



Analysis of crop area statistics

in times of synoptics, multi-sensor high accuracy crop mapping

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Background and motivation

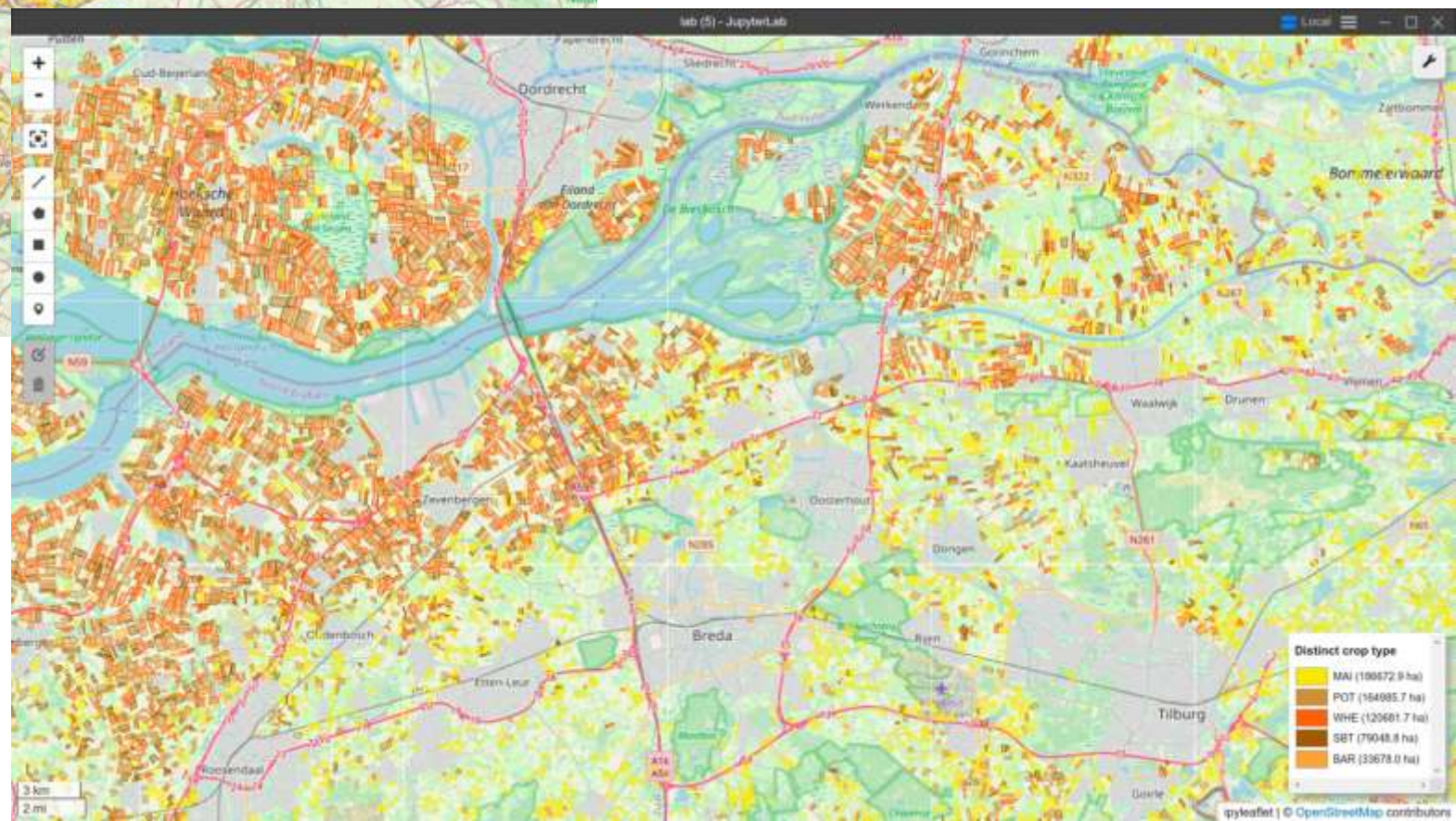
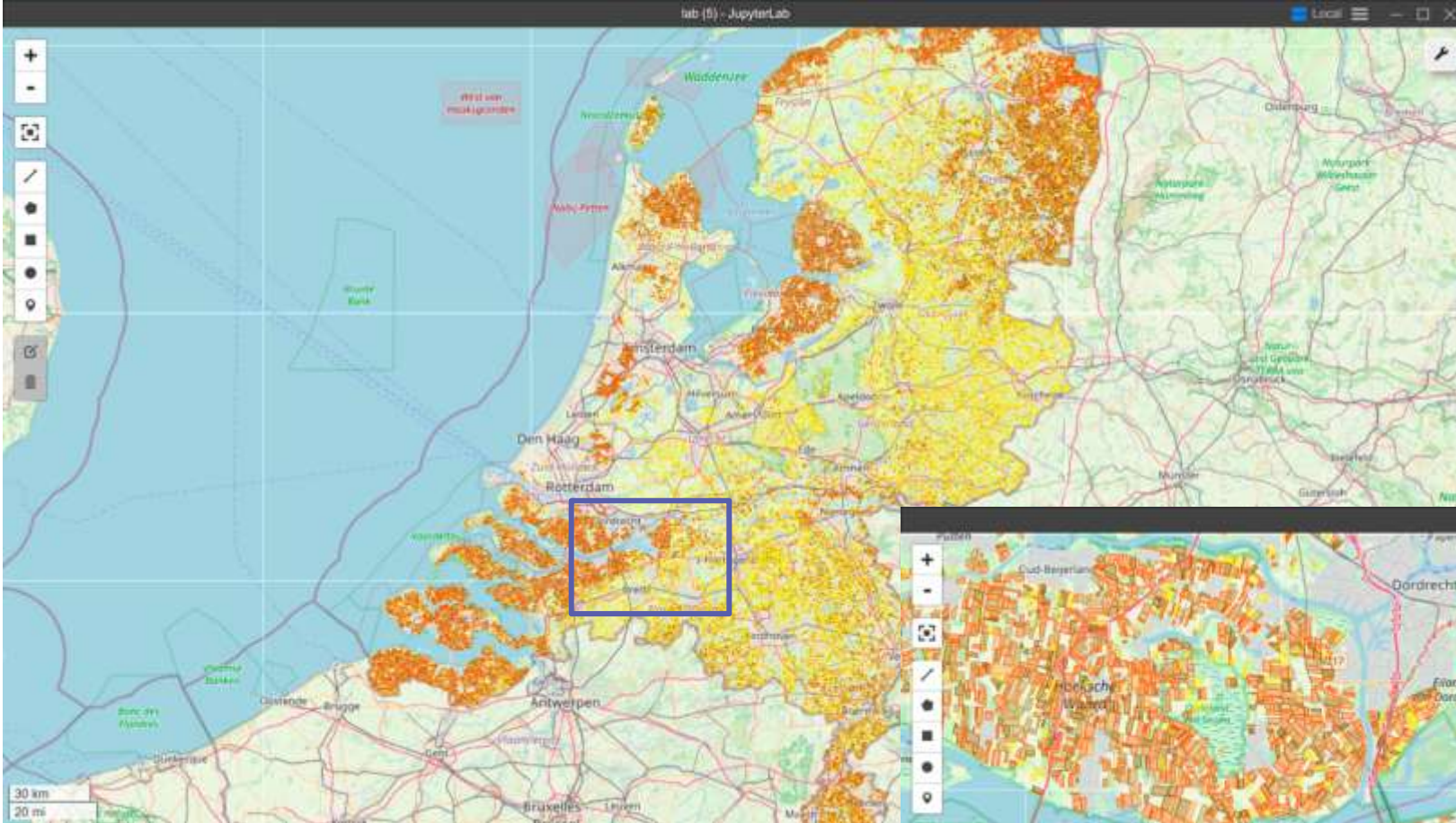
- Crop type mapping now possible at synoptic continental level
- Using full, free and open European Union Copernicus Sentinel data
- Modern machine learning methods reach high accuracies
- Still, the current statistical understanding is that crop area estimates should not be calculated directly from “pixel counting”
- Is this understanding still correct and are alternative sampling approaches really “efficient”?
- We test this against European reference data drawn from open access IACS annual parcel declarations (GSA)

