TOWARDS THE EXPLOITATION OF SENTINEL-1, -2 AND -3 FOR HIGH RESOLUTION CROP MAPPING ALONG THE GROWING SEASON

François Waldner[1], Igor Savin[2] and Pierre Defourny[1]

[1] **Université catholique de Louvain (BE)**
[2] **Dokuchaev Soil Institute (RU)**

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Agriculture monitoring, why?

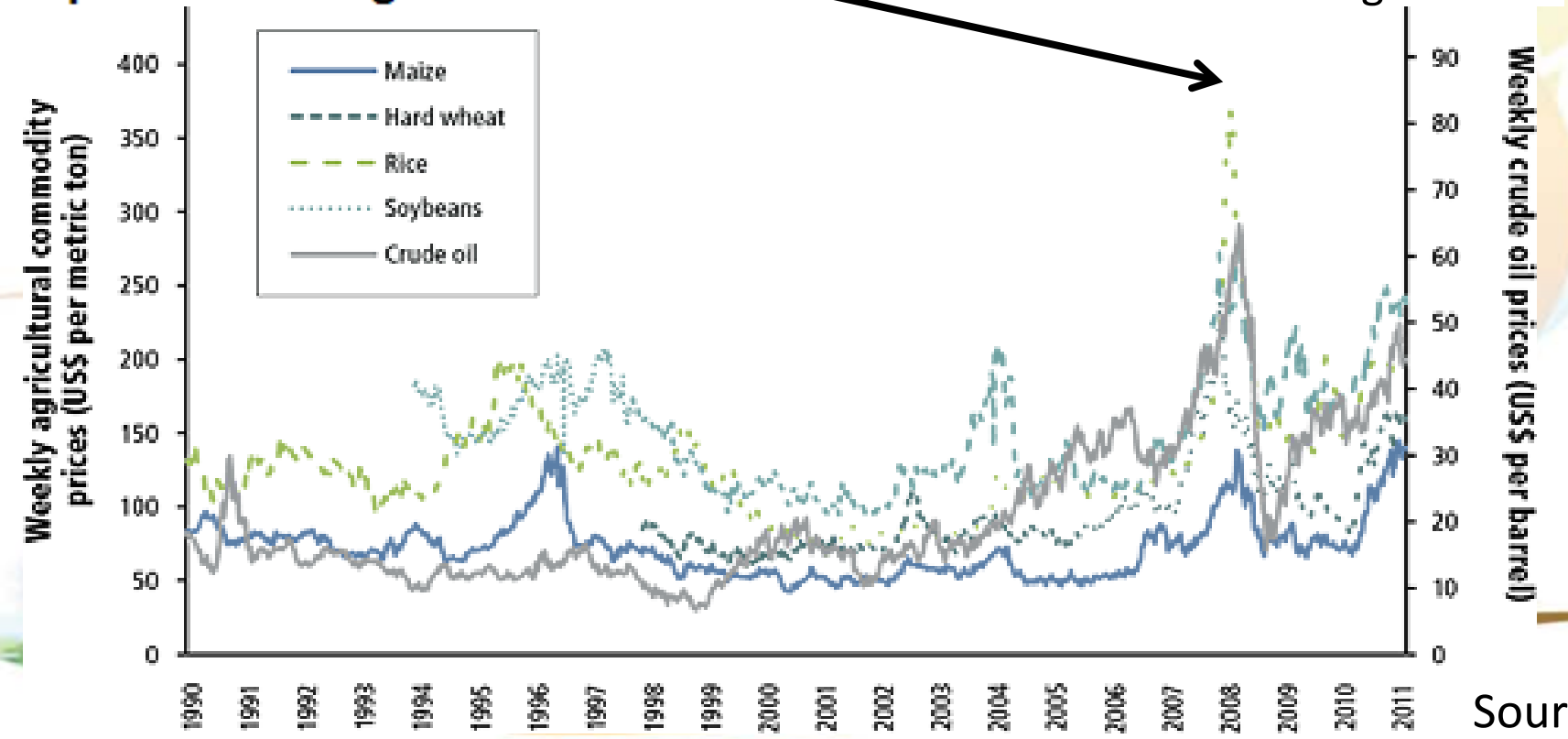
Agricultural statistics are needed at the regional, national and international levels by governments, traders and food industries.

For food security and to stabilize the market prices

→ G-20 initiatives: AMIS–FAO and GEOGLAM

Russia bans grain exports because of fire and drought, sending prices soaring

Source: Washington Post

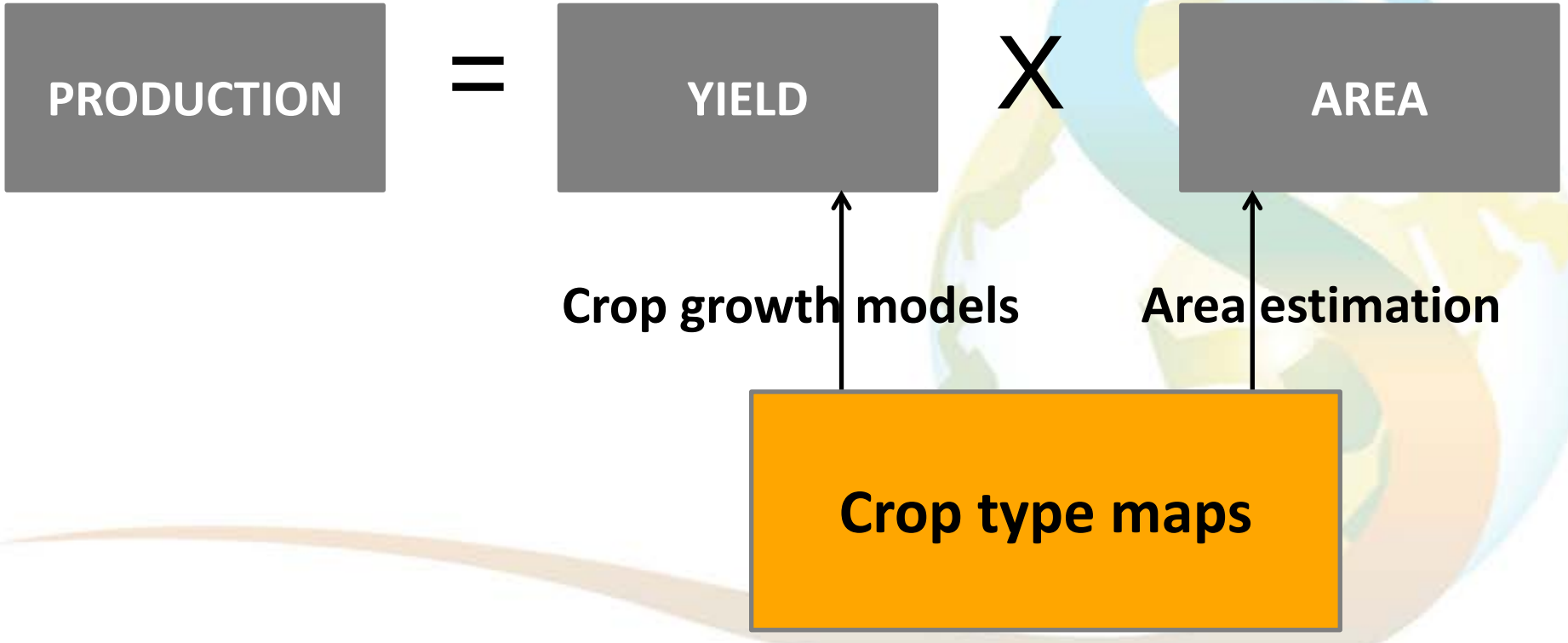


Source: ifpri

Crop specific information is a prerequisite for monitoring

There is a need to improve agricultural monitoring.

Crop type information is a pre-requisite:



Partial time-series for annual crop type maps

Crop identification exploits differences in:

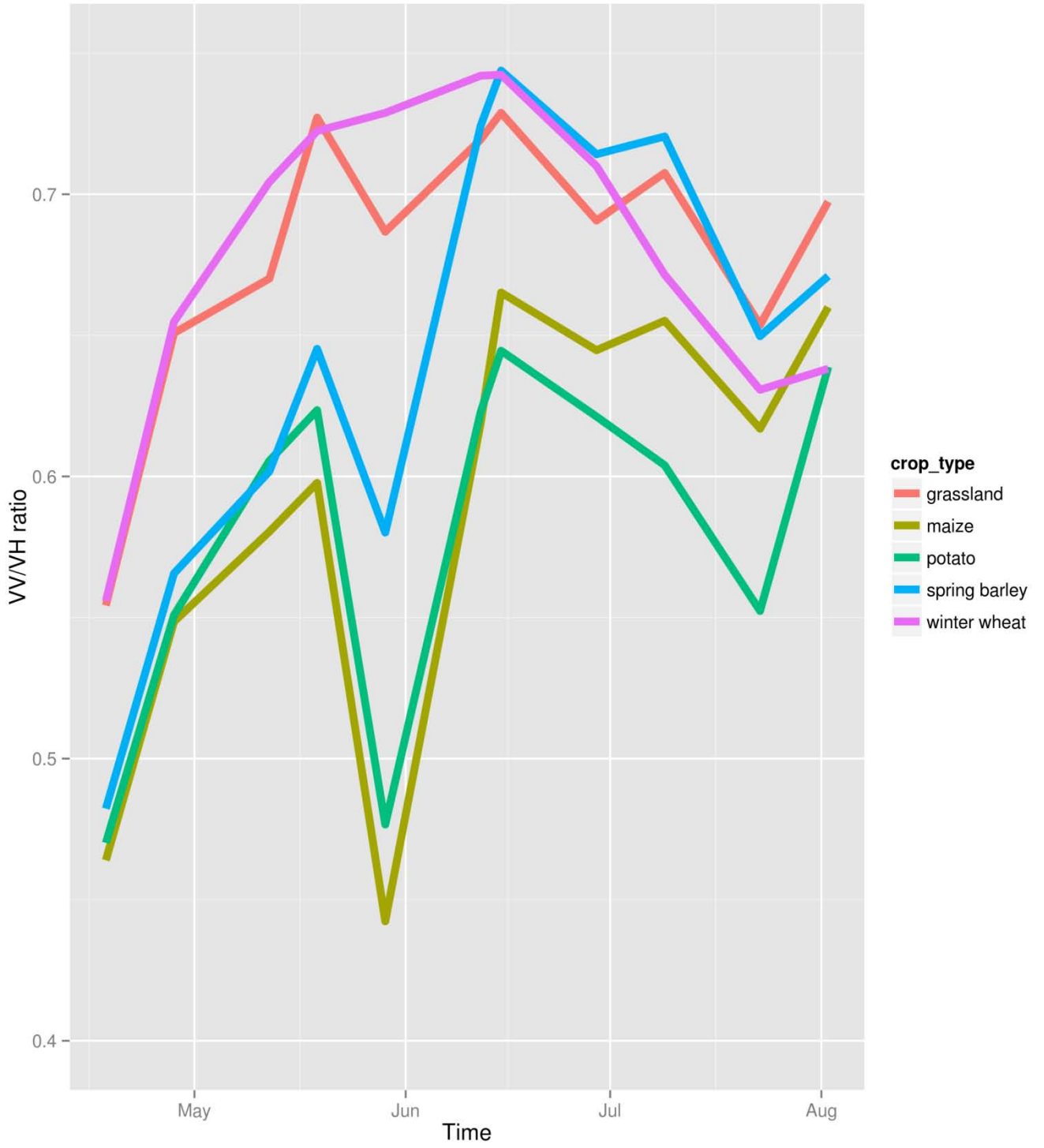
- spectral properties
- timing of those properties
- crop architecture

Because of rotations and agricultural practices, fields are sown with a different crop each year

→ **annual** crop type maps

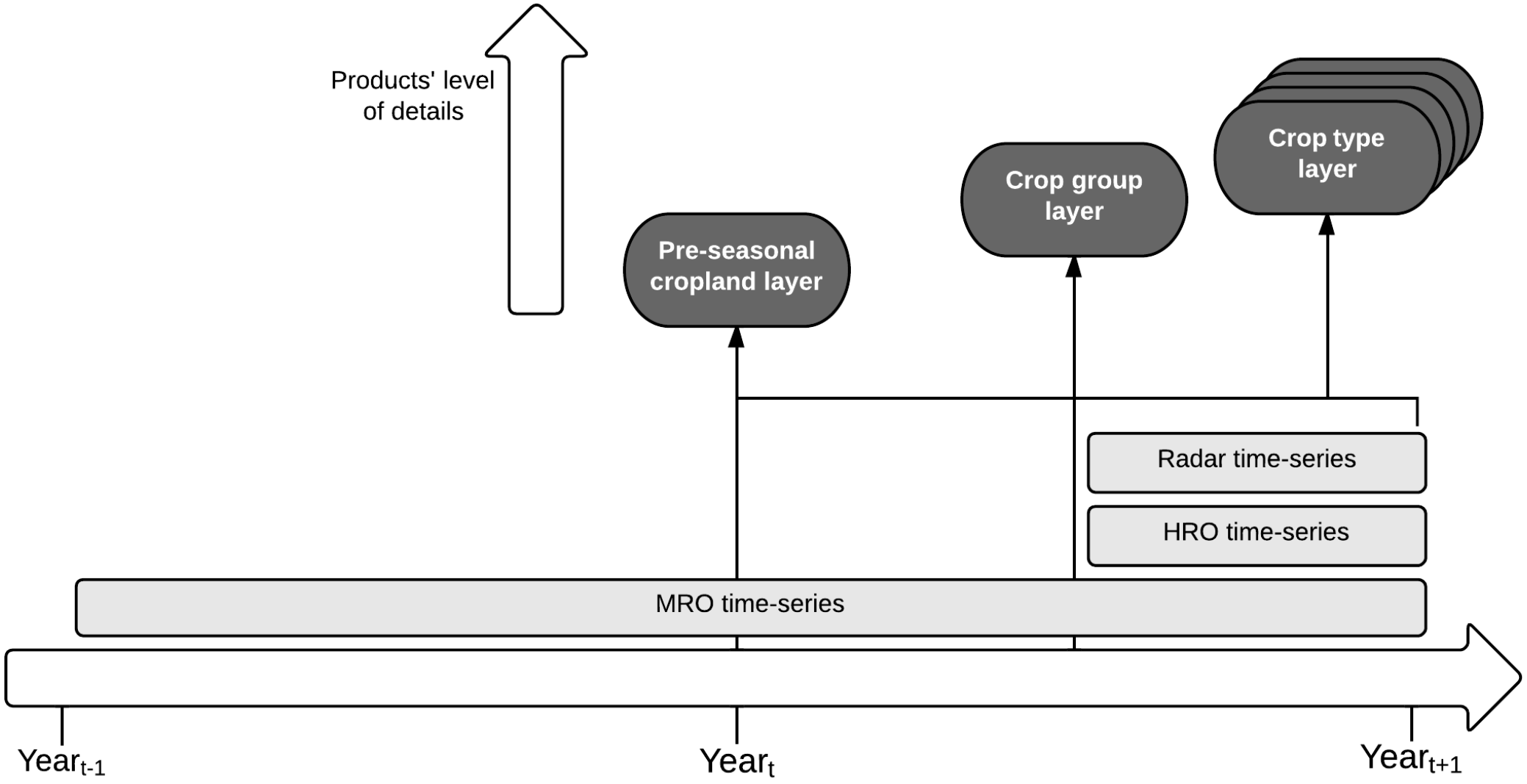
To support monitoring, crop maps need to be available asap in the season

→ **partial** time-series

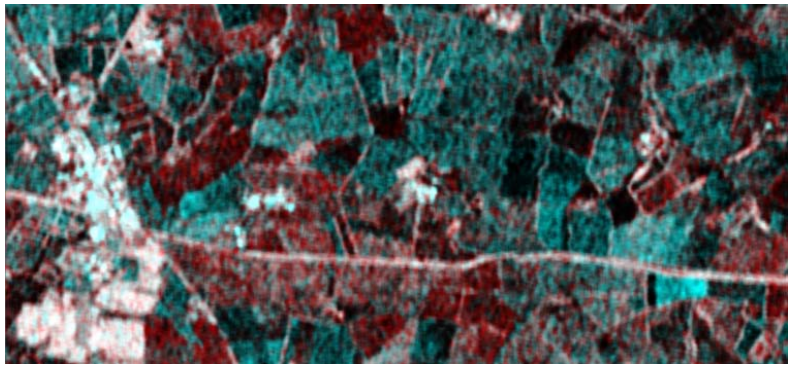

0.7
0.6
0.5
0.4
VV/VH ratio
May
Jun
Jul
Aug
Time
crop_type
grassland
maize
potato
spring barley
winter wheat

An improved level of details along the season

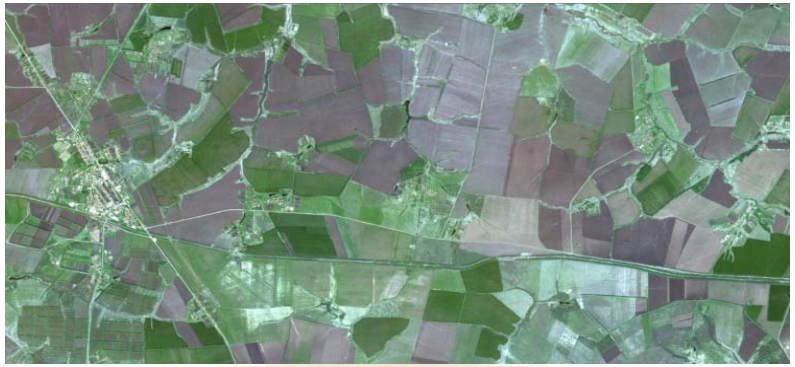
OBJECTIVE: Produce and update crop maps along the season as information accumulates



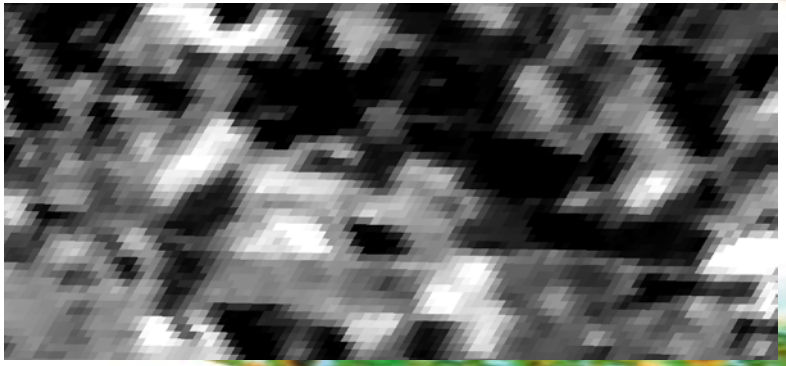
Exploiting the complementarity of S-1, S-2 and S-3



	Sentinel-1 (SAR)
+	• weather independent • temporal resolution (night acquisitions)
–	• number of bands • difficult to interpret

