Annual Cropland Mapping in Five Contrasted Agrosystems with Medium to Large Field Size

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JECAM
Joint Experiment for Crop Assessment and Monitoring

SIGMA

Scope: Comparing methods across sites in a standardized fashion

Starting point

Classification methods have been developed according to the peculiarities of each cropping system.

Learn about the strengths and limitations of each others methods in different contexts.

Goal

This experiment aims at comparing cropland mapping methodologies (satellite data preparation (indices, temporal features) + classifier) across sites with similar average field size.

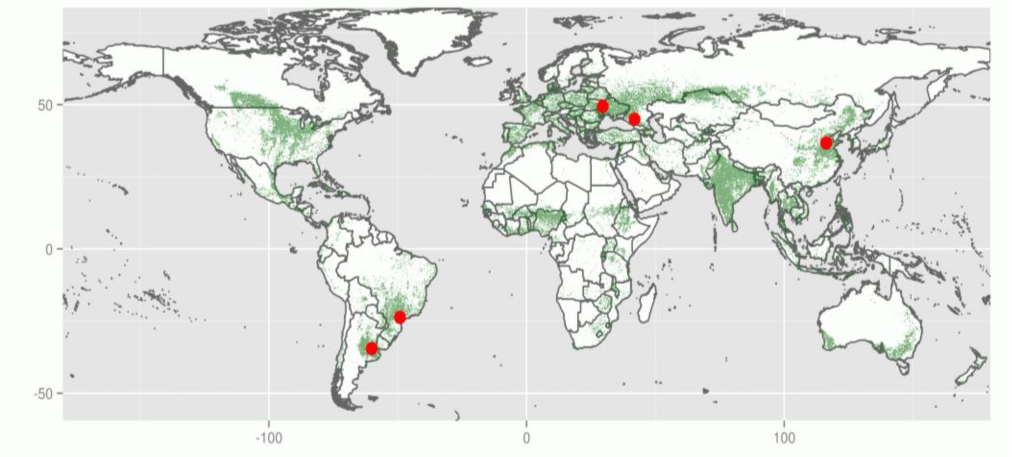
To isolate the effect of the methodology:

- **input satellite data were the same** for different test sites,
- **methodologies** proposed by different teams **were evaluated on the same calibration and validation data** for five sites.

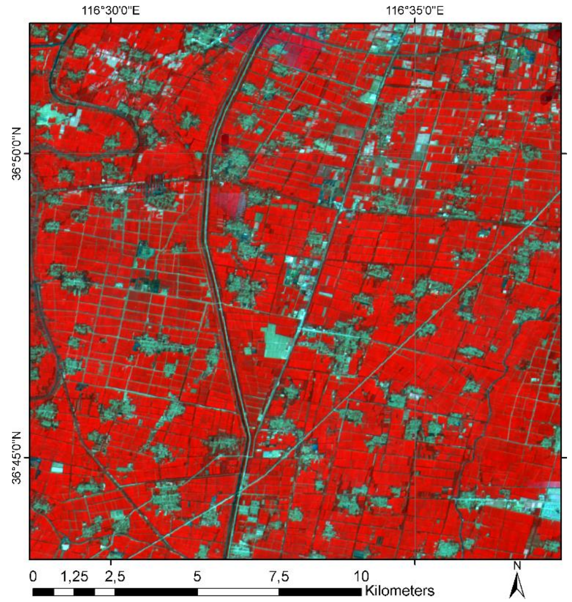
Three main objectives

1. Evaluating the performance a cropland classification method in order to identify their strengths and limitations
2. Quantifying the share of error due to spatial resolution of the input data
3. Assessing the robustness of the methodologies in other agrosystems as an indicator of the potential for upscaling to larger scales

