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AI-driven Parcel Delineation in Ukraine using Open Satellite Data

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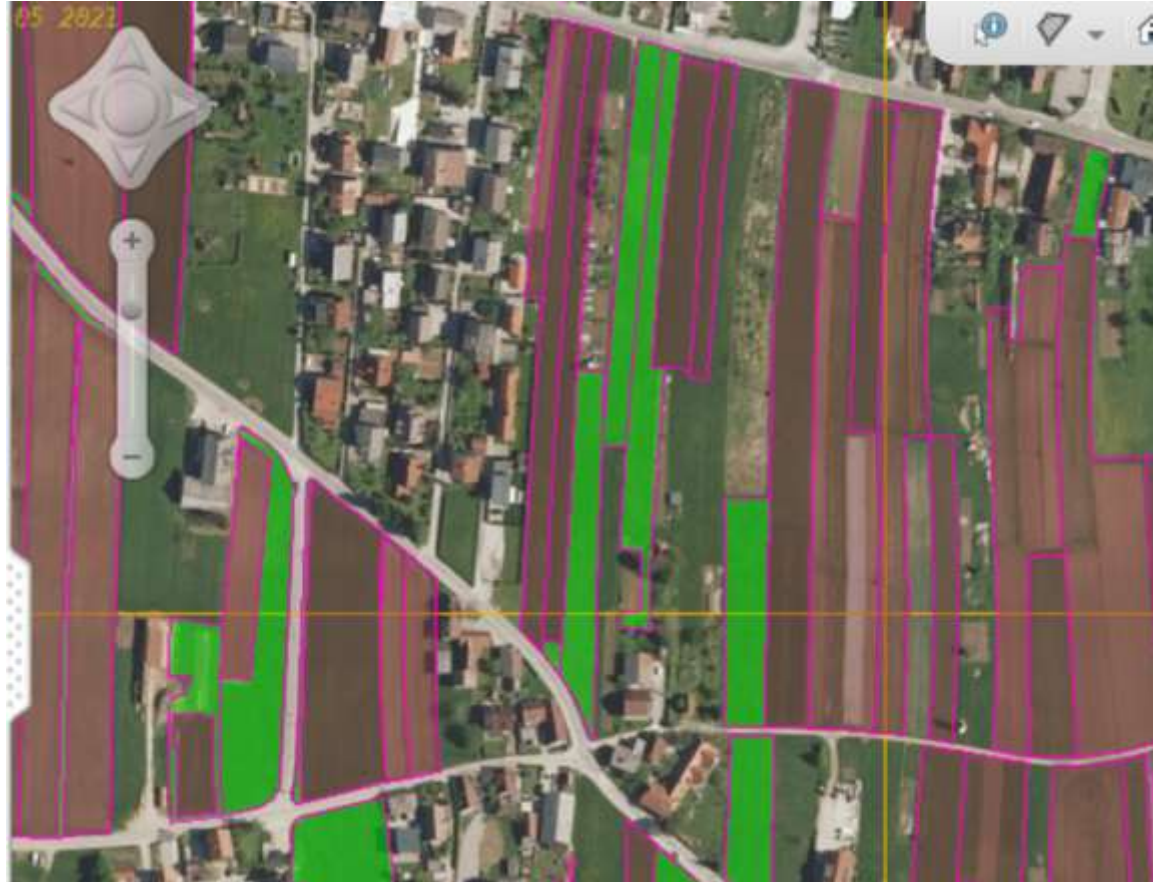


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LPIS and EU CAP

LPIS is commonly carried out annually in many EU countries using manual field delineation



Key policy objectives of the CAP 2023-27

https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/cap-glance/key-policy-objectives-cap-2023-27_en



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Challenges in Ukraine

- Incomplete/Outdated cadastral coverage
- Rapid land-cover/land-use changes
- High landscape diversity → from tiny to huge fields
- Large area → high data costs & time-consuming manual work



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Objective – automatization of LPIS

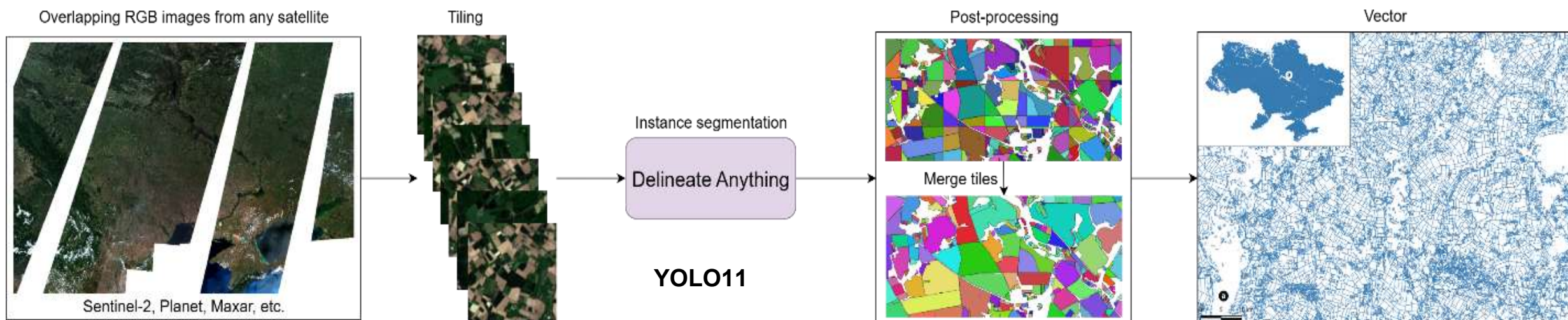
1. Automated parcel delineation
2. Automated LCG (Land Cover Group) assignment
3. Scalable to national-level deployment
4. Support for both commercial and open satellite data



