

# SAR와 광학 퓨전 영상을 이용한 트리기반 토지 피복 분류

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- S1 vs S2 vs Fusion
- Tree-based Method Comparison

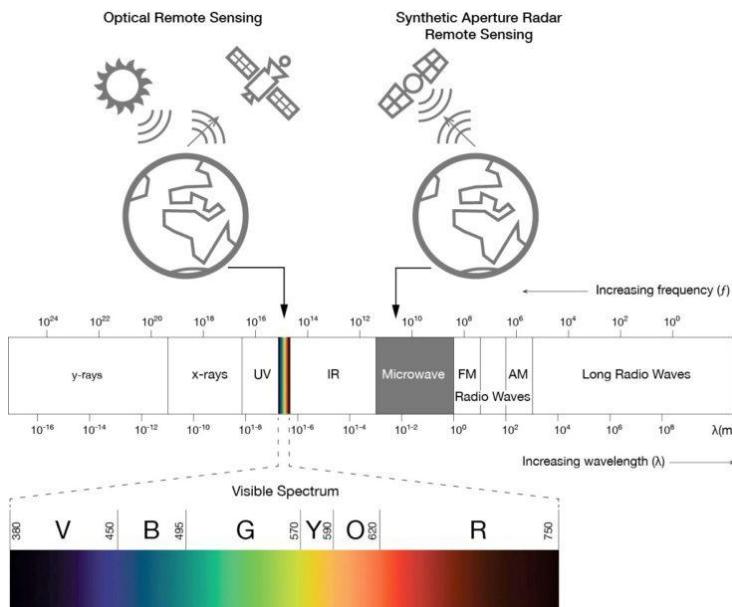
### 결론

- Result
- Future Study

# 1 서론 - Introduction

“SAR와 광학 퓨전 영상을 이용한 트리기반 토지 피복 분류”

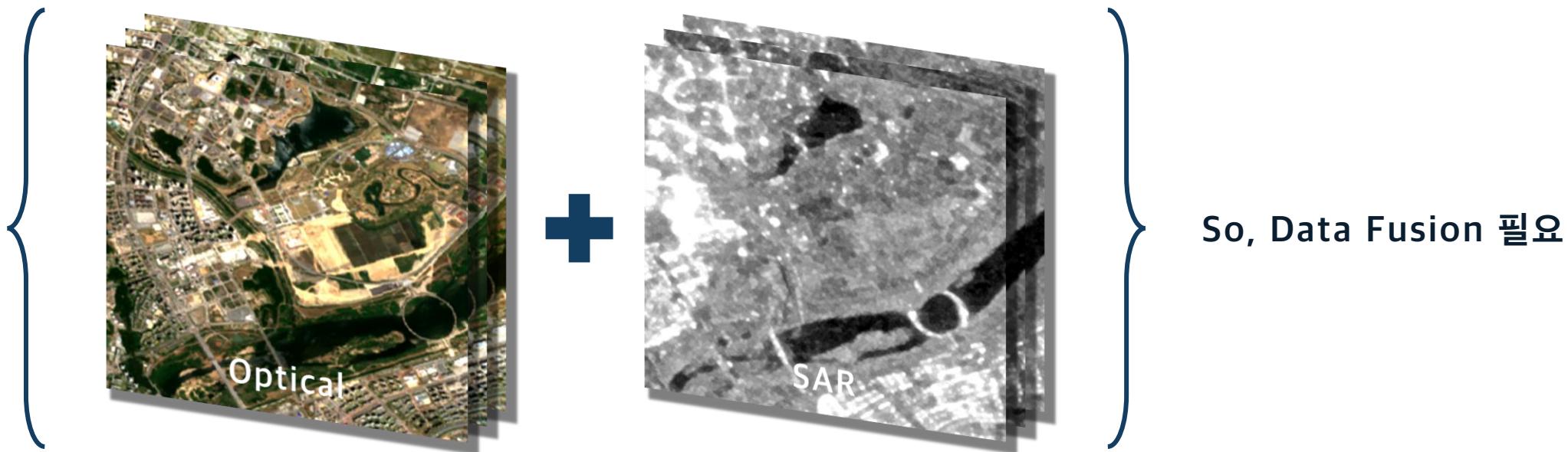
## ▶ Data Fusion의 중요성



# 1 서론 - Introduction

“SAR와 광학 퓨전 영상을 이용한 트리기반 토지 피복 분류”

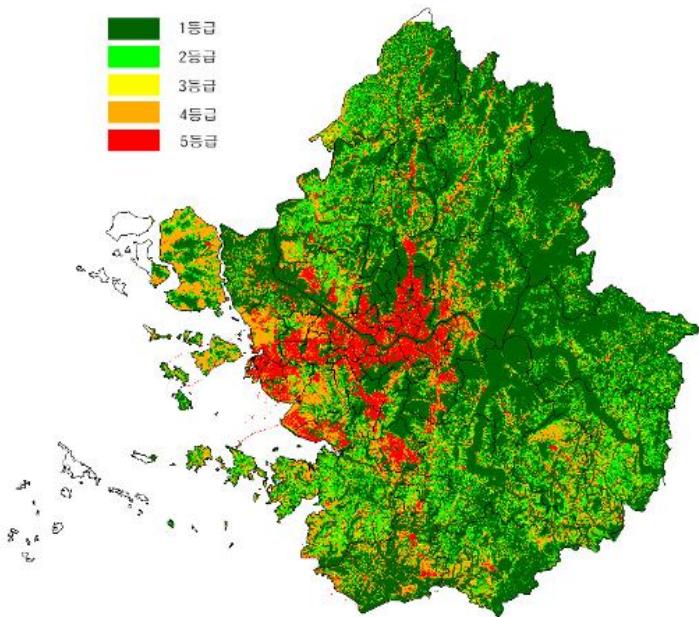
## ▶ Data Fusion의 중요성



# 1 서론 - Introduction

## “SAR와 광학 퓨전 영상을 이용한 트리기반 토지 피복 분류”

### ▶ 토지 피복 분류의 필요성



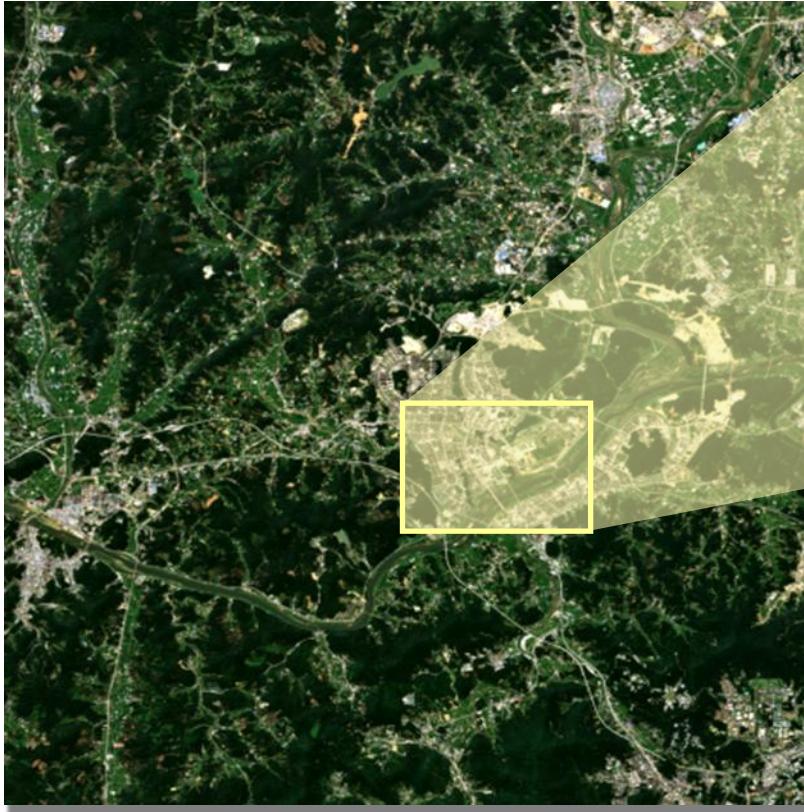
#### < 토지 피복 지도 >

- 토지의 특성과 토지 피복 상태를 시각적으로 표현한 지도
- 자연적 요인, 자연환경과 인간의 상호작용에 의해 끊임없이 변화, 이러한 변화는 재해 발생 가능성 및 규모에 영향

따라서 토지 피복의 변화 과정과 원인 -> 자연과 사회·경제 전반에 미치는 영향 평가 및 예측 중요

# 1 서론 - Study Area

▶ 세종시, AOI( 394X766 Pixel )



## Coordinates

- 127.231, 36.504
- 127.299, 36.469

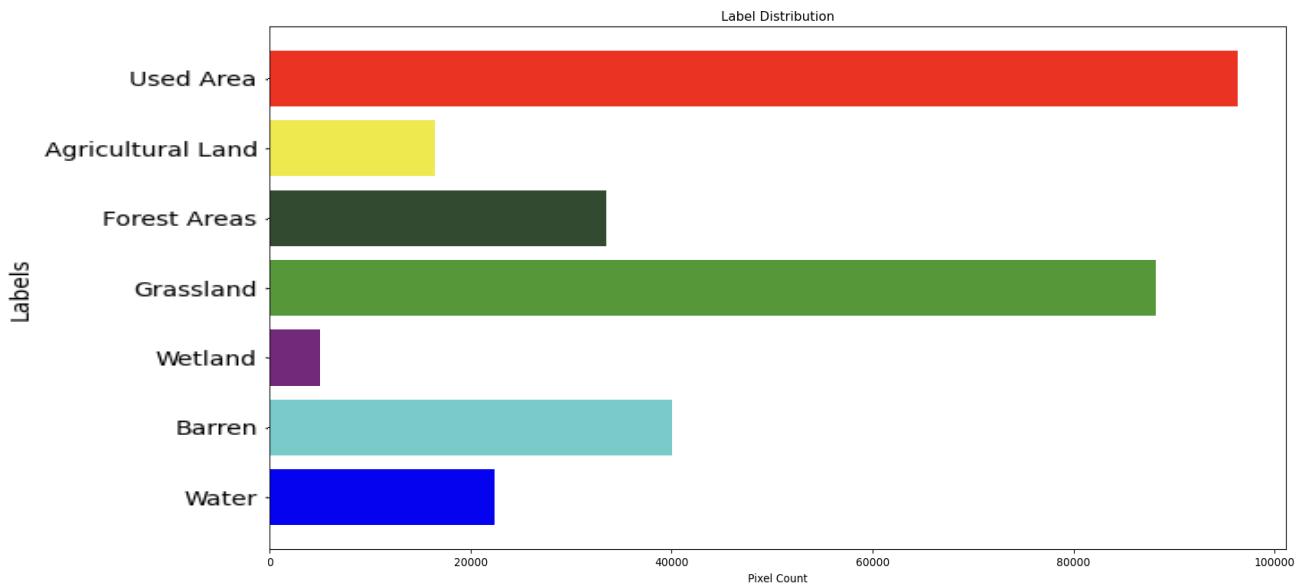
## Why 세종시?

