



Geoinformatics Unit

# National Cropland Classification with Agriculture Census Information and EO Datasets

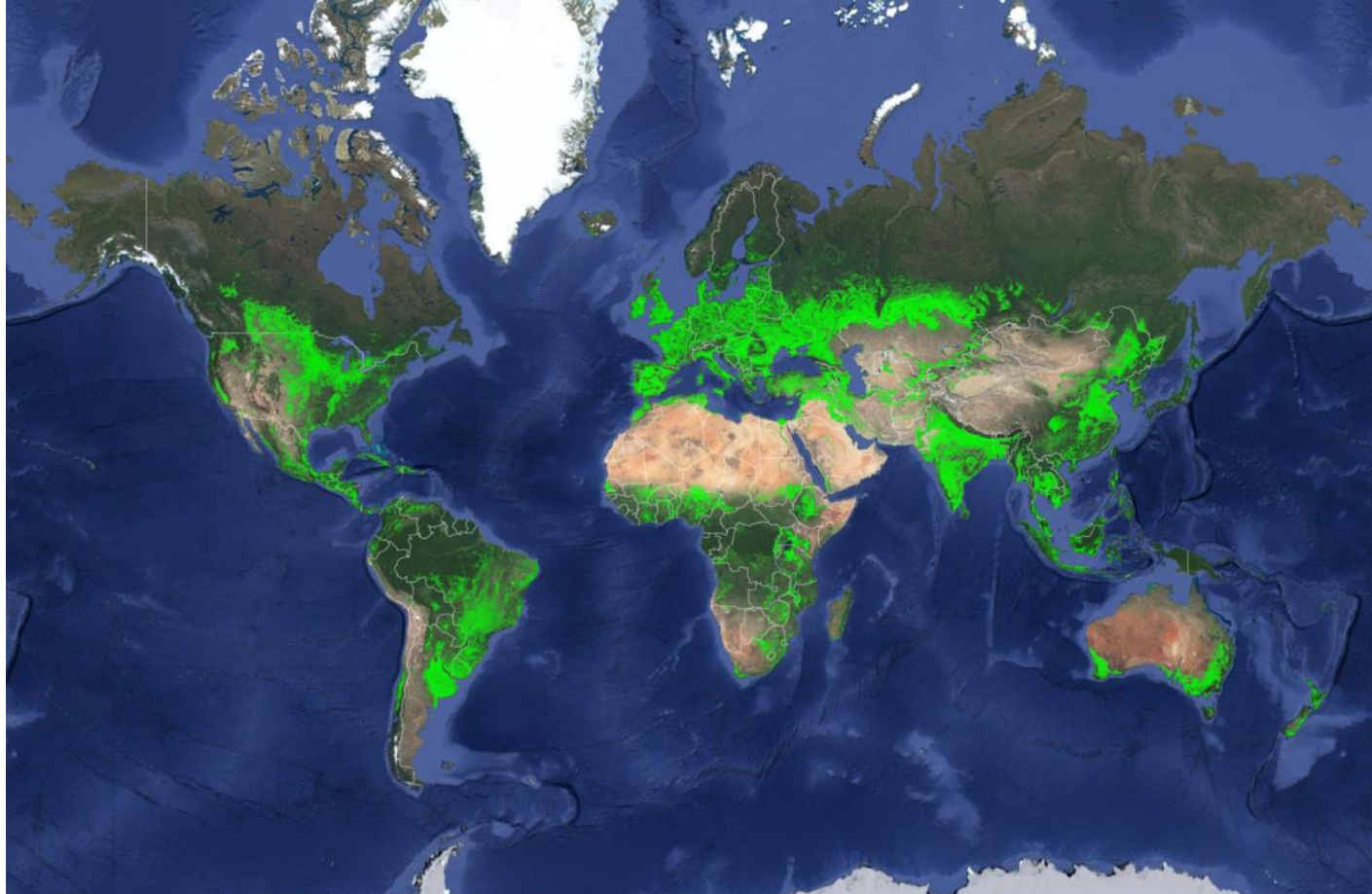
**Junshi Xia<sup>1</sup>**, Naoto Yokoya<sup>2,1</sup>, Bruno Adriano<sup>1</sup>

<sup>1</sup>RIKEN

<sup>2</sup>The University of Tokyo

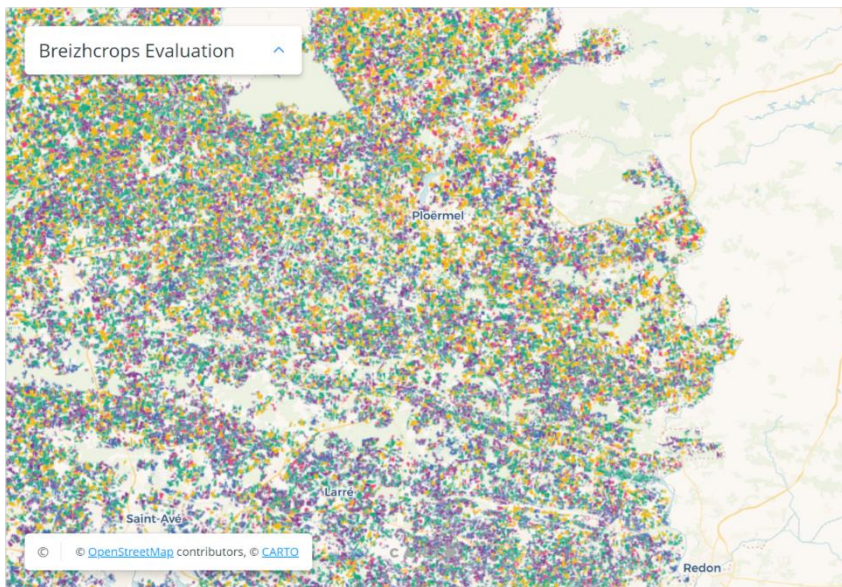


## Global Food Security -> Global cropland mapping



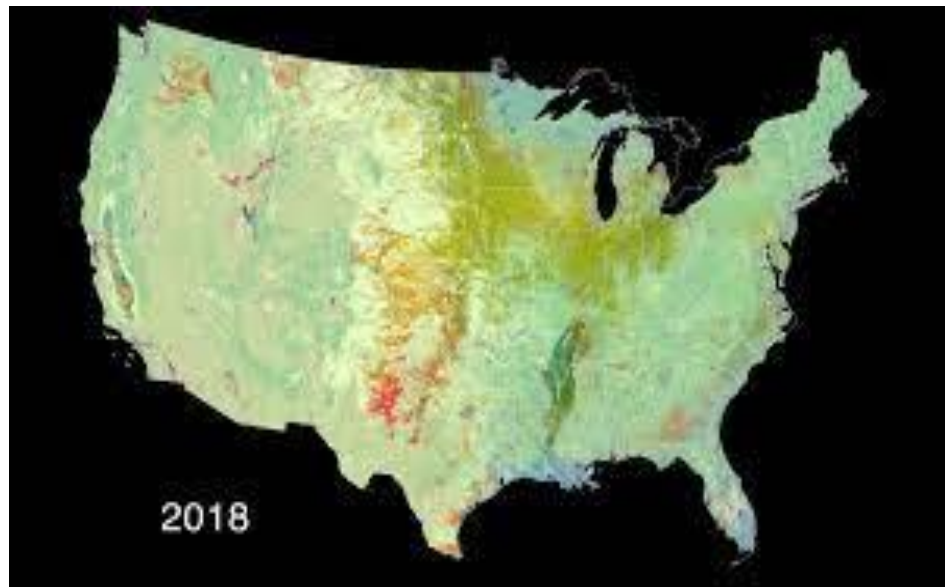
<https://www.croplands.org/app/map>.