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DelAny (DA) Pipeline Overview





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Data & Study Areas

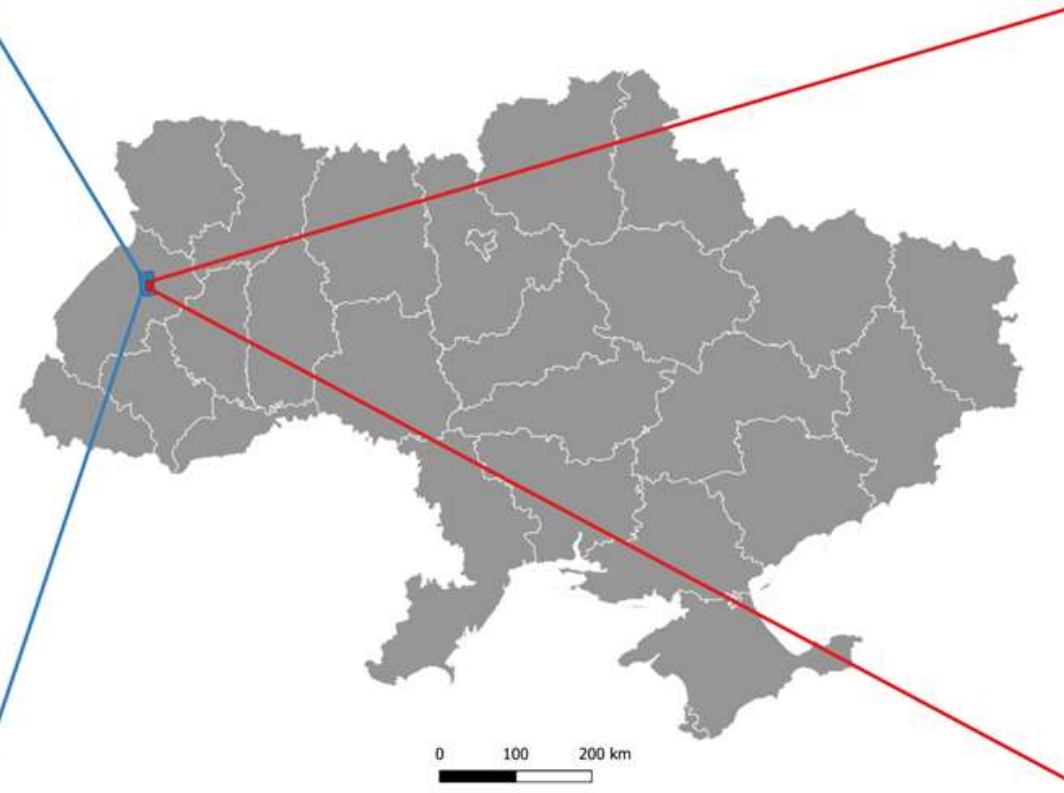
Sentinel-2



Satellite



Ukraine, Lvivska oblast, LPIS Ukraine Pilot 2025



Maxar



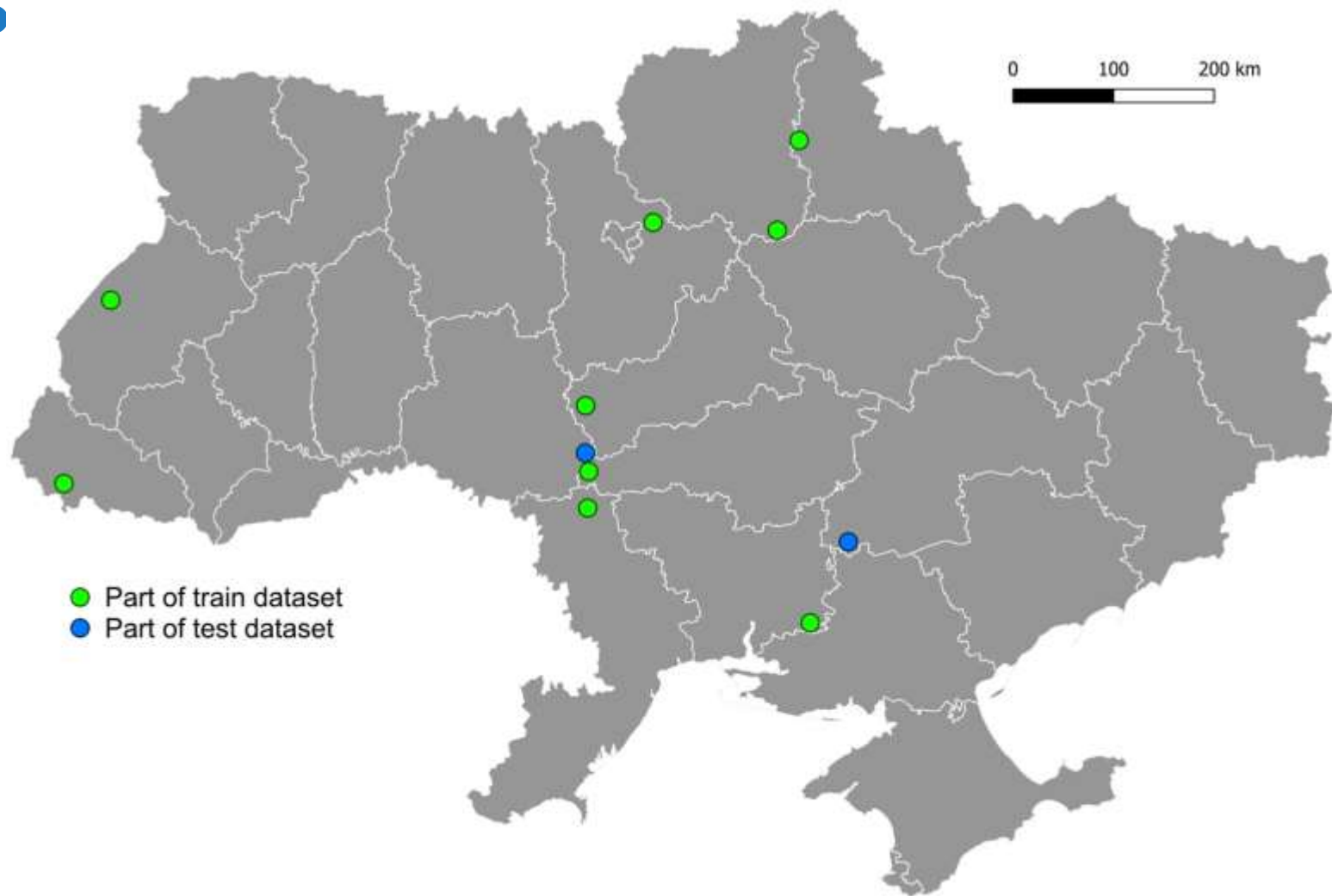


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Data & Study Areas

11 pilot test sites from the LPIS Ukraine Pilot 2024 were used for training and validation of the DelAny model



