2025 DRAGON 6 SYMPOSIUM

14-18 JULY 2025

[PROJECT ID. 95177]

[MONITORING CROP GROWTH WITH BIG EARTH OBSERVATION SATELLITE DATA IN SUPPORT OF AGRICULTURAL MANAGEMENT]







2025 Dragon 6 Symposium

- Inform on the project’s objectives
- Detail the Copernicus Sentinels, ESA, Chinese and ESA Third Party Mission data utilised to achieve the project’s objectives (complete slide 4)
- Detail the in-situ data measurements and requirements
- Provide details on field data collection campaigns and periods in P.R. China or other study areas
- Inform on the project’s schedule, planning & contribution of the partners for the following year
- Report on the level and training of young scientists on the project achievements, including academic exchanges
- Brief overview on the European and Chinese young scientist's research (presented by the YSs, if attending the symposium)

2025 Dragon 6 Symposium

<JULY 15 2025>

ID. 95177

PROJECT TITLE: MONITORING CROP GROWTH WITH BIG EARTH OBSERVATION SATELLITE DATA IN SUPPORT OF AGRICULTURAL MANAGEMENT

PRINCIPAL INVESTIGATORS:

CHINESE LI: PROF. JINLONG FAN, BEIJING NORMAL UNIVERSITY, CHINA

EUROPEAN LI: PROF. PIERRE DEFOURNY, UNIVERSITE CATHOLIQUE DE LOUVAIN, BELGIUM

CO-INVESTIGATORS:

Dr. Miao Zhang, Associate professor, Aerospace Information Research Institute, Chinese Academy of Sciences

Dr. Qiaomei Su, Associate professor, Taiyuan University of Technology

Dr. Xiangsuo Fan, Associate professor, Guangxi University of Science and Technology

Prof. Yeping Zhang, National Satellite Meteorological Center

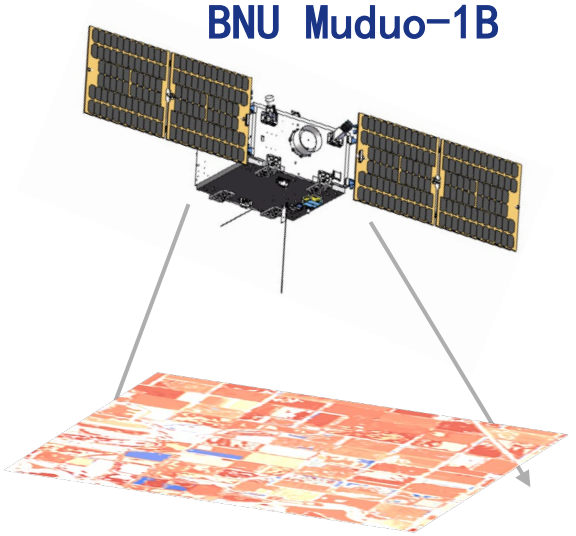


Main Objective

- to use high resolution of **optical, SAR and hyperspectral** satellite data from Europe and China for crop monitoring, in particular with a focus on **hyperspectral** data

EnMAP

- **The German Spaceborne Imaging Spectrometer**
- **420 nm to 1000 nm (VNIR) and 900 nm to 2450 nm (SWIR)**
- **30 km swath width at a spatial resolution of 30 x 30 m**
- **nadir revisit time of 27 days and off-nadir (30°) pointing feature for fast target revisit (4 days)**

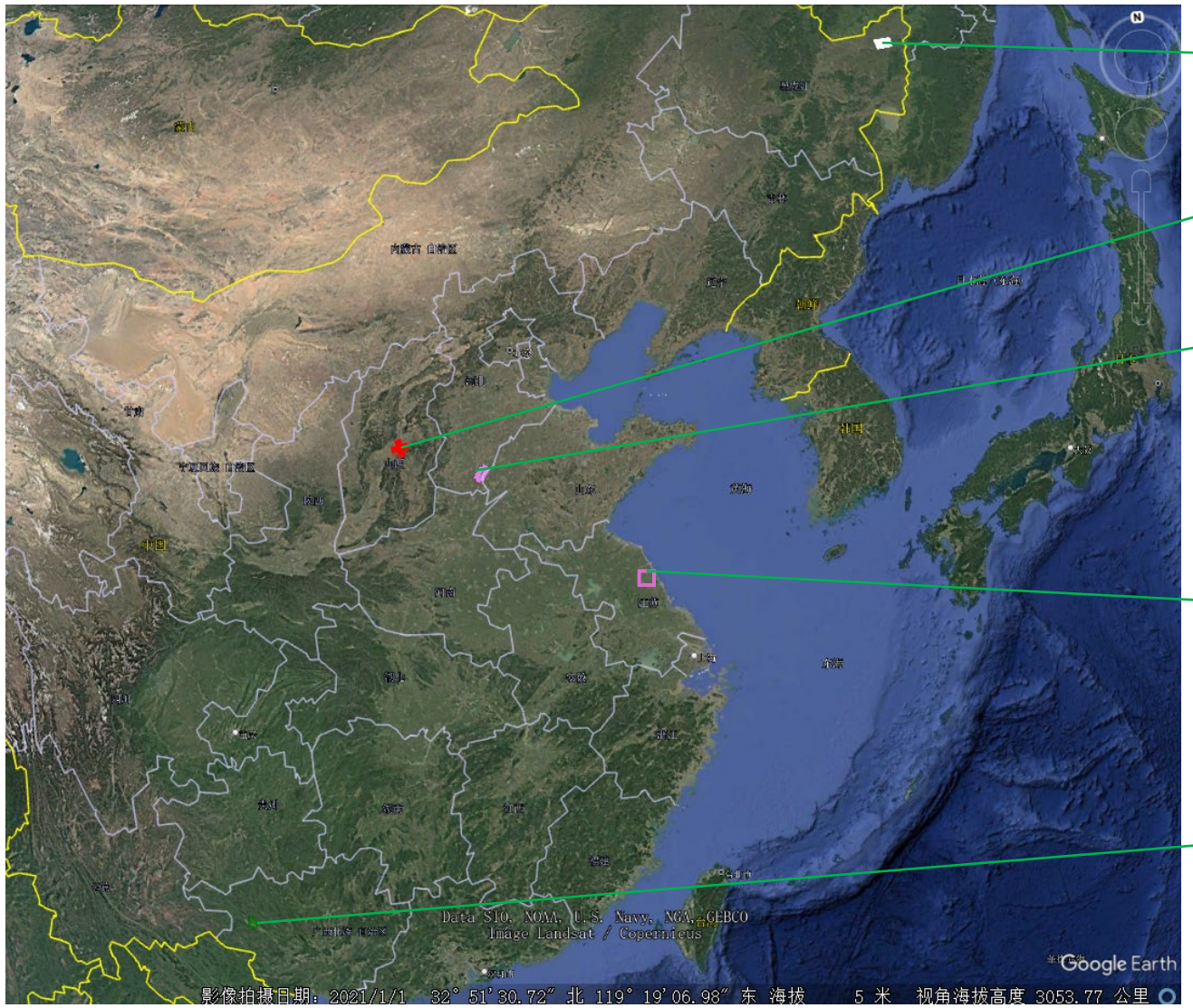


- **Beijing Normal University Muduo-1B Imaging Spectrometer**
- **410 nm to 1020 nm (VNIR) in 10m resolution**
- **1180 nm to 2480 nm (SWIR) in 30m resolution**
- **30 km swath width**

2025 Dragon 6 Symposium



Belgium-Hesbaye: winter cereals, potato, spring cereals and maize



Chuangye: Rice

Jinzhong: Maize

Guantao: Winter wheat, maize, bean, cotton

Yancheng: Winter wheat, barley, garlic, Rice, Maize

Guangxi: Sugarcane and vegetable

Scientific Questions for Dragon 6

(1) What are the performance differences between multispectral time series (Sentinel-2, Chinese GF series) and hyperspectral imagery (EnMap, Chinese Hyperspectral, Orbita and satellite launched by BNU in early 2026) for crop type mapping, in particular between similar crop types ?

(2) What is the transferability from one year to another for crop type classification models based on multispectral time series on one hand, and hyperspectral data on the other hand ?

Workplan 1

1. Chuangye Farm, China – The main task is the discrimination between rice species and rice varieties using EnMAP hyperspectral and Chinese hyperspectral satellite data and then the performance comparison
2. Guantao and Yancheng, China – The main tasks is crop type discrimination and hyperspectral model transferability testing from one year to another
3. Hesbaye, Belgium – The farm land is in the flat and hilly area. The main task is to discriminate similar crop types (e.g. wheat, barley, spelt, rye) with various sources of satellite data, including hyperspectral data

Scientific Questions for Dragon 6

(1) What are the performance differences between multispectral time series (Sentinel-2, Chinese GF series) and hyperspectral imagery (EnMap, Chinese Hyperspectral, Orbita and satellite launched by BNU in early 2026) for crop type mapping, in particular between similar crop types ?

(2) What is the transferability from one year to another for crop type classification models based on multispectral time series on one hand, and hyperspectral data on the other hand ?

Workplan 2

1. Chuangye Farm, China – The main task is crop management practice identification with various satellite data in support of crop management
2. Jinzhong, China – The main task is the crop type, crop management practice identification with various satellite data, under the complex agricultural cultivation in typic northern China
3. Guangxi, China – The main tasks is crop type discrimination with deep learning model under the complex agricultural cultivation in typic southern China

Teams and Contribution

Chinese Teams:

Prof. Jinlong Fan, BNU

Dr. Miao Zhang, AIRCAS
Dr. Qiaomei Su,TYUT
Dr. Xiangsuo Fan,GXUST
Prof. Yeping Zhang,NSMC

1. Project coordination and management
2. Site management, Field survey and data collection in study sites in China
3. Crop type mapping with various Chinese satellite data
4. Crop monitoring with high resolution satellite data

European Teams:

Prof. Pierre Defourny, UCLouvain
Res. Maxime Troiani, UCLouvain

1. European site management
2. Field data collection in European site
3. EnMap data access coordination
4. State-of-the-art EO data processing

Field Campaigns and Data Acquisition

Field Selection

- Large pure block of more than 1 ha with the same crop type
- Minimum 200+ large fields

Period of Field Campaign

- Guantao (March - April for winter, August for summer)
- Yancheng (March - April for winter, July-August for summer)
- Chuangye (July -August)
- Hesbaye (May-June)
- Jinzhong (November - February for winter practices, and July - August for crop mapping)
- Guangxi (July – November)

Site Plan

- Guantao, 2024/2025/2026
- Yancheng, 2024/2025/2026
- Hesbaye, 2024/2025/2026
- Chuangye, 2025/2026/2027/2028
- Jinzhong, 2025/2026/2027/2028
- Guangxi, 2025/2026/2027/2028

Satellite data to be acquired

- Sentinel- 1/2
  - Since Growing Season 2024 – 2028
- EnMap
  - Since Growing Season 2024 - 2027
- GF-1/6
  - Since Growing Season 2024- 2028
- BNU-1A/B
  - Since Growing Season 2026- 2028

Dragon 6 EO Data Delivery

Data access (list all missions and issues if any). NB. in the tables please insert cumulative figures (since June 2025) for no. of scenes of high bit rate data (e.g. S1 100 scenes). If data delivery is low bit rate by ftp, insert “ftp”

ESA /Copernicus Missions	No. Scenes
1. SENTINEL 2A/B/C	200
2. SENTINEL 1A/B/C	100
3.	
4.	
5.	
6.	
Total:	300
Issues:	

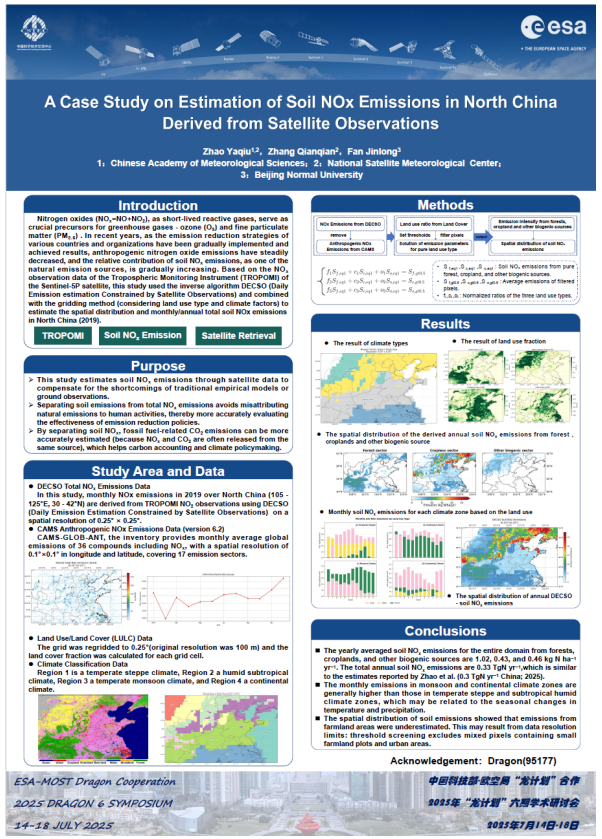
ESA Third Party Missions	No. Scenes
1. LANDSAT8/9	200
2.EnMap	50
3.	
4.	
5.	
6.	
Total:	250
Issues: EnMap is not the third party mission data but we will access these data through the agreement between EnMap and UCLouvan	

Chinese EO data	No. Scenes
1. GF-1/6	300
2. BNU 1B	100
3. Jilin-1 High Resoultion Optical Imager (JL1-GP01 and JL1-GP02)	100
4. CBERS-4 MUXCAM	100
5. SDGSAT-1 MSI Multispectral Imager	100
6.	
Total:	700
Issues:Jilin-1 released a dataset and we will check if some data is available for our study.	

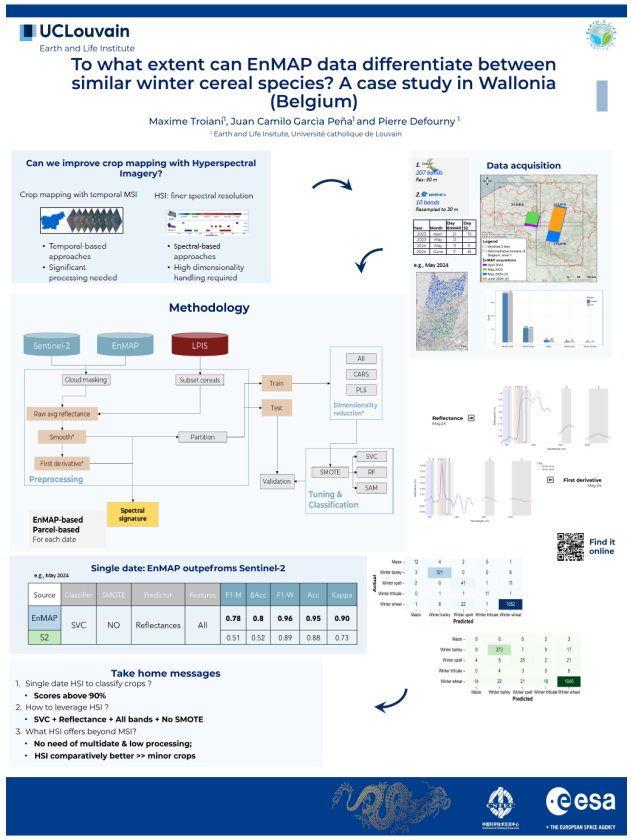
European Young Scientists contributions in Dragon 6

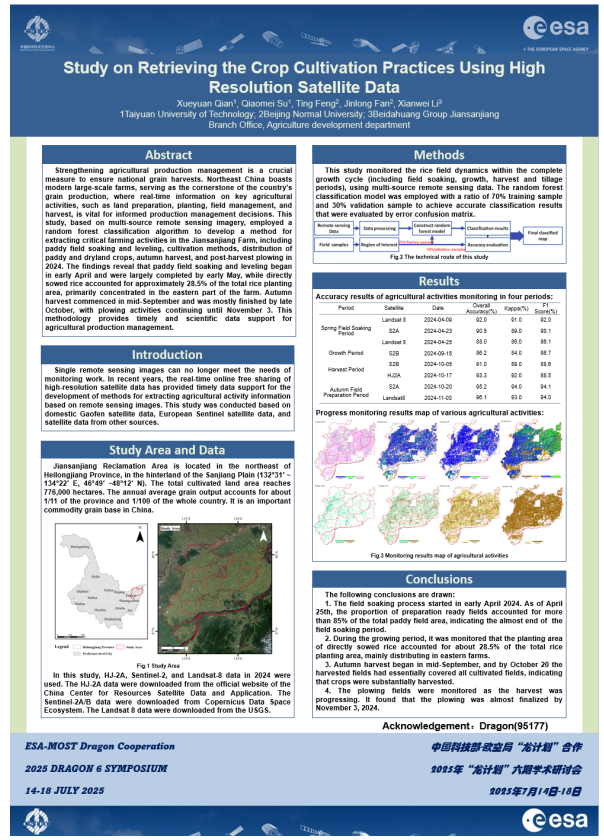
Name	Institution	Poster title	Contribution including period of research
Yaqiu Zhao	National Satellite Meteorological Center	A Case Study on Estimation of Soil Nox Emissions in North China Derived from Satellite Observations	July 2024 – July 2027
Xueyuan Qian	Taiyuan University of Technology	Study on Retrieving the Crop Cultivation Practices Using High Resolution Satellite Data	July 2024 – July 2026
Xiangsuo Fan	Guangxi University of Science and Technology	D-CGG: Research on Hyperspectral Remote Sensing Classification Algorithm Based on Convolutional Neural Network and Linkage Graph Attention Collaboration	July 2024 – July 2028
Maxime Troiani	Université catholique de Louvain	To what extent can EnMAP data differentiate between similar winter cereal species? A case study in Wallonia (Belgium)	July 2024 – July 2028

European Young Scientists contributions in Dragon 6









Overview of European YSs research



Hyperspectral satellite imagery for cereal discrimination

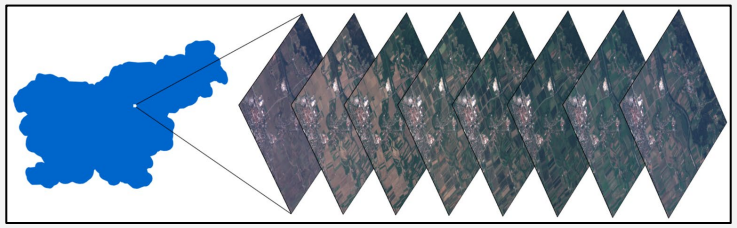
Maxime Troiani & Juan Camilo García Peña,
Earth and Life Institue, UCLouvain, Belgium





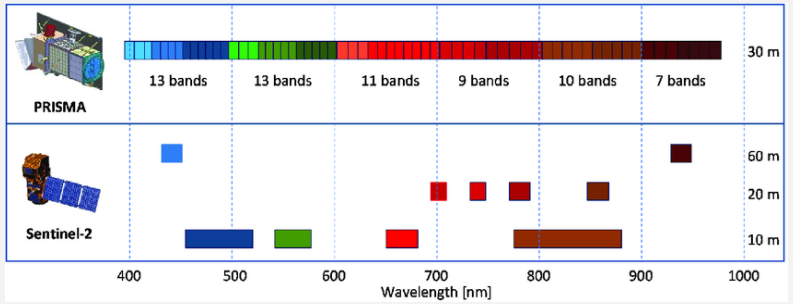
Context & Objectives

Crop mapping with temporal MSI



- Temporal-based approaches
- Significant processing needed

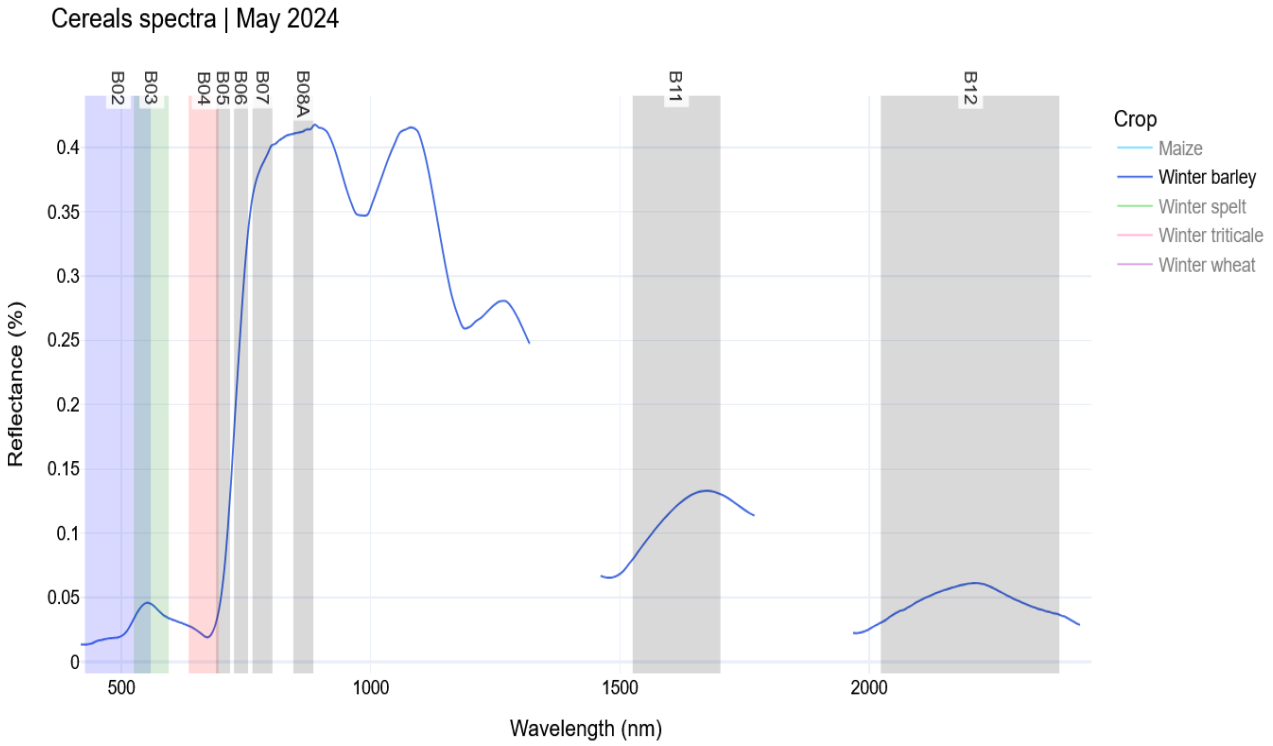
HSI: finer spectral resolution



- Spectral-based approaches
- High dimensionality handling required

Context & Objectives

- Classify cereals using HSI >> Benchmark, best way to handle HSI?
- Compare HSI and MSI-based classification >> added value at all?



Data & study area

1. EnMAP

207 bands

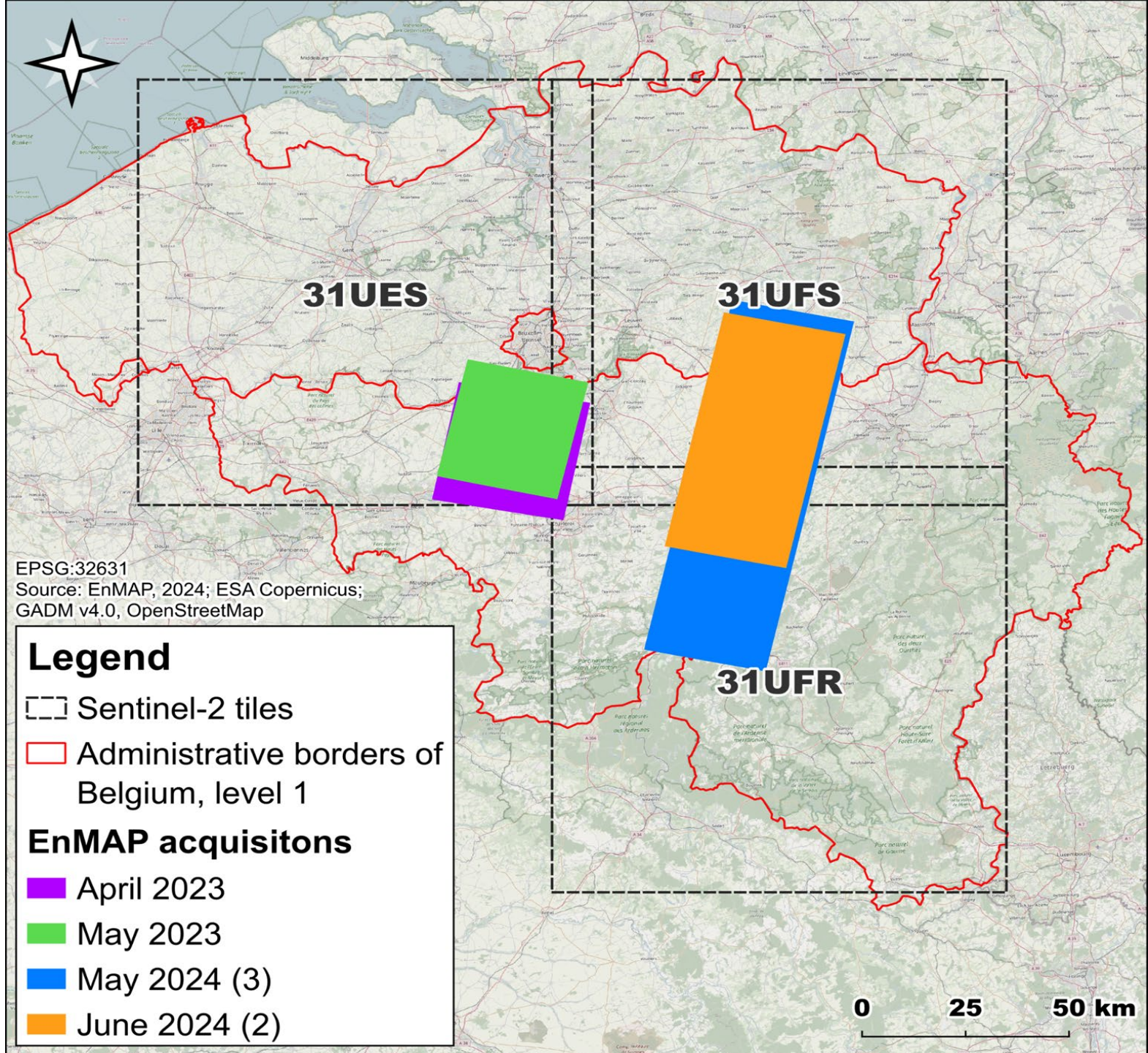
Res: 30 m

2. sentinel-2

10 bands

Resampled to 30 m

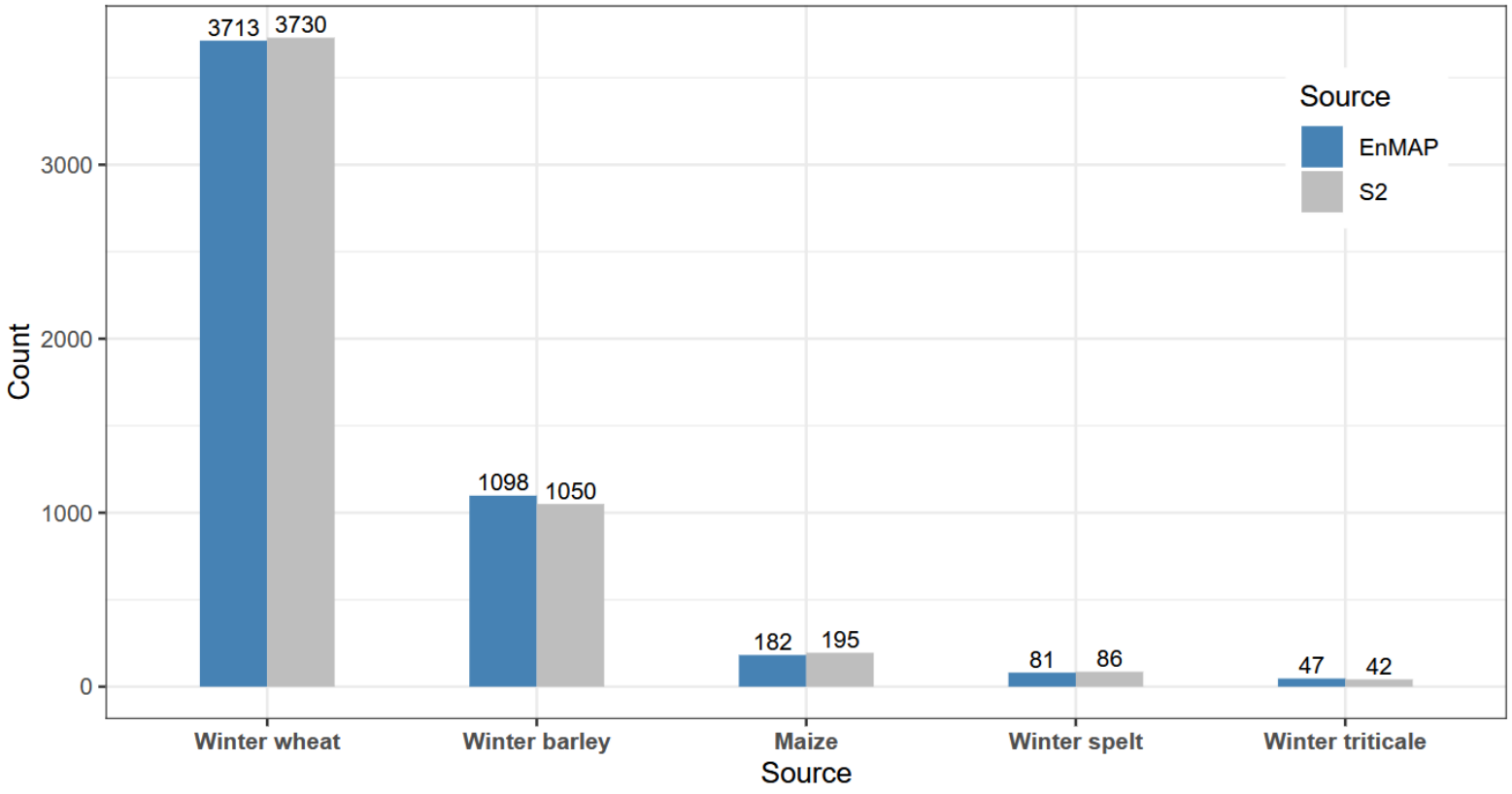
Year	Month	Day EnMAP	Day S2
2023	April	21	15
2023	May	3	-
2024	May	11	11
2024	June	7	8

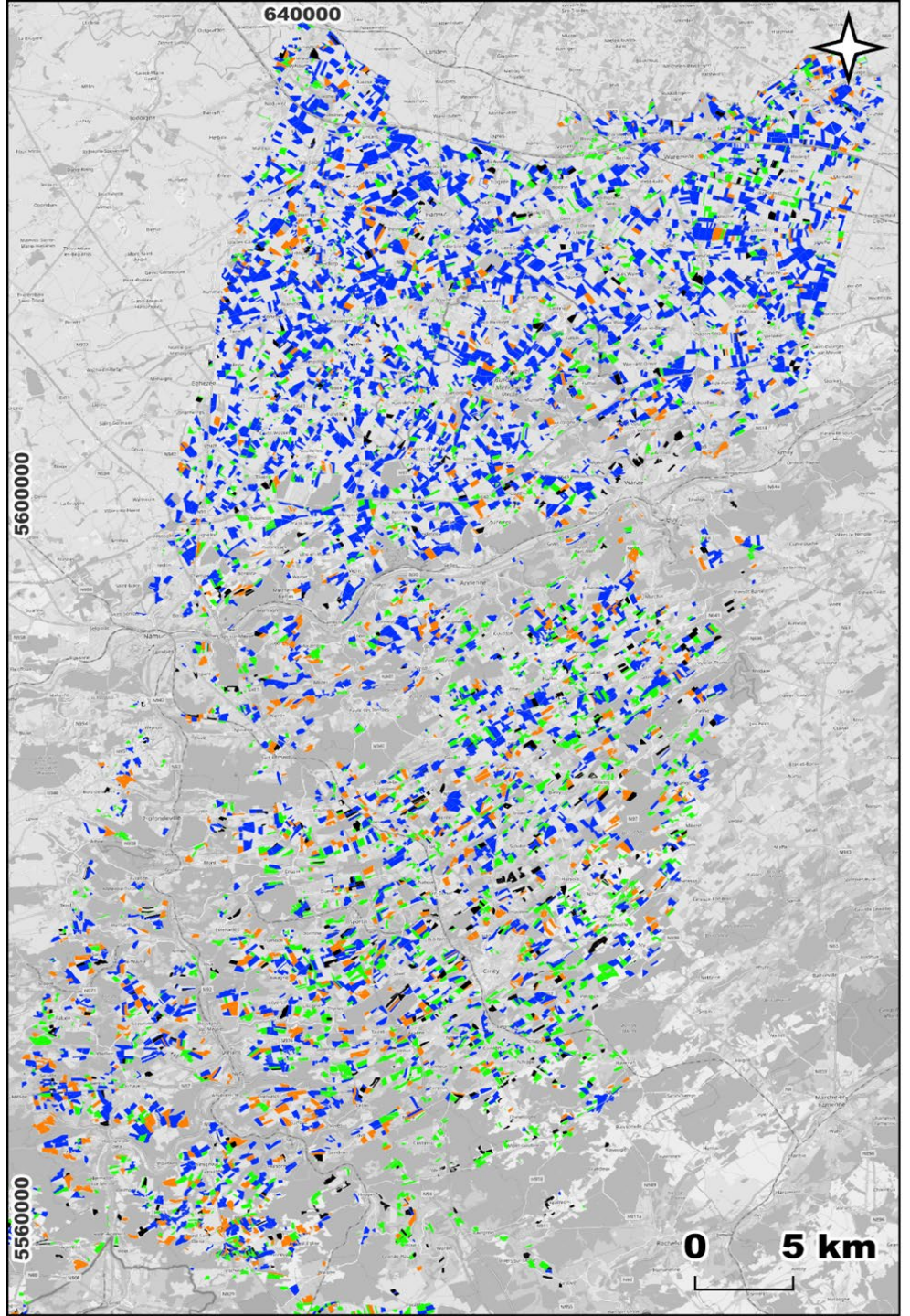


Data & study area

Crop	Winter wheat	Winter barley	Maize	Winter spelt	Winter triticale	Spring Wheat
Date	All	All	Not June 24	Not May 23		Only June 24

e.g., May 2024





Data preprocessing

EnMAP

S2

- Smooth and resample (30 m)
- Cloud masking

LPIS

Cloud masking

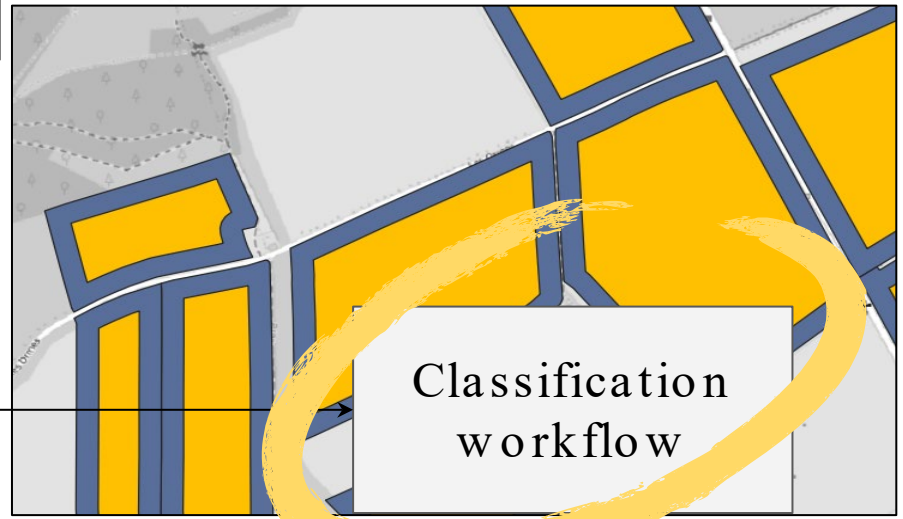
Inner buffer (30m)

NDVI

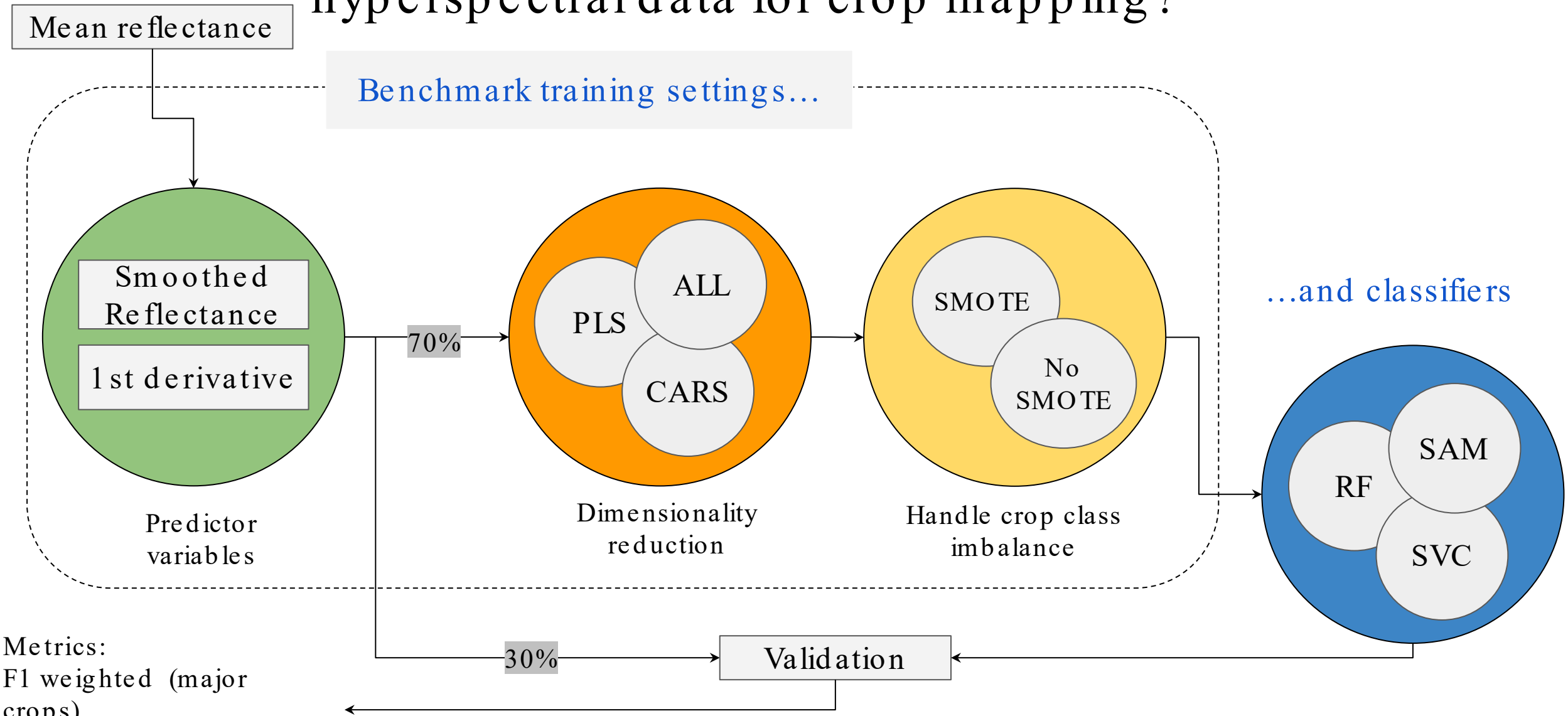
Mean reflectance / parcel & band

Discard (NDVI<0.7)

Discard (< 30 obs)



Workflow on EnMAP: How to leverage hyperspectral data for crop mapping?



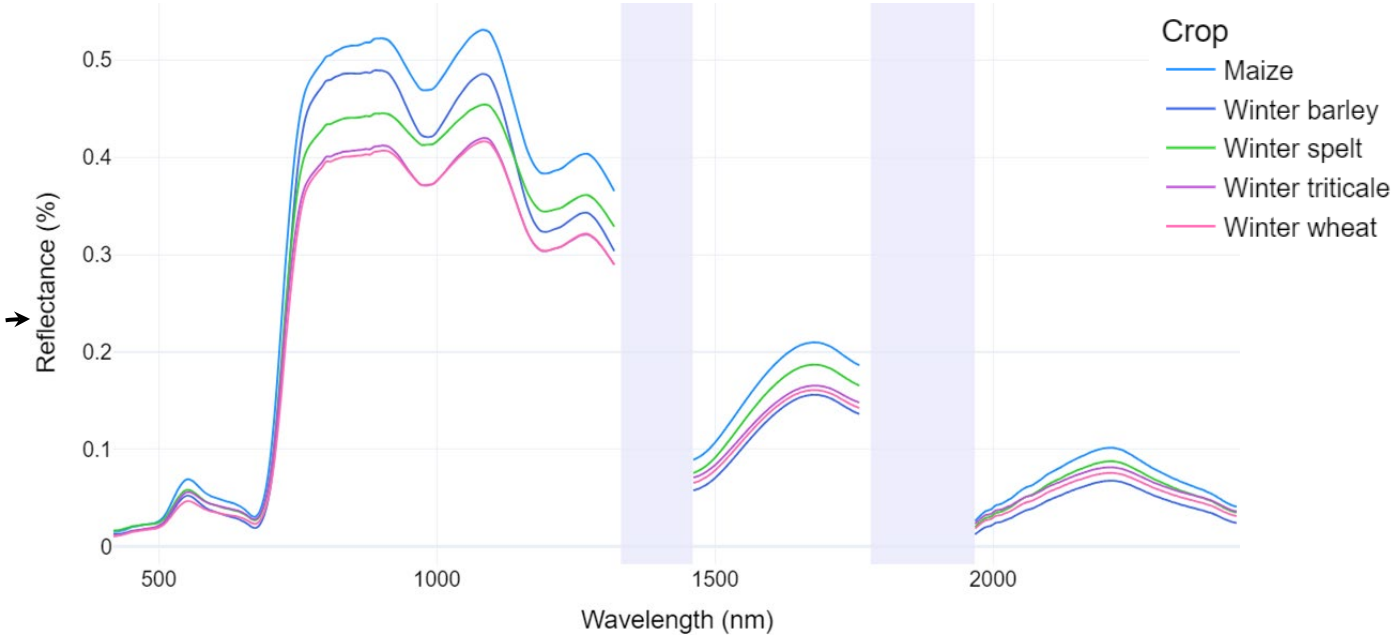
Metrics:
F1 weighted (major crops)
F1 macro (minor crops)
Kappa

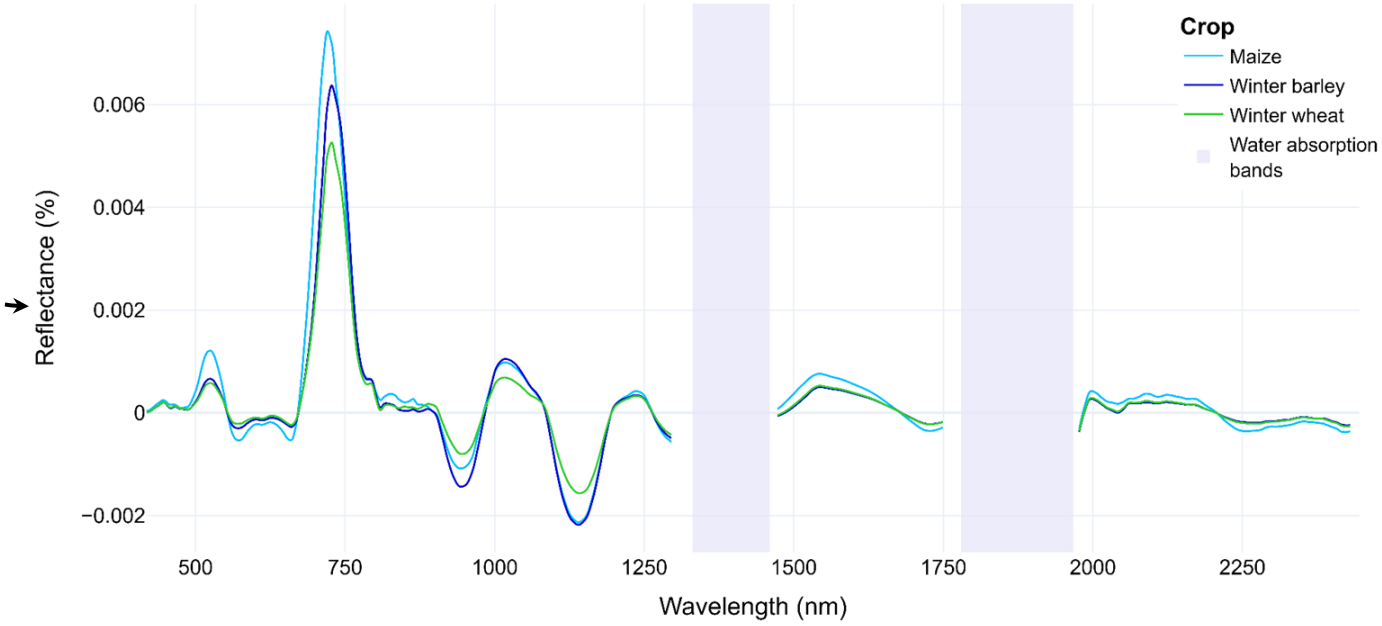
Predictor variables

Mean reflectance / parcel band

Smoothed Reflectance

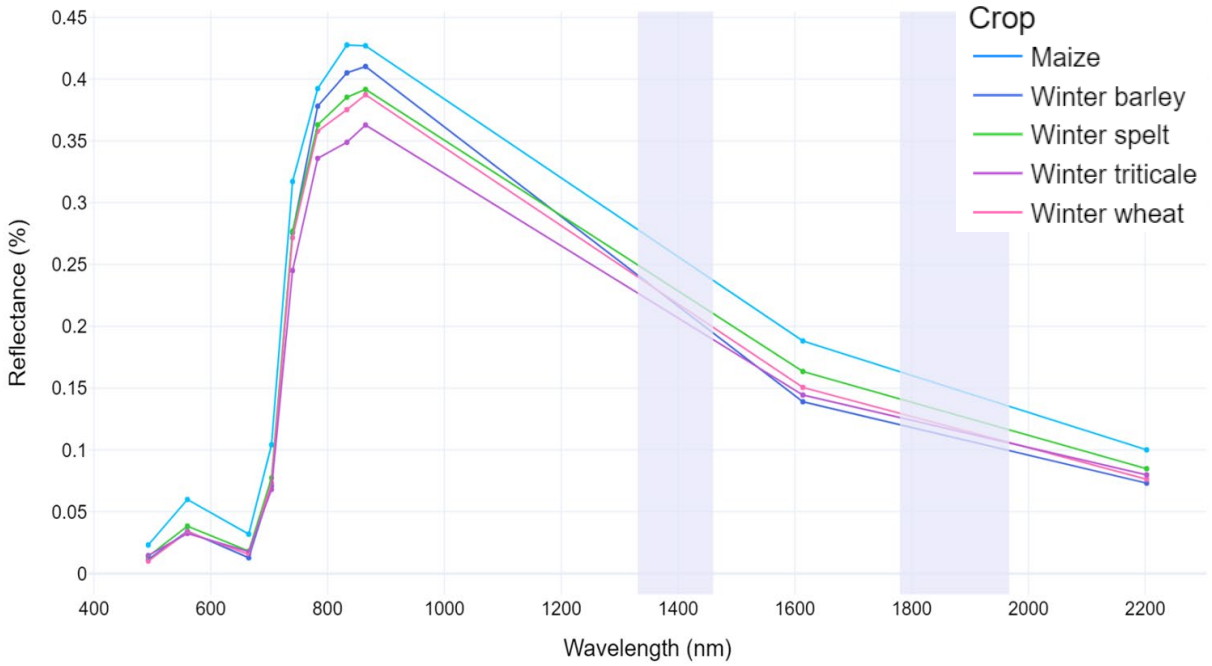
1st derivative



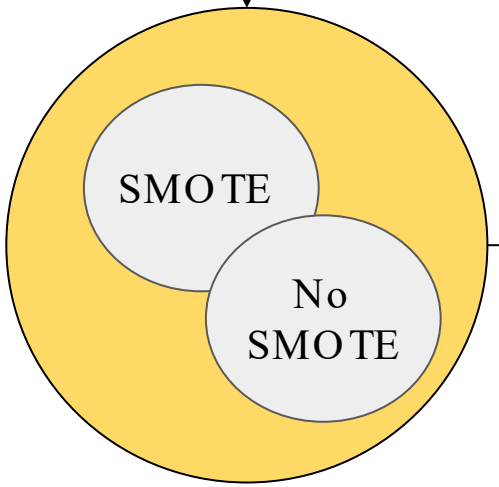


Workflow on Sentinel-2: Comparing sensors

Mean reflectance

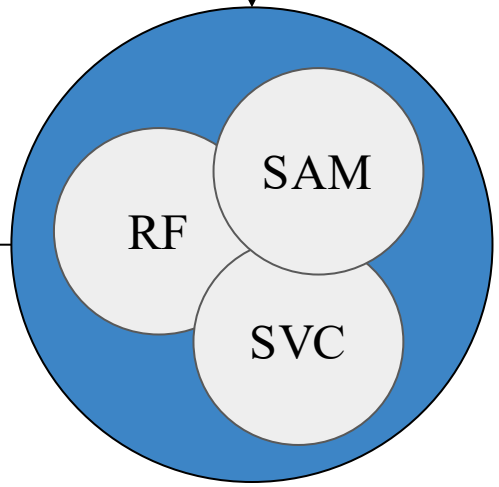


70%



Handle crop class imbalance

👉 No 1st derivative and band selection



Classifiers

30%

Validation

F1 weighted
F1 macro
Kappa

vs EnMAP

Compare best scores

Effect size between sensors

Benchmark results

e.g. May 2024

Classifier	Predictor	Reduction	Smote	F1-M	BAcc	F1-W	Acc	Kappa
RF	Ref	PLS	TRUE	0.76	0.74	0.93	0.93	0.84
SAM	Deriv	PLS	FALSE	0.47	0.66	0.80	0.74	0.54
SVC	Ref	None	FALSE	0.78	0.80	0.96	0.95	0.89

SVC

- Best overall
- Minor classes always

RF

- Also best
- Minor classes: some

SAM

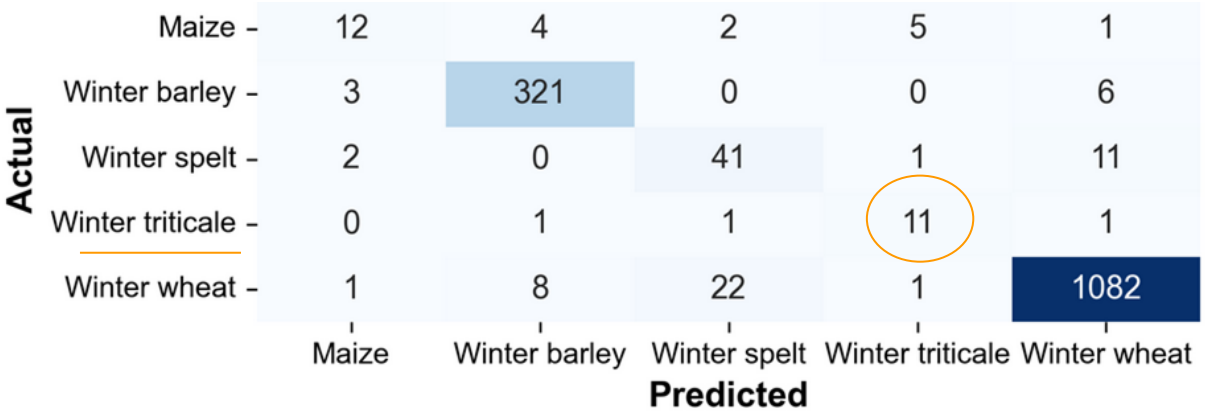
- Lowest scores
- Ok for major classes

EnMAP & S2 results

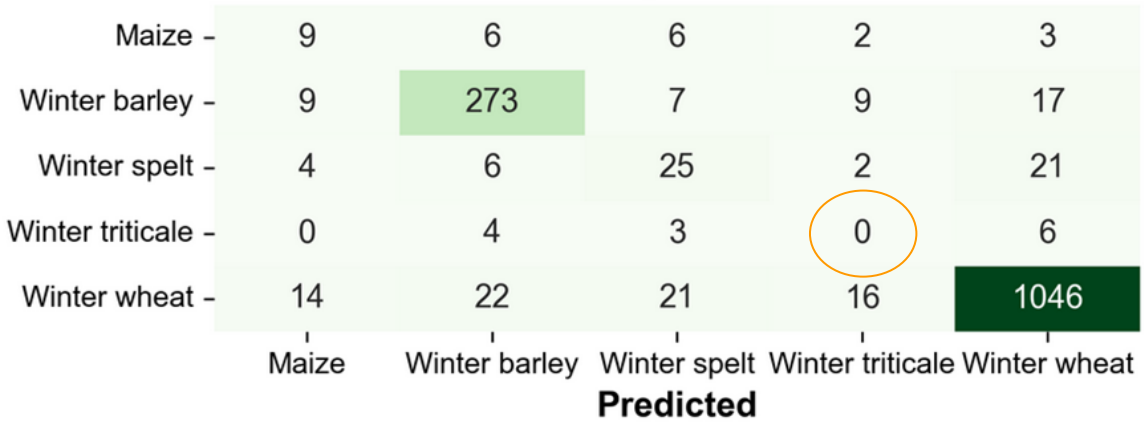
e.g. May 2024

Source	Classifier	SMOTE	Predictor	Features	F1-M	BAcc	F1-W	Acc	Kappa
EnMAP	SVC	NO	Reflectances	All	0.78	0.8	0.96	0.95	0.90
S2					0.51	0.52	0.89	0.88	0.73

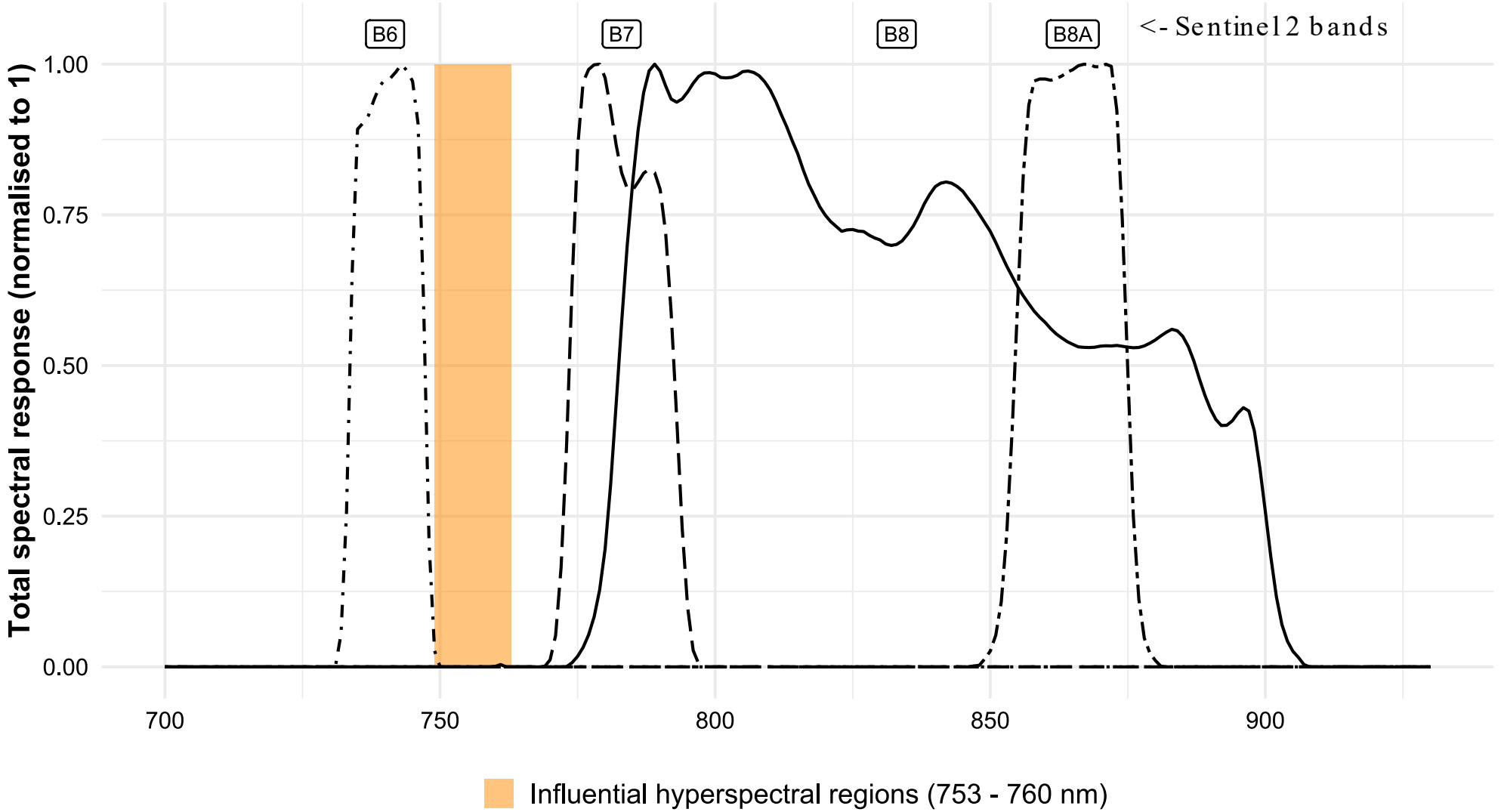
EnMAP



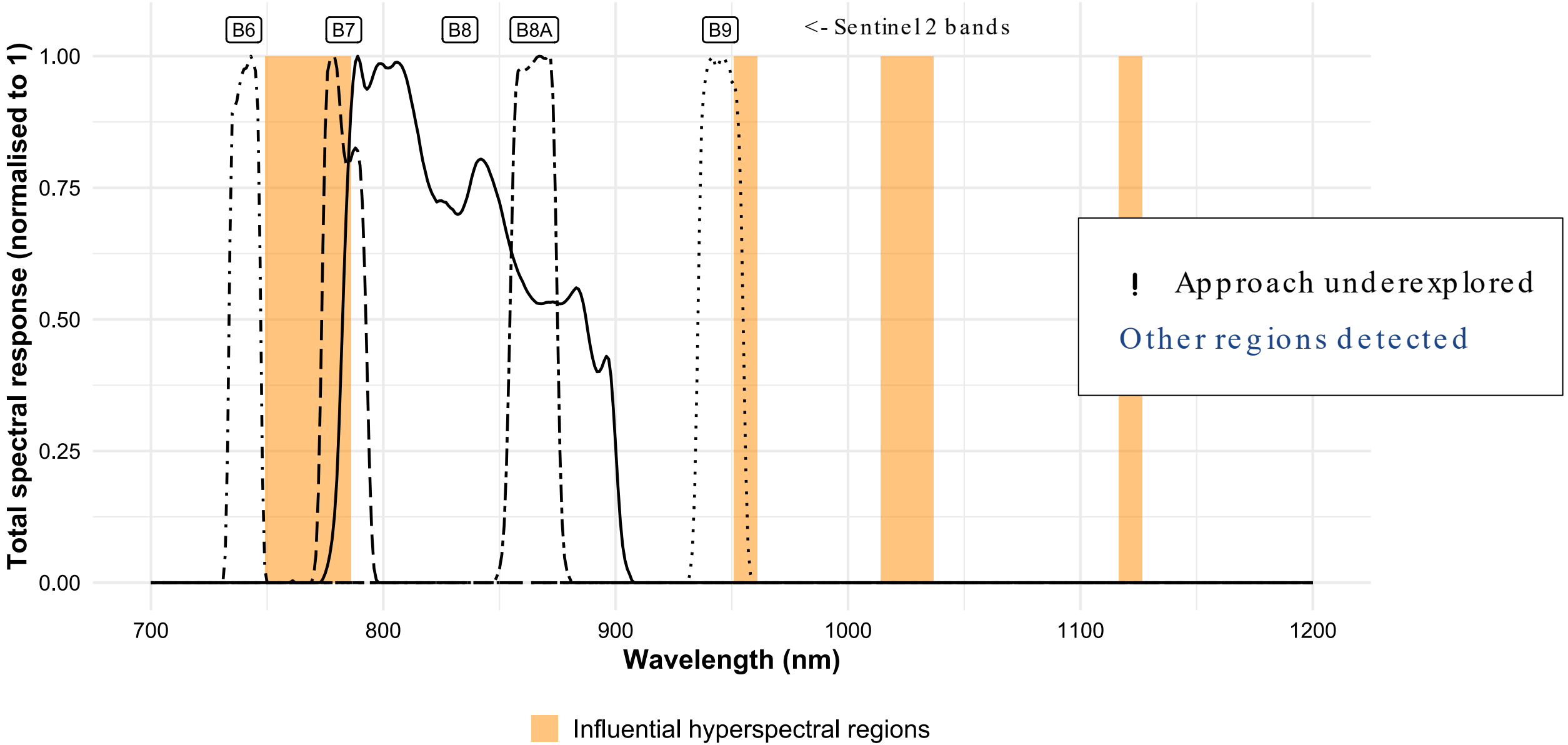
S2



Key spectral regions



Promising but further analysis is needed



Take home messages

1. Single date HSI to classify crops?
    1. Scores above 90%

2. How to leverage HSI?
    1. SVC + Reflectance + All bands + No SMOTE

3. What HSI offers beyond MSI?
    1. No need of multidate & low processing
    2. HSI comparatively better >> minor crops



Overview of Chinese YSs research



Crop discrimination from satellite imagery across 5 sites in China

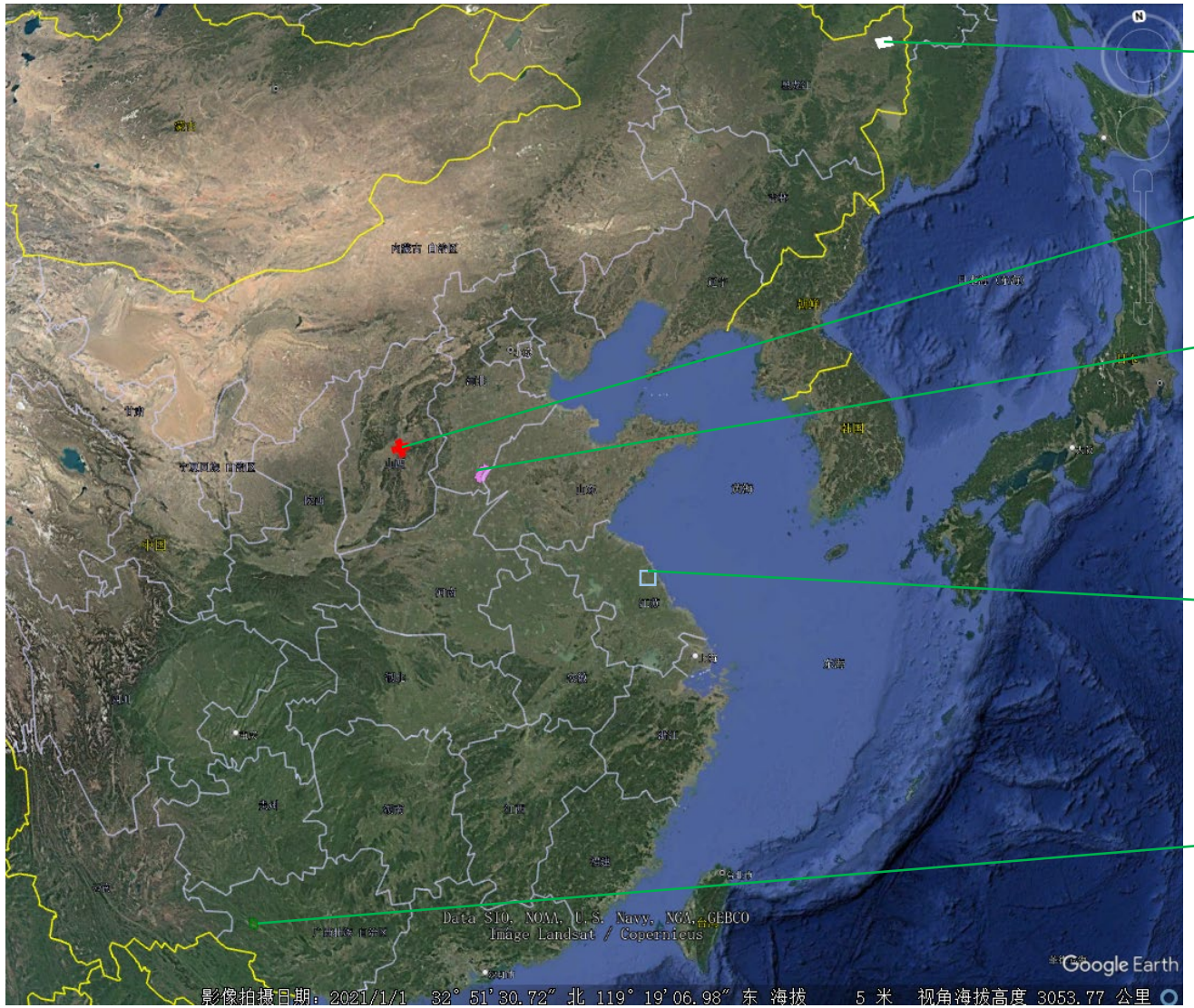
Miao Zhang, Xiangsuo Fan, Qiaomei Su and Jinlong Fan







Overview of Chinese YSs research 1-2/5 Guantao&Yancheng



Chuangye:
Rice

Jinzhong:
Maize

Guantao:
Winter wheat, maize, bean, cotton

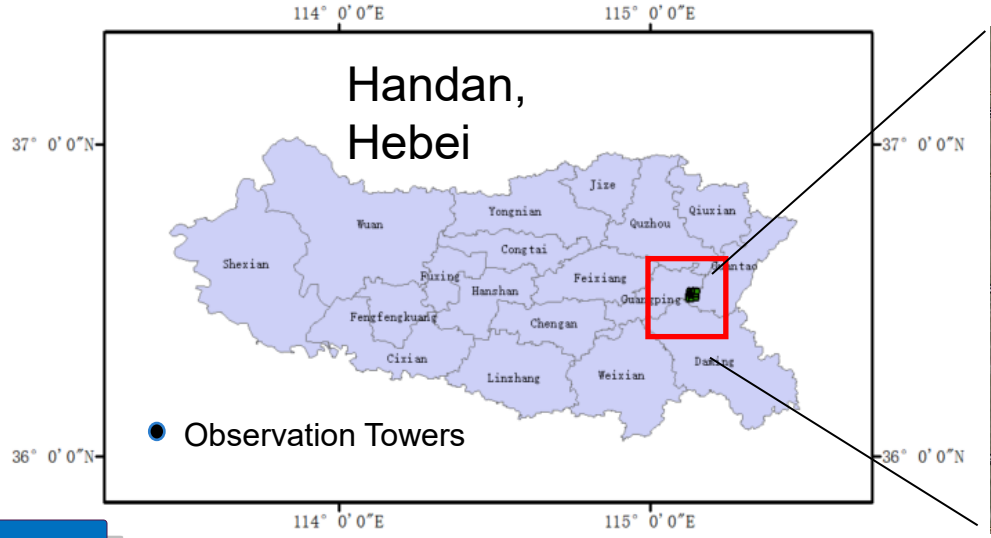
Yancheng:
Winter wheat, barley, garlic, Rice, Maize

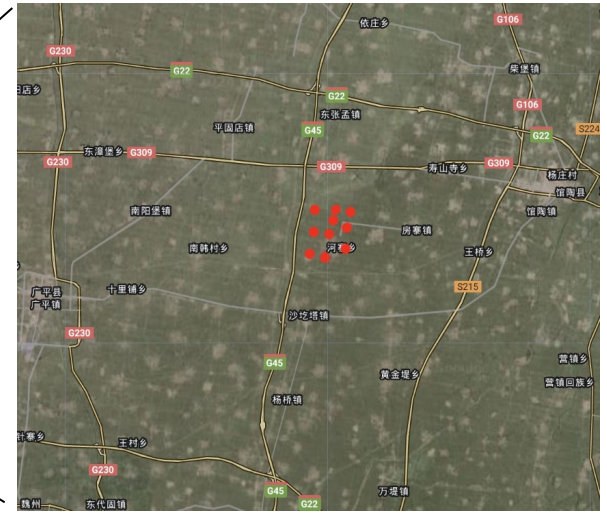
Guangxi:
Sugarcane and vegetable

China Guantao JECAM site and experiments

Experimental areas

- Located in Handan, Hebei Province
- Construction of ten observation towers
- Equipments for crop conditions monitoring using mounted cameras
- Observation equipments for climate data and flux data





Experimental activitiess and research priorities



- Survey of crop types
- Collection of crop variables including planting density, biomass, yield, harvest index, etc.
- Digital photos taken during crop survey
- **Research Priorities**
  - Mapping of cropland and utilization, crop type mapping
  - Remote sensing estimation of biomass, harvest index and crop yield
  - Identification of crop diseases, pests and yields using AI approach

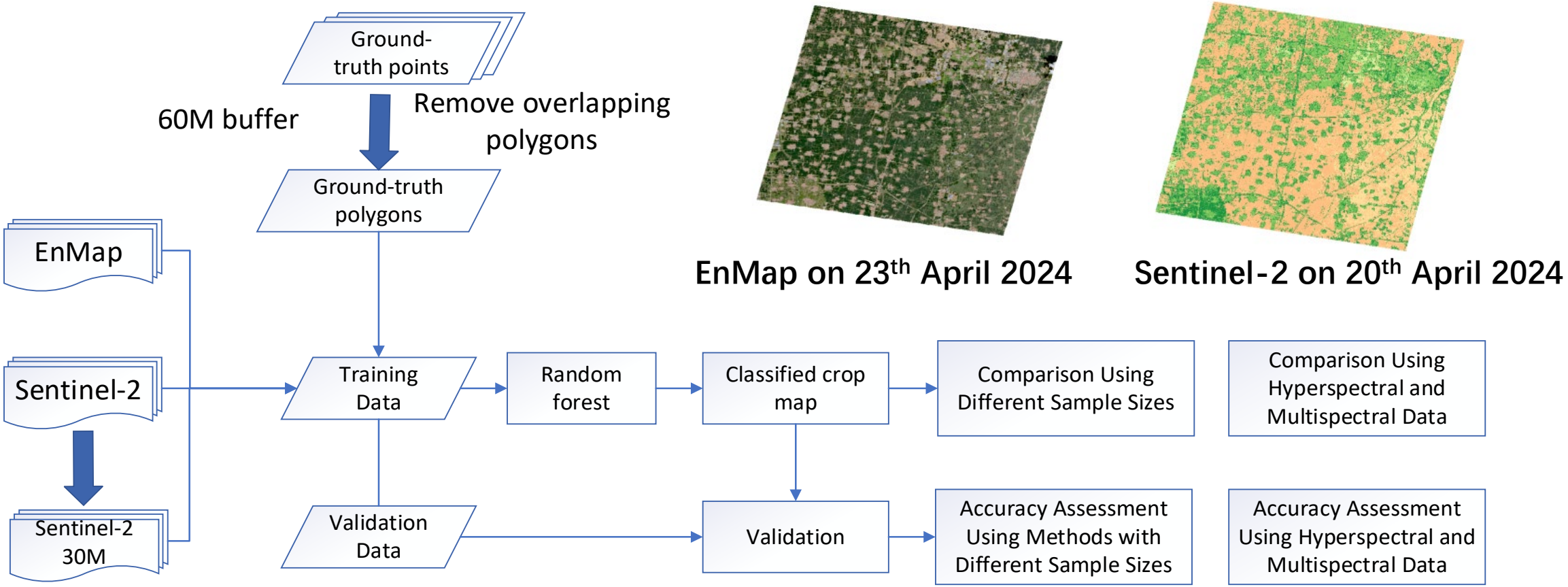
Research Activities

- Crop type classification
  - using multi-spectral images
  - using EnMAP hyperspectral data
- Comparison of classification performance

Crop type classification

Objective: Investigation on the early detection of various crop types using ENMAP or combination of EnMap and Sentinel-2 (however, only one EnMap image in late April)

- Comparison of classification accuracy using different RS data
- Comparison of classification performance with different percent of training sets



EnMap on 23th April 2024

Sentinel-2 on 20th April 2024

Points sample for classification

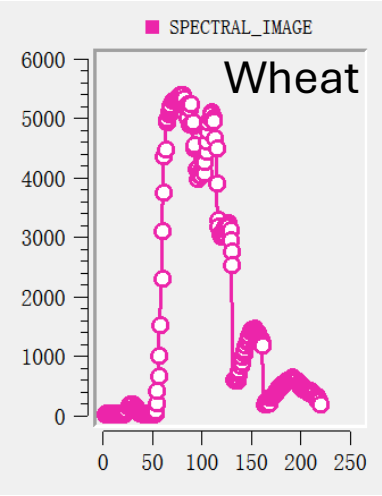
Data collection on March 27, 2024

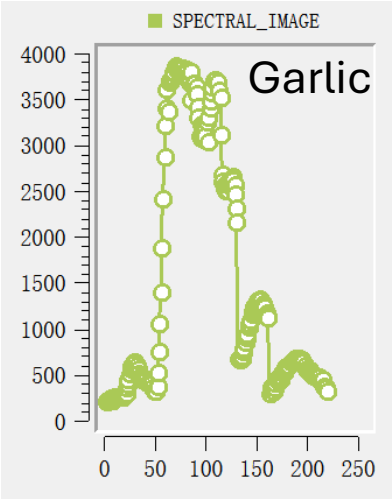
5 types of samples

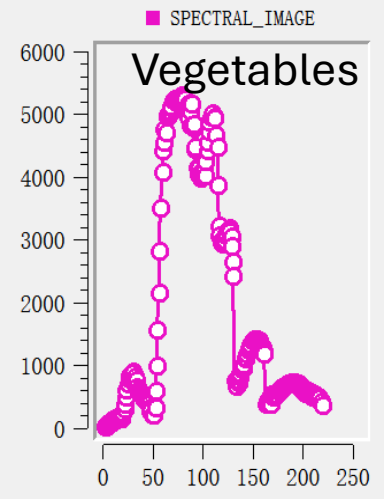
- wheat： 328
- garlic： 87
- vegetables： 83
- fallow： 42
- orchard (pear trees)： 59

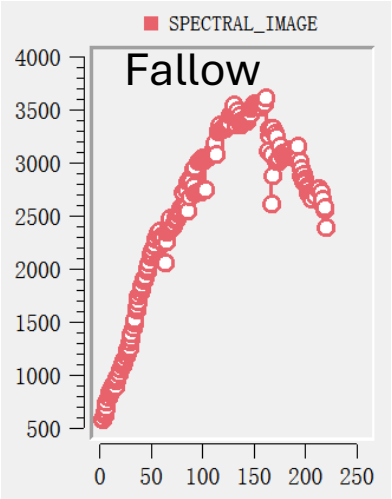
2/3 for training
1/3 for validation

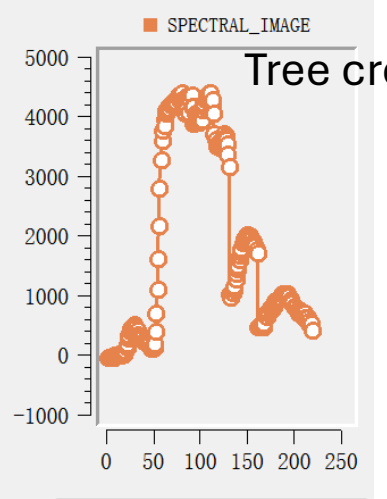












Crop classification

Preliminary classification

Sentinel-2 10m	
PA	0.99
UA	0.97
OA	0.96
F1-score	0.96

Sentinel-2 resampled to 30m	
PA	0.98
UA	0.96
OA	0.96
F1-score	0.96

EnMap 30m	
PA	1
UA	0.98
OA	0.99
F1-score	0.99

A

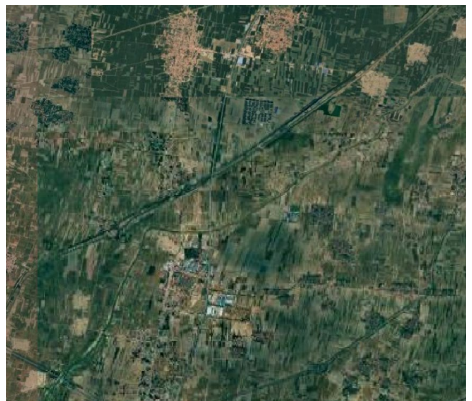


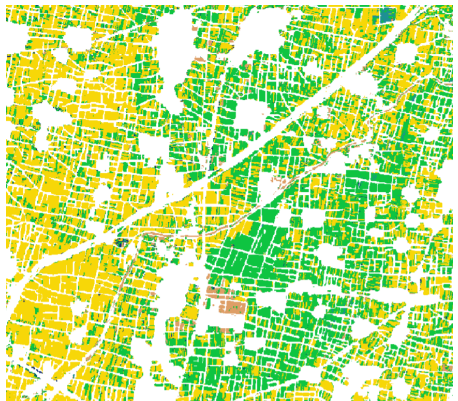


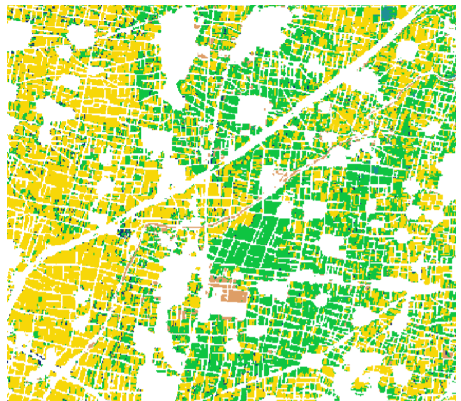


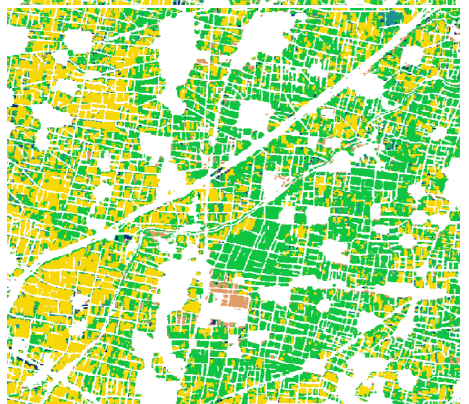


B



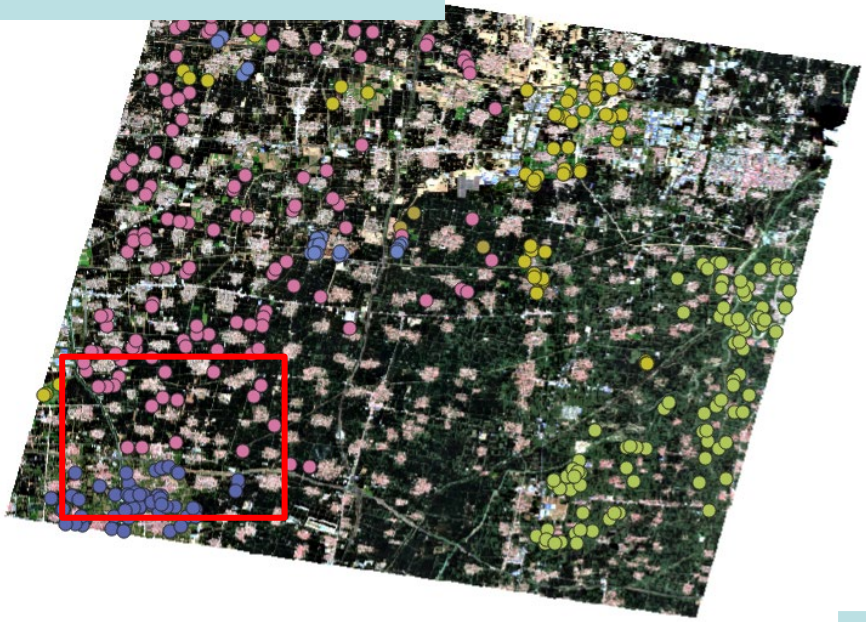






Extrapolate point samples to polygons

Points



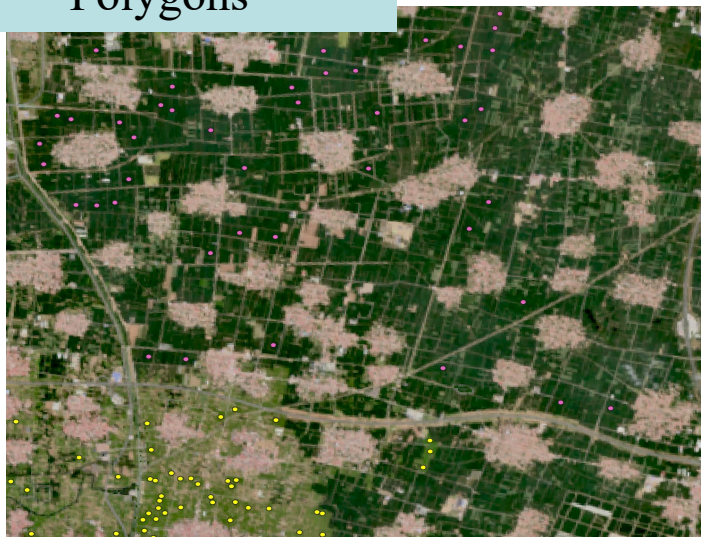
- wheat： 118
- garlic： 91
- vegetables： 60
- fallow： 33
- orchard (pear trees)： 54

Total number of screened polygons

60m buffer

Remove overlapping polygons and mixed polygons

Polygons

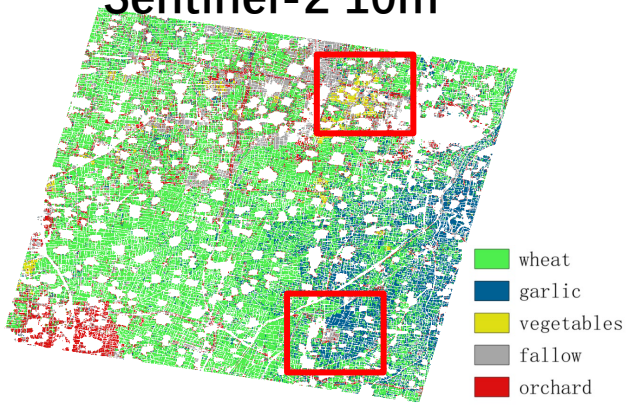


Randomly select 20% of polygons for training

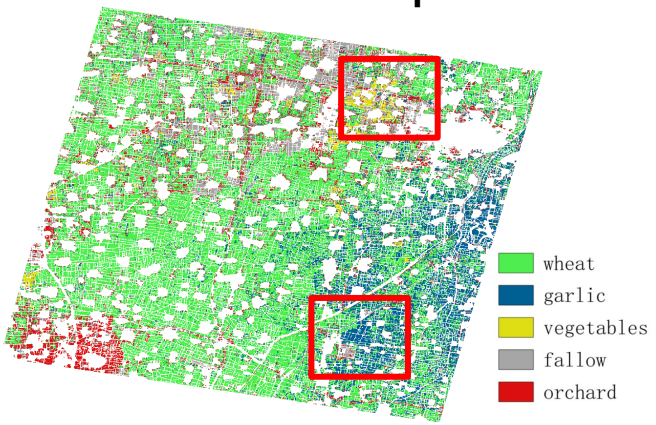
Class	Polygon count	Pixels (30m)	Pixels (10m)
wheat	23	234	2085
garlic	18	184	1627
vegetables	12	118	1079
fallow	6	59	538
orchard	10	104	916

Preliminary classification

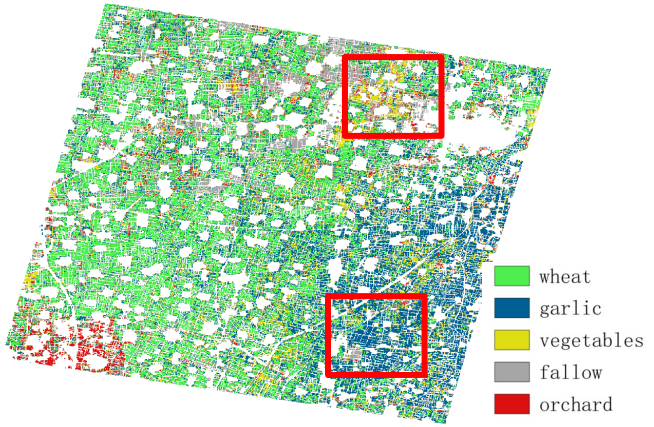
Sentinel-2 10m



Sentinel-2 resampled to 30m

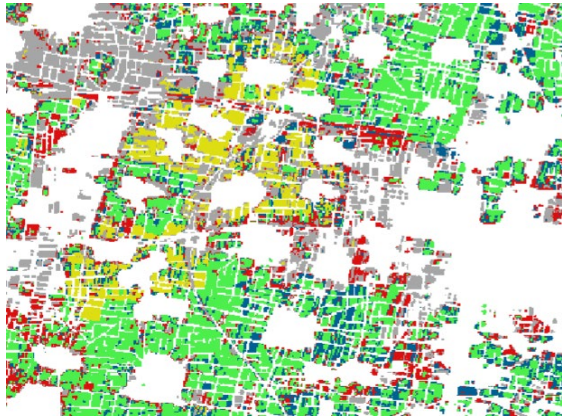


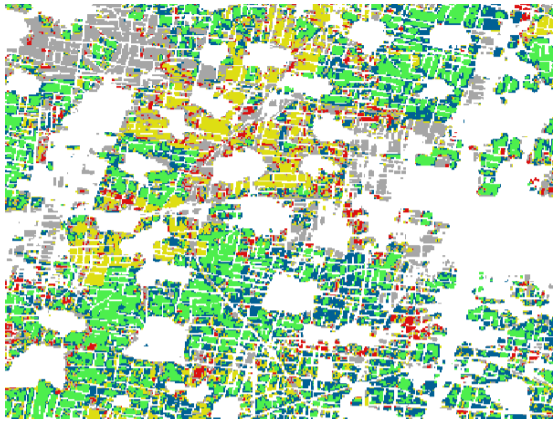
EnMap 30m



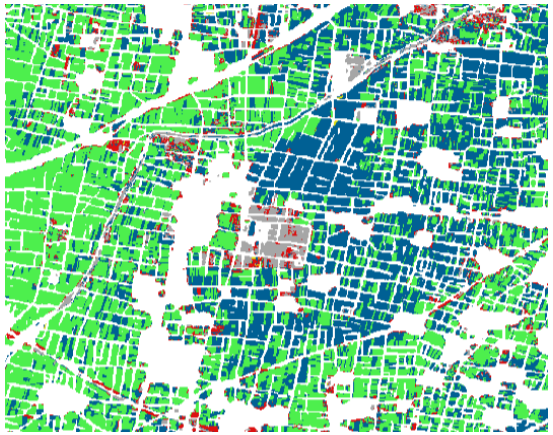


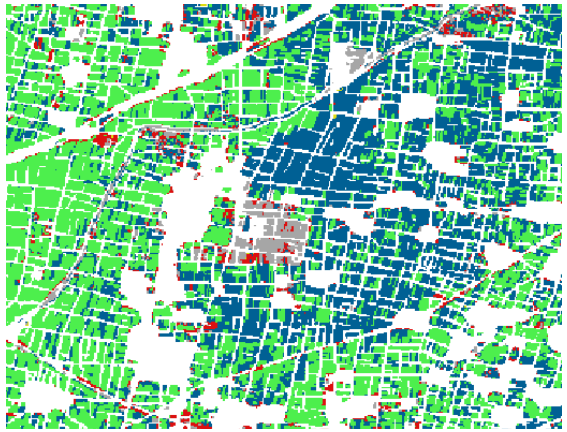


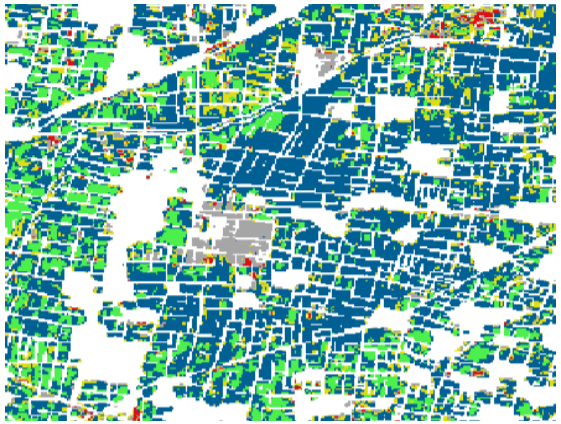




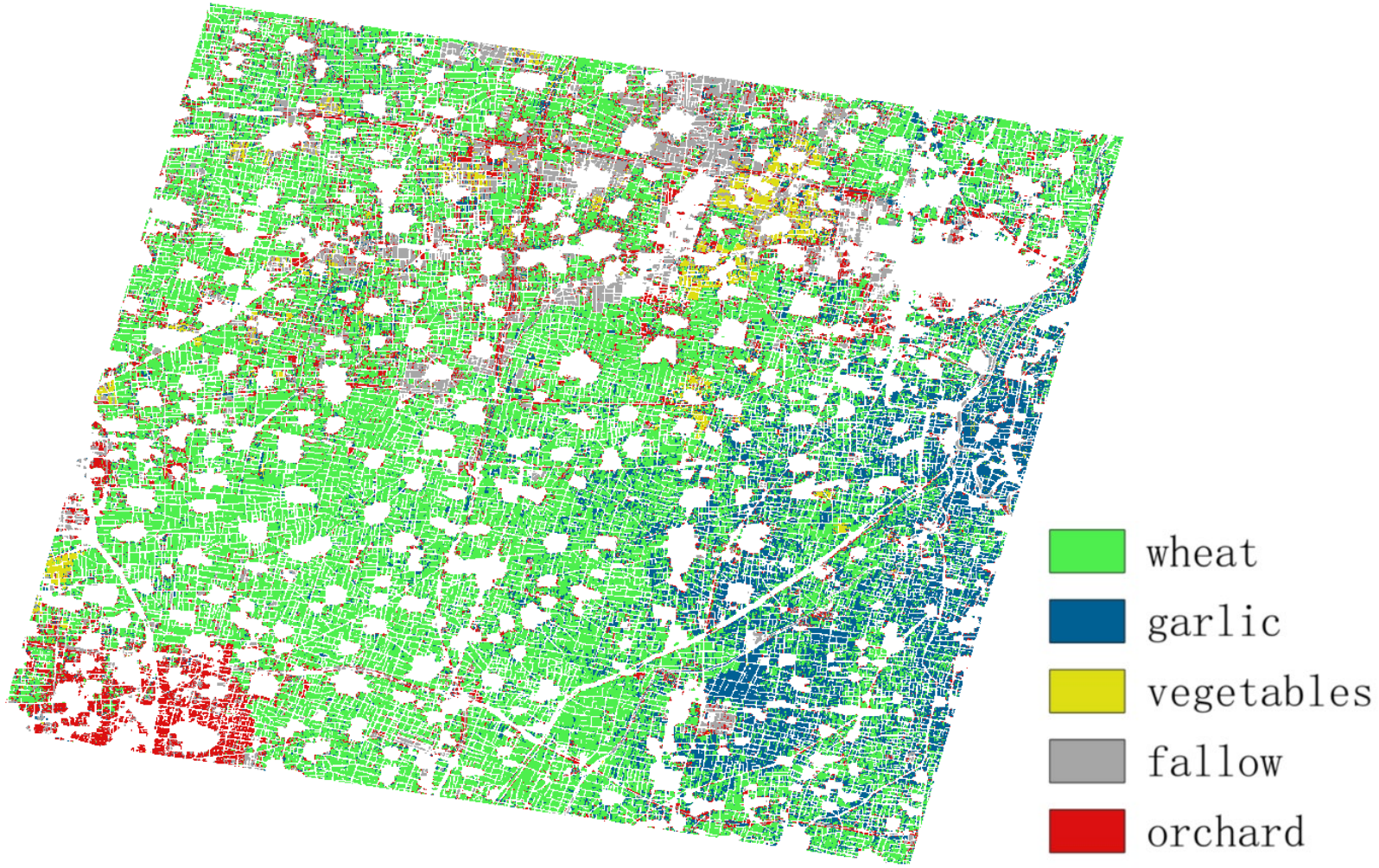








Classification using Sentinel-2 on 20th April 2024

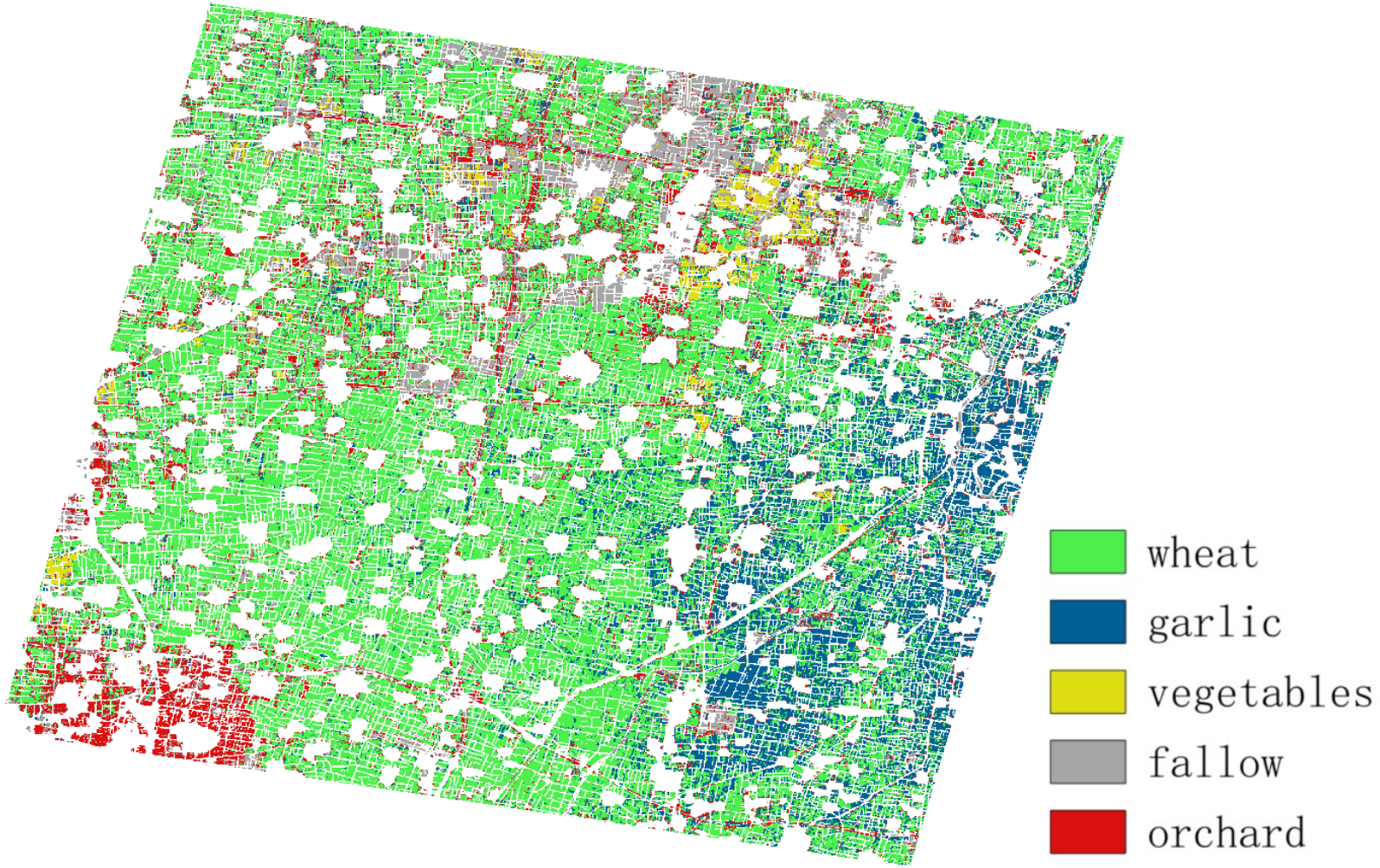


	1	2	3	4	5
1	970	0	0	0	0
2	0	720	7	0	1
3	0	3	480	0	0
4	0	0	0	269	0
5	0	2	0	0	445

Metric	Precision	Recall	F1-score
wheat	1	1	1
garlic	0.993	0.989	0.991
vegetable	0.986	0.994	0.99
fallow	1	1	1
orchard	0.998	0.996	0.997
Macro avg	0.995	0.996	0.995
Weighted avg	0.996	0.996	0.996

Kappa	0.994	-	-
Overall accuracy	99.55%	-	-

Classification using resampled 30m Sentinel-2

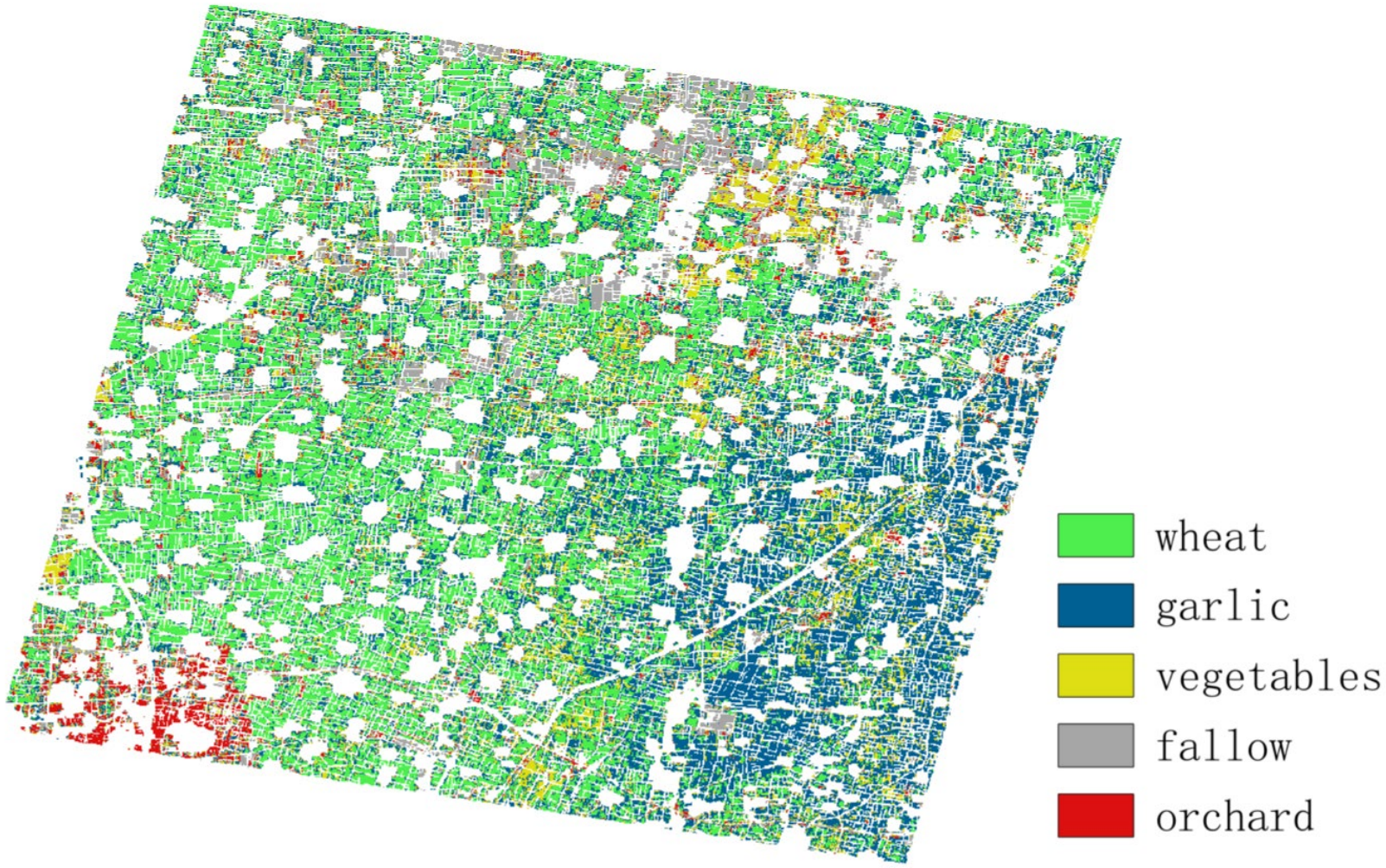


	1	2	3	4	5
1	8634	3	0	0	1
2	2	6432	94	4	7
3	0	35	4295	5	15
4	0	3	0	2449	2
5	0	25	0	12	3961

Metric	Precision	Recall	F1-score
wheat	1	1	1
garlic	0. 99	0. 984	0. 987
vegetable	0. 979	0. 987	0. 983
fallow	0. 991	0. 998	0. 995
orchard	0. 994	0. 991	0. 992
Macro avg	0. 991	0. 992	0. 991
Weighted avg	0. 992	0. 992	0. 992

Kappa	**0.990**	-	-
Overall accuracy	**99.20%**	-	-

Classification using EnMap on 23 April 2024



	1	2	3	4	5
1	764	7	0	0	0
2	0	579	2	0	5
3	0	1	389	1	2
4	0	0	0	225	0
5	0	9	6	0	363

Metric	Precision	Recall	F1-score
wheat	1	0. 991	0. 995
garlic	0. 971	0. 988	0. 98
vegetable	0. 98	0. 99	0. 985
fallow	0. 996	1	0. 998
orchard	0. 981	0. 96	0. 971
Macro avg	0. 986	0. 986	0. 986
Weighted avg	0. 986	0. 986	0. 986

Kappa	0. 982	-	-
Overall accuracy	98. 60%	-	-

High accuracy achieved with only 10% samples

- Randomly select 10% of each category for training
- Accuracy reached 99% for all different satellite inputs
- Small number of high-quality sample polygons is sufficient to separate the main winter crops
- Hyperspectral data does not show advantages over multispectral data, because of the distinct spectral differences among classes

Class	Polygon count	Pixcel count (30m)	Pixcel count (10m)
wheat	11	107	998
garlic	9	92	818
vegetables	6	59	538
fallow	3	30	272
orchard	5	52	457

S2 10m

	1	2	3	4	5
1	9721	6	0	0	0
2	6	7259	72	0	16
3	0	42	4833	1	16
4	0	0	11	2662	48
5	25	29	2	4	4398

Metric	Precision	Recall	F1-score	Support
wheat	0. 997	0. 999	0. 998	9727
garlic	0. 99	0. 987	0. 988	7353
vegetable	0. 983	0. 988	0. 985	4892
fallow	0. 998	0. 978	0. 988	2721
orchard	0. 982	0. 987	0. 984	4458
Macro avg	0. 99	0. 988	0. 989	29151
Weighted avg	0. 99	0. 99	0. 99	29151

Kappa	0. 988	-	-	29151
Overall accuracy	99. 05%	-	-	29151

S2 30m

	1	2	3	4	5
1	1096	0	0	0	0
2	0	818	1	0	1
3	0	3	540	0	0
4	0	0	1	294	3
5	3	2	0	0	495

Metric	Precision	Recall	F1-score	Support
wheat	0. 997	1	0. 999	1096
garlic	0. 994	0. 998	0. 996	820
vegetable	0. 996	0. 994	0. 995	543
fallow	1	0. 987	0. 993	298
orchard	0. 992	0. 99	0. 991	500
Macro avg	0. 996	0. 994	0. 995	3257
Weighted avg	0. 996	0. 996	0. 996	3257

Kappa	0. 994	-	-	3257
Overall accuracy	99. 57%	-	-	3257

EnMAP 30m

	1	2	3	4	5
1	866	0	0	0	0
2	0	657	1	0	0
3	1	4	437	0	2
4	0	136	0	114	0
5	9	1	11	6	394

Metric	Precision	Recall	F1-score	Support
wheat	0. 989	1	0. 994	866
garlic	0. 823	0. 998	0. 902	658
vegetable	0. 973	0. 984	0. 979	444
fallow	0. 95	0. 456	0. 616	250
orchard	0. 995	0. 936	0. 965	421
Macro avg	0. 946	0. 875	0. 891	2639
Weighted avg	0. 942	0. 935	0. 928	2639

Kappa	0. 915	-	-	2639
Overall accuracy	93. 52%	-	-	2639

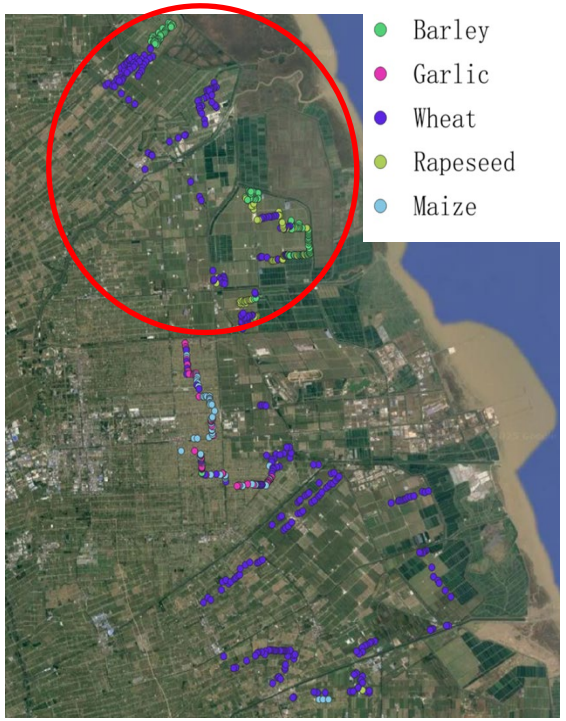
Data collection in Yancheng wheat & barley areas

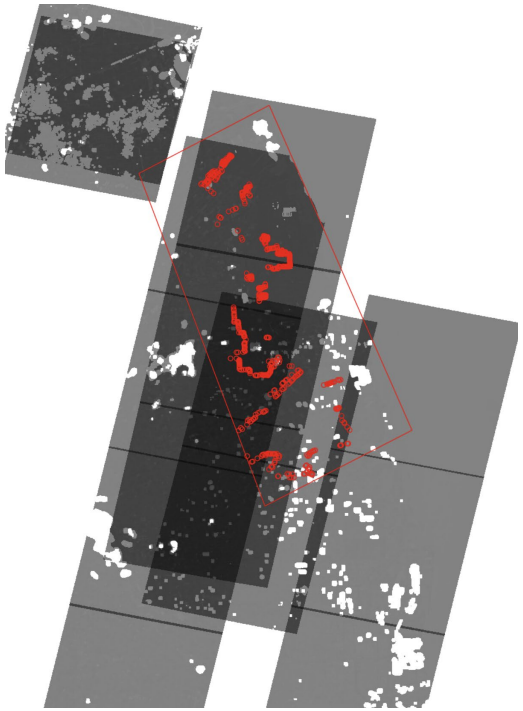
- The survey was conducted on May 15th, before the peak of growing season
- The dominant crop is wheat, with some barley farms
- The boundaries of the barley planting plots were determined
- Digital photos were taken during the crop survey

Experimental activitiess

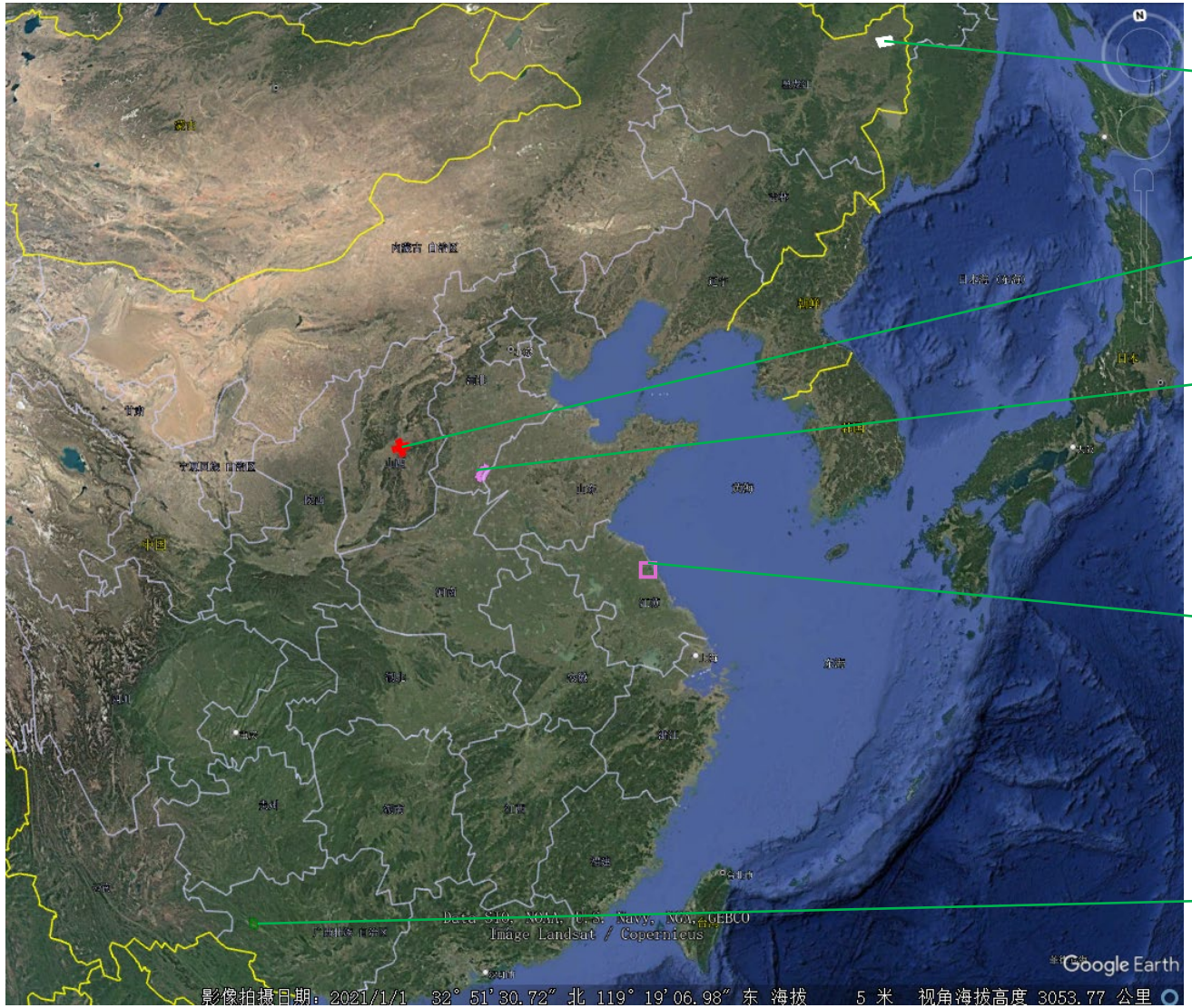








Overview of Chinese YSs research 3/5 Guangxi



Chuangye:
Rice

Jinzhong:
Maize

Guantao:
Winter wheat, maize, bean, cotton

Yancheng:
Winter wheat, barley, garlic, Rice, Maize

Guangxi:
Sugarcane and vegetable

Research Activities

➢ **Crop type classification**

- **deep learning model under the complex agricultural cultivation**





Overview of Chinese YSs research 3/5 Guangxi

- Ground data

The team traveled to the study area in October 2020 for outdoor sample collection, and part of its route is shown in Fig. A handheld GPS camera was utilized to photograph the types of features as the car moved, and the types of crops photographed are shown in Fig.

- Sentinel-2 and ESA third party mission LANDSAT 8 data

Landsat 8 has 11 bands in total: 9 from the Land Imager (8 at 30m resolution: coastal, blue, green, red, near-infrared, 2 shortwave infrared, and cirrus; and 1 panchromatic at 15m), and 2 thermal infrared bands at 100m resolution.

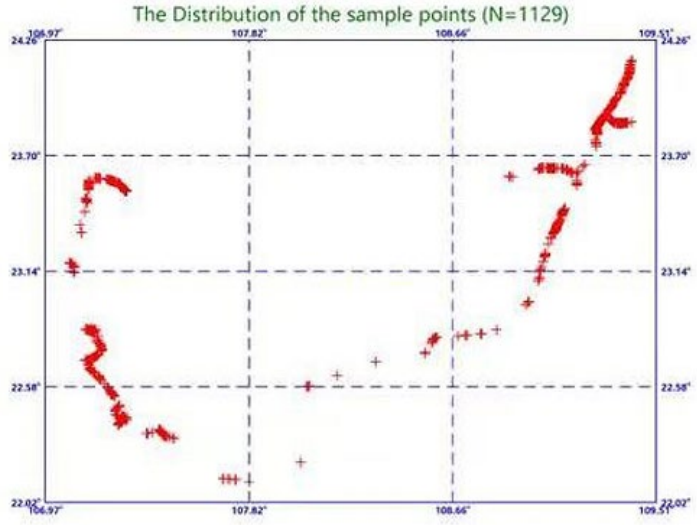


Figure Longitude and latitude maps of selected sampling sites



Figure Rice and Sugarcane field

Overview of Chinese YSs research 3/5 Guangxi

- Classification based on multilayer convolutional recurrent neural network
  - A multilayer convolutional recurrent neural network (HCRNN) of combining CNN and RNN modules at pixel-level classification
  - The band information of satellite image is adapted to a 1D sequence and reshaped to a 3D matrix, where spatial features are extracted and resized by four convolutional layers
  - The 2D-CNN features are fed into an RNN consisting of two GRU units, using global mean pooling to avoid overfitting.
  - The four RNNs process the features in parallel to capture inter-band dependencies
  - Finally, the features are fused and fed into the MLP for high-precision classification via the ReLU activation function to fully exploit the spatial-temporal information

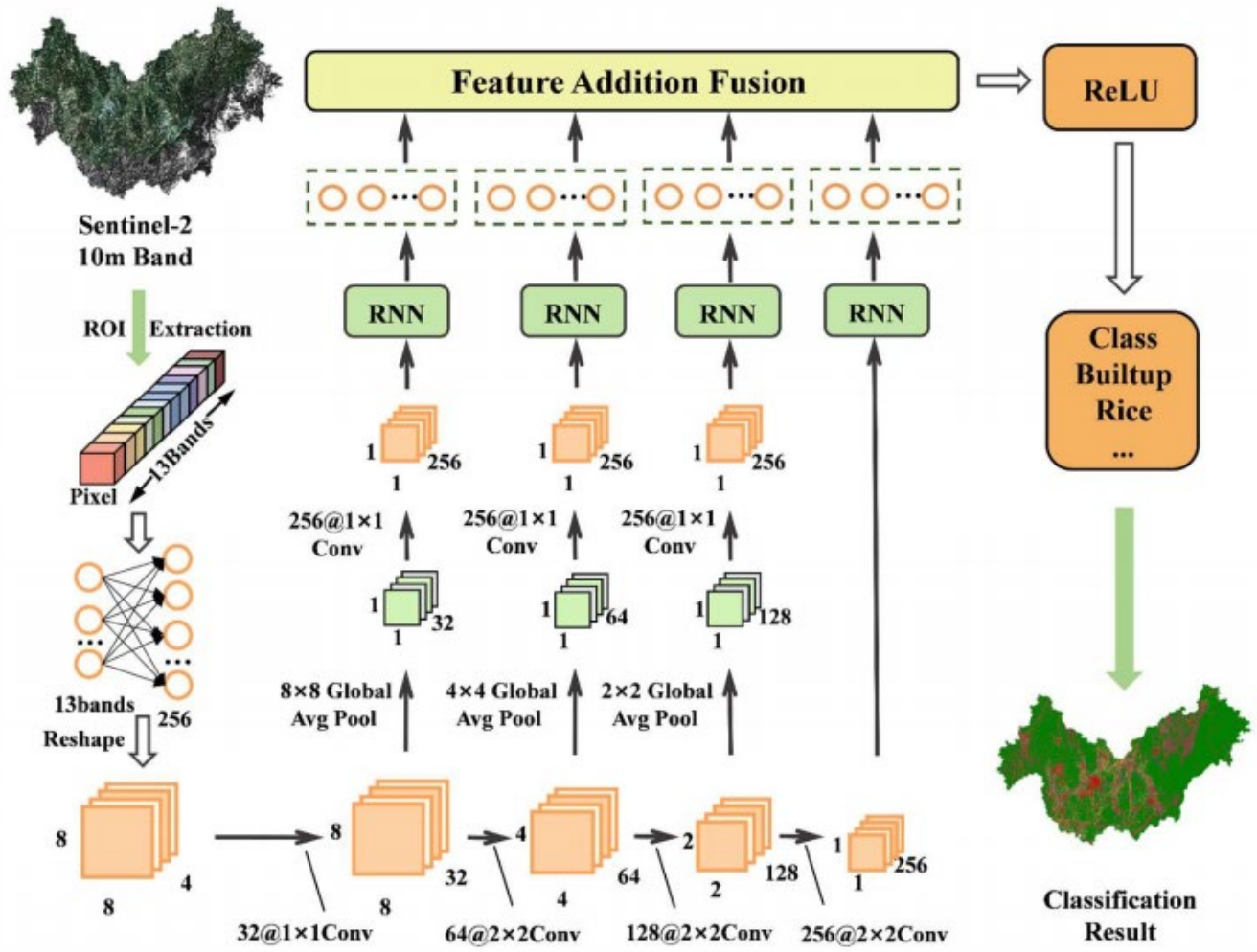


Figure Hierarchical Convolutional Recurrent Neural Network（HCRNN）

Overview of Chinese YSs research 3/5 Guangxi

- The results of different classification methods in Laibin City, Guangxi are shown below

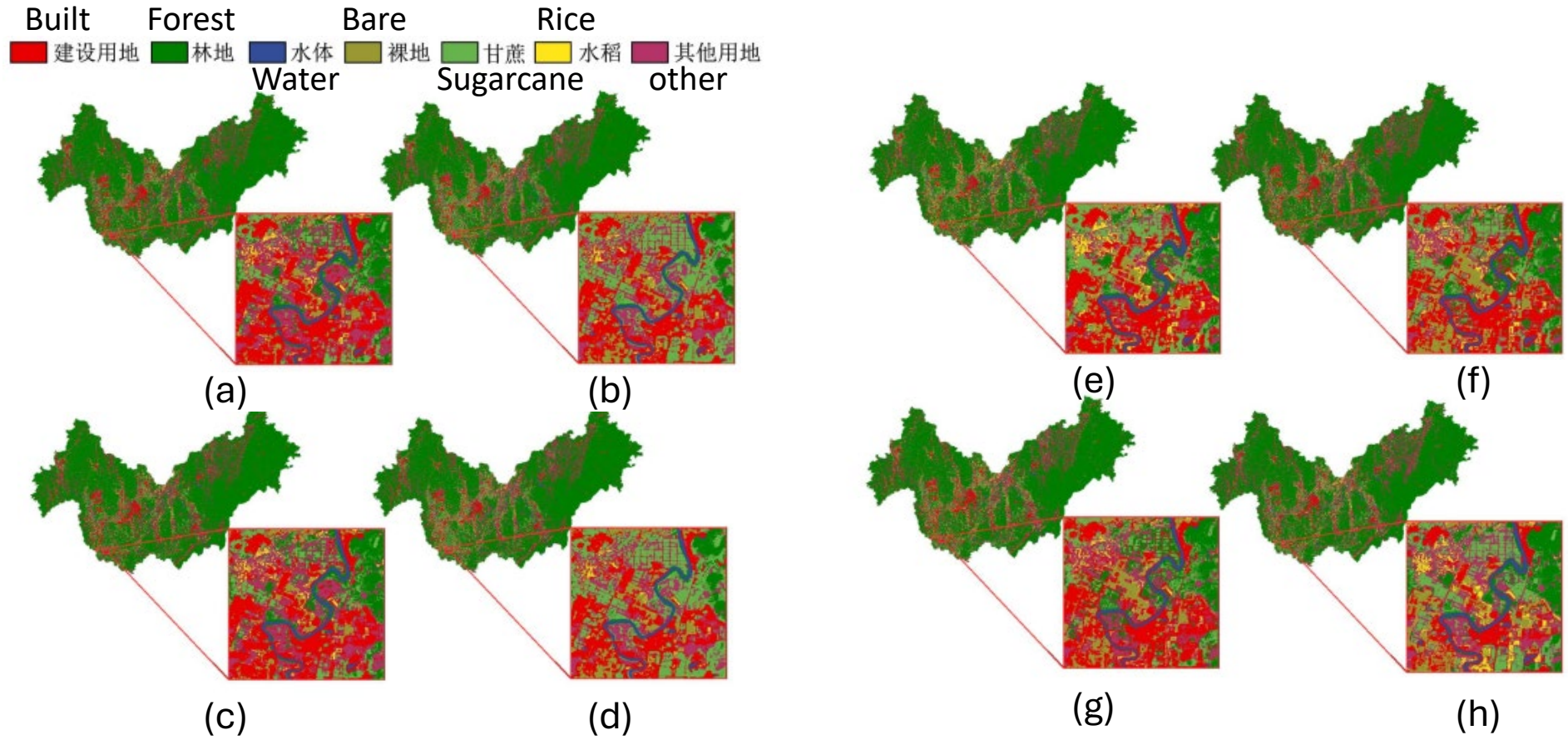


Figure Classification results of different models: (a)SVM; (b)KNN; (c) RF; (d)1D-CNN; (e) Transformer ; (f) SpectralFormer; (g)RNN; (h) HCRNN

Overview of Chinese YSs research 3/5 Guangxi

- HCRNN model demonstrates superior performance in comparison with traditional machine learning models (e.g., SVM, KNN, RF) and deep learning methods (e.g.,ViT, SpectralFormer, RNN)
- HCRNN mines the time-series information and spatial features more efficiently and thus significantly outperforms the other models

Table 2-1 Classification results with 2017 dataset in Laibin

类别名称	SVM	KNN	RF	1D-CNN	ViT	Spectral-Former	RNN	HC-RNN
建设用地	94.89	90.83	94.56	91.80	96.00	95.40	95.33	**97.09**
林地	98.42	98.10	98.88	98.30	99.04	**99.31**	98.92	99.22
水体	96.39	96.45	95.60	95.80	97.61	97.13	96.96	**98.35**
裸地	**100.00**	96.44	92.89	93.33	**100.00**	99.56	99.11	**100.00**
甘蔗	79.19	85.89	84.30	72.03	90.65	90.83	88.18	**92.83**
水稻	28.29	33.55	39.47	37.50	71.05	69.74	69.08	**78.95**
其他用地	95.92	91.77	92.10	89.06	90.18	93.94	91.64	**96.34**
OA(%)	95.08	94.04	94.94	92.79	96.14	96.55	95.84	**97.62**
AA(%)	84.73	84.72	85.40	82.54	92.08	92.27	91.32	**94.68**
Kappa	0.9340	0.9201	0.9321	0.9031	0.9482	0.9538	0.9442	**0.9681**

Table 2-2 Classification results with 2019 dataset in Laibin

类别名称	SVM	KNN	RF	1D-CNN	ViT	Spectral-Former	RNN	HC-RNN
建设用地	98.35	98.01	**99.30**	96.81	99.11	99.13	98.99	98.93
林地	97.87	95.65	97.31	93.87	97.19	97.88	97.01	**99.03**
水体	97.47	97.89	97.32	96.25	97.64	**98.64**	97.04	98.07
裸地	93.06	97.00	92.50	93.25	93.80	95.86	95.31	**97.56**
甘蔗	87.70	88.89	86.81	84.44	89.77	85.42	89.54	**91.50**
水稻	70.99	75.93	67.28	65.22	**80.86**	76.54	72.84	74.07
其他用地	74.08	80.34	77.05	71.84	81.20	88.49	81.39	**89.09**
OA(%)	94.50	94.35	94.61	91.76	95.34	95.98	95.17	**97.03**
AA(%)	88.50	90.53	88.23	85.96	91.37	91.71	90.93	**92.61**
Kappa	0.9247	0.9232	0.9062	0.8877	0.9366	0.9452	0.9337	**0.9596**

Table 2-3 Classification results with 2021 dataset in Laibin

类别名称	SVM	KNN	RF	1D-CNN	ViT	Spectral-Former	RNN	HC-RNN
建设用地	96.27	94.32	96.31	94.60	95.09	95.36	95.12	**96.49**
林地	90.99	90.95	90.42	91.32	94.22	96.03	93.99	**96.64**
水体	96.46	96.51	95.64	94.59	97.32	96.93	97.66	**97.80**
裸地	71.53	79.36	73.67	57.47	74.73	87.54	89.50	**93.42**
甘蔗	**92.69**	89.91	91.42	85.70	85.83	91.86	87.45	89.57
水稻	16.06	38.32	14.60	1.82	69.23	64.47	46.52	**73.26**
其他用地	63.86	68.34	71.12	49.55	78.98	71.84	75.63	**85.95**
OA(%)	89.03	88.51	88.97	84.43	90.85	91.58	90.70	**93.93**
AA(%)	75.69	79.67	76.17	67.87	85.06	86.29	83.70	**90.45**
Kappa	0.8600	0.8541	0.8598	0.8002	0.8836	0.8629	0.8818	**0.9230**

Overview of Chinese YSs research 3/5 Guangxi

- A parallel network architecture HDAM-Net with a hybrid dual attention
- A fusion MCA + SAM (MS) attention mechanism to improve VIT network, which can capture the correlation information between features
- A multilayer residual cascade convolution (MSCRC) network model using Double Cross-Attention Module (DCAM) attention mechanism, which is able to efficiently utilize the spatial dependency between multiscale encoder features
- The dual-channel parallel architecture is utilized to solve the structural differences and realize the enhancement of image classification

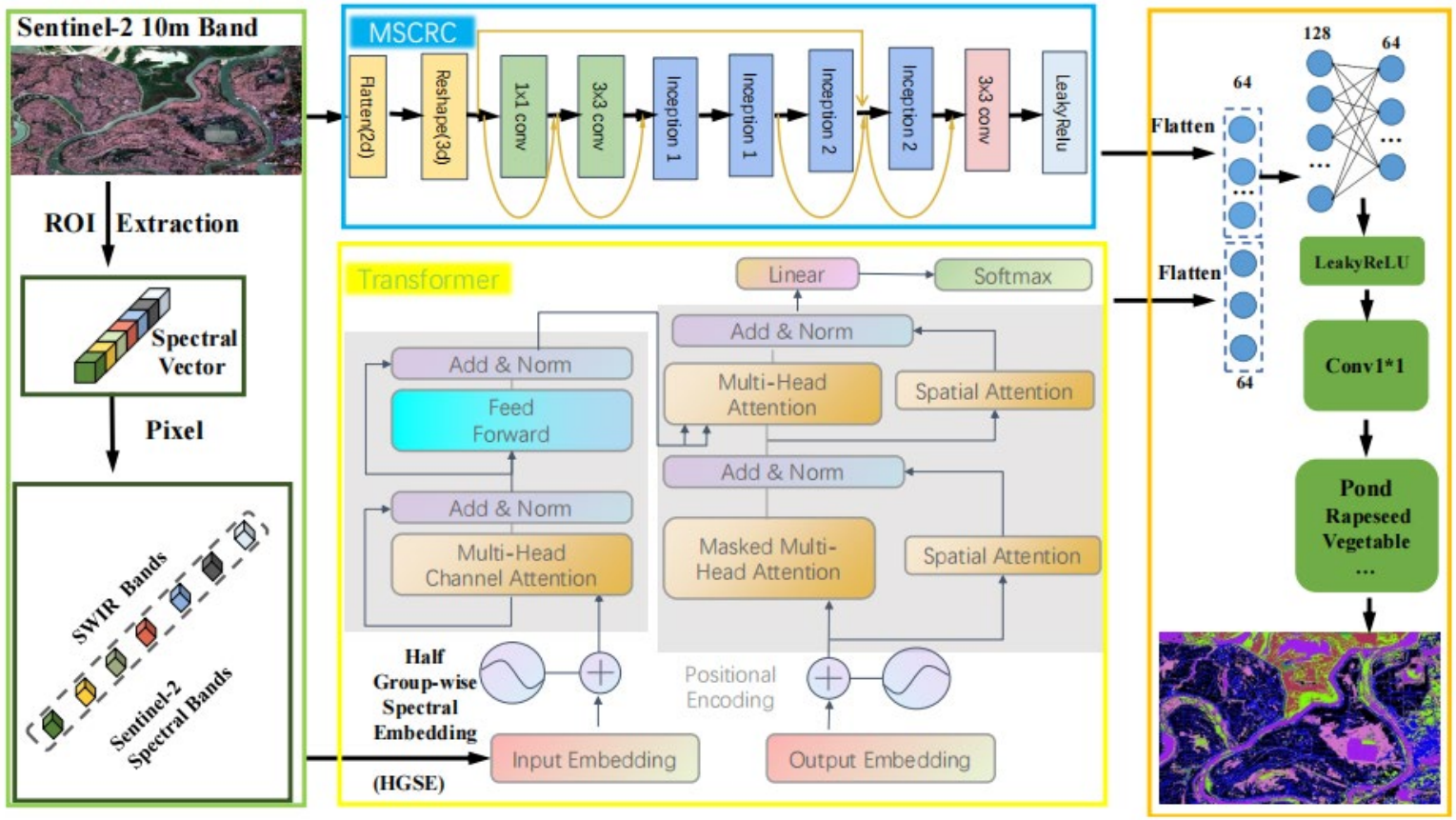


Figure 1. Schematic structure of the HDAM model

Overview of Chinese YSs research 3/5 Guangxi

Comparative Analysis of models

- The performances of models, SVM, KNN, RF, CNN, RNN, ViT, VITCNN and HDAM-Net
- HDAM-Net obtained the highest score (OA: 99.42%, AA :99.25%, Kappa: 0.9931), proving its excellent ability to extract time series and spatial features from spectral data

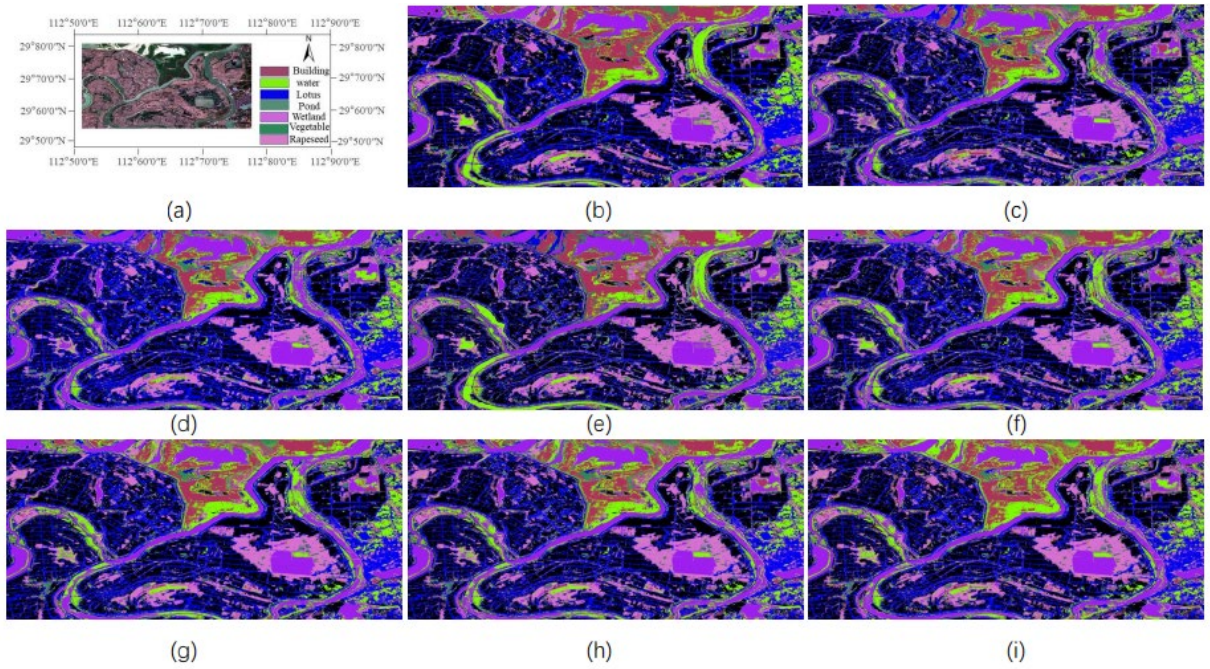
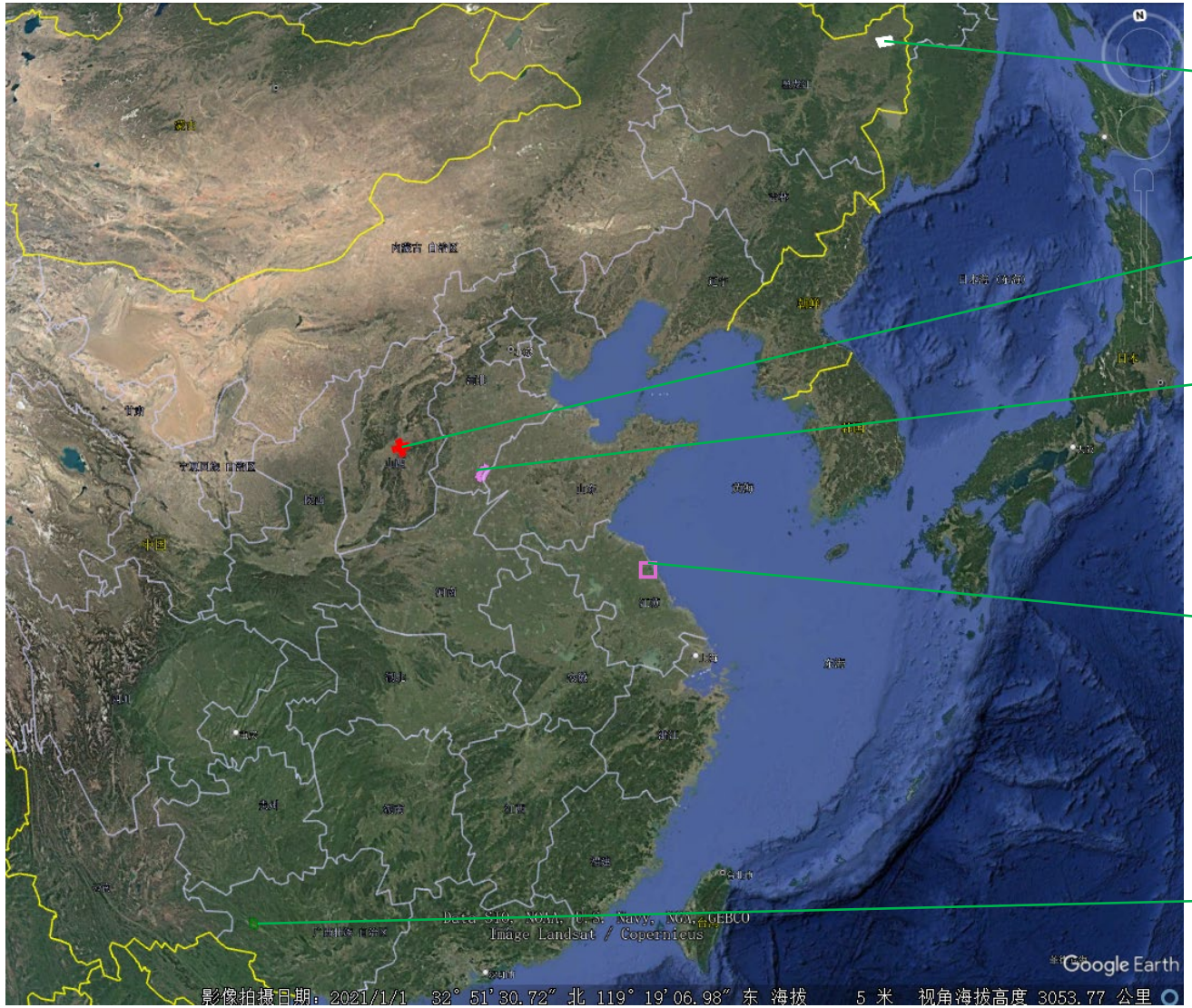


Fig. Classified results in Xiangyin County study area: (a) SVM, (b) KNN,(c) RF, (d) CNN, (e) RNN, (f) ViT, (g) VITCNN, (h) HDAM-Net, (i) VITCNN

Table 1. Accuracy of various algorithms in Xiangyin County study area

C N.	Various Algorithms							
	SVM	KNN	RF	CNN	RNN	ViT	ViTCNN	HDAM-Net
1	95.18	90.12	95.52	81.13	94.60	97.24	98.37	**99.81**
2	97.69	99.62	99.56	95.31	99.27	98.74	99.78	**99.67**
3	96.26	96.77	97.45	86.17	98.03	99.63	99.92	**100.00**
4	84.66	89.93	90.33	77.39	92.94	93.18	96.84	**99.55**
5	76.11	91.87	88.88	49.18	97.75	91.32	93.17	**96.01**
6	94.33	98.02	96.31	78.05	96.38	98.35	98.64	**99.88**
7	97.34	99.55	98.00	90.36	99.47	99.19	99.81	**99.76**
OA (%) ↑	92.47	95.13	95.52	82.26	96.27	96.92	98.32	**99.42**
AA (%) ↑	91.66	95.13	95.16	79.66	96.07	96.81	98.08	**99.25**
Kappa ↑	0.9102	0.9419	0.9466	0.7883	0.9555	0.9633	0.9800	**0.9931**

Overview of Chinese YSs research 4/5 Jinzhong



Chuangye:
Rice

Jinzhong:
Maize

Guantao:
Winter wheat, maize, bean, cotton

Yancheng:
Winter wheat, barley, garlic, Rice, Maize

Guangxi:
Sugarcane and vegetable

Research Activities

- **Identifying the farming practices of conservation agriculture**
  - **Bare fields in winter**
  - **Irrigated fields in winter**
  - **Straw mulching fields in winter**
  - **Film mulching fields in spring**
- **Crop type classification**
  - **using multi-spectral images**
  - **using hyperspectral data (EnMAP/ BNU)**
  - **Model transferability**

Bare fields



Winter irrigation



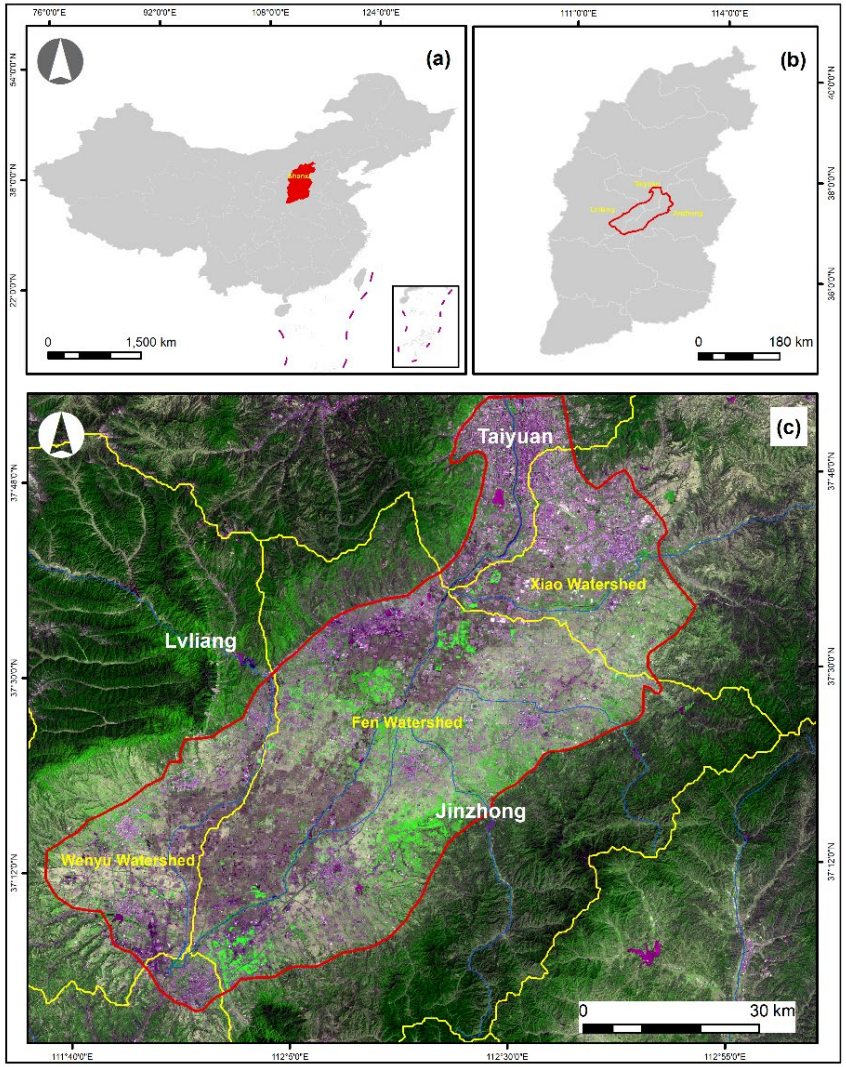
Straw mulching



Film mulching



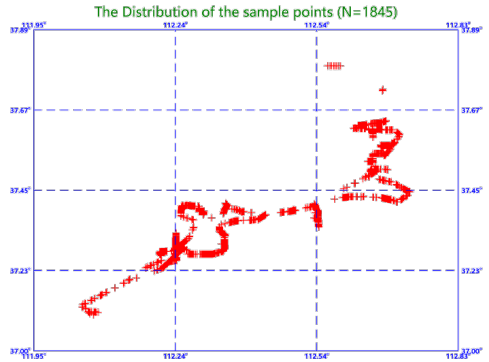
Overview of Chinese YSs research 4/5 Jinzhong

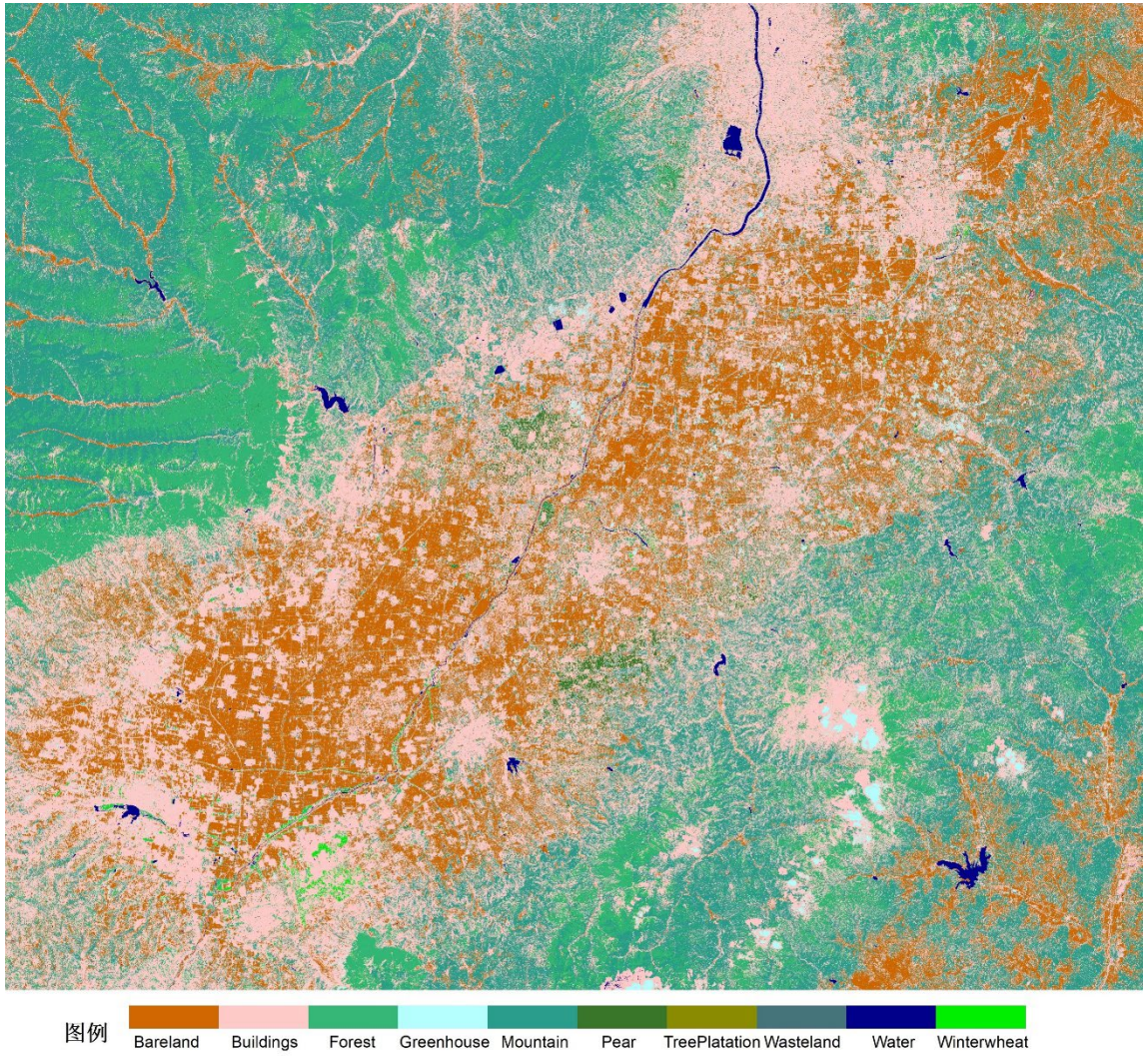


Bare soil period duration

- conservation agriculture
- Soil wind erosion

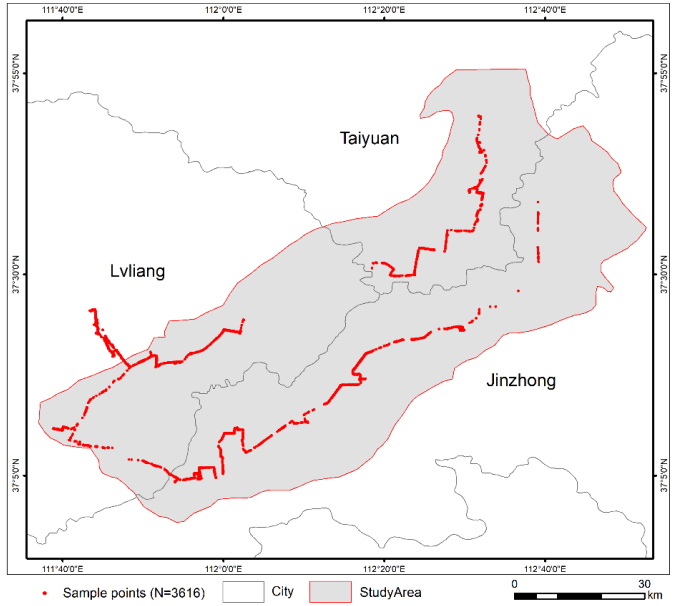






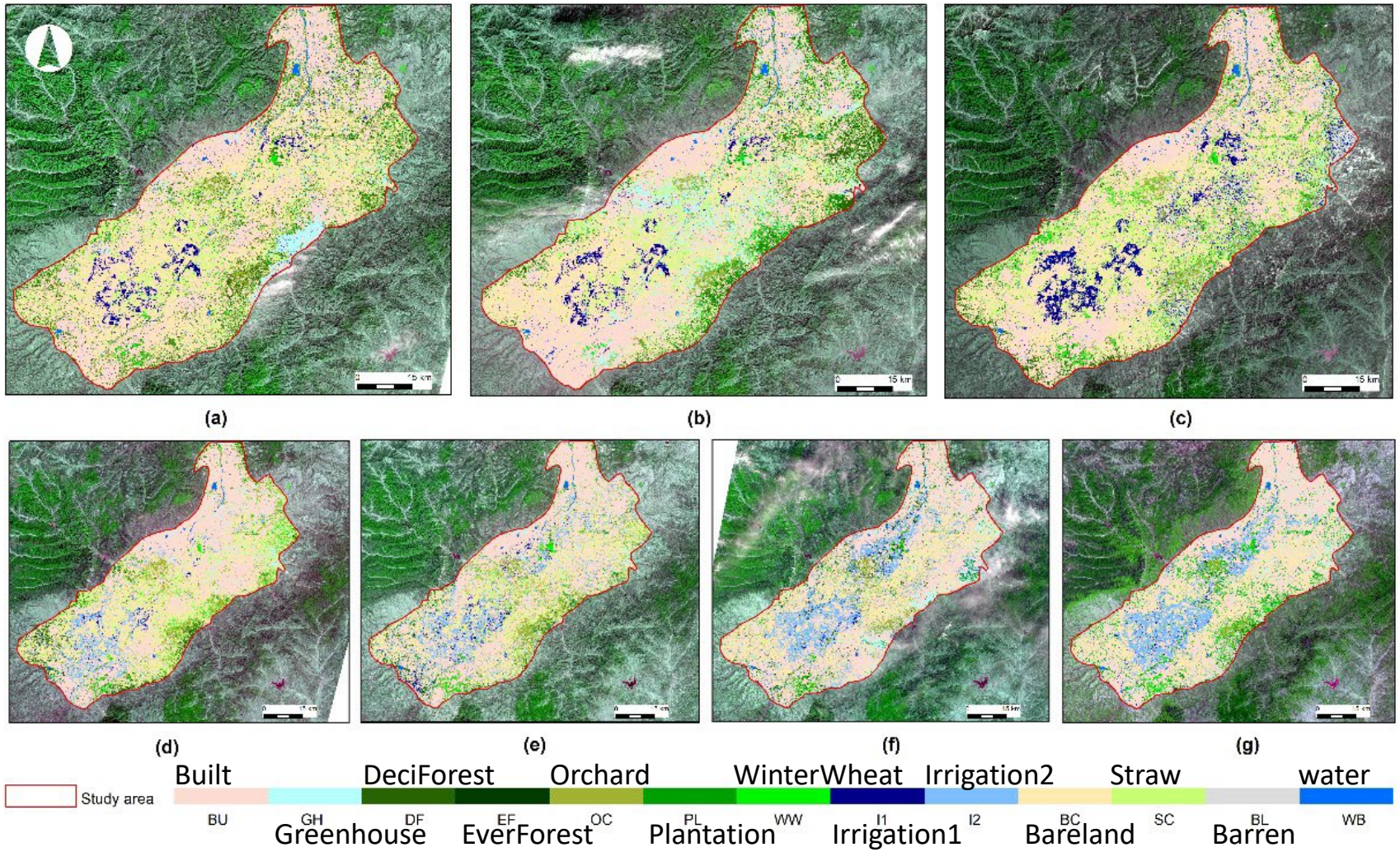
Source: Sentinel-2 April 25, 2022

Overview of Chinese YSs research 4/5 Jinzhong



No.	Date
1	2022/12/27
2	2023/01/04
3	2023/01/25
4	2023/03/03
5	2023/03/27
6	2023/04/08
7	2023/04/29

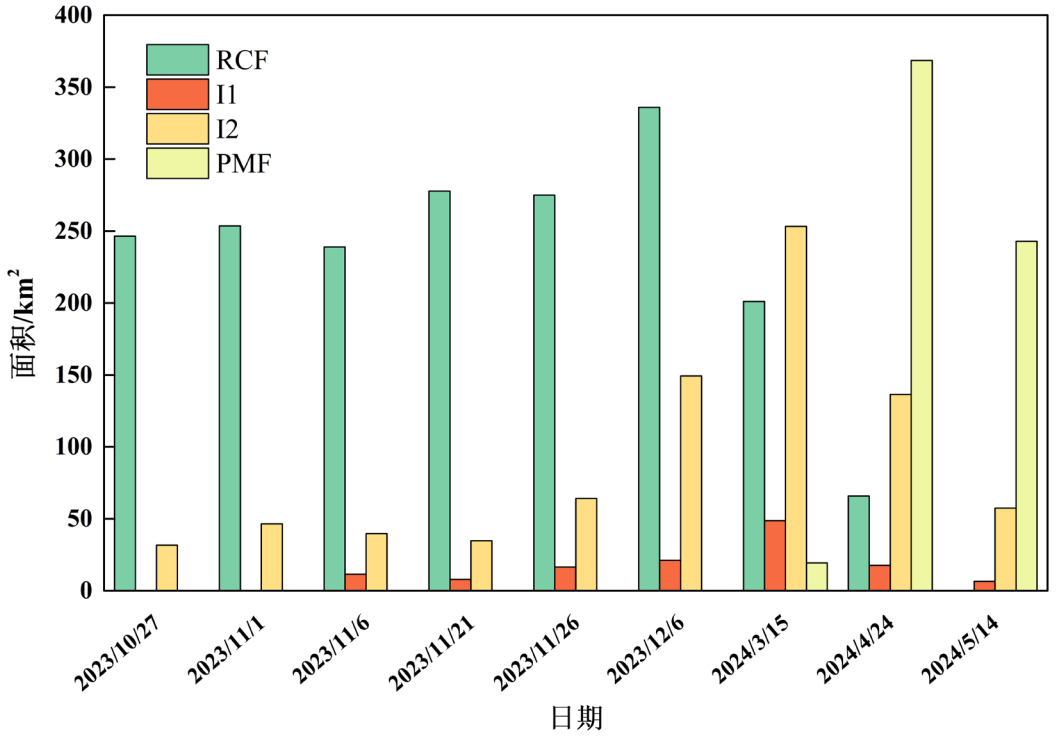
Identifying the Farm Fields Irrigated out of season with GF-1 Satellite Images

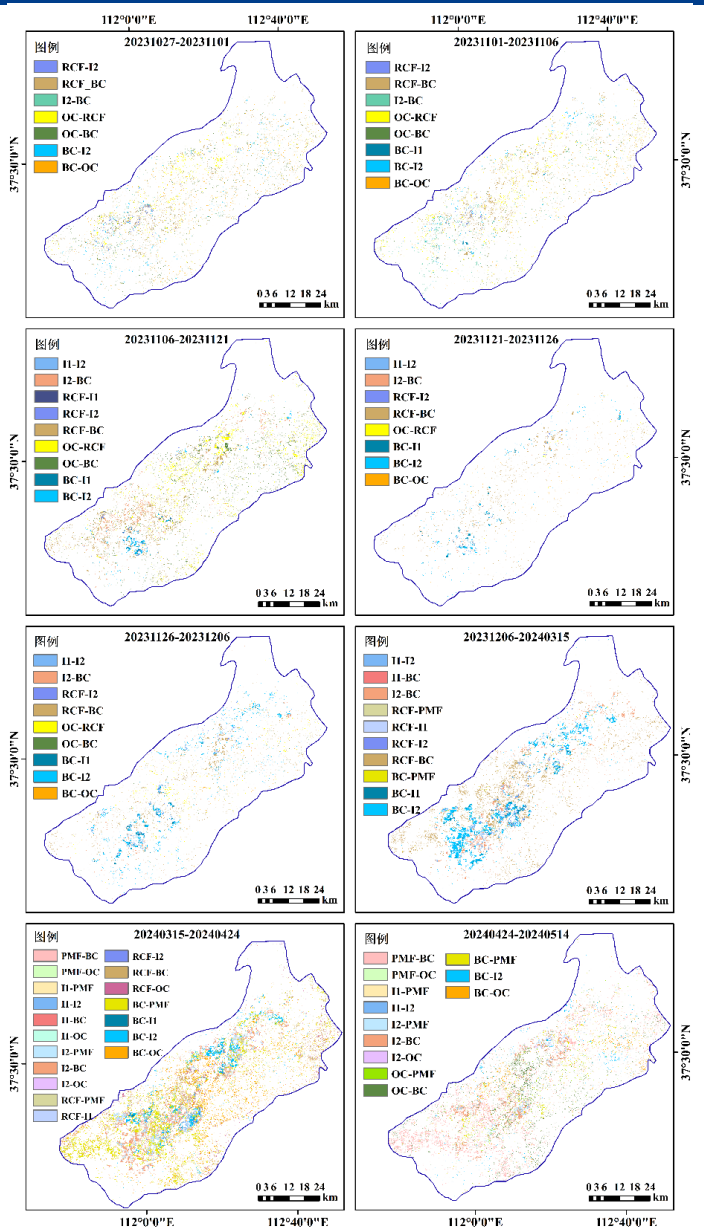


Overview of Chinese YSs research research 4/5 Jinzhong

Identifying the farming practices, including **straw mulching, winter irrigation and film mulching**

Period	Date
Autumn	2023/10/27
	2023/11/1
Winter	2023/11/21
	2023/12/6
	2024/3/15
Spring	2024/4/24
	2024/5/14



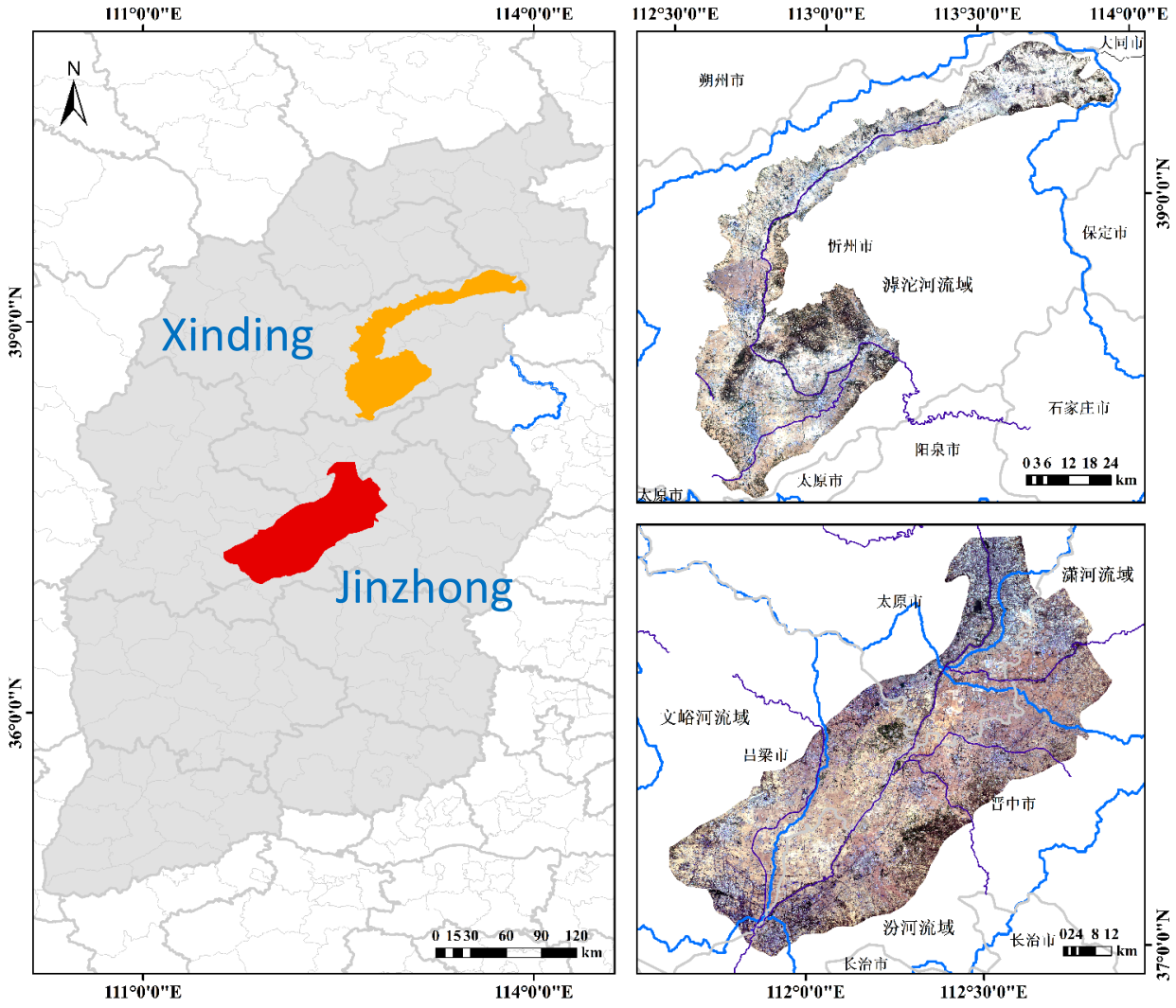


RCF: Straw mulching fields **I1/I2:** Irrigated fields **PMF:** Film mulching fields

Overview of Chinese YSs research research 4/5 Jinzhong

	2023/10/27	2023/11/1	2023/11/6	2023/11/21	2023/11/26	2023/12/6	2024/3/15	2024/4/24	2024/5/14
OA	**96.5**	**96.2**	**95.3**	**96.0**	**96.3**	**95.4**	**97.4**	**96.1**	**96.7**
Kappa	**96.0**	**96.0**	**95.0**	**96.0**	**96.0**	**95.0**	**97.0**	**96.0**	**96.0**
F1	**96.8**	**96.3**	**94.8**	**96.0**	**96.3**	**95.9**	**97.4**	**96.0**	**96.5**
PMF	-	-	-	-	-	-	96.9	97.8	98.2
I1	-	-	87.5	99.6	100.0	100.0	100.0	95.7	98.9
I2	100.0	98.7	100.0	98.0	99.6	98.9	99.5	93.9	99.7
RCF	99.6	97.7	97.6	99.1	97.4	96.8	98.5	95.9	-
BC	100.0	100.0	93.1	99.1	95.7	94.3	95.7	97.9	98.9
BL	91.1	92.2	87.1	96.4	91.8	93.3	98.8	95.9	91.3
GH	94.8	97.9	92.8	95.9	95.4	98.9	98.9	97.3	87.9
IS	99.3	98.2	95.1	99.1	97.3	96.8	93.0	99.1	93.5
OR	95.9	95.8	98.8	97.3	96.1	96.4	100.0	93.0	96.9
OC	94.3	95.0	97.1	87.3	92.9	91.7	-	94.3	99.4
WB	100.0	93.4	95.1	94.1	93.6	99.8	100.0	100.0	99.5
GL	95.1	94.5	95.2	93.9	94.5	92.7	96.6	93.3	96.9
WW	-	-	-	95.1	100.0	96.2	98.2	95.1	96.9
WOL	95.0	95.3	97.6	93.2	97.4	91.4	98.2	95.1	96.2

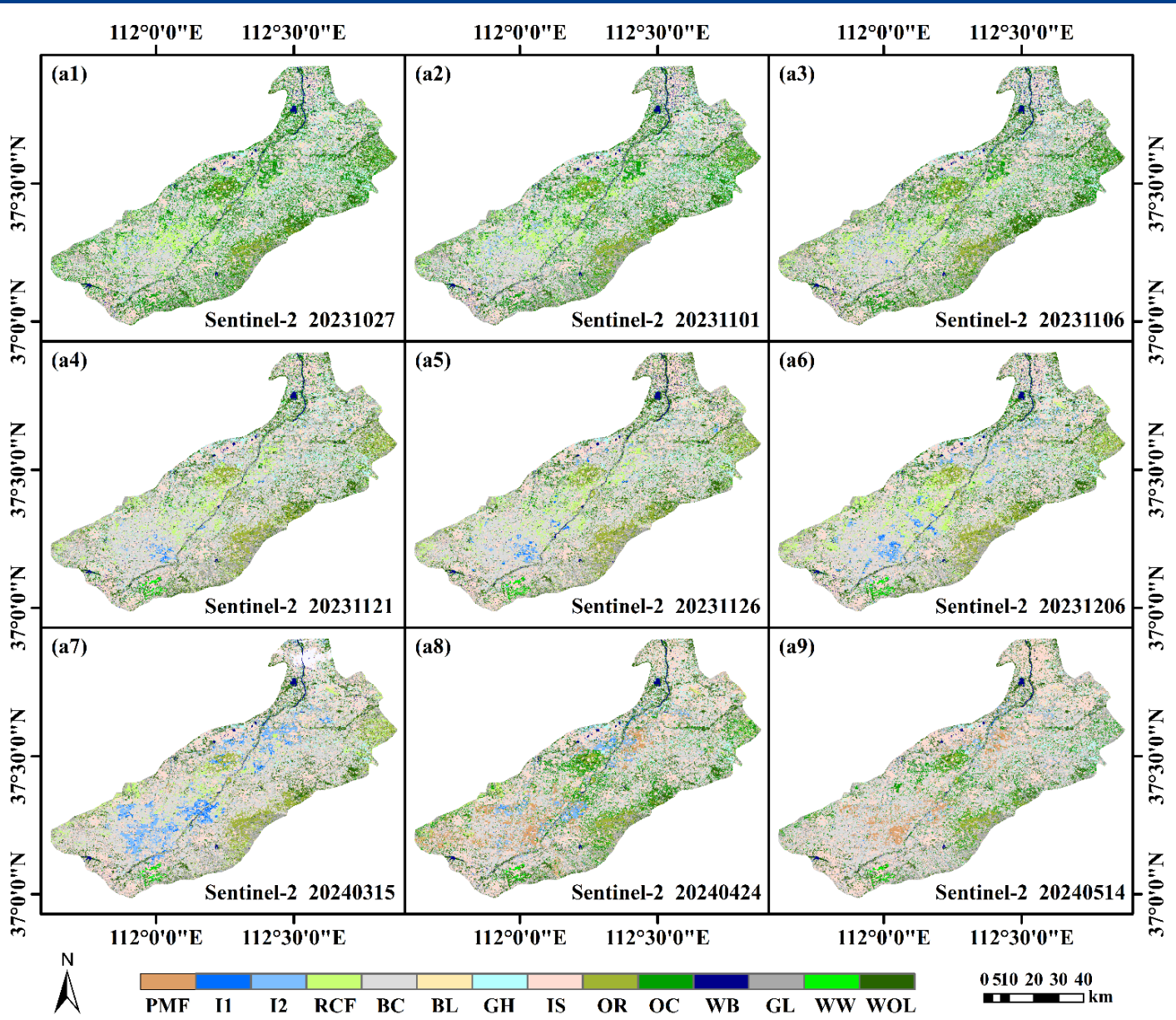
Overview of Chinese YSs research 4/5 Jinzhong

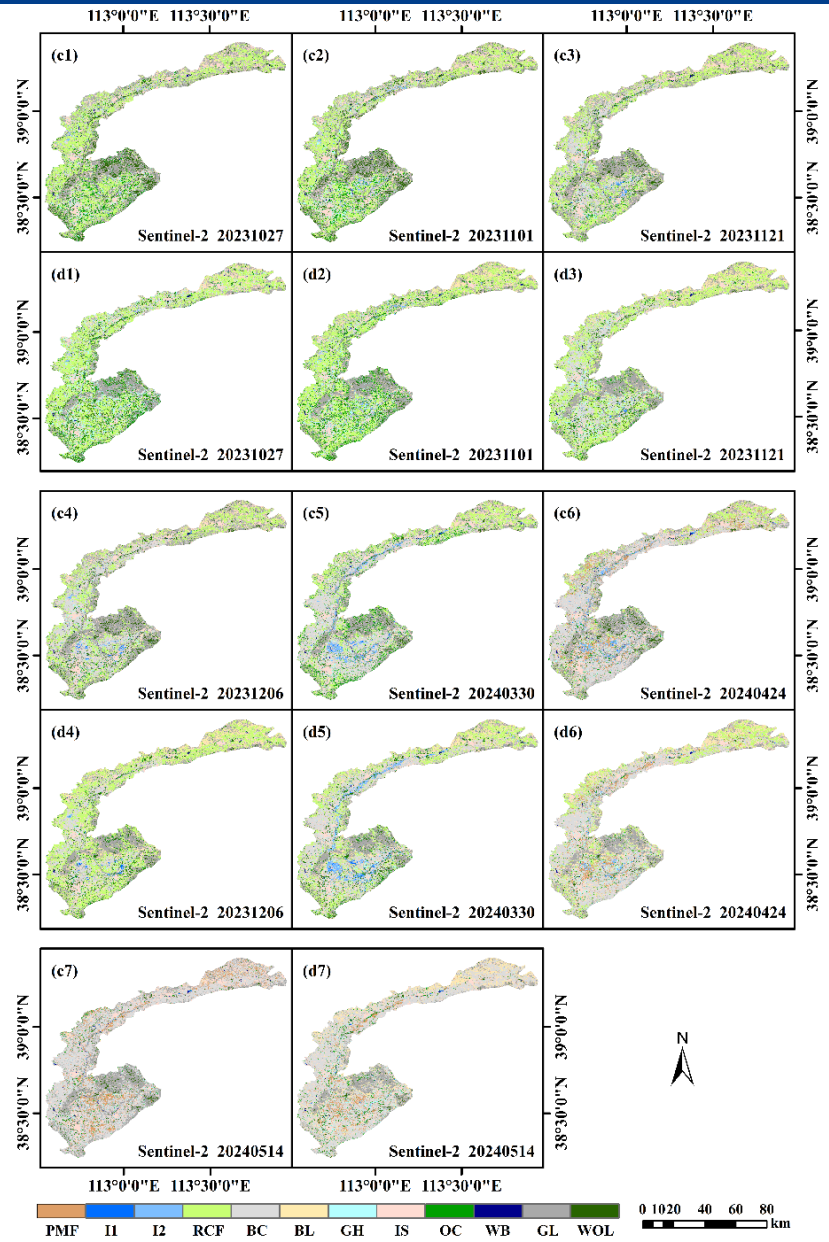


Classification model transferability

Period	Jinzhong	Xinding
Autumn	2023/10/27	2023/10/27
	2023/11/1	2023/11/1
Winter	2023/11/21	2023/11/21
	2023/12/6	2023/12/6
	2024/3/15	2024/3/30
Spring	2024/4/24	2024/4/24
	2024/5/14	2024/5/14

Overview of Chinese YSs research 4/5 Jinzhong

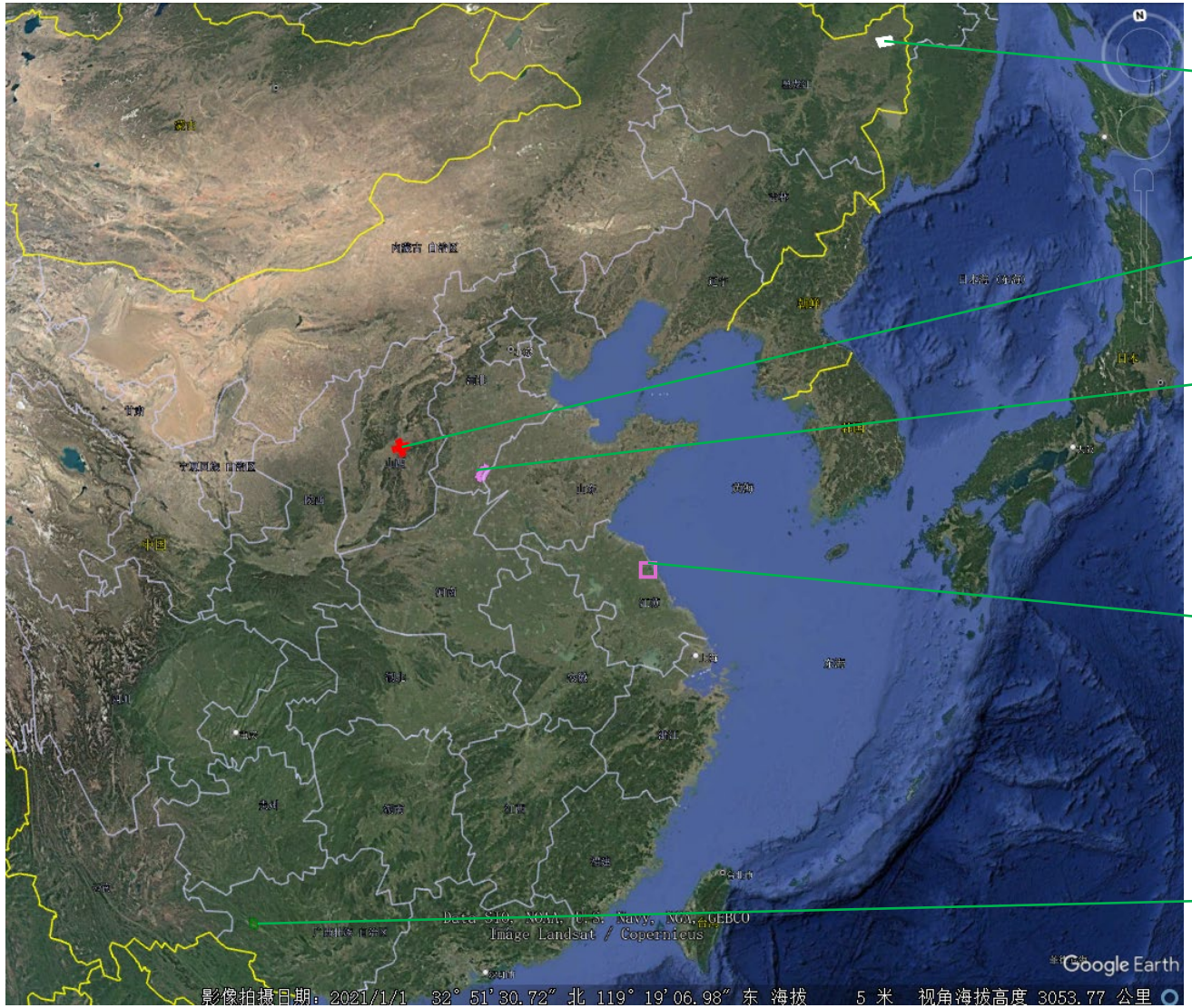




Overview of Chinese YSs research 4/5 Jinzhong

	Transferred Model							Model with training samples						
	2023/10/27	2023/11/1	2023/11/21	2023/12/6	2024/3/30	2024/4/24	2024/5/14	2023/10/27	2023/11/1	2023/11/21	2023/12/6	2024/3/30	2024/4/24	2024/5/14
OA	**88.2**	**90.4**	**92.5**	**94.2**	**89.0**	**88.0**	**92.4**	**95.6**	**94.7**	**96.1**	**95.7**	**95.5**	**95.5**	**96.6**
Kappa	**87.0**	**89.0**	**91.0**	**93.0**	**88.0**	**87.0**	**91.0**	**95.0**	**94.0**	**96.0**	**95.0**	**95.0**	**95.0**	**96.0**
F1	**87.8**	**90.5**	**90.0**	**93.2**	**83.4**	**86.9**	**91.9**	**95.9**	**94.6**	**96.5**	**95.5**	**93.1**	**96.1**	**95.8**
PMF	-	-	-	-	75.0	76.8	94.8	-	-	-	-	80.7	93.0	98.6
I1	-	-	80.2	95.1	95.9	90.9	93.6	-	-	100.0	100.0	100.0	100.0	96.5
I2	100.0	98.7	70.7	83.0	75.1	81.0	97.0	100.0	97.3	95.8	94.9	97.1	100.0	98.8
RCF	100.0	100.0	96.4	99.4	90.6	86.9	-	96.9	96.3	94.1	92.5	92.7	100.0	-
BC	85.1	93.9	97.8	97.6	93.3	88.1	96.9	99.7	90.0	96.2	96.0	94.6	93.4	97.7
BL	74.1	79.8	92.4	95.1	90.1	83.9	92.4	95.0	99.8	95.7	96.0	92.8	95.8	98.5
GH	73.9	79.1	86.3	92.8	79.0	76.1	83.0	96.9	93.5	95.7	90.1	98.7	94.1	77.3
IS	87.0	87.4	93.4	94.1	93.3	90.1	94.9	96.4	96.6	94.7	97.6	96.7	94.5	96.0
OC	92.3	92.9	91.7	86.1	64.5	95.5	85.6	98.2	99.7	100.0	94.8	91.9	95.3	93.4
WB	97.0	99.6	97.9	99.5	96.0	96.2	99.4	93.4	94.1	98.6	100.0	98.8	100.0	100.0
GL	75.6	79.8	89.4	90.0	78.6	78.5	76.3	88.5	86.5	91.9	92.6	93.6	90.5	97.4
WOL	93.2	93.4	93.3	92.9	98.6	99.0	97.1	93.4	92.4	98.5	96.0	97.0	96.7	99.7

Overview of Chinese YSs research 5/5 Chuangye



Chuangye:
Rice

Jinzhong:
Maize

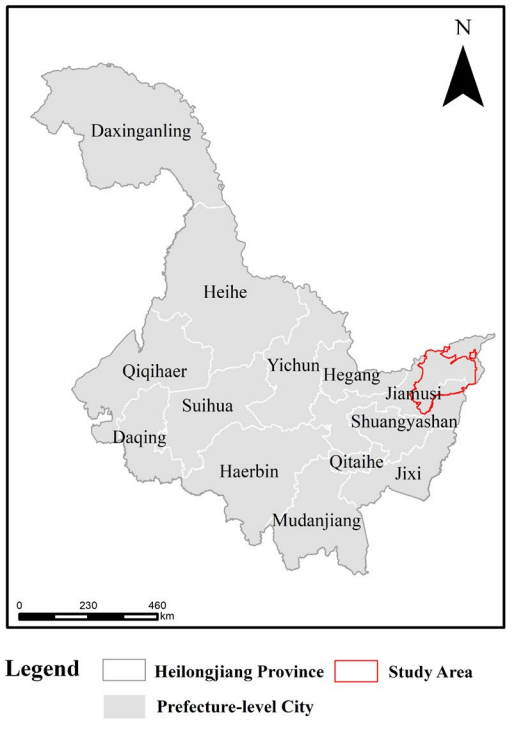
Guantao:
Winter wheat, maize, bean, cotton

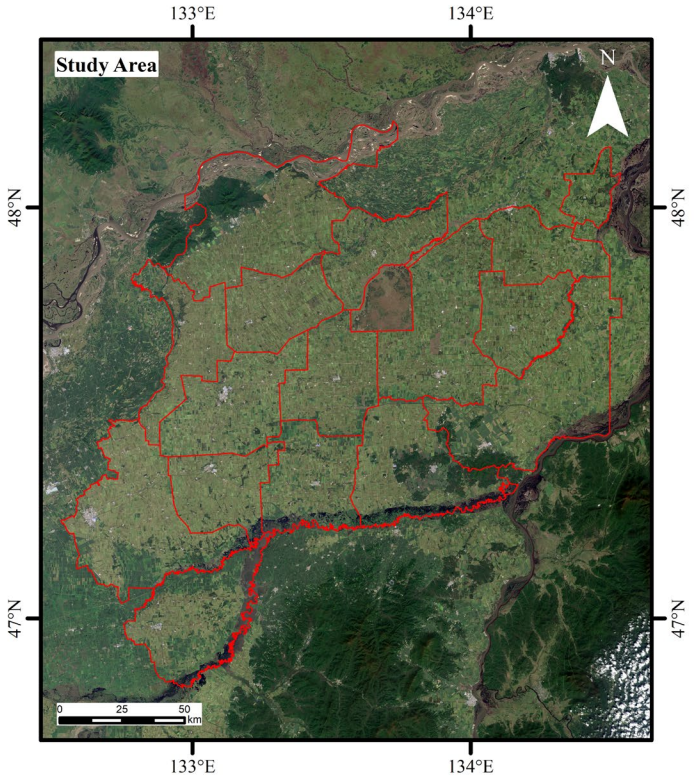
Yancheng:
Winter wheat, barley, garlic, Rice, Maize

Guangxi:
Sugarcane and vegetable

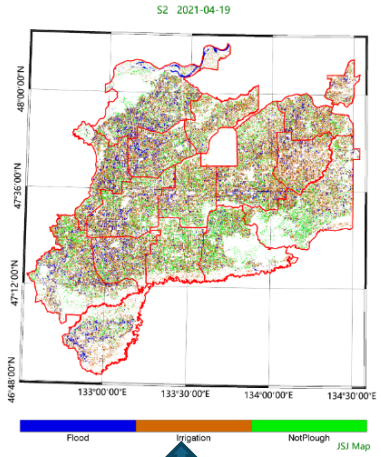
Research Activities

- **Timely farming practices identification**
  - Rice field preparation
  - Transplanted and directly sowed rice
  - Harvest
  - Plough
- **Crop type classification**
  - using hyperspectral data (EnMAP/ BNU)
  - using multi-spectral images
  - Rice variety separation with hyperspectral data

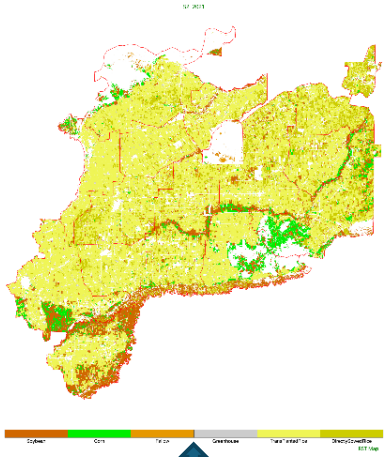




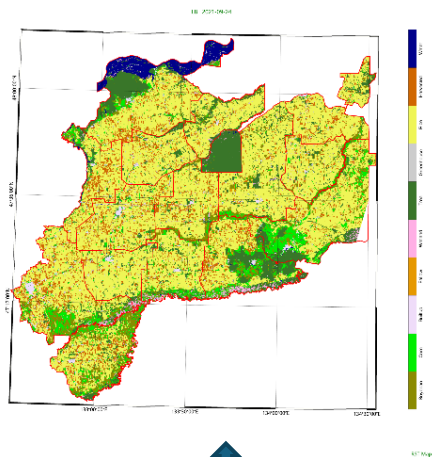
Overview of Chinese YSs research 5/5 Chuangye



Multiple images of field preparation



Crop type map



Harvest and plough maps

Middle April to Middle May
Field Preparation

	4/19 S2A		
农场	平地泡田	灌水未整地	未耕作
创业农场	22%	59%	19%
大兴农场	24%	60%	16%
红卫农场	11%	53%	36%
洪河农场	13%	59%	27%
浓江农场	23%	56%	20%
七星农场	19%	54%	26%
前锋农场	16%	62%	22%
前进农场	20%	56%	24%
前哨农场	16%	68%	16%
胜利农场	10%	48%	42%
八五九农场	12%	52%	36%
二道河农场	18%	70%	12%
勤得利农场	29%	49%	22%
青龙山农场	22%	58%	20%
鸭绿河农场	11%	65%	24%

Statistics for every farm

Middle June to Middle July
Crop Type Maping

2021年建三江各农场农作物遥感面积

水稻种植方式遥感监测结果				
插秧稻（万亩）	直播稻（万亩）	水稻（万亩）	大豆（万亩）	玉米（万亩）
53.9	3.0	56.9	6.6	13.3
48.7	8.6	57.2	4.7	3.3
89.5	24.8	114.3	8.1	3.1
58.6	9.6	68.2	7.5	1.3
57.7	3.4	61.2	2.1	1.9
81.5	14.2	95.7	5.1	6.0
59.1	4.7	63.9	0.1	0.0
44.5	6.8	51.3	2.7	0.2
72.5	17.5	90.0	1.7	0.4
55.3	5.2	60.5	0.3	0.2
105.7	3.2	108.9	14.9	13.1
51.6	2.8	54.4	24.7	13.2
74.0	29.3	103.2	15.9	26.9
47.5	11.4	58.8	2.5	2.9
46.2	30.0	76.2	3.0	1.0
946.4	174.5	1120.8	99.9	86.7

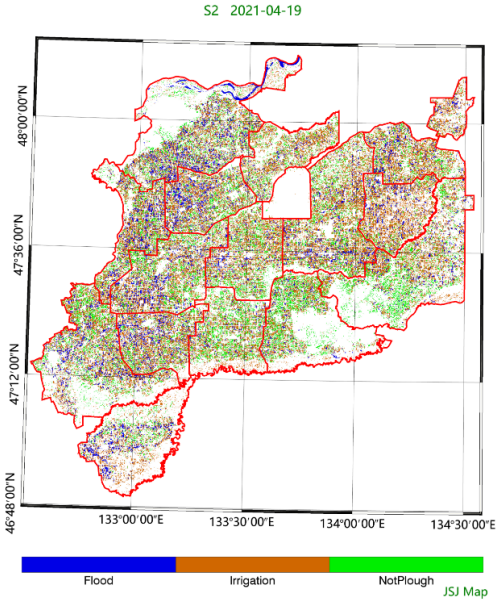
Cultivated acreages for paddy rice and dryland crops

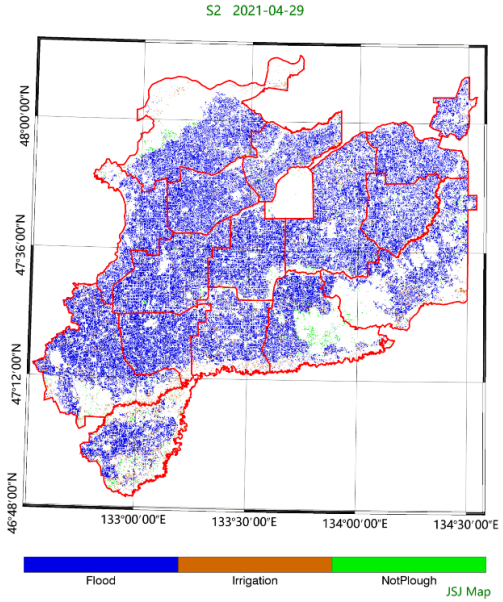
Middle Sep. to end Oct.
Harvest and plough

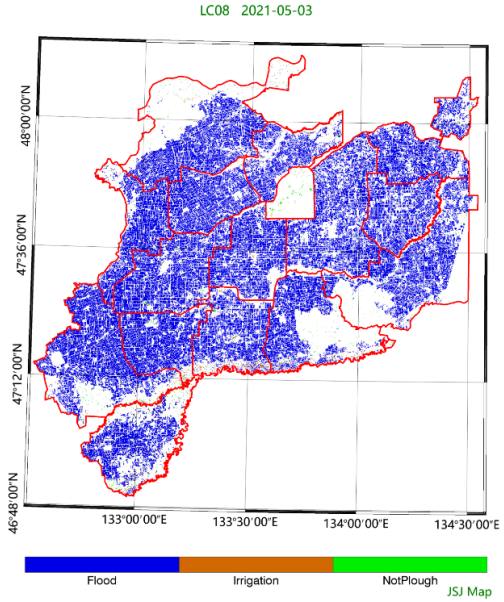
农场	水稻收获占比(9.24)
胜利	20.4%
红卫	8.8%
前锋	4.6%
洪河	12.7%
青龙山	19.4%
勤得利	14.8%
浓江	12.3%
鸭绿河	5.5%
前进	16.9%
创业	10.8%
七星	19.4%
大兴	18.7%
八五九	8.5%
二道河	6.3%
前哨	9.5%
平均	12.6%

Statistics for Harvest and plough in fall

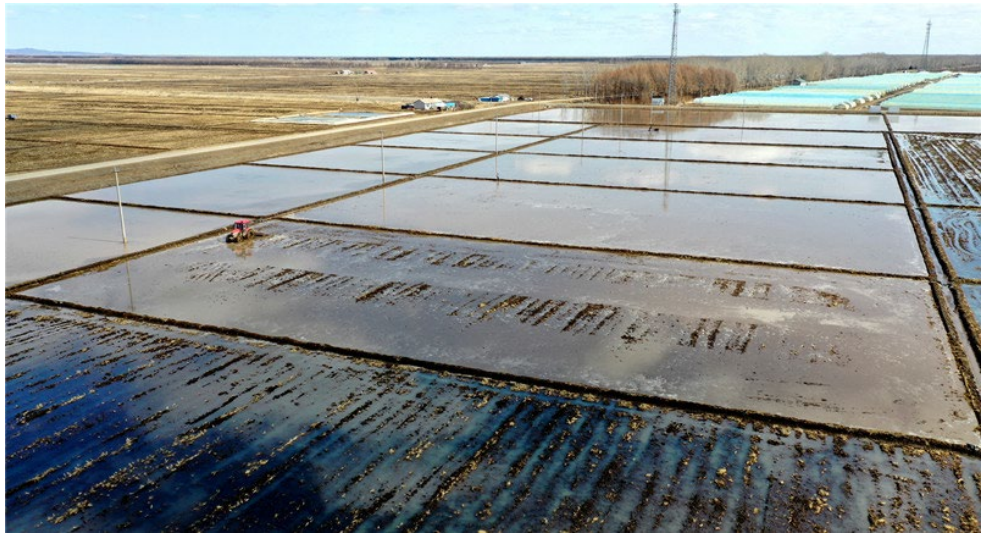
Overview of Chinese YSs research 5/5 Chuangye







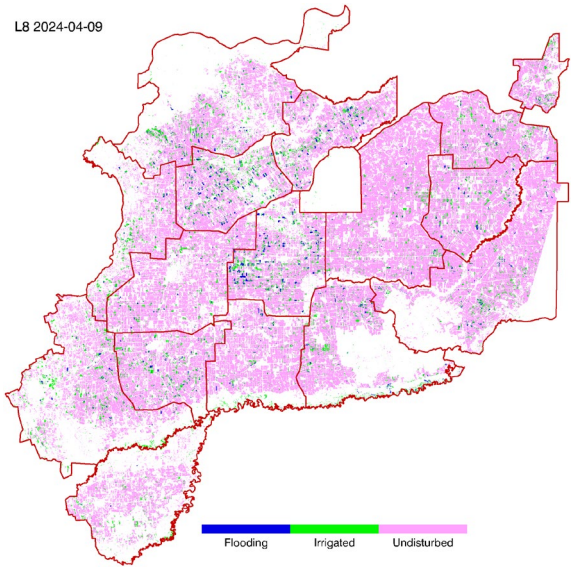


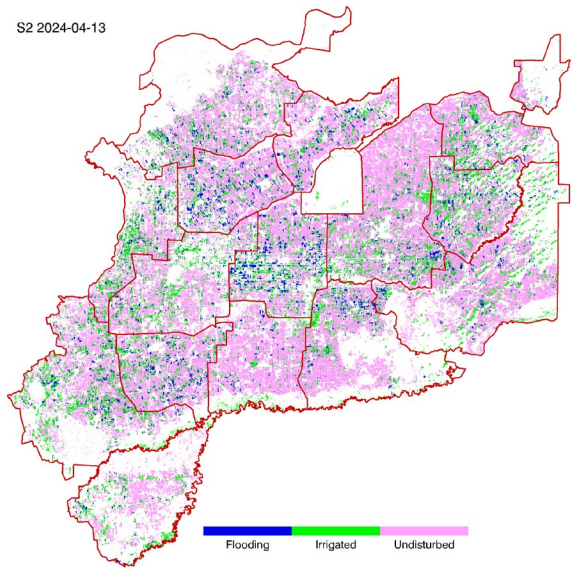


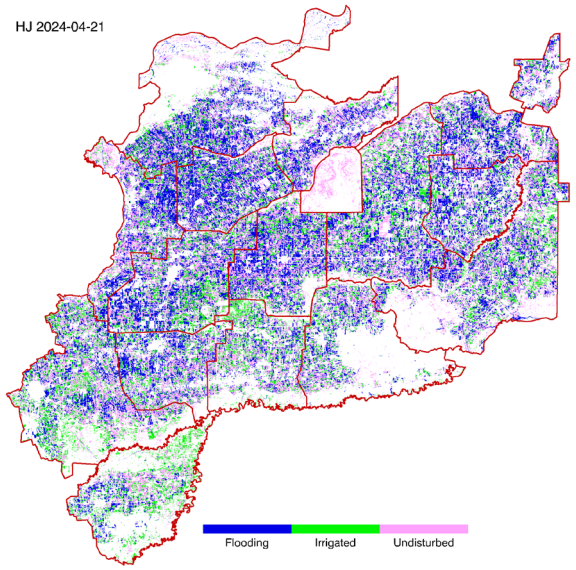


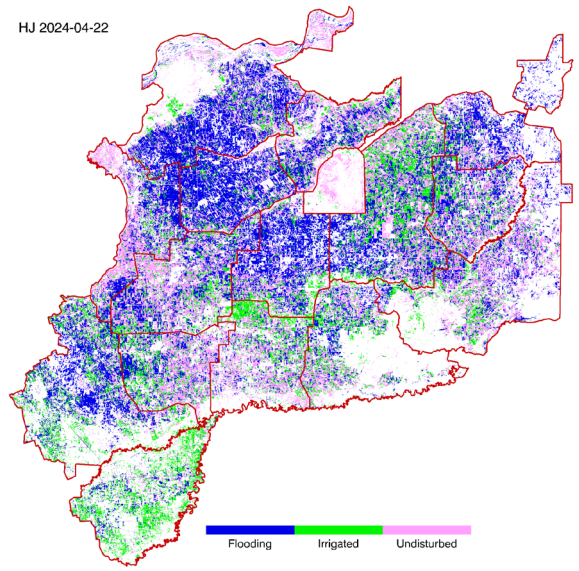


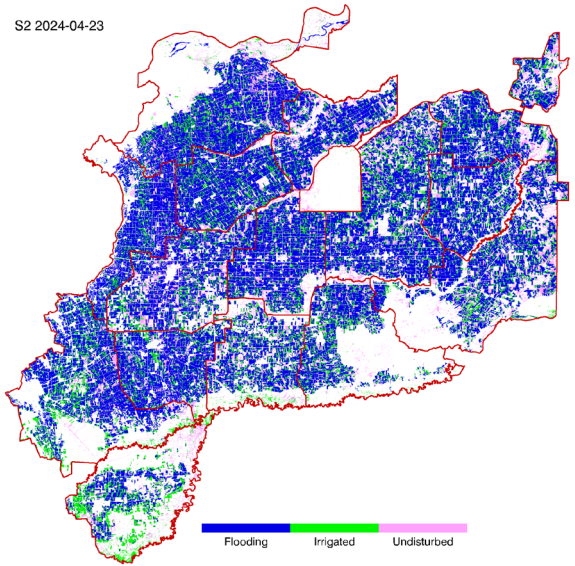
Overview of Chinese YSs research 5/5 Chuangye

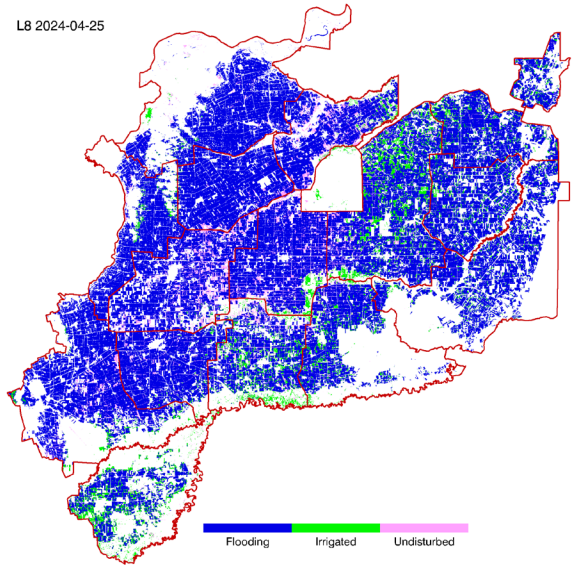


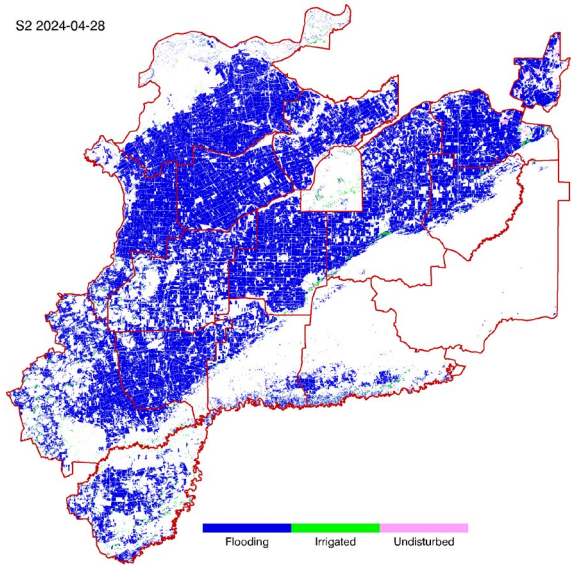


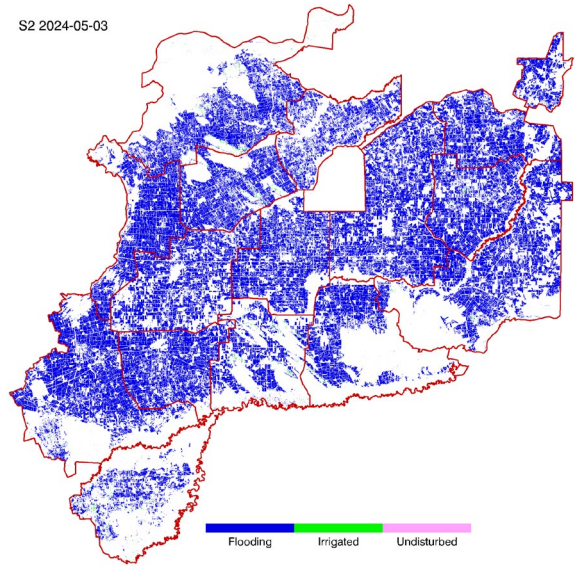




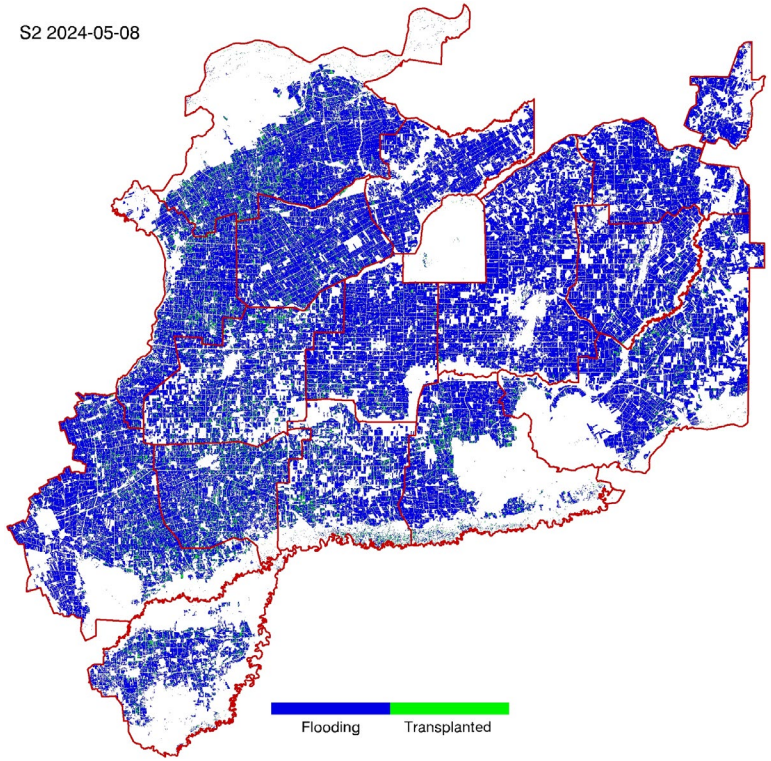


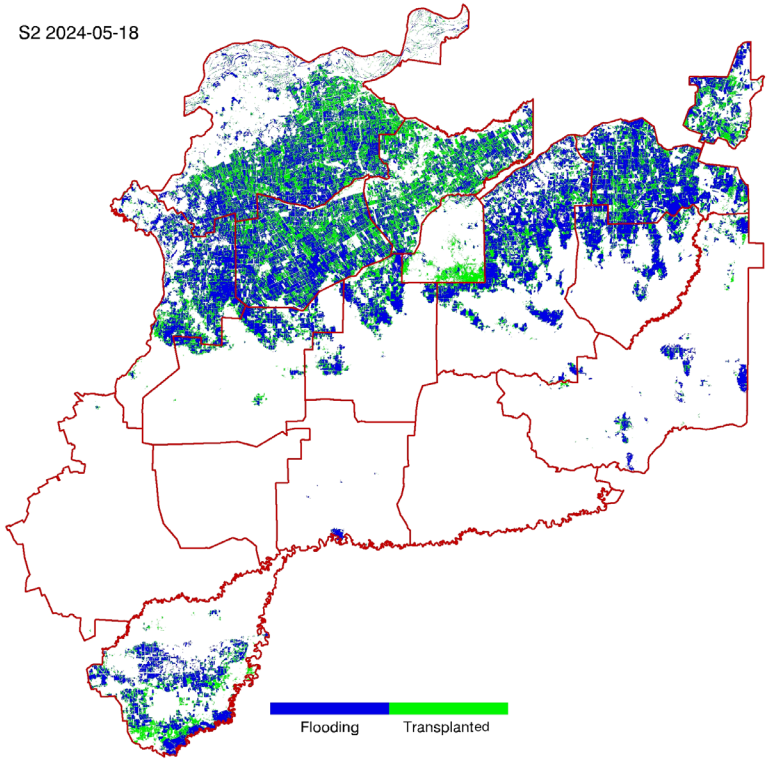


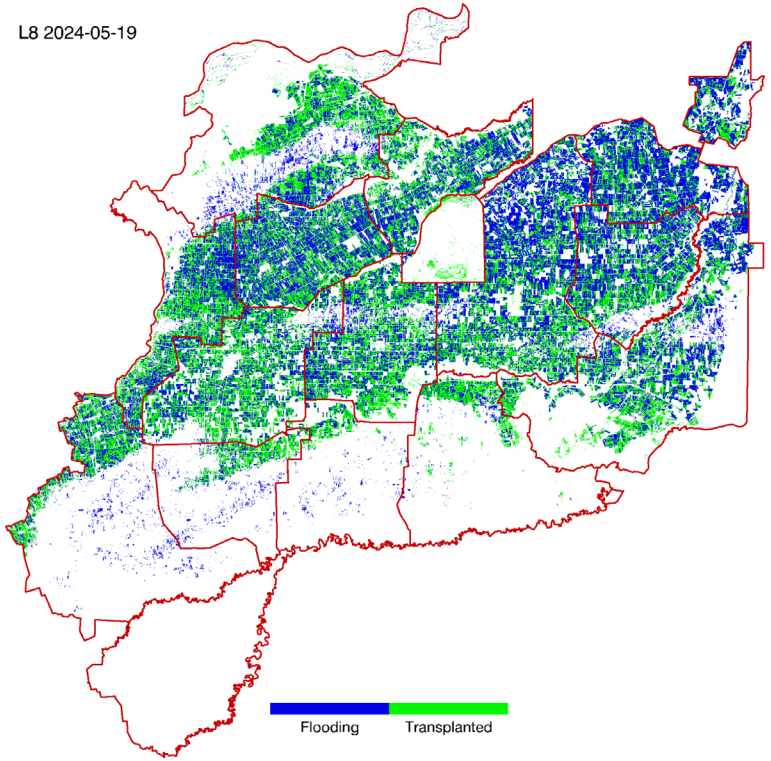




Overview of Chinese YSs research 5/5 Chuangye

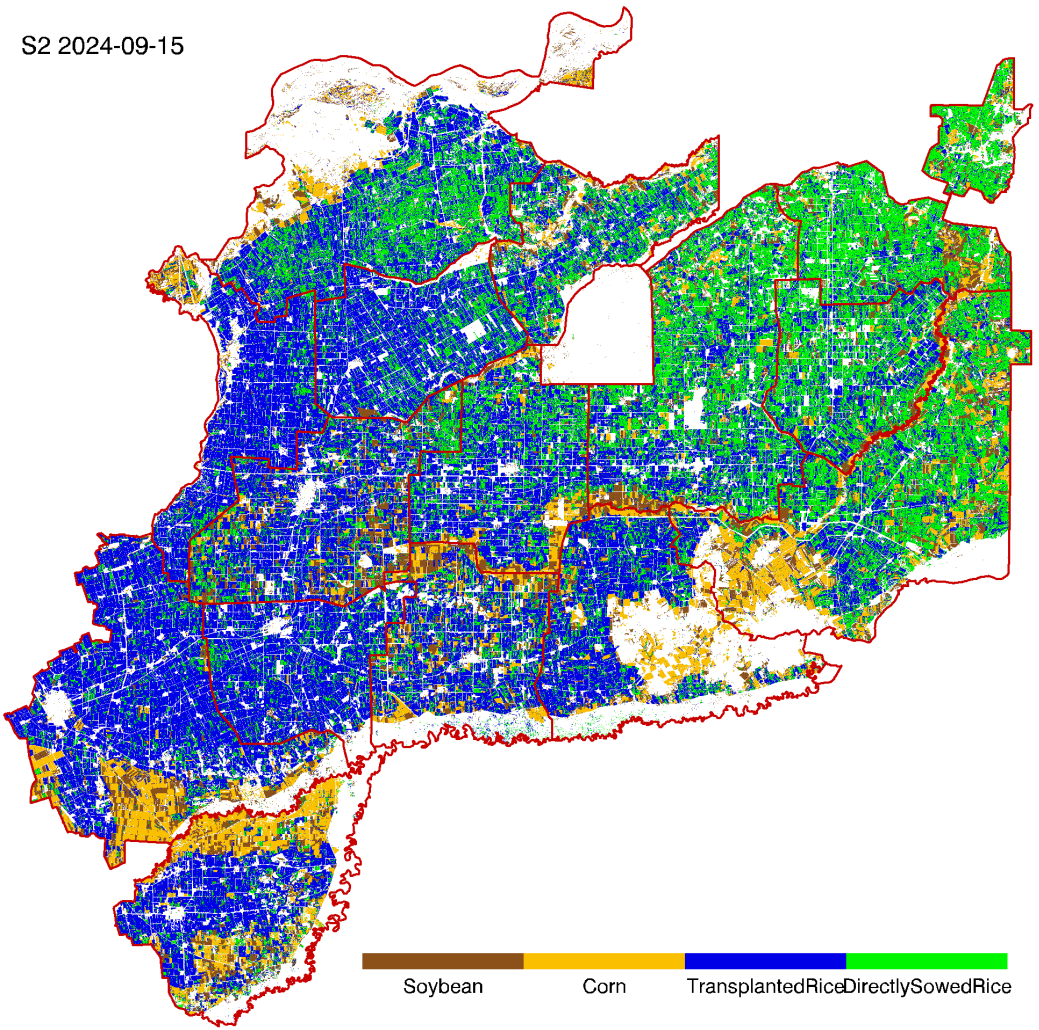




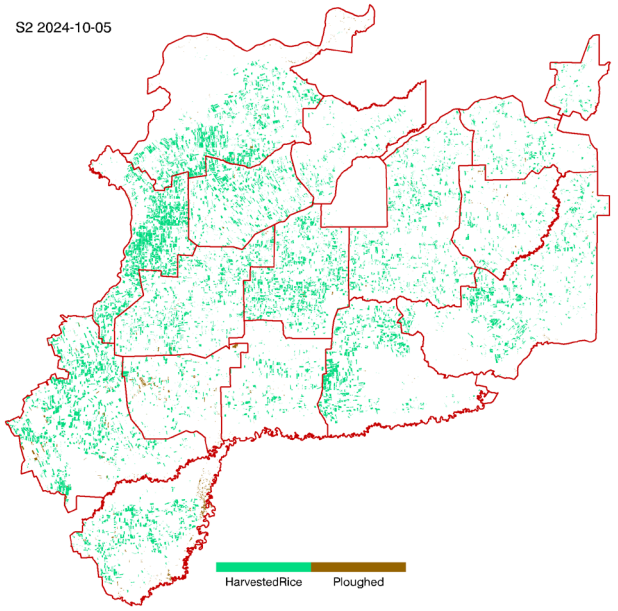


Overview of Chinese YSs research 5/5 Chuangye

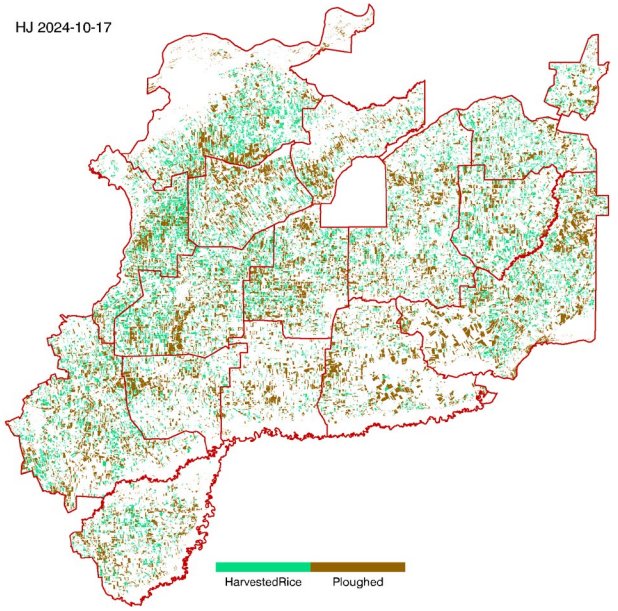
S2 2024-09-15



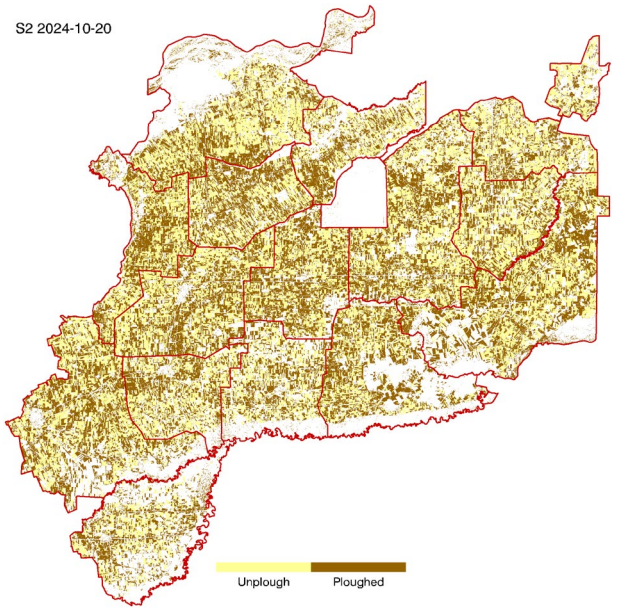
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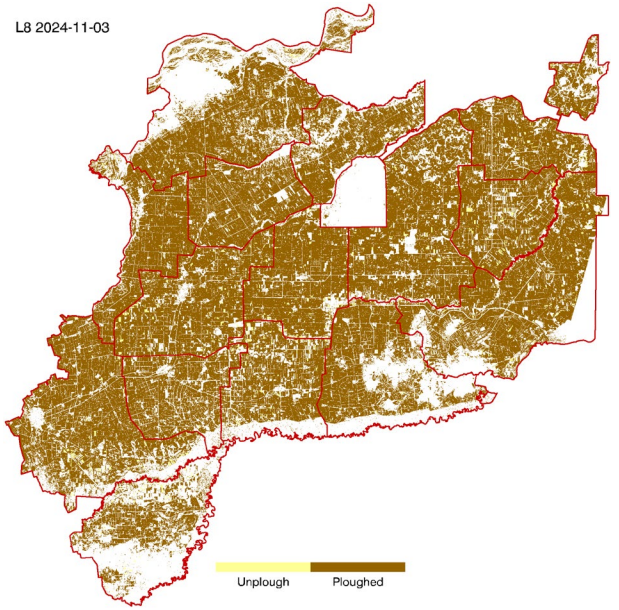
HJ 2024-10-17



S2 2024-10-20



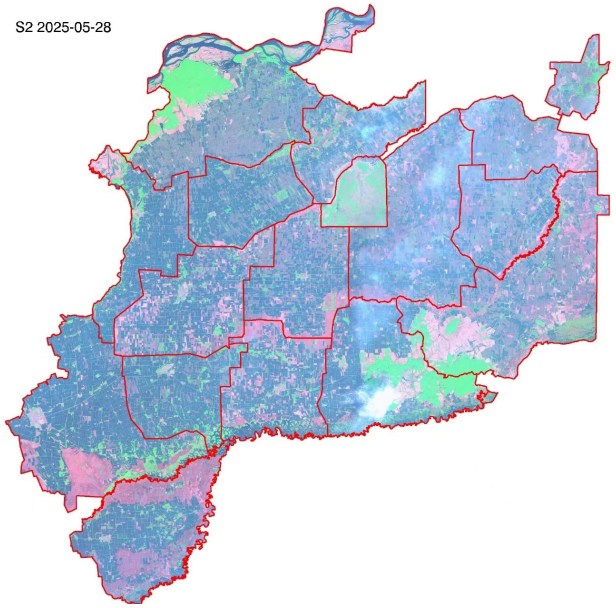
L8 2024-11-03

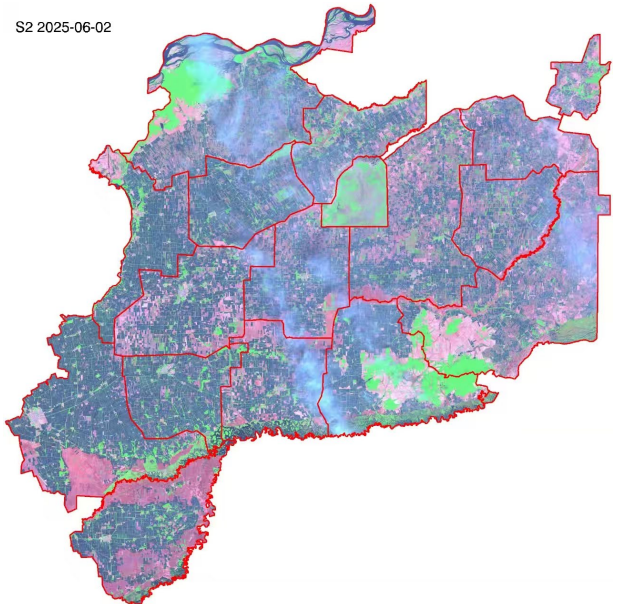


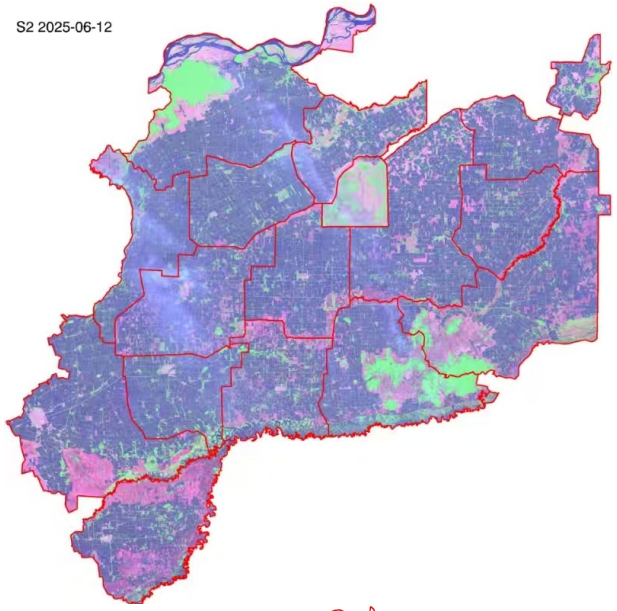
Accuracy results of agricultural activities monitoring in four periods

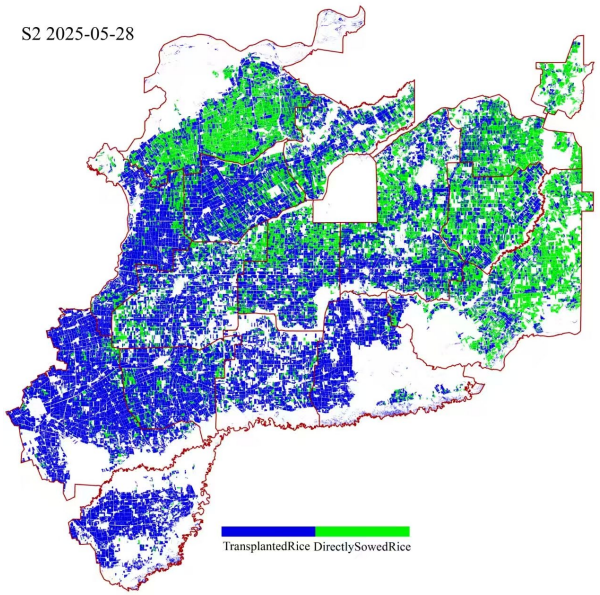
Period	Satellite	Date	Overall Accuracy	Kappa	F1 Score
Spring Field Soaking Period	Landsat 8	2024-04-09	92.0	91.0	92.0
	S2A	2024-04-23	90.5	89.0	90.1
	Landsat 8	2024-04-25	88.0	86.0	86.1
Growth Period	S2B	2024-09-15	86.2	84.0	86.7
Harvest Period	S2B	2024-10-05	91.0	89.0	88.6
	HJ2A	2024-10-13	92.1	91.0	89.3
	HJ2A	2024-10-17	93.3	92.0	88.5
Autunm Field Preparation Period	S2A	2024-10-20	95.2	94.0	94.1
	Landsat8	2024-11-03	96.1	93.0	94.0

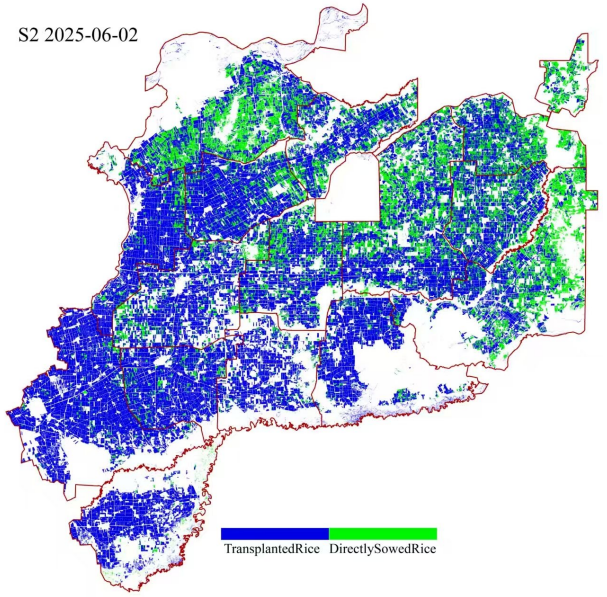
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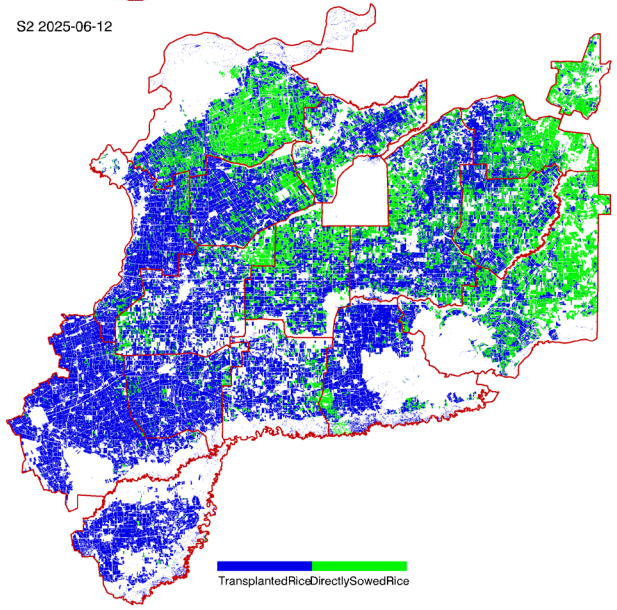






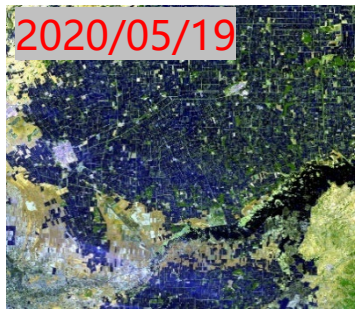


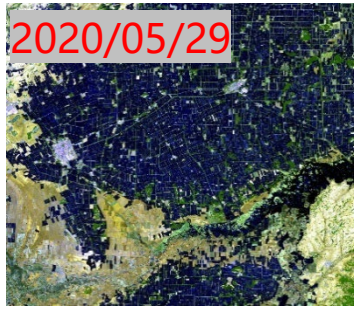


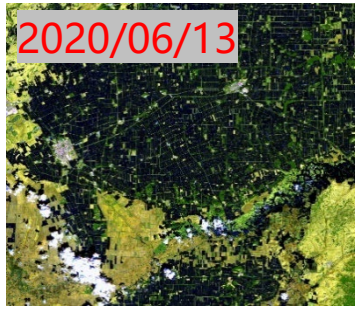


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Rice Varieties Mapping with Sentinel-2 Satellite data

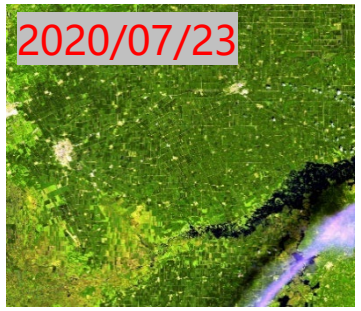


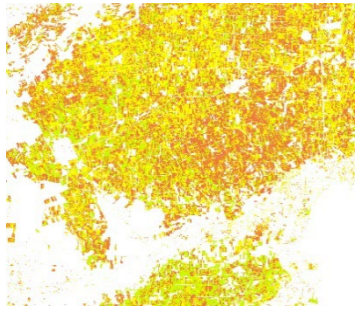




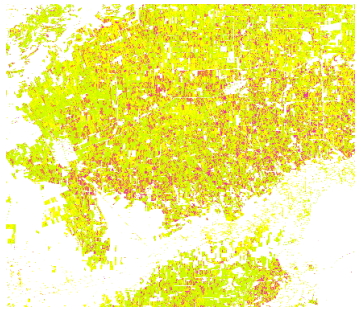


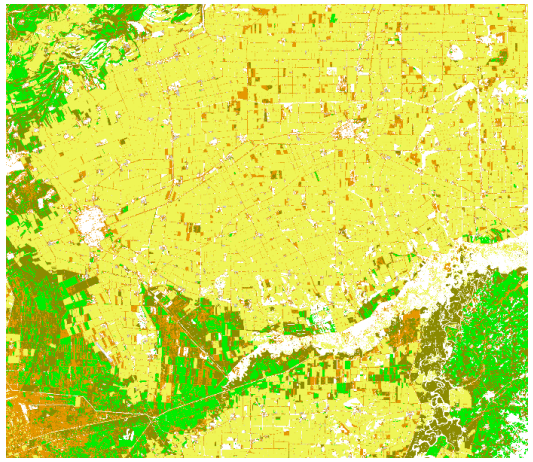


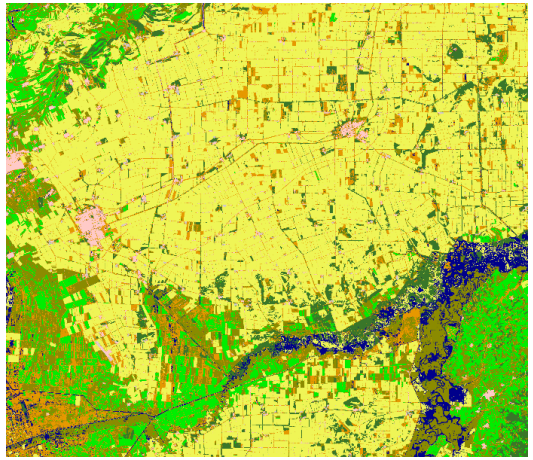


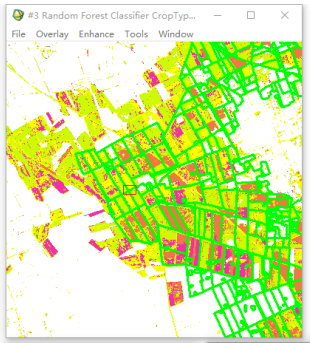




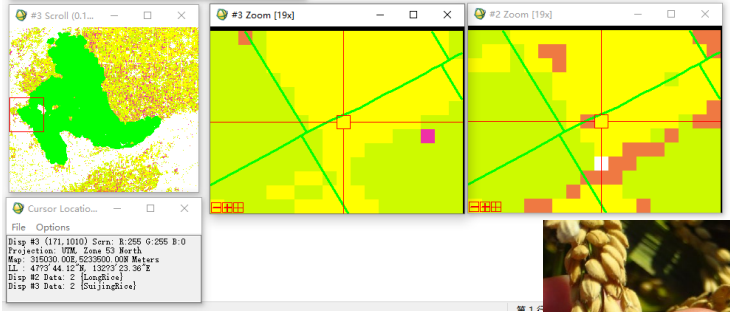




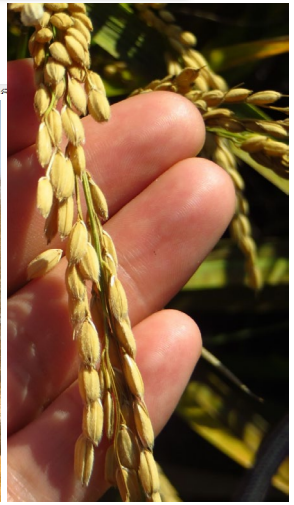




Qixing Farm Rice variety: Suijing18 long rice











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Long and Suijing

Sticky and Xinnian

Normal and longjing

Sticky and Sanjiang

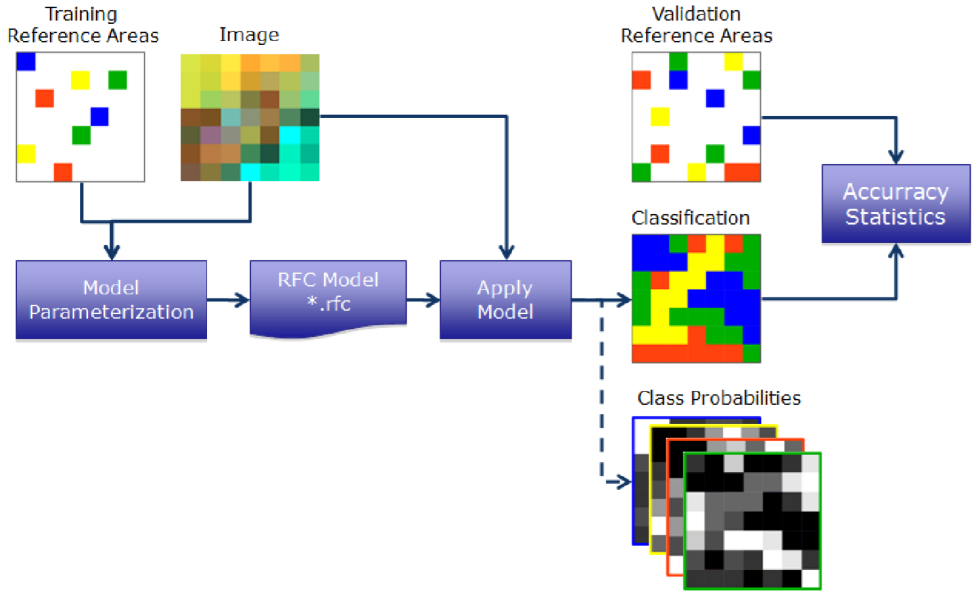


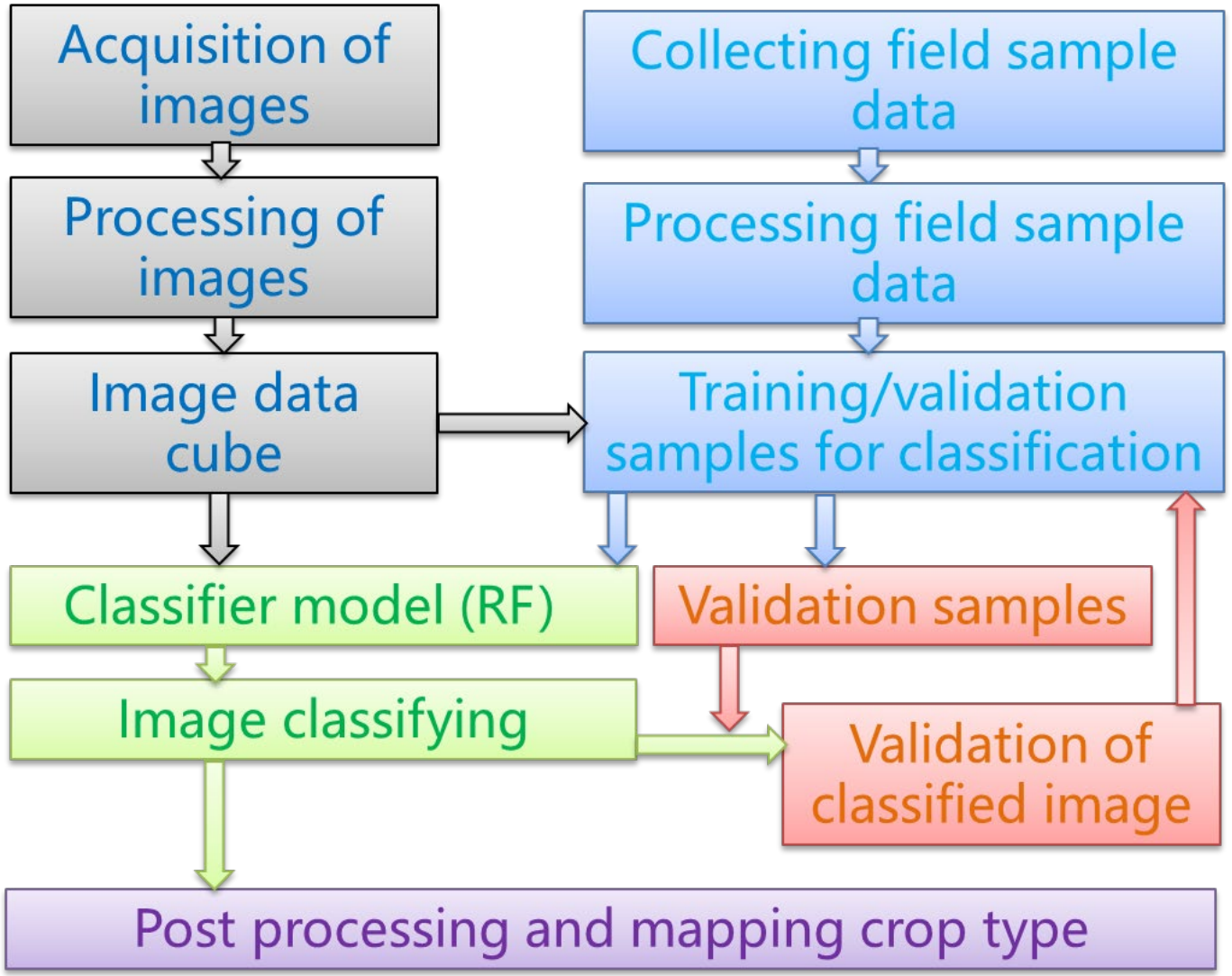


Overview of Chinese YSs research

Crop Mapping Key steps

- **Remote sensing data processing**
- **Training sample collection and evaluation**
- **Classification algorithm and application**
- **Validation and feedback**
- **Post classification and noise filtering**





Thank you very much for your attention !







Thanks to European young researchers for visiting us!