# Cropland datasets



BreizhCrops

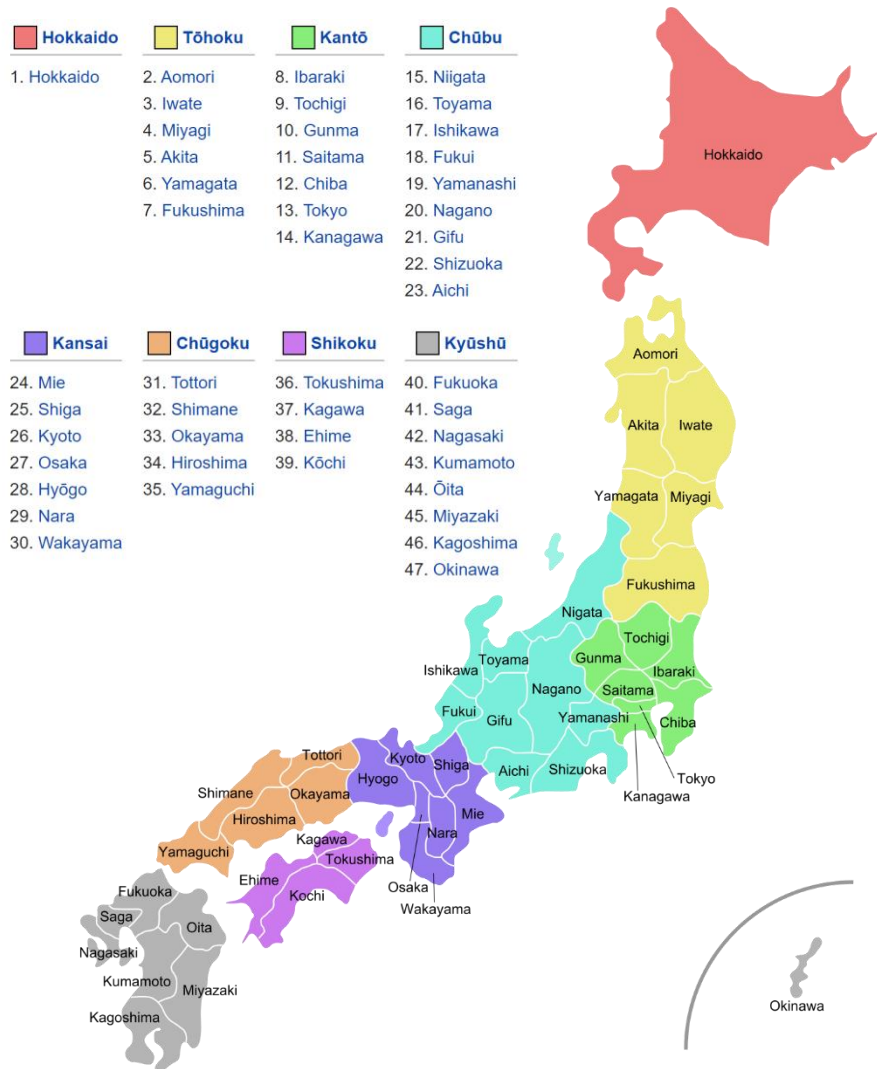
<https://breizhcrops.org/>



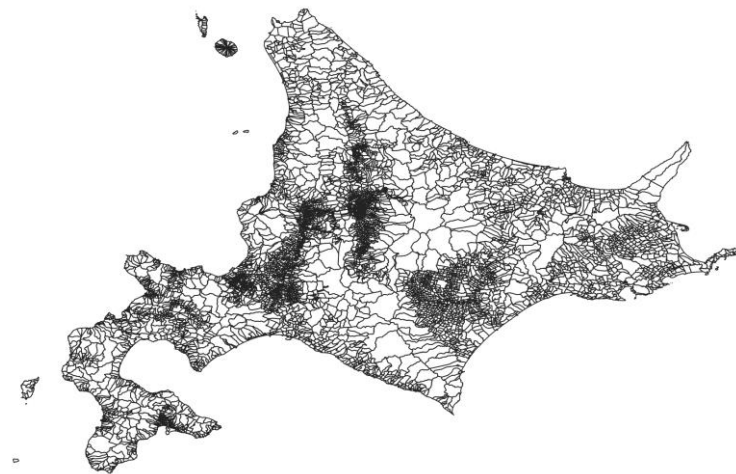
Cropland Data Layer (CDL) of USA

[https://www.nass.usda.gov/Research\\_and\\_Science/Cropland/Release/index.php](https://www.nass.usda.gov/Research_and_Science/Cropland/Release/index.php)

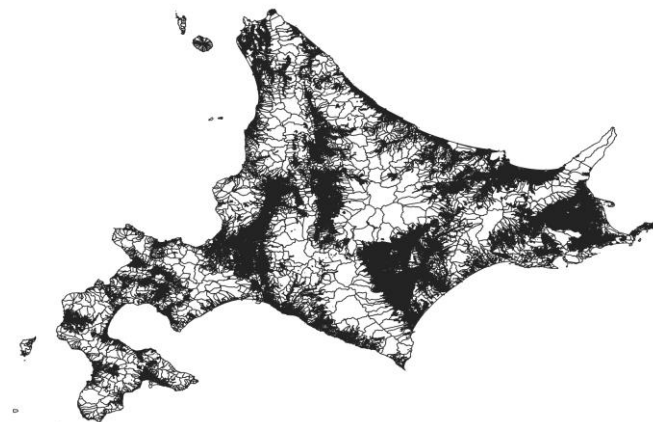
Objective: Japan Cropland with **Census** information and **EO** datasets



Source from Wiki



Agricultural rural communities (7295)



Crop field boundary (~900K) from MAFF



[illegible]

# Hokkaido

2015

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

Sentinel-1(4 Mosaic)

Landsat-8(4 Mosaic)



2015: Apr-May (L8)



2015: Aug-Sep (L8)

# Hokkaido

## 2015

### Sentinel-1 (4 Mosaic)

Jan

Feb

Mar

Apr

May

Jun

Jul

Aug

Sep

Oct

Nov

Dec










Landsat-8(4 Mosaic)



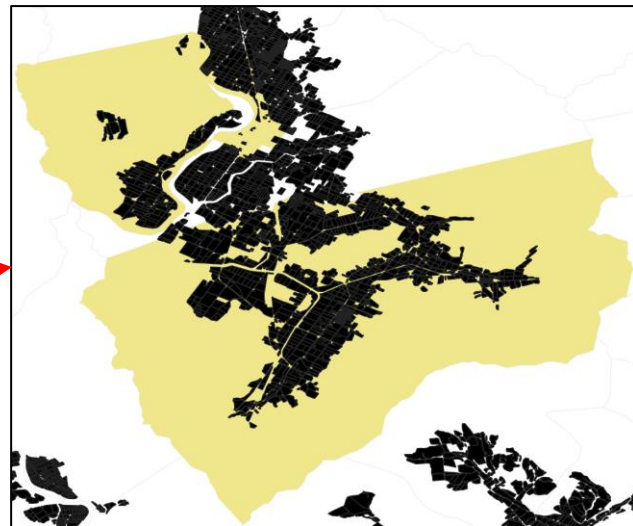
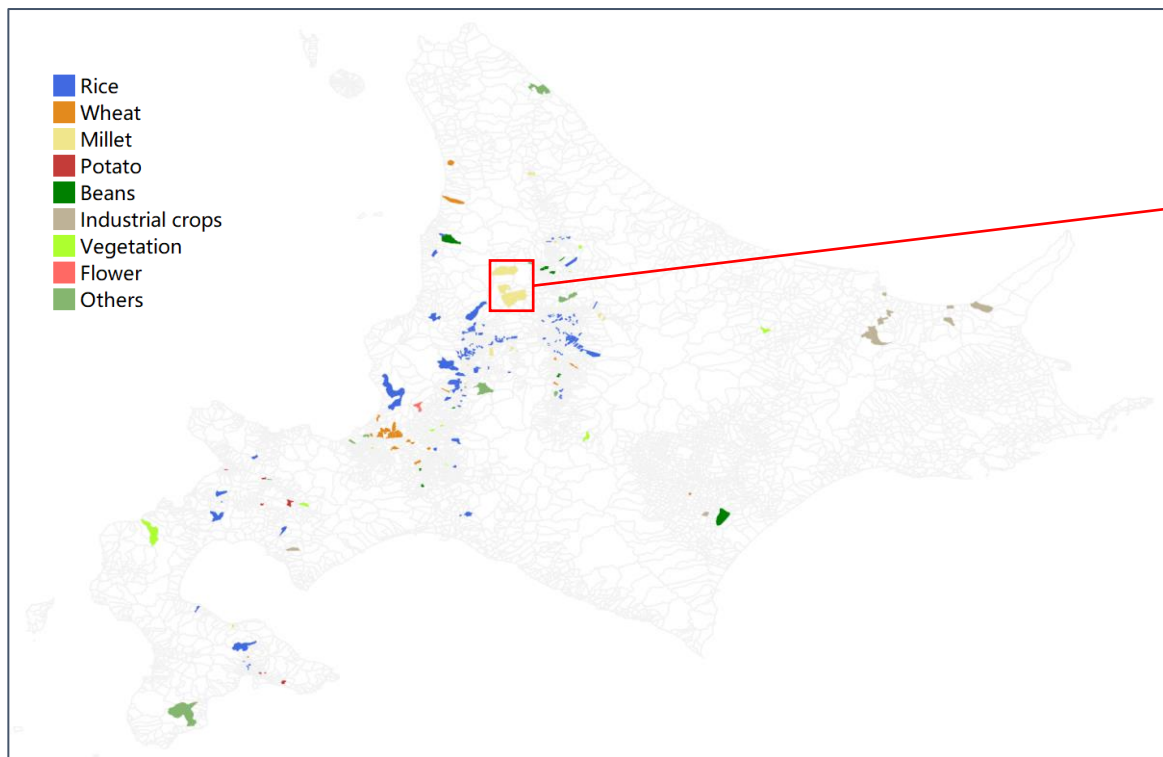
2015: Apr-May (S1)

