



In-season crop type mapping without labels

Assessing impacts of the Russian invasion on
Ukraine's agriculture

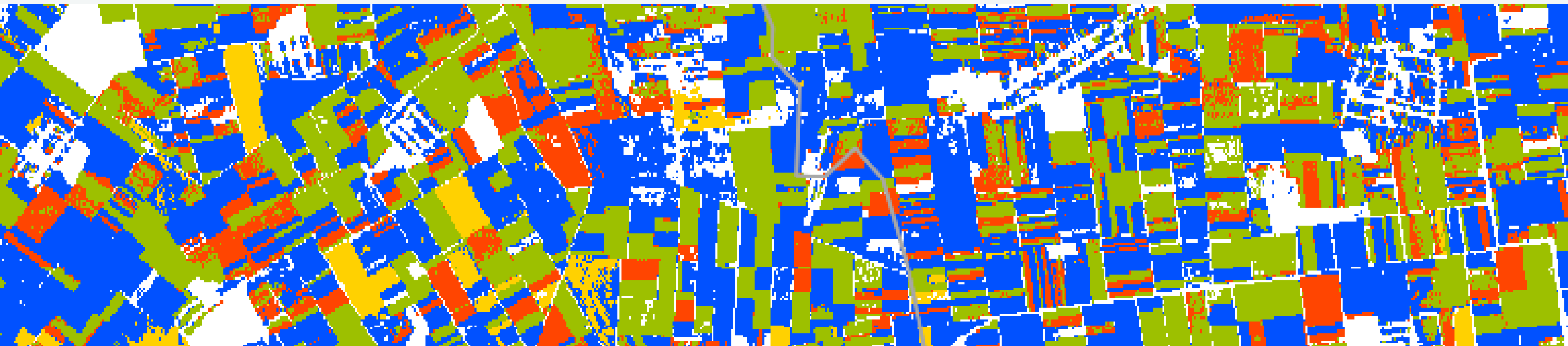
J. Wagner^(a,c), I. Becker-Reshef^(a,b,c), S. Nair^(a,c), Y. Sadeh^(c,d), S. Skakun^(b,c), B. Munshell^(b,c), S. Baber^(b,c) & F. Nerry^(a)

(a) Laboratoire ICube, Team TRIO, Université de Strasbourg, FRANCE

(b) Department of Geographical Sciences, University of Maryland, MD, USA

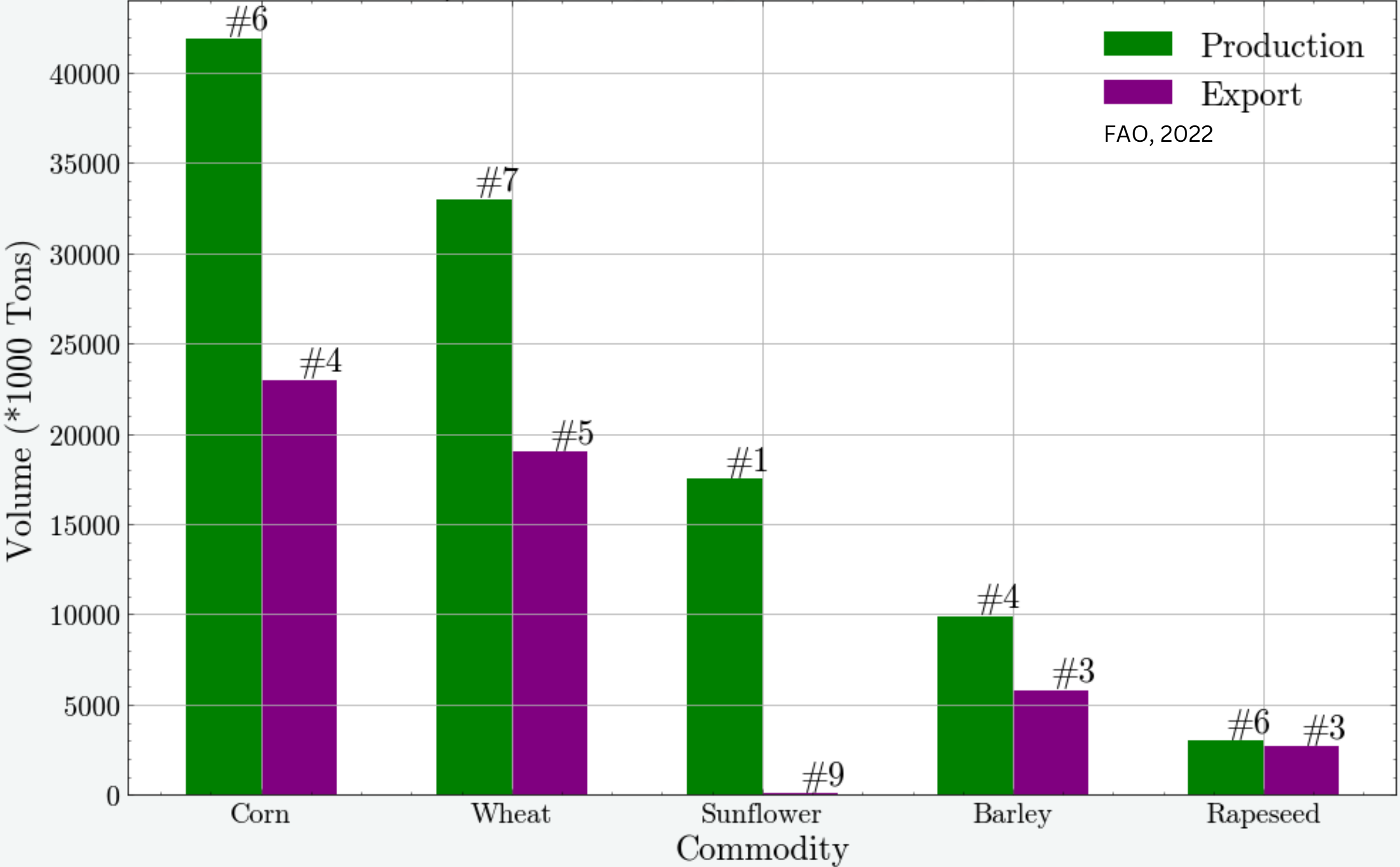
(c) NASA Harvest

(d) Department of Geography, University of Monash, AUSTRALIA



Ukraine : a bread basket agricultural producer

Production/Export by major commodity - Ukraine 2022



March 2022 : immediate concerns about Ukraine's production and production losses

Column: Concerns rise over Black Sea spring crops amid Russia-Ukraine war

By Karen Braun  REUTERS®

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30% of Ukraine farmland impacted by war; USDA says corn crop to be cut by more than half

For Ukraine's three main export crops, sunflower production is forecast to be off by 37%, wheat production down more than 35% and corn production off by 54%, the U.S. Department of Agriculture said on Thursday, May 12, 2022, its World Agricultural Supply and Demand Estimates.

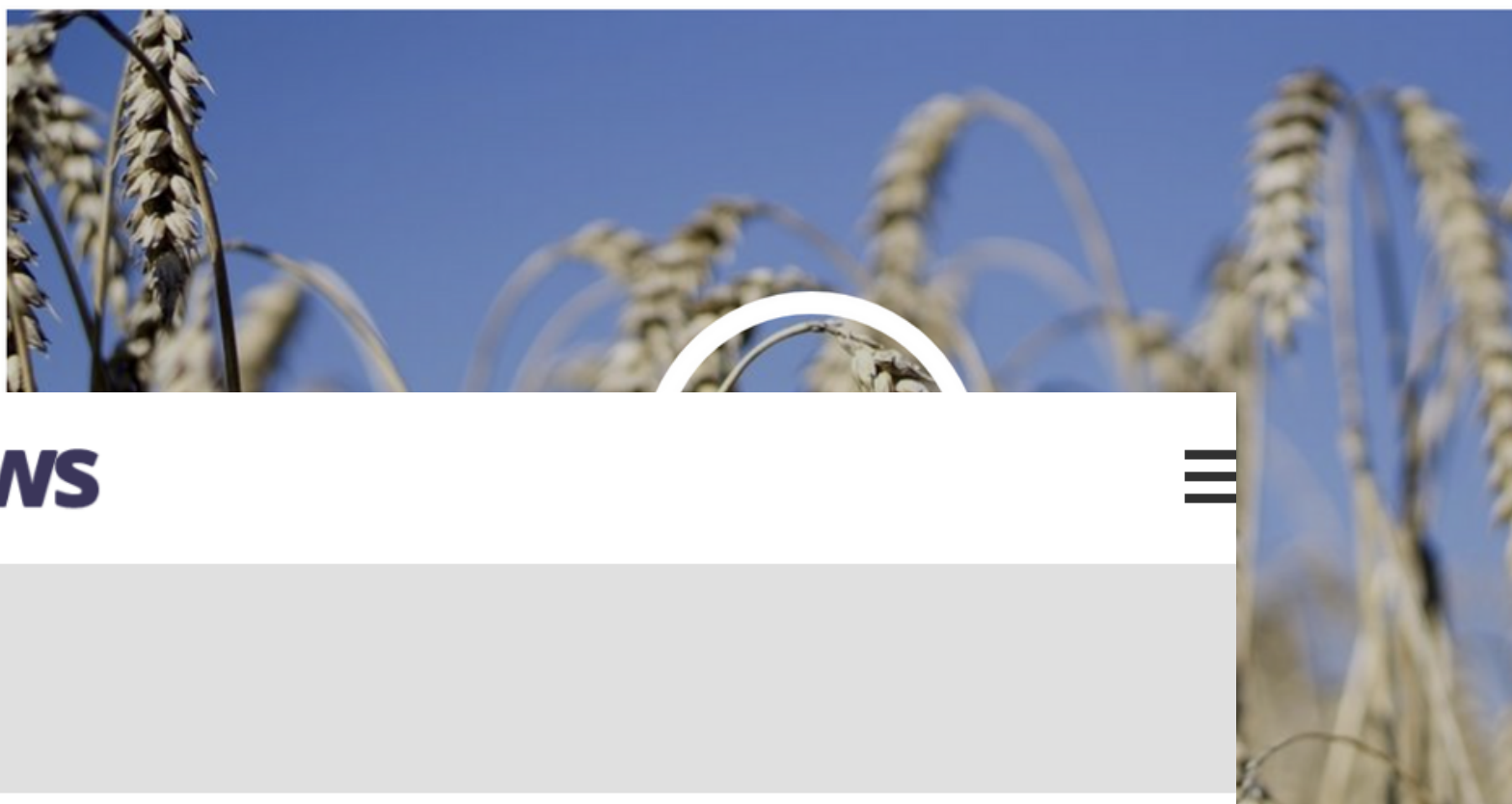


Bloomberg

Markets

Half of Harvests in Crop Giant Ukraine Could Be Wiped Out by War

- Conflict, lack of fuel and fertilizers are hindering plantings
- That threatens bigger global shortages and higher food prices



Farm Policy News

News Summary

Planted Acres in Ukraine Could Fall By Half

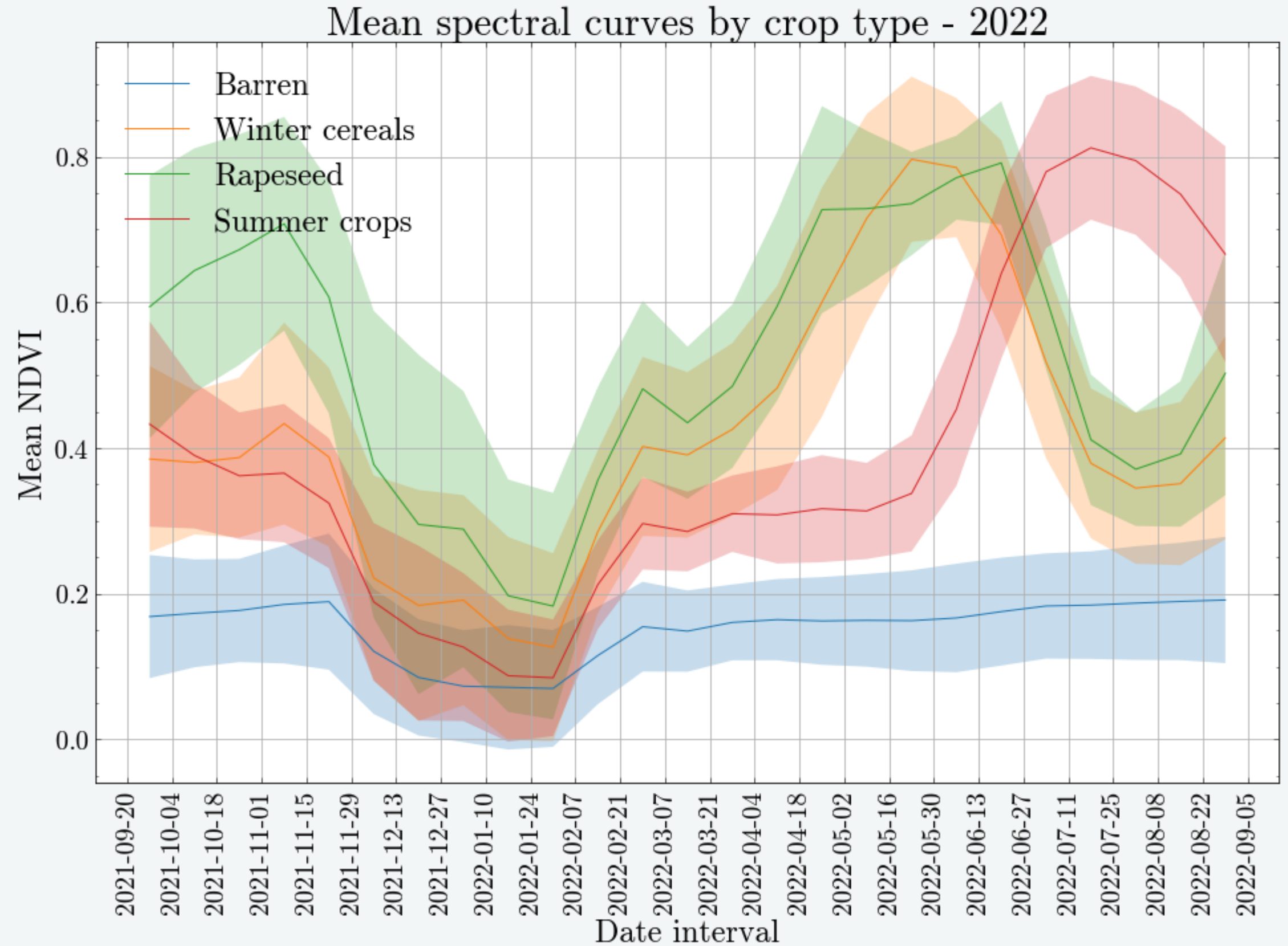
🕒 March 23, 2022 👤 Keith Good 📁 trade



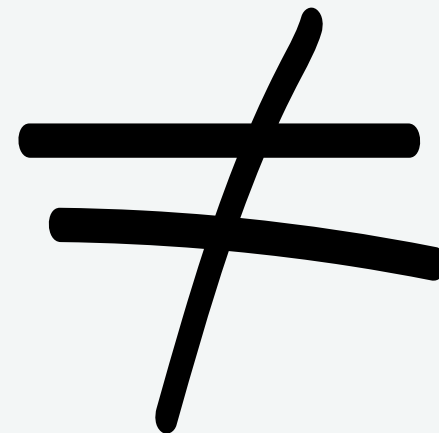
In-season and end of season crop type mapping

- Crops = dynamic land cover
- Usually mapped at end of season
- Using labeled data



In-season and end of season crop type mapping

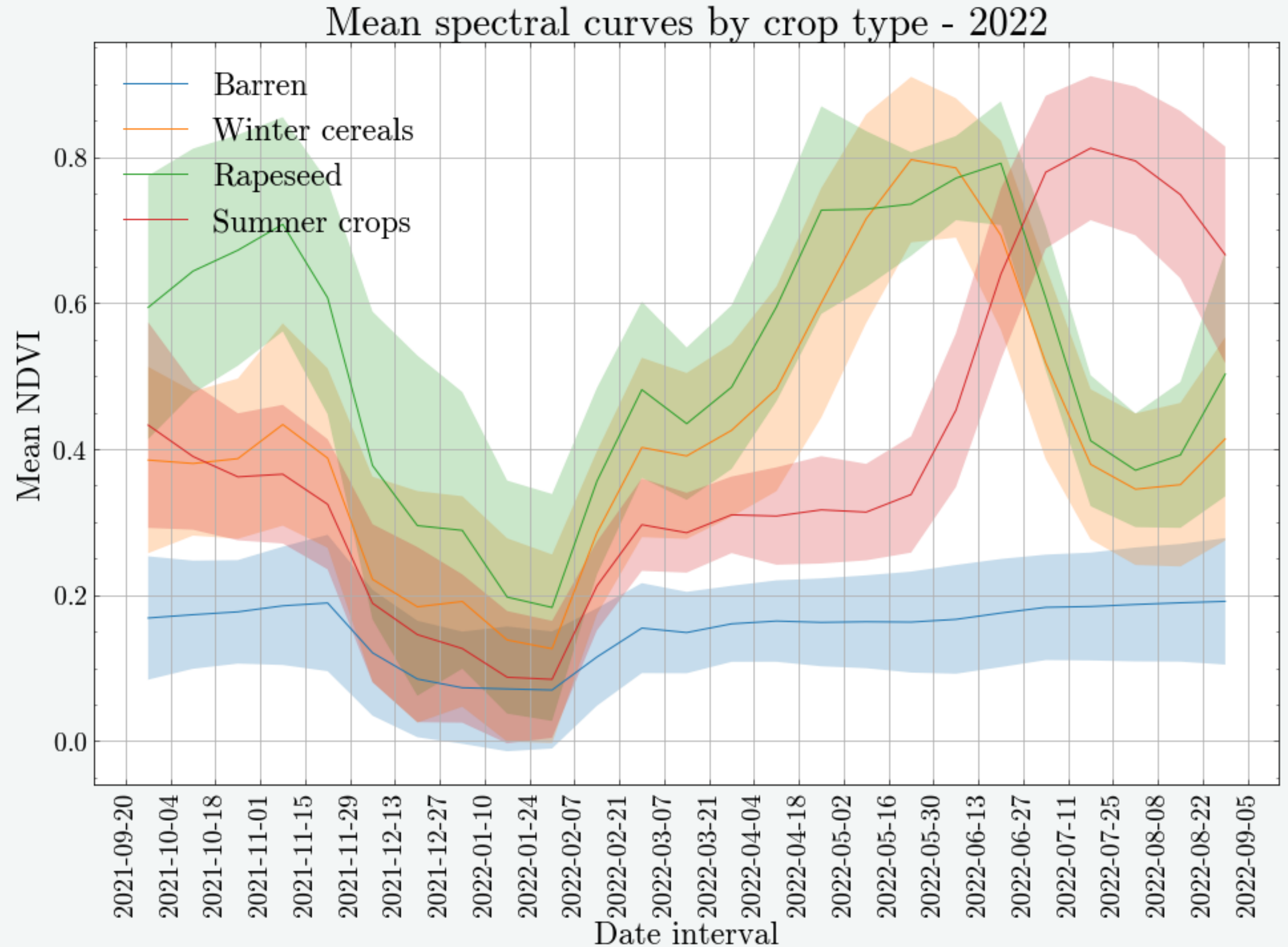
- Usually mapped at end of season
- Using labeled data for supervised classification



