Satellite imagery-based delineation of land use categories for use in a Land Parcel Identification System (LPIS) in Ukraine

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Policy and context

CAP → **LPIS** → **IACS**

EU Common agricultural policy

Land parcel backbone

Implementation system

Key Requirement
- ≤ 0.5 m accuracy
- stability
- measurability
- orthoimagery

Reference parcels
- real-world features
- boundaries
- eligible area

Why It Matters
- subsidy control
- compliance
- transparency

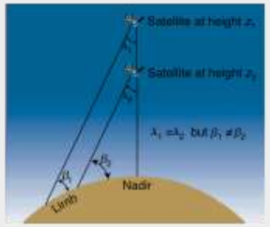
Challenge in Ukraine
- no airborne imagery
- cost constraints
- need to scale nationally (600 kkm^2)

Goal: test satellite based LPIS
- accurate
- scalable
- CAP compliant

Problem statement

Key constraints

Cloud cover
(≤ 10%)

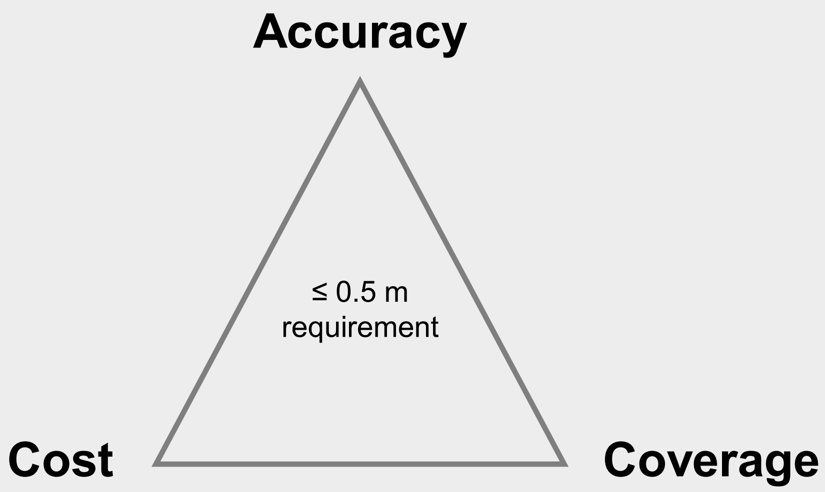


Viewing angle limits
(off-nadir angle ≤ 10)

Multi-date mosaic
(Spring image)

Data access

LPIS challenge



Can satellite VHR meet EU LPIS standards?

Study objective

Core objective

Test satellite VHR tasking for EU-compliant LPIS

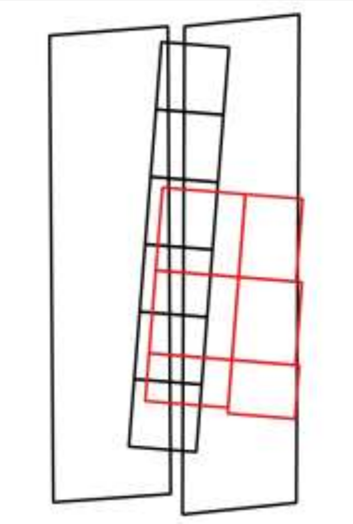
VHR 1 vs **VHR 2**

0.3 m | 0.7 m

Evaluate

↓

Accuracy • Feasibility • Scalability



Spatial coverage and overlap
VHR1 - VHR2
(image footprints)

Data overview

Satellite data sources

VHR1

Maxar → 0.3 m

- Coverage: **101 km²**
- single-date acquisition:
  - 25 May 2025
  - 6 tiles total
- strip overlap: none
- off nadir angle: 18 (!)

VHR2

Satellogic → 0.7 / 1.0 m

- Coverage: **403 km²**
- multi-date acquisition:
  - 22 Apr 2025 → 178 km²
  - 26 Apr 2025 → 159.5 km²
  - 30 May 2025 → 84 km² (1 m !)
- 46 tiles total
- strip overlap: 21.5 km²
- off nadir angle: 10

VHR2 is based on multi-date acquisitions with multiple spatial resolution tiles and overlaps, which introduces mosaicking and consistency challenges compared to a single VHR dataset.