북서부: 산악 지형, 남동부: 평지  $\Rightarrow$  다양한 지형 구조

독특한 모양의 구조물  $\Rightarrow$  분류가 잘 이루어지는지

# 1 서론 - Study Area

## ▶ 세종시, 지역특징

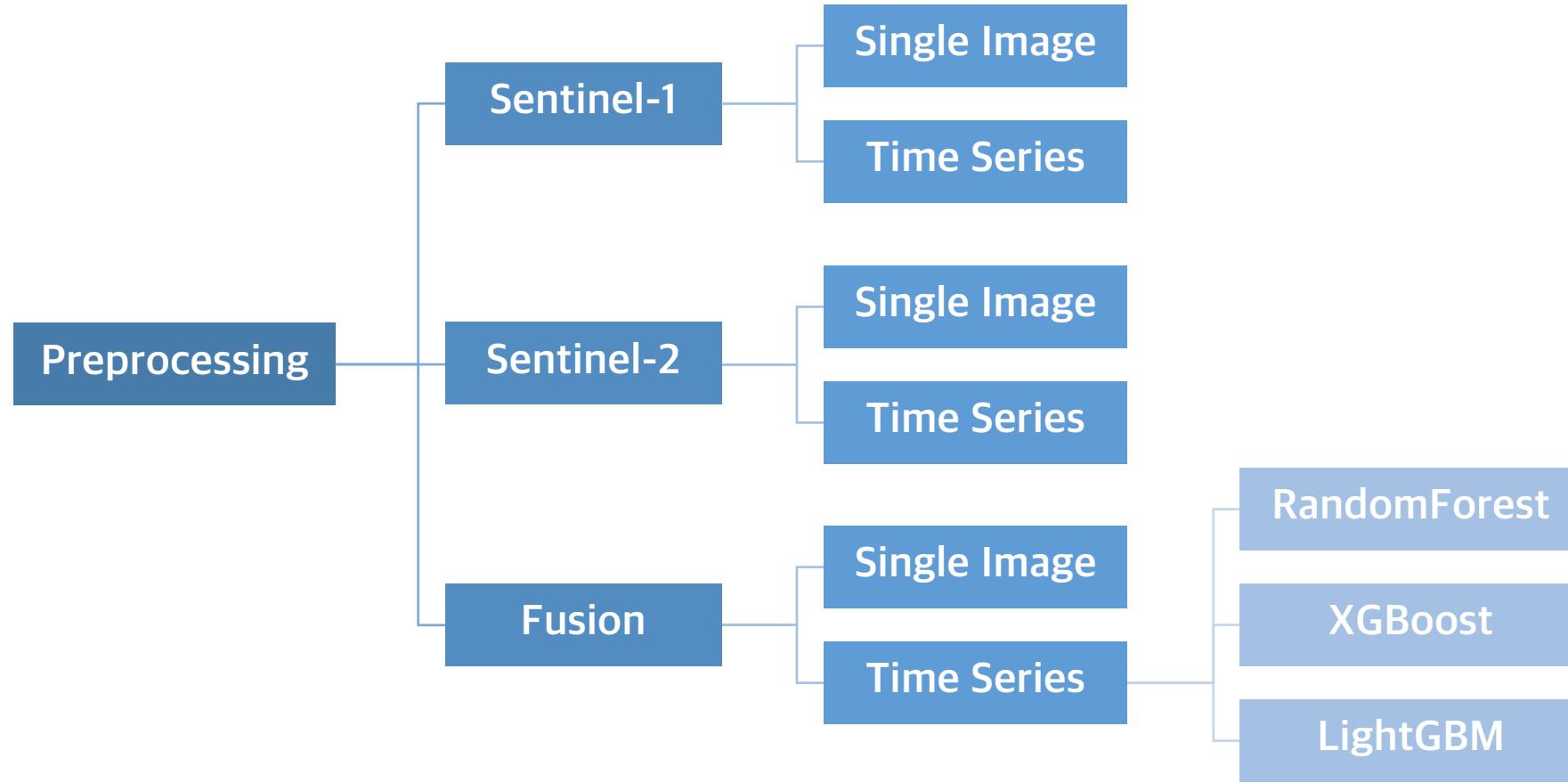


### 지역 특징

원 모양의 구조물, 교량, 논 …

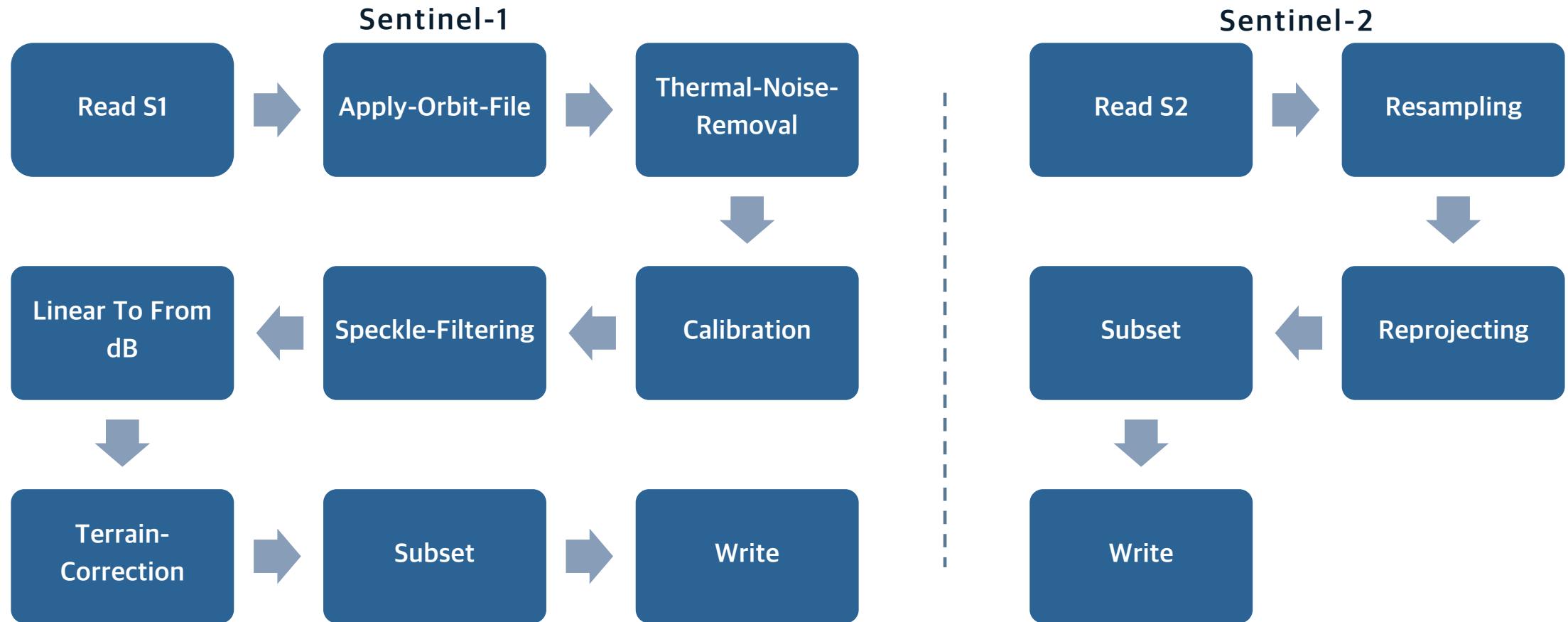
Used Area > Grassland > … > Wet land

# 1 서론 - Study Flow Chart



# 1 서론 - Data Preprocessing

## ▶ Flow Chart



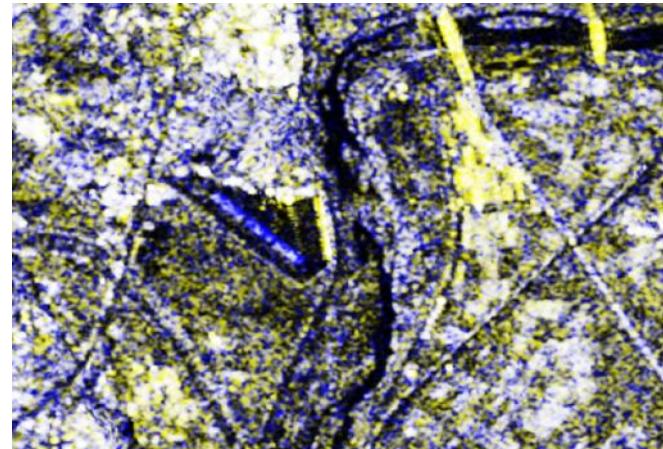
# 1 서론 - Data Preprocessing

## ▶ Sentinel-1 Characteristic

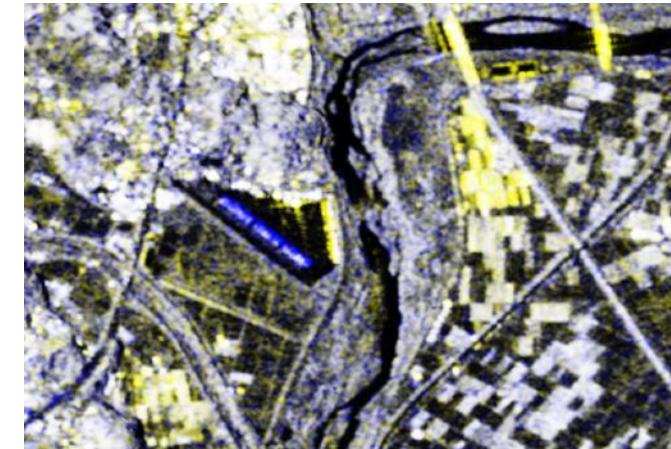
영상개수 및 날짜

Index	Date
1	2022-04-11
2	2022-04-23
3	2022-05-17
4	2022-05-29
5	2022-06-10
6	2022-09-14
7	2022-09-26

- GRD(Ground Range Detected)
- VV : 표면의 거친 정도, VH : 표면의 굴곡
- Speckle 상쇄, 물체 특성 파악  $\Rightarrow$  VV/VH ratio



Raw Data



Filtering

# 1 서론 - Data Preprocessing

## ▶ Sentinel-2 Characteristic

영상개수 및 날짜

Index	Date
1	2022-04-17
2	2022-04-27
3	2022-05-17
4	2022-06-01
5	2022-06-11
6	2022-09-09
7	2022-09-24

밴드 해상도 및 파장

Band ID	Resolution(m)	Wavelength
B01	60	443
B02	10	490
B03	10	560
B04	10	665
B05	20	705
B06	20	740
B07	20	783
B08	10	842
B09	60	945
B11	20	1610
B12	20	2190

# 1 서론 - Data Preprocessing

## ▶ Sentinel-2 Characteristic

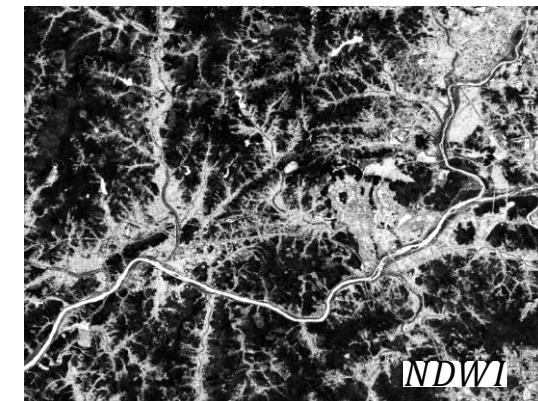
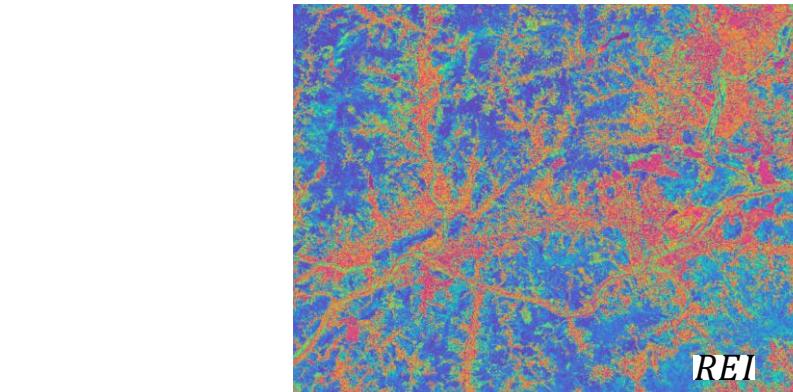
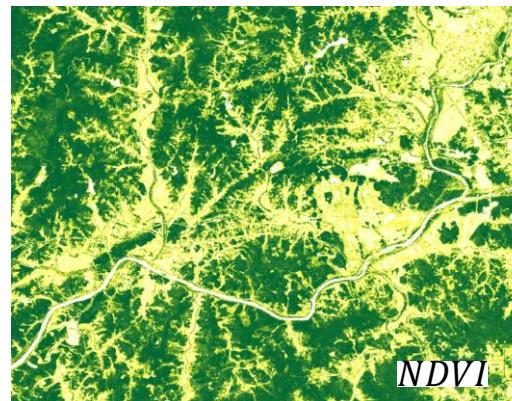
### Feature Engineering (Vegetarian Index)

$$NDVI = \frac{\text{band } 8(\text{NIR}) - \text{band } 4(\text{Red})}{\text{band } 8(\text{NIR}) + \text{band } 4(\text{Red})}$$

$$NDWI = \frac{\text{band } 3(\text{Green}) - \text{band } 8(\text{NIR})}{\text{band } 3(\text{Green}) + \text{band } 8(\text{NIR})}$$

$$\text{Red Edge Index} = \frac{\text{band } 8(\text{NIR}) - \text{band } 5(\text{RedEdge})}{\text{band } 8(\text{NIR}) + \text{band } 5(\text{RedEdge})}$$

$$EVI2 = 2.5 \frac{\text{band } 8(\text{NIR}) - \text{band } 4(\text{Red})}{\text{band } 8(\text{NIR}) + 2.4\text{band } 4(\text{Red}) + 1}$$



# 1 서론 - Data Preprocessing

## ▶ Fusion

Sentinel-1 Date	Sentinel-2 Date	ΔDays
2022-04-11	2022-04-17	6
2022-04-23	2022-04-27	4
2022-05-17	2022-05-17	0
2022-05-29	2022-06-01	2
2022-06-10	2022-06-11	1
2022-09-14	2022-09-09	-5
2022-09-26	2022-09-24	-2