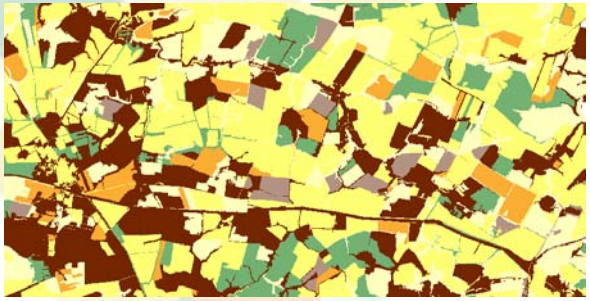


	Sentinel-2 (HRO)
+	• **spatial resolution** • number of bands
–	• cloud contamination • temporal resolution



	Sentinel-3 (MRO)
+	• **temporal frequency** • number of bands
–	• cloud contamination • spatial resolution

Efficient and robust crop mapping



The study focuses on two contrasted areas

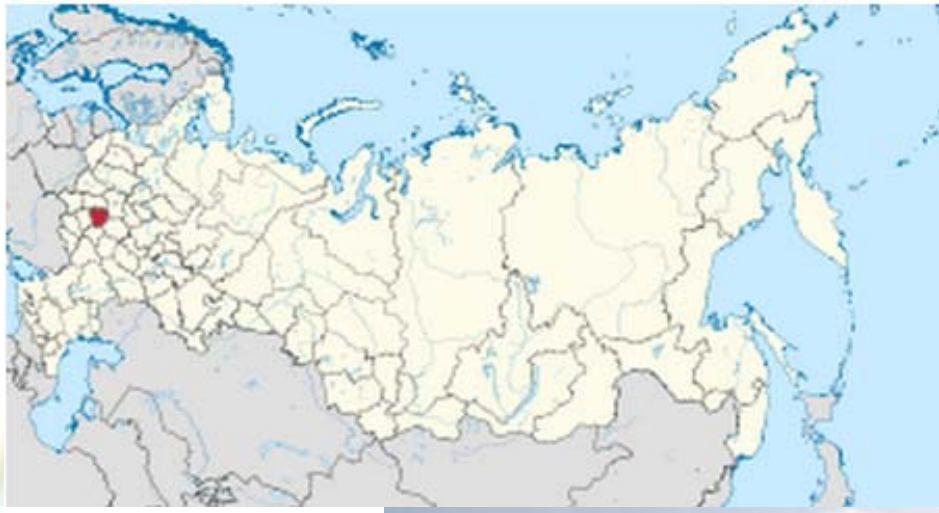
South African site

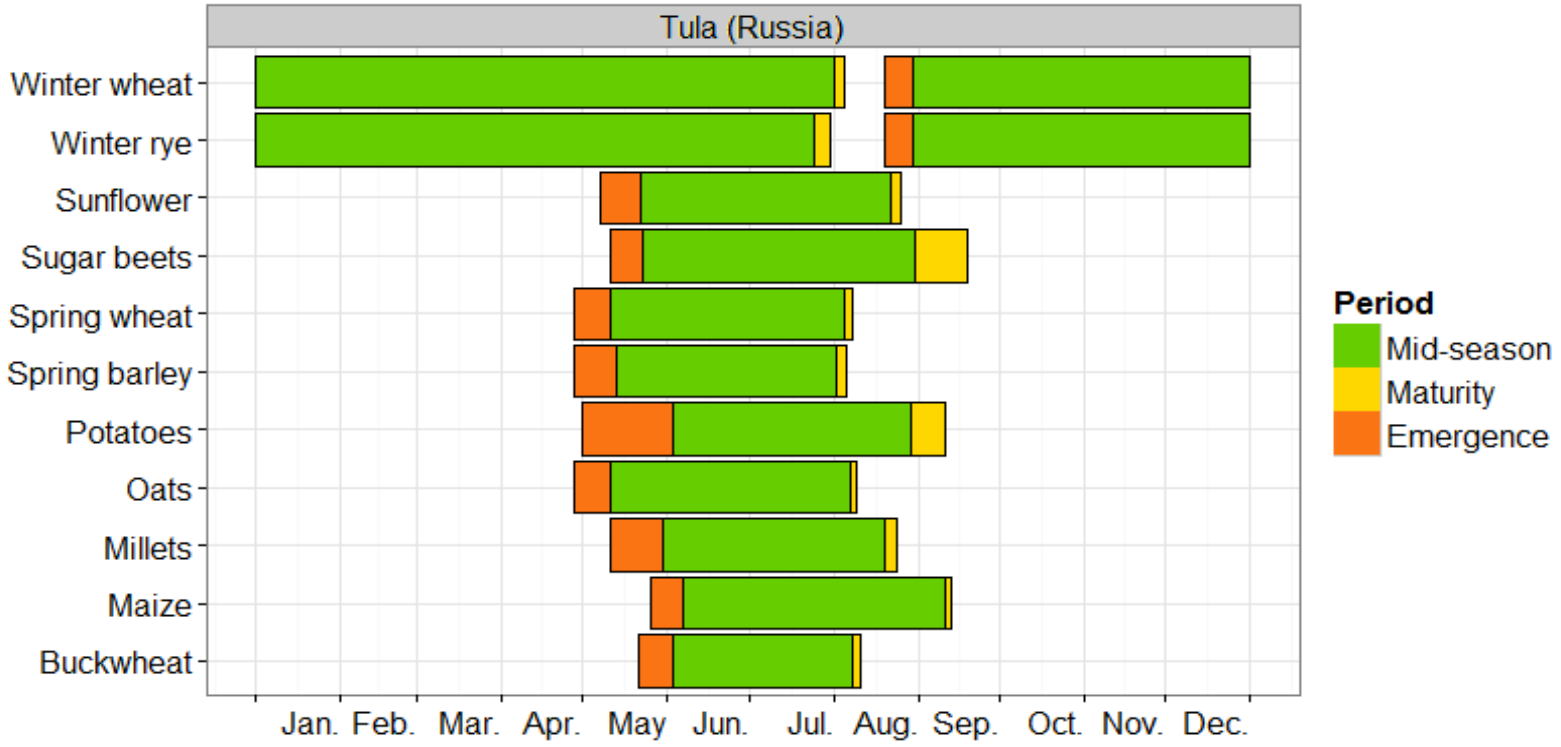
- Free State Province is SA's breadbasket (70% of total grain production)
- sub-humid to semi-arid climate
- Field size: 0,5-40 ha
- Home gardens, small scale and commercial farming
- Continuous growing season
- 129 000 km²

The study focuses on two contrasted areas

Tula oblast

- Continental climate
- Field size: 70-ha
- Winter crops are planted in August, summer crops in April
- 26 000 km²





Proxy data acquisition plan

Large sites to simulate the wide swath of sentinel-2 (280-km)

→ integrate the spatial gradient of vegetation conditions across the image

Russia (acquired):

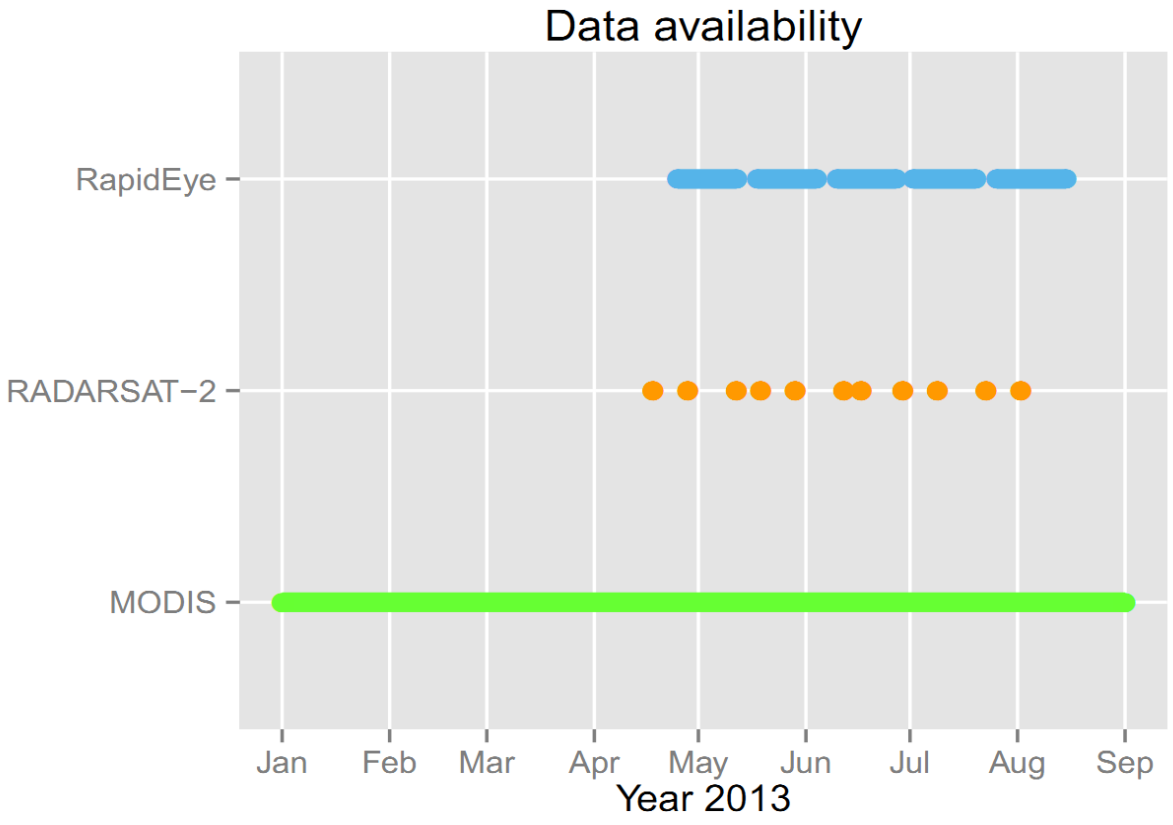
13 Radarsat-2 images (300x300 km)

