire territory of South Korea
 - Time: 2022 (+2020, 2024)
 - Spatial resolution: 30 m (Landsat-native)
- **Seasonal Composites (Reference Year: 2022)**
 - Spring: March – May
 - Summer: June – August
 - Autumn: September – November
 - Winter: December – February
- **Additional Input for High -Resolution Test Modelling**
 - Sentinel-2 imagery (2022), 10 m spatial resolution
 - Purpose: evaluate applicability of higher -resolution inputs and enable qualitative map -level comparison with Landsat -based results
 - Outcome: assess spatial/scale-dependent characteristics and validate effectiveness for high -resolution ecosystem mapping

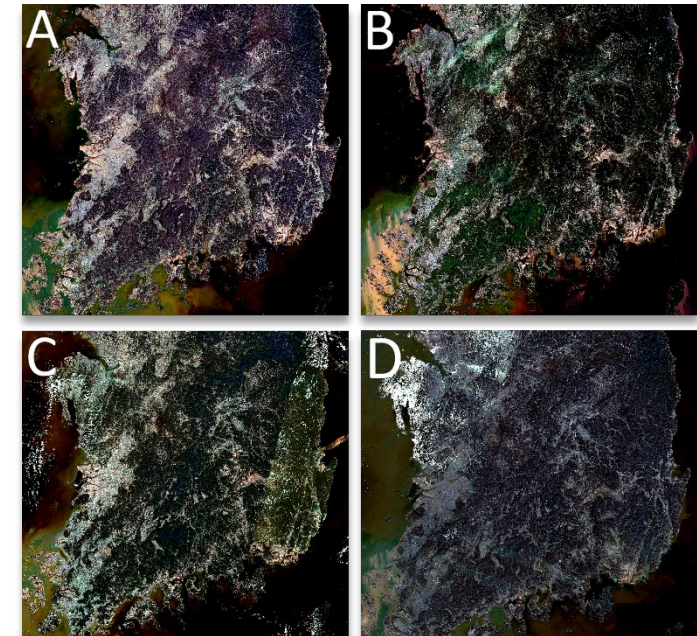


Fig. Example of Landsat-8/9 RGB seasonal composites over the Korean Peninsula (2022) — (A) Spring, (B) Summer, (C) Autumn, (D) Winter

02. Inputs for Classification

② Spectral Index Extraction for Model Construction

❖ Input Variable Summary

- **Seasonal composites:** Spring (Mar–May), Summer (Jun–Aug), Autumn (Sep–Nov), Winter (Dec–Feb)
- **Variables:** reflectance, spectral indices, temperature(LST, MK -PRISM), DEM, latitude, longitude, etc.

❖ Base Input Bands (Landsat -8/9)

- **6 Surface Reflectance bands (B2 –B7):** visible and infrared regions — reflecting physical properties of ecosystems
- **LST:** added to capture thermal differences among ecosystem types, particularly for distinguishing vegetation and urbanized areas

❖ Spectral Indices

- **NDVI (Normalized Difference Vegetation Index)** : vegetation vigor and distribution
- **MNDWI (Modified Normalized Difference Water Index):** water bodies and wetlands
- **NDBI (Normalized Difference Built -up Index):** built-up vs. bare soil distinction
- **UI (Urban Index):** supplementary discrimination of urbanized areas

- ❖ Total 51 input variables derived from multi -seasonal inputs were used for model training

02. Spectral Indices Used for Classification

② Spectral Index Extraction for Model Construction - Detailed

▪ Index Formulations

Index	Formula (Source)
NDVI (Normalized Difference Vegetation Index)	$\frac{NIR - Red}{NIR + Red}$
MNDWI (Modified Normalized Difference Water Index)	$\frac{Green - SWIR1}{Green + SWIR1}$
NDBI (Normalized Difference Built-up Index)	$\frac{SWIR1 - NIR}{SWIR1 + NIR}$
UI (Urban Index)	$\frac{SWIR2 - NIR}{SWIR2 + NIR}$
LST (Land Surface Temperature)	Derived from thermal band

02. Spectral Indices Used for Classification

③ Preprocessing and Normalization

❖ Purpose of Preprocessing

- Correct radiometric differences arising from acquisition time and location
- Prevent training bias caused by scale differences among input variables of different units (reflectance, indices, temperature)

❖ Normalization Method

- Z-score normalization applied to all input variables
- Transforms data distribution to mean = 0, standard deviation = 1

❖ Variables Normalized

- Surface Reflectance
- Land Surface Temperature (LST)
- Spectral Indices (NDVI, MNDWI, NDBI, UI)
- MK-PRISM air temperature
- DEM elevation
- Latitude, Longitude