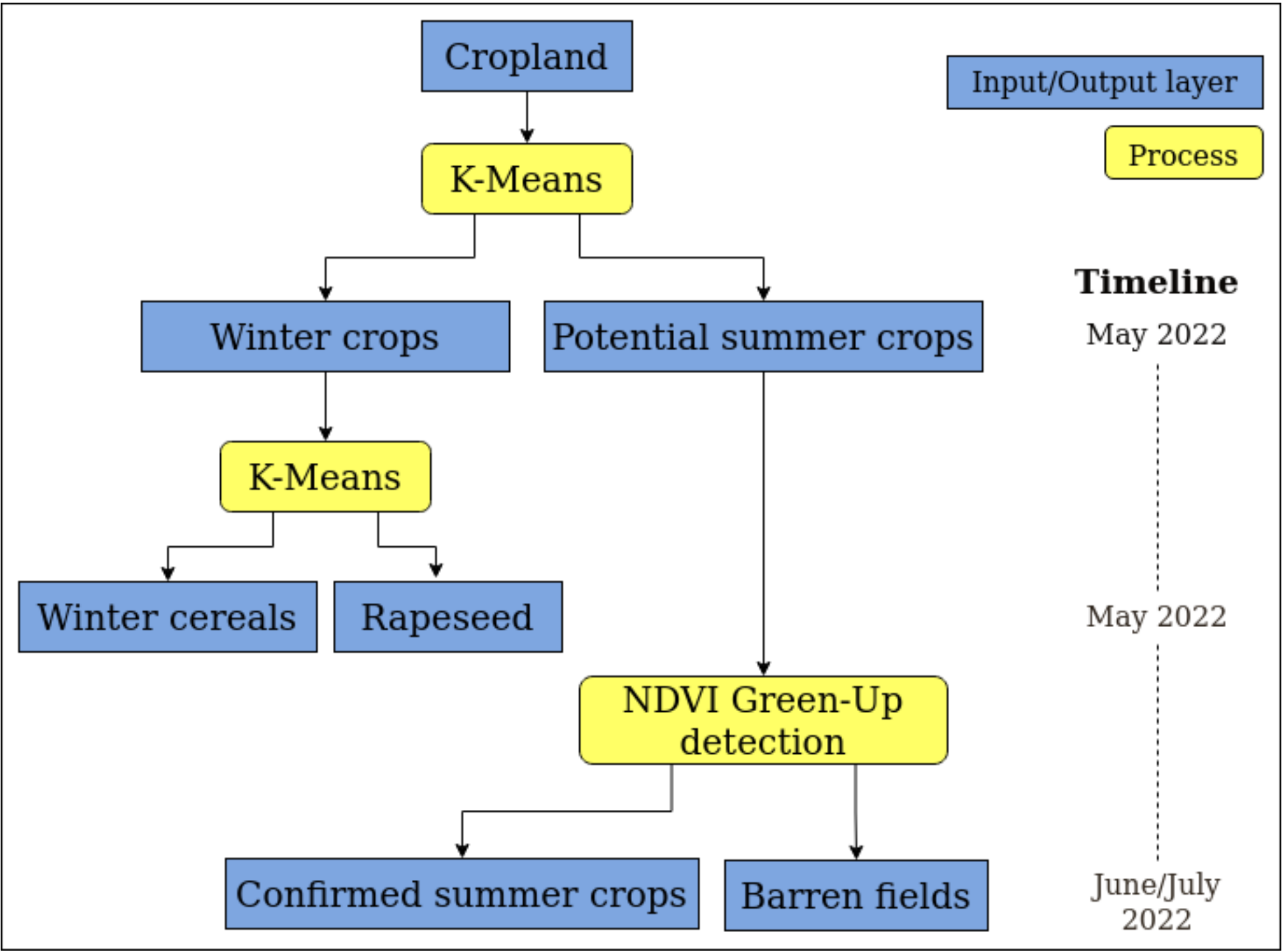
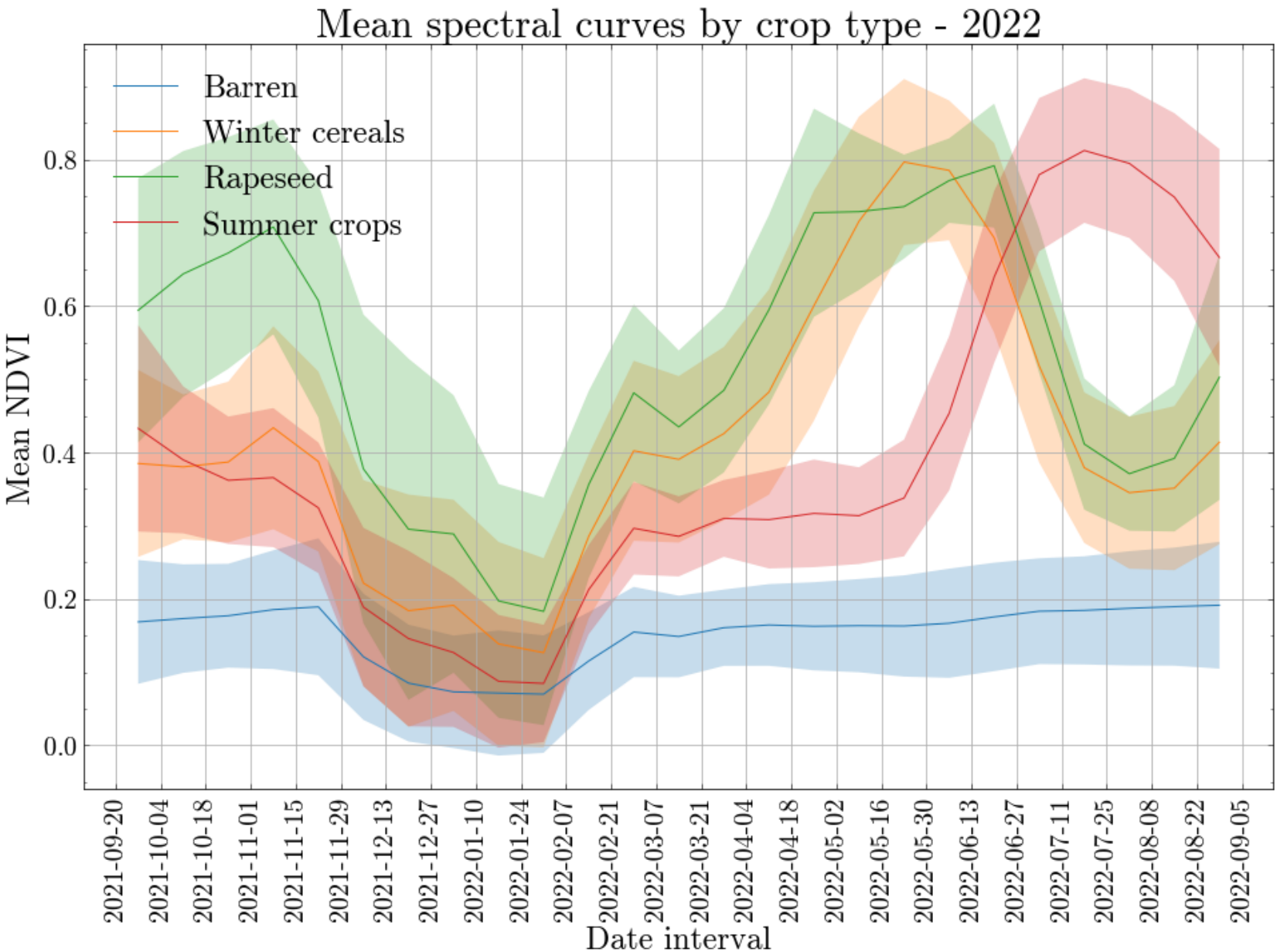
- Requirement for in-season mapping
- No recent labeled data available

Crop type mapping in Ukraine : the concept

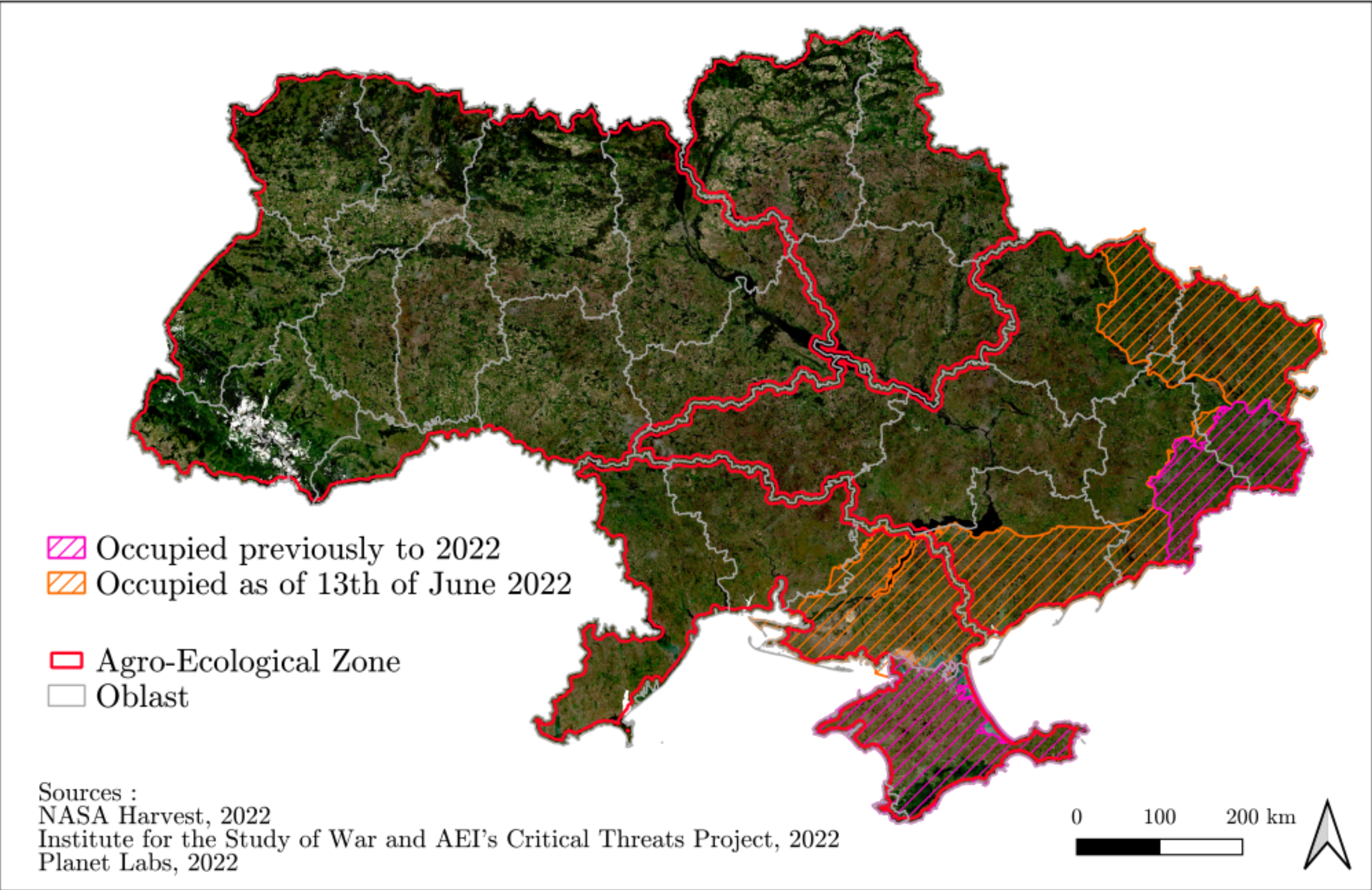
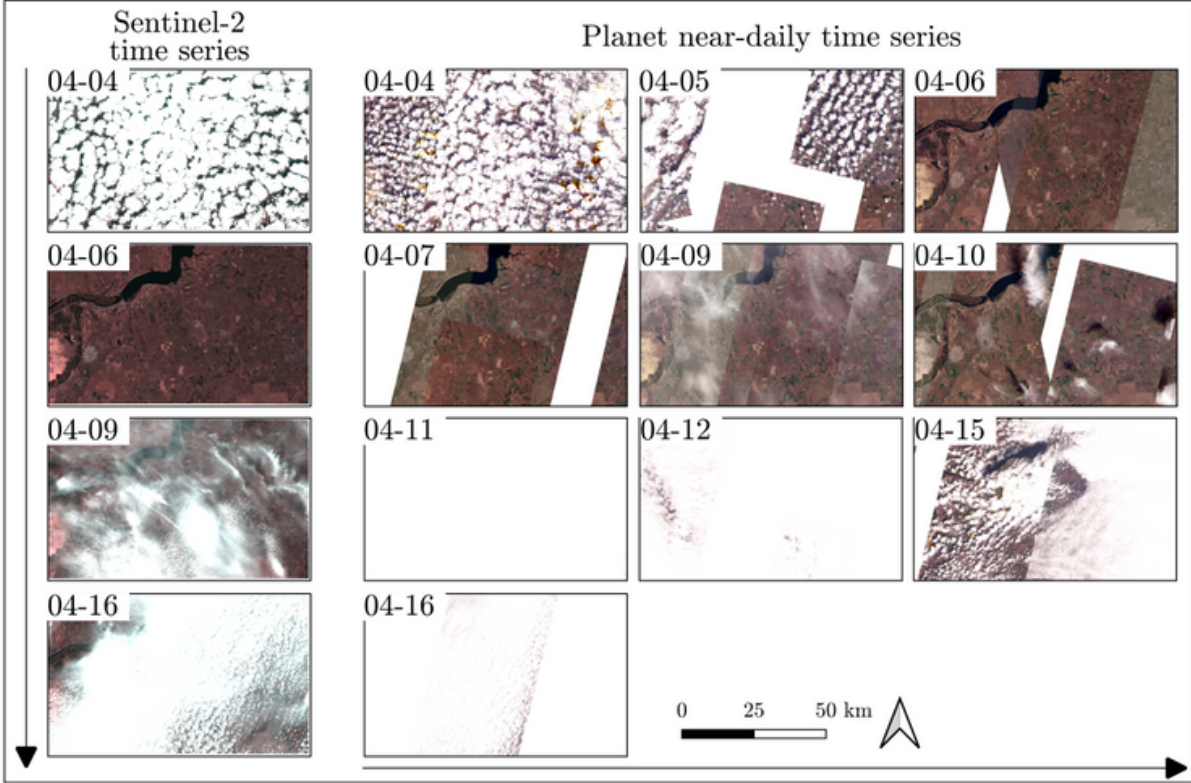
- Crops = dynamic land cover
- Different crops can be distinguished at different moments in time
- Requires a dynamic mapping approach