5 RapidEye coverages (500 25x25 km images)

South Africa (in acquisition):

13 Radarsat-2 coverages (200 70x150 km im.)

13 RapidEye coverages (4300 25x25 km im.)

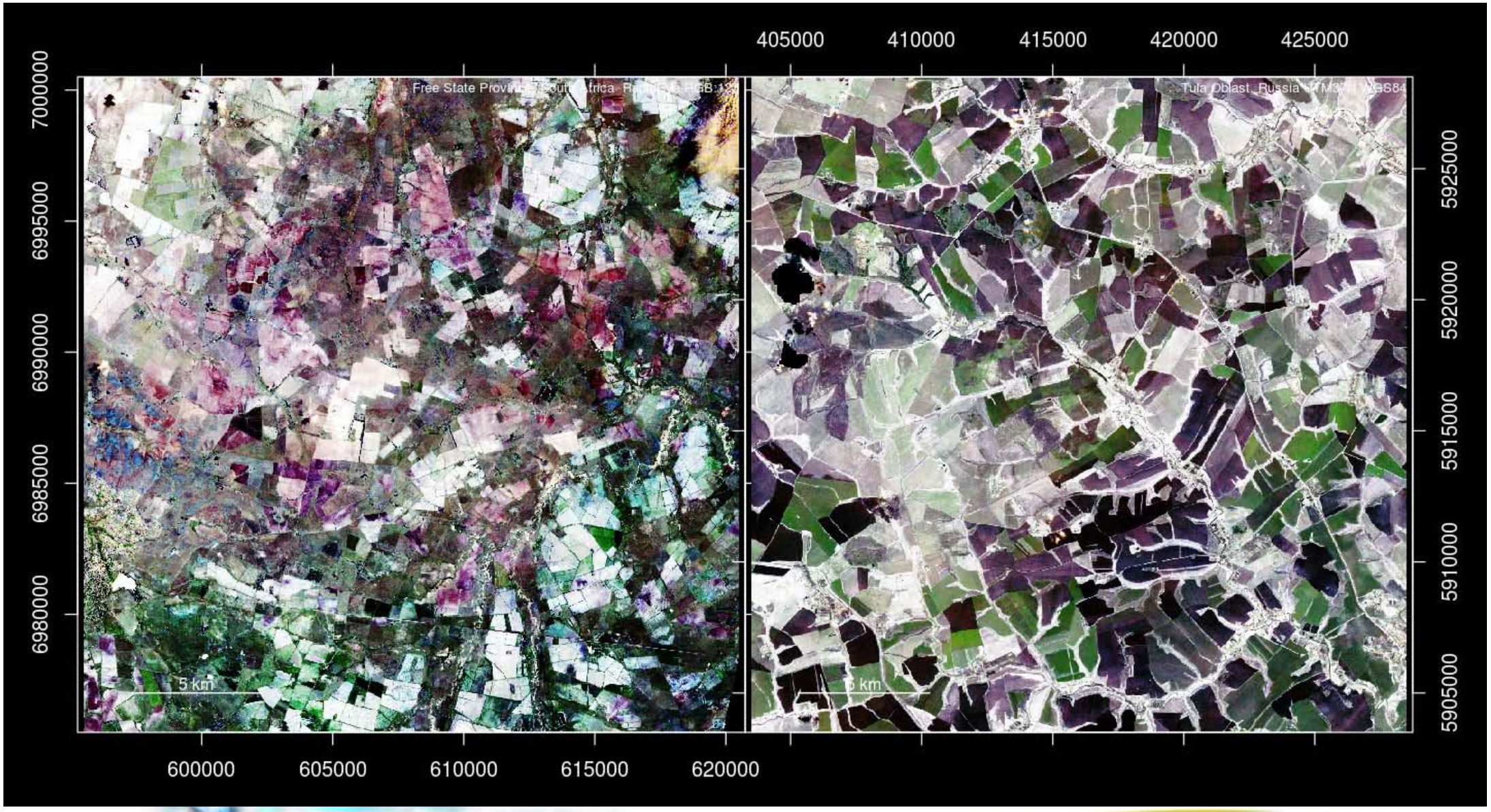


→ 5 spectral bands TOA

→ VV-VH back-scattering coefficients

→ 10-day mean composite MSAVI

RapidEye's view



Cropland mask based on the previous year time-series

Cropland | Crop groups | Crop types

Existing land cover maps contain cropland information BUT:

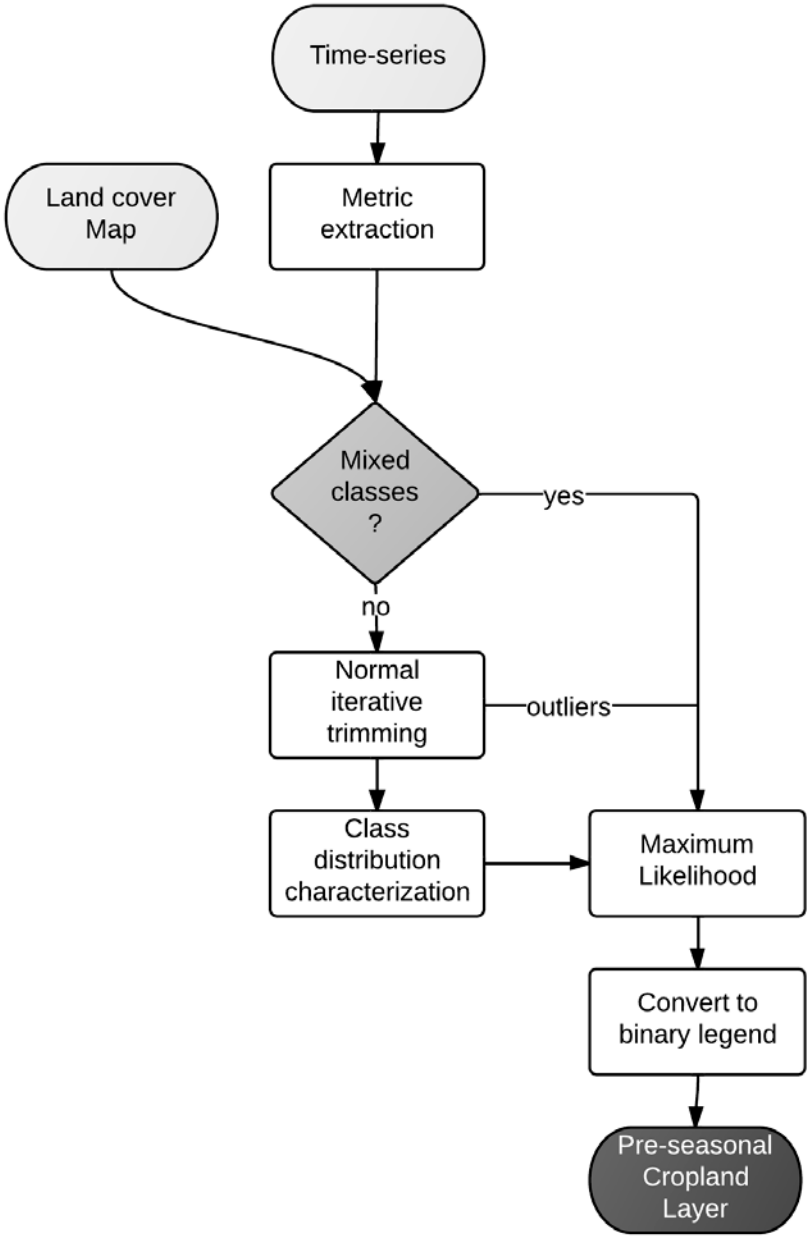
- general maps
- global maps need local tuning
- changes
- how to allocate the mosaic classes?