❖ Expected Effect

- Reduces the influence of outliers
- Enables the deep learning model to learn ecosystem-specific spectral patterns more effectively

03. Model Architecture

④ Model Architecture and Training Approach for Ecosystem Type Classification

❖ Motivation

- Conventional machine learning models rely on single-pixel information only
- A CNN-based deep learning model was built to jointly learn spectral information of a target pixel and its surrounding context

❖ Input Configuration

- Patch-based pixel-wise classification
- Input patch size: 3×3
- Simultaneous learning of target pixel and neighboring pixels' spectral characteristics

❖ Core Design: Residual Connections

- Applied to mitigate issues in training deep networks
- Adds input data to the output of subsequent operations
- Prevents gradient vanishing and minimizes information loss as depth increases

03. Model Architecture

④ Model Architecture and Training Approach for Ecosystem Type Classification

❖ Overall Architecture

- Feature extraction through three sequential SkipBlocks
- Each block contains:
 - 3×3 Convolution
 - Batch Normalization
 - SiLU activation function

❖ Optimization Effect

- Batch Normalization stabilizes data distribution and accelerates training
- SiLU activation enables effective extraction of nonlinear ecosystem characteristics

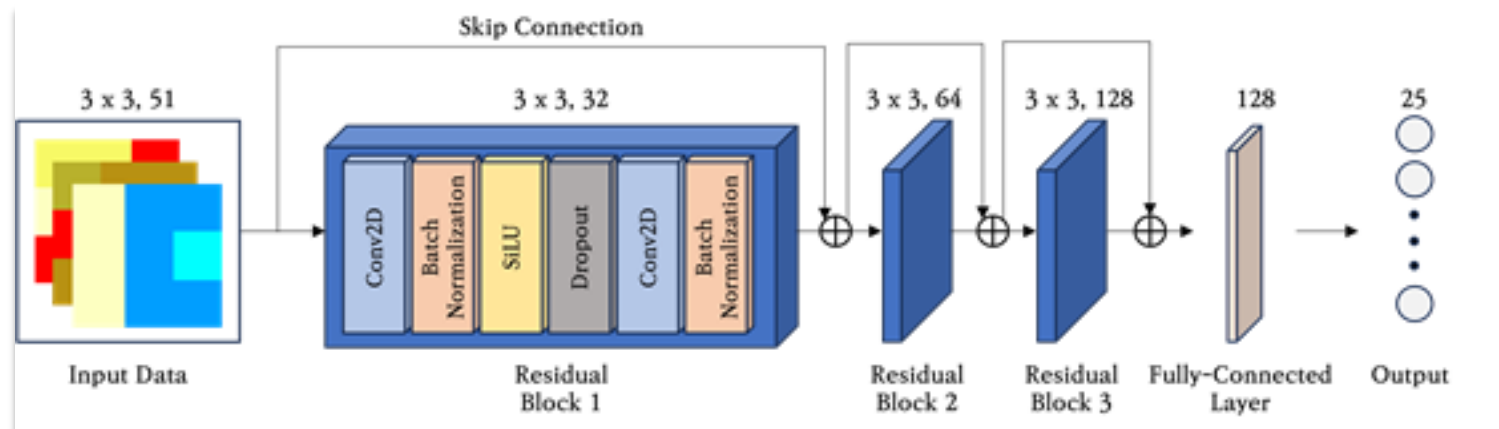


Fig. The architecture of CNN model used in this work



Results and Conclusion

- 01. 36 Type Ecosystem Classification Map for South Korea Based on GET
- 02. CNN Model Results for Ecosystem Type Classification
- 03. CNN-Based Time Series Mapping
- 04. Conclusion

01. 36 Type EFG Classification Map for South Korea Based on GET

- A total of 36 EFG were classified for 2022 by integrating multiple environmental thematic maps
- CNN-based classification modeling was conducted using the label data and satellite imagery