Research Objectives

- Derive crop area statistics from a mature, operational crop type (CTY) mapping service using “pixel counting”
- Compare to national GSA-labeled crop area
- Determine factors that impact on the cross-comparison
- Derive crop area estimates from proposed point and frame samples
- Compare to GSA and CTY outputs
- Study multi-annual change in crop area (means not variance!)
- Extrapolate to areas which lack a GSA reference

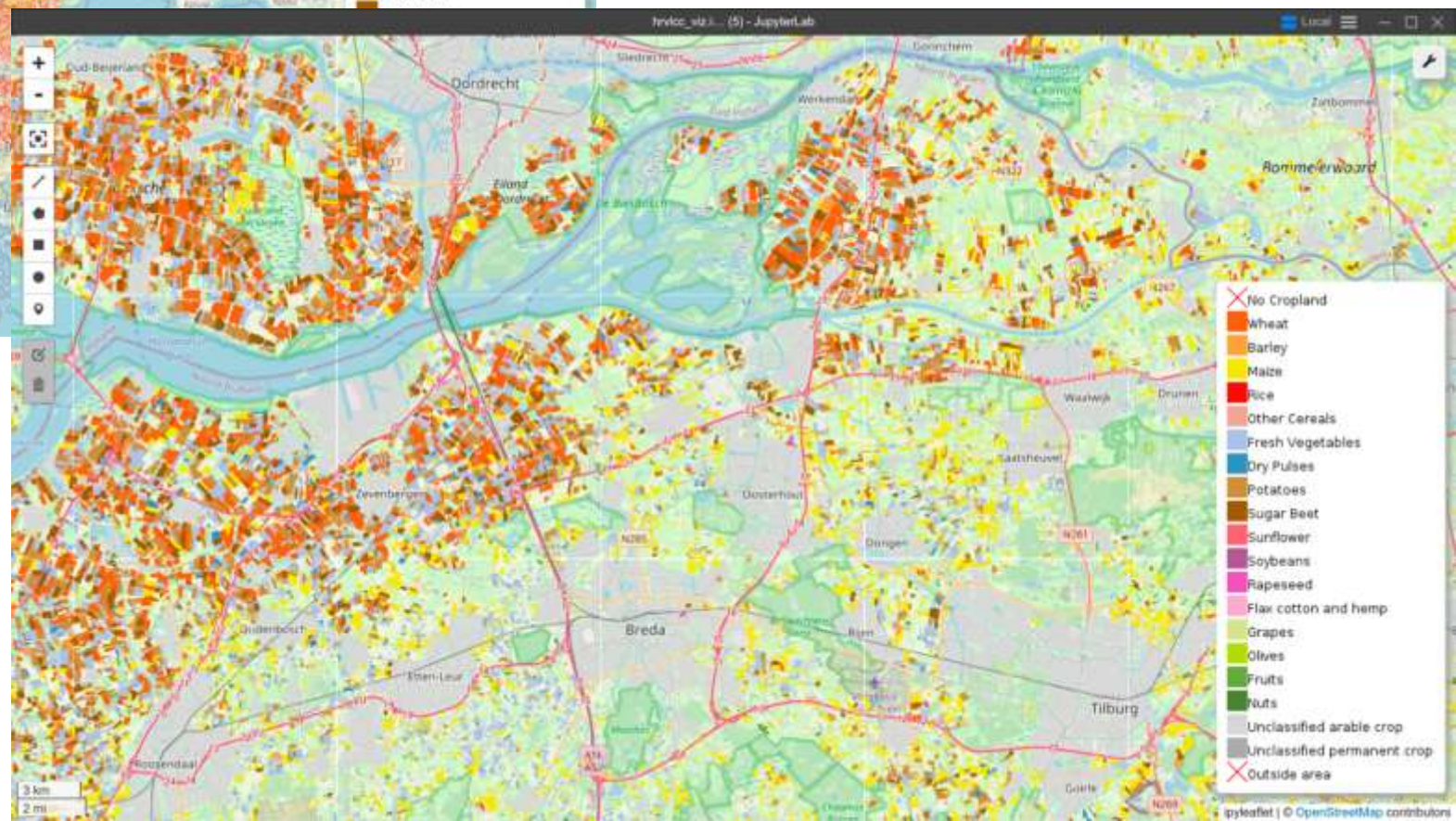
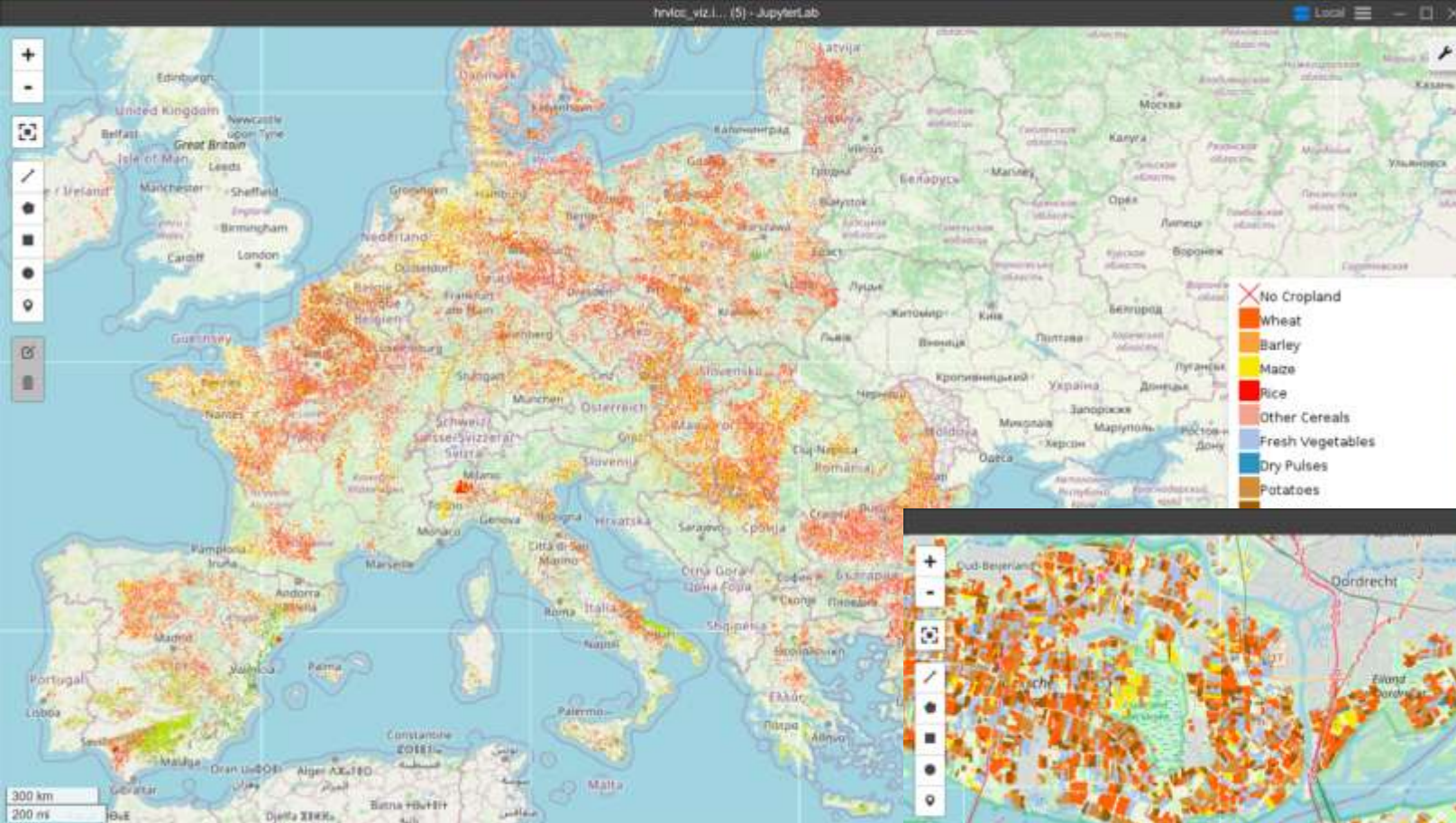
Data and Methodology