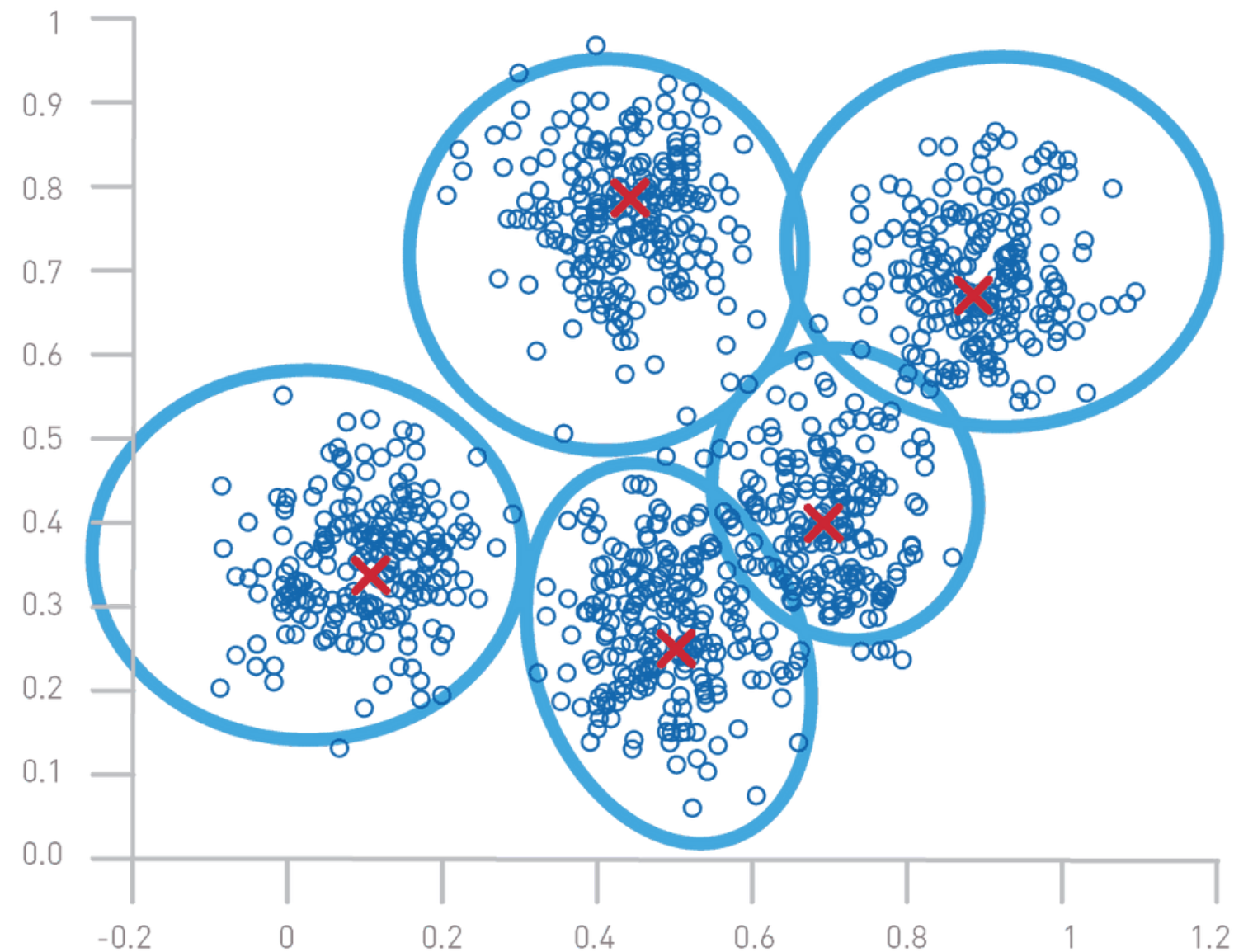
Crop type mapping in Ukraine : the concept



Crop type mapping in Ukraine : the data



Unsupervised classification : K-means clustering

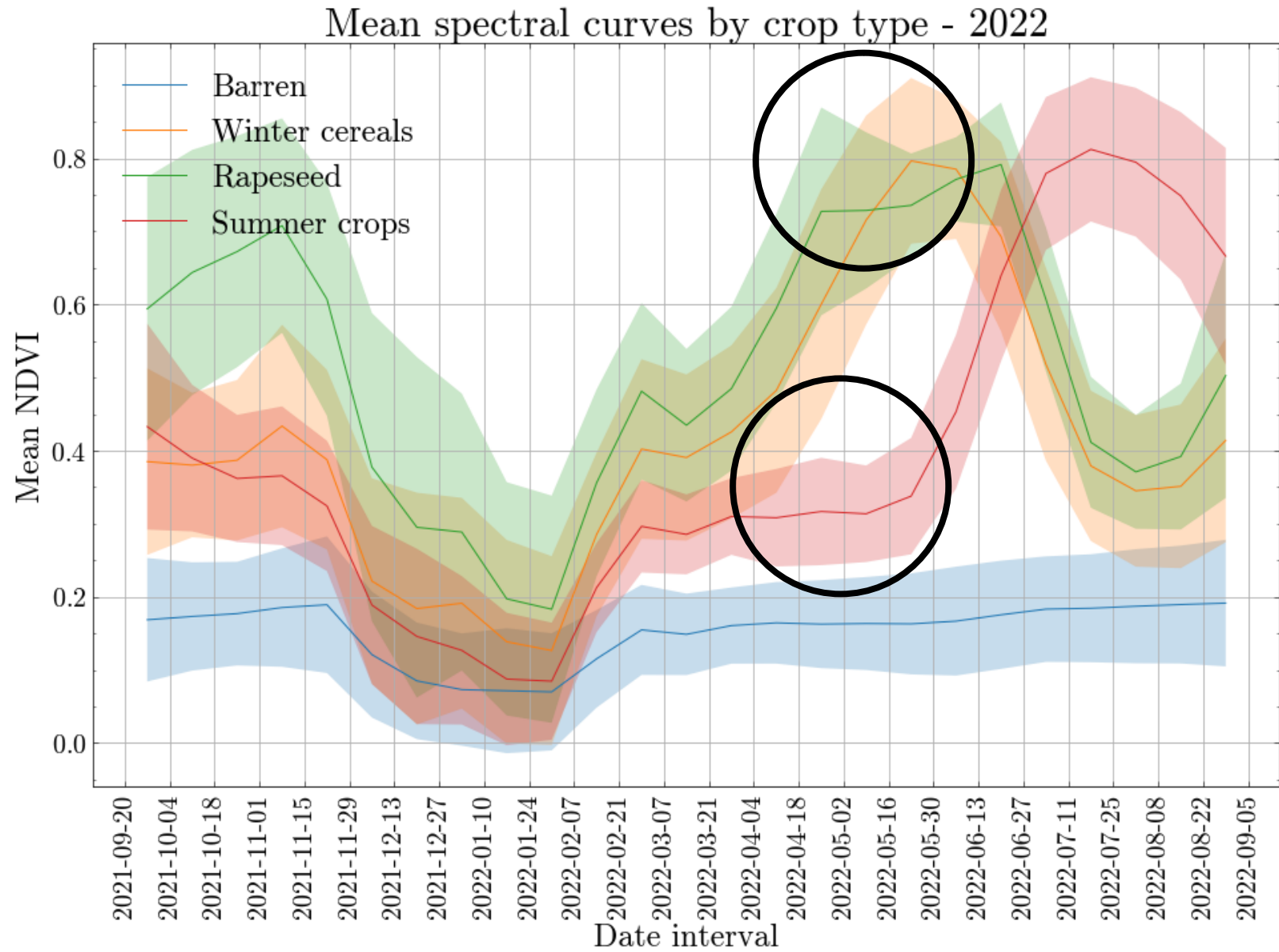


K-means :

- Takes a set of independent variables
- Groups them into a given number of classes such as
 - Inter-class variance is maximized
 - Intra-class variance is minimized
- User determines the semantic significance of each class

K-means clustering applied to Ukraine : winter and summer crop separation

Statement : winter crops are green in April-beginning of May, summer crops are still barren



K-means clustering applied to Ukraine : winter and summer crop separation

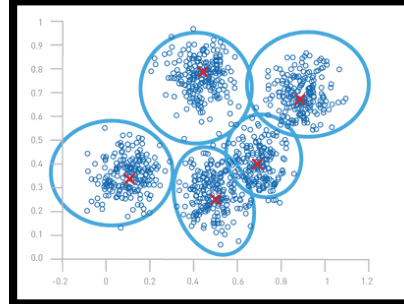
Input features
2 images : May 02, May 16

Cluster training
N = 6

Raw clustering output

Table 4: Input features, description or equation and processing step for rapeseed clustering

Feature	Description/equation	Step
Red (<i>R</i>)	Red spectral band	1 & 2
Green (<i>G</i>)	Green spectral band	1 & 2
Blue (<i>B</i>)	Blue spectral band	1 & 2
Normalized Difference Red Index (<i>NDRI</i>)	$\frac{R-G}{R+G}$	1 & 2
Normalized Difference Yellow Index (<i>NDYI</i>)	$\frac{G-B}{G+B}$	1 & 2
Squared Ratio Yellow Index (<i>RYI</i> ²)	$\frac{G^2}{B}$	2



K-means clustering applied to Ukraine : winter and summer crop separation



Table 3: Clusters and decision criteria

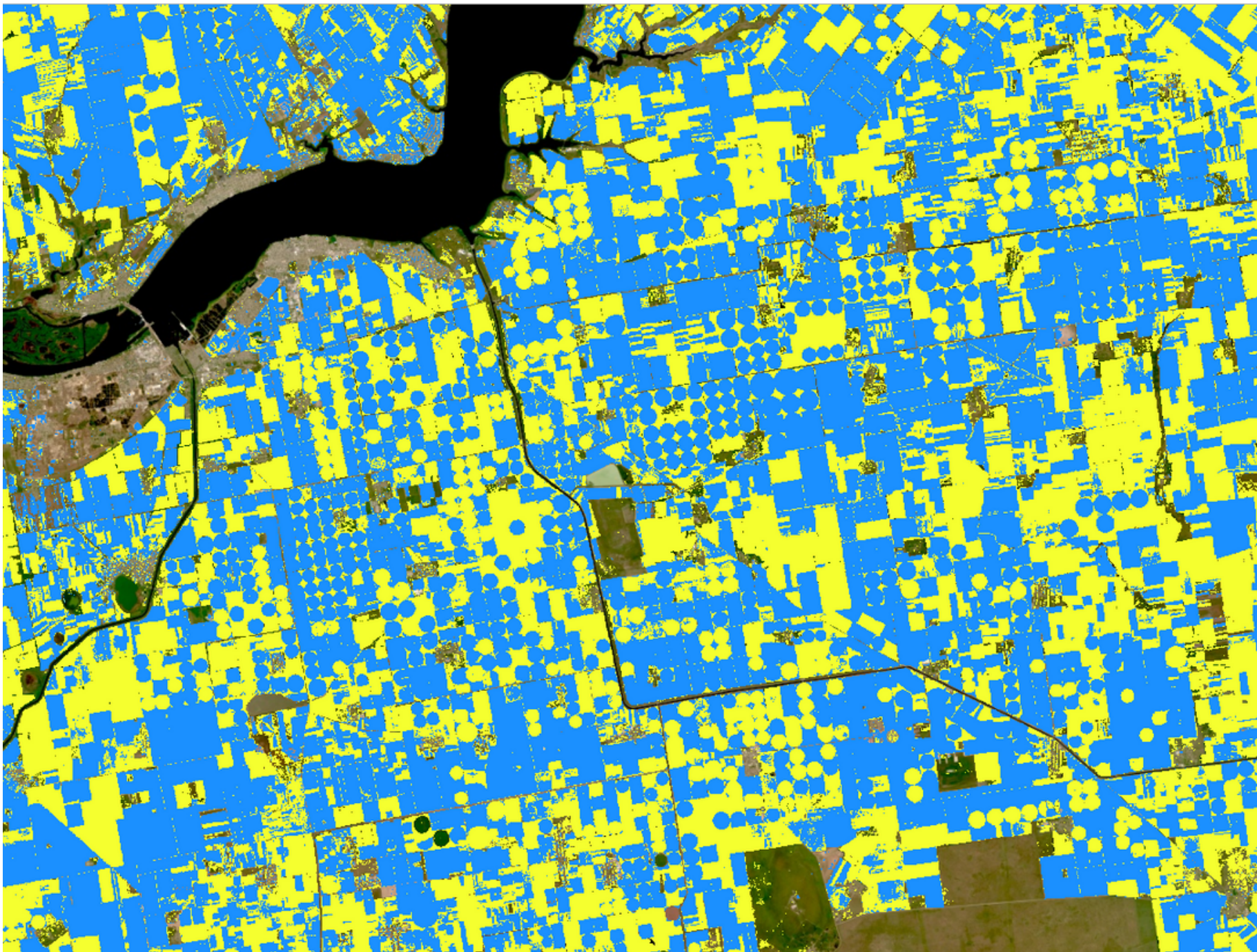
Cluster	Decision criteria
Wintercrop	Looking green or yellow, strong NDVI signal, positive <i>NDVI slope</i>
Bare soil	Looking brown, low NDVI, Negative or low <i>NDVI slope</i>
Clouds	White color, puffy contours, low NDVI
No data	Everything masked previously to classification



K-means clustering applied to Ukraine : winter and summer crop separation - after relabeling

Winter vs. potential summer crops separation (winter crops in yellow)

20220418_20220502



K-means clustering applied to Ukraine : wintercereals and rapeseed separation



Statement : Rapeseed flowers are bright yellow

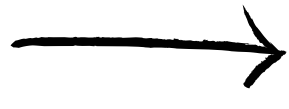
- First 2 weeks of May = peak flowering phase
- Ideal for training and algorithm

K-means clustering applied to Ukraine : wintercereals and rapeseed separation (training phase)

Input features
1 image : May 16



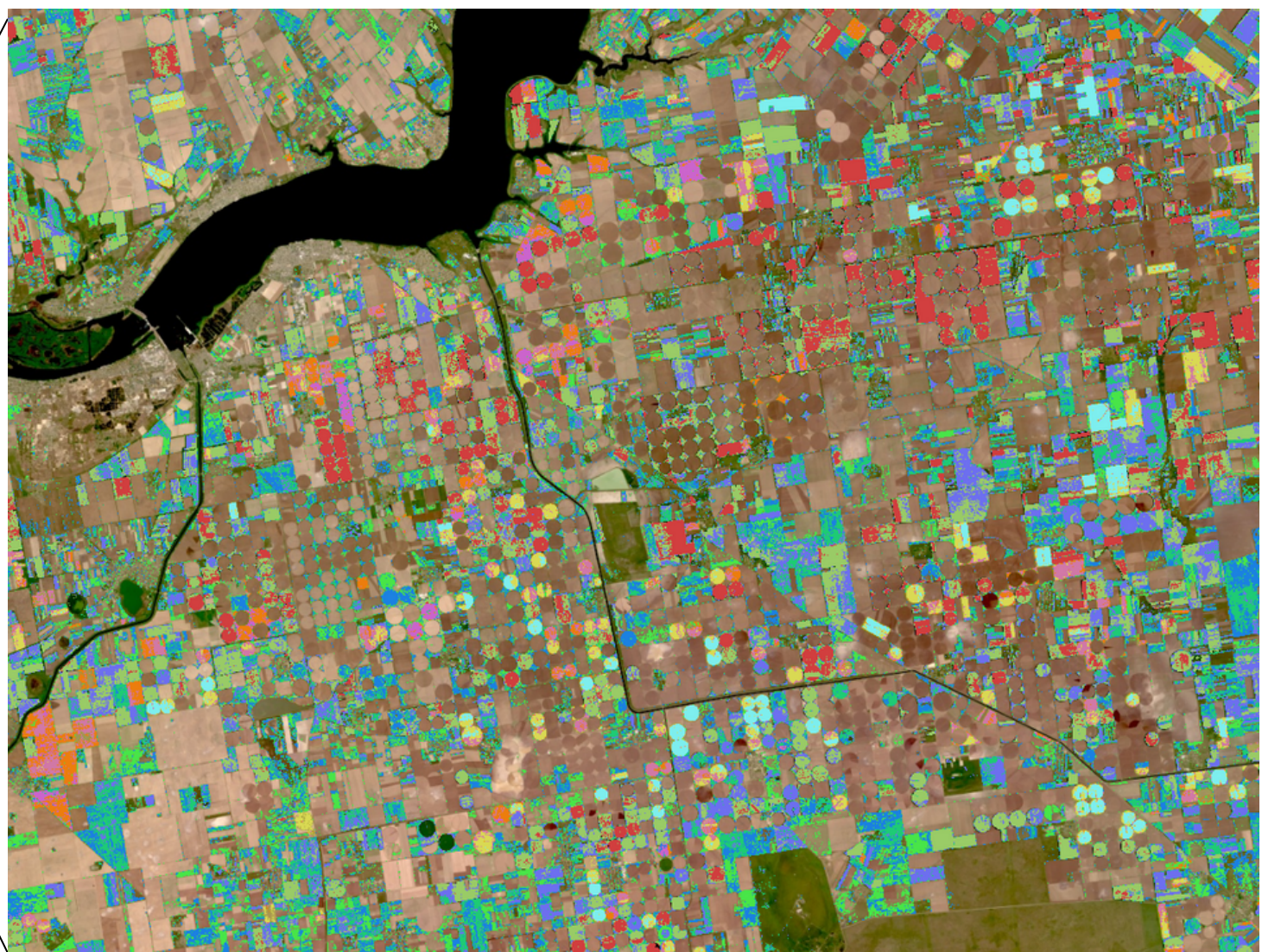
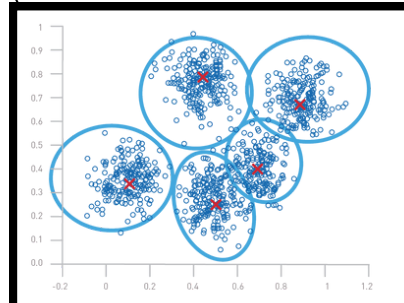
Cluster training
N = 12



Raw clustering output

Table 4: Input features, description or equation and processing step for rapeseed clustering

Feature	Description/equation	Step
Red (<i>R</i>)	Red spectral band	1 & 2
Green (<i>G</i>)	Green spectral band	1 & 2
Blue (<i>B</i>)	Blue spectral band	1 & 2
Normalized Difference Red Index (<i>NDRI</i>)	$\frac{R-G}{R+G}$	1 & 2
Normalized Difference Yellow Index (<i>NDYI</i>)	$\frac{G-B}{G+B}$	1 & 2
Squared Ratio Yellow Index (<i>RYI</i> ²)	$(\frac{G}{B})^2$	2