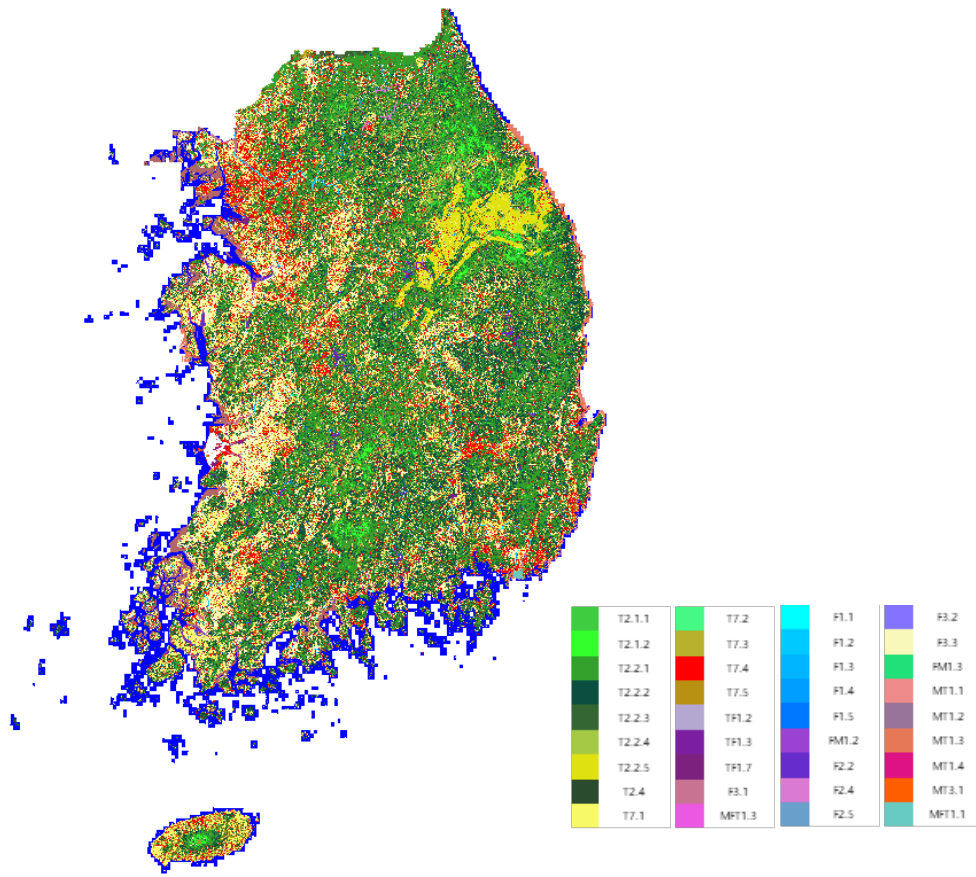


Fig. 36 classes EFG Label Map for 2022

02. CNN Model Results for Ecosystem Type Classification

- A CNN model trained using Landsat-8/9 imagery (30 m) and label data achieved an overall accuracy of approximately **84.51%**
- By incorporating Sentinel-2, the CNN model trained on 10 m spatial resolution input data achieved an accuracy of approximately **84.96%**
- The integration of satellite imagery with different spectral characteristics led to a partial improvement in ecosystem classification performance

Landsat-8/9 Model Accuracy

Code	Precision	Recall	F1-Score
T2.1.1	97.09	100.00	98.52
T2.1.2	98.95	94.00	96.41
T2.2.1	79.09	87.00	82.86
T2.2.2	95.6	87.00	91.1
T2.2.3	87.50	77.00	81.91
T2.4	75.65	87.00	80.93
T7.1	74.80	92.00	82.51
T7.2	91.51	97.00	94.17
T7.3	89.77	79.00	84.04
T7.4	87.91	80.00	83.77
T7.5	84.27	75.00	79.37
TF1.2	90.91	90.00	90.45
TF1.3	94.17	97.00	95.57
TF1.7	90.82	88.12	89.45
F1.1	49.30	35.00	40.94
F1.2	57.35	78.00	66.1
F1.3	81.37	83.00	82.18
F1.4	80.90	72.00	76.19
F1.5	70.43	81.00	75.35
F2	85.39	76.00	80.42
F3.3	95.79	91.00	93.33
MT1	85.96	98.00	91.59
MT1.2	96.04	97.00	96.52
M1	96.67	87.00	91.58
OA		84.51%	

Sentinel-2 Model Accuracy

Precision	Recall	F1-Score
99.00	99.00	99.00
92.45	98.00	95.15
84.54	82.00	83.25
89.72	96.00	92.75
80.61	79.00	79.8
88.30	83.00	85.57
78.50	84.00	81.16
89.52	94.00	91.71
87.50	77.00	81.91
87.25	89.00	88.12
78.57	77.00	77.78
94.00	94.00	94.00
97.94	95.00	96.45
94.00	93.07	93.53
51.92	54.00	52.94
66.67	56.00	60.87
78.70	85.00	81.73
73.68	70.00	71.79
75.00	81.00	77.88
83.17	84.00	83.58
88.57	93.00	90.73
90.38	94.00	92.16
96.88	93.00	94.90
91.75	89.00	90.36
	84.96%	