- [Copernicus High Resolution Vegetated Land Cover Characteristics](#) service generates annual (2017-2024) Crop Type maps (CTY)
- Integrates Sentinel-1 and -2 time series in [supervised neural network classification method](#) (using selected GSA and LUCAS labels)
- 10 m resolution for all EEA-38, for 9 distinct crop types, 10 groups
- In EU-27 annual GSA declarations are open access in an increasing number of Member States
- Delineated on 1:5000 scale reference maps, crop label + attributes
- We use [Netherlands \(NL\) GSA](#) which was not used in model training
- Crop area statistics in NL is derived from GSA ([CBS](#))
- Analytics based on geospatial python libraries and open data formats



GSA Netherlands 2019

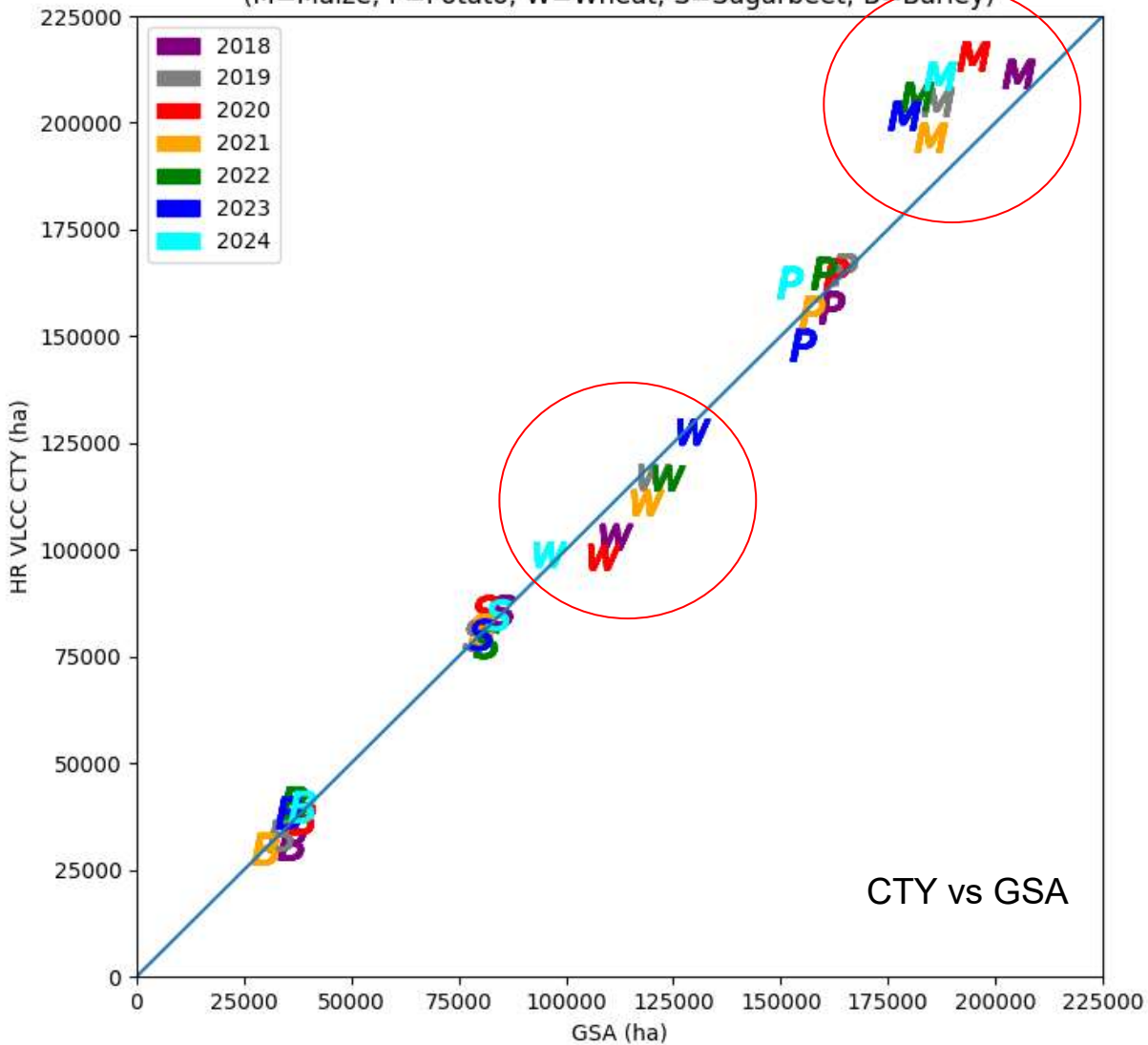
- 1.87 MHa in 772565 parcels
- 331 crop labels (!)
- 5 major arable crops shown