Sentinel

10.0 m

- Coverage: **Ukraine**
- multi-date acquisition in 2025
- generated crop map supporting land cover classification

Methodology workflow

Workflow

1 Imagery preprocess →

- VHR1 pansharpening
- VHR mosaicking
- VHR radiometric correction
- S2 crop map production

2 Delineate →

- Expert-driven manual delineation of reference parcels
- Land cover classes:
  - Arable land
  - Permanent crop
  - Permanent grassland
  - Agroforestry
  - Personal farming

3 Segment →

- Automated VHR segmentation (field boundaries)

4 Validate

- Delineation VHR1vsVHR2
- Segmentation vs delineation

Key principle of manual delineation: Physical block boundaries = stable physical features

Key principle of automated delineation: Image segments = annual/seasonal crop boundaries

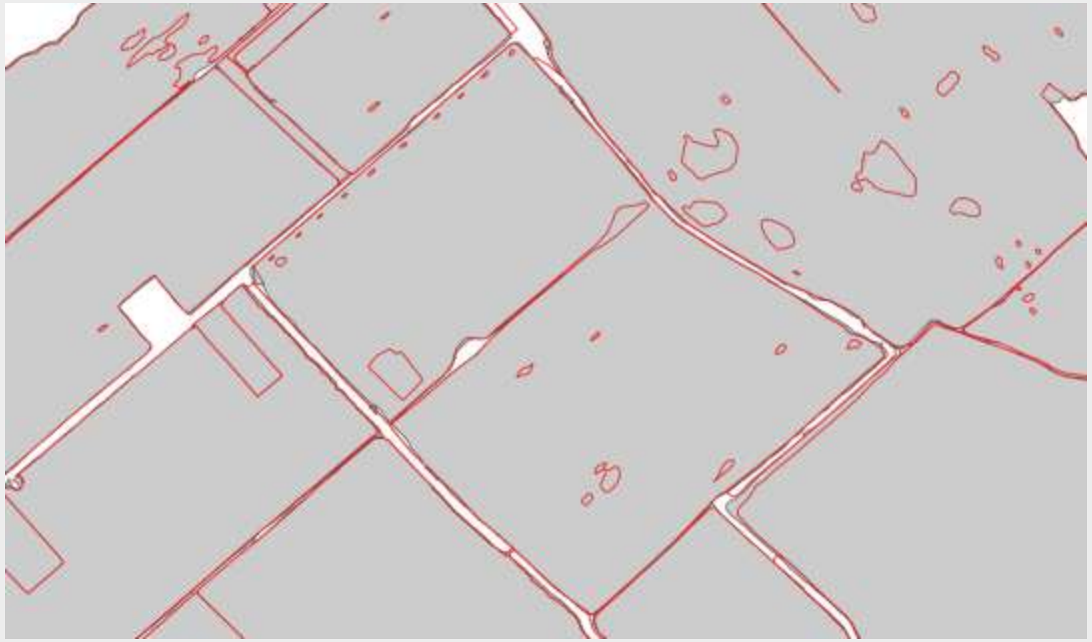
Manual vs automated delineation

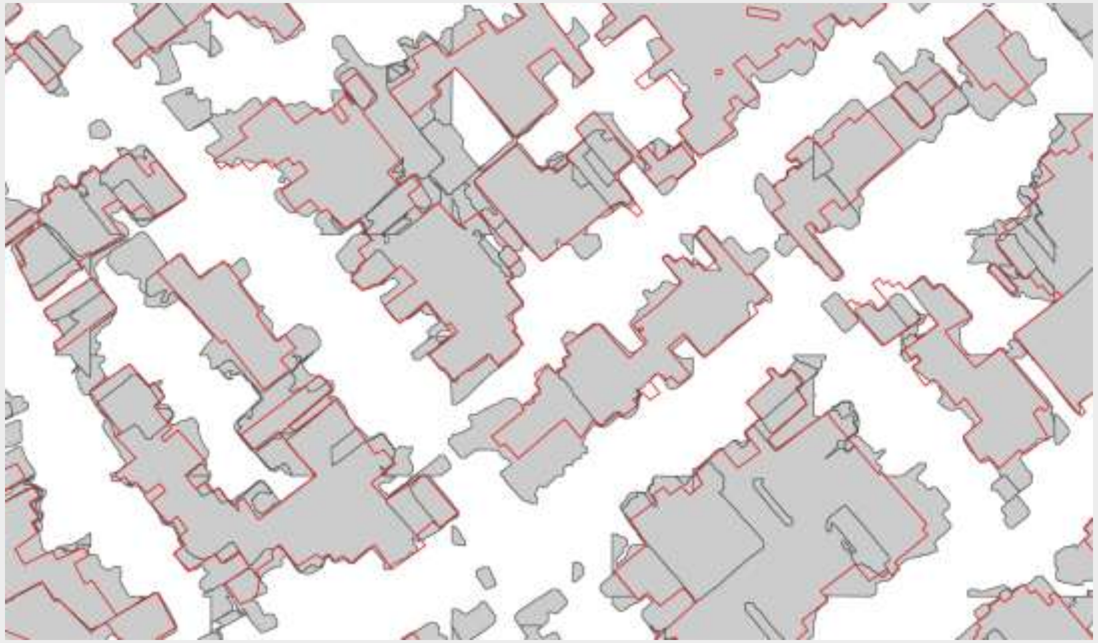
In open agricultural areas:
- Fields are large, uniform