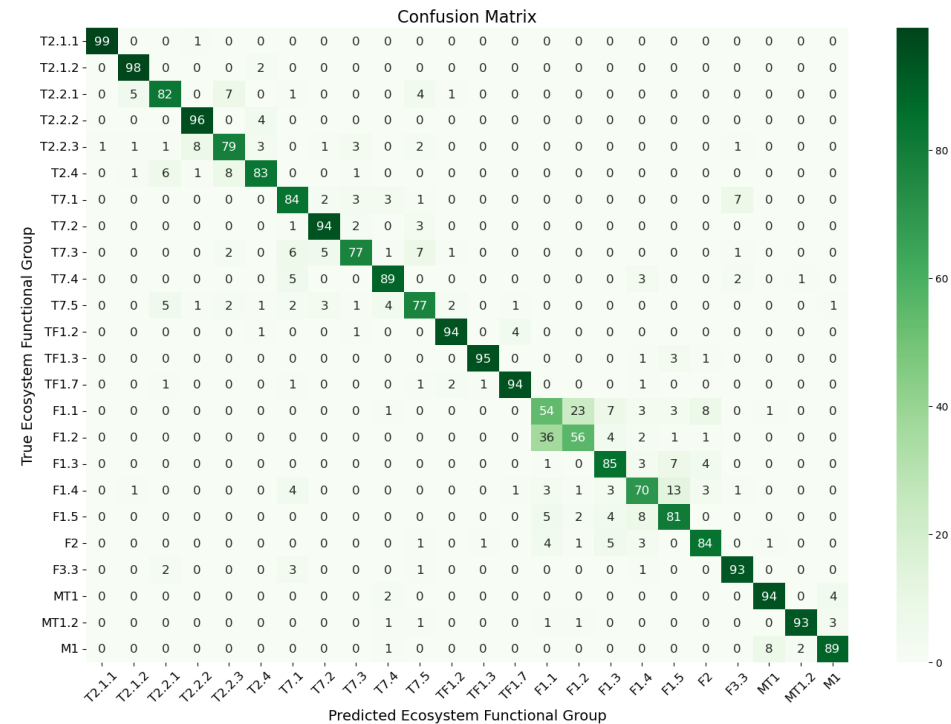
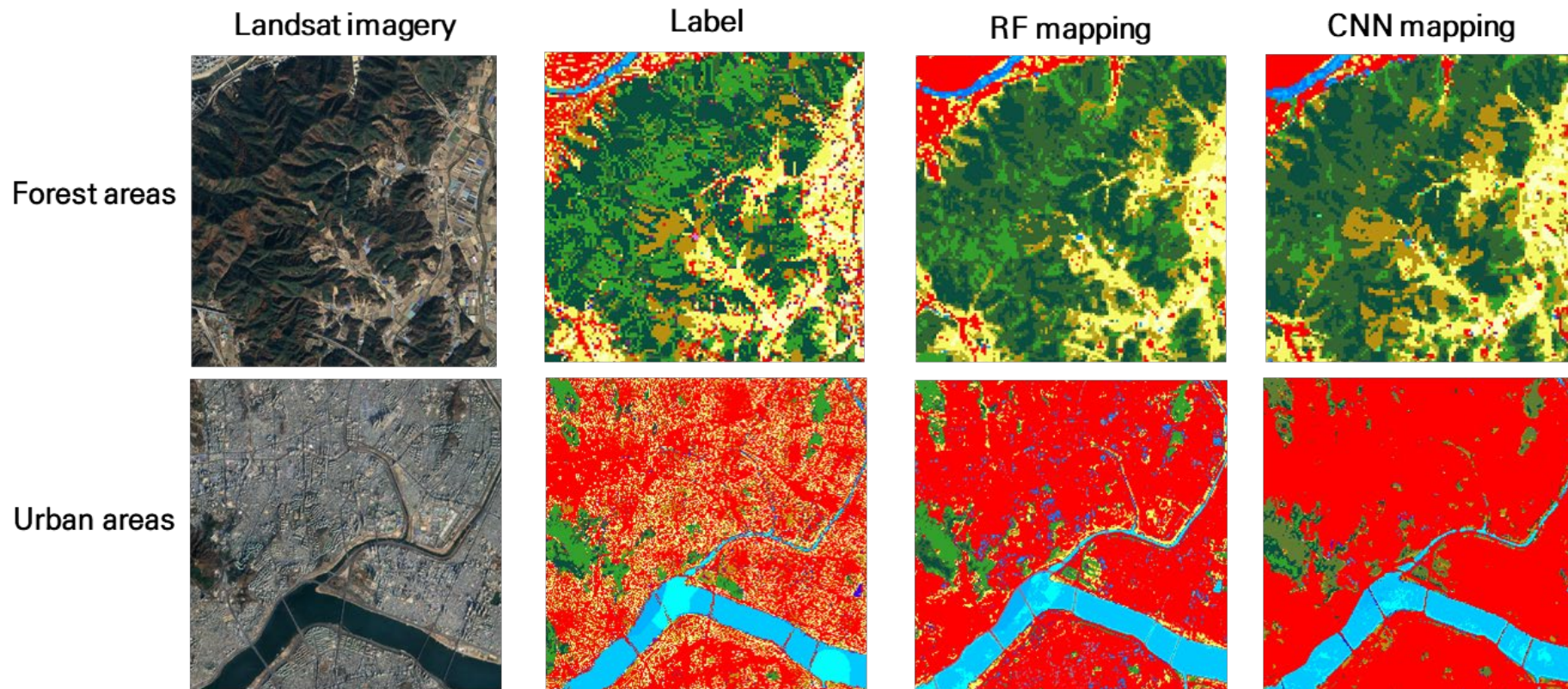