# Pure Labels from Census Data

- Pure ratio = (sale class area)  $\div$  (crop area)
- Ratio threshold definition
  - Rice > 0.8 or 0.9 (except Tokyo and Okinawa)
  - Others > 0.2-0.9 based on the numbers
  - top 10 or top 5 according to the small numbers
  - Only few (2-5) numbers that all selected
  - Selected the largest numbers

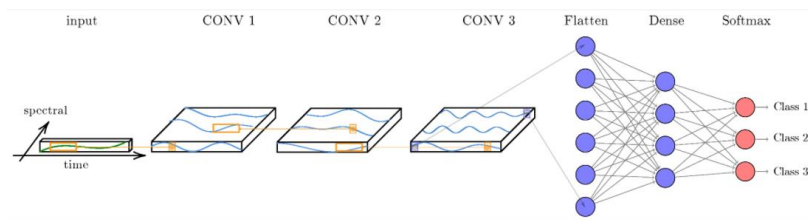
	Rice	165
	Wheat	21
	Millet	21
	Potato	10
	Beans	12
	Industrial crops	11
	Vegetation	13
	Flower	5
	Others	10



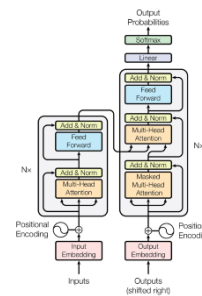


	Rice	Wheat	Millet	Potato	Beans	Industrial	Vegetation	Flower	Others
01Hokkaido	>0.8	>0.5	>0.5	Top 10	>0.5	>0.5	>0.5	Top 5	Top 10
02Aomori	>0.8	>0.4	Top 5	Top 5	Top 5	>0.1	Top 5	>0.1	>0.3
03Iwate	>0.8	Only 2	>0.4	Top 5	Top 5	Top 5	Top 5	>0.3	Top 5
04Miyagi	>0.9	Only 4	>0.4	>0.2	Top 5	>0.1	Top 5	>0.2	>0.3
05Akita	>0.8	Only 2	Top 5	Top 5	>0.1	Top 5	>0.1	Top 5	>0.3
06Yamagata	>0.9	Top 5	>0.4	Top 5	Top 5	>0.2	>0.1	>0.1	Top 5
07Fukushima	>0.9	Only 2	>0.4	Top 5	Top 5	>0.1	>0.1	>0.1	>0.3
08Ibaraki	>0.9	Top 5	>0.4	Top 5	Top 5	>0.1	>0.1	>0.1	>0.3
09Tochigi	>0.8	>0.67	>0.45	Top 5	Top 5	>0.1	>0.1	>0.1	>0.3
10Gunma	>0.8	>0.6	Only 5	Top 5	Top 5	>0.6	Top 10	Top 5	Top 5
11Saitama	>0.9	>0.6	Only 7	Top 5	>0.1	>0.6	>0.5	>0.6	Top 10
12Chiba	>0.9	Top 5	Only 1	>0.5	Top 10	Only 2	Top 10	>0.5	>0.5
13Tokyo	>0.1	Only 4	None	>0.1	Top 5	>0.2	>0.1	>0.2	Top 5
14Kanagawa	>0.6	Only 2	Only 1	Top 5	Top 5	Top 10	Only 4	>0.1	Only 4
15Niigata	>0.9	Only 2	Top 5	Only 4	Top 5	Top 5	Top 5	Top 8	>0.2
16Toyama	>0.9	Top 10	Top 5	Top 5	Top 10	None	Only 4	Top 5	Top 5
17Ishikawa	>0.9	Top 10	Top 5	Top 6	Top 10	Only 1	Only 4	Top 5	Top 4
18Fukui	>0.9	Top 10	Top 5	Top 5	Top 9	None	Top 5	Only 2	Only 4
19Yamanashi	>0.7	Only 4	Top 10	Top 5	Top 5	> 0.1	Top 5	Only 2	None
20Nagano	>0.8	Top 10	>0.5	Top 5	Top 5	Top 5	Top 10	Top 10	Top 5
21Gifu	>0.8	>0.25	Top 5	Top 5	Top 5	>0.6	Top 5	Top 5	>0.1
22Shizuoka	>0.8	Top 5	Only 2	>0.3	Only 3	>=1	>0.6	>0.5	Top 10
23Aichi	>0.9	>0.4	Only 2	Top 5	>0.3	>0.4	>0.3	>0.4	Top 5
24Mie	>0.9	>0.4	None	Top 5	>0.3	>0.6	Only 4	>0.3	Top 5
25Shiga	>0.9	>0.3	Top 5	Only 5	Top 5	>0.3	Only 3	Only 2	>0.1
26Kyoto	>0.8	Only 5	Only 5	Top 5	Top 5	>0.6	Top 5	Top 5	Top 5
27Osaka	>0.8	None	None	Top 5	Top 5	None	Only 1	>0.4	Only 2
28Hyogo	>0.9	>0.2	Top 5	Top 5	>0.3	Top 5	>0.1	>0.4	Top 5
29Nara	>0.8	Only 4	Only 2	Top 5	Only 2	>0.4	Only 1	>0.4	None
30Wakayama	>0.8	None	None	>0.4	Only 5	>0.4	>0.6	>0.3	Only 2
31Tottori	>0.8	Only 2	>0.2	Top 5	Top 5	Top 5	>0.6	Top 2	>0.6
32Shimane	>0.9	Only 2	>0.2	Top 5	Top 5	Top 5	Top 5	Top 5	>0.2
33Okayama	>0.9	>0.4	>0.2	Top 5	>0.3	>0.1	>0.1	Top 5	>0.1
34Hiroshima	>0.9	Only 1	>0.2	>0.3	>0.1	>0.1	>0.1	Only 4	>0.1
35Yamaguchi	>0.9	>0.1	Only 3	Top 5	>0.1	>0.3	>0.2	>0.1	Top 5
36Tokushima	>0.9	Only 3	Only 3	>0.9	>0.1	>0.2	>0.6	>0.3	>0.1
37Kagawa	>0.9	>0.4	None	>0.2	Only 5	>0.3	>0.4	>0.3	>0.1
38Ehime	>0.8	>0.4	Only 3	Top 5	Top 5	Top 5	>0.2	>0.3	Top 5
39Kochi	>0.9	None	None	>0.1	Only 4	>0.6	>0.2	>0.2	>0.2
40Fukuoka	>0.9	>0.9	Only 2	Top 5	>0.5	>0.6	>0.4	>0.4	>0.3
41Saga	>0.8	>0.9	None	Top 5	>0.4	>0.6	>0.6	Top 5	>0.3
42Nagasaki	>0.8	>0.2	Top 5	>0.9	>0.1	>0.6	>0.2	>0.3	>0.1
43Kumamoto	>0.9	>0.6	>0.2	>0.4	>0.3	>0.6	>0.6	>0.6	>0.6
44Oita	>0.8	>0.6	>0.1	>0.2	>0.2	>0.4	>0.4	Top 5	>0.4
45Miyazaki	>0.8	Only 3	>0.2	>0.6	Top 5	>0.6	>0.4	>0.6	>0.5
46Kagoshima	>0.8	Only 1	>0.2	>0.9	>0.1	>0.9	>0.6	>0.4	>0.2
47Okinawa	>0.2	None	>0.1	>0.2	Only 1	>0.9	>0.1	>0.6	Only 2