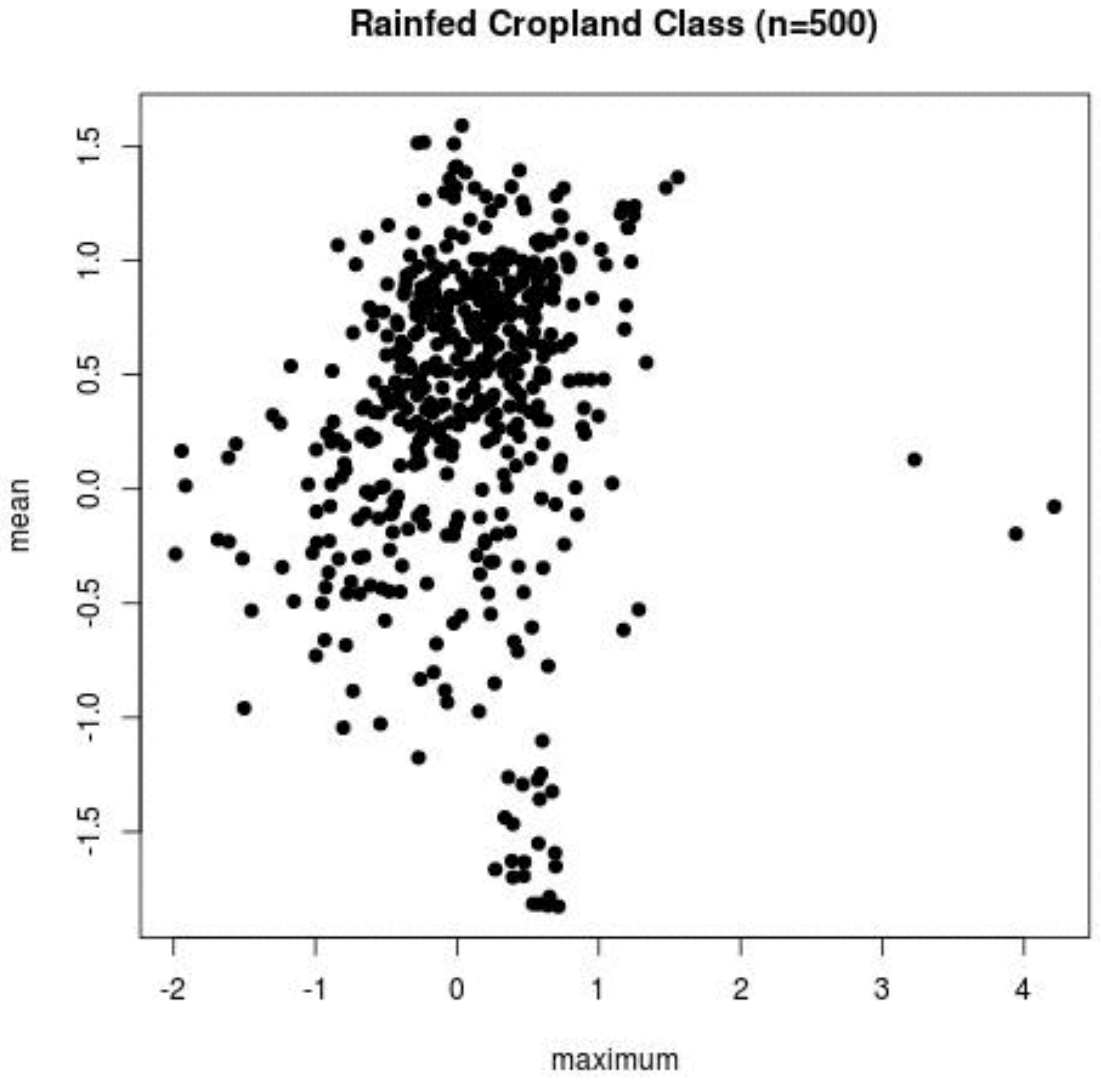
→ Image-to-map discrepancy detection to update the land cover map (GlobCover 2009)

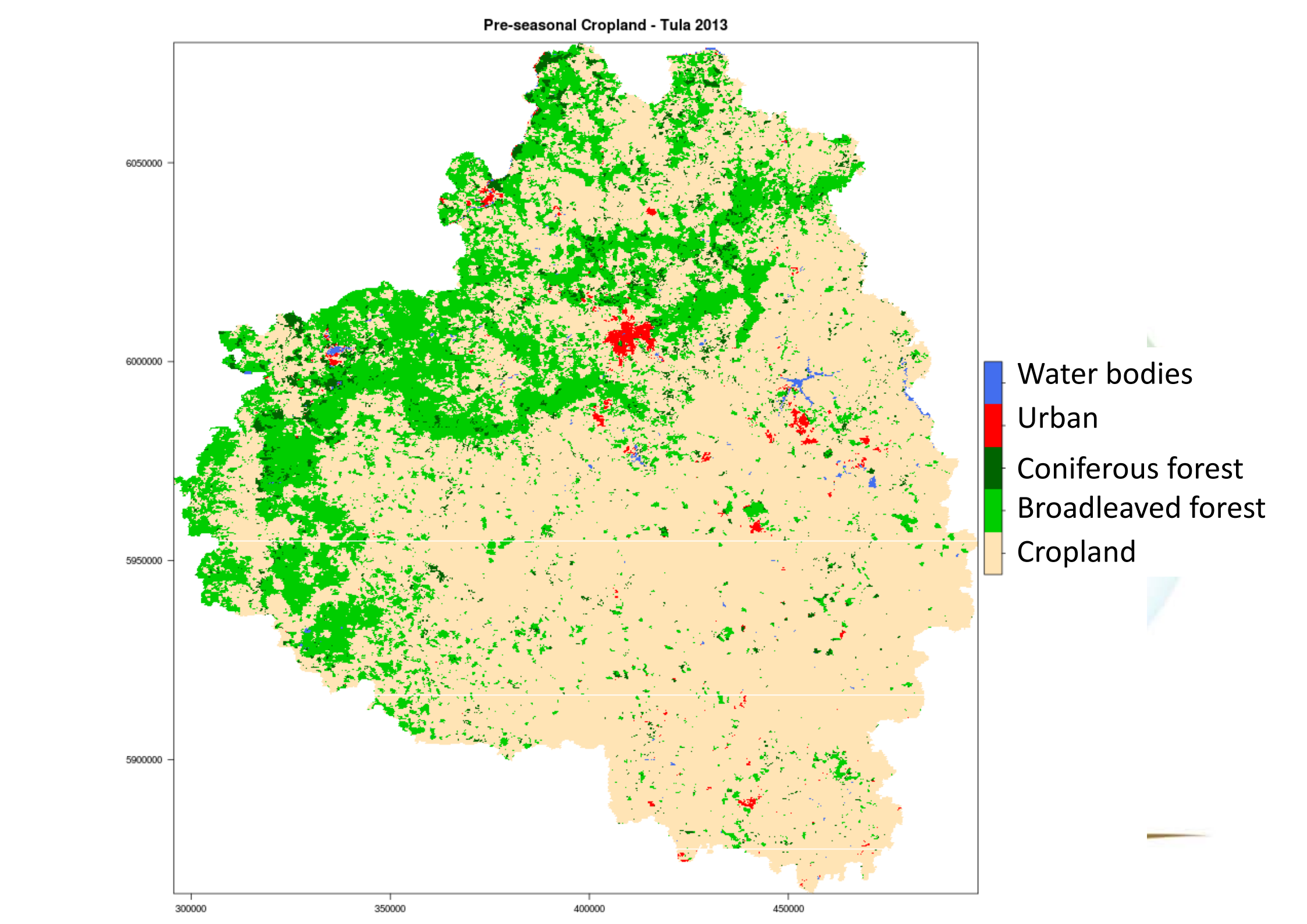
→ Easily transposable to other sites

Multi-variate normal iterative trimming to detect outliers

Cropland | Crop groups | Crop species



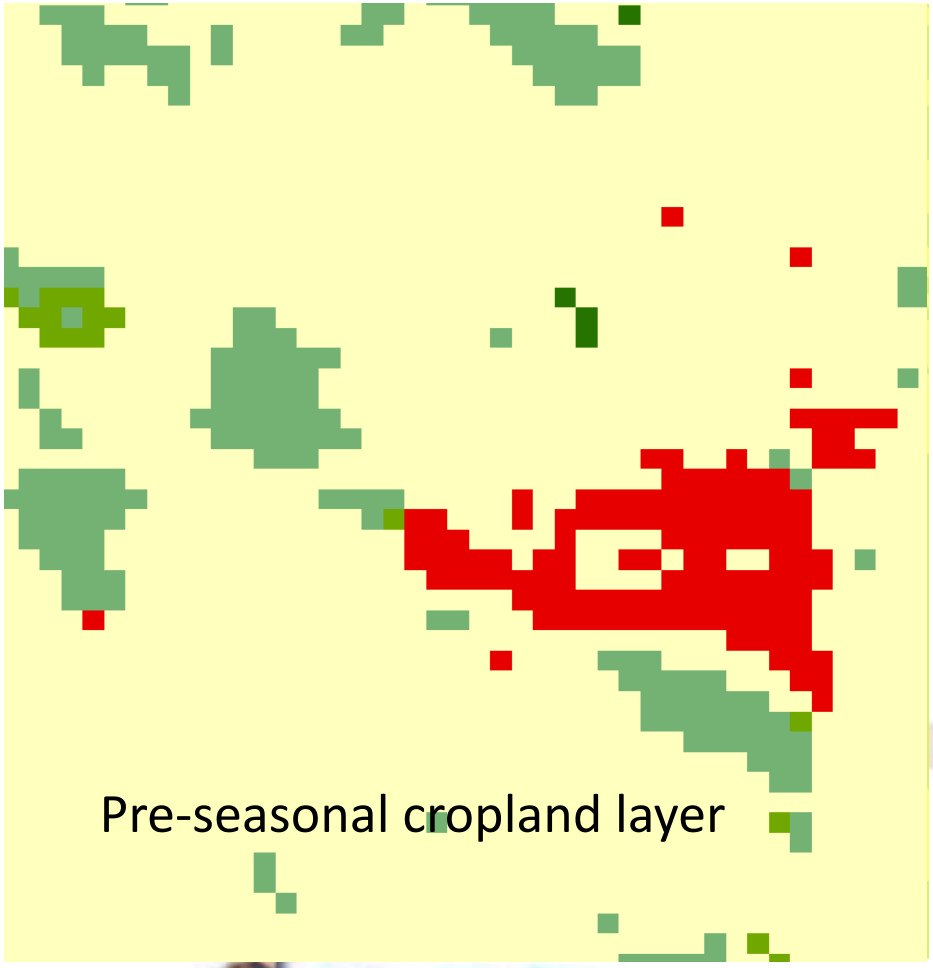



Pre-seasonal Cropland - Tula 2013
6050000
6000000
5950000
5900000
300000
350000
400000
450000
Water bodies
Urban
Coniferous forest
Broadleaved forest
Cropland