Fig. Sentinel-2 CNN Model Confusion Matrix

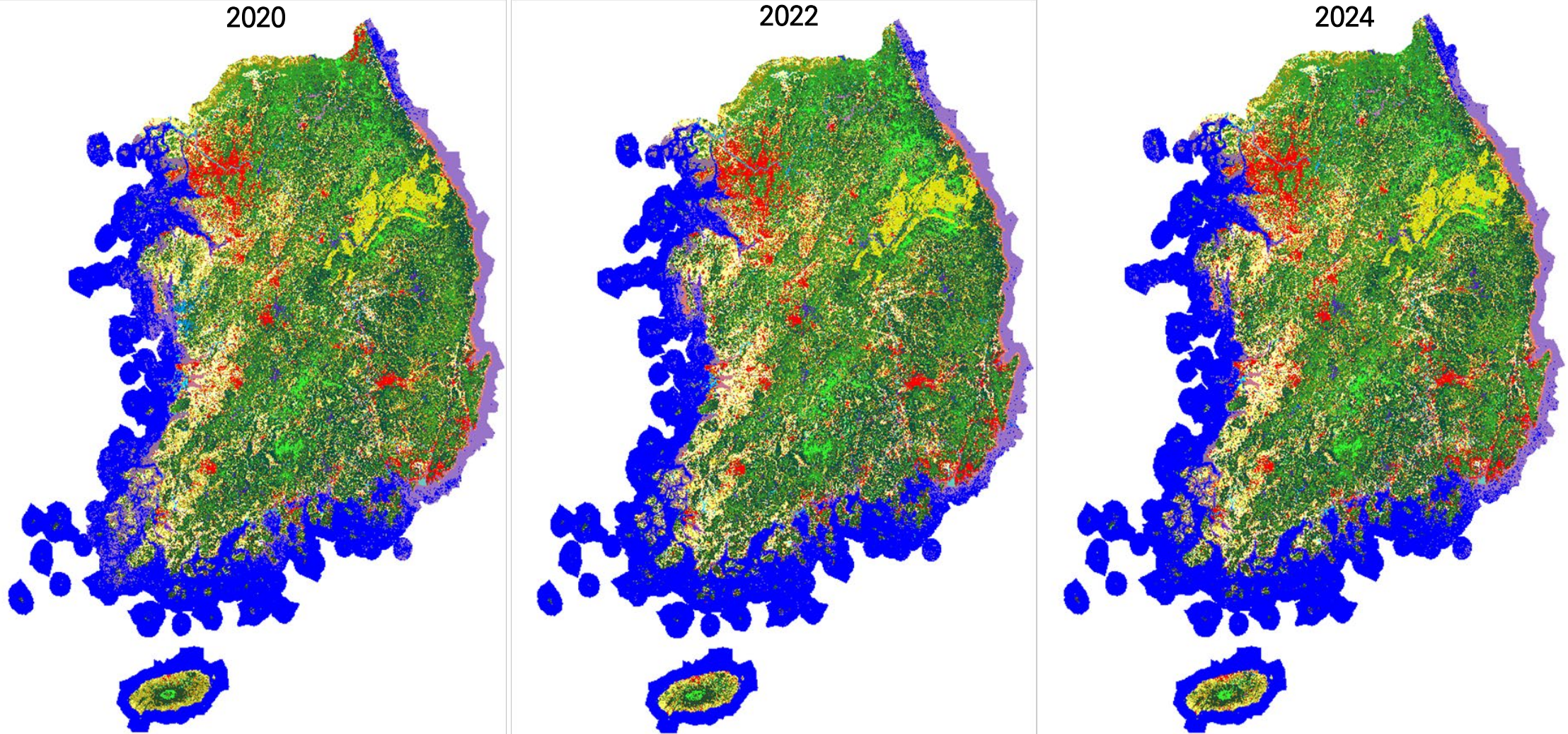
03. CNN-Based Time Series Mapping

- CNN model correctly classified it as grassland, whereas the RF model misclassified grassland as forest
- RF model produced false urban detections over river areas, whereas the CNN model showed improved urban mapping results