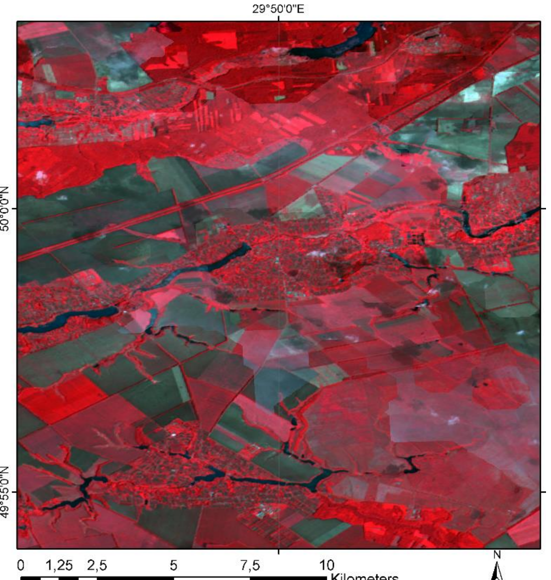
Five JECAM sites involved



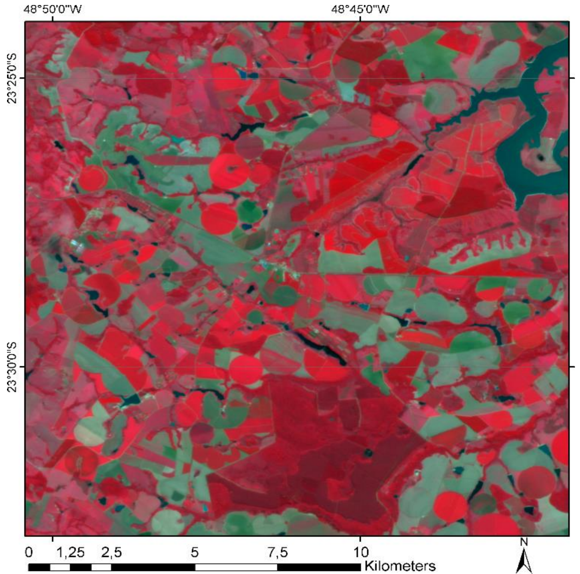
CHINA



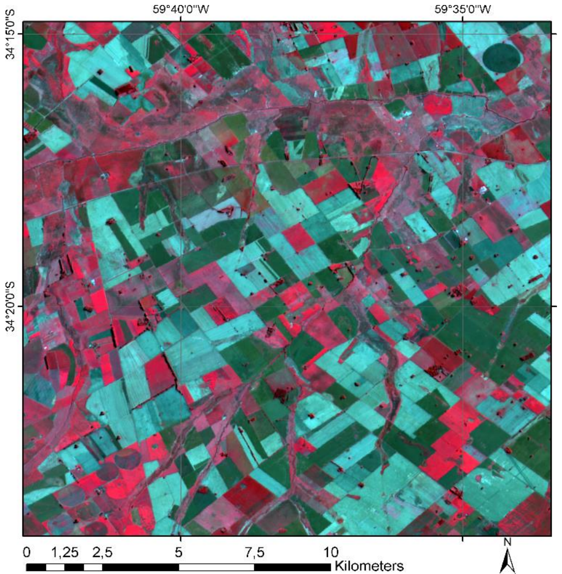
UKRAINE



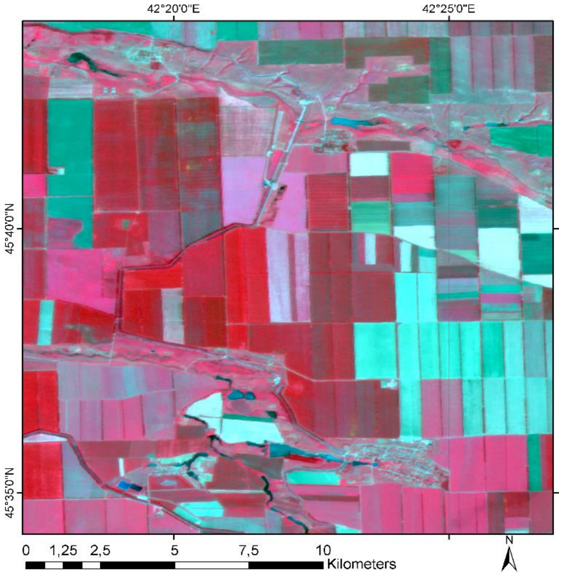
BRAZIL



ARGENTINA



RUSSIA



In situ data collected by local JECAM teams

Growing season of interest: 2014

Area: 90x90km

Input satellite data: MODIS (Terra+Aqua) 7-day mean composites

In situ data collected by the JECAM partners:

site	Area [ha]	Area covered by polygons [%]	Number of polygons	Cropland polygons [%]	Mean cropland polygon size [ha]
Argentina	774002	1.13	348	81.0	27.1
Brazil	507728	3.68	847	36.0	21.3
China	360802	0.46	92	48.9	17.7
Rusia	362487	14.57	588	83.7	77.1
Ukraine	1135346	2.21	608	74.0	46.9

High resolution cropland maps derived from Landsat-8 and DEIMOS for wall to wall validation and Pareto boundary analysis