### Collocation

- 각 영상에 대해 ±7일 이내 되도록 영상 다운
- SNAP의 Collocation tool 이용
- 다중 센서 데이터를 생성
- Axis=0으로 Band 결합
- Resampling 과정 수행

	vv_band_0	vh_band_0	B1_0	B2_0	B3_0	B4_0	B5_0	B6_0	B7_0	B8_0	B9_0	B11_0	B12_0	NDVI_0	NDWI_0	REI_0	EVI2_0	vv / vh_0
0	-8.930844	-14.212313	1685.0	1404.0	1732.0	1804.0	2162.0	2670.0	2793.0	3038.0	3208.0	3239.0	2468.0	0.434201	-0.471480	0.182096	0.220868	5.281468
1	-11.038798	-14.585727	1564.0	1411.0	1702.0	1761.0	2186.0	2616.0	2805.0	2948.0	3208.0	3264.0	2473.0	0.438169	-0.470189	0.218285	0.215436	3.546928
2	-11.756577	-14.187460	1564.0	1431.0	1656.0	1872.0	2186.0	2616.0	2805.0	3046.0	3208.0	3264.0	2473.0	0.402330	-0.514434	0.152575	0.207585	2.430882
3	-11.065881	-13.323935	1523.0	1433.0	1632.0	1862.0	2109.0	2434.0	2680.0	3024.0	3208.0	3419.0	2596.0	0.402633	-0.524096	0.125317	0.206134	2.258054
4	-9.245694	-13.778767	1523.0	1399.0	1598.0	1798.0	2109.0	2434.0	2680.0	2871.0	3208.0	3419.0	2596.0	0.402023	-0.515593	0.163083	0.194579	4.533072

# 1 서론 - Label Data

## ▶ 토지피복지도 ( 환경공간정보서비스, 2022)



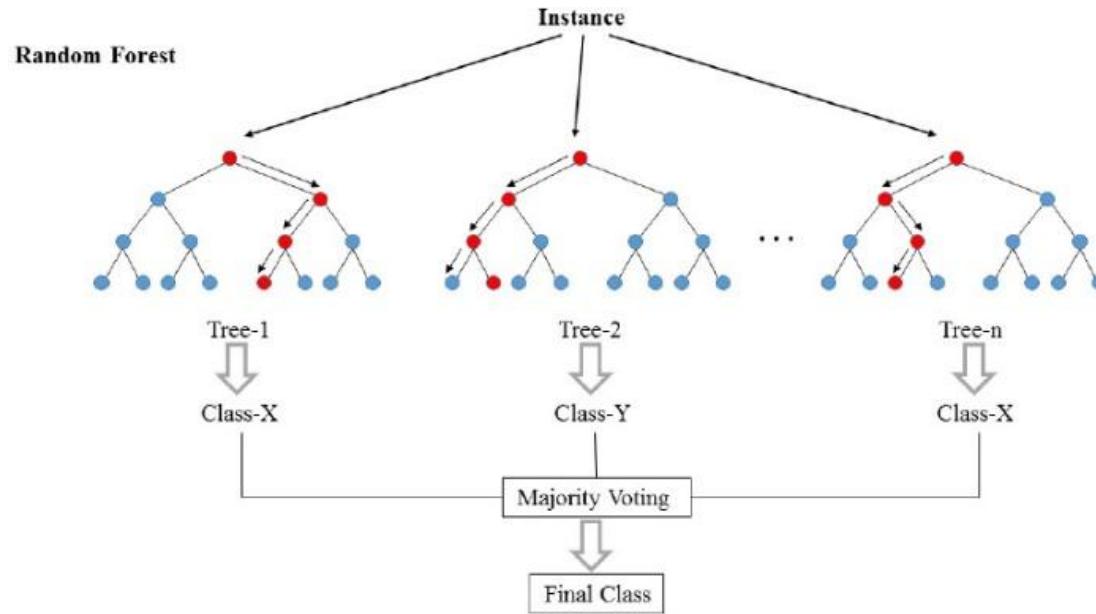
### 토지피복지도

- 환경공간정보서비스에서 제공하는 토지피복지도 이용
- 2022년 중분류 현행화된 자료 사용
- 22개로 나뉘는 중분류 지도를 7개로 나뉘는 대분류로 변환
- shp 파일을 rasterize를 통해 사용

label	name	label	name	label	name	label	name
100	Used Area	300	Forest Areas	500	Wetland	700	Water
200	Agricultural Land	400	Grassland	600	Barren		

# 2 본론 - Tree-based Methods Concepts

## ▶ RandomForest Classifier

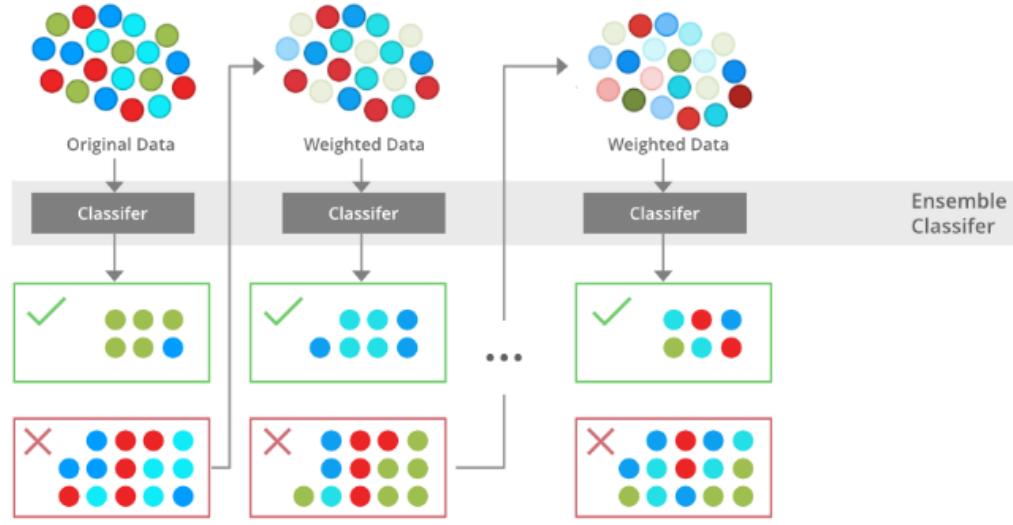


### Random Forest

- 양상별 학습 알고리즘
- 여러 개의 결정 트리를 기반으로 분류
- 무작위한 여러 개의 결정트리 예측을 결합하여 더 강력하고 안정적인 예측
- 오버피팅 문제 완화 가능
- 아웃 라이어에 영향을 크게 받지 않음

# 2 본론 - Tree-based Methods Concepts

## ▶ XGBoost Classifier

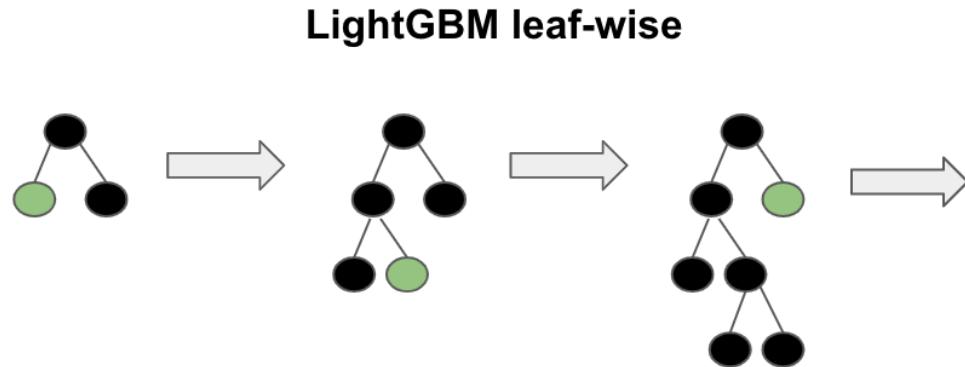


### XGBoost

- RF에 비해 조금 더 진보된 알고리즘
- Gradient Boosting 방법을 사용
- 예측이 잘 수행되지 못한 값들에 가중치를 두어 다음 모델에 부여하는 방식
- 오버피팅 문제 완화 가능
- 아웃 라이어에 영향을 크게 받지 않음