03. CNN-Based Time Series Mapping

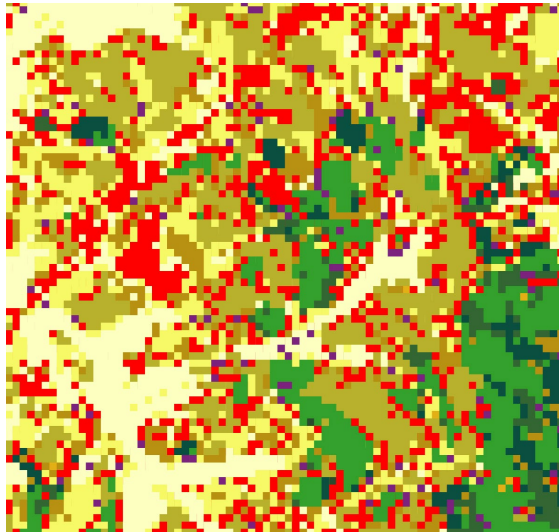
- CNN-based time-series mapping using Landsat-8/9 imagery



03. CNN-Based Time Series Mapping

- The results enabled detection of forest or cropland conversion into urban areas driven by industrial development

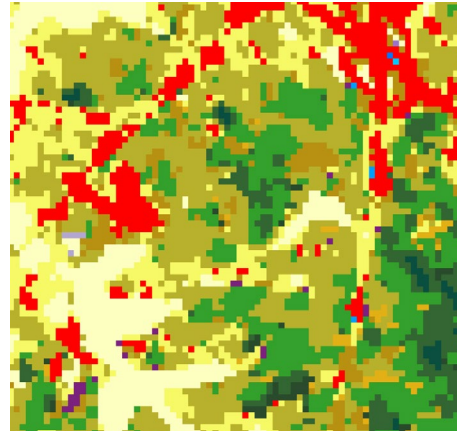
#Case 1



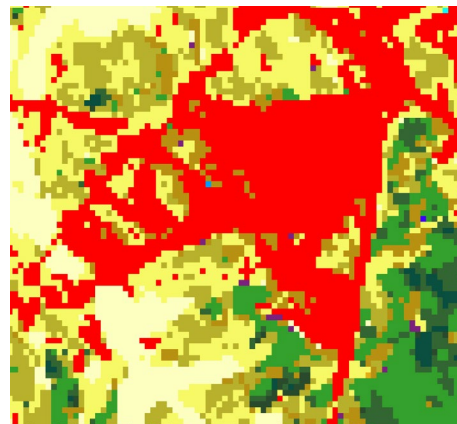
Label map (2022)

Year 2022

CNN mapping



Year 2024



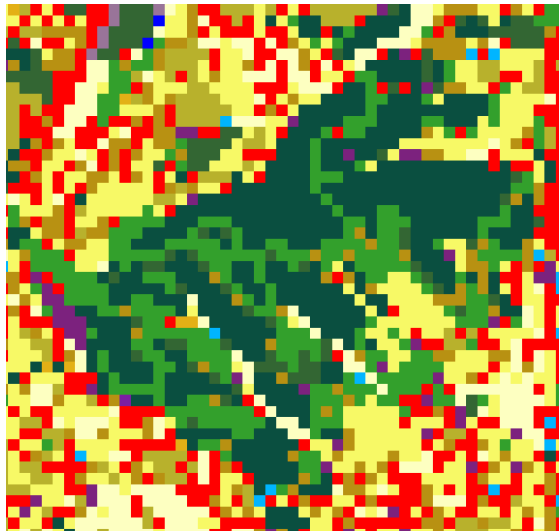
Google Earth Image



03. CNN-Based Time Series Mapping

- The results enabled detection of forest or cropland conversion into urban areas driven by industrial development

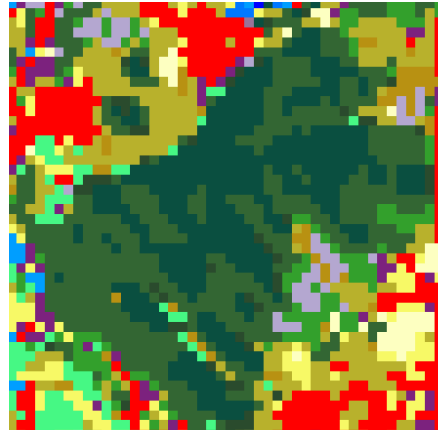
#Case 2



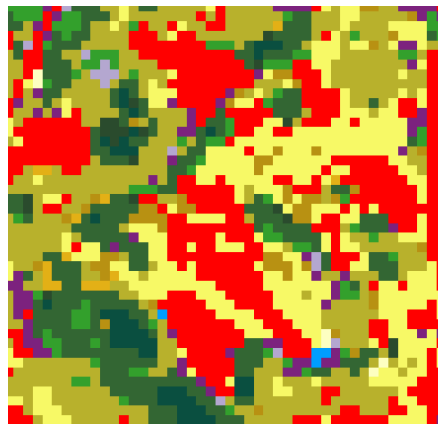
Label map (2022)