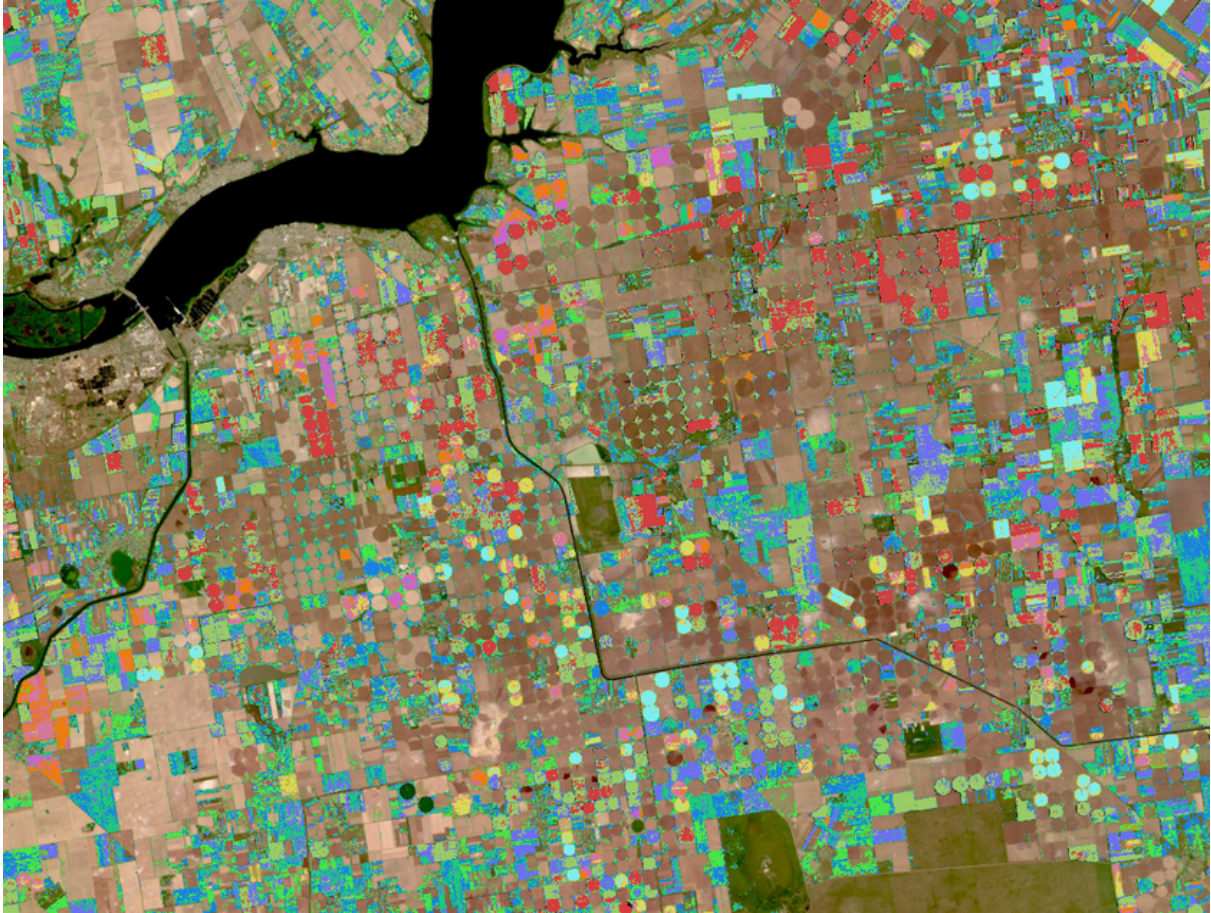


K-means clustering applied to Ukraine : wintercereals and rapeseed separation (training phase)

Statement : Rapeseed flowers are bright yellow



Input image



Raw clusters

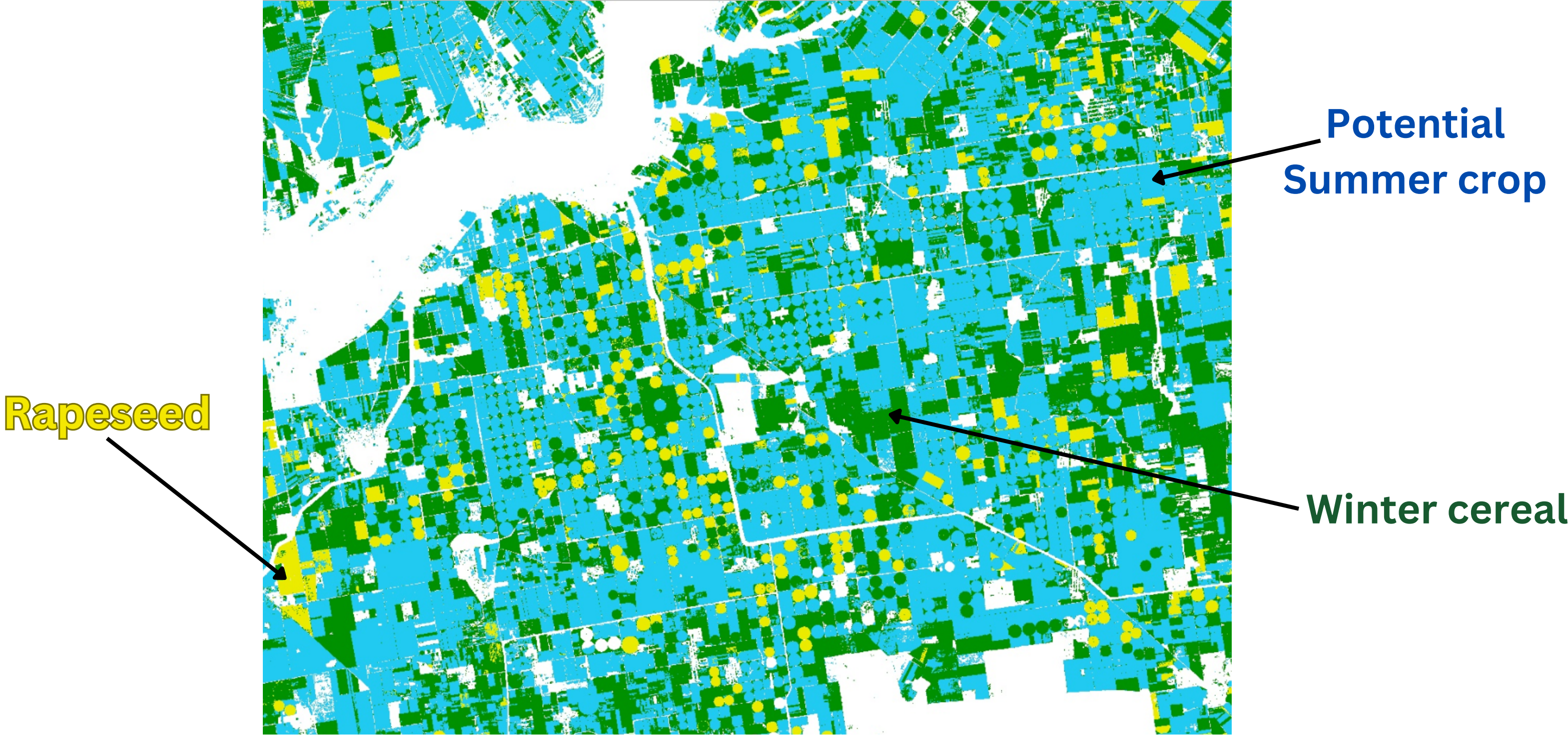


Relabeled clusters

Rapeseed system applied over three images covering 1.5 months to make sure all rapeseed flowering is captured in Ukraine

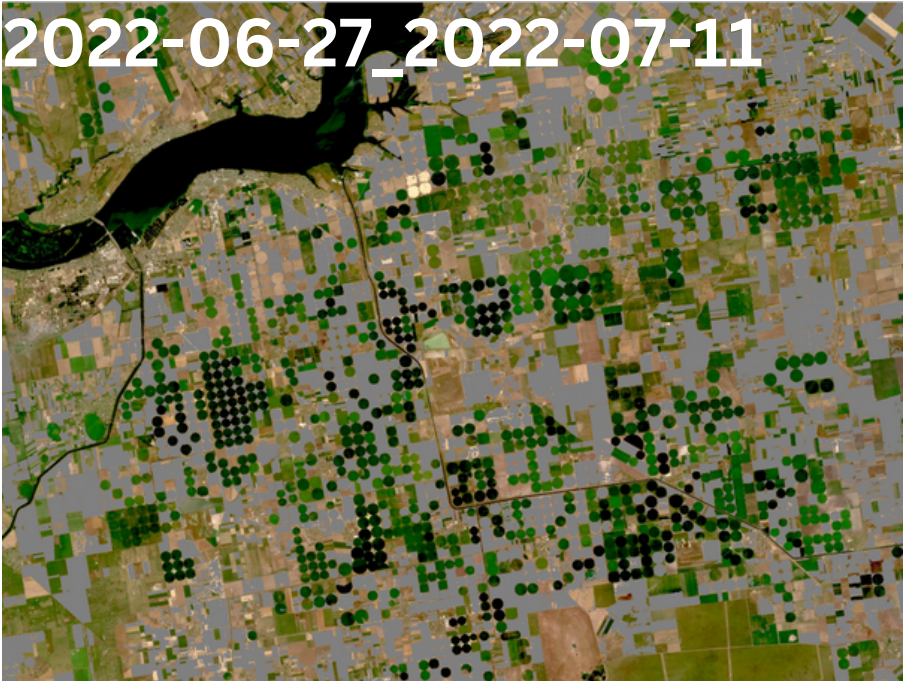
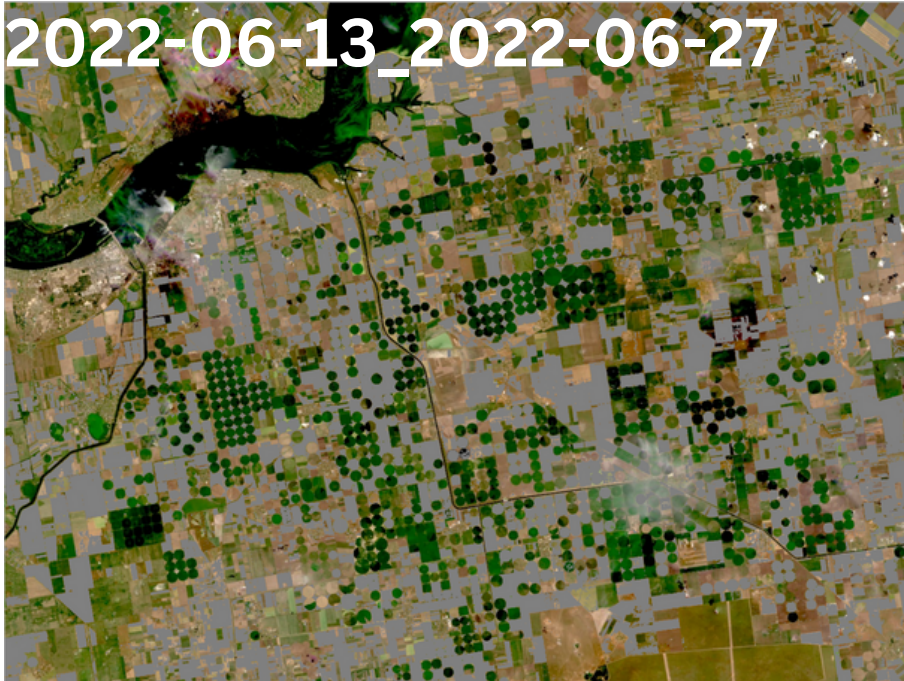
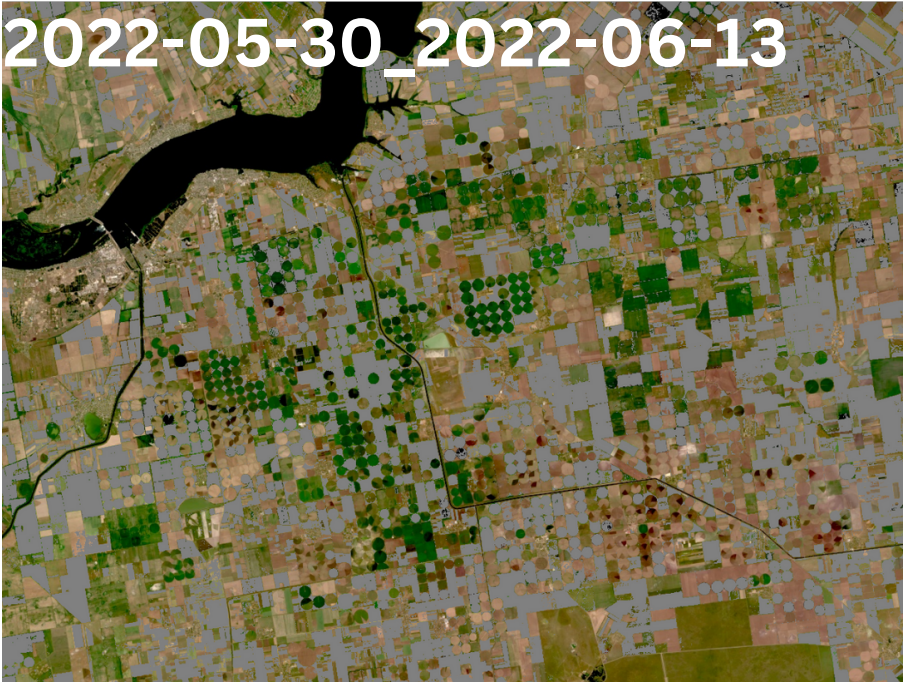
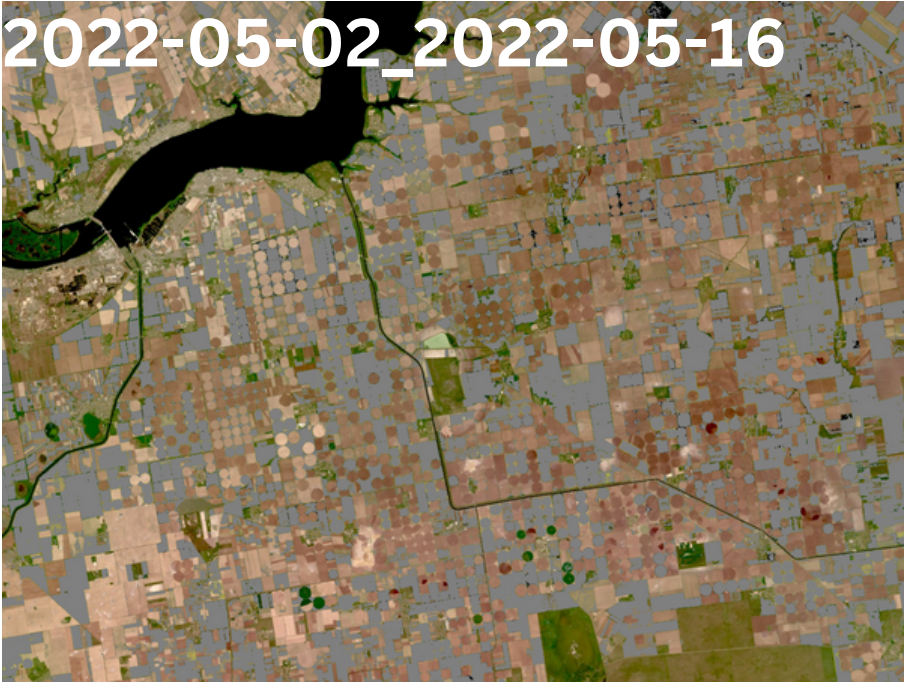
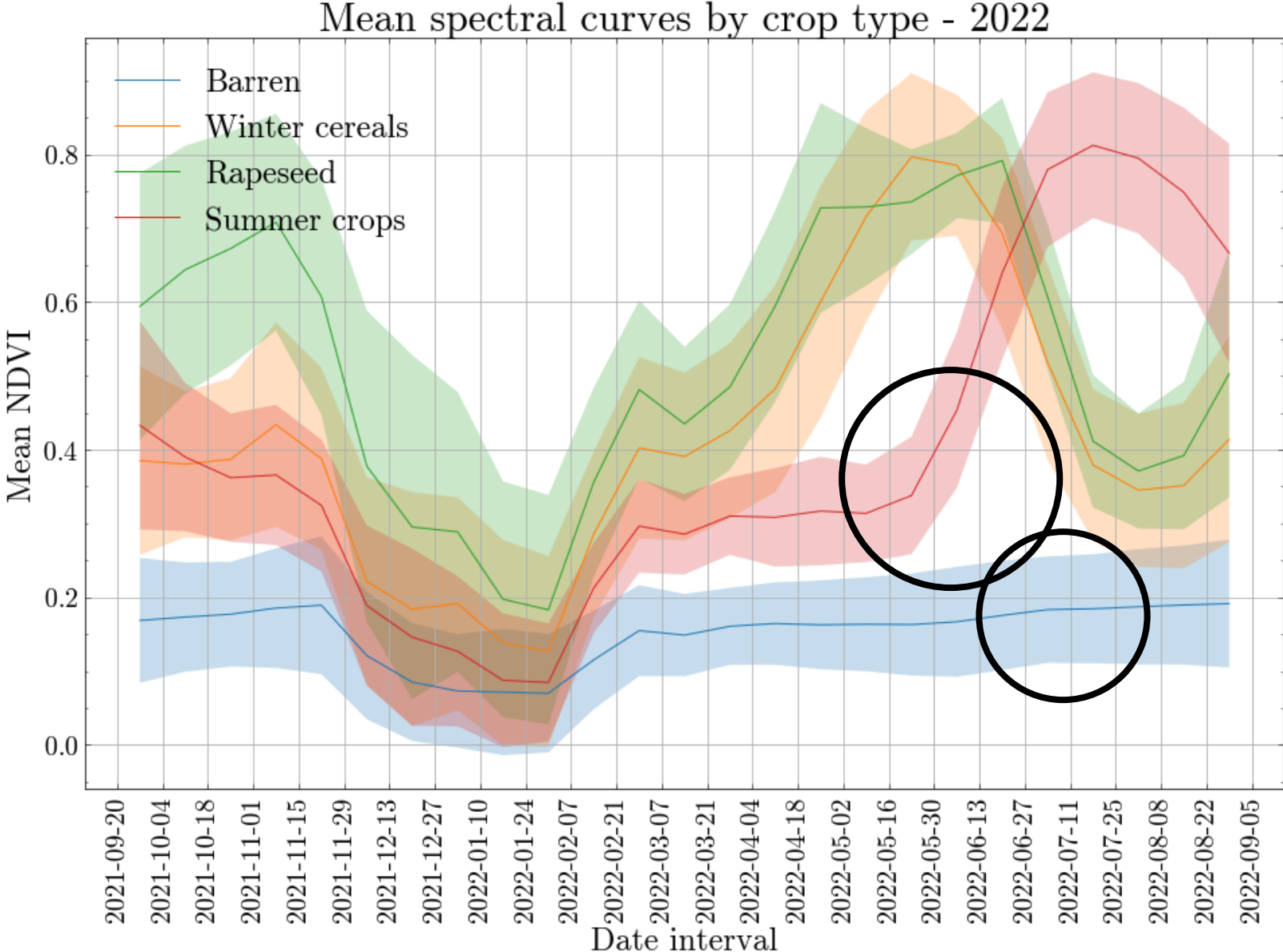


K-means clustering applied to Ukraine : wintercereals and rapeseed , potential summer crops status 2022-06-27



Green-up detection for summer crop mapping : summer crop and non planted fields separation

Statement : Summer crops green-up in June/July whereas non planted fields show no green-up signal



Crop type mapping in Ukraine : summer crops vs. bare soil

Uncertain Green-Up =

Rule 1 : $locSlope > 0$

Rule 2 : $globSlope > 0$

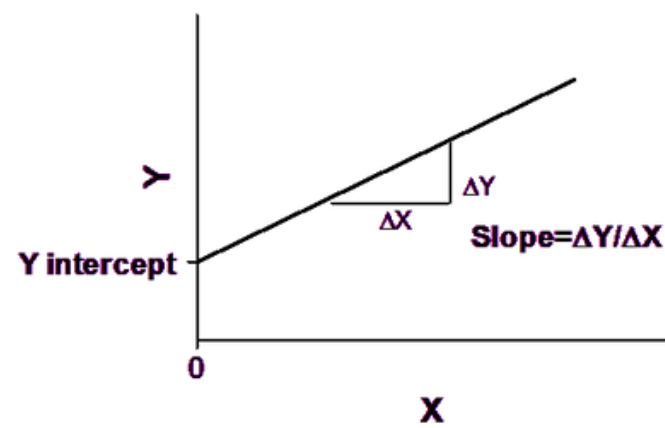
Rule 3 : $NDVI\Delta \geq 0.2$

Certain Green-Up =

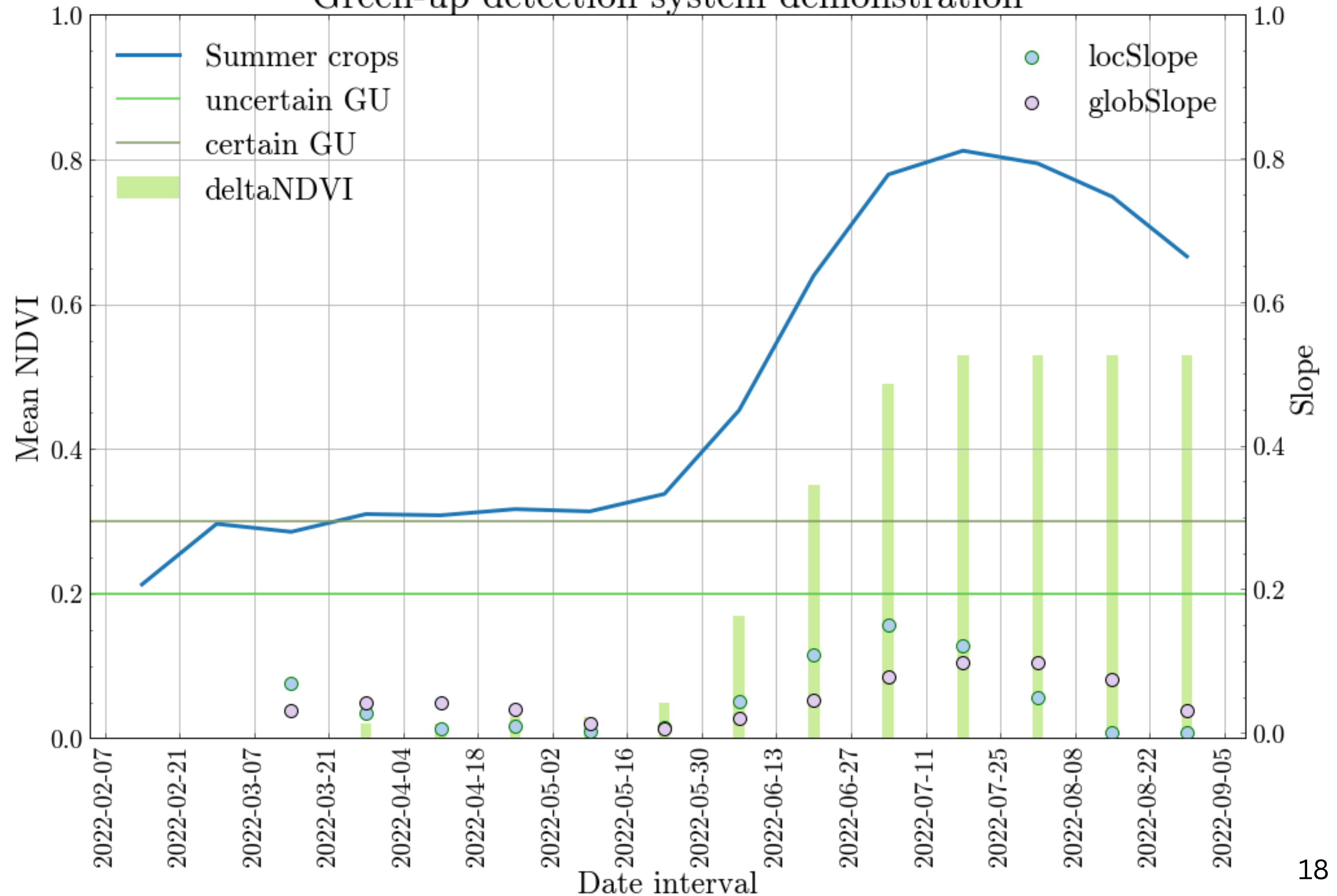
Rule 1 : $locSlope > 0$

Rule 2 : $globSlope > 0$

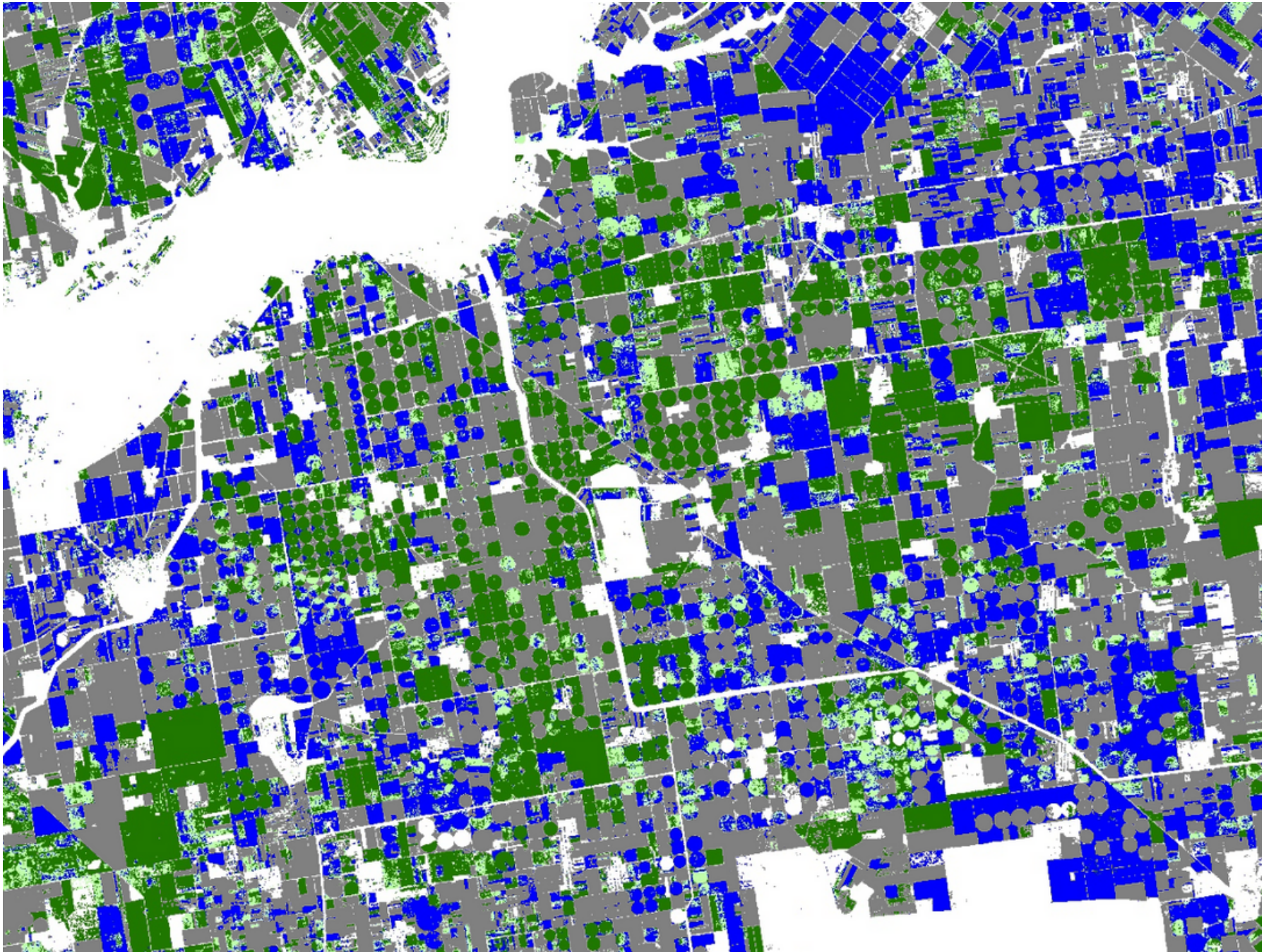
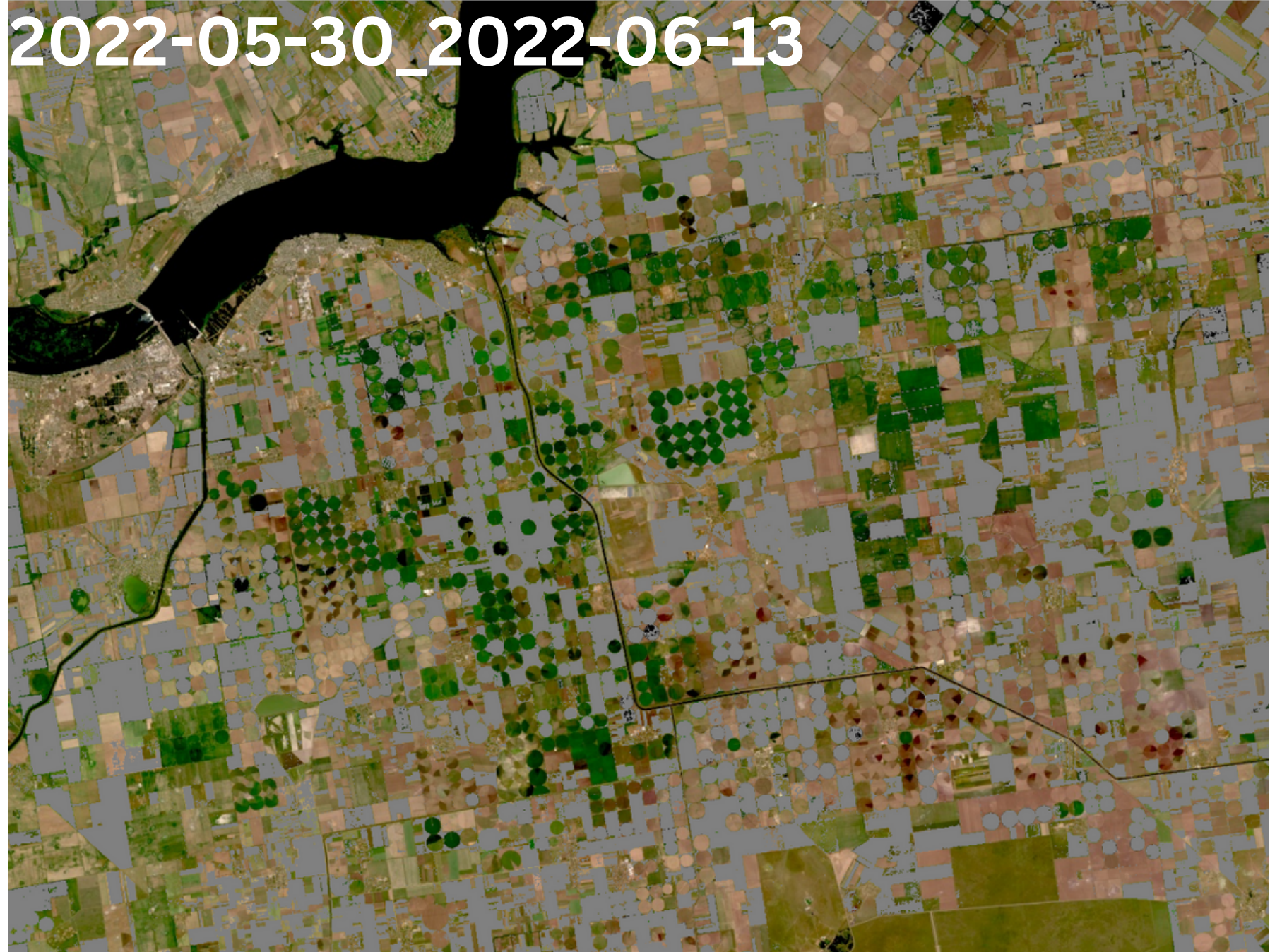
Rule 3 : $NDVI\Delta \geq 0.3$



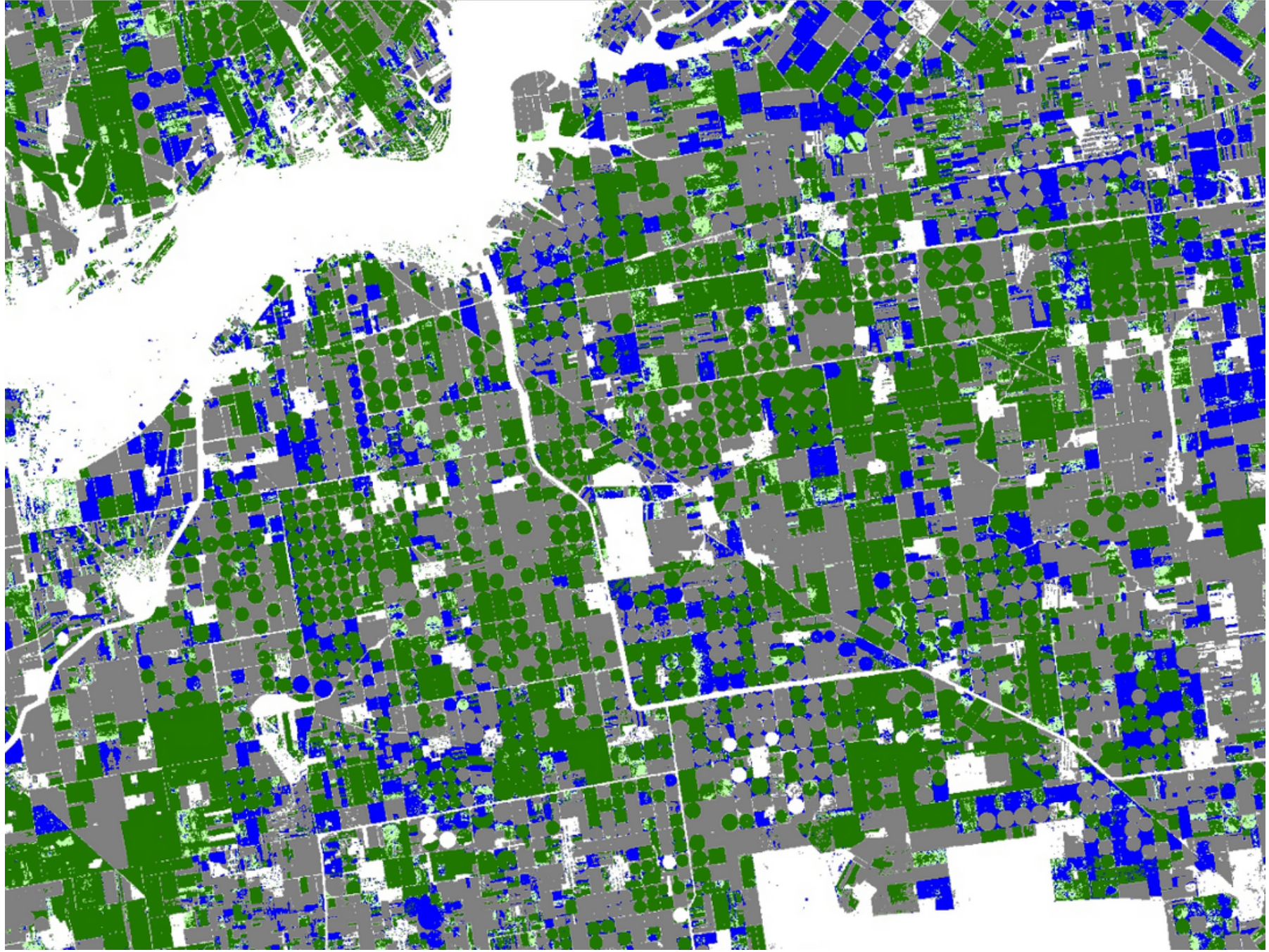
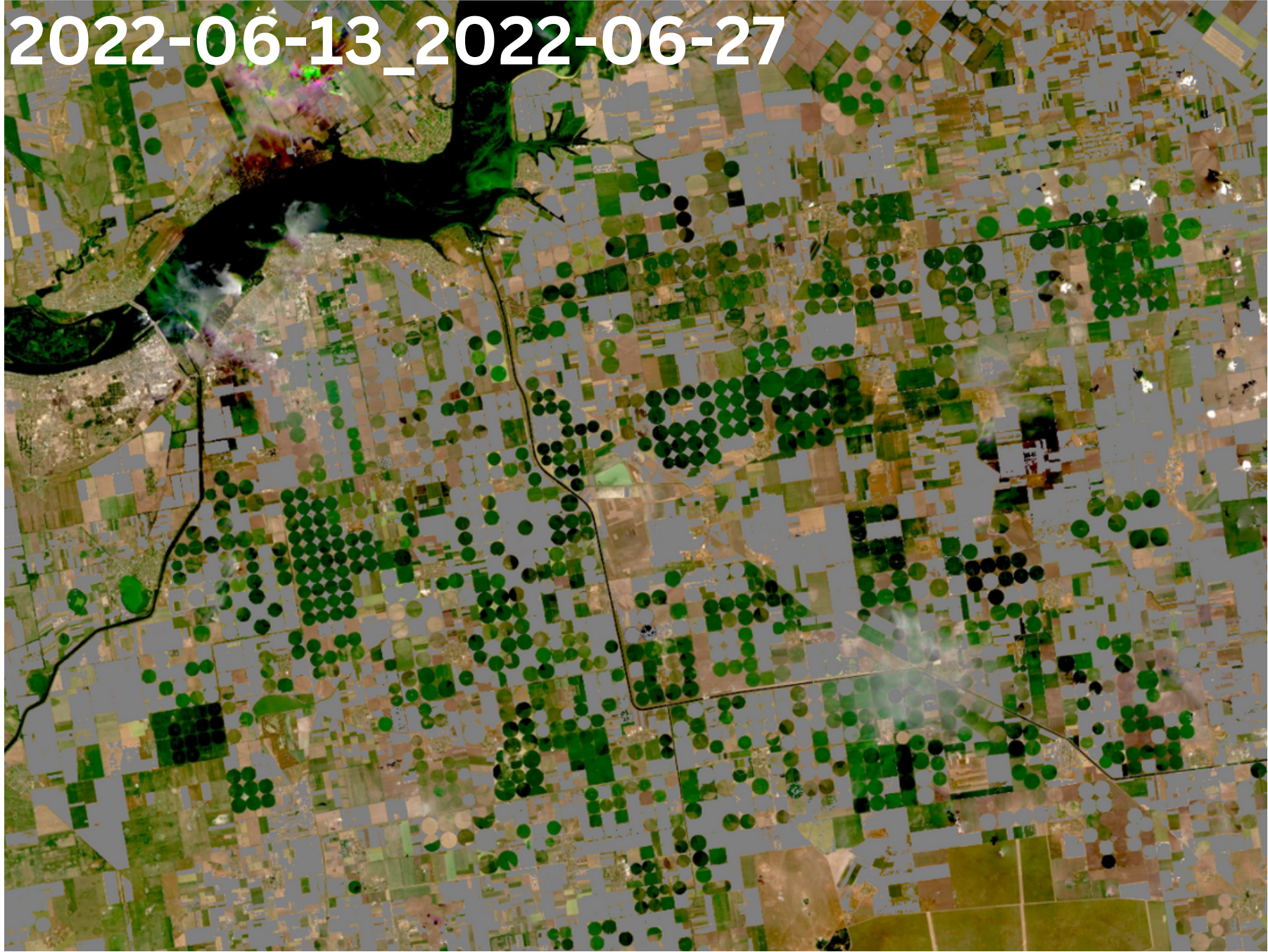
Green-up detection system demonstration



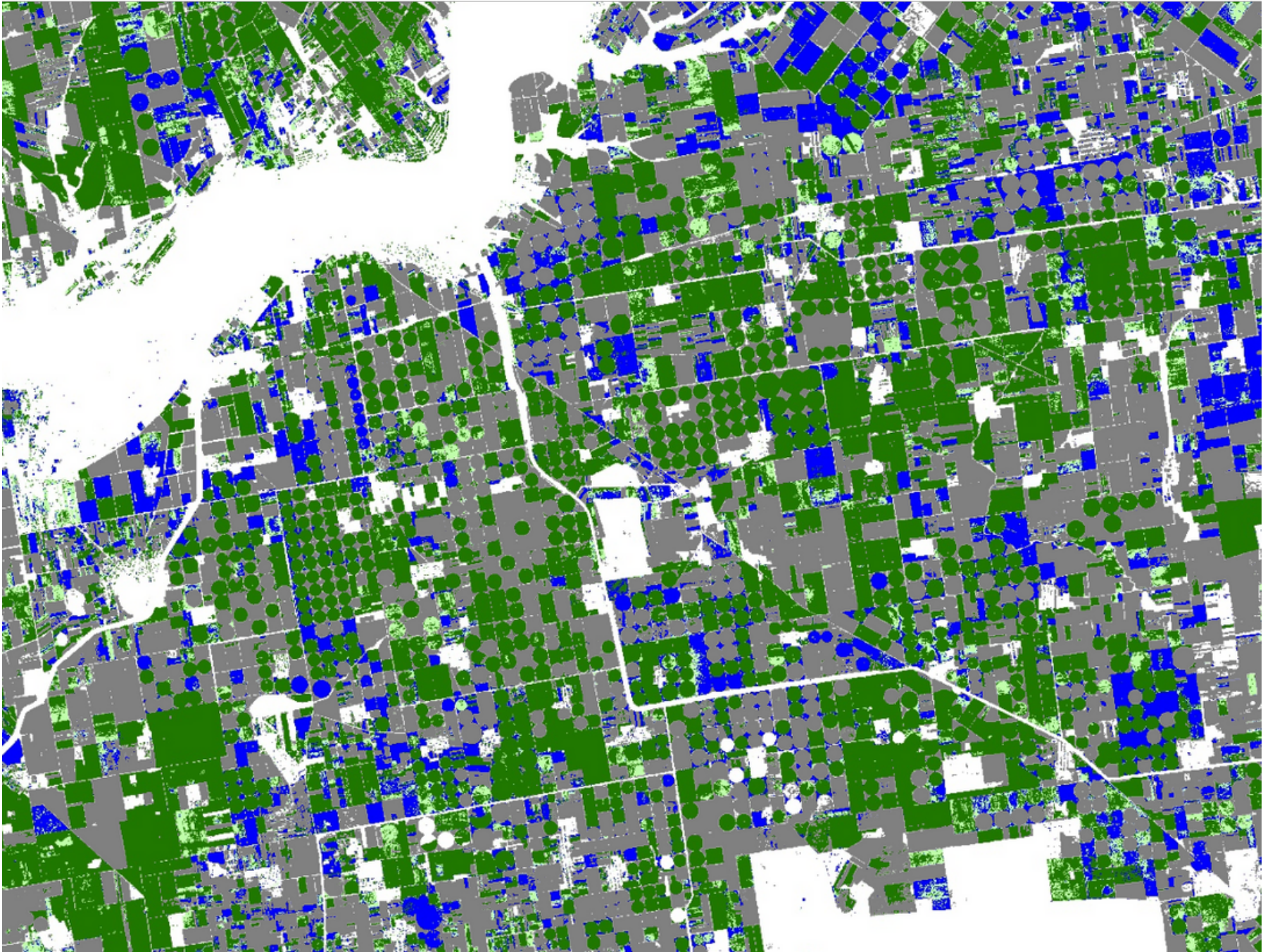
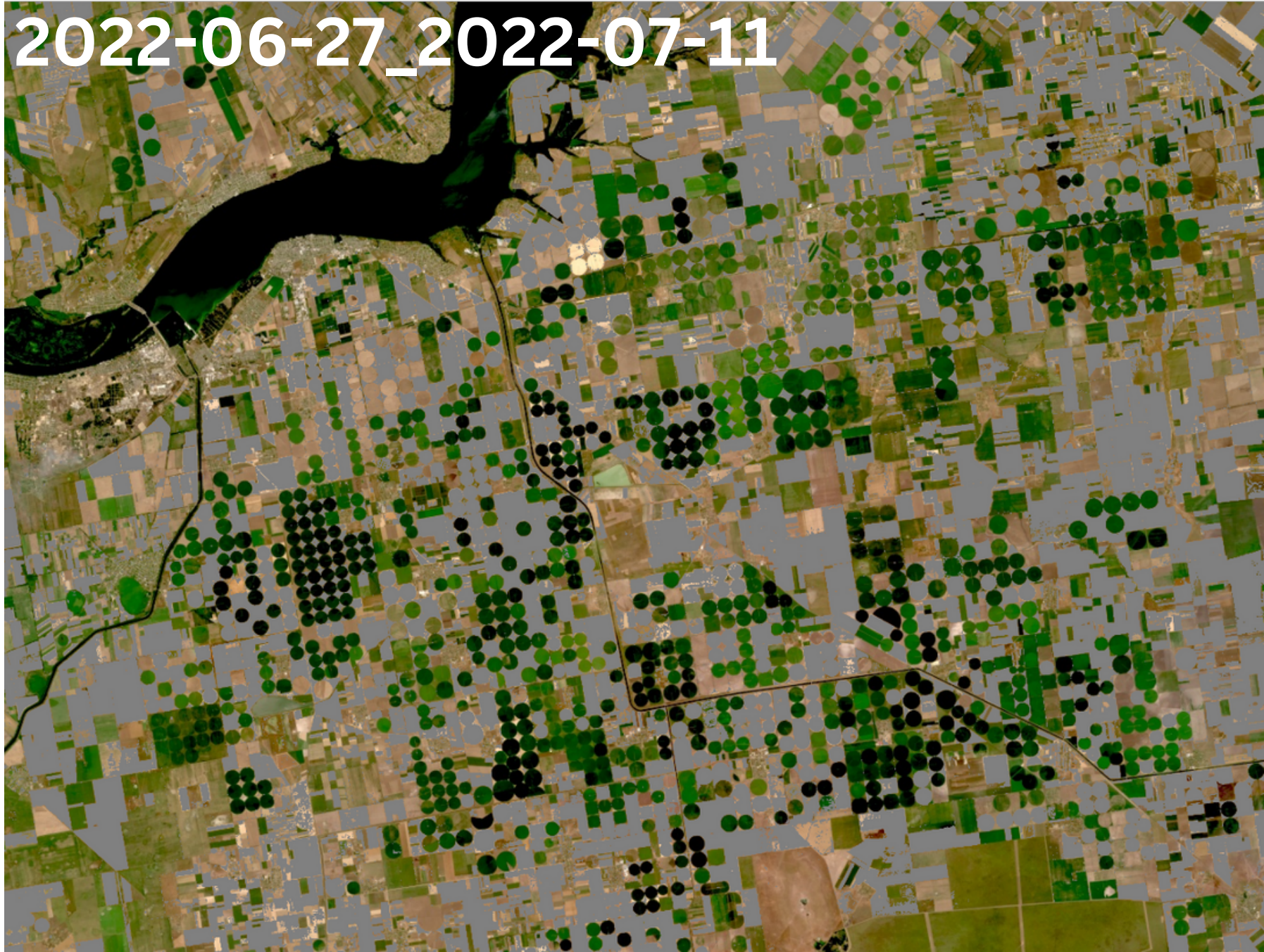
Crop type mapping in Ukraine : summer crops vs. bare soil



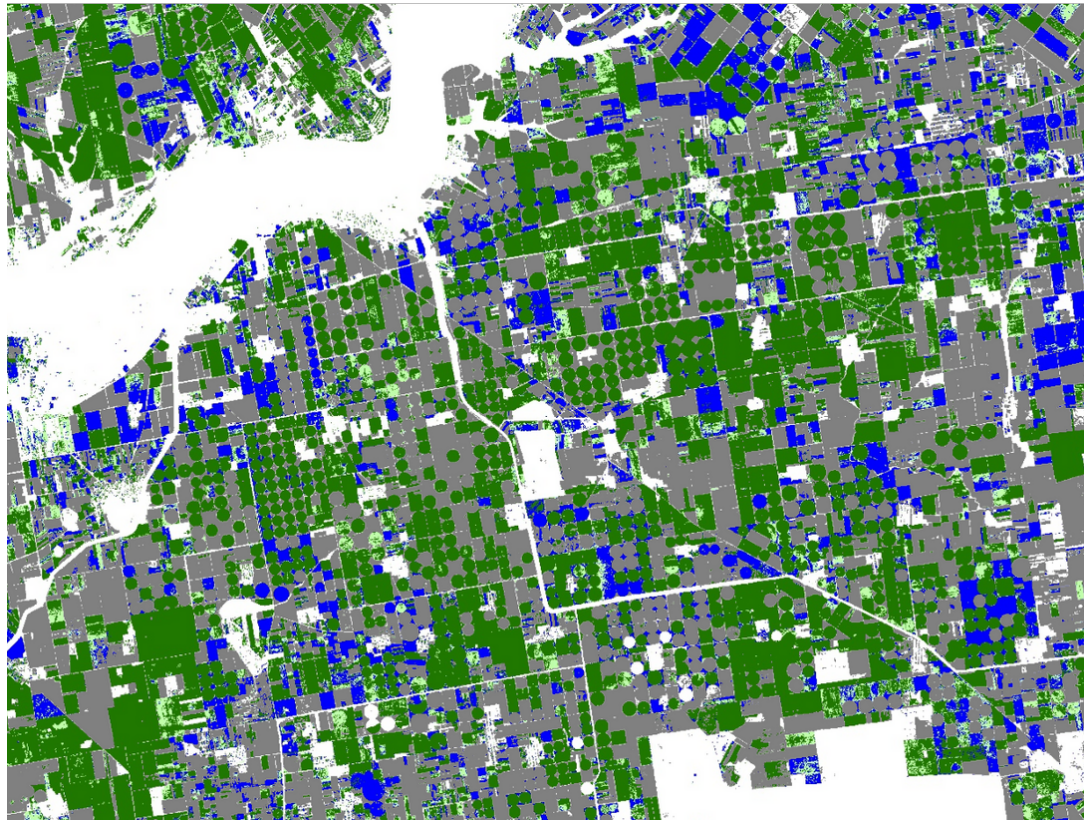
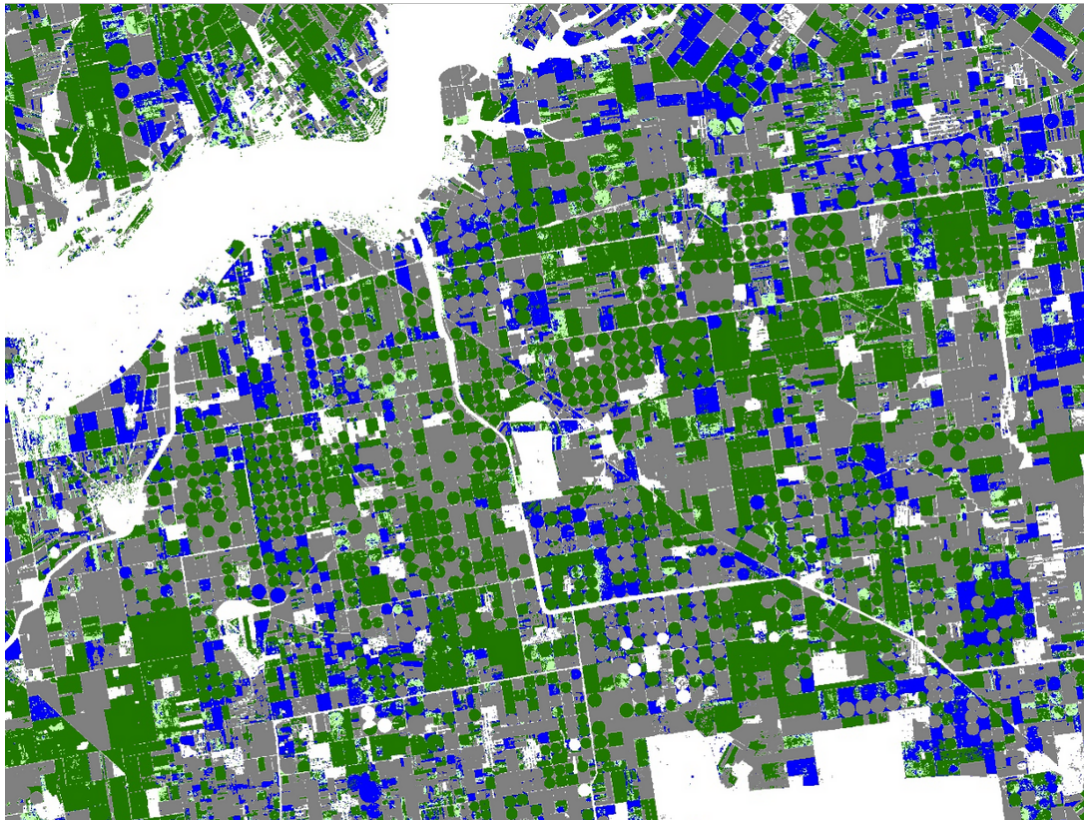
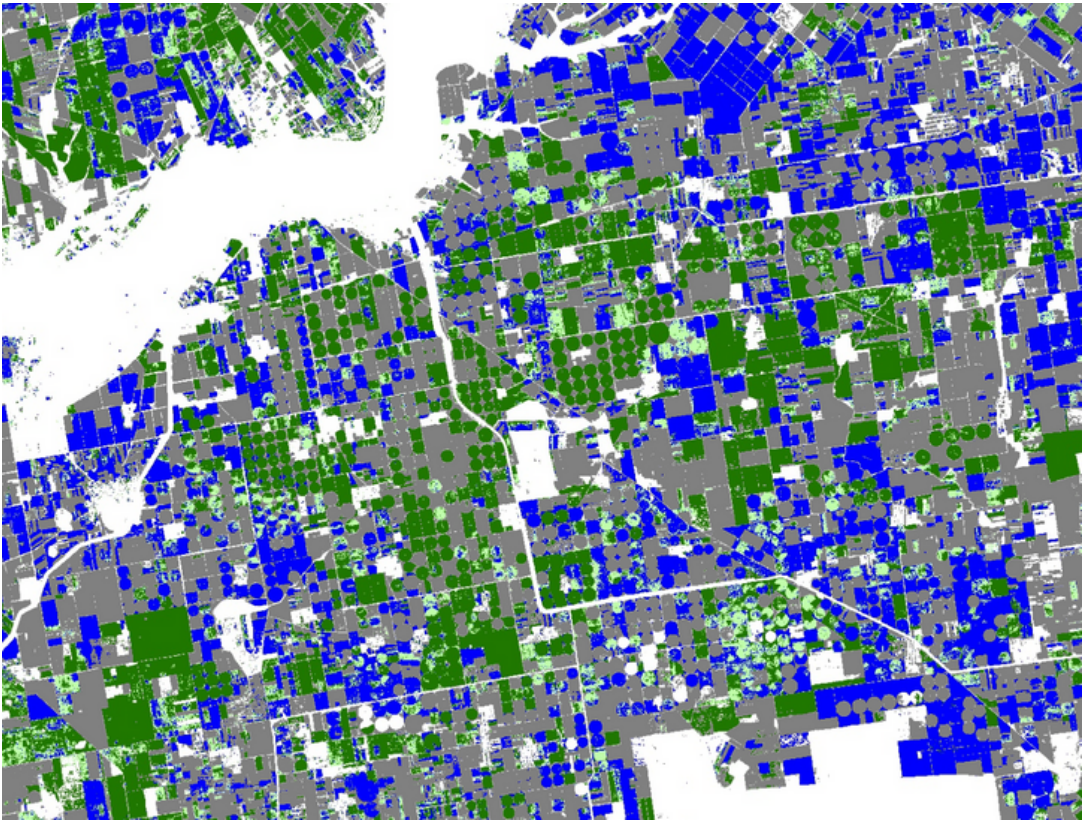
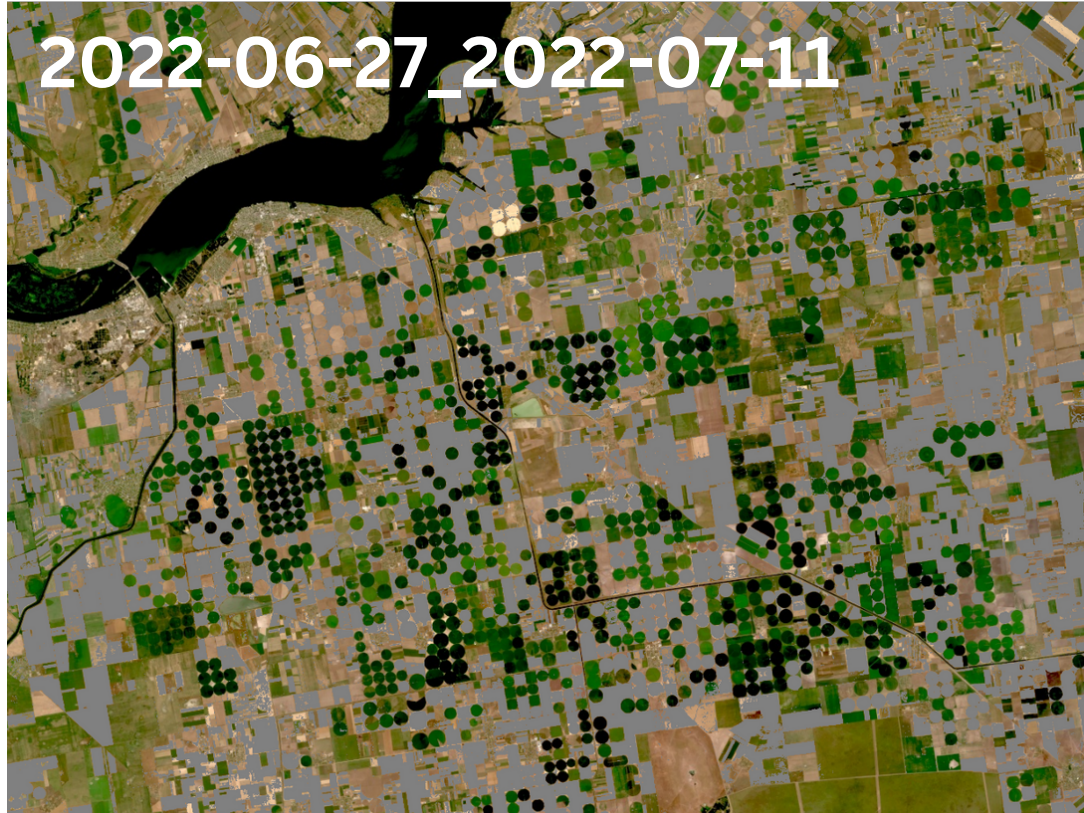
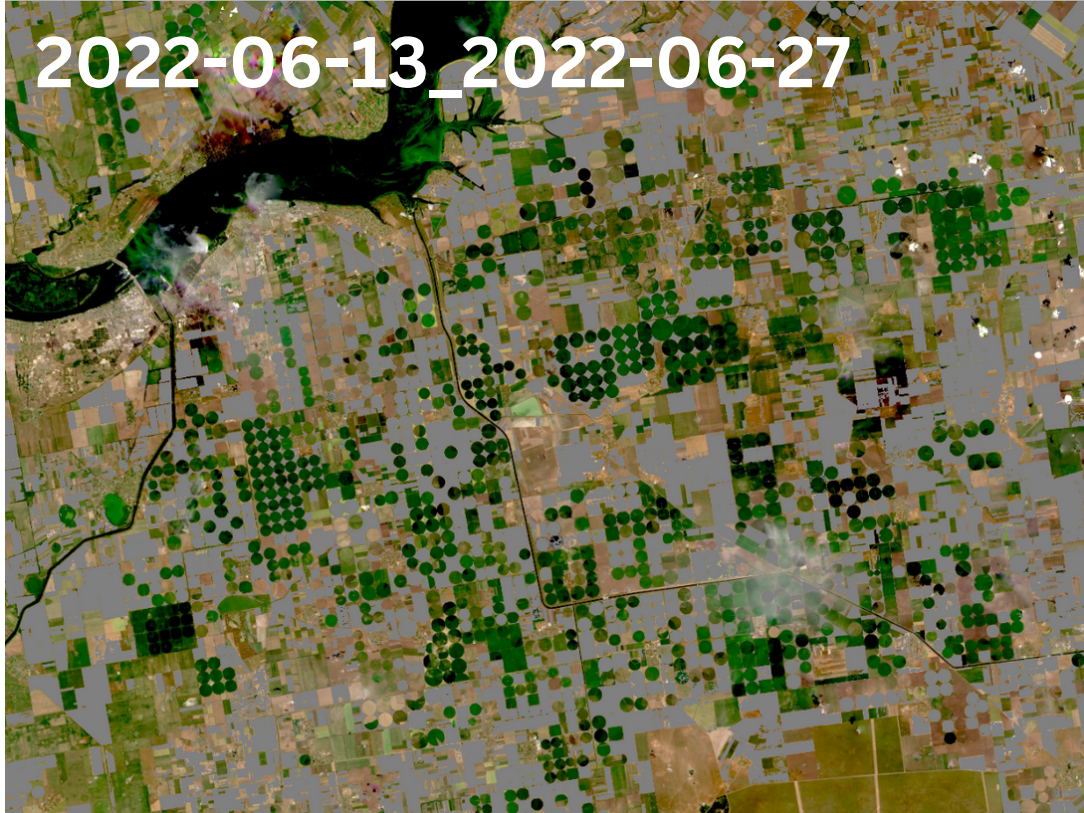
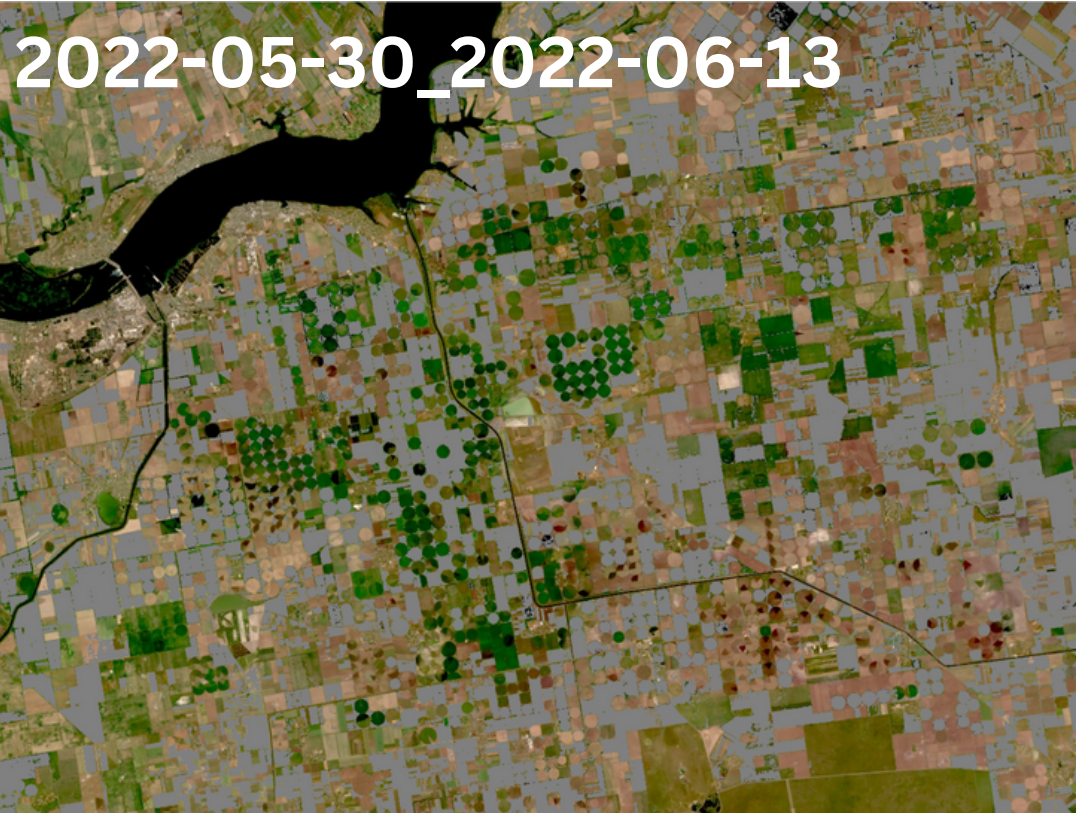
Crop type mapping in Ukraine : summer crops vs. bare soil



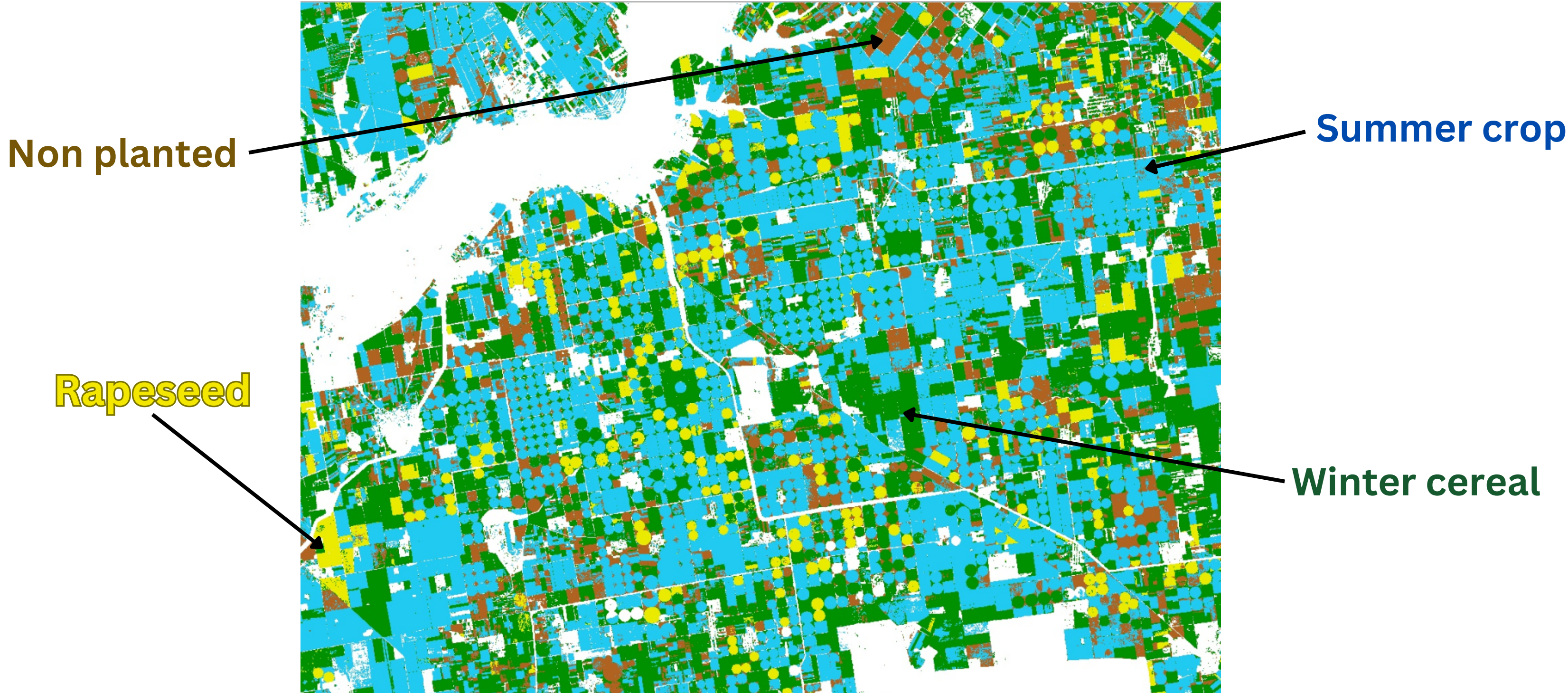
Crop type mapping in Ukraine : summer crops vs. bare soil



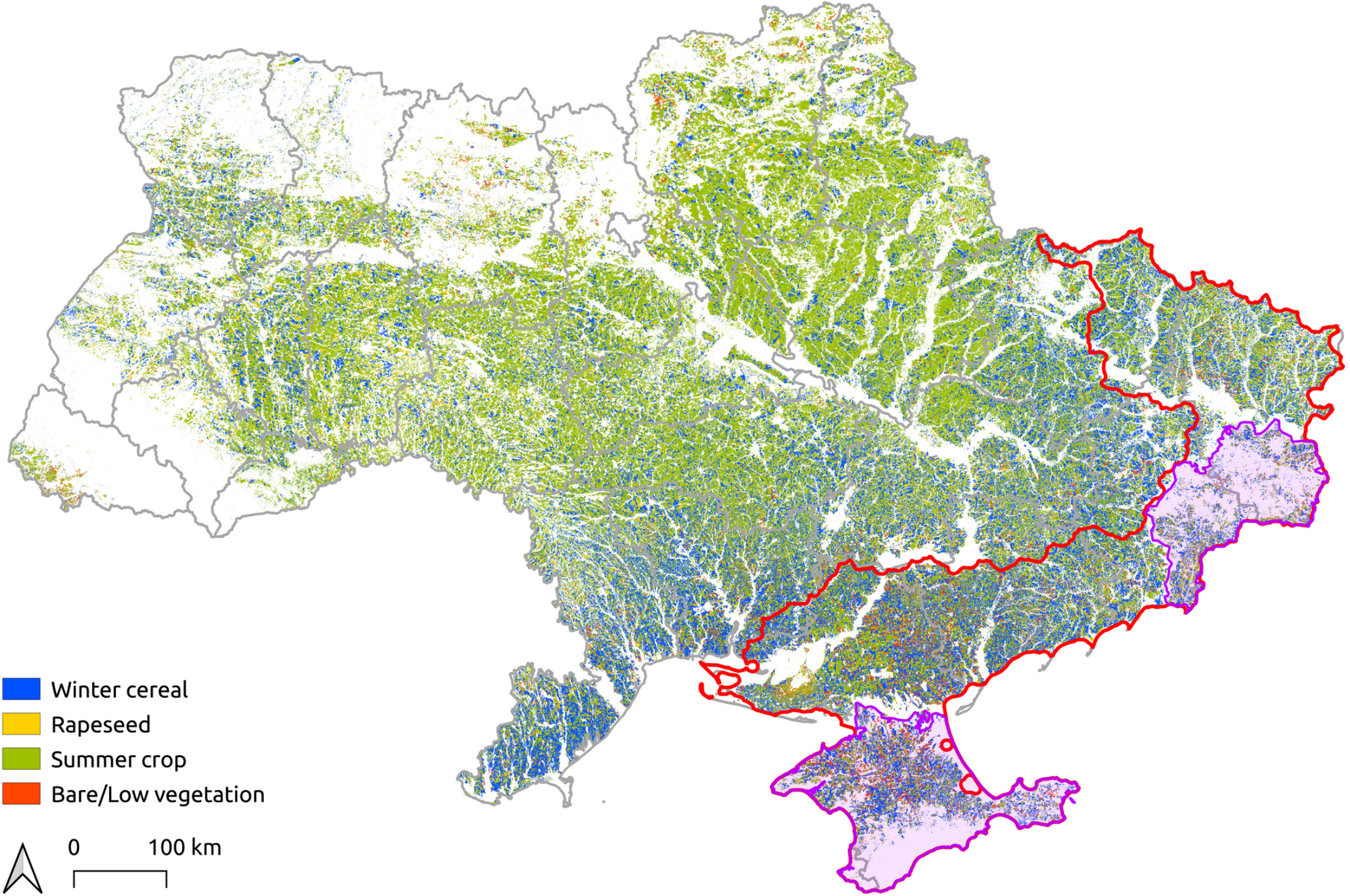
Crop type mapping in Ukraine : summer crops vs. bare soil



K-means clustering applied to Ukraine : wintercereals and rapeseed , summer crops and non planted fields - status 2022-07-11



Crop type mapping in Ukraine : the map



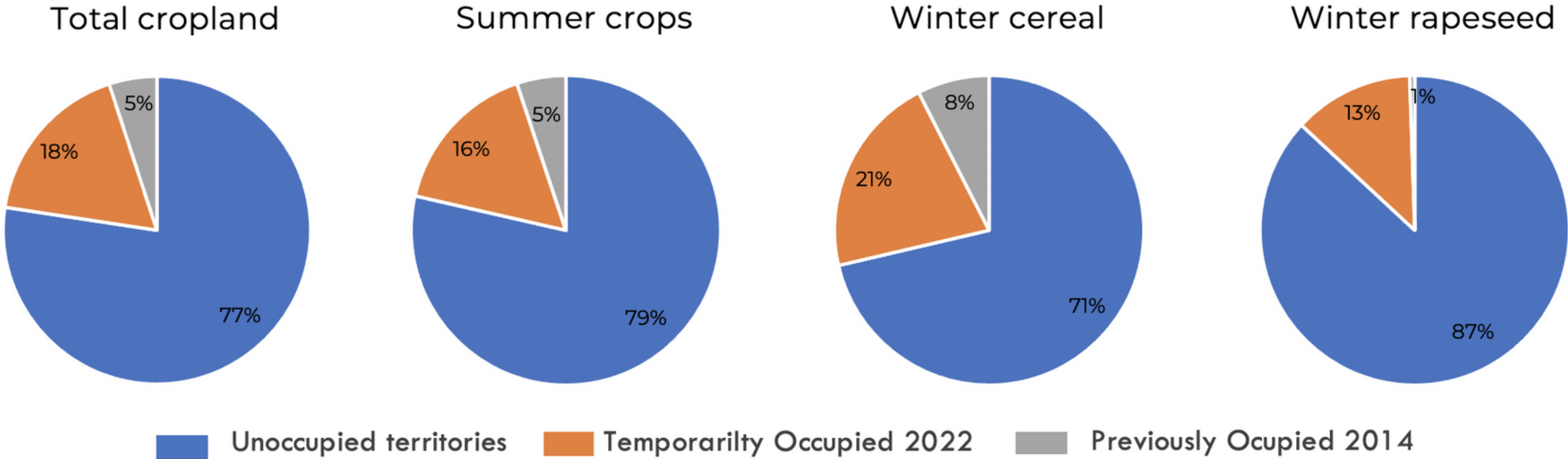
Crop type mapping in Ukraine : performance metrics

	Free as of 2022-07-11		Occupied as of 2022-07-11		Occupied as 2014	
Class	F1-score	Overall accuracy	F1-score	Overall accuracy	F1-score	Overall accuracy
Non crop	0.88	0.83	0,87	0.80	0.80	0.67
Non Planted/Barren	0.65		0.67			
Winter cereal	0.83		0.84			
Rapeseed	0.95		0.95			
Summer crop	0.84		0.75			



Crop type mapping in Ukraine : planted area proportions

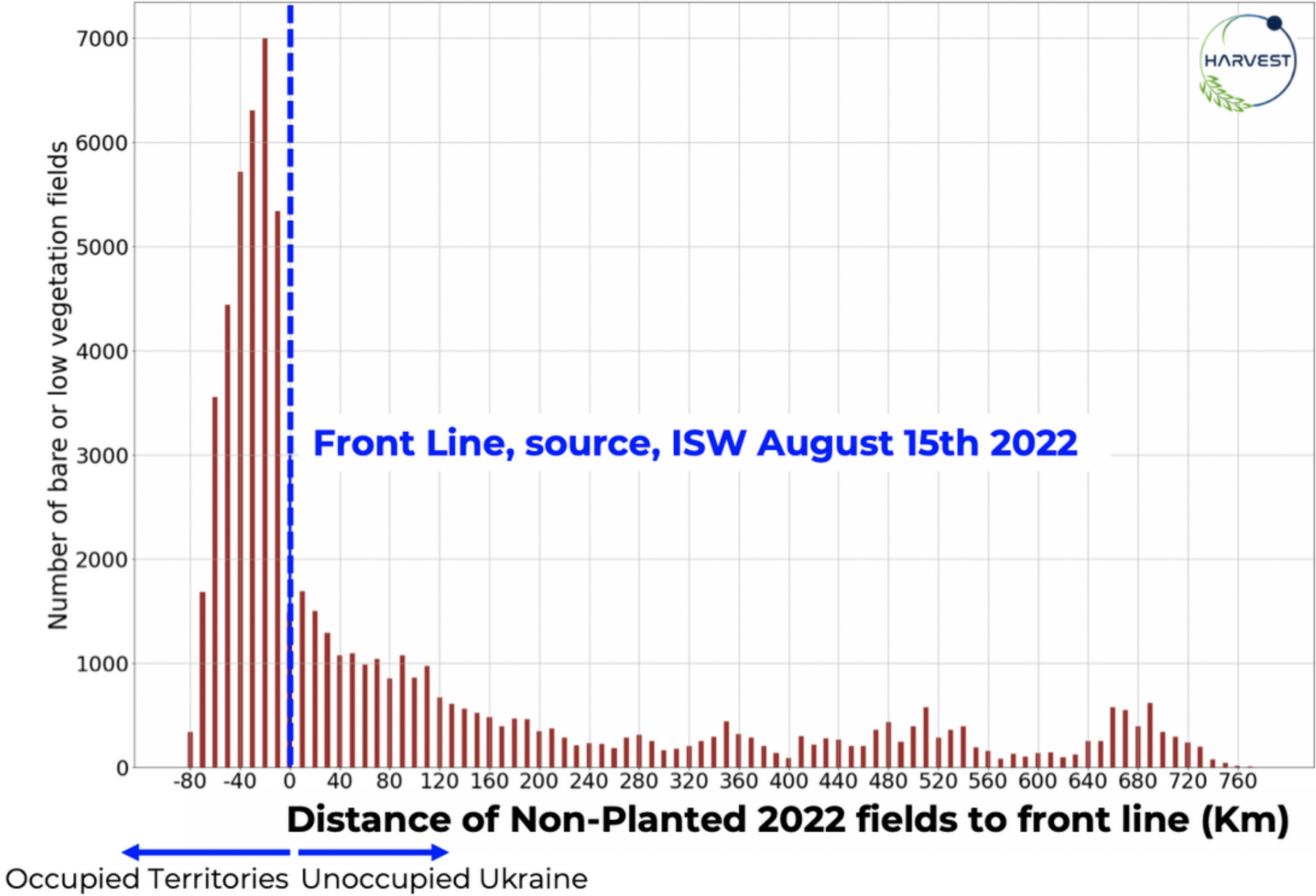
Ukraine Crop Proportions By Occupation Status (As of July 11, 2022)



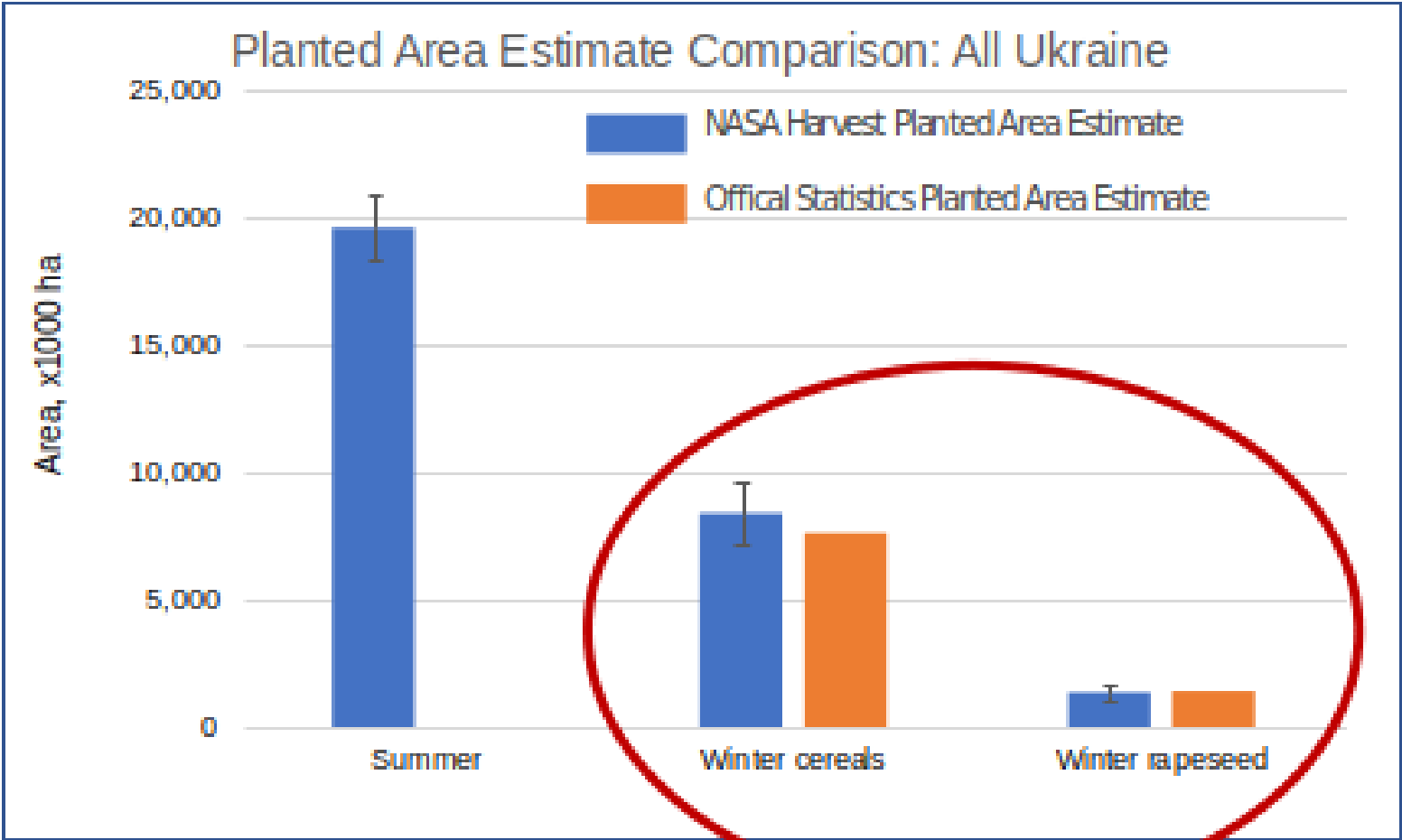
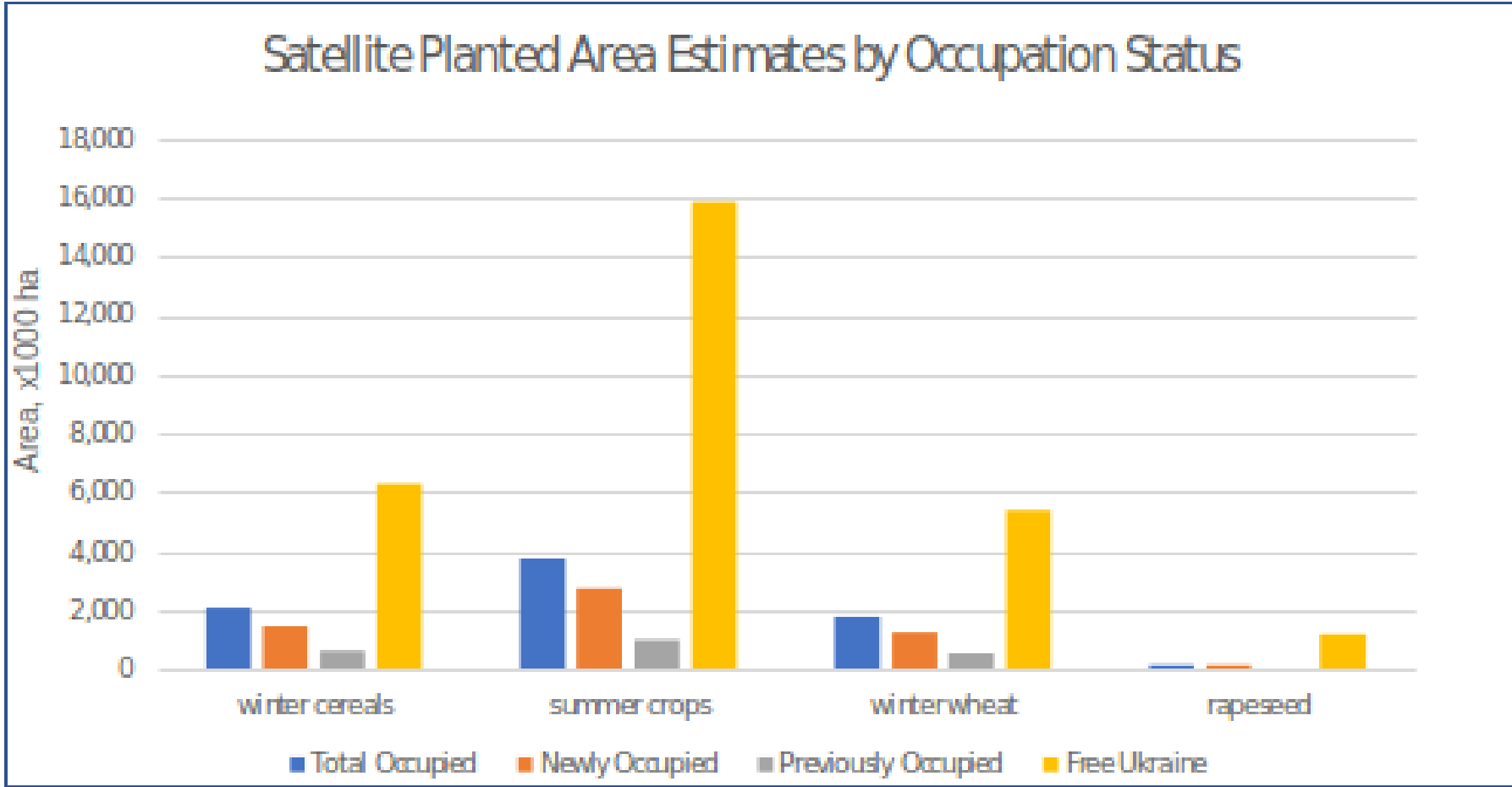
Crop type mapping in Ukraine : barren fields

Distance Between Non-planted Fields & Front Line

Bin size = 10km



Crop type mapping in Ukraine : planted areas



Thank you for your attention !

NASA Harvest Ukraine Rapid Assessment Team



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Becker-Reshef



Josef Wagner



Shabarinath Nair



Yuval Sadeh



Sheila Baber



Blake Munshell



Brian Barker



Ritvik Sahaipal



Abdul Quadir



Sergii Skakun



Mehdi Hosseini



Saeed
Khahhazan



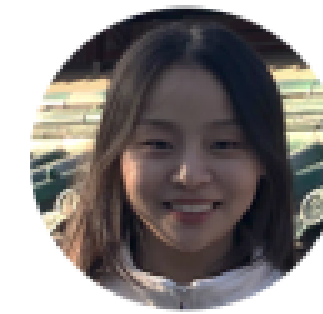
Michael Humber



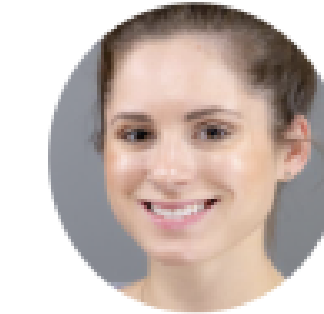
John Kenisten



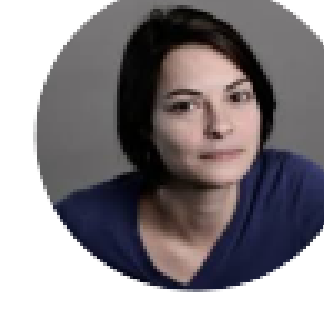
Erik Duncan



Fangjie Li



Mary Mitkish



Natacha Kalecinski