# 2 본론 - Tree-based Methods Concepts

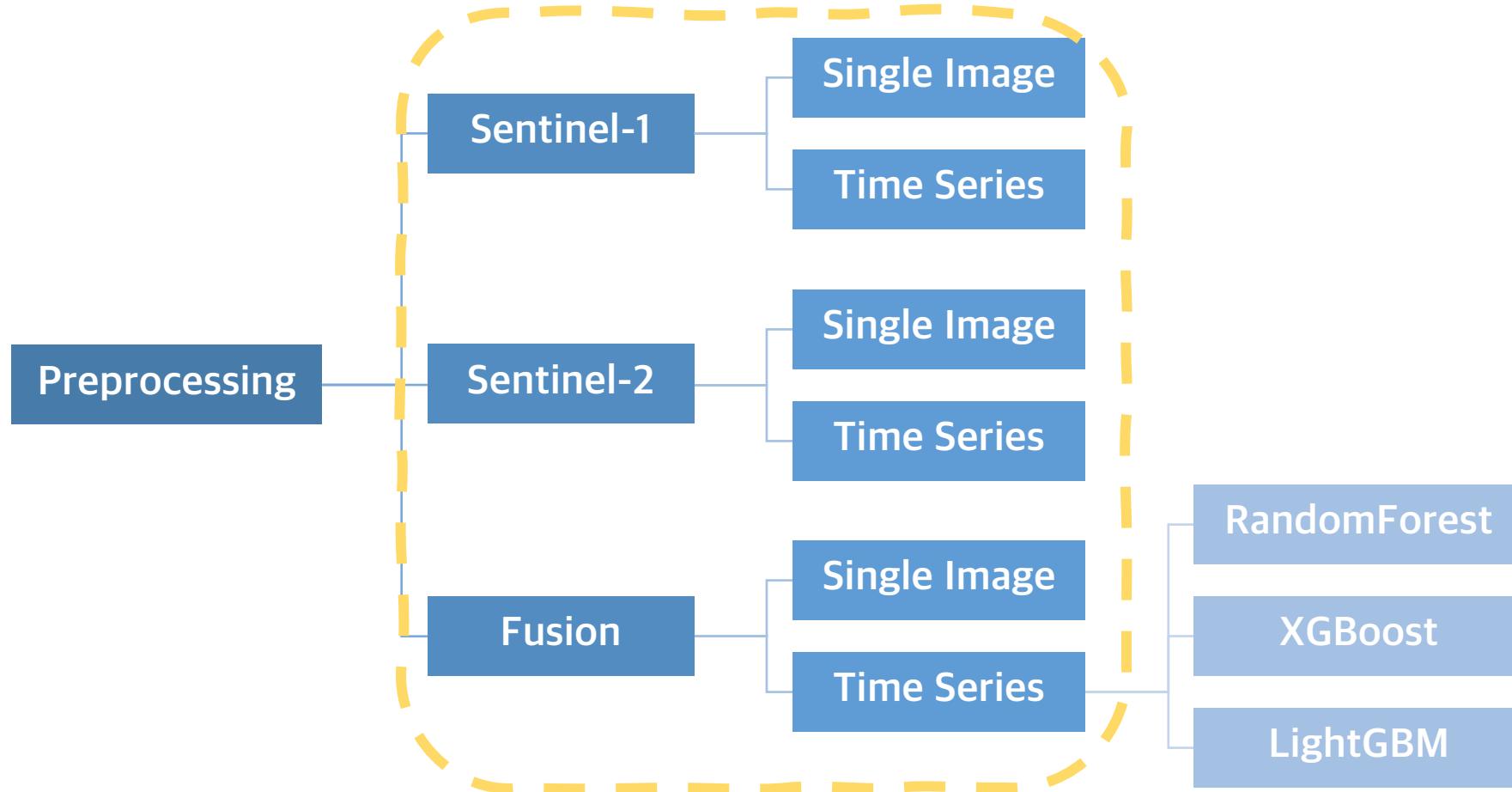
## ▶ LightGBM Classifier



### LightGBM

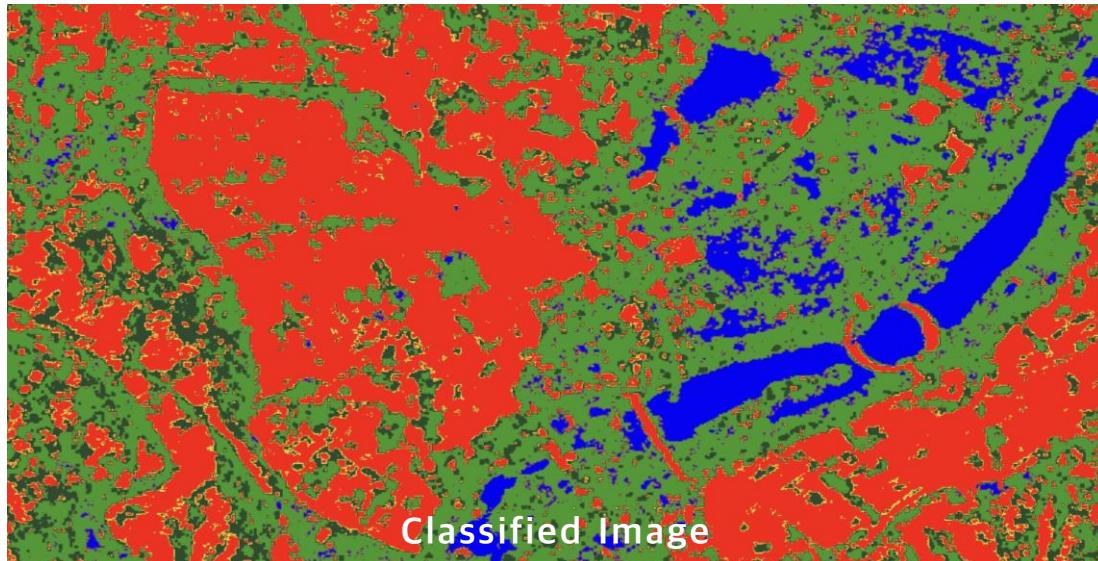
- gradient boosting 방식의 모델
- 노드를 분할할 때, 최대 손실 값을 갖는 leaf 노드를 지속적으로 분할 (leaf-wise)
- 데이터셋 및 고차원 데이터셋에서 탁월한 성능
- 학습 데이터에 대한 인코딩을 자동으로 수행
- 아웃 라이어에 영향을 크게 받지 않음

## 2 본론 - S1 vs S2 vs Fusion



## 2 본론 - Only Sentinel-1 Image segmentation

### ▶ Single Image



Classified Image



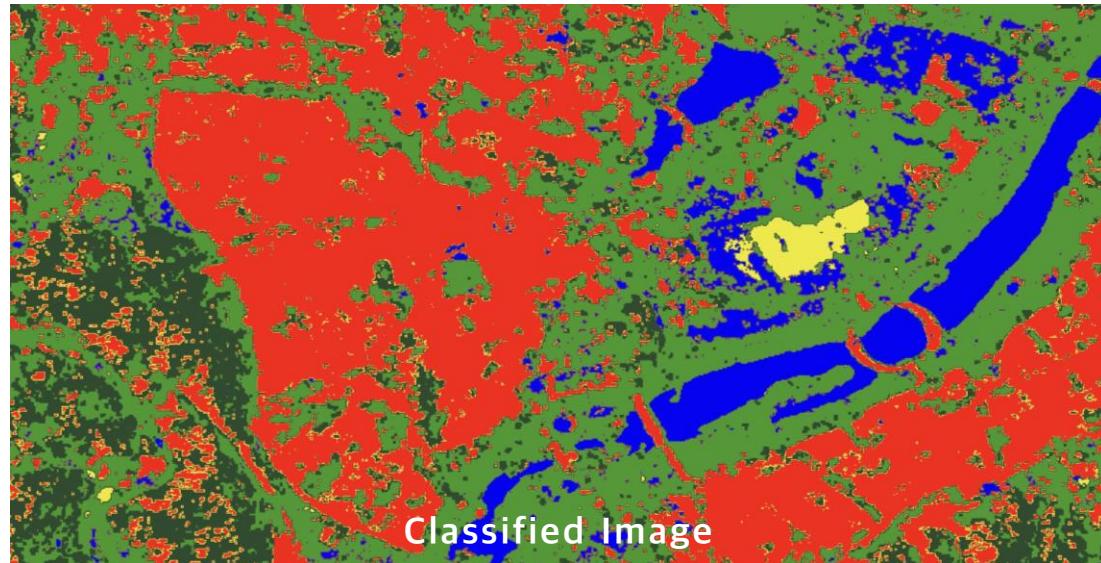
Label Image

☞ Hyperparameter(Randomsearch)  
{'n\_estimators': 100, 'min\_samples\_split': 10,  
                  'min\_samples\_leaf': 1, 'max\_depth': 10}

Used Area
Agricultural Land
Forest Areas
Grassland
Wetland
Barren
Water

## 2 본론 - Only Sentinel-1 Image segmentation

### ▶ Time Series Image



Classified Image



Label Image

Used Area
Agricultural Land
Forest Areas
Grassland
Wetland
Barren
Water

#### ☞ Hyperparameter(Randomsearch)

```
{'n_estimators': 100, 'min_samples_split': 2,  
 'min_samples_leaf': 1, 'max_depth': 30}
```

## 2 본론 - Only Sentinel-2 Image segmentation

### ▶ Single Image



☞ Hyperparameter(Randomsearch)

```
{'n_estimators': 100, 'min_samples_split': 20,  
 'min_samples_leaf': 6, 'max_depth': 20}
```

Used Area
Agricultural Land
Forest Areas
Grassland
Wetland
Barren
Water

## 2 본론 - Only Sentinel-2 Image segmentation

### ▶ Time Series Image



Classified Image



Label Image

☞ Hyperparameter(Randomsearch)  
{'n\_estimators': 200, 'min\_samples\_split': 8,  
 'min\_samples\_leaf': 12, 'max\_depth': 20}

Used Area
Agricultural Land
Forest Areas
Grassland
Wetland
Barren
Water

## 2 본론 - Fusion Image segmentation

### ▶ Single Image



Classified Image



Label Image

☞ Hyperparameter(Randomsearch)

```
{'n_estimators': 100, 'min_samples_split': 20,  
 'min_samples_leaf': 6, 'max_depth': 20}
```

Used Area
Agricultural Land
Forest Areas
Grassland
Wetland
Barren
Water

## 2 본론 - Fusion Image segmentation

### ▶ Time Series Image



Classified Image



Label Image

Used Area
Agricultural Land
Forest Areas
Grassland
Wetland
Barren
Water

#### ☞ Hyperparameter(Randomsearch)

```
{'n_estimators': 300, 'min_samples_split': 5,  
 'min_samples_leaf': 1, 'max_depth': 30}
```

# 2 본론 - Comparison by Datasets

## ▶ Evaluation

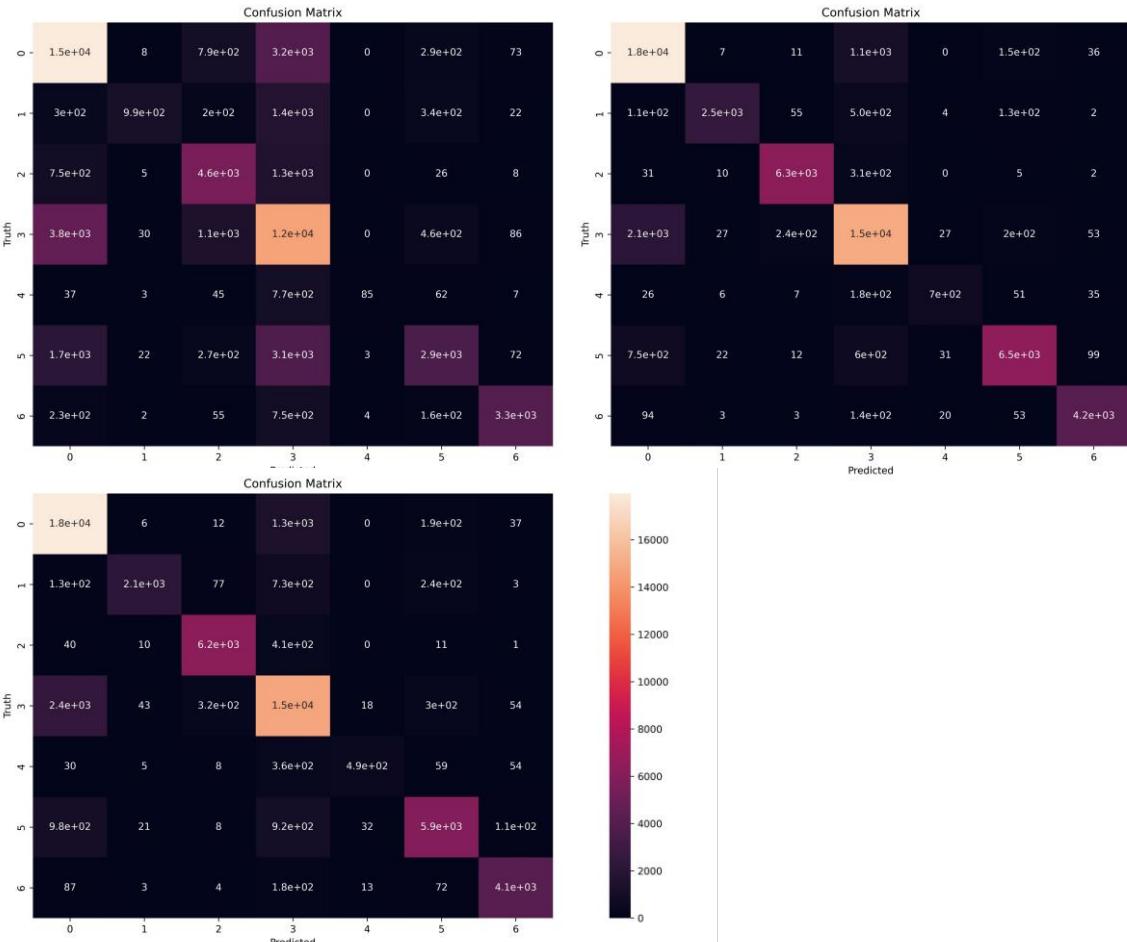
### Accuracy score - Single Image

Data	Accuracy score
S1 Only	X_test, y_test 0.5024
	X,y 0.5104
S2 Only	X_test, y_test 0.7780
	X,y 0.8293
Fusion	X_test, y_test 0.7926
	X,y 0.8455

### Accuracy score - Time Series

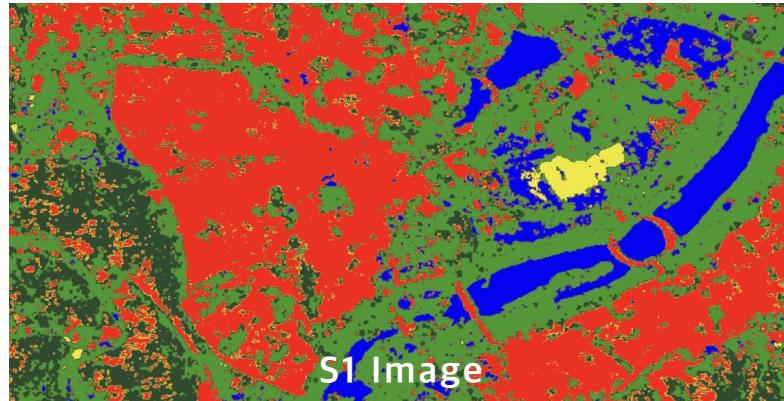
Data	Accuracy score
S1 Only	X_test, y_test 0.5983
	X,y 0.6554
S2 Only	X_test, y_test 0.8356
	X,y 0.8888
Fusion	X_test, y_test 0.8460
	X,y 0.9076