Five classification methods to benchmark

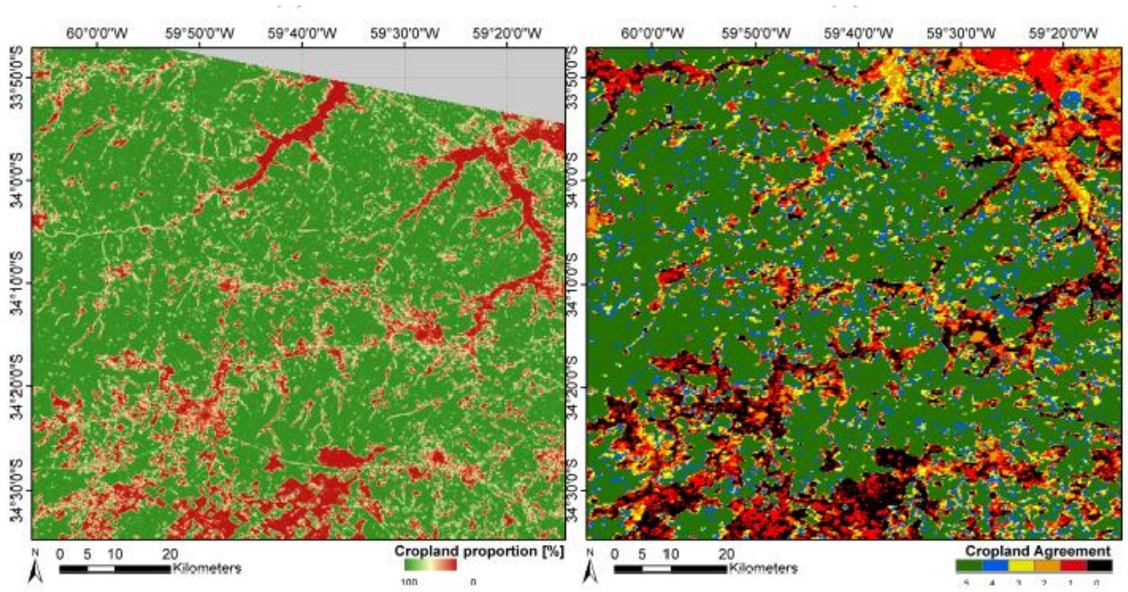
METHODS HAVE DIFFERENT NEEDS AND CONTRAINTS

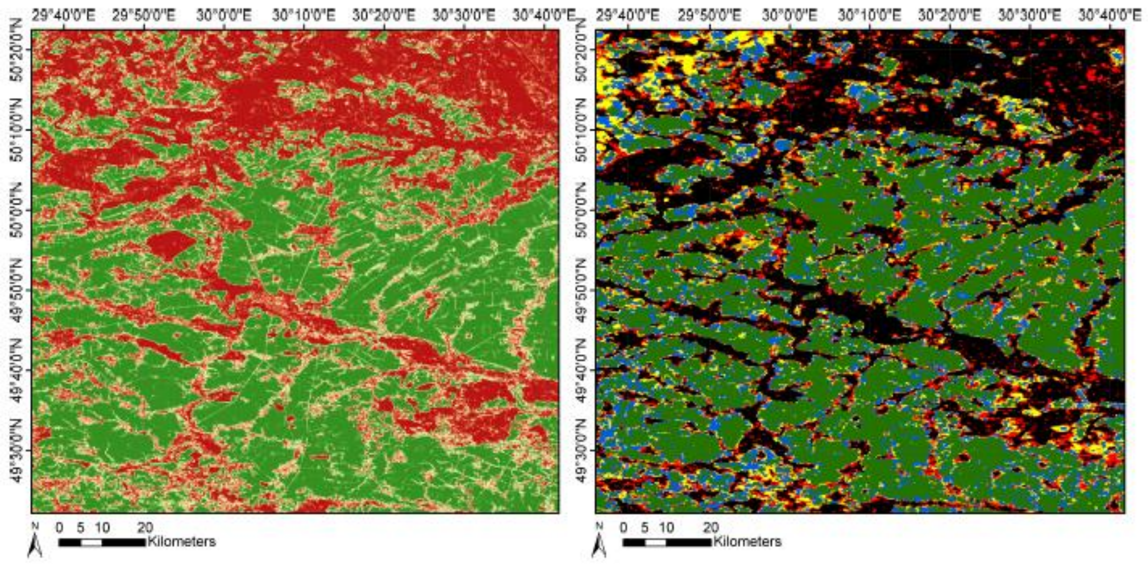
TRAINING WITH 50% OF THE IN SITU DATA SET AND VALIDATION WITH THE REMAINING 50%

Method	Features	Classifier	Team
Time-series analysis and ensemble classification	NDVI temporal features	Ensemble of five classifiers	INTA
Neural Network Ensemble	Reflectance time-series	Neural network ensemble	SRI
Decision Tree classification	Five crop specific NDVI features	Decision tree	RADI
Large-Scale Arable Lands Mapping method	Three PVI temporal features	Maximum likelihood	IKI
Knowledge-based cropland classification	Five reflectance temporal features	Support Vector Machine	UCL

Good consistency between methods

- Methods are consistent with one another
- Most errors are:
  - located at the fringes of cropland;
  - observed in areas likely to be confused (grassland, abandoned cropland)





