gisat

TerraSAR-X test

Case study on TerraSAR-X use within CwRS campaign on the test sites in the Czech Republic

T6 - New Radar Sensors

Ljubljana 3rd-5th December 2008

Goals of TerraSAR-X case study

Geometrical quality assessment of TSX products

in line with CTS

performed on datasets ortho-corrected by both GISAT and Infoterra

Test on TerraSAR-X image use within CAPI

with particular emphasis on crops discrimination

including dedicated ground survey

The test is performed using standard procedures of CwRS
on two sites of 2008 year: **AKAT** and **HLOH**, where TerraSAR-X images were acquired.

TSX data used

TerraSAR-X data acquired over AKAT and HLOH sites

HLOH: TSX Mode: StripMap

TSX product: MGD (*Multi Look Ground Range Detected)*
Enhanced processing level: **TSX RaN SAR *(Radiometrically Corrected)***

Multi-temporal data:
- Single polarisation – HH (5.5., 13.6.and 3.9. 2008)
- Dual polarisation – VV, HH (15.8. 08)

Ortho-rectified in PCI Geomatica by GISAT

TSX_StripMap data – HLOH site CwRS08

AKAT: TSX Mode: SpotLight

Delivered two distinct TSX products:

Basic processing level: **EEC** (***Enhanced Ellipsoid Corrected)***
- based on SRTM
- pixel size :0.75m, 16u, UTM

Enhanced procesing level: **ORI** (***Orthorectified Images)***
- 1m res, 16u, KRON
- declared enhanced geometric localization accuracy
- based on more precise DEM delivered by GISAT (national DEM - 2m, from ZABAGED)

Mono-temporal data
Ortho-corrected by Infoterra

TSX ortho-correction - HLOH site

TSX StripMap HLOH site

Orthorectification by GISAT:

PCI Geomatica v10.1.3

TerraSAR-X-Specific Model

reference ortho-corrected data: RGB orthophoto CR (0.5m)

national DEM 2m from ZABAGED

resampling method: Nearest Neighbour

output projection: KRON

Tab.1 – TSX Stripmap orthorectification summary statistics

		date	**15.8.**	**3.9.**	**5.5.**	**18.6.**
		pixel size (m)	2.8	1.3	1.3	1.3
		spatial resolution (m)	6	3	3	3
		polarization	dual	single	single	single
GCPs		**number**	**36**	**43**	**49**	**48**
	RMSE (m)	x-direction	2.8	1.2	1.3	1.4
		y-direction	2.4	1.3	1.2	1.2
		total	***3.7***	***1.8***	***1.8***	***1.8***
Control Points		**number**	**10**	**10**	**10**	**10**
	RMSE (m)	x-direction	3.2	1.7	1.2	1.6
		y-direction	1.7	1.0	1.6	1.6
		total	***3.6***	***2.0***	***2.0***	***2.3***

Notes:

- GCPs collection may be more problematic, especially in case of natural terrain without roads crossing etc.;
- high quality and resolution reference data necessary

geometrical quality checks - AKAT site

Spotlight data (AKAT site)

two orthocorrected products on **different processing level** received from Infoterra:

EEC (***Enhanced Ellipsoid Corrected***)
SRTM, pixel size: 0.75m
delivery projection: UTM

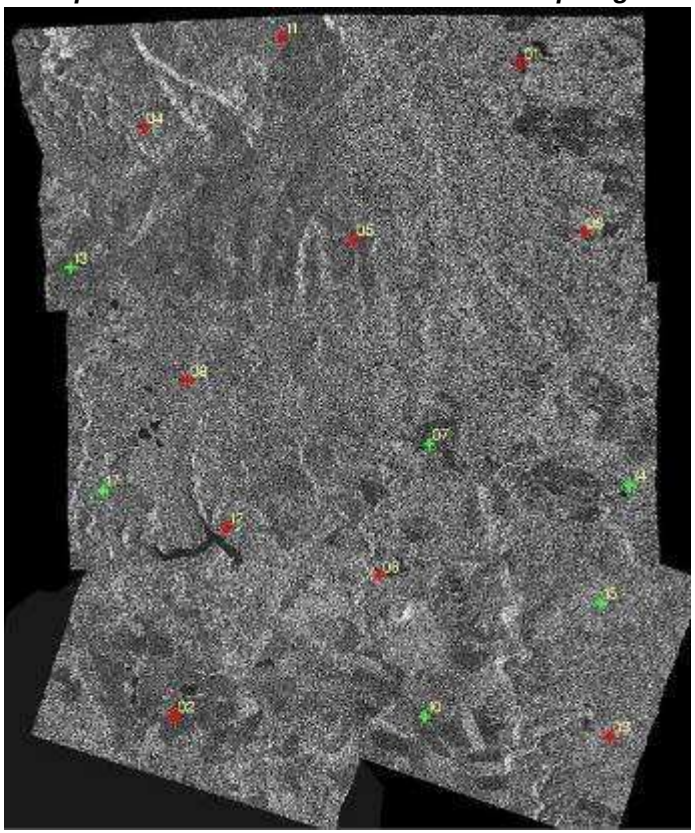
ORI (***Orthorectified Images***)
national DEM 2m, pixel size: 1m
delivery projection: KRON

EEC – mosaiced and reprojected to KRON (in PCI Geomatica)

15 independently collected checkpoints based on orthocorrected RGB ortophoto (0.5m) as reference

comparison of EEC and ORI products positional accuracy – currently under deeper analyses by Infoterra and GISAT

Checkpoints distribution over TerraSAR-X Spotlight mosaic



+ ***GCP with residual EEC > residual ORI***

+ ***GCP with residual EEC < residual ORI***

Tab. 2 – Checkpoints summary statistics

	RMSE (m)			*max. residual (m)*		
	x	**y**	**total**	**x**	**y**	**total**
AKAT_Spotlight_EEC	5,41	1,66	**5,66**	8,76	4,54	***8,78***
AKAT_Spotlight_ORI	5,70	1,48	**5,89**	13,22	4,17	***13,86***

Test on TSX use in CAPI

Test on TerraSAR-X images use within CAPI includes:

selection of suitable TSX product for CAPI purposes (multi-temporal vs. mono-temporal, single vs. dual polarization)

multi-temporal **data pre-processing** (image filtering, multi-temporal composition)

CAPI simulation with use of TSX data focused on:

parcel boundaries detection

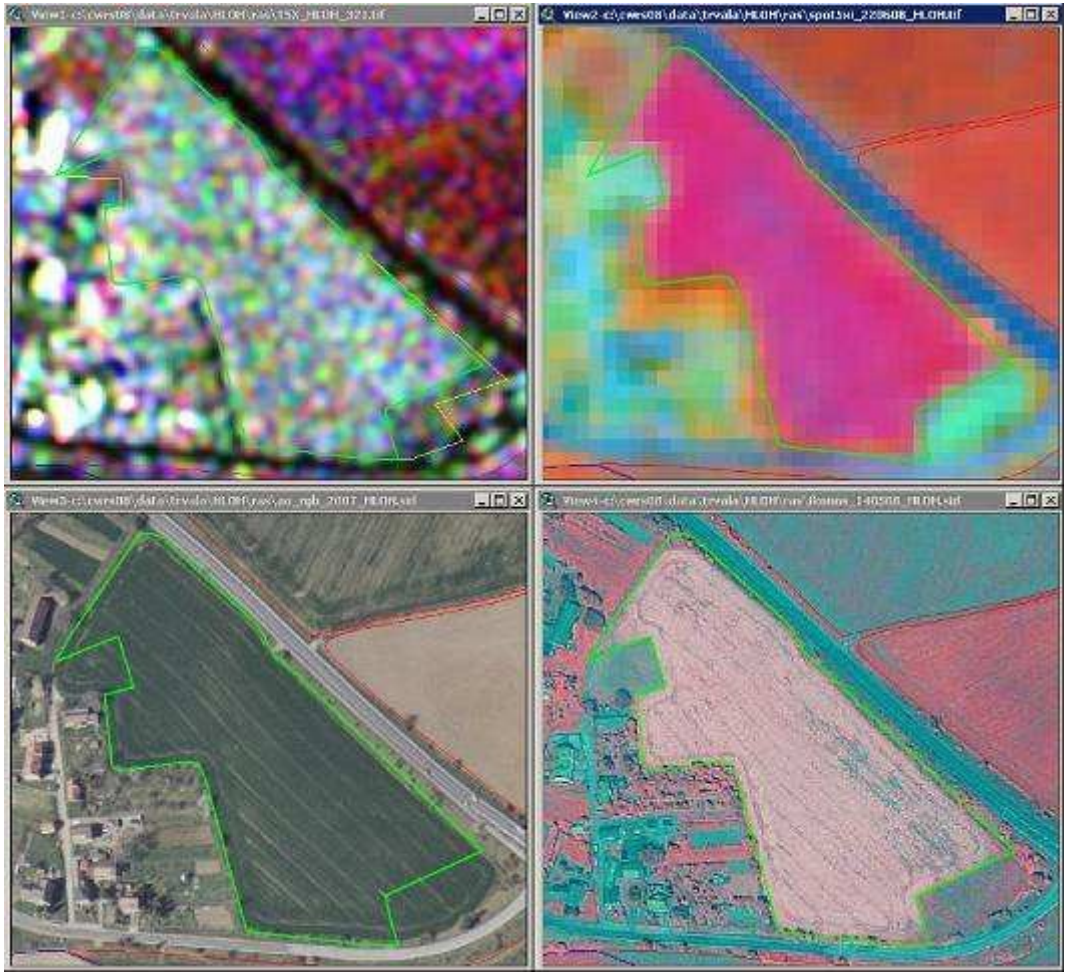
discrimination of agricultural land use – crop category (arable crops x grassland x orchards etc.)