# Classification methods comparisons (Ibaraki)



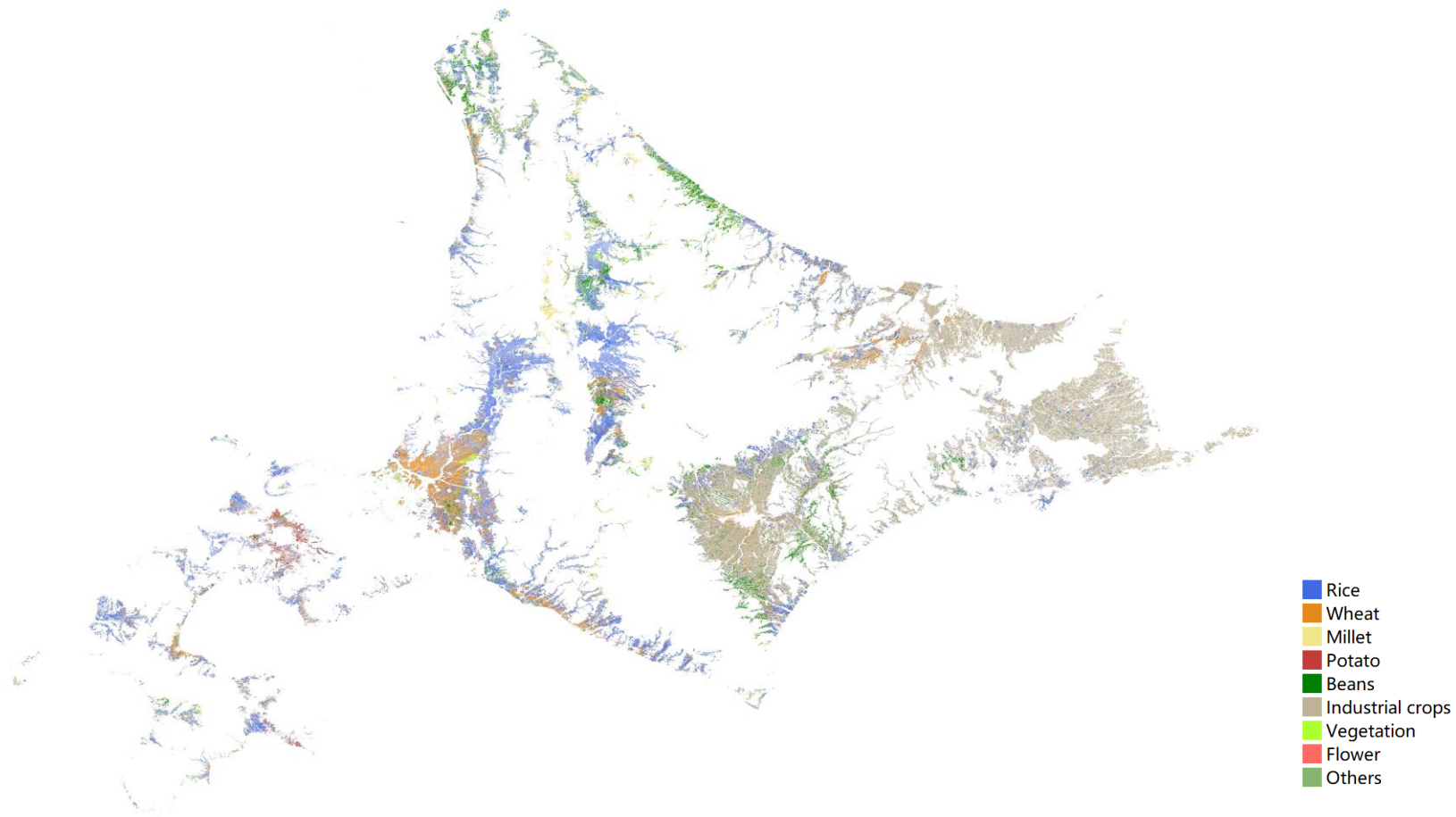
TempCNN



Transformer

Figure 1: The Transformer - model architecture.

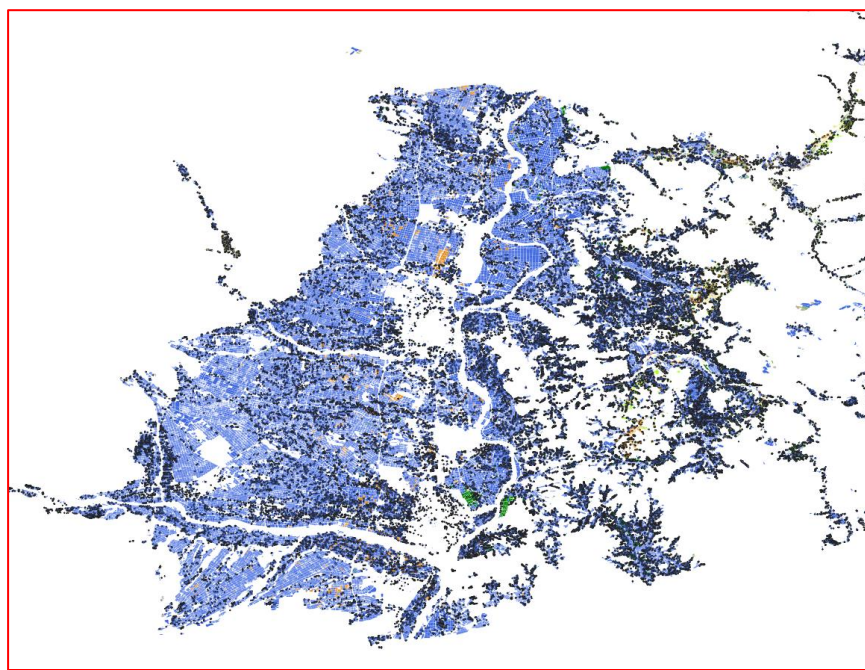
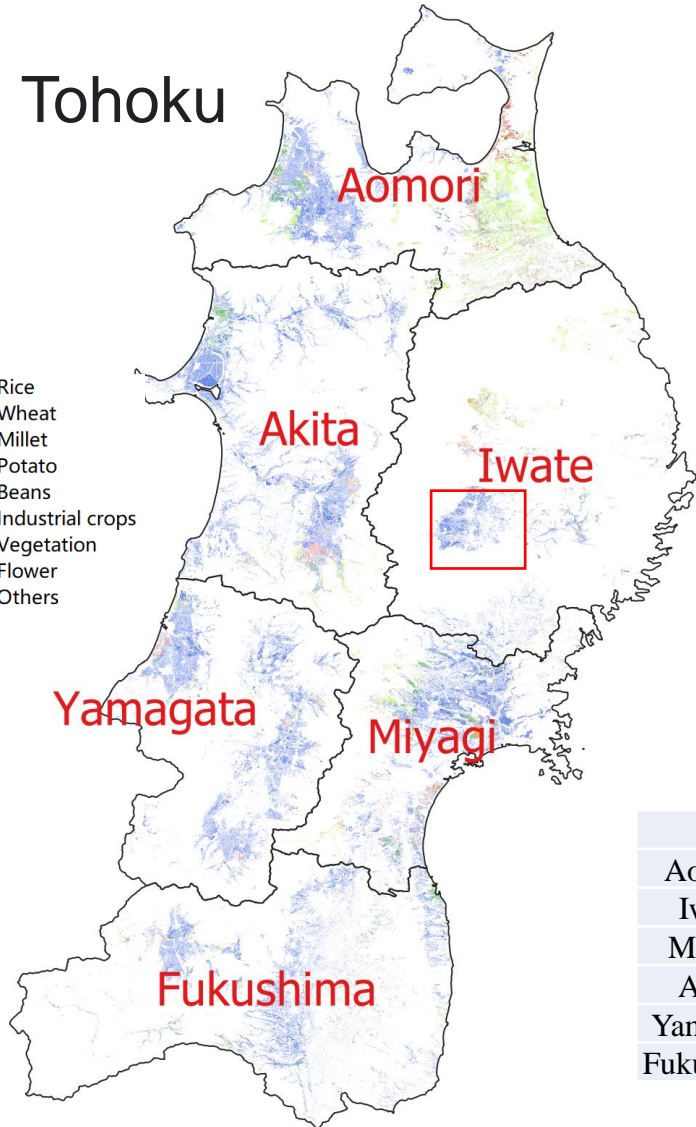
Method	Rice	Wheat	Millet	Potato	Beans	Industrial	Vegetation	Flower	Others	OA	mean F1
RF (pixel-based)	0.86	0.41	0.72	0.57	0.46	0.62	0.58	0.54	0.76	0.86	0.61
RF (parcel-based)	0.87	0.40	0.71	0.58	0.45	0.63	0.57	0.55	0.75	0.87	0.62
TempCNN	0.85	0.40	0.77	0.68	0.47	0.67	0.59	0.55	0.77	0.86	0.63
LSTM	0.82	0.38	0.74	0.66	0.43	0.63	0.51	0.47	0.63	0.83	0.61
Transformer	0.86	0.41	0.71	0.63	0.46	0.68	0.57	0.55	0.84	0.88	0.63