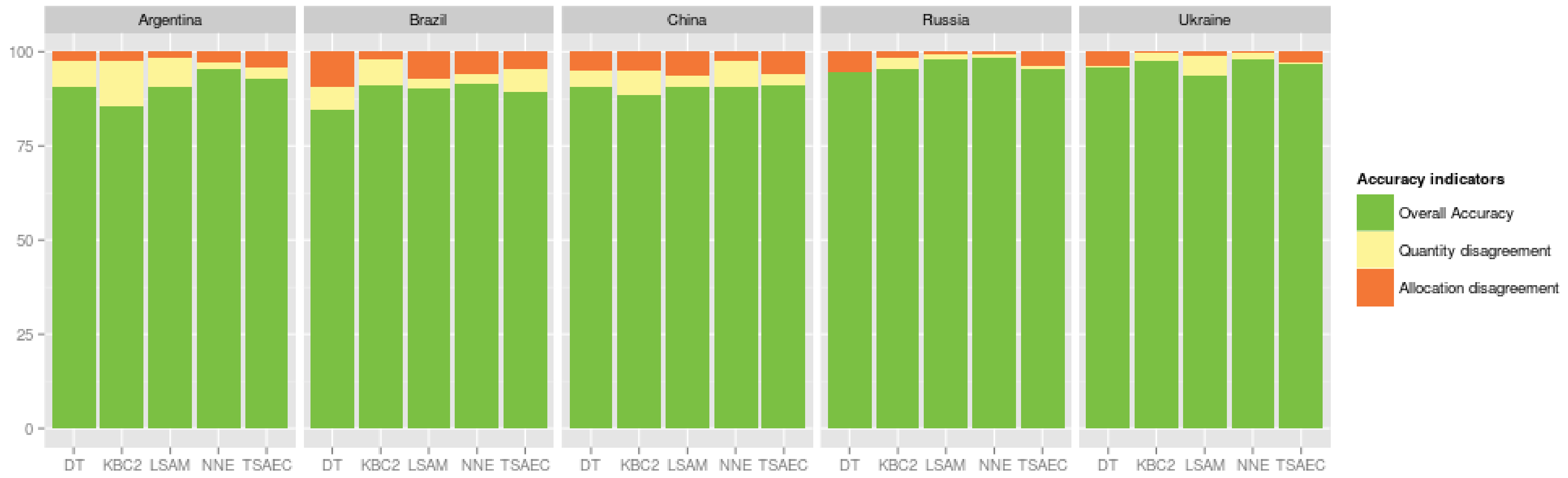
Traditional accuracy assessment

Methods were validated with an independent set.

Overall accuracy figures range from 85% to 98%, most of them being in the range of 90 to 95%.

Users’ and producers’ accuracies are generally around 90%.

The **site effect** on accuracy is significant at a **95%** confidence level (Kruskall-Wallis test), the **method** effect is **not**.