crop discrimination (interpretation key creation)

detection of non-eligible use indicating e.g. **abandoned land**

dedicated ground survey - reference ground truth information including photo documentation performed by **standard procedures** using **dedicated software environment** (ArcGIS, ArcView, PCI Geomatics)

Test on TSX use in CAPI – DATASET



Auxiliary data:

standard CwRS dataset: VHR (ikonos), RGB ortophoto (0.5m), HR data (SPOT5 XS)

Reference ground data based on **ground survey**

including photo documentation

TSX multi-temporal RGB composition

TSX multi-temporal RGB composition and CwRS dataset: SPOT5 XS, RGB ortophoto, VHR (ikonos) in standard CwRS software environment based on ArcView

Test on TSX use in CAPI – DATASET

Dedicated ground survey:

carried out for **155 parcels** randomly selected from 2557 on HLOH site (6,1%)

Time series: 7. 4., 10. 5., 27. 6. and 26. 8. 2008

including photo documentation

Tab.3 – Ground survey statistics

agricultural use	number of parcels	crops	number of parcels
arable land	***77*** *(50%)*	winter cereal	***36***
		oilseed rape	***12***
		maize	***6***
		spring cereal	***6***
		fodder (alfaalfa)	***4***
		mustard	***3***
		mixed	***6***
		pea	***1***
		sugarbeet	***1***
		sunflower	***1***
		other	***1***
pasture	***12*** *(8%)*		
orchard	***2*** *(1%)*		
abandoned	***64*** *(41%)*		

TSX product selection

Selection of appropriate TSX product for CAPI purposes

There exists more combinations how to acquire TSX data!

higher spatial resolution 1m – mono-temporal (AKAT)

x

lower spatial resolution 3 (6) m – multi-temporal (HLOH) ------ ***time series***

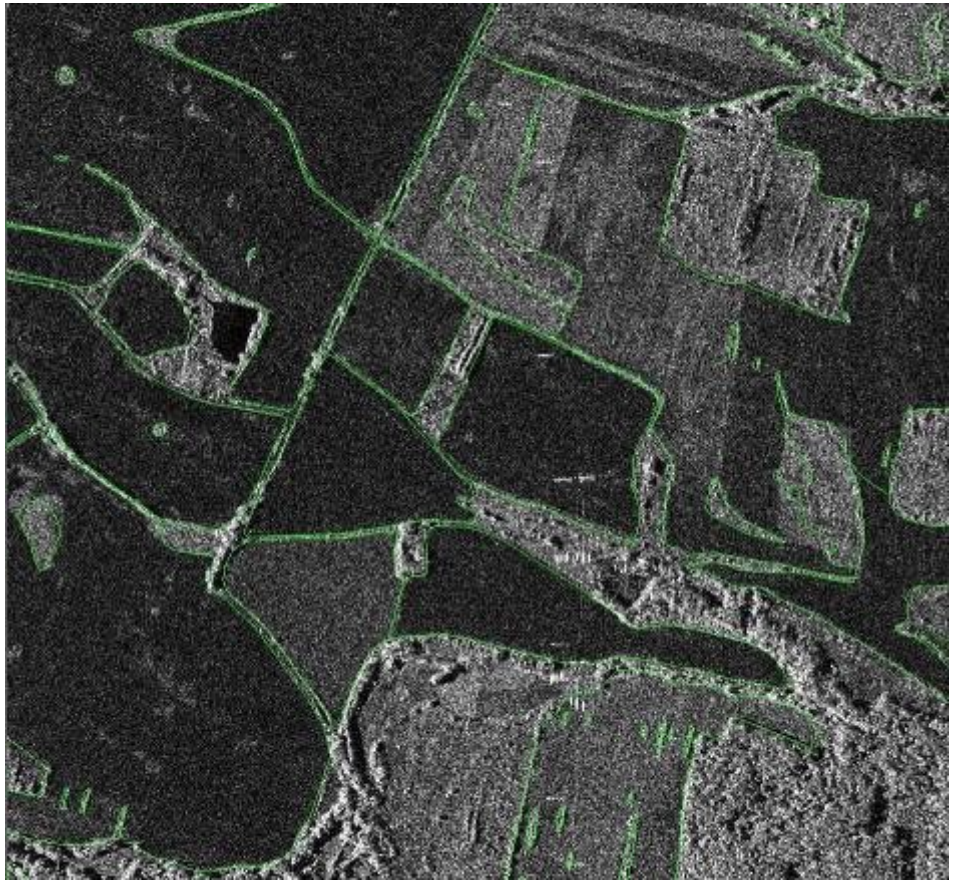
single (3m) x dual (6m) polarization

Criteria for selection:

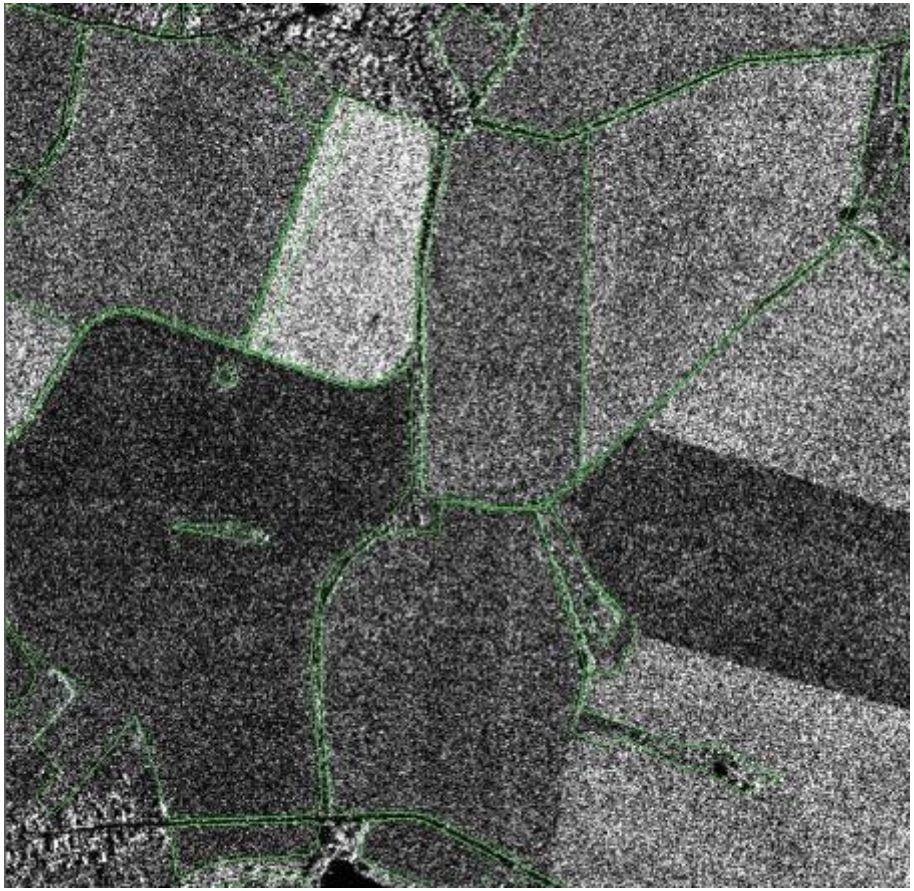
positional accuracy
parcel boundaries detection
ineligible areas detection
agriculture land use / crop discrimination

TSX product selection

SpotLight (1:10 000)