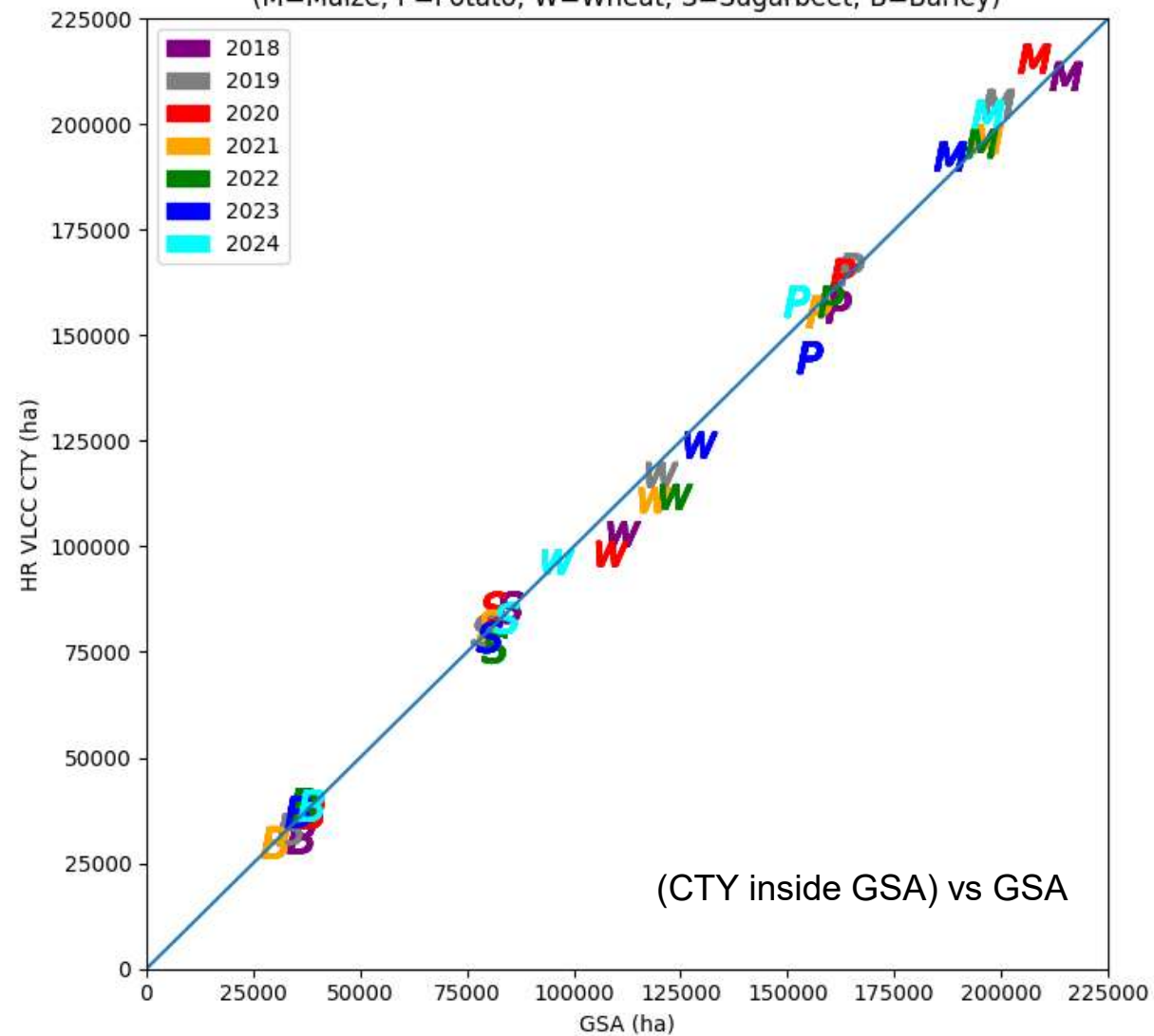
HRVLCC CTY EEA-38 2019

- 19 crop classes, 9 distinct crops
- For NL: 2.08 Mha (+11 %!)