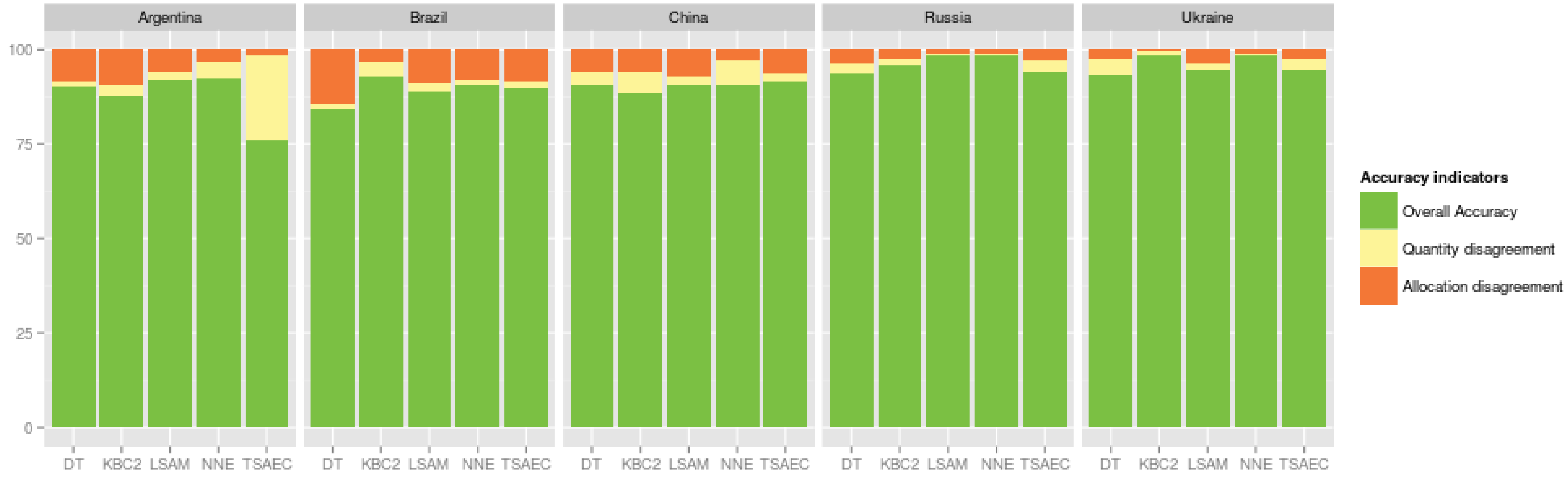


Validation accounting for class proportion

Landscapes are dominated by cropland → **artificially increase the weight of the non-dominating class** before deriving the accuracy

Ten subsets were randomly selected constraining equality of the non-cropland and cropland classes sets.