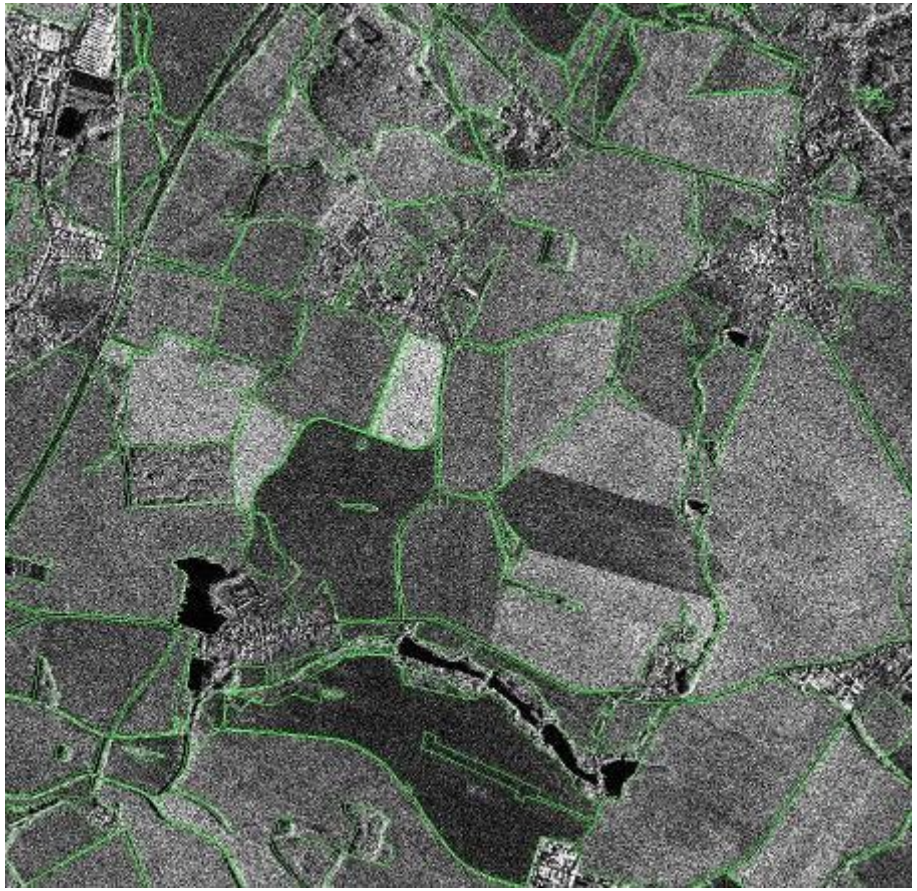


StripMap



TSX product selection

Mono-temporal (1:25 000)



Multi-temporal (1:25 000)

TSX product selection

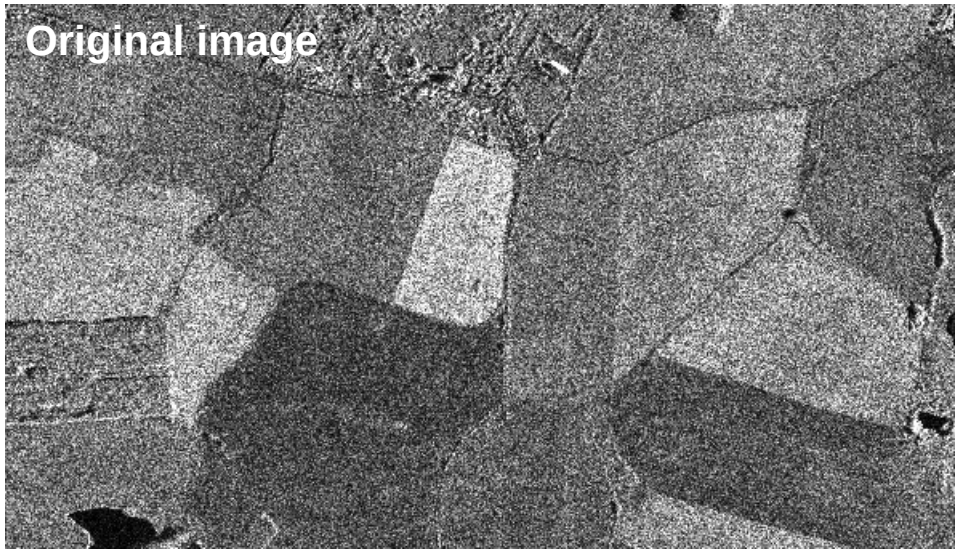
Dual polarization

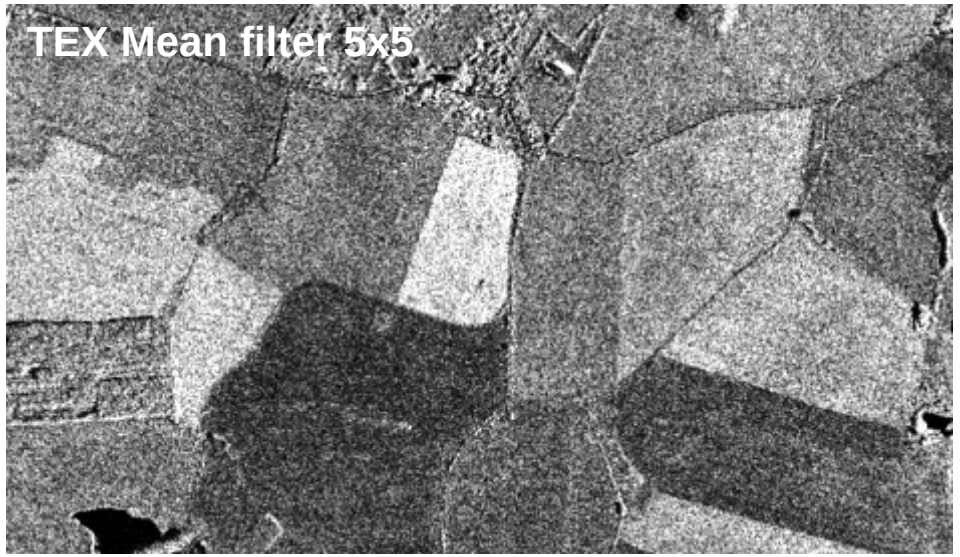
Multi-temporal - single

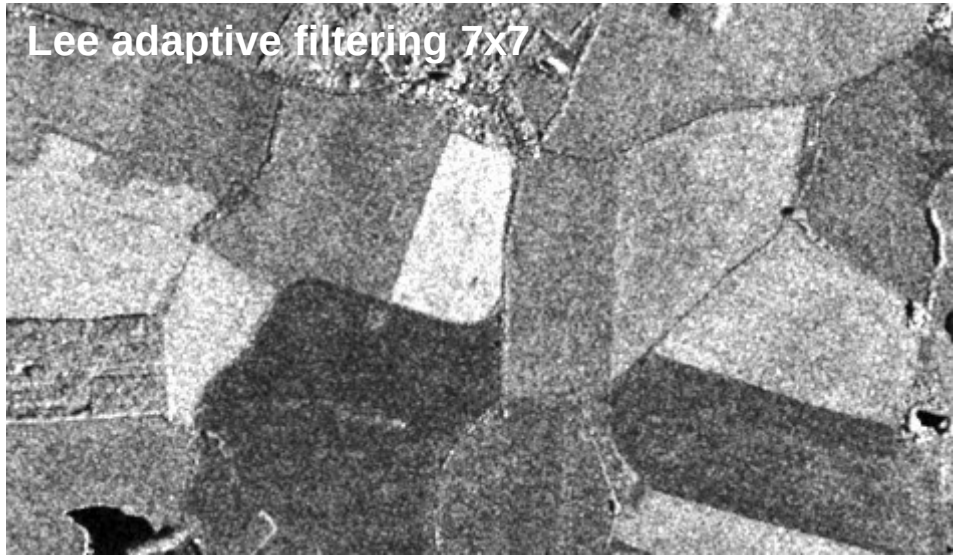
Data pre-processing

Image filtering (speckle removal)

- Enhancement of thematic information for CAPI
- Spatial resolution degradation (field boundaries)
- Tests of Mean and Lee adaptive filters