### Confusion Matrix - Time Series



# 2 본론 - Fusion Image segmentation

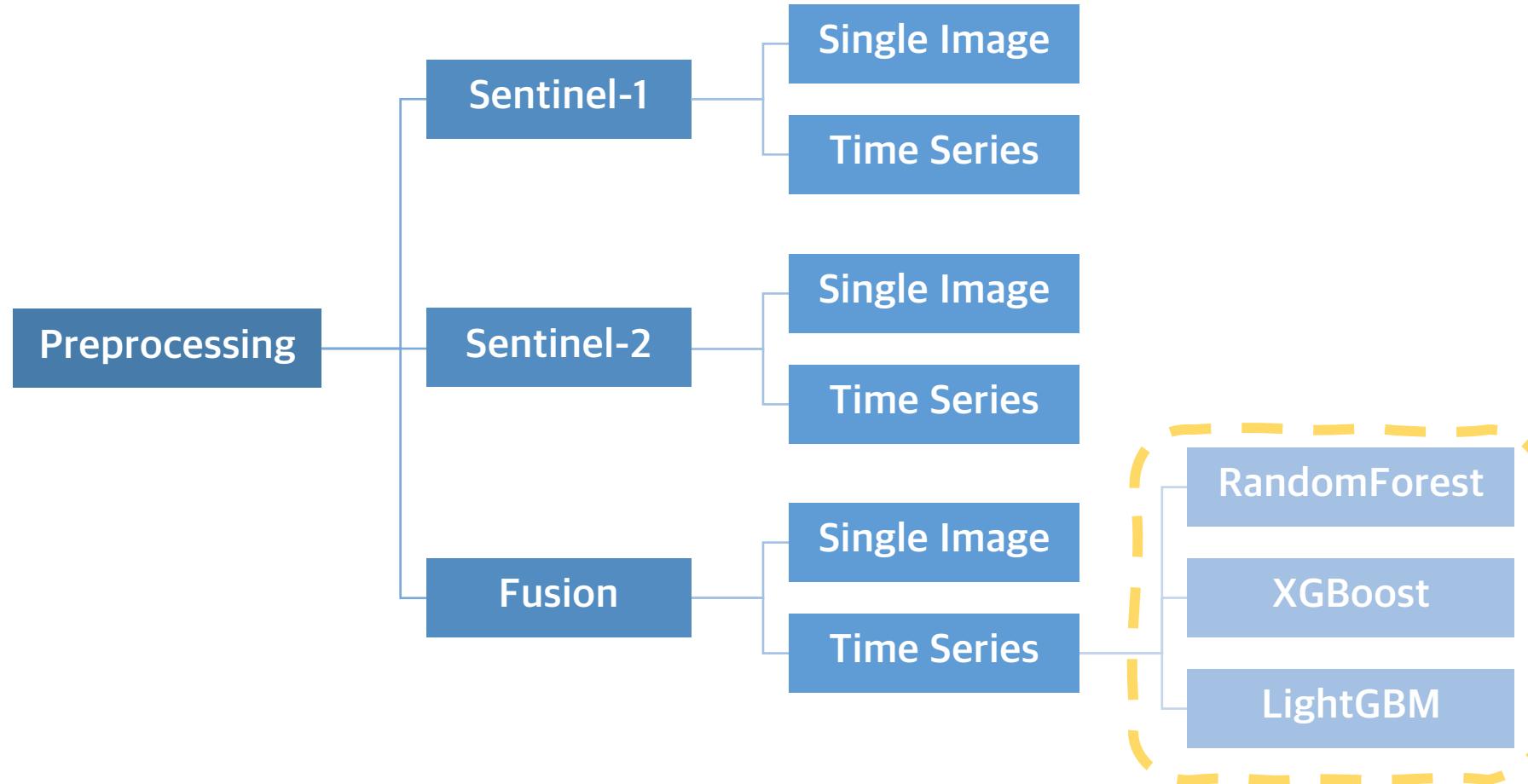
## ▶ Time Series Image



Data	Accuracy score	
S1 Only	y_test	0.5983
	y	0.6554
S2 Only	y_test	0.8356
	y	0.8888
Fusion	y_test	0.8460
	y	0.9076

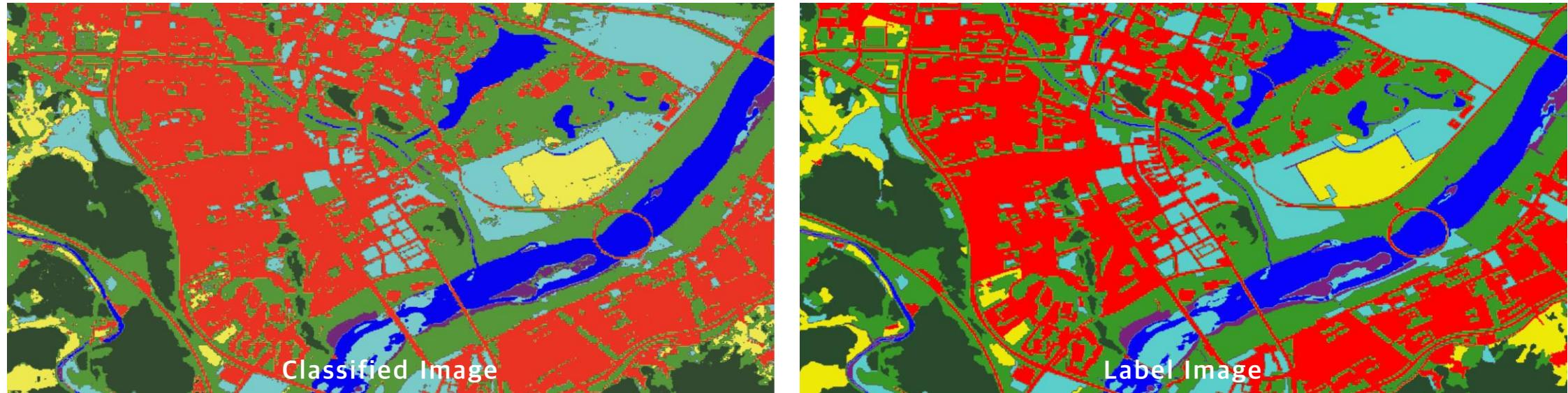


## 2 본론 - Tree-based Methods Concepts



## 2 본론 - Tree-based Method Comparison

### ▶ RandomForest Classifier



#### ☞ Hyperparameter(Randomsearch)

```
{'n_estimators': 300, 'min_samples_split': 5,  
 'min_samples_leaf': 1, 'max_depth': 30}
```

## 2 본론 - Tree-based Method Comparison

### ▶ XGBoost Classifier

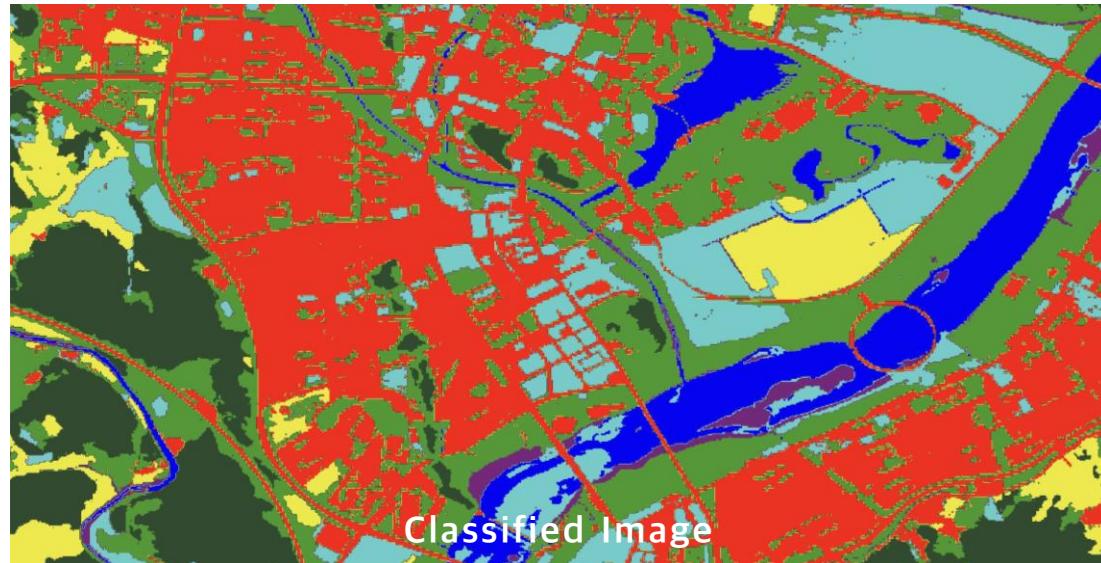


☞ Hyperparameter(Randomsearch)  
{Default}

Used Area
Agricultural Land
Forest Areas
Grassland
Wetland
Barren
Water

## 2 본론 - Tree-based Method Comparison

### ▶ LightGBM Classifier



#### ☞ Hyperparameter(Randomsearch)

```
{'subsample': 1.0, 'num_leaves': 50, 'n_estimators': 300, 'min_child_samples': 100,  
'max_depth': 10, 'learning_rate': 0.1, 'boosting_type': 'gbdt'}
```