Locations of 11 LPIS Ukraine Pilot 2024 territories



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Super-resolution - Sentinel-2

2 approaches to super-resolution:

1. SEN2SRLite –
super-resolution to **2.5 m**
2. SEN2SRLite –
2.5 m output aggregated to **5 m**

S2 RGBN - 10m



SEN2SRLite RGBN - 2.5m



<https://github.com/ESAOpenSR/sen2sr>

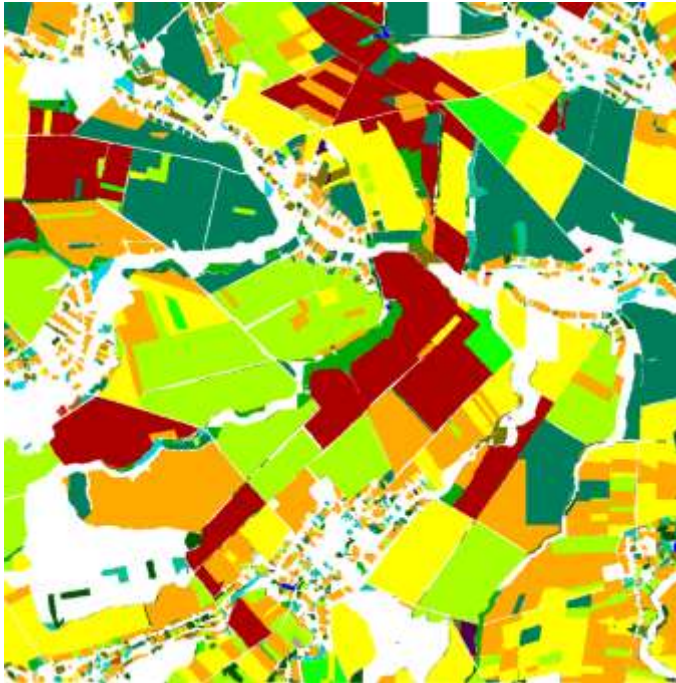


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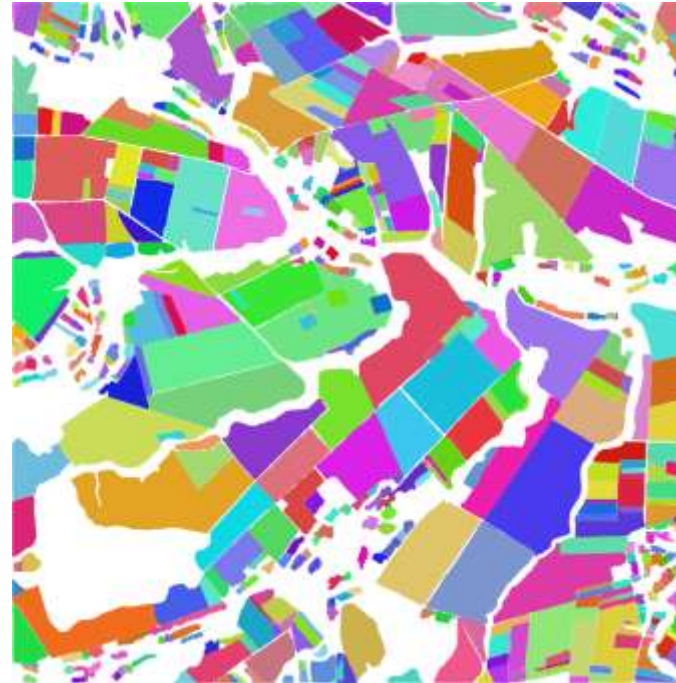