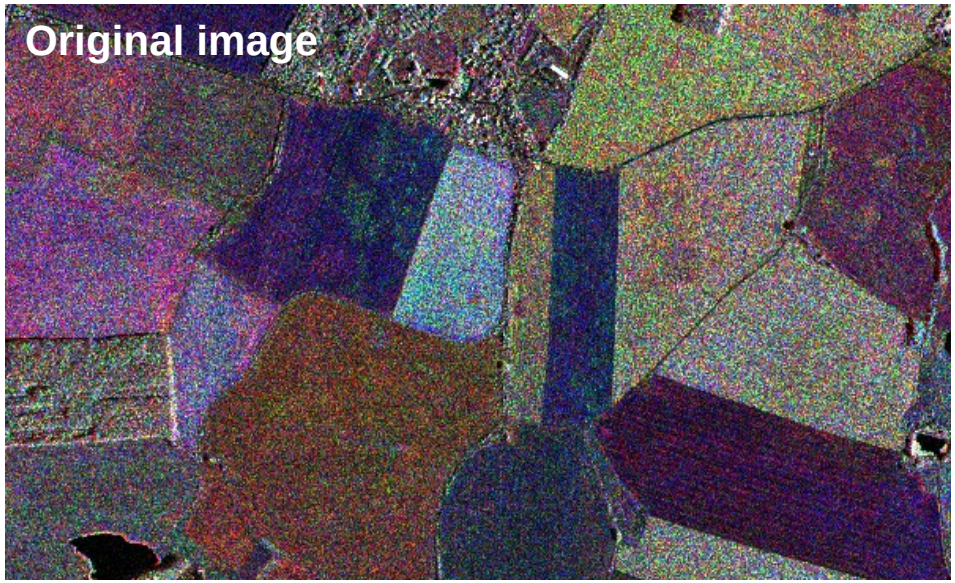


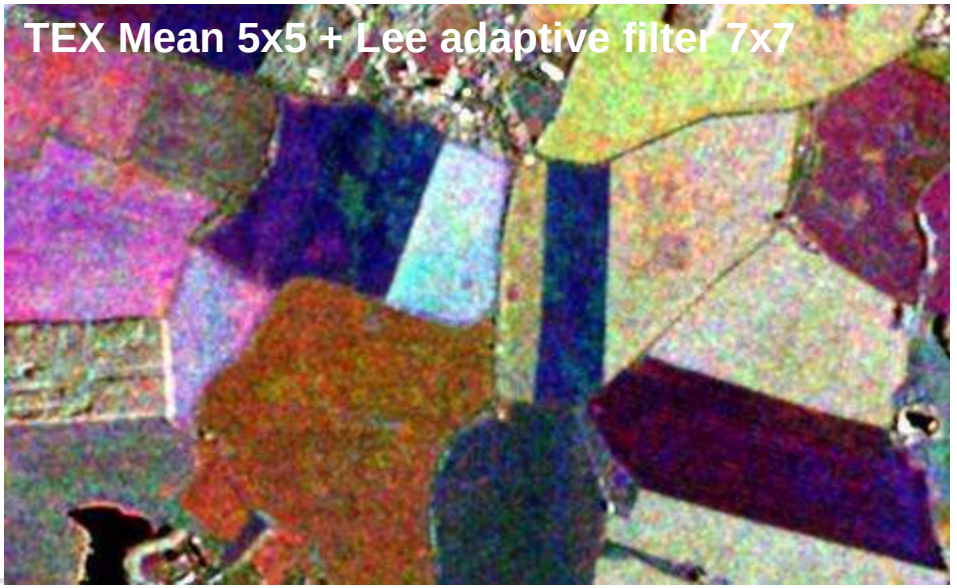


Data pre-processing

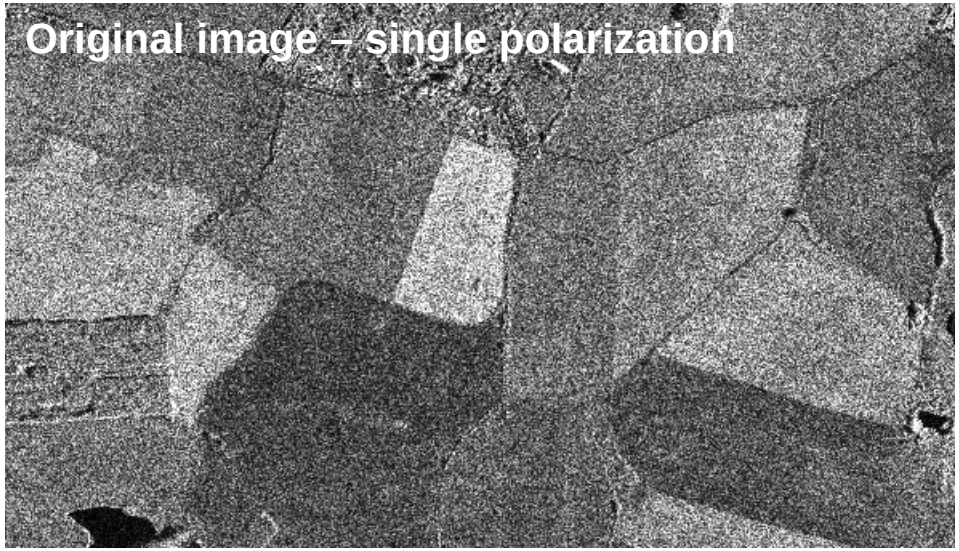
Multi-temporal composition (RGB)

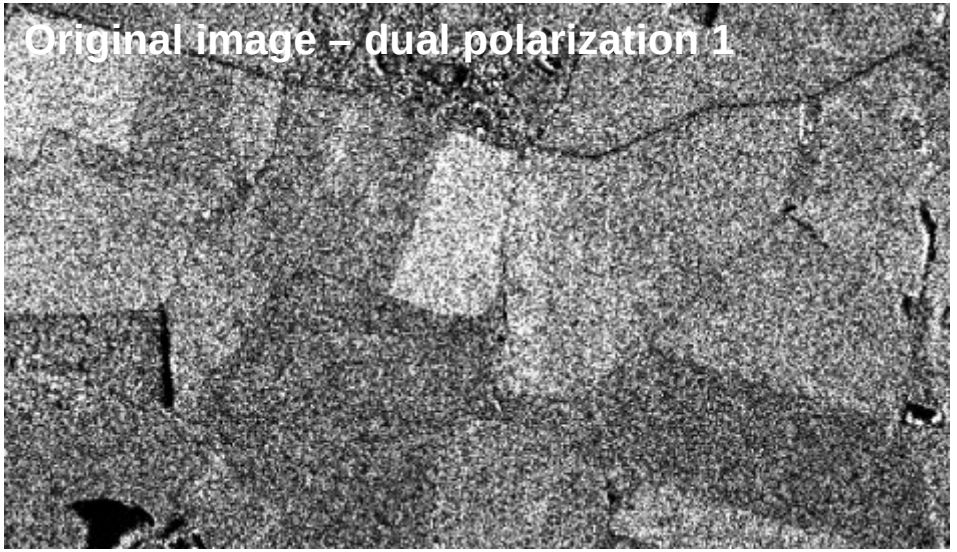
spring – summer – autumn composition
LUT applied

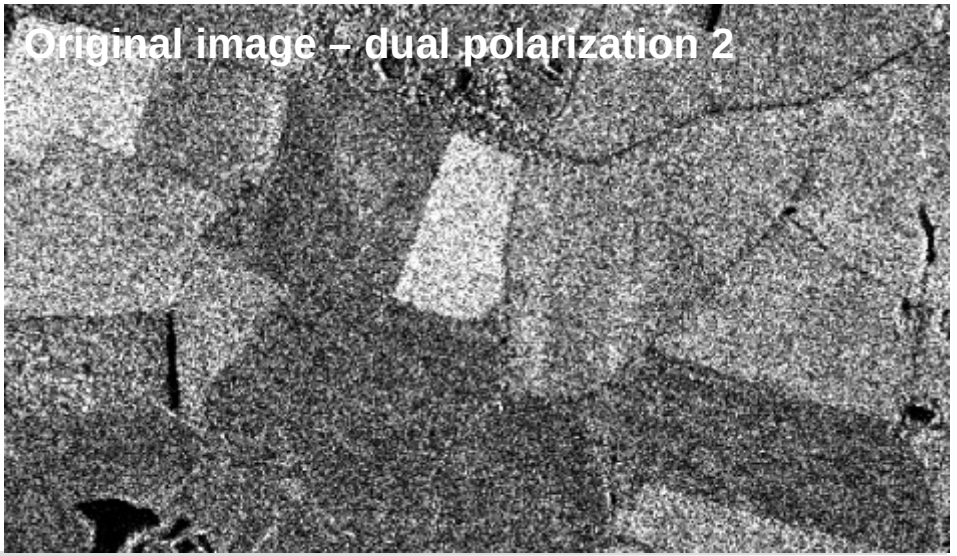




Data pre-processing



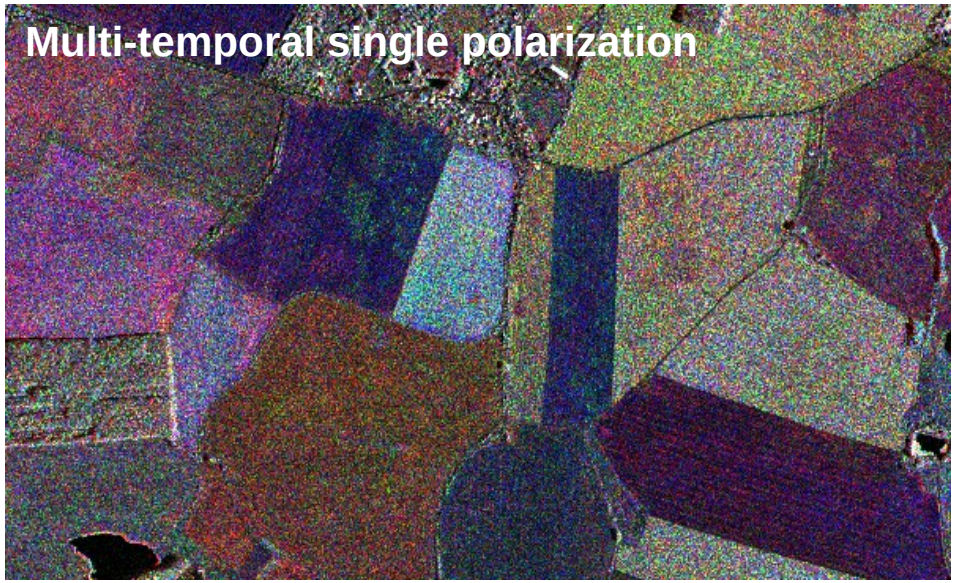


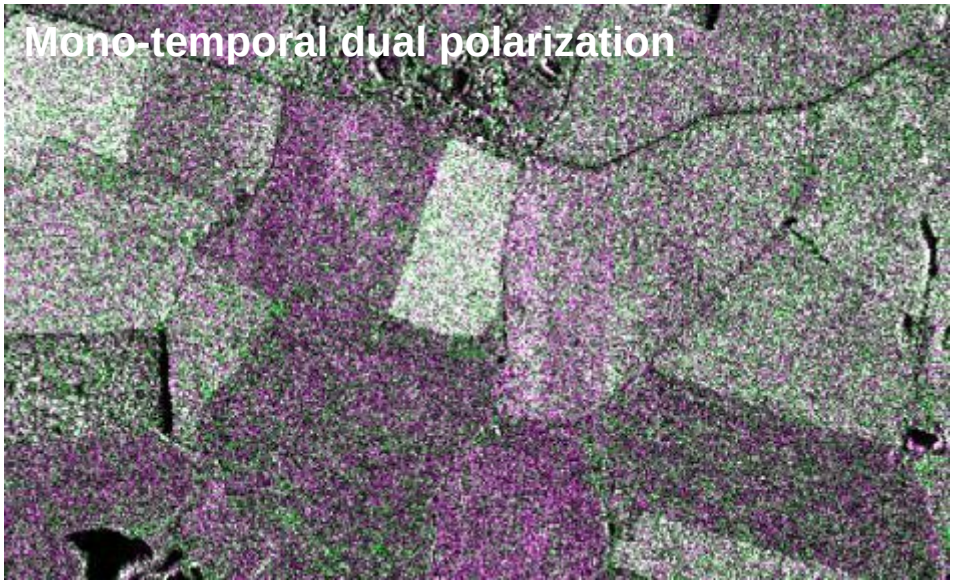


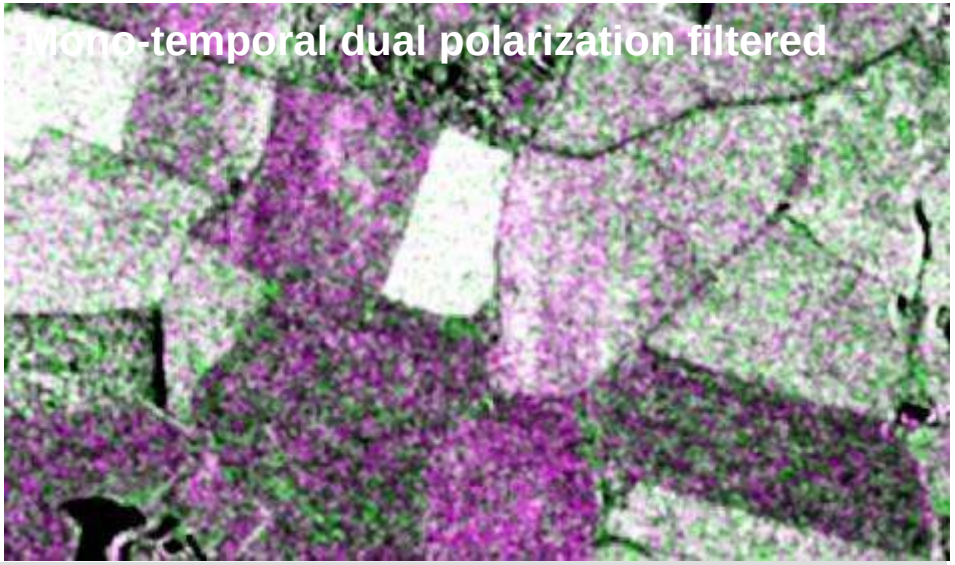
Single vs. dual polarization

3 m vs. 6 m

Data pre-processing







Single vs. dual polarization compositions

Multi-temporal single polarization vs.
Mono-temporal dual polarization

CAPI examples

Parcel boundaries detection

adjacent parcels with **identical crops:**

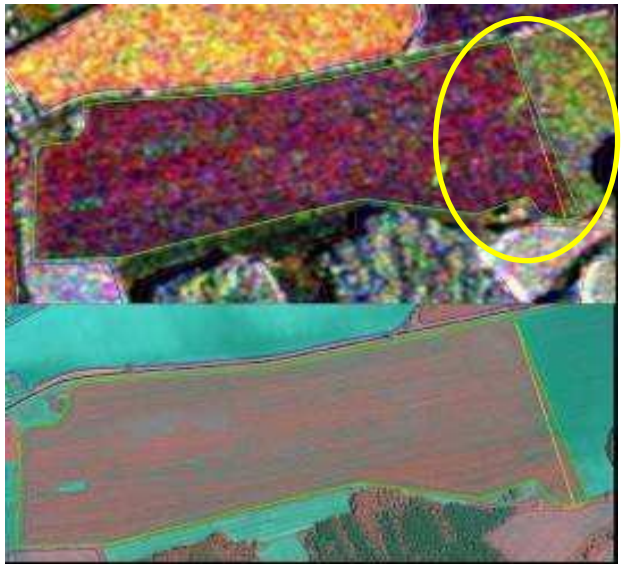
possible uncertainties caused by image noise

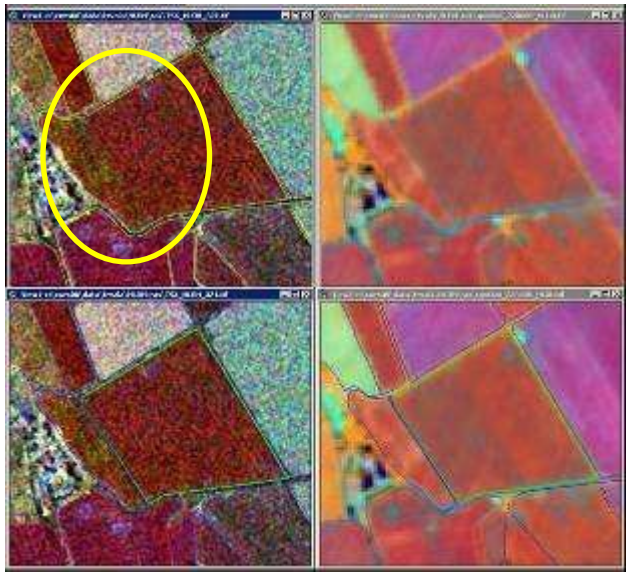
adjacent parcels with **different crops:**

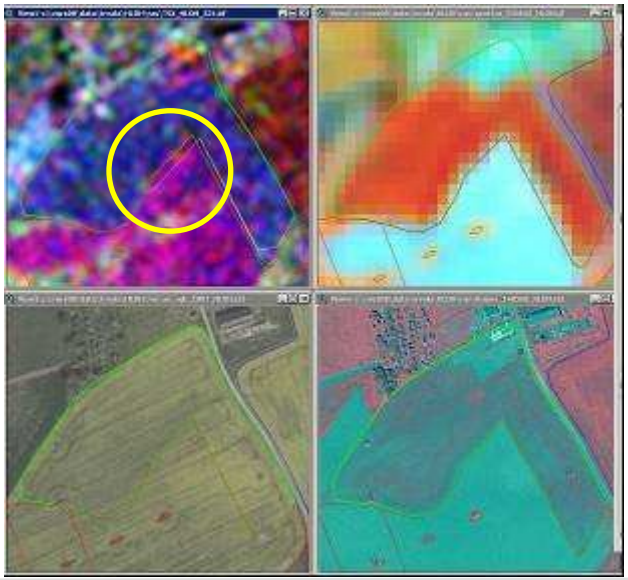
boundary changes based on TSX data quite reliable;

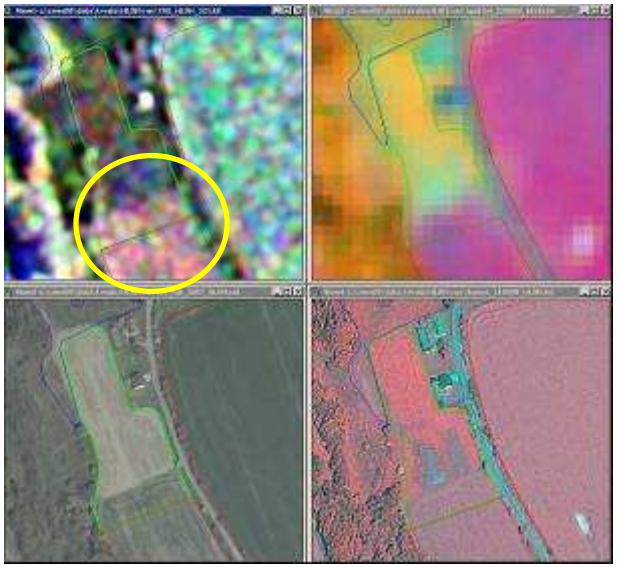
for accurate boundary editing - VHR data necessary

* in general: **comparable with "single" HR optical imagery**



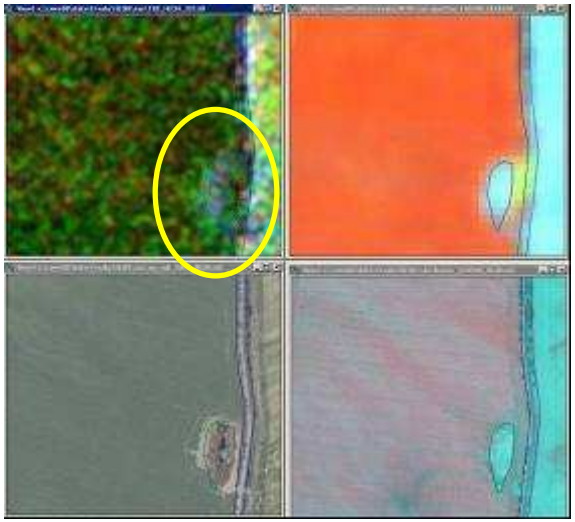


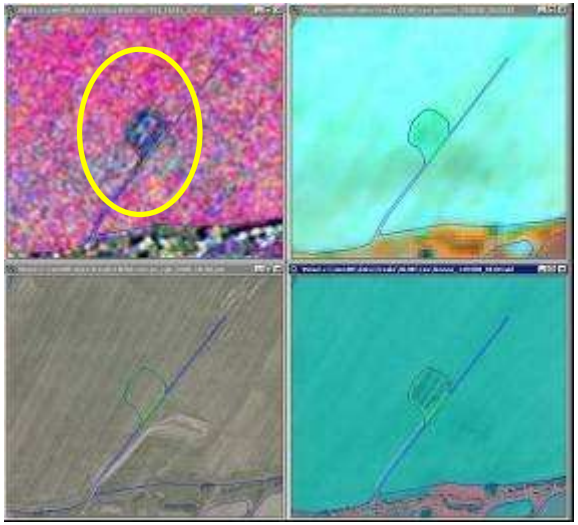


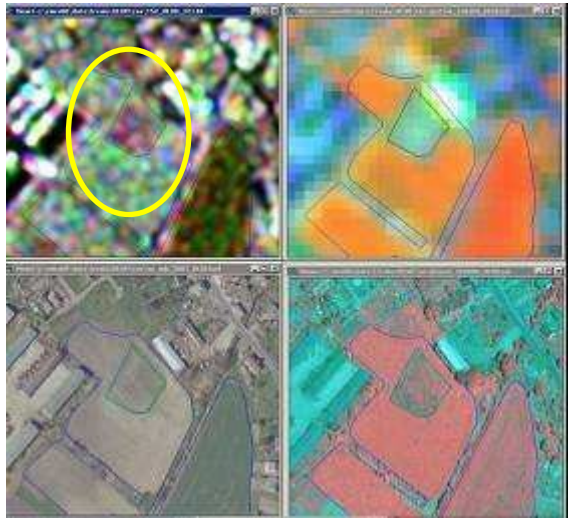


CAPI examples

Non-eligible use detection







quite **easily recognizable**

non-eligible areas have **different characteristics** than the rest of a parcel

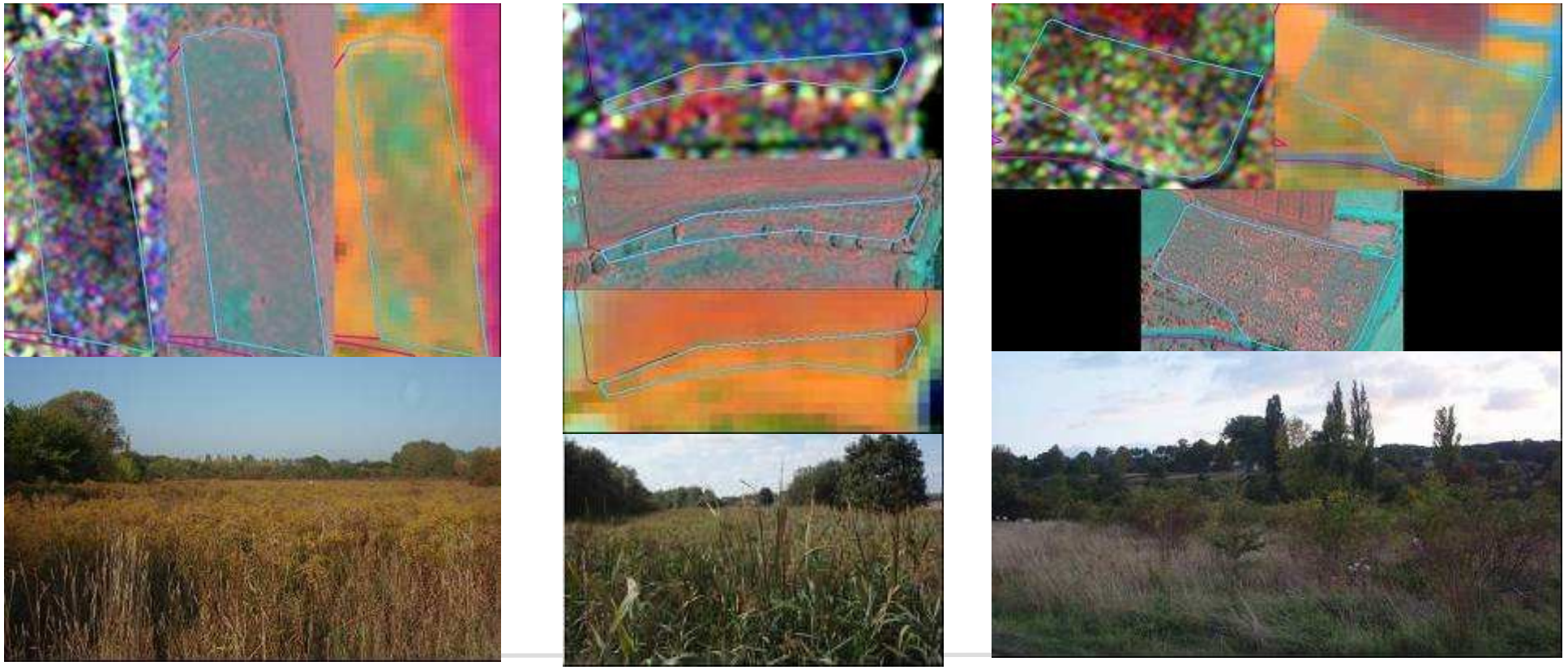
comparable with “single“ **HR optical imagery**

Non-eligible area on grassland

Abandoned land detection

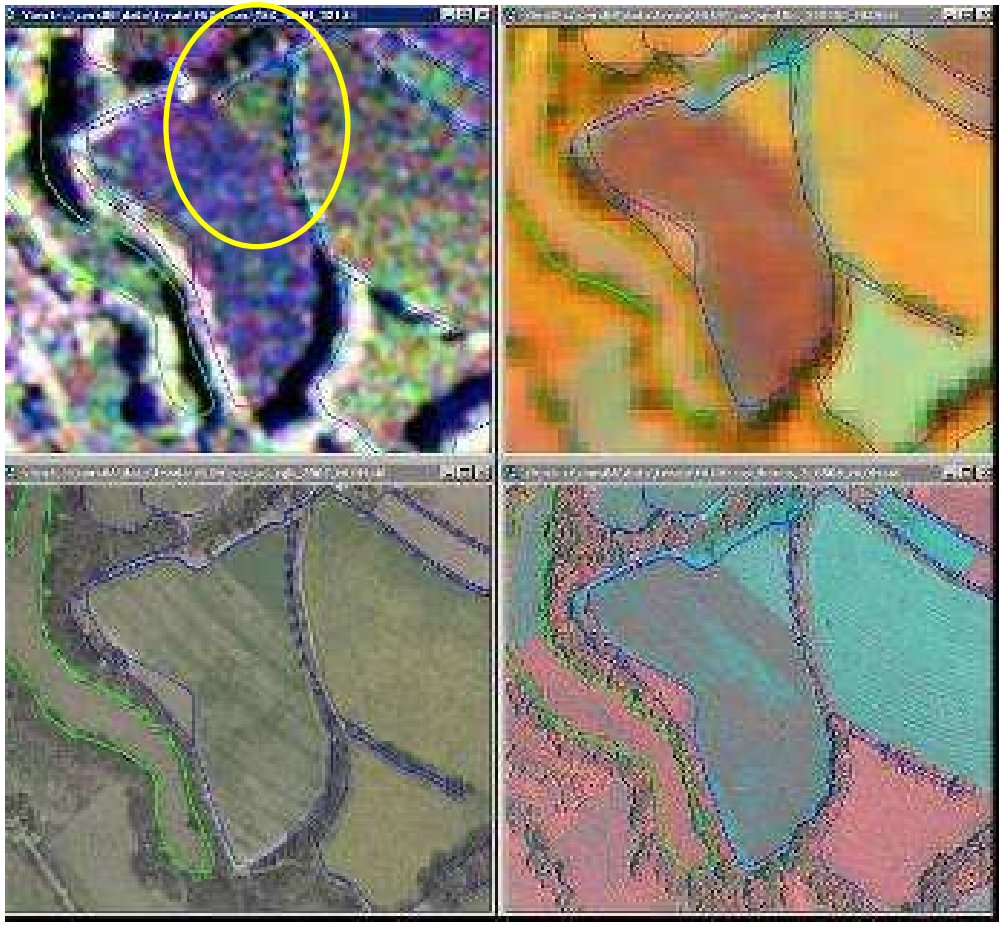
characteristic: **high texture** indicates parcels with overgrown vegetation with possible occurrence of shrubs = potential abandoned land

quite probable confusion with eligible pastures, witch have similar spectral and textural characteristics

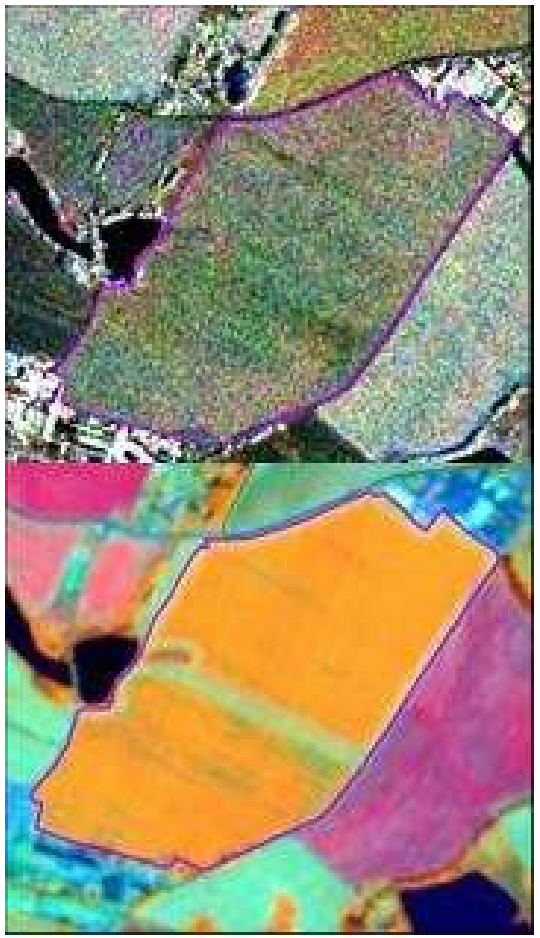


Agricultural land use

Crop categories: arable land vs. grassland



Lucerne

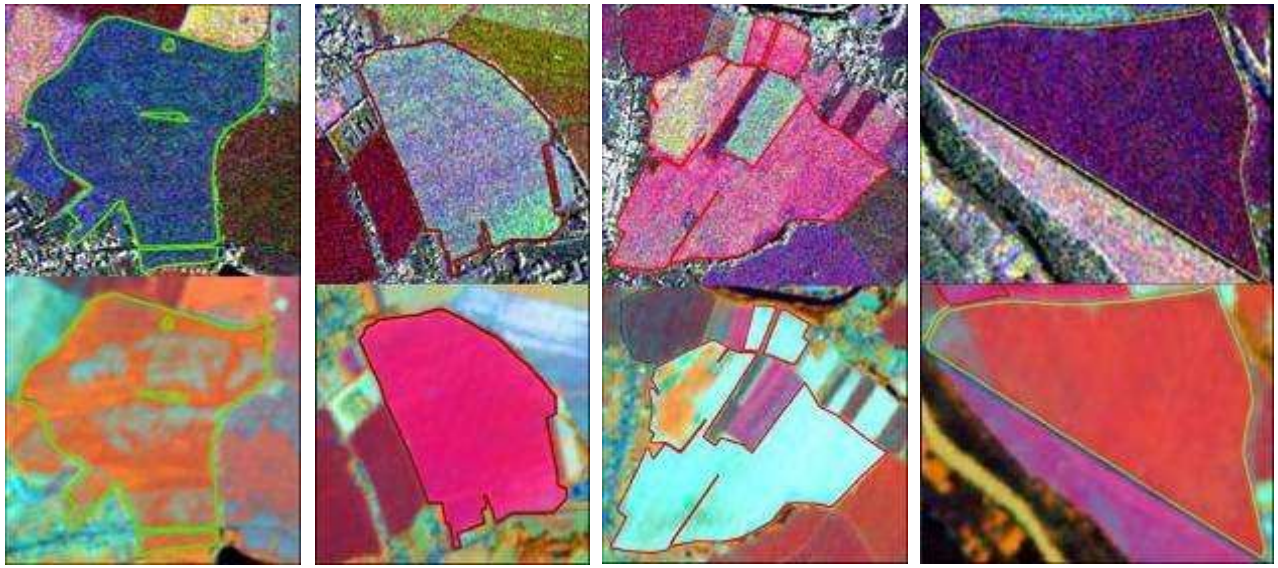


Crop discrimination

using information about crops location obtained through ground survey
interpretation logic - time series

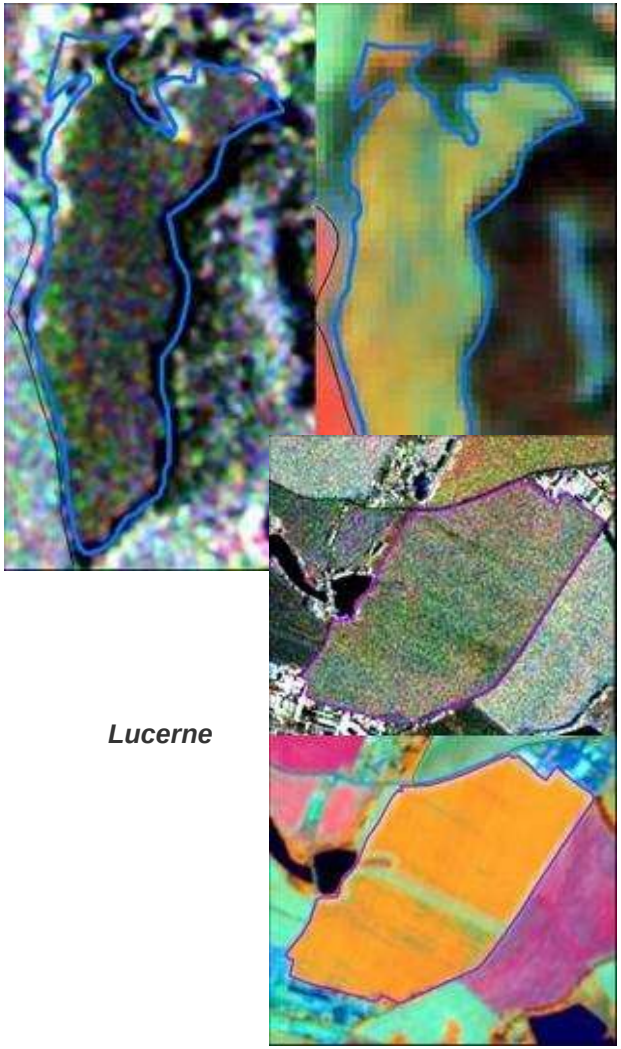
Interpretation key creation

Easily distinguishable crops



Spring cereals *Oilseed rape* *Maize* *Winter cereals*

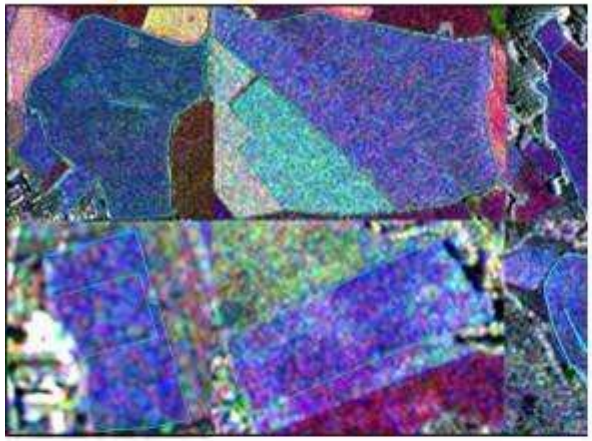
Uncertainties *Grassland*



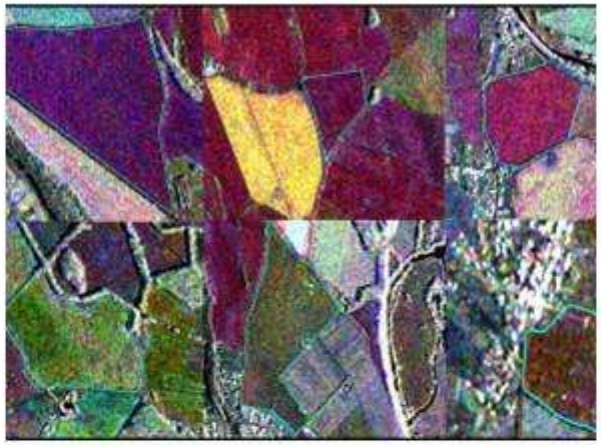
Lucerne

Interpretation key

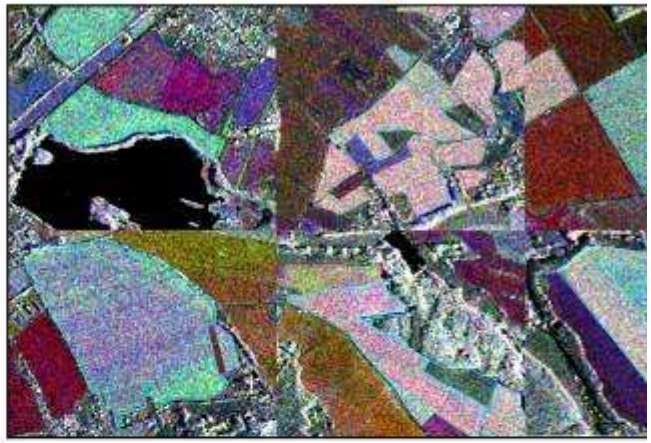
Spring cereals



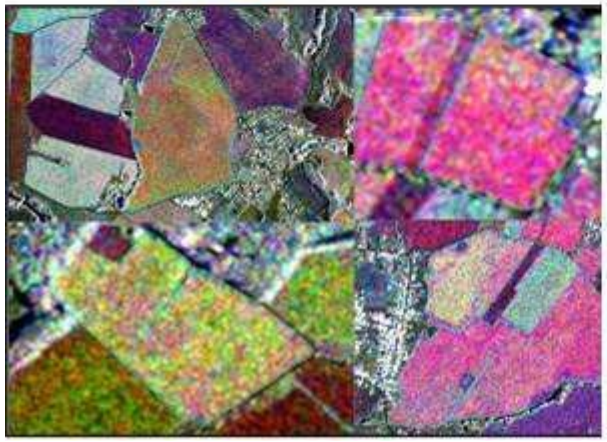
Winter cereals



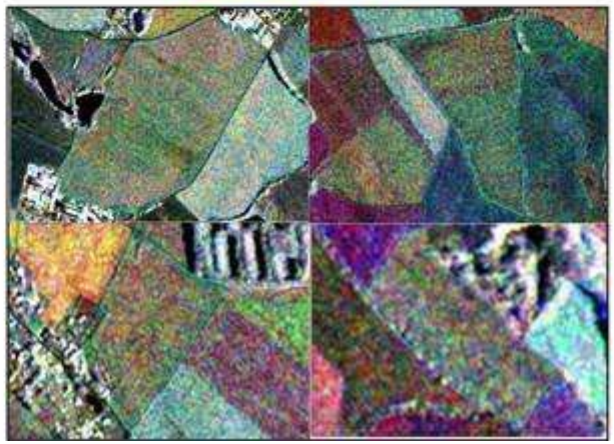
Oilseed rape



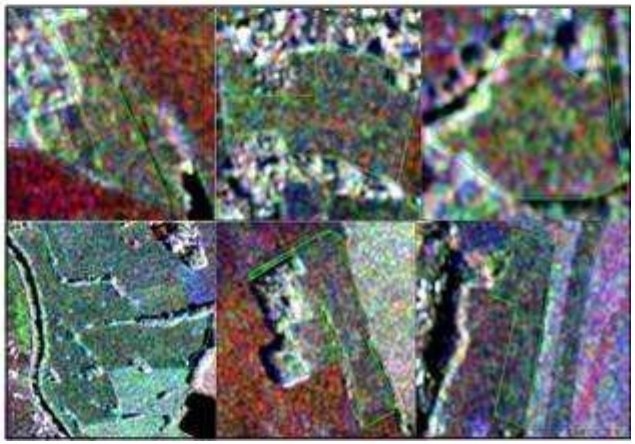
Maize



Lucerne



Grassland



CAPI summary

TSX data potential for CAPI:

parcel boundaries editing:

TSX spatial resolution is not sufficient for accurate position locating

ancillary VHR data necessary

agricultural land use / crop categories discrimination:

muti-temporal data necessary

image pre-processing for enhancement of thematic information (filtering, RGB multi-temporal composition)

Possible discrimination of:

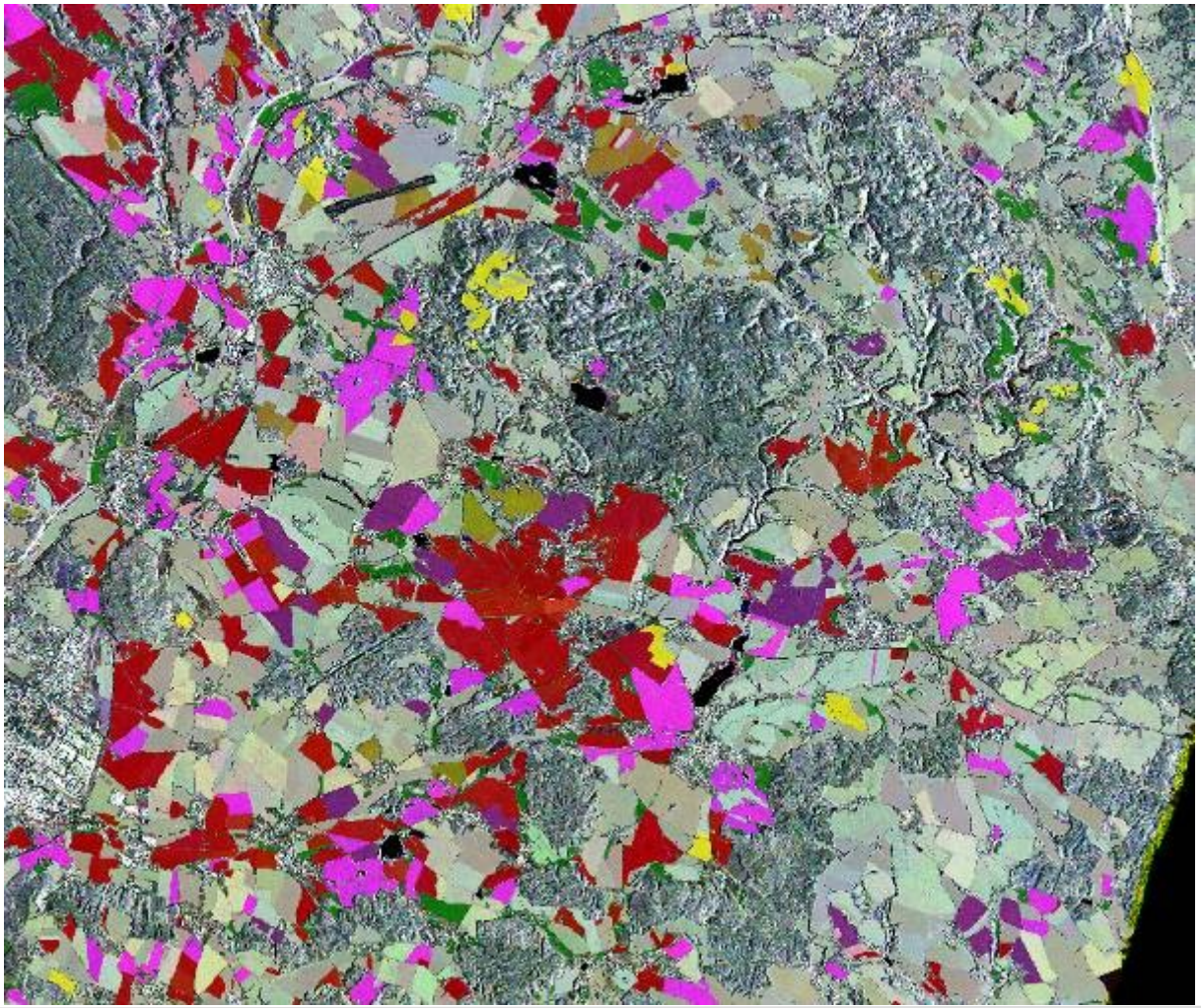
- **agricultural land use – crop categories**
- **crop discrimination**
- **non-eligible land**

Comparable with *single* HR optical imagery

- **ability to distinguish different crops on TSX data depends on particular crop type image acquisition timing**

Future work

Automatic detection of crops by means of Object-oriented Image Analysis
NOT FINISHED!!!




Thank you for your attention!