Year 2022

CNN mapping



Year 2024

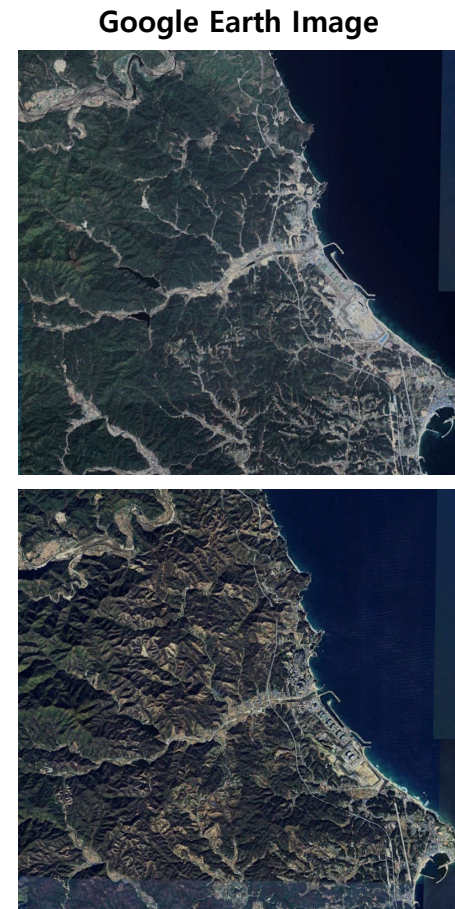
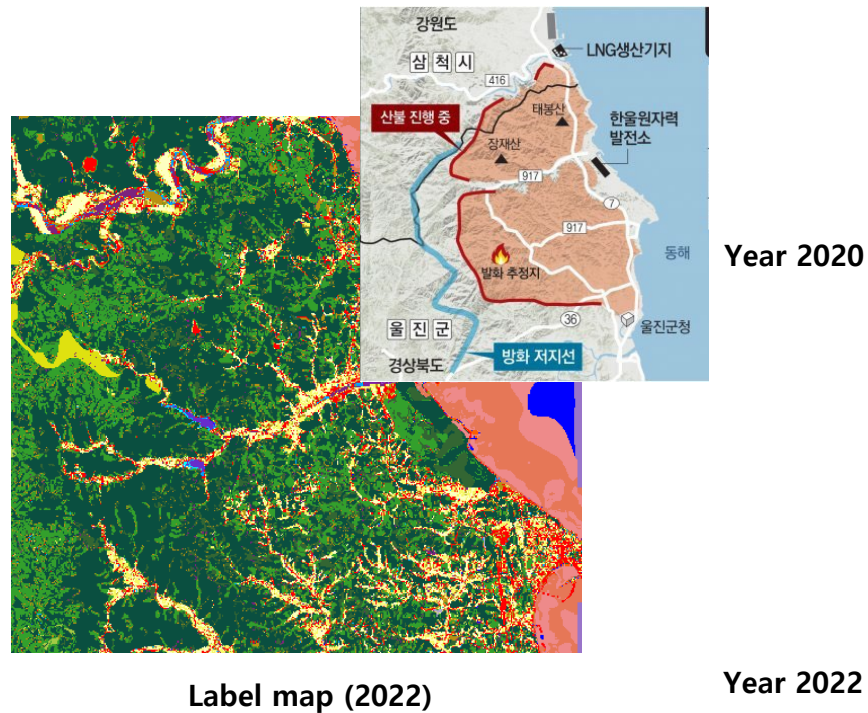