Classification result (F1 score: 0.85)

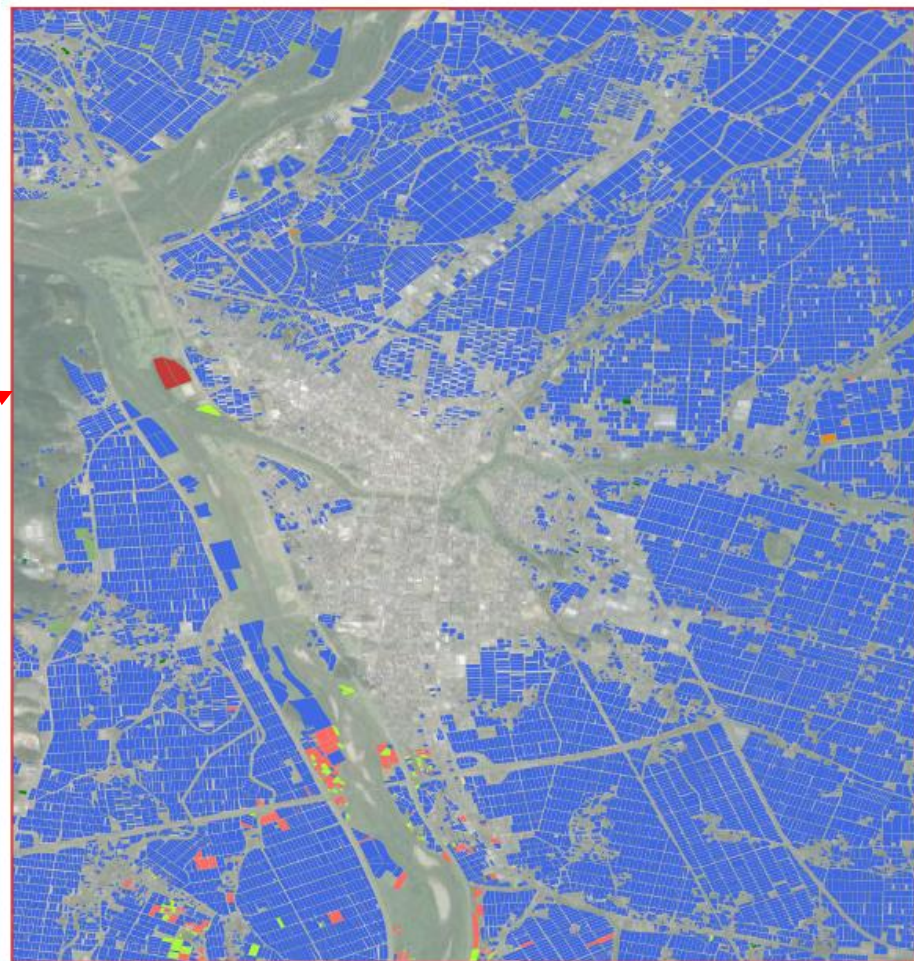
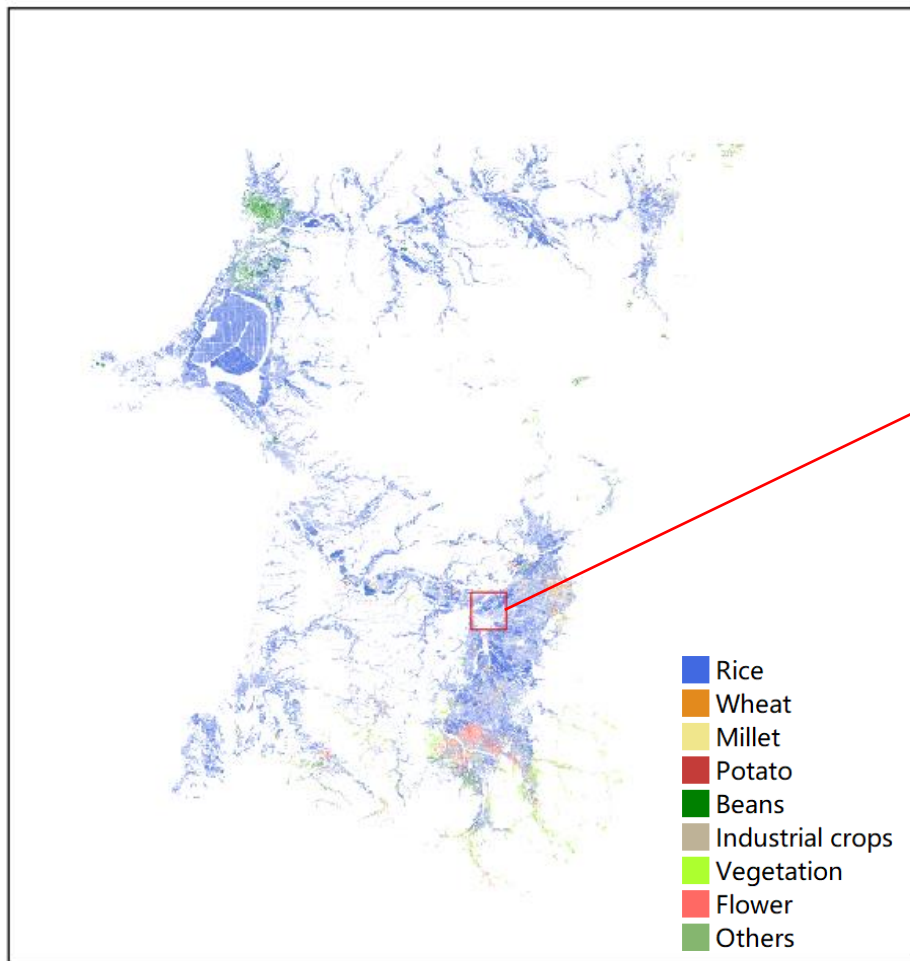
# Tohoku

- Rice
- Wheat
- Millet
- Potato
- Beans
- Industrial crops
- Vegetation
- Flower
- Others