Assessment of the pre-seasonal cropland layer

Cropland | Crop groups | Crop species

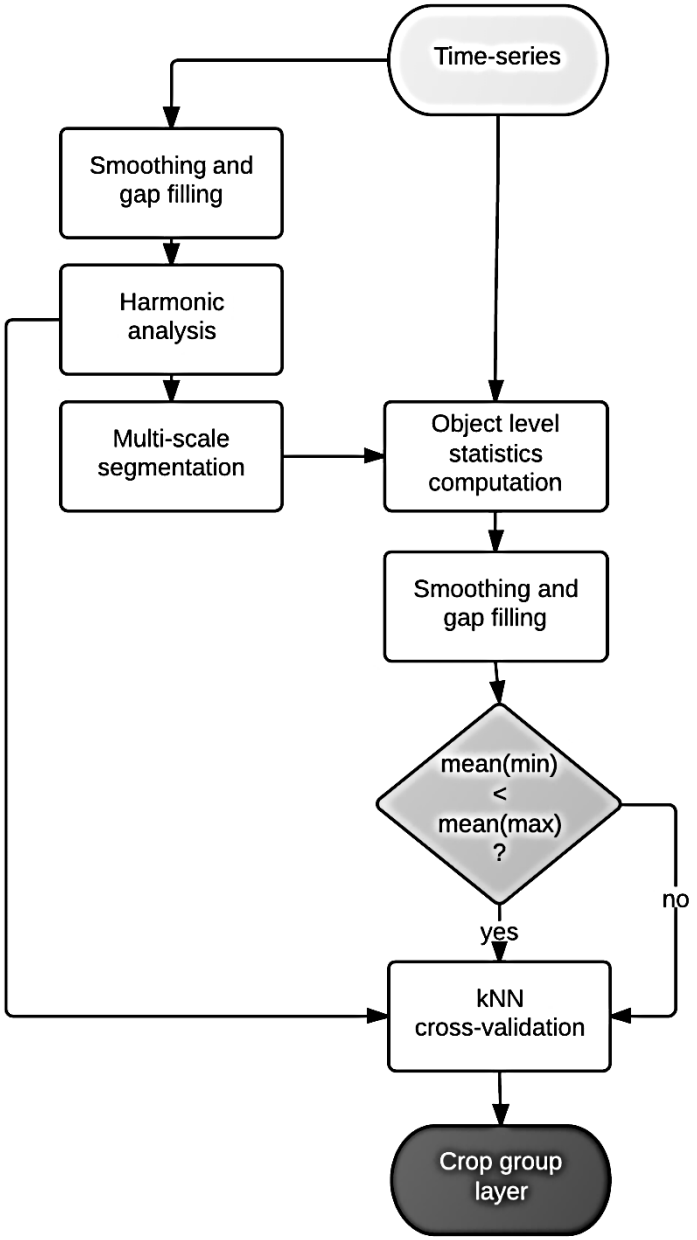
Visual check

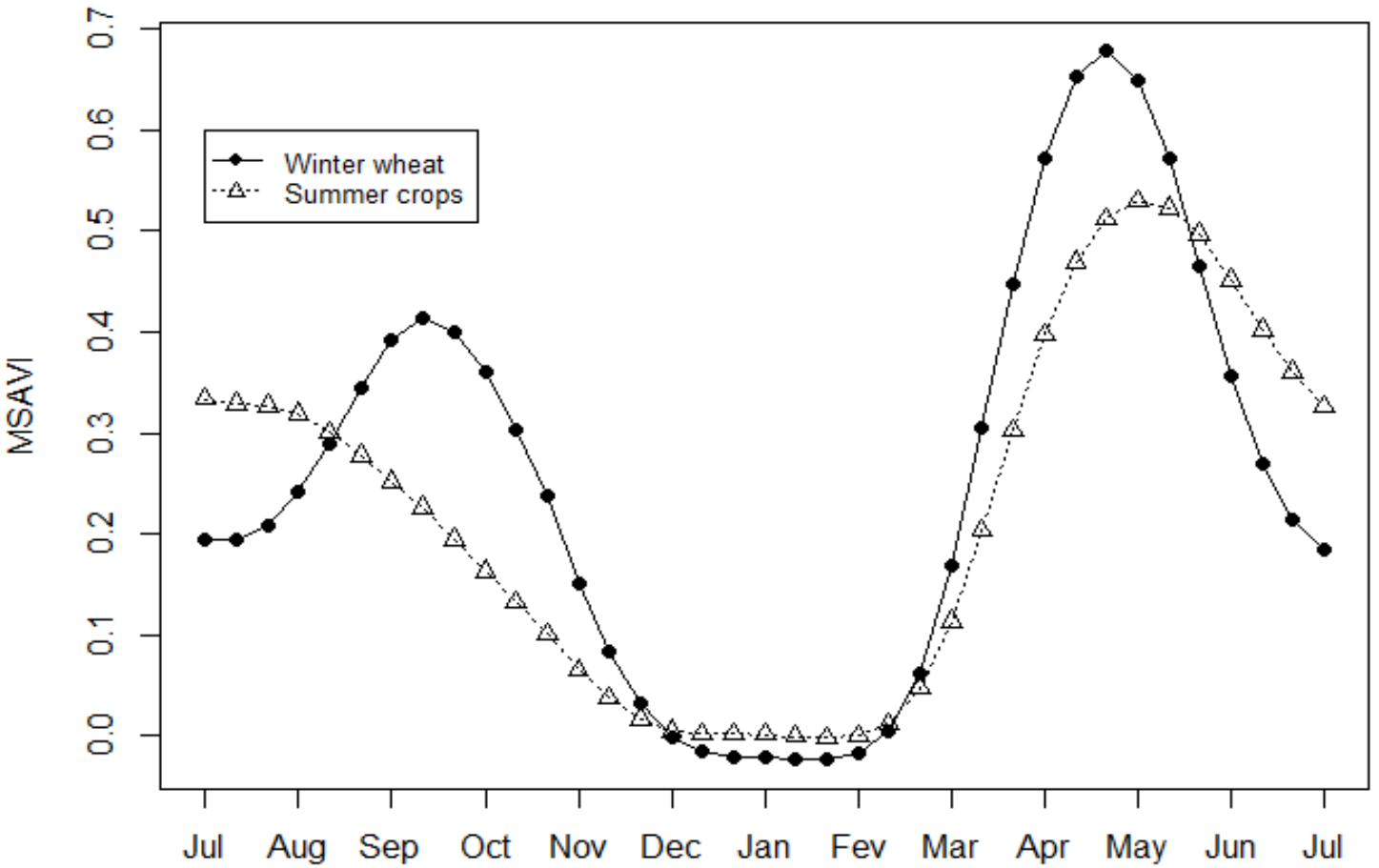


Quantitative validation

Automated and adaptive winter crop detection

Cropland | Crop groups | Crop types





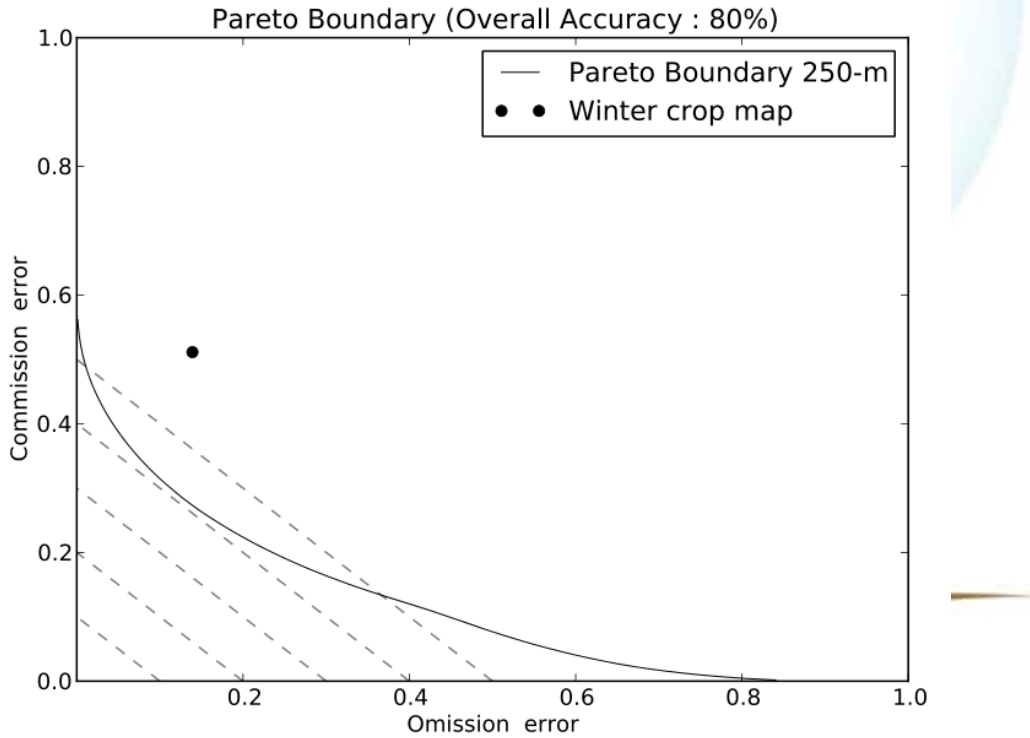
Assessment of the crop group cropland layer