No significant difference compared to the traditional accuracy assessment (paired t test)



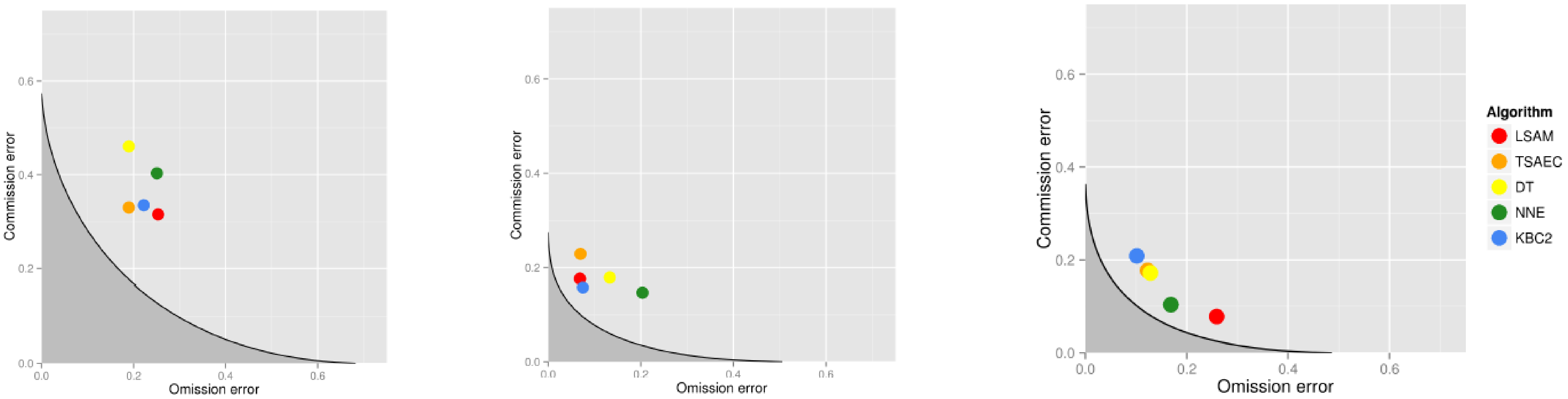
The effect of the spatial resolution varies across sites

High resolution cropland maps were used to assess the effect of MODIS’ spatial resolution on the accuracy (Pareto boundary method).

The Pareto boundary is related to the landscape fragmentation.

This low resolution bias (grey area under the curve) accounts for 10%, 20% and 35% of the errors respectively, confirming the importance of the site effect on the accuracy.

No tendency of the methods in their omission/commission error rates across sites.