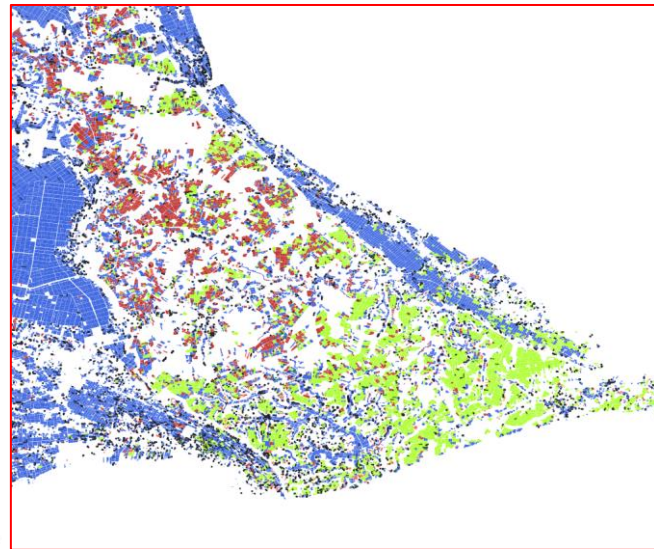
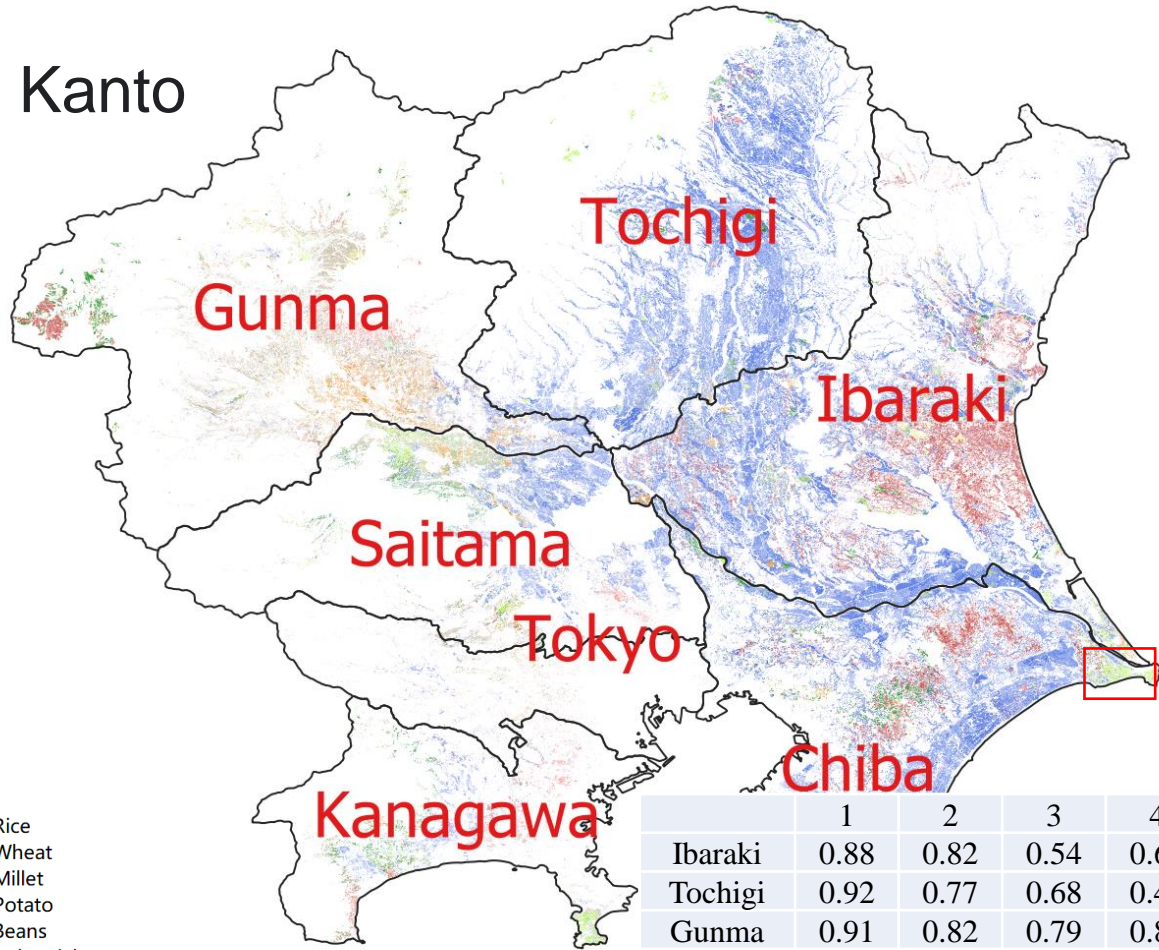


	1	2	3	4	5	6	7	8	9	all
Aomori	0.90	0.86	0.92	0.56	0.67	0.86	0.86	0.76	0.83	0.86
Iwate	0.90	0.81	0.90	0.65	0.78	0.87	0.86	0.76	0.76	0.87
Miyagi	0.93	0.83	0.92	0.45	0.84	0.94	0.86	0.76	0.83	0.86
Akita	0.88	0.86	0.76	0.72	0.81	0.92	0.86	0.76	0.80	0.85
Yamagata	0.96	0.68	0.80	0.80	0.62	0.88	0.77	0.84	0.72	0.93
Fukushima	0.96	0.78	0.89	0.41	0.88	0.76	0.67	0.70	0.84	0.92





# Kanto

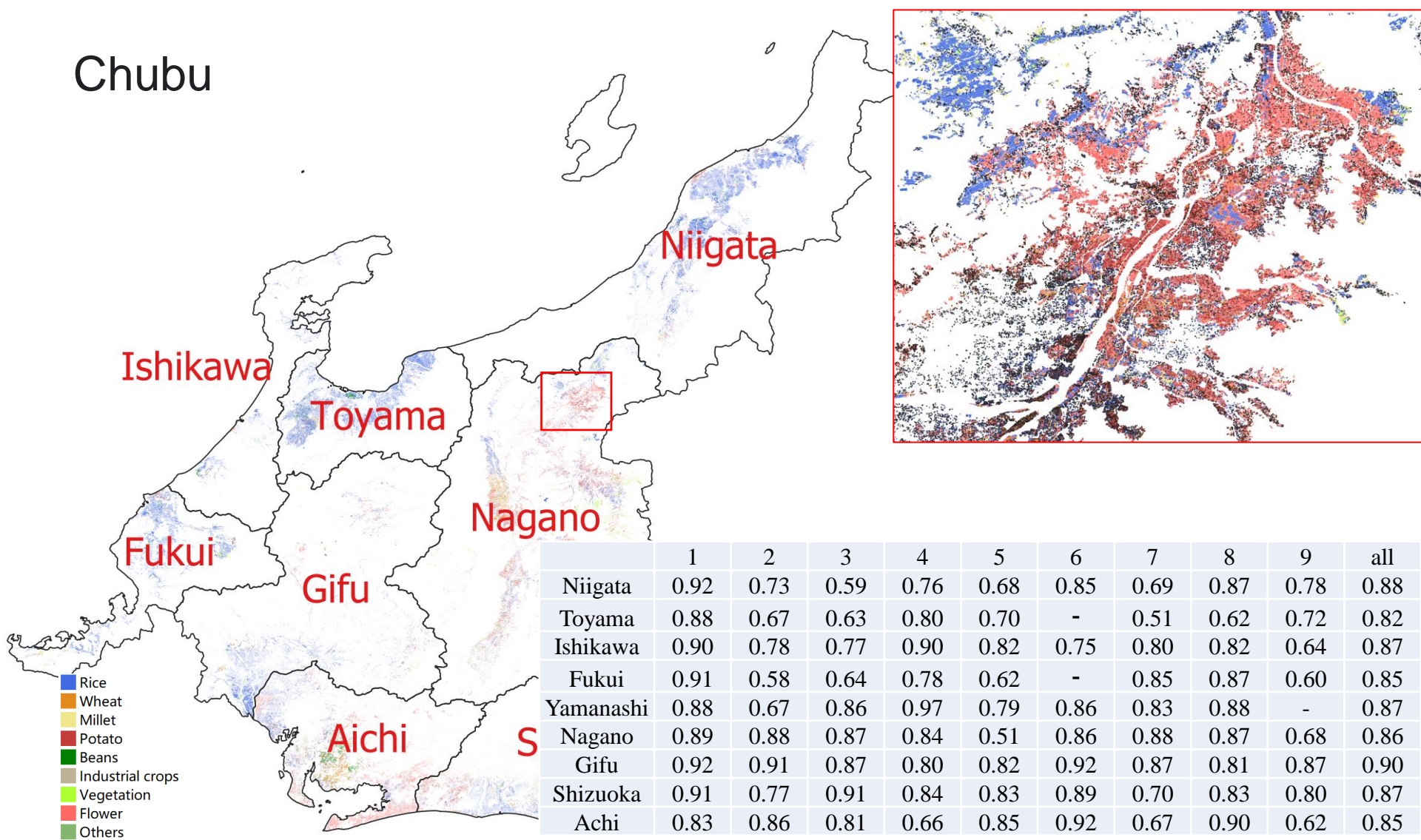


- Rice
- Wheat
- Millet
- Potato
- Beans
- Industrial crops
- Vegetation
- Flower
- Others

	1	2	3	4	5	6	7	8	9	all
Ibaraki	0.88	0.82	0.54	0.63	0.74	0.79	0.82	0.83	0.69	0.86
Tochigi	0.92	0.77	0.68	0.46	0.79	0.68	0.79	0.68	0.80	0.88
Gunma	0.91	0.82	0.79	0.85	0.88	0.91	0.73	0.76	0.69	0.86
Saitama	0.94	0.80	0.74	0.79	0.75	0.88	0.79	0.78	0.79	0.86
Chiba	0.93	0.72	0.41	0.86	0.67	0.26	0.81	0.74	0.54	0.88
Tokyo	0.80	0.72	-	0.41	0.64	0.62	0.93	0.74	0.60	0.71
Kanagawa	0.93	0.68	0.28	0.62	0.77	0.78	0.79	0.78	0.67	0.85