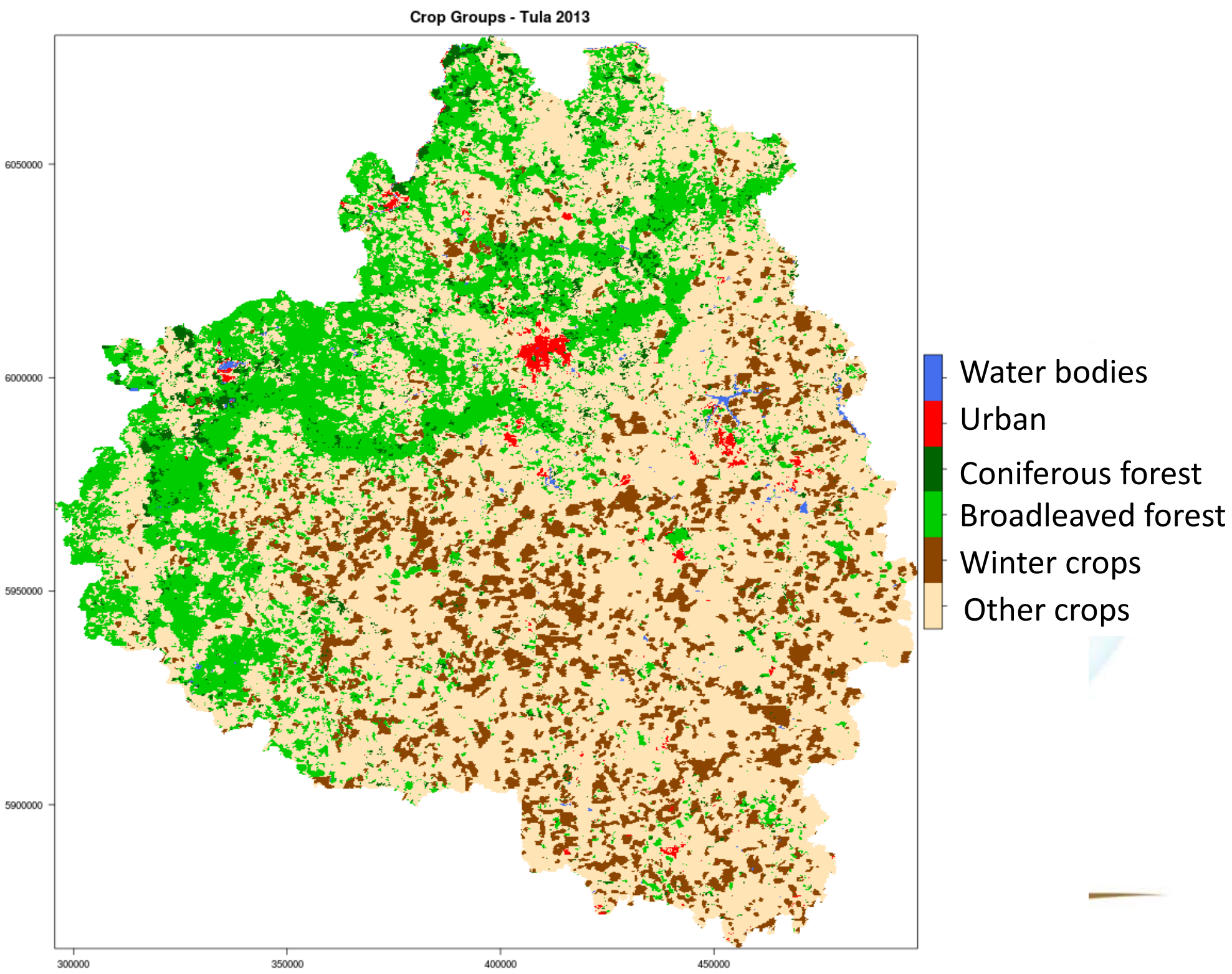
Cropland | Crop groups | Crop types

Visual check

Winter crop within field variability at the end of the winter limits the accuracy

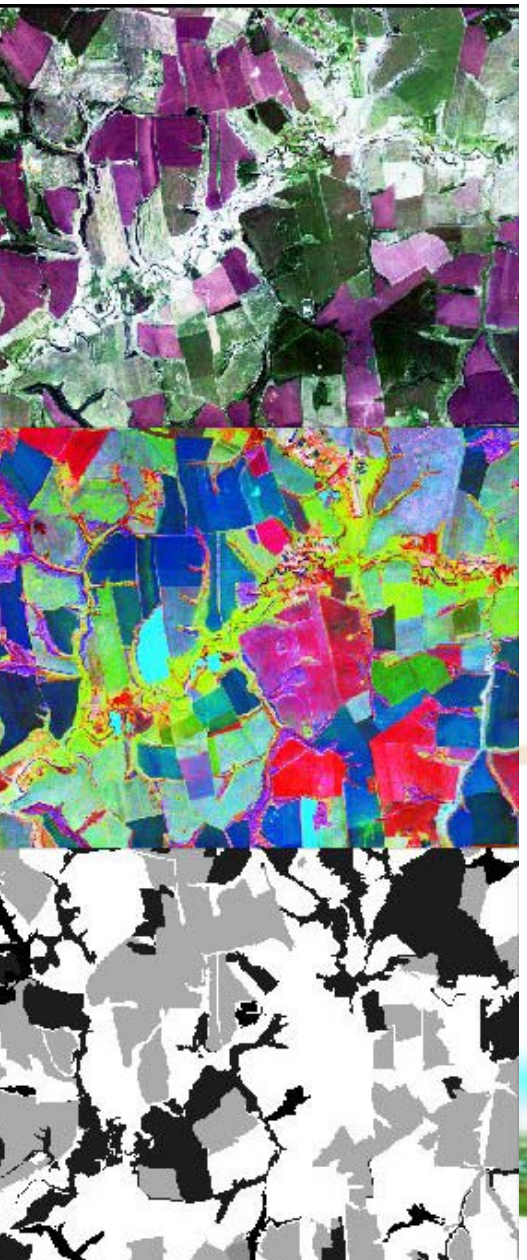
Classification	Reference Other	Winter crops	User Acc.
Other	346	104	0.77
Winter crops	37	143.00	0.79
Producer Acc.	0.90	0.58	
Overall Acc.	0.78		

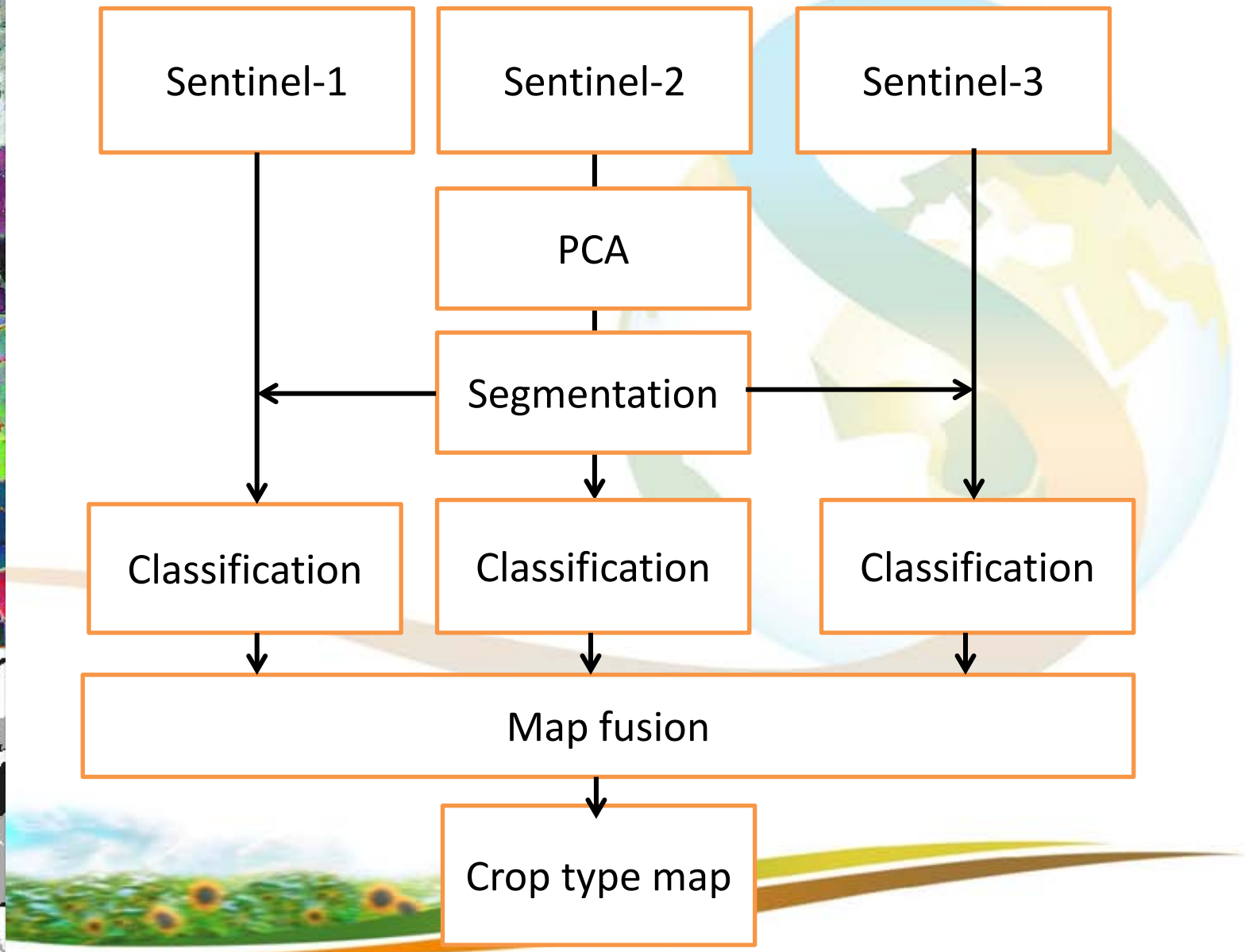


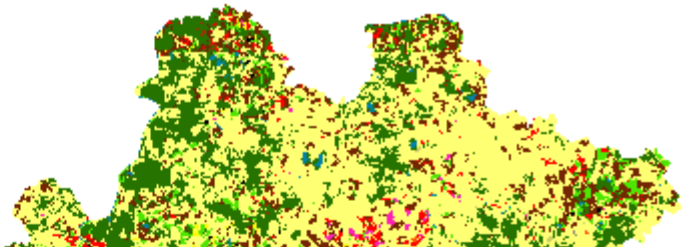

Crop Groups - Tula 2013
6050000
6000000
5950000
5900000
300000
350000
400000
450000
Water bodies
Urban
Coniferous forest
Broadleaved forest
Winter crops
Other crops