DelAny-Hybrid (DA-HY) Pipeline Overview

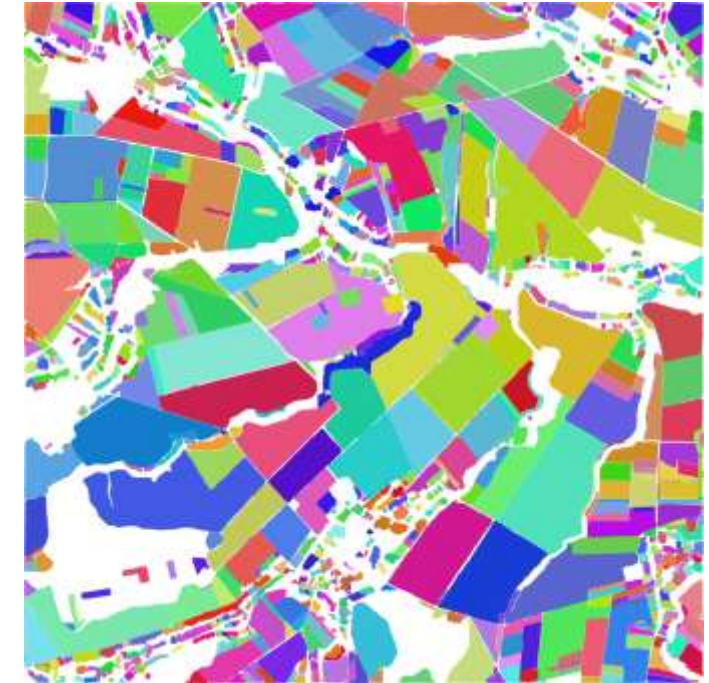
Execute DelAny model
on 2.5m & 10m data &
merge polygons with same
LCLU



Execute DelAny pipeline
on 5m data



Result



Difference of 10m & 2.5m and 5m delineation.
Assign LCG. Dissolve by LCG. Insert 5m delineation

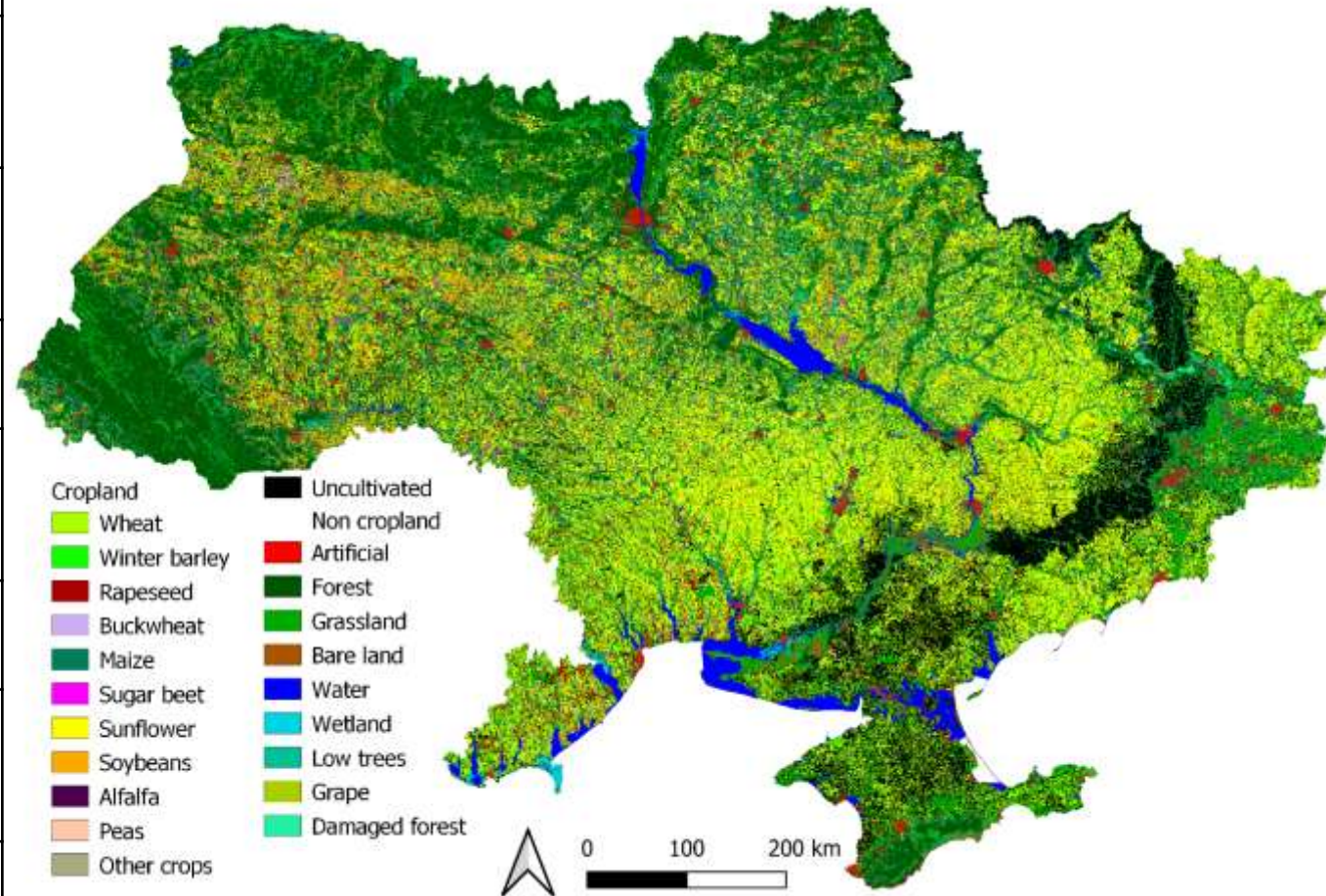


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Auxillary Data & Land Cover Group Assignment

Condition	Assigned Land Cover Group
Cropland took more than 30% of area AND less than 30% of area are within settlement bounds	AL - Arable land
Cropland took more than 30% of area AND greater-or-equal than 30% of area are within settlement bounds	PF - Arable land for personal farming
Dominant (most common) topic is Cropland AND less than 30% of area are within settlement bounds	AL - Arable land
Dominant (most common) topic is Cropland AND greater-or-equal than 30% of area are within settlement bounds	PF - Arable land for personal farming
Dominant (most common) topic is Grassland AND less than 30% of area are within settlement bounds	PG - Permanent grassland
Dominant (most common) topic is Grassland AND greater-or-equal than 30% of area are within settlement bounds	PF - Arable land for personal farming
Dominant (most common) topic is Permanent crops	PC - Permanent crops
Dominant (most common) topic is Forest	AF - Agroforestry
Else	- non LPIS compliant



Kussul, N., et al. "Assessment of war-induced agricultural land use changes in Ukraine using machine learning applied to Sentinel satellite data." *International Journal of Applied Earth Observation and Geoinformation* 140 (2025): 104551



Experiments

Execute DelAny (DA) on:

- Sentinel-2 (5m and 2.5m)
- Satellogic (1m and 3m)
- Maxar (0.3m and 2.5m)

Build DelAny-Hybrid (DA-HY) on:

- Sentinel-2 (5m and 2.5m)

Assign Land Cover Group (LCG)

Compare result with manual LPIS:

$$Coverage = \frac{|P \cap G|}{|G|} \quad IoU = \frac{|P \cap G|}{|P \cup G|} \quad Purity = \frac{|P \cap D|}{|D|}$$

Where: P - Prediction (Automatic delineation), G - Ground-truth (Manual delineation), D - Dominant class of LCLU per polygon

Results



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Manual, Satellogic 1m



DA, Satellogic 3m



DA-HY*, Sentinel-2 2.5m





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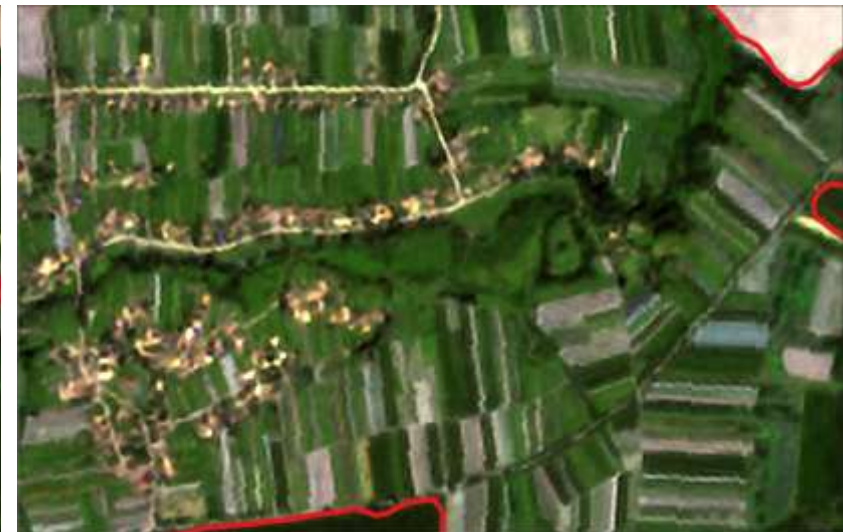
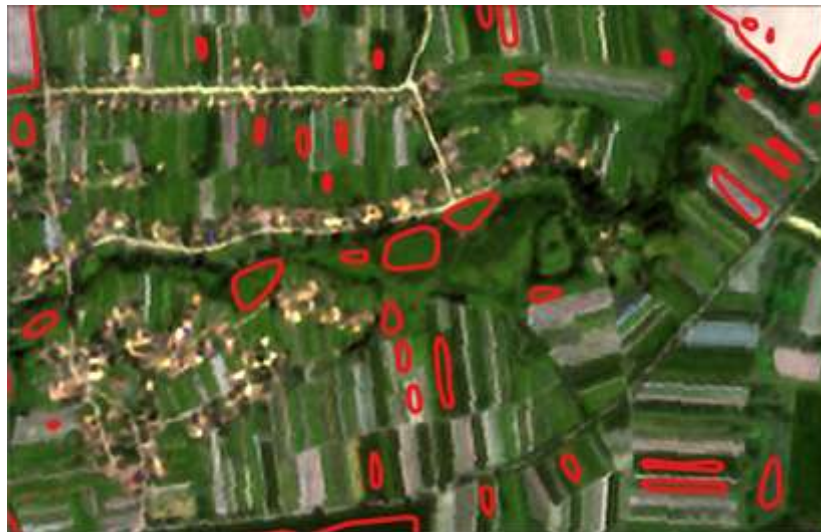


Results compared to other products

DA-HY*, Sentinel-2 2.5m

Sinergise (2024)

NASA Harvest (2023)



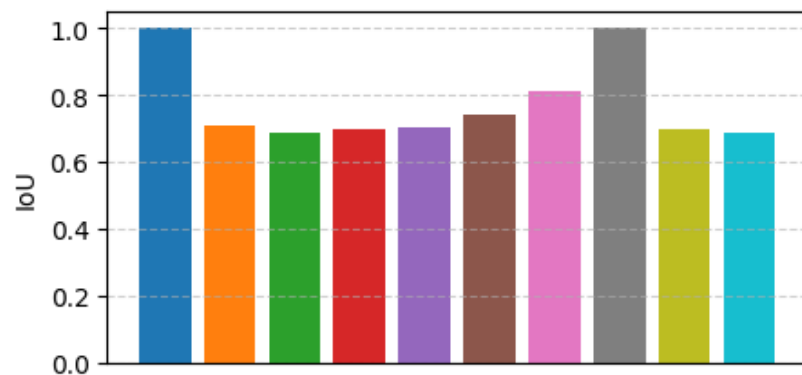


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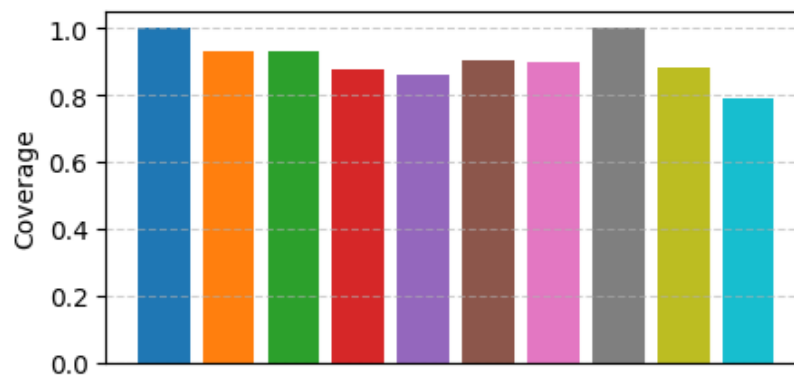


LPIS Metrics

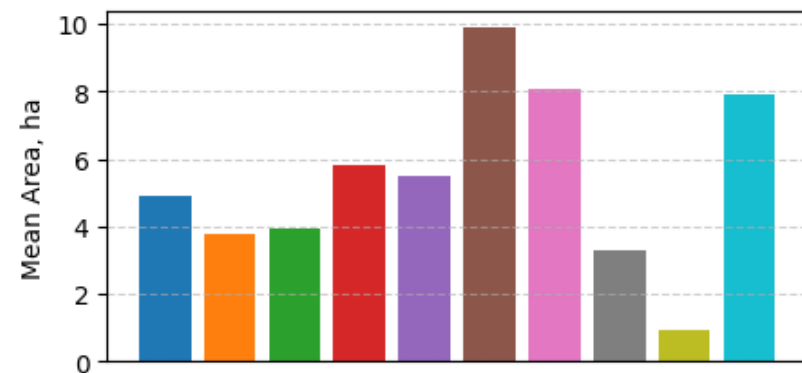
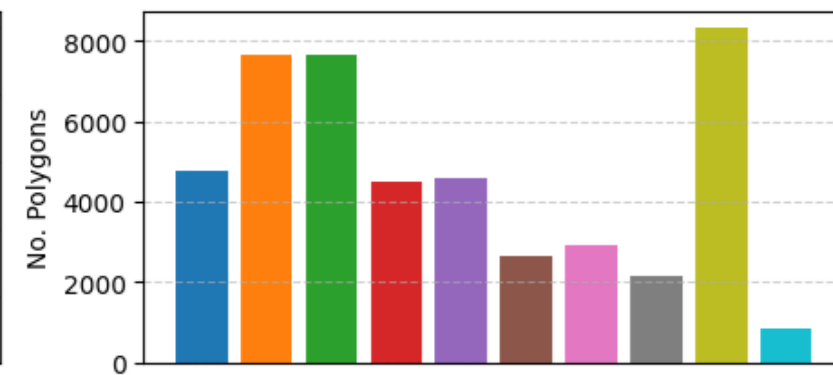
IoU



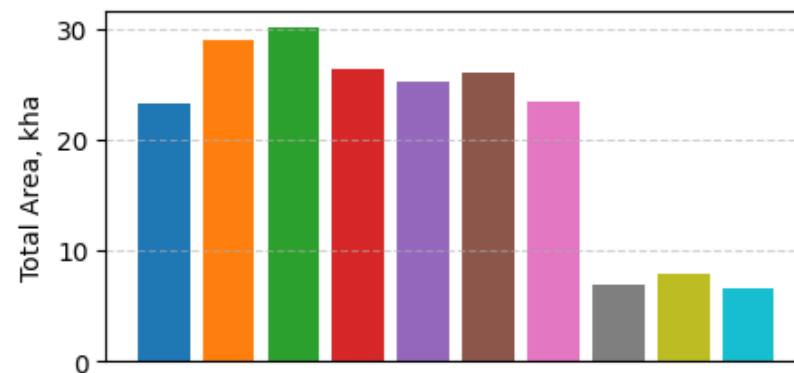
Coverage



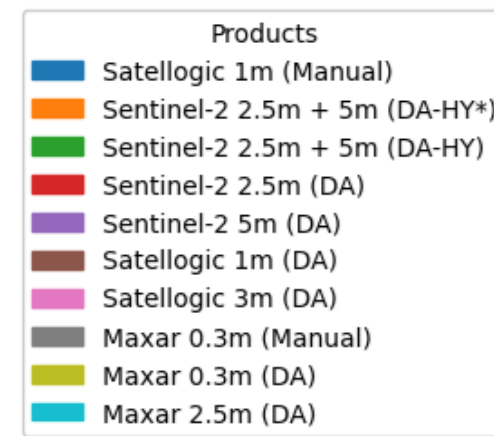
No. of Polygons



Mean Area, ha



Total Area, kha





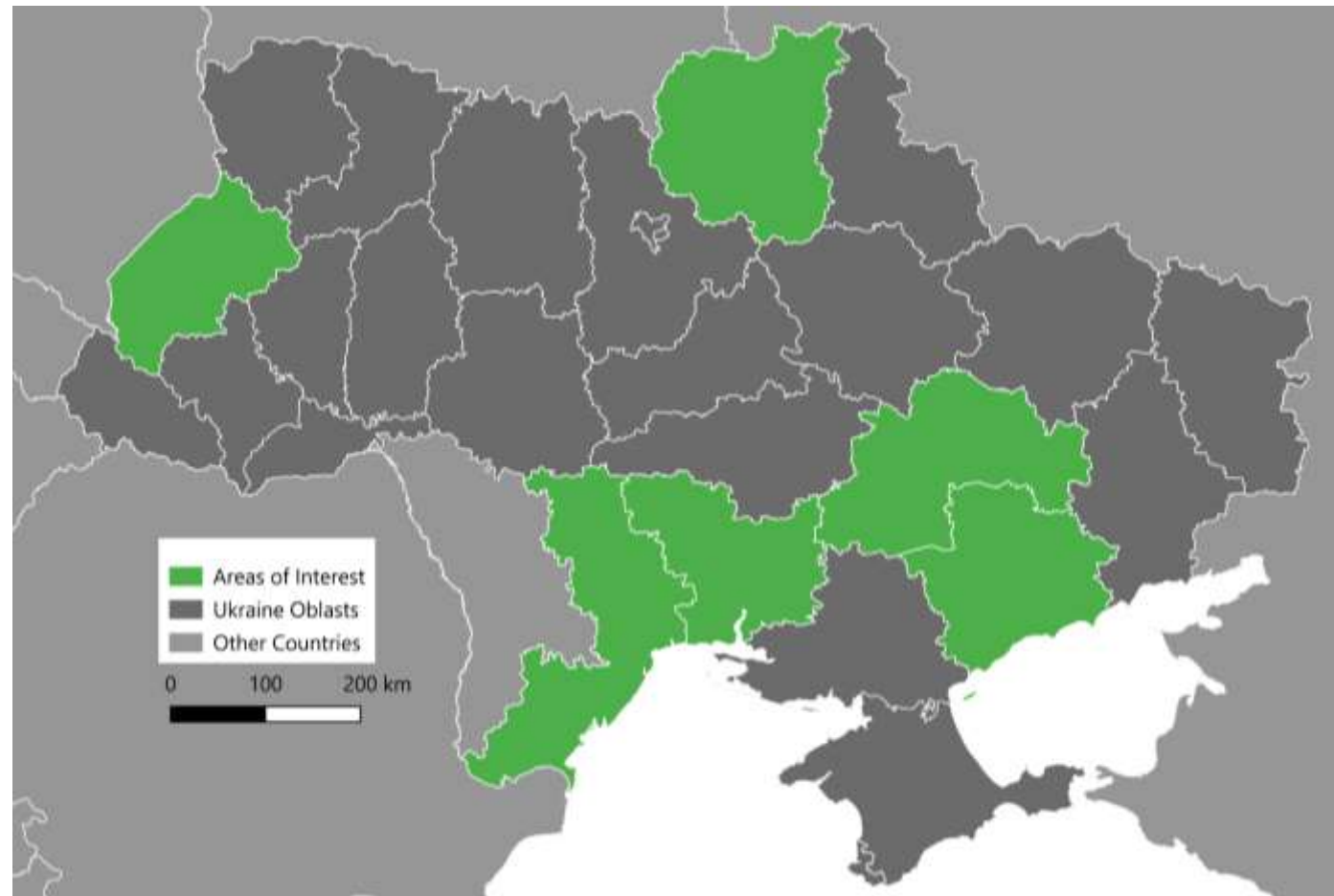
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Large scale deployment

Full pipeline applied to 6 oblasts on 2025 imagery:

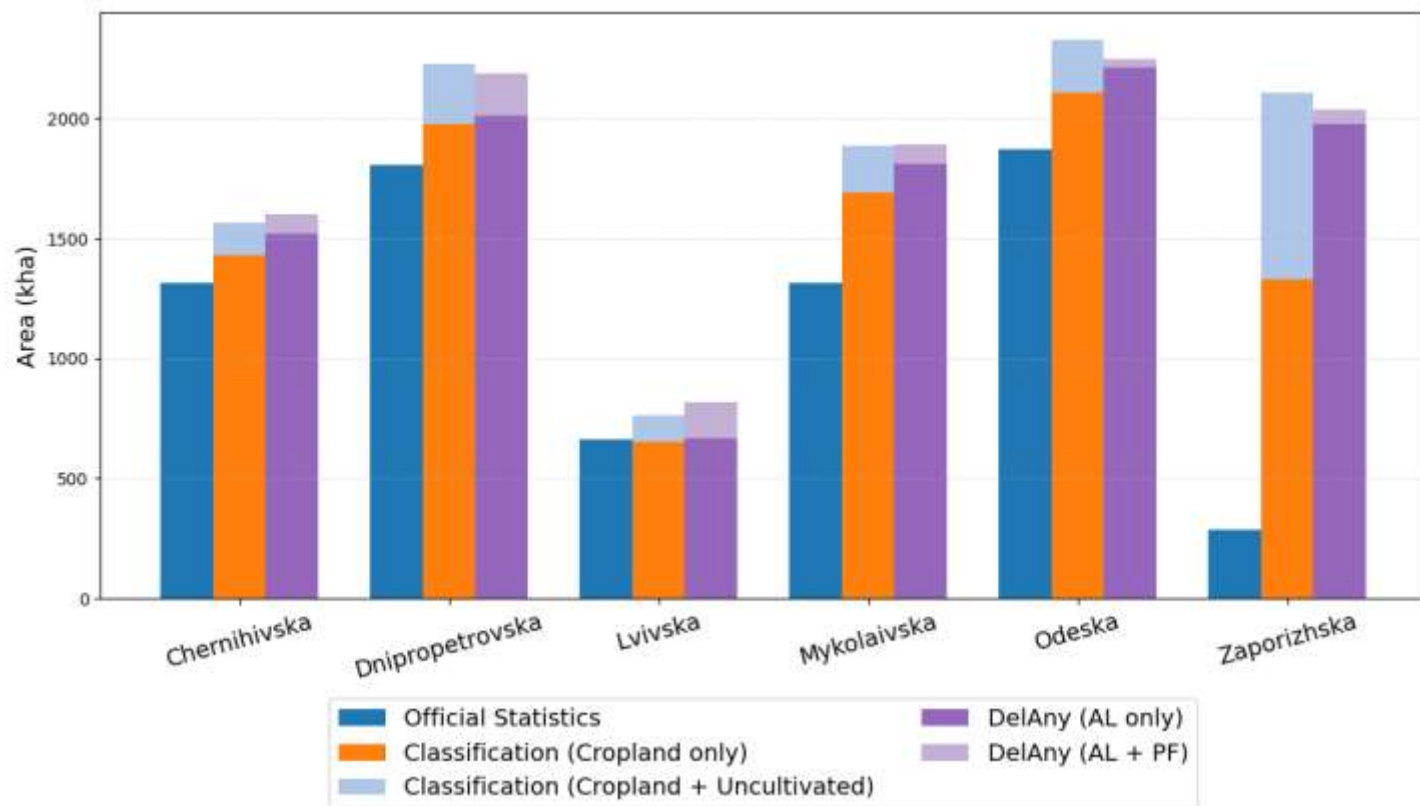
- Chernihivska
- Dnipropetrovska
- Lvivska
- Mykolaivska
- Odeska
- Zaporizhska





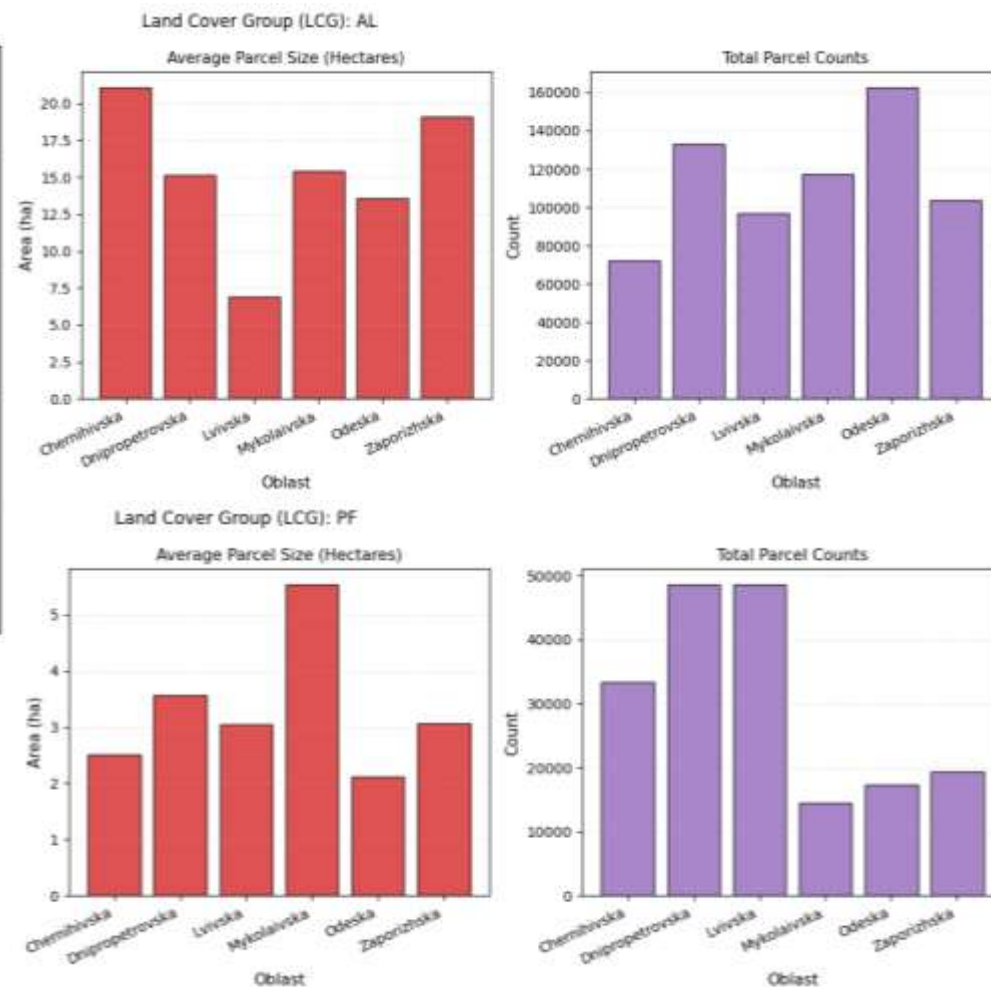
Metrics – Arable Land

Arable land area in 2025 in thousands of hectares according to different data sources



AL - Arable land

PF - Arable land for personal farming





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Advantages and Limitations

- + Fast processing
- + Support wide range of optical products
- + Aligns with LPIS specifications
- Does not perform well on very high-resolution imagery ($< 1-2$ m)
- Windbreak detection limited to Sentinel-2 data
- Oversegmentation in grassland areas
- Automatic LCG classification may confuse:
 - arable land (AL) with private fields (PF)
 - private fields (PF) with permanent crops (PC)
- Requires manual correction in some areas



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Take home message

DelAny-Hybrid on 2.5m Sentinel-2 data delivers the most complete automated LPIS

Manual LPIS

Time: 1–2 human-weeks per 100 km²
All Ukraine ~ 1500-3000 PM

Cost: Requires **costly VHR imagery**

DelAny / DelAny-Hybrid

DA: <0.5 days nationwide (5 m)
DA-HY: 5 days nationwide (2.5 m)

Works with **open data**



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Thank you for attention!