→ easier to segment

In closed / village landscapes:
- Fields are:
    - Smaller
    - Irregular
    - Visually heterogeneous

      → Model gets confused





---- Delineation ---- Segmentation

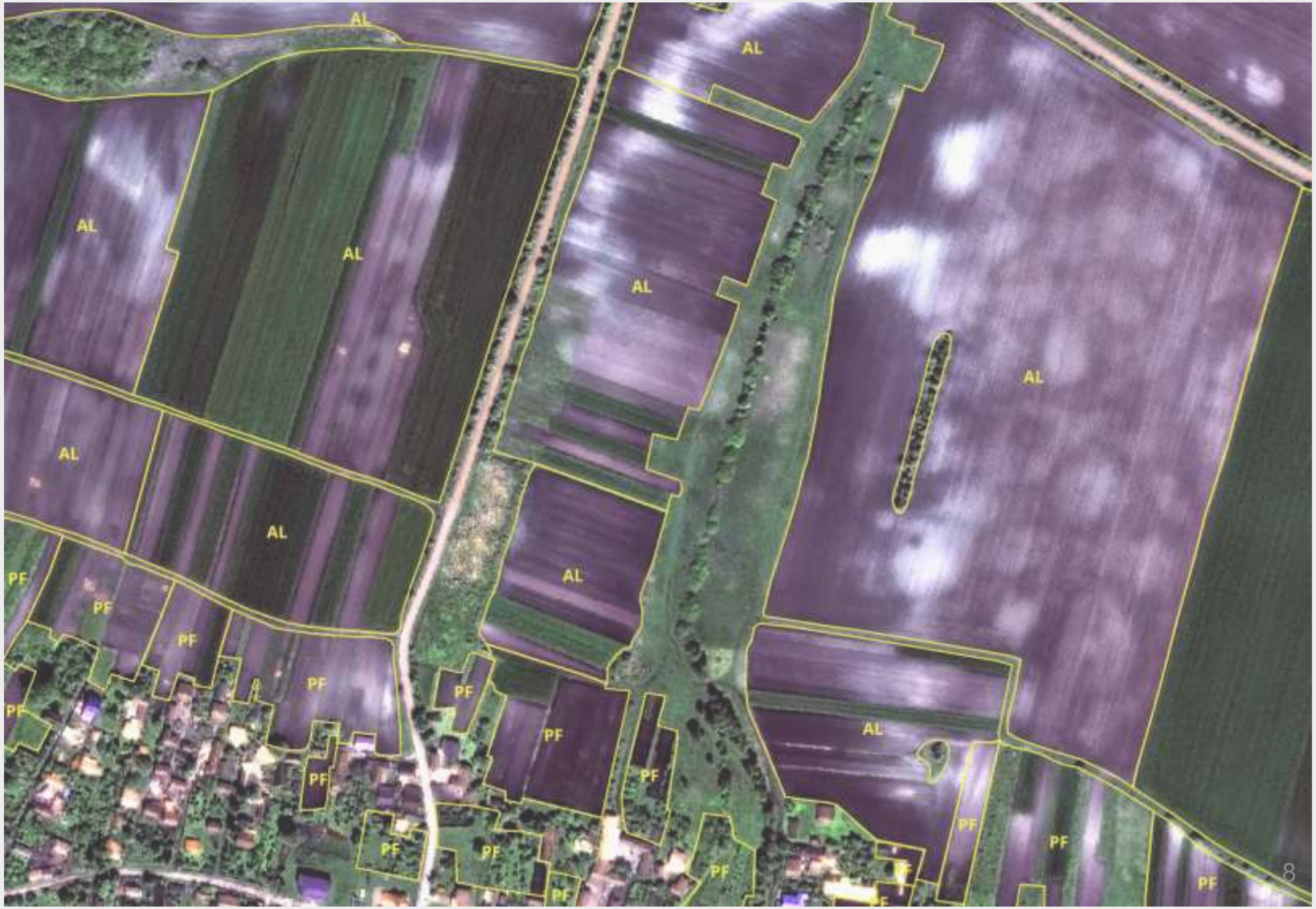
Accuracy strategy

Target
≤ 0.5 m positional accuracy

How we achieve it
By delineating stabile physical features (roads, build-up, tree lines, block edges, distinct land cover classes)