Used Area
Agricultural Land
Forest Areas
Grassland
Wetland
Barren
Water

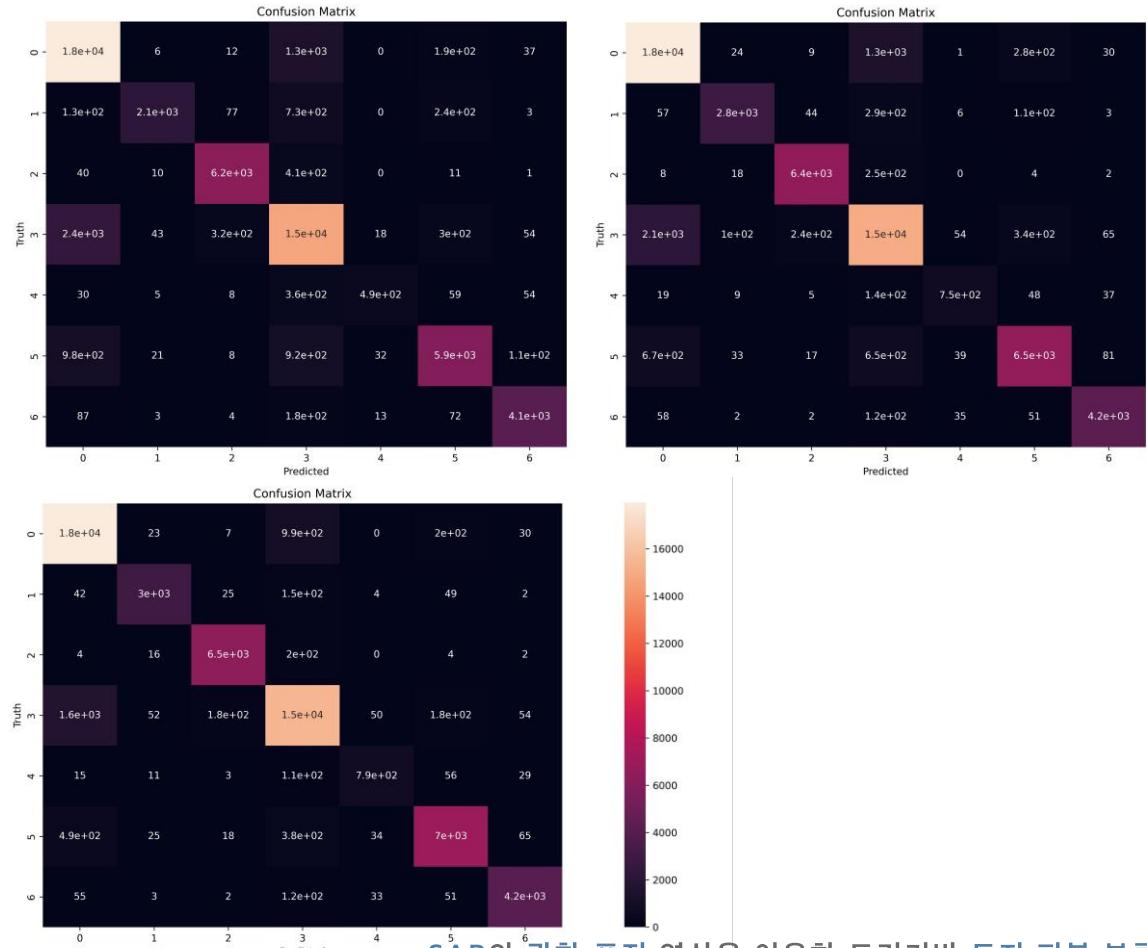
# 2 본론 - Comparison by Methods

## ▶ Evaluation

Accuracy score - Tree based Methods

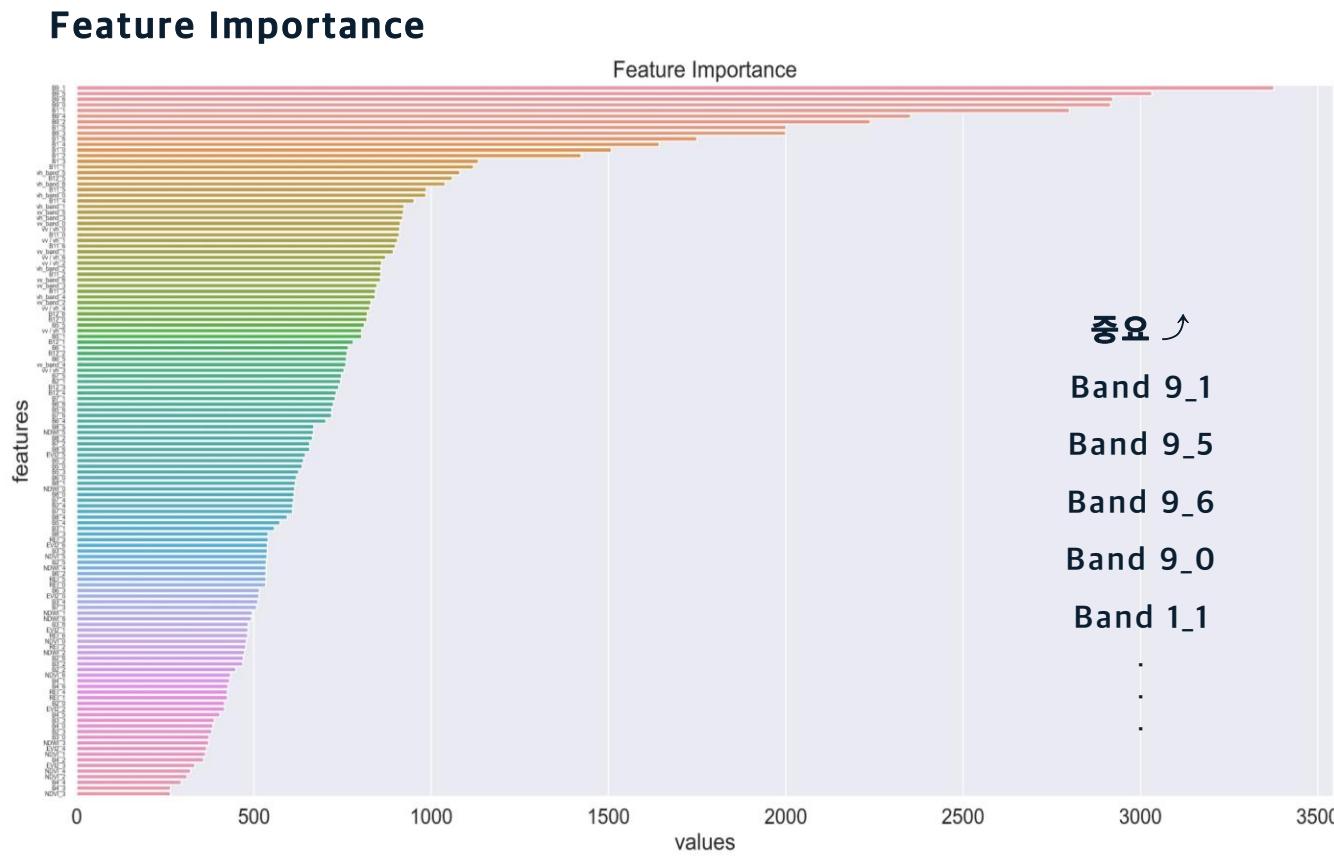
Data	Accuracy score
Random Forest	X_test, y_test 0.8460
	X,y 0.9076
XGBoost	X_test, y_test 0.8785
	X,y 0.9107
LightGBM	X_test, y_test 0.9108
	X,y 0.9517

Confusion Matrix - Tree based Methods



# 2 본론 - Comparison by Methods

# ► Evaluation

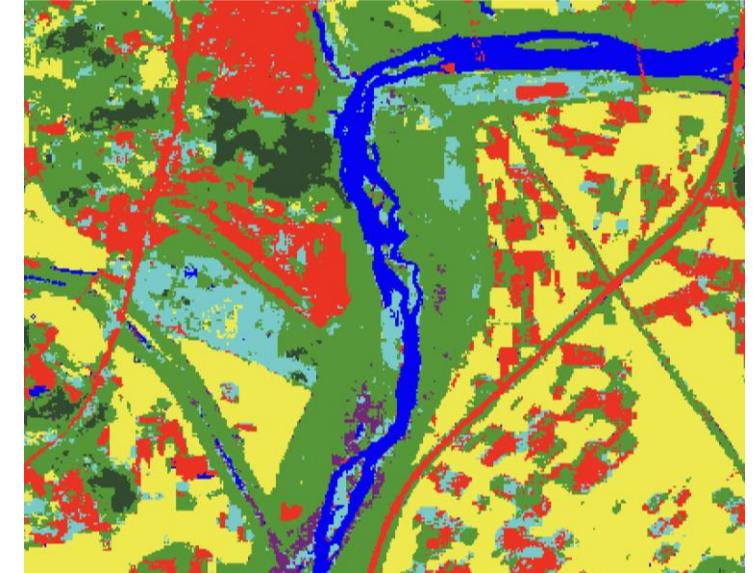
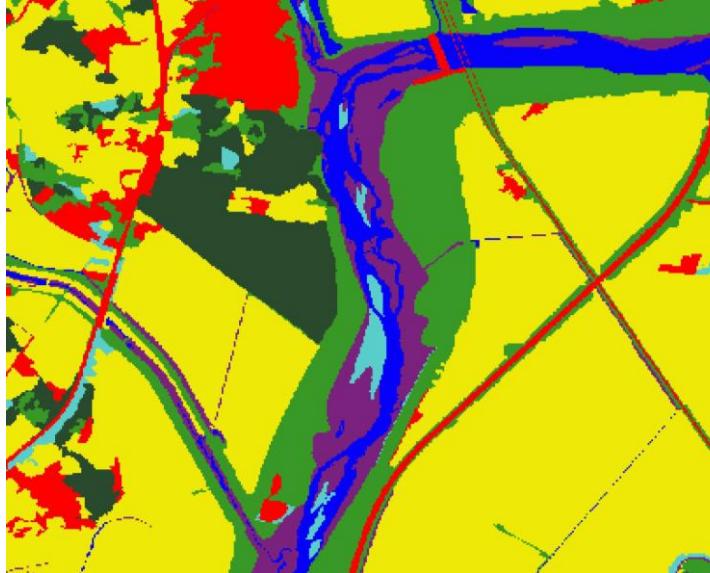


## Classification report- LGBM

label	precision	recall	f1-score	support
100	0.89	0.94	0.91	19262
200	0.96	0.92	0.94	3283
300	0.96	0.97	0.97	6696
400	0.89	0.88	0.88	17636
500	0.87	0.78	0.82	1006
600	0.93	0.87	0.9	8001
700	0.96	0.94	0.95	4477
accuracy			0.91	60361
macro avg	0.92	0.9	0.91	60361
weighted avg	0.91	0.91	0.91	60361

# 3 결론 - Result

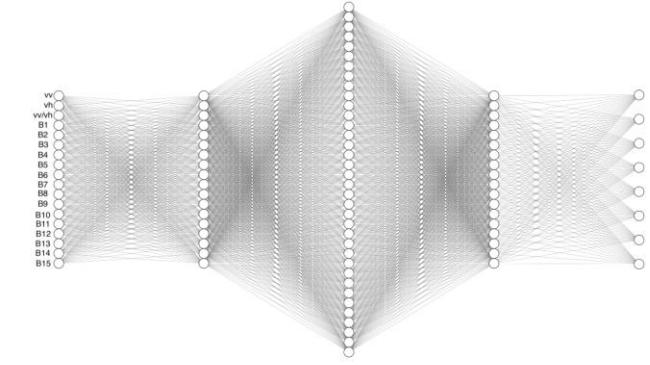
## ▶ Application



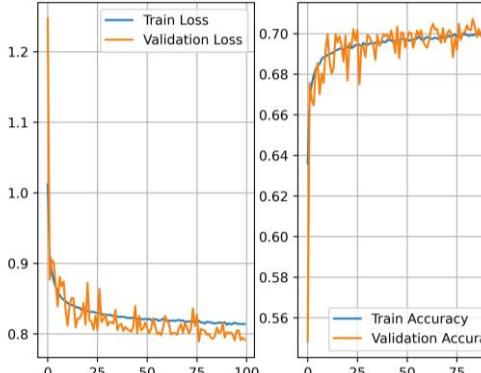
**Accuracy score**

Data	Accuracy score
LightGBM	0.6123

# 레이어(18,36,18)



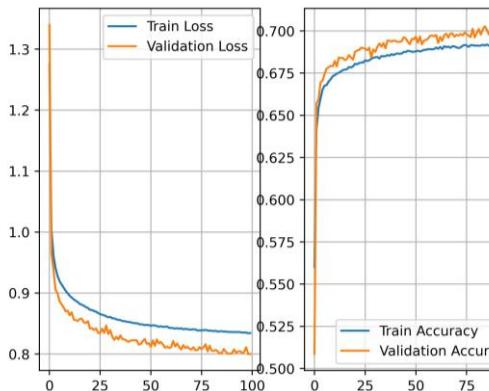
Epochs=100, learing\_rate=0.01



CNN Classified Image



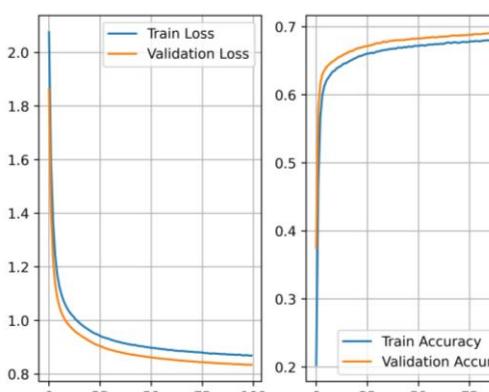
Epochs=100, learing\_rate=0.001



CNN Classified Image



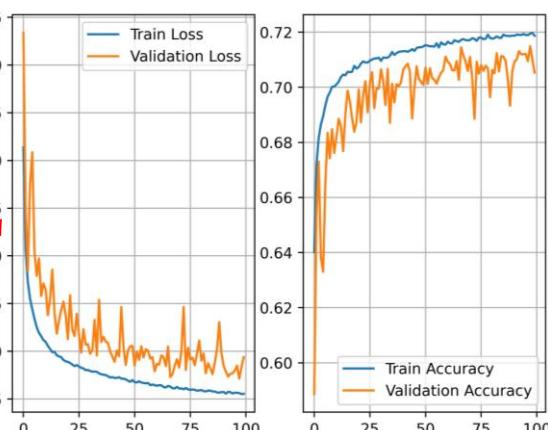
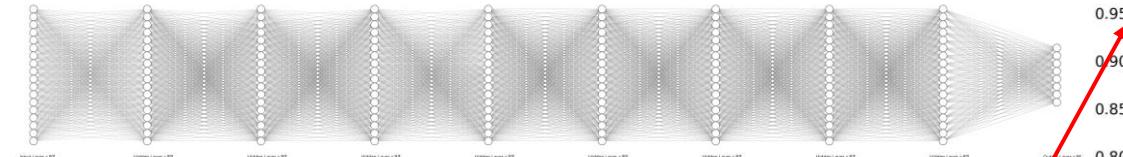
Epochs=100, learing\_rate=0.0001



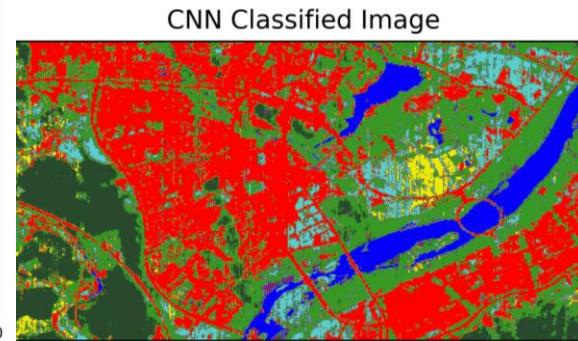
CNN Classified Image



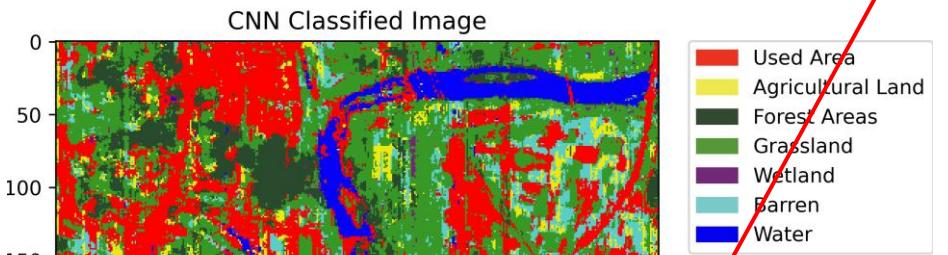
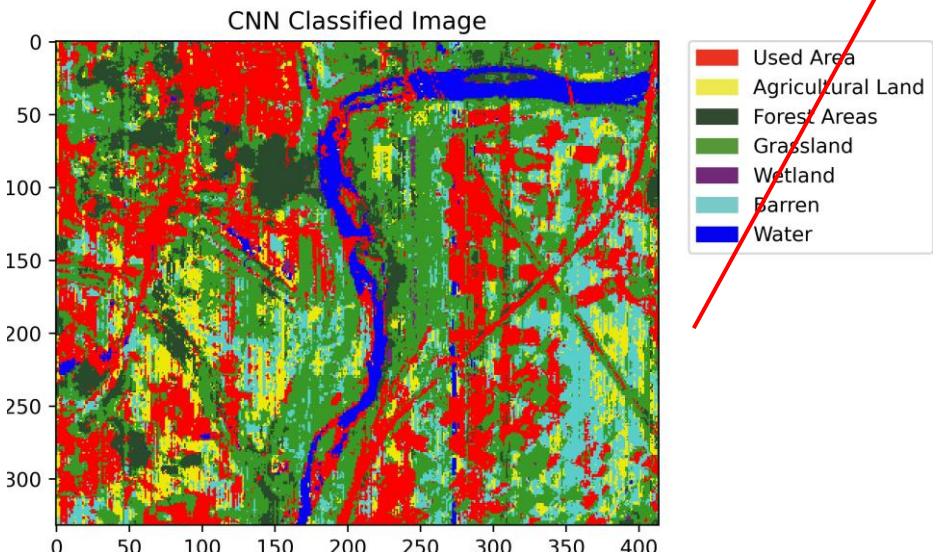
# 레이어(18,18,18,18,18,18,18,18)