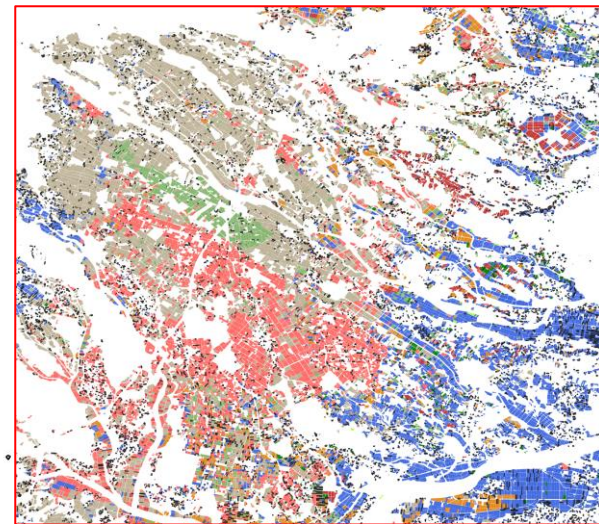
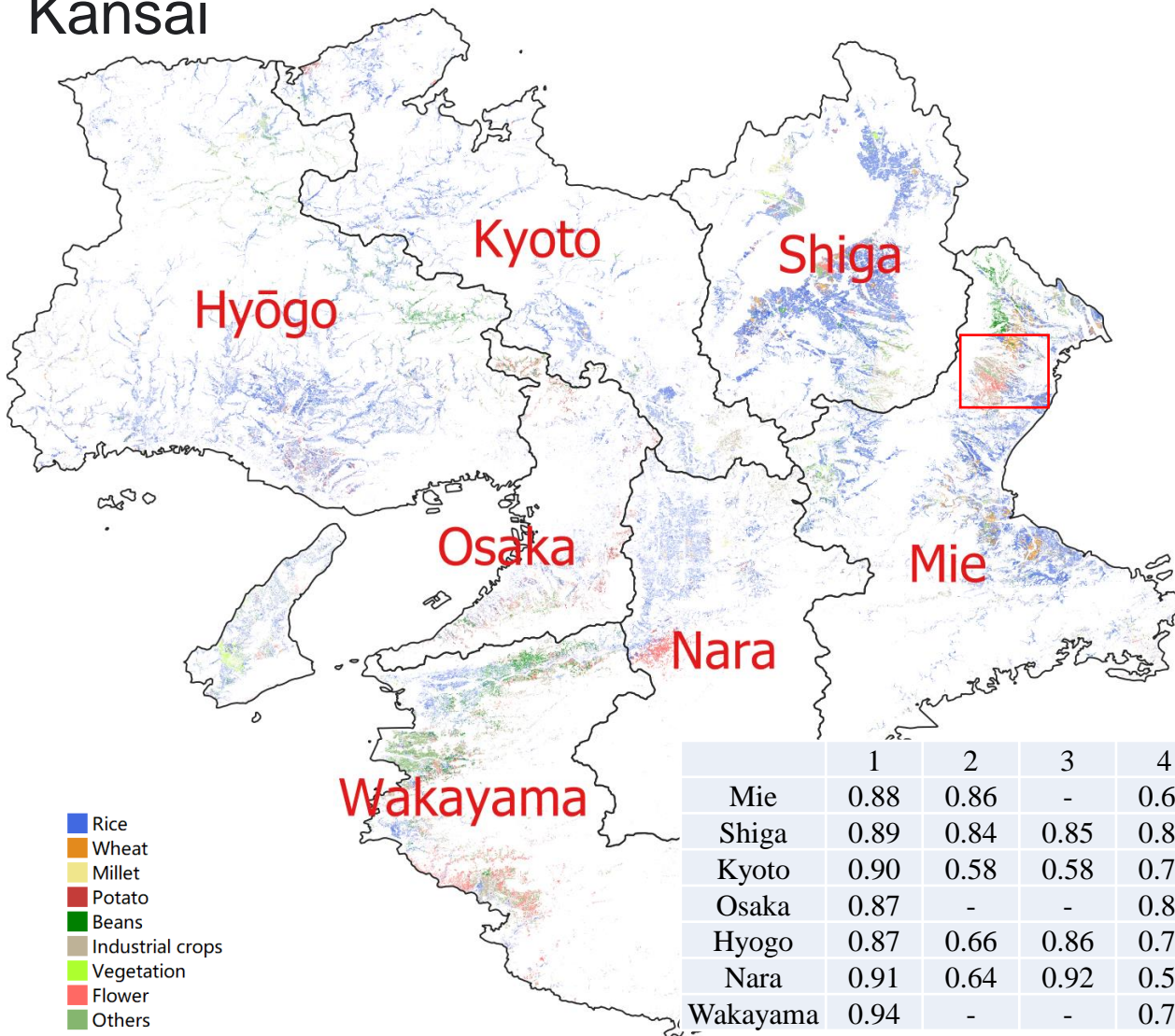


# Chubu



	1	2	3	4	5	6	7	8	9	all
Niigata	0.92	0.73	0.59	0.76	0.68	0.85	0.69	0.87	0.78	0.88
Toyama	0.88	0.67	0.63	0.80	0.70	-	0.51	0.62	0.72	0.82
Ishikawa	0.90	0.78	0.77	0.90	0.82	0.75	0.80	0.82	0.64	0.87
Fukui	0.91	0.58	0.64	0.78	0.62	-	0.85	0.87	0.60	0.85
Yamanashi	0.88	0.67	0.86	0.97	0.79	0.86	0.83	0.88	-	0.87
Nagano	0.89	0.88	0.87	0.84	0.51	0.86	0.88	0.87	0.68	0.86
Gifu	0.92	0.91	0.87	0.80	0.82	0.92	0.87	0.81	0.87	0.90
Shizuoka	0.91	0.77	0.91	0.84	0.83	0.89	0.70	0.83	0.80	0.87
Aichi	0.83	0.86	0.81	0.66	0.85	0.92	0.67	0.90	0.62	0.85