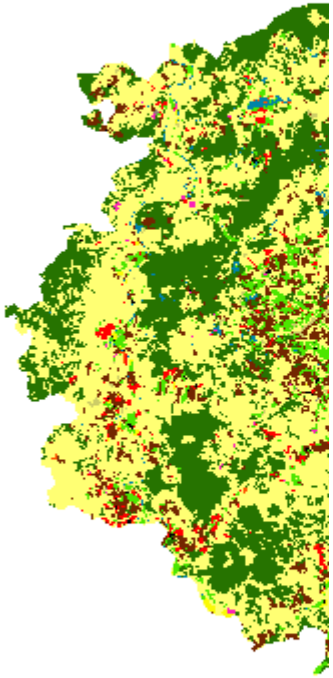
An iterative segmentation-classification-fusion approach (at each new HR acquisition)

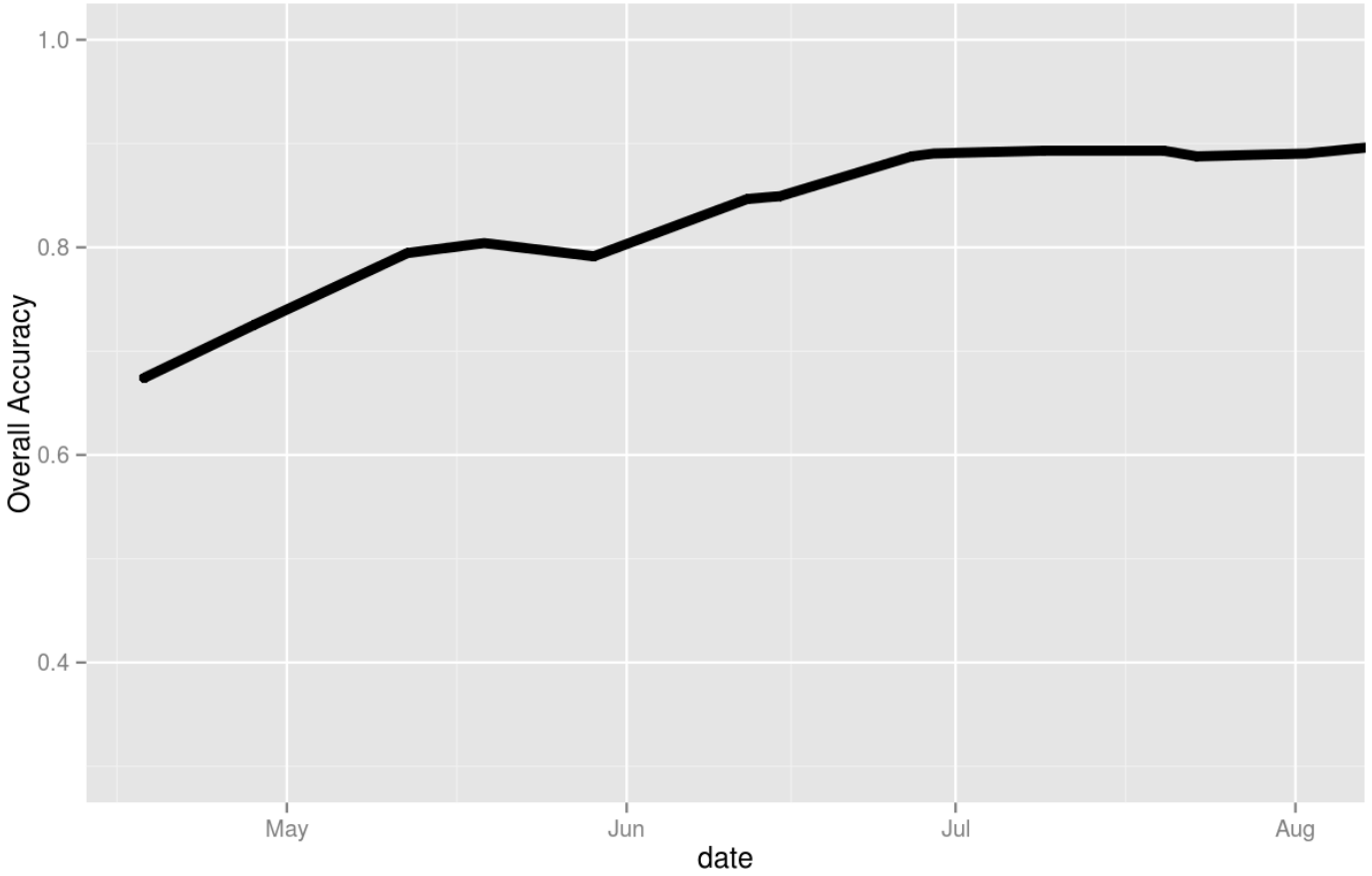
Cropland | Crop groups | Crop types

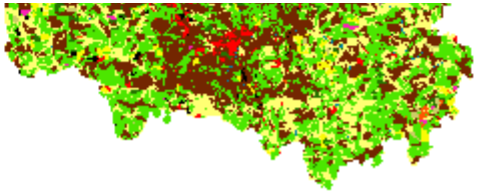












Legend

0 15 30 60

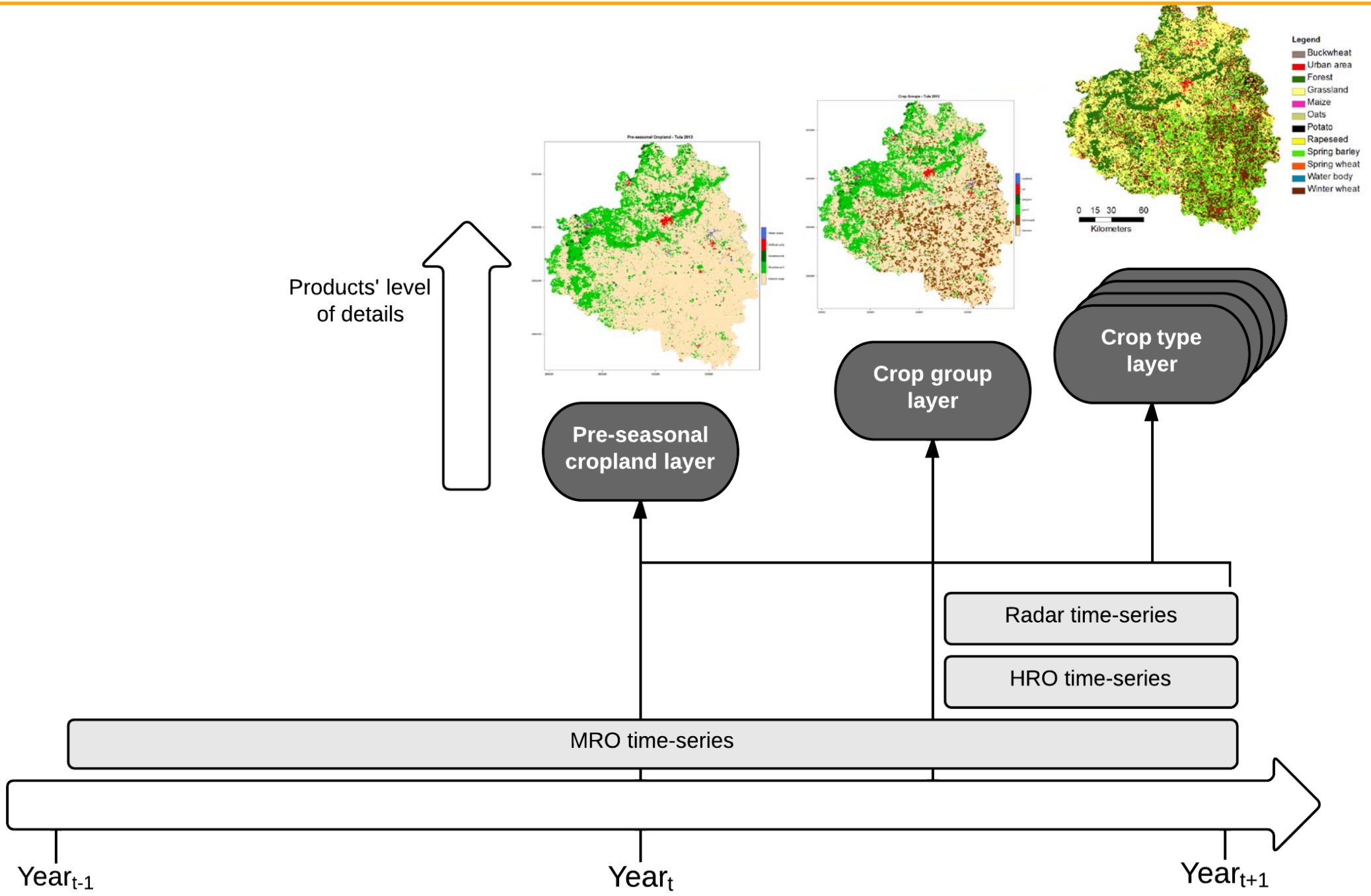
Kilometers

Conclusions

Support agriculture monitoring by providing 3 products along the season using S1, 2 and 3:

- Reduce dependence on data type
- Improve the spatial and thematic accuracy aling the season
- Using S2 defined objects improves the classification of SAR images
- S-3's frequent revisit capacity allows updating rapidly crop information, even before the spring
- 90% of overall accuracy at the end of June

Conclusions



Thanks for your attention !

francois.waldner@uclouvain.com

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