Refinement process
Cross-checks
(internal + external)

Key principle
Geometry > Spectral signal



Validation framework

What We Check

✓ Completeness
✓ Consistency
✓ Topology
✓ Spatial accuracy
✓ Thematic correctness

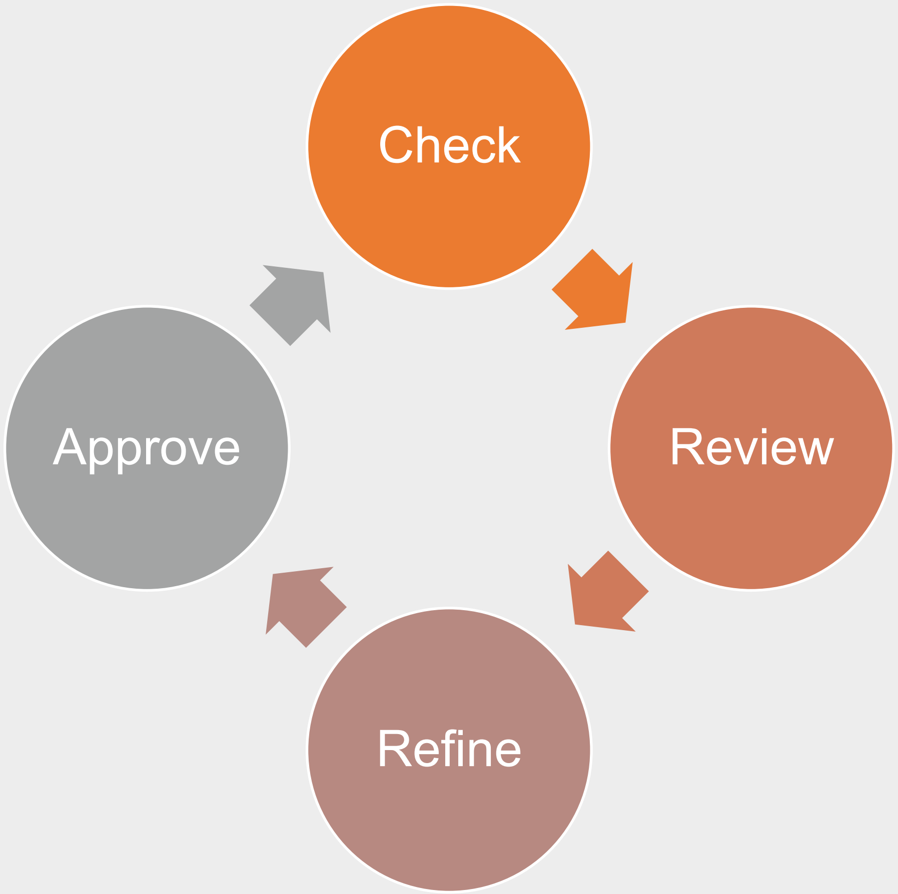
Iterative Process

- Repeat until compliant

Outcome

LPIS-ready dataset

Multi-step validation



Results: VHR comparison

VHR 1 vs **VHR 2**

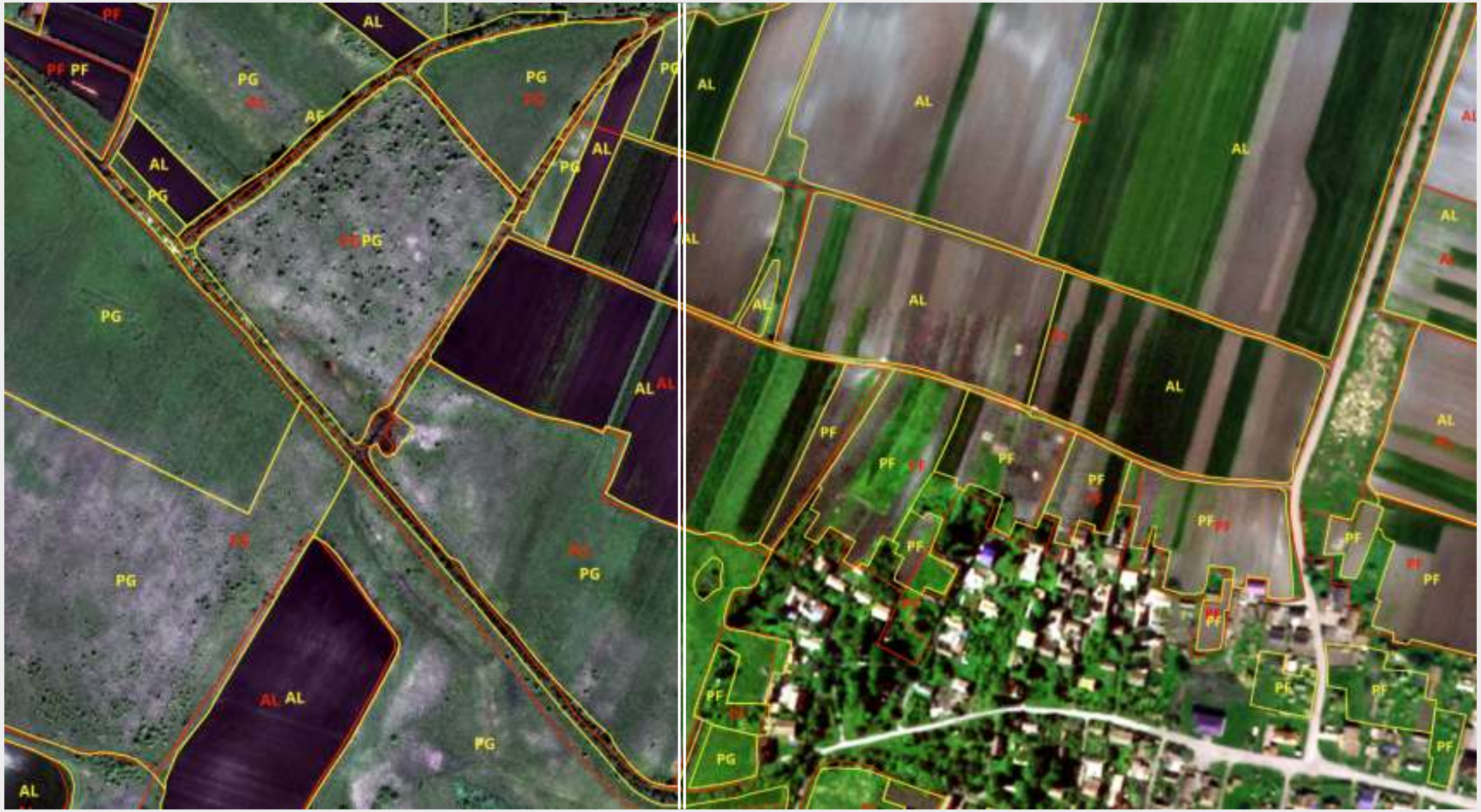
Clean, sharp boundaries

Feasible LCC interpretaion

Easy compliance

Minimal correction

0.3 m



Less precise boundaries

More corrections needed

Missing area

LCC confusion

0.7 m

Role of Sentinel data

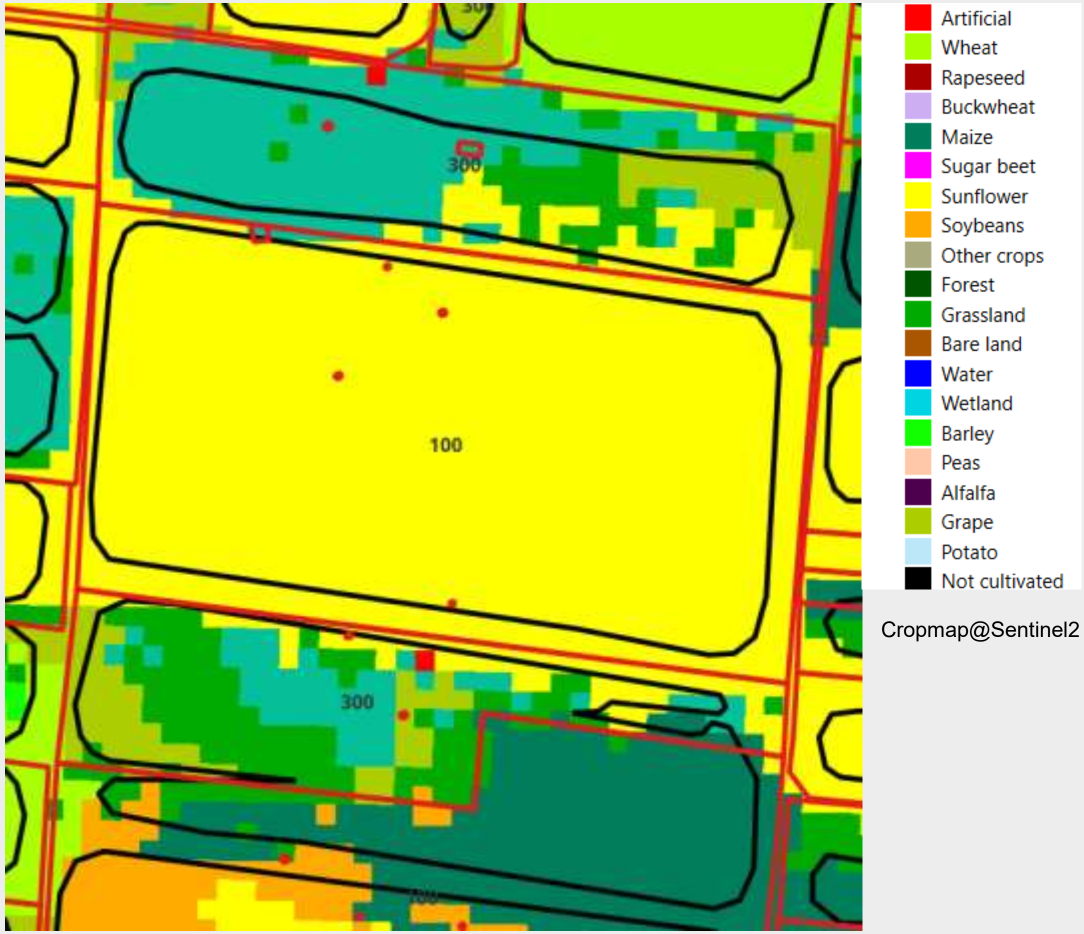
 Sentinel 2 (10m)

It supports
- Temporal information
- Crop dynamics
- Land use classification

Limitations
- Low spatial resolution
- Weak for narrow, small and irregular features

Key idea

VHR = geometry
Sentinel = context



Cropmap@Sentinel2

Key challenges

Acquisition constraints

- Cloud cover
- Viewing angle