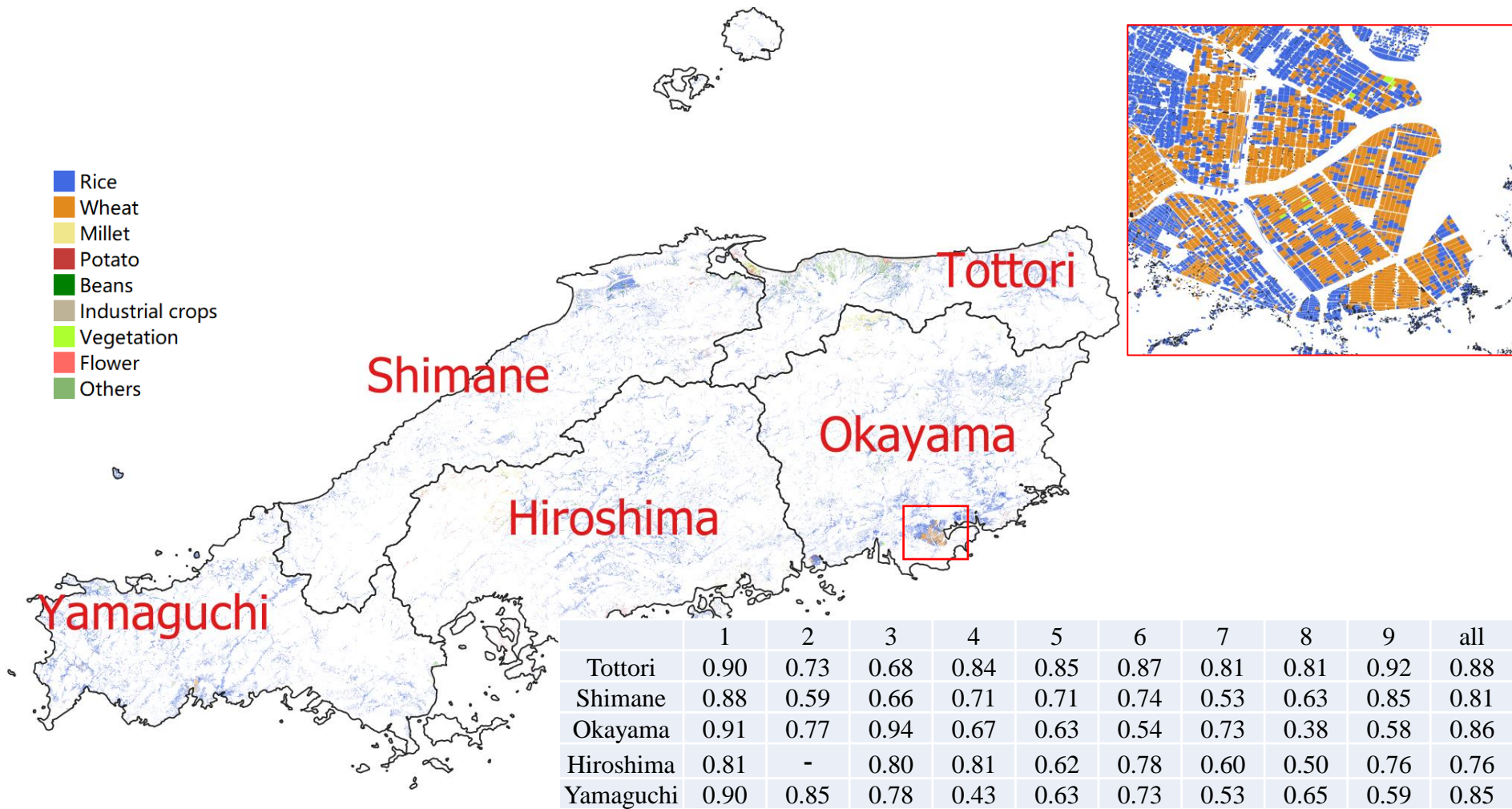
# Kansai



	1	2	3	4	5	6	7	8	9	all
Mie	0.88	0.86	-	0.67	0.91	0.89	0.78	0.79	0.81	0.86
Shiga	0.89	0.84	0.85	0.80	0.76	0.98	0.88	0.90	0.90	0.88
Kyoto	0.90	0.58	0.58	0.78	0.81	0.94	0.61	0.71	0.63	0.87
Osaka	0.87	-	-	0.83	0.83	-	0.18	0.77	0.82	0.83
Hyogo	0.87	0.66	0.86	0.78	0.87	0.82	0.81	0.77	0.90	0.84
Nara	0.91	0.64	0.92	0.53	0.49	0.93	0.54	0.82	-	0.88
Wakayama	0.94	-	-	0.76	0.83	0.89	0.64	0.87	0.93	0.90

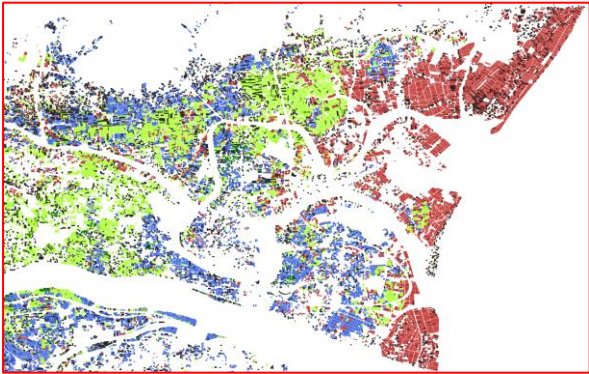
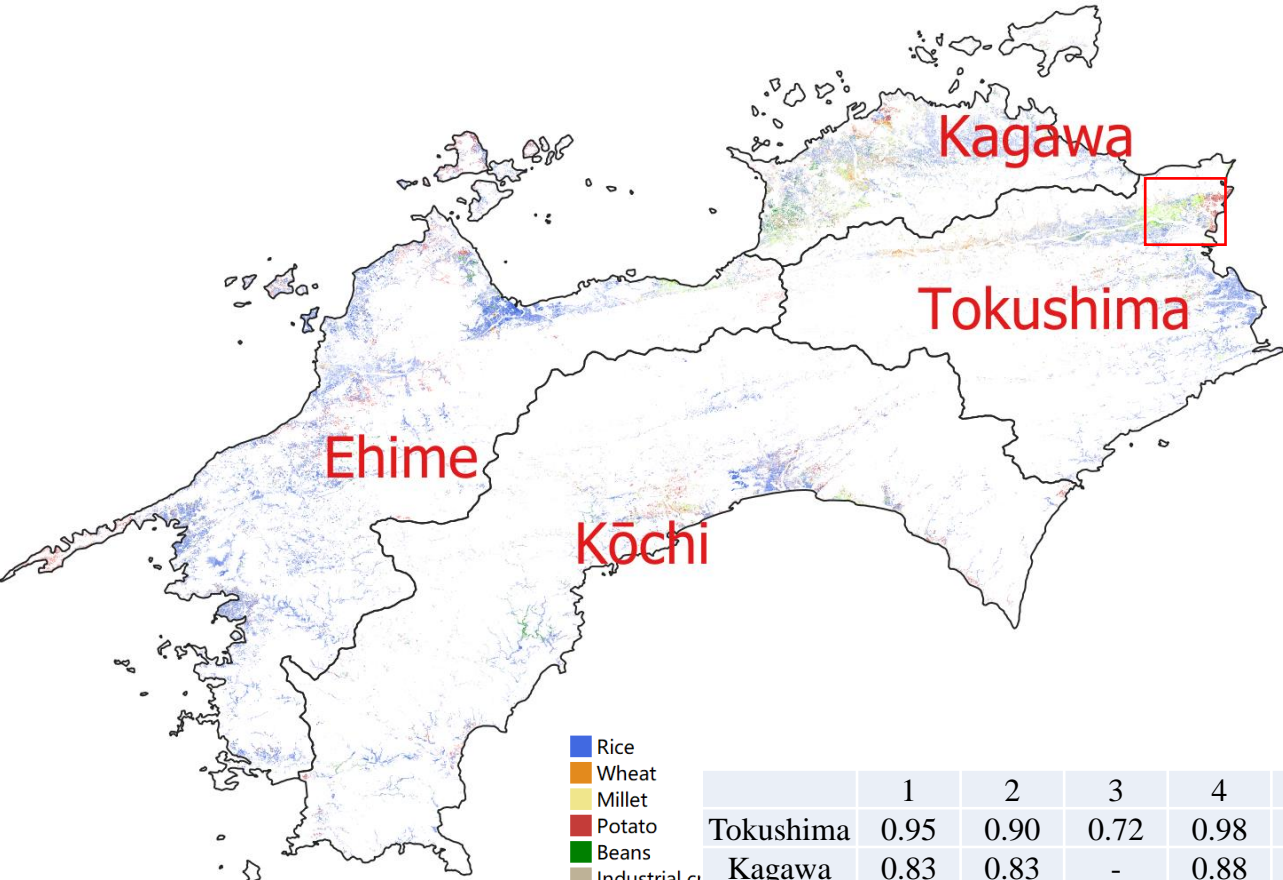


# Chugoku





# Shikoku



- Rice
- Wheat
- Millet
- Potato
- Beans
- Industrial ci
- Vegetation
- Flower
- Others

	1	2	3	4	5	6	7	8	9	all
Tokushima	0.95	0.90	0.72	0.98	0.76	0.84	0.91	0.82	0.86	0.94
Kagawa	0.83	0.83	-	0.88	0.80	0.86	0.77	0.78	0.74	0.82
Ehime	0.93	0.69	0.54	0.83	0.66	0.71	0.91	0.84	0.58	0.88
Kochi	0.89	-	-	0.87	0.79	0.88	0.81	0.83	0.83	0.86

Kyushu



Okinawa

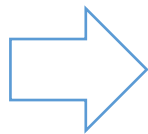


	1	2	3	4	5	6	7	8	9	all
Fukuoka	0.78	0.80	0.58	0.73	0.53	0.86	0.79	0.60	0.69	0.77
Saga	0.87	0.87	-	0.77	0.86	0.80	0.75	0.67	0.76	0.83
Nagasaki	0.79	0.96	0.92	0.91	0.78	0.87	0.82	0.69	0.77	0.86
Kumamoto	0.89	0.91	0.87	0.85	0.67	0.91	0.69	0.57	0.93	0.88
Oita	0.88	0.84	0.55	0.72	0.64	0.54	0.90	0.61	0.68	0.82
Miyazaki	0.80	0.75	0.51	0.85	0.74	0.72	0.75	0.84	0.78	0.79
Kagoshima	0.90	0.88	0.85	0.94	0.79	0.98	0.86	0.82	0.90	0.94
Okinawa	0.84	-	0.99	0.76	0.94	0.96	0.85	0.85	-	0.92

# Conclusions

- ✓ Accuracies of rice > 85% over 45 prefectures
- ✓ Accuracies of other crop types differ in different prefectures
- ✓ First high-resolution cropland map of Japan

- ✓ Limited labels (except rice)
- ✓ Very poor ratio for other classes
- ✓ Unbalanced class ratio
- ✓ Sparse labels



**Improve with**

- ✓ Noisy label learning
- ✓ Imbalanced label learning
- ✓ Real ground truth labels
- ✓ High-resolution datasets