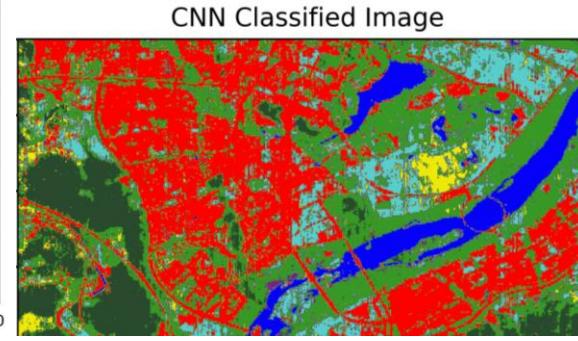
Epochs=100, learing\_rate=0.01



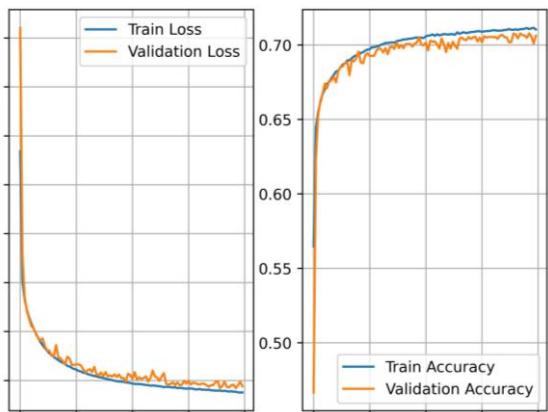
Used Area
Agricultural Land
Forest Areas
Grassland
Wetland
Barren
Water



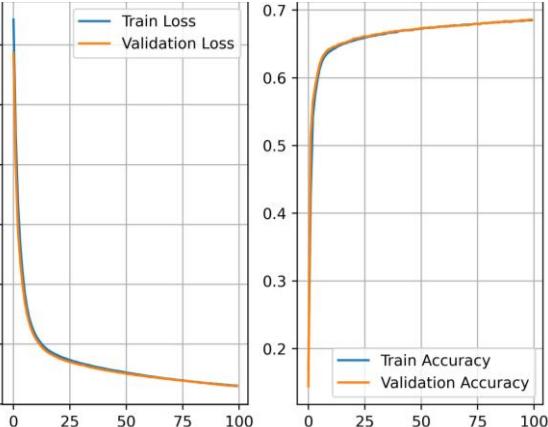
Epochs=100, learing\_rate=0.001



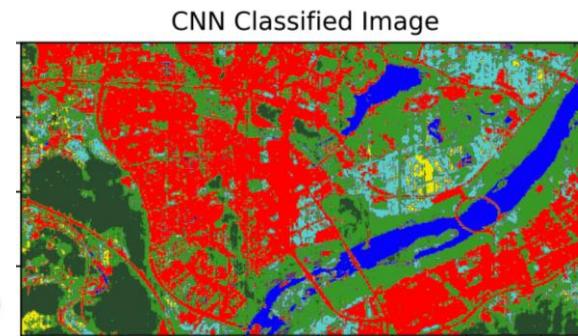
Used Area
Agricultural Land
Forest Areas
Grassland
Wetland
Barren
Water



CNN Classified Image

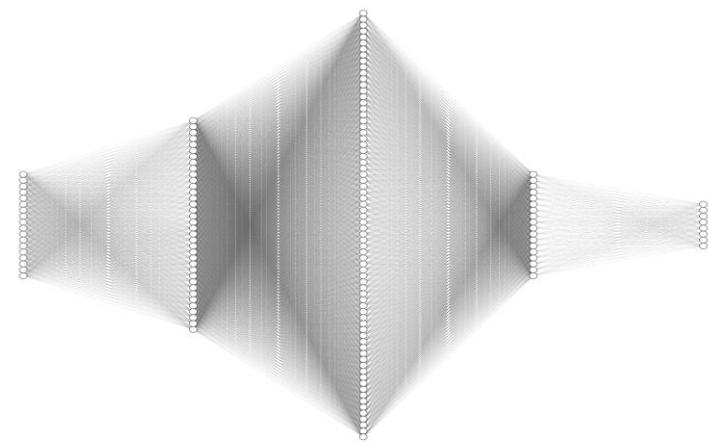


Epochs=100, learing\_rate=0.0001

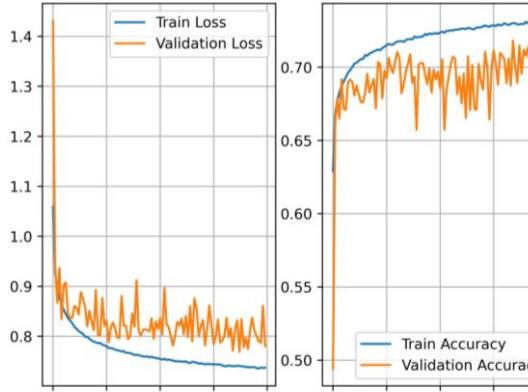


Used Area
Agricultural Land
Forest Areas
Grassland
Wetland
Barren
Water

레이어(18,36,72,36,18)



Epochs=100, learing\_rate=0.01

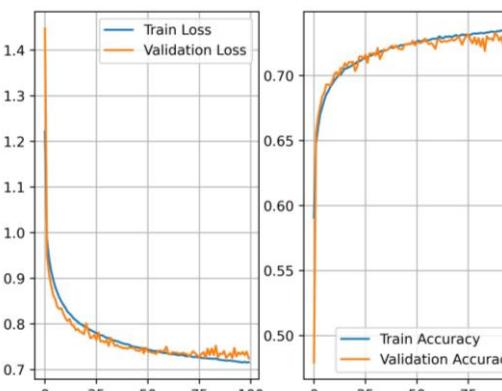


CNN Classified Image



Used Area
Agricultural Land
Forest Areas
Grassland
Wetland
Barren
Water

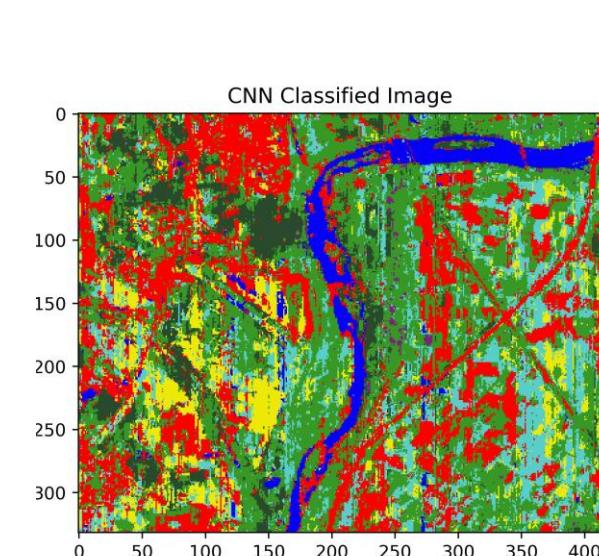
Epochs=100, learing\_rate=0.001



CNN Classified Image

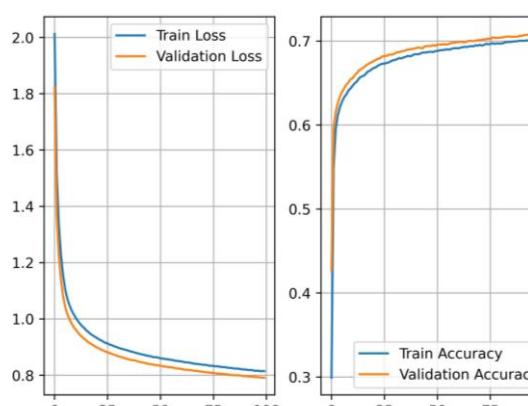


Used Area
Agricultural Land
Forest Areas
Grassland
Wetland
Barren
Water



Used Area
Agricultural Land
Forest Areas
Grassland
Wetland
Barren
Water

Epochs=100, learing\_rate=0.0001

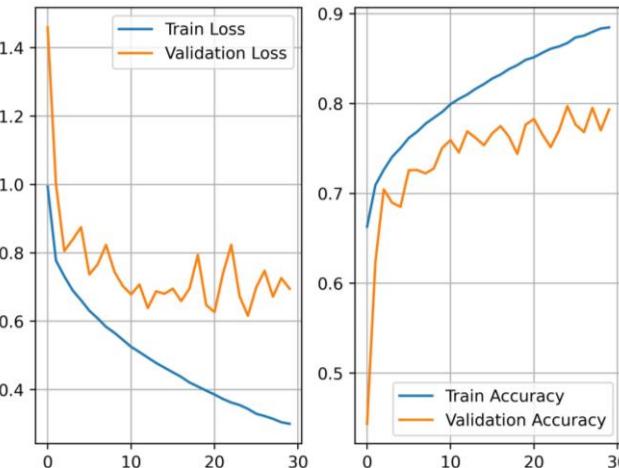
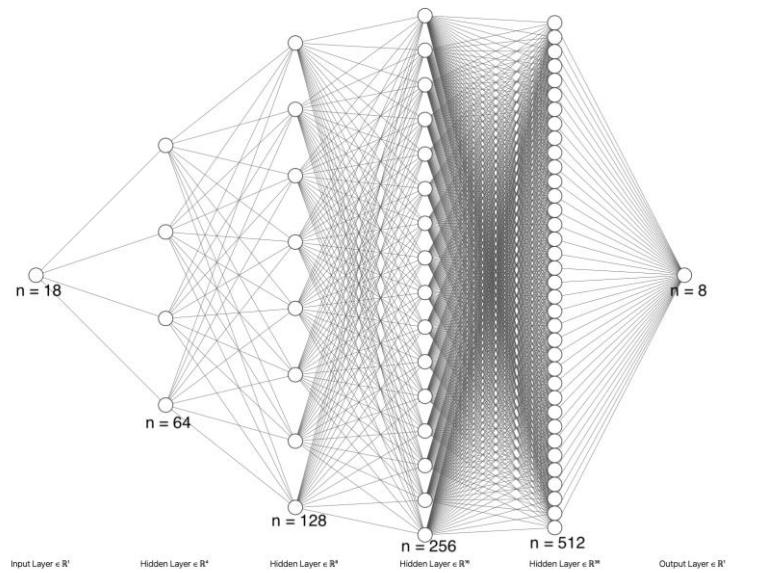


CNN Classified Image



Used Area
Agricultural Land
Forest Areas
Grassland
Wetland
Barren
Water

# 레이어(64,128,256,518)

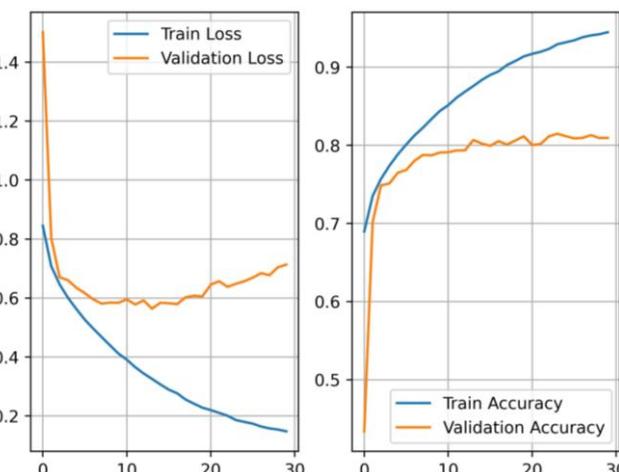


Epochs=30, learning\_rate=0.01

CNN Classified Image



- Used Area
- Agricultural Land
- Forest Areas
- Grassland
- Wetland
- Barren
- Water

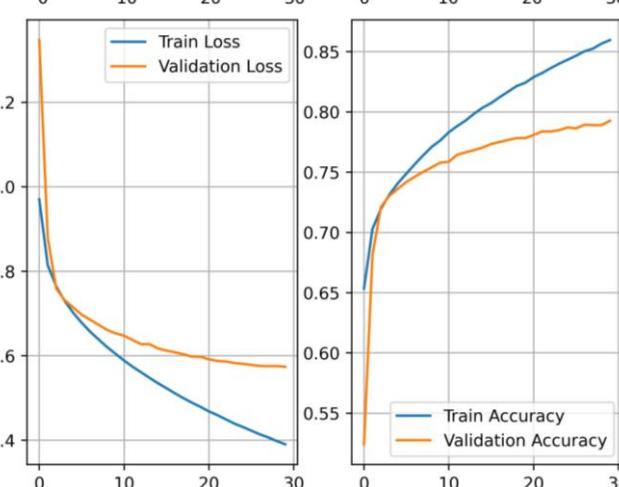
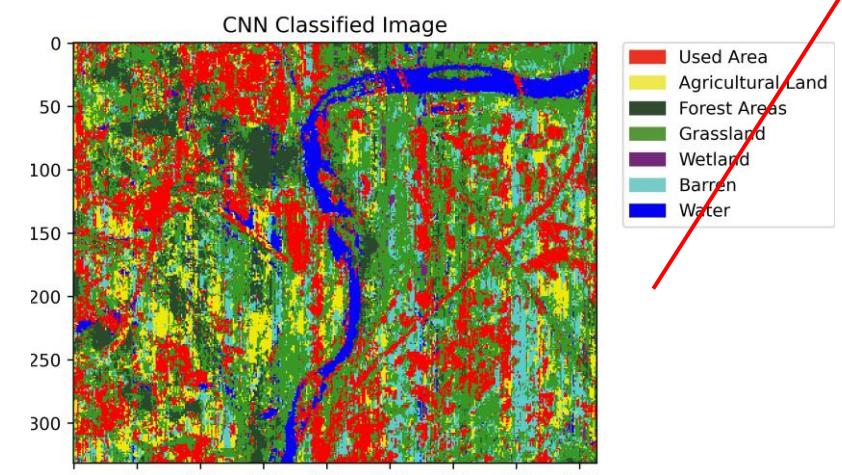


Epochs=30, learning\_rate=0.001

CNN Classified Image



- Used Area
- Agricultural Land
- Forest Areas
- Grassland
- Wetland
- Barren
- Water



Epochs=30, learning\_rate=0.0001

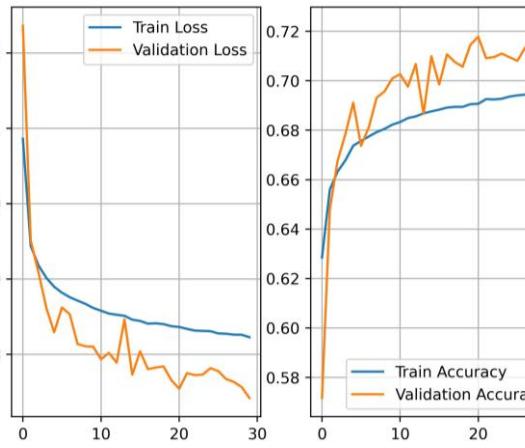
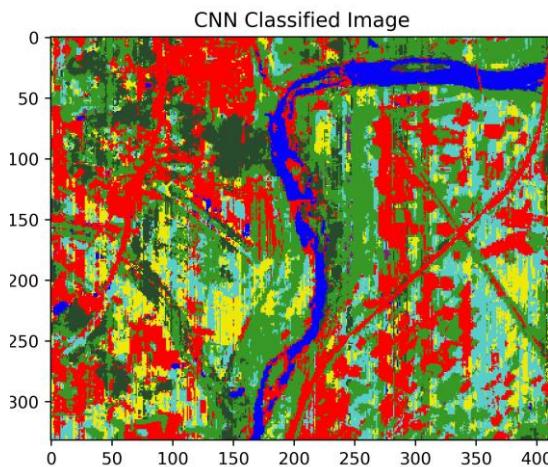
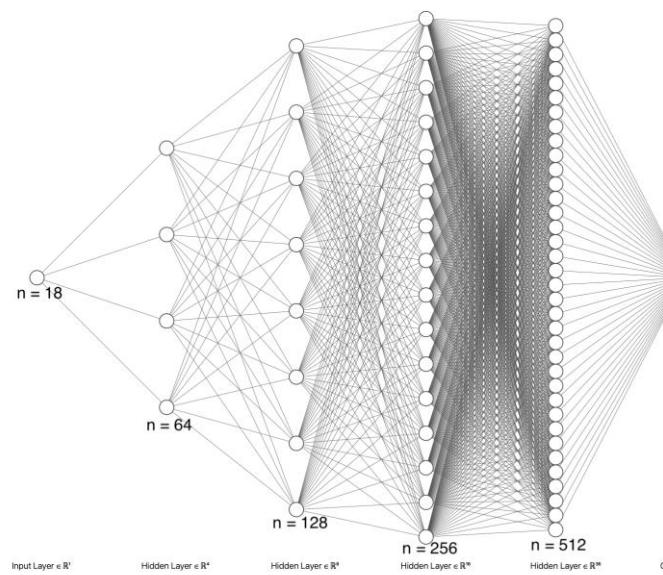
CNN Classified Image



- Used Area
- Agricultural Land
- Forest Areas
- Grassland
- Wetland
- Barren
- Water

레이어(64,128,256,518)

드롭아웃(0.25, 0.25, 0.25, 0.25, 0.4)



Epochs=30, learing\_rate=0.01

CNN Classified Image



Used Area	Red
Agricultural Land	Yellow
Forest Areas	Dark Green
Grassland	Light Green
Wetland	Purple
Barren	Cyan
Water	Blue

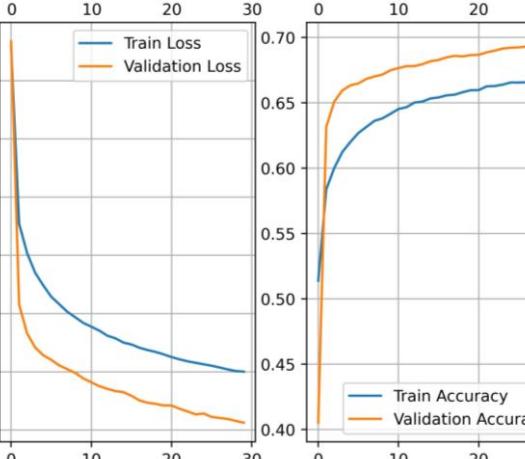


Epochs=30, learing\_rate=0.001

CNN Classified Image



Used Area	Red
Agricultural Land	Yellow
Forest Areas	Dark Green
Grassland	Light Green
Wetland	Purple
Barren	Cyan
Water	Blue



Epochs=30, learing\_rate=0.0001

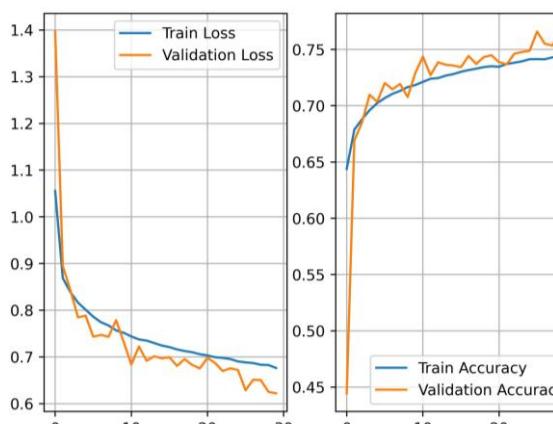
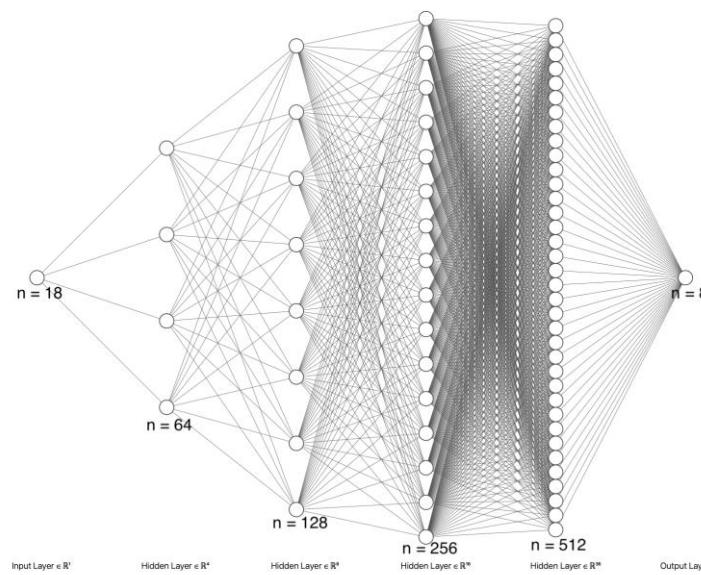
CNN Classified Image



Used Area	Red
Agricultural Land	Yellow
Forest Areas	Dark Green
Grassland	Light Green
Wetland	Purple
Barren	Cyan
Water	Blue

레이어(64,128,256,518)

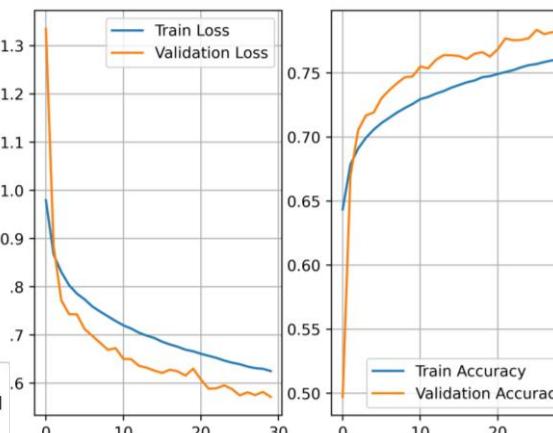
드롭아웃(0.1, 0.1, 0.1, 0.1, 0.2)



Epochs=30, learning\_rate=0.01  
CNN Classified Image



- Used Area
- Agricultural Land
- Forest Areas
- Grassland
- Wetland
- Barren
- Water

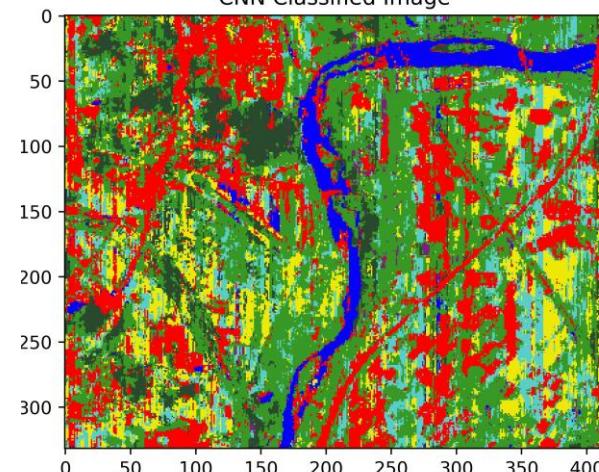


Epochs=30, learning\_rate=0.001  
CNN Classified Image

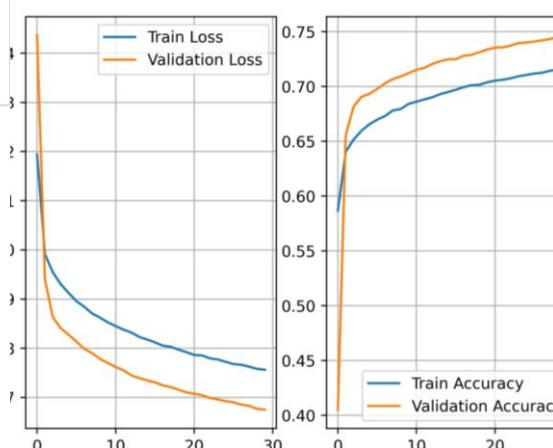


- Used Area
- Agricultural Land
- Forest Areas
- Grassland
- Wetland
- Barren
- Water

CNN Classified Image



- Used Area
- Agricultural Land
- Forest Areas
- Grassland
- Wetland
- Barren
- Water



Epochs=30, learning\_rate=0.0001  
CNN Classified Image



- Used Area
- Agricultural Land
- Forest Areas
- Grassland
- Wetland
- Barren
- Water