- Limited tasking capacity
- Failed initial coverage order by both satellite providers
- Extended time window

Data issues

- Multi-date mosaics
- Radiometric inconsistency
- Geometric alignment effort

Operational limits

- Data access restriction
- Uneven coverage from Satellogic
- Scalability constraints

The main challenge is not producing LPIS locally - it's scaling it

Key contributions

What We Deliver
- Satellite-based LPIS feasibility
- Hybrid workflow (manual + automated)
- 0.5 m compliant methodology
- Multi-sensor integration (VHR + Sentinel)

Innovation
- Eligibility resolution
- Structured validation framework
- Integration with automated inputs

Impact □ Pathway to national LPIS implementation

Scalability & future work

Towards national rollout

What's Needed
- Improved satellite **tasking**
- **Homogeneous** data quality
- **Efficient** processing workflows

Future Work
- Better **mosaic** consistency
- Enhanced **automation** support
- **Optimized** cost–accuracy balance

Key Condition:
Consistency across large areas

The methodology is proven - but scaling it requires consistent data acquisition, improved satellite capacity, and efficient workflows to maintain quality across large areas

Conclusions

Key takeaways

- Satellite VHR is viable for LPIS creation
- But digital ortho-imagery clearly the preferred LPIS source
- Digital ortho-imagery is technically superior at equivalent cost
- Manual delineation remains essential
- VHR2 0.7 m = cost-efficient alternative (with effort)
- Multi-sensor approach improves results

✓ 0.5 m accuracy is achievable with specific space sensors

The key is combining expert interpretation, multi-sensor data, and strong validation. Scaling this approach will depend on improving data consistency and acquisition capacity.

In the Ukraine recovery context, state-of-the-art “collect once, use often” digital ortho-imagery is a key enabler

Implemented under the World Bank–EU funded LPIS Pilot, Ukraine (2025)

Thank you

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