

# Semi-automated extraction of Landscape Features from VHR satellite data

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# Goals and motivations

Landscape Features: GAEC for control „Maintaining of landscape features protecting soil against water, and wind erosion“

- GAEC control: visual interpretation of current VHR image and historical aerial orthophotos
- LPIS does not include any information on Landscape Features

Landscape Features: ecological, geo-morphological or estetical value ...

- There are not any information on spatial distribution and changes of LF - various ecological studies
- Protection of soil against erosion also in other (non-European) regions

# Objective

Develop and test methodology for identification and extraction of LF by automatic/semi-automatic procedure from satellite images

= reference layer for GAEC controls

- As much as automated procedure
  - Identify LF
  - Extract polygon layer of LF
- Compare with visual interpretation
- Derive basic statistics
- Accuracy assessment based on manual extraction as ground truth
- Apply developed methodology



# Landscape Features defined

- hedgerow (windbreak, trees and shrubs in rows)
- solitary trees
- groups of trees
- wooden embankment
- ditch, dike, channel, earthen embankment, ... etc.

Definition: non-productive parts of agricultural landscape with ecological and geomorphological value

→ focus lies on vegetation units



# Data used

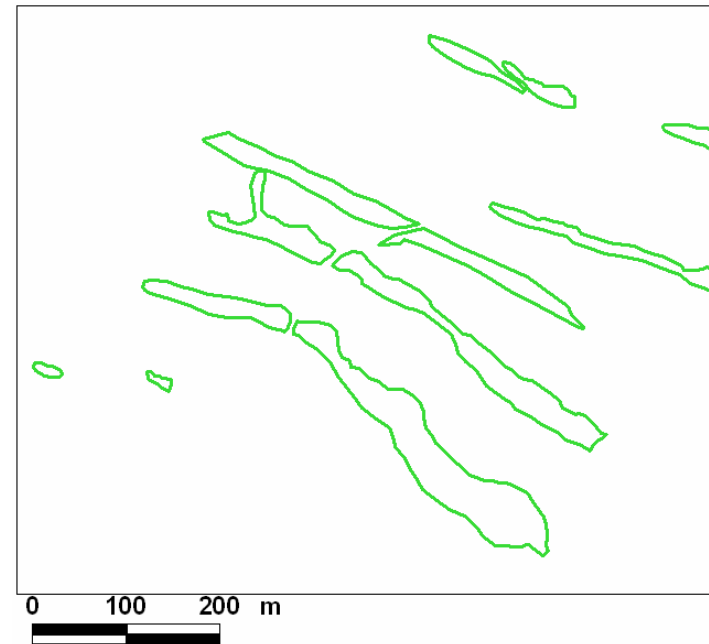