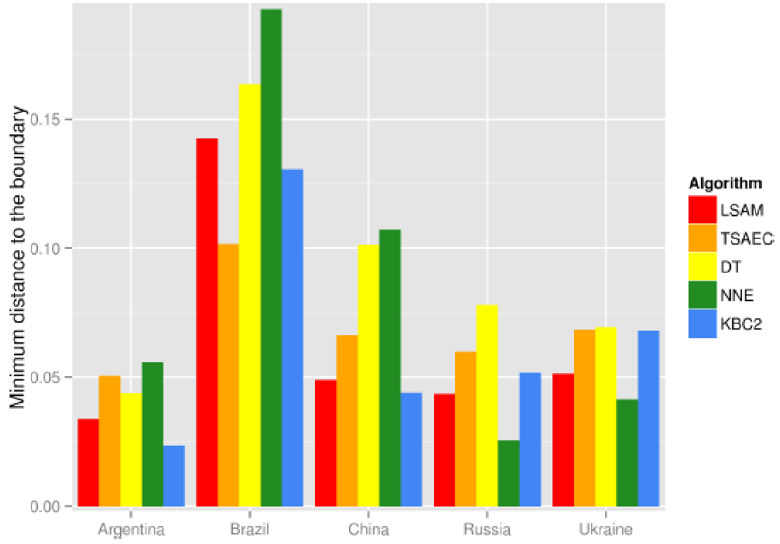


The site effect remains significant after correcting for the low resolution bias

The **minimum distance to the boundary is an accuracy indicator** free of effects due to the spatial resolution of the data.

The minimum distance to the boundary remains significantly different across sites (Kruskall-Wallis test).

→ other effects such as crop diversity, soil types, data quality

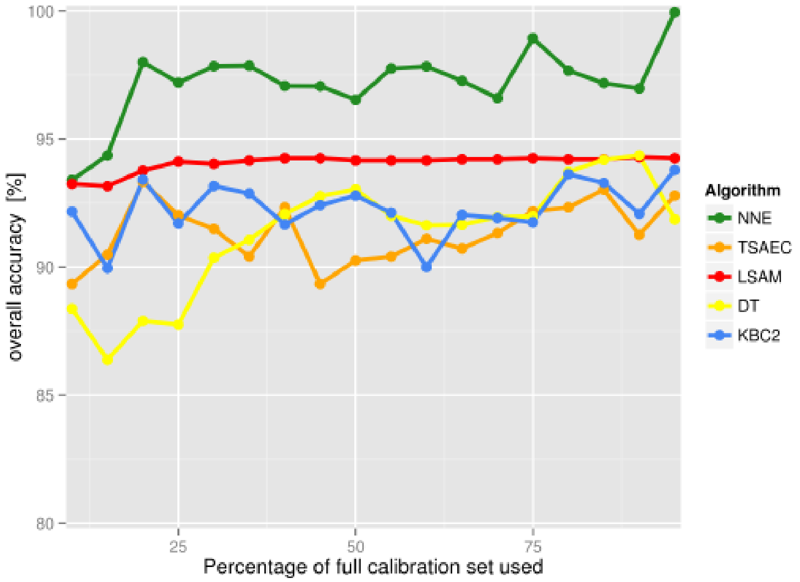


Sensitivity to the amount of training data

When mapping large areas, the suitability of a supervised classification method depends also on its ability **to deal with limited training data** as the are difficult/expensive to collect.

For the Ukrainian site, the training data set was systematically reduced (from 95% down to 10% of its total amount) and the accuracy of the resulting maps was assessed.

With only **20%-30% of the calibration set (2% of the area), four methods reach their overall accuracy** saturation plateau (92%-98).



Conclusion and perspectives

- Five methods tested on five contrasted sites with the same input satellite data, calibration data and validation data
- Overall accuracy ranges from 85% to 95%
- The site effect is more important than the method effect
- The site effect includes 1) the cropland fragmentation and 2) specific agrosystem characteristics

→ **Paper submitted to "Remote Sensing"**

"Cropland mapping in five contrasted agrosystems dominated by large sized fields"
François Waldner, Diego De Abeyllera, Santiago R. Verón, Miao Zhang, Bingfang Wu,Dmitry Plotnikov, Sergey Bartalev, Mykola Lavreniuk, Sergii Skakun, Nataliia Kussul,Guerric Le Maire, Stéphane Dupuy, Ian Jarvis and Pierre Defourny; **2015**

A follow-up experiment…

- Expand the comparison to **larger areas** (200x200km or 400x400km)
- Compare input **satellite data** (MODIS, PROBA-v 300m and PROBA-v 100m)
- Compare **training data** (in situ, derived from **existing land cover maps, geowiki**)
- Benchmark methods based on their **classification uncertainty**

Interested teams are welcome to join!!!

Many thanks to Francois for the presentation preparation.