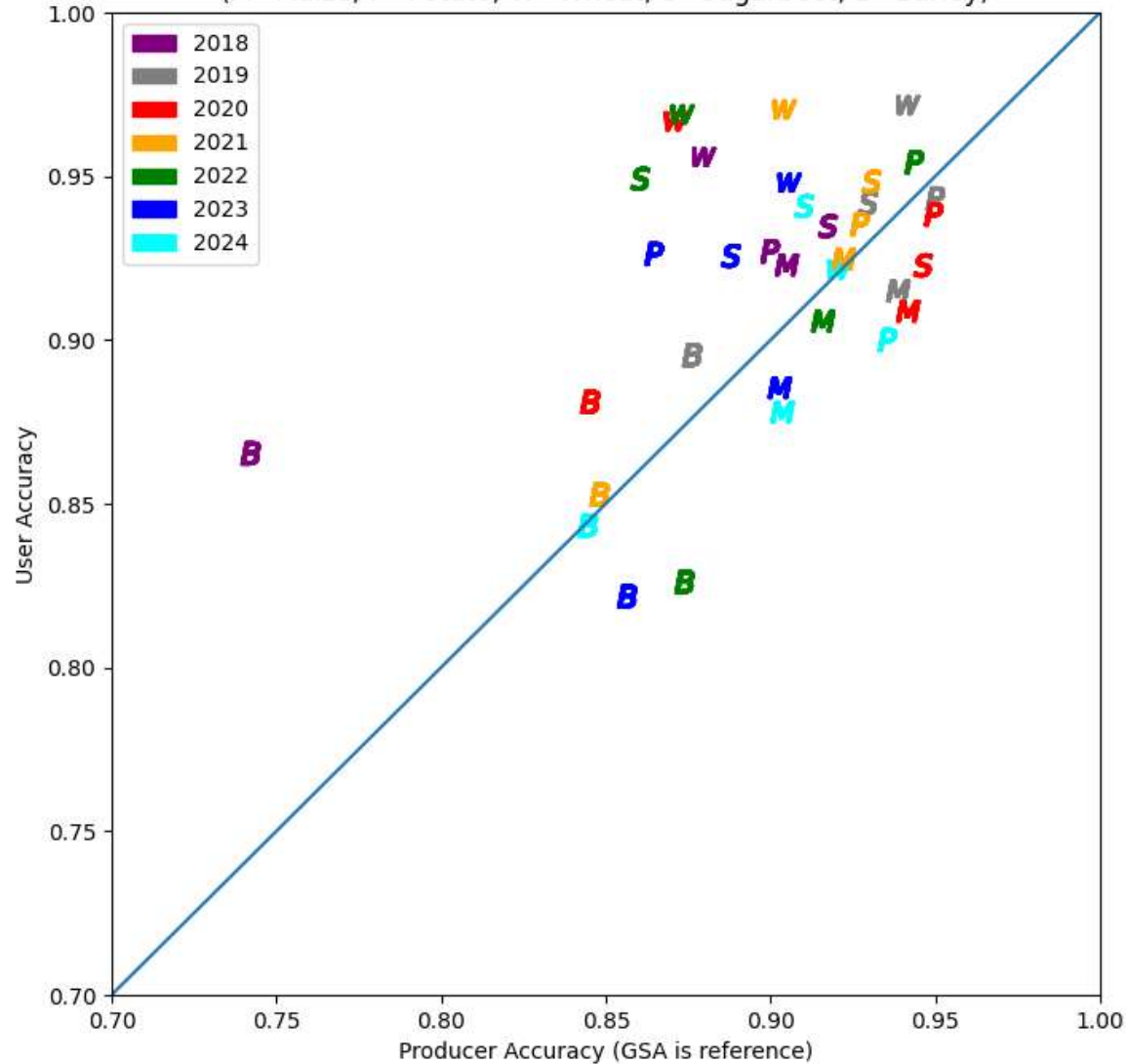
Area estimates for 5 major crops in Netherlands
(M=Maize; P=Potato; W=Wheat; S=Sugarbeet; B=Barley)