Google Earth Image



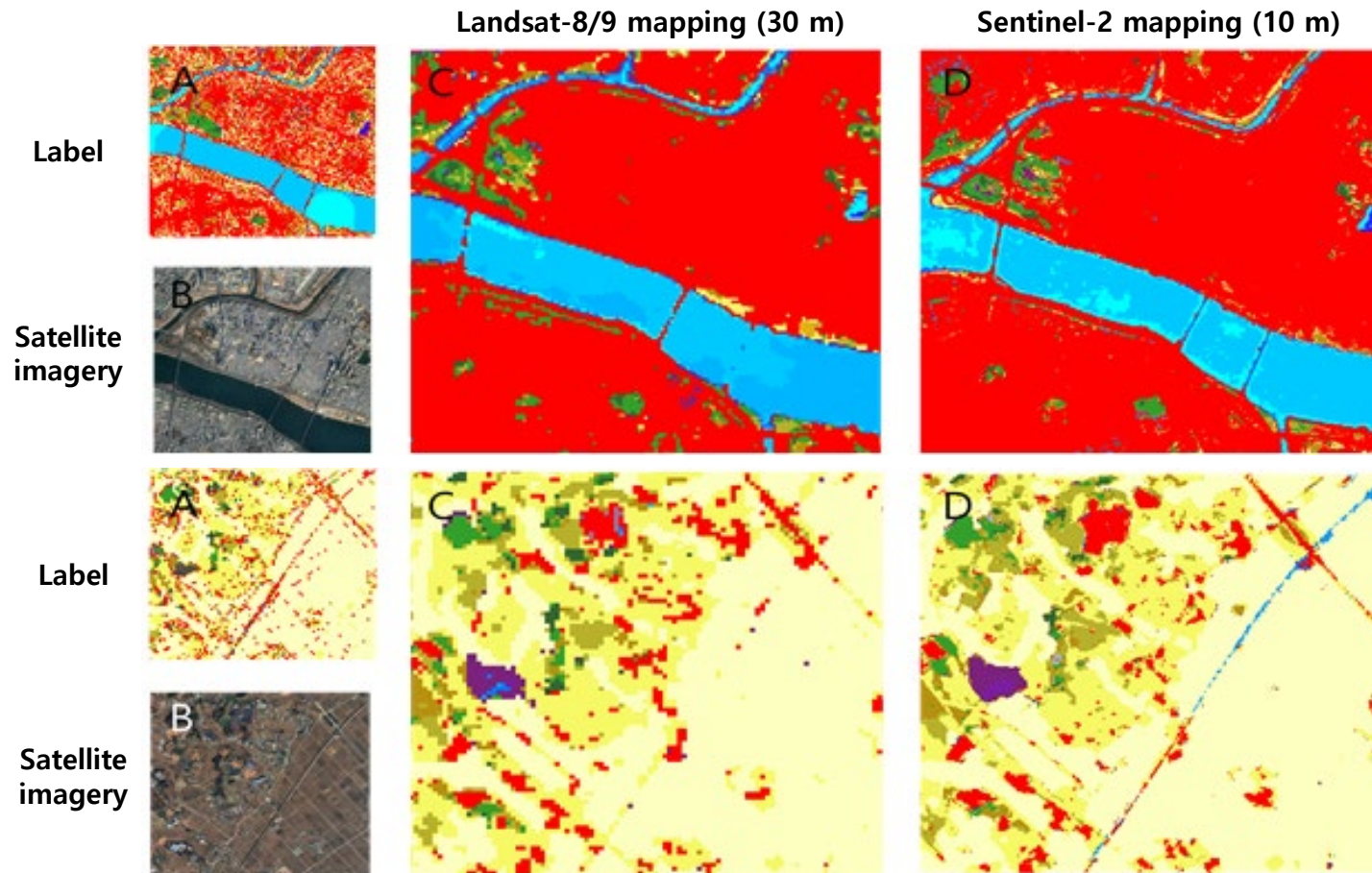
03. CNN-Based Time Series Mapping

- Time-series analysis of wildfire-induced ecosystem changes
- Burned forest areas in the 2022 Uljin–Samcheok wildfire were reclassified into urban areas based on satellite imagery and CNN-based mapping



03. CNN-Based Time Series Mapping

- Integrating 10 m Sentinel-2 with Landsat-8/9 produces more detailed results than 30 m Landsat-based mapping
- It enables classification of narrow features (e.g., bridges, irrigation channels)



04. Conclusion

- The IUCN GET provides a globally consistent ecosystem framework, but national-scale refinement is necessary in regions with fragmented and heterogeneous landscapes
- Integrating country-specific environmental datasets enables more detailed and ecologically meaningful Ecosystem Functional Group (EFG) classification
- Remote sensing and AI-based models provide an efficient approach for large-scale ecosystem mapping and time-series ecosystem monitoring
- Higher-resolution satellite imagery improved the representation of fragmented and narrow ecosystem features, although with increased computational cost
- Integrating GET with national datasets and AI-based remote sensing approaches can support future biodiversity monitoring and international ecosystem observation collaborations, including APBON initiatives



Thanks for attention

A Framework for Ecosystem Functional Group Mapping Based on the
IUCN Global Ecosystem Typology



Q&A

A Framework for Ecosystem Functional Group Mapping Based on the
IUCN Global Ecosystem Typology