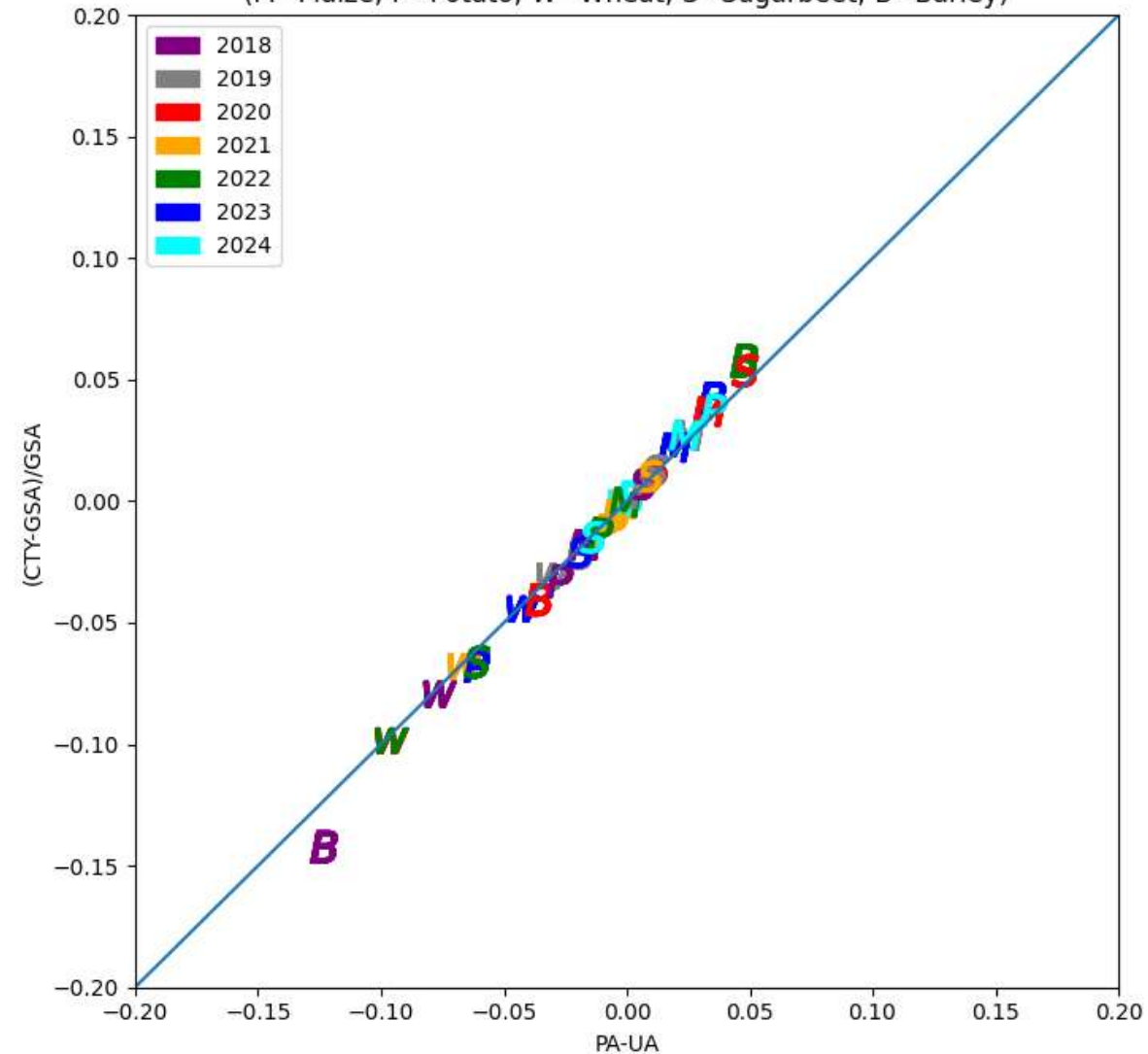
Area estimates for 5 major crops in Netherlands
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Accuracies for 5 major crops in Netherlands
(M=Maize; P=Potato; W=Wheat; S=Sugarbeet; B=Barley)



Relative Area over/under estimation for 5 major crops in Netherlands
(M=Maize; P=Potato; W=Wheat; S=Sugarbeet; B=Barley)



Key findings



- Close match between GSA and CTY area estimates, for major crops
- CTY includes crop area outside the GSA coverage (mostly maize, grassland)
- Balance between PA-UA links to over/underestimates in crop area
- Correction leads to a drop in RMSE from 5013 ha to 439 ha (all data)
- No systematic CTY improvements of UA and PA in successive years

Netherlands 2019 area estimates, comparison between GSA, CTY and statistical samples

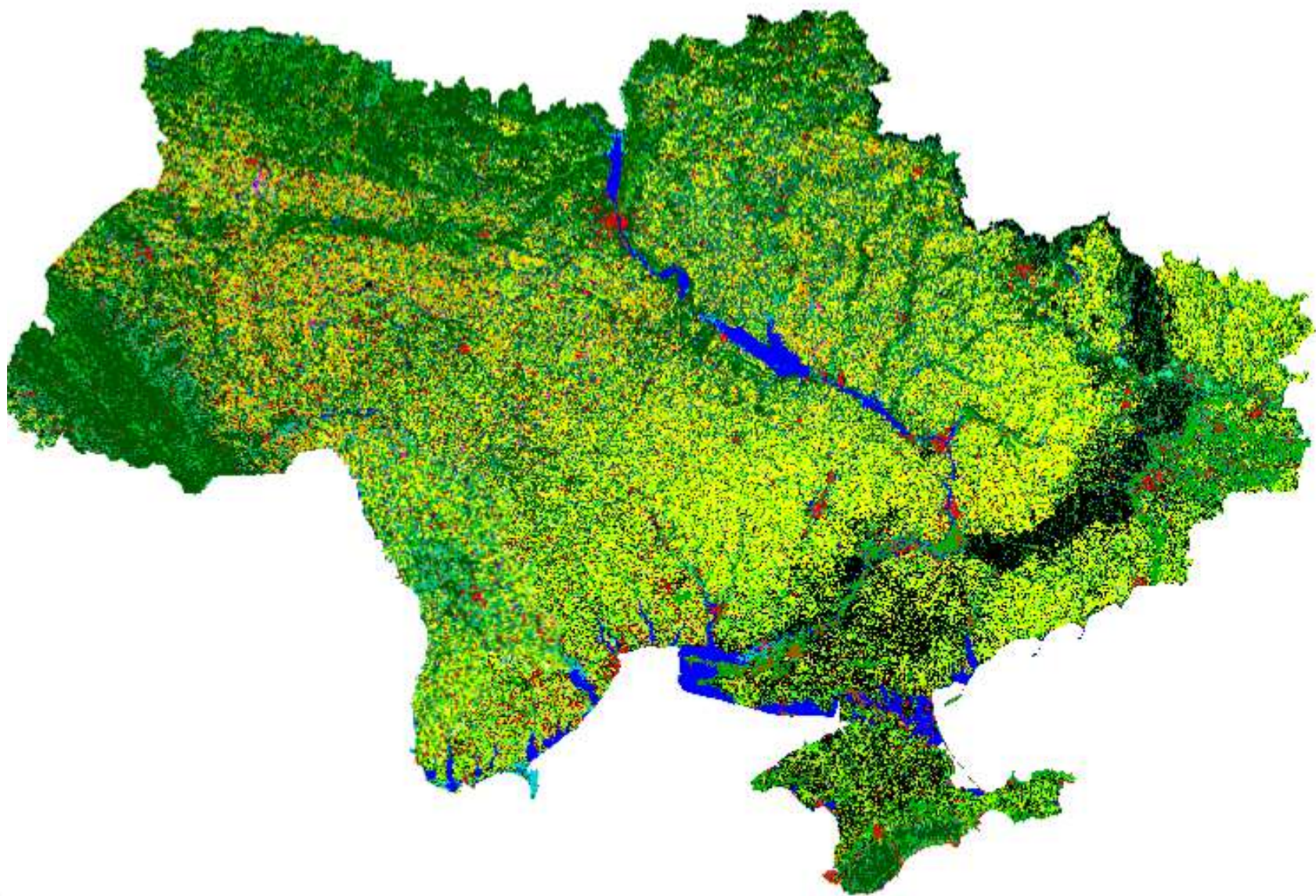
crop	GSA (ha)	Rel area (GSA)	Rel area (CTY in GSA)	Rel area (CTY Corr)	LUCAS points @ 2km	Frame 500 m @ 10 km	Frame 1000 m @ 10 km
WHE	120676.9	0.202	0.195	0.202	0.267	0.277	0.253
BAR	33677.3	0.056	0.055	0.056	0.051	0.062	0.063
SBT	79056.2	0.132	0.133	0.132	0.165	0.146	0.133
MAI	199412.5	0.334	0.341	0.344	0.201	0.237	0.257
POT	164999.5	0.276	0.276	0.275	0.315	0.279	0.293

WHE = Wheat; BAR = Barley, SBT = Sugar beet; MAI = Maize, POT = Potato

Discussion

- CTY has limited value if GSA is available.
- GSA is richer labelled, more timely (in-season)
- But CTY covers EU states that do not release GSA, EEA38 - EU27
- We have comparable CTY for Moldova and Ukraine (no GSA/EEA38)
- With high UA and PA for major crops types
- And large differences in major crop area compared to official stats
- This study confirms confidence in CTY derived area stats
- Statistical point and frame samples not adequate for area estimation

- Artificial
- Wheat
- Rapeseed
- Buckwheat
- Maize
- Sugar beet
- Sunflower
- Soybeans
- Other crops
- Forest
- Grassland
- Bare land
- Water
- Wetland
- Winter barley
- Peas
- Alfalfa
- Low trees
- Grape
- Uncultivated
- Potatoes
- Tomato
- Damaged forest
- Nuts trees
- Other cereal



Recommendations

- CTY at continental level important for policy impact/trend analysis
- Ensure gradual improvement in classification methodology
- Push UA and PA (> 90%) for wider range of distinct crops/varieties
- With back-processing to maintain consistency
- At least same year delivery, best if in-season
- Focus sampling on UA/PA determination
- “Counting pixels”: from “not done” to “best alternative”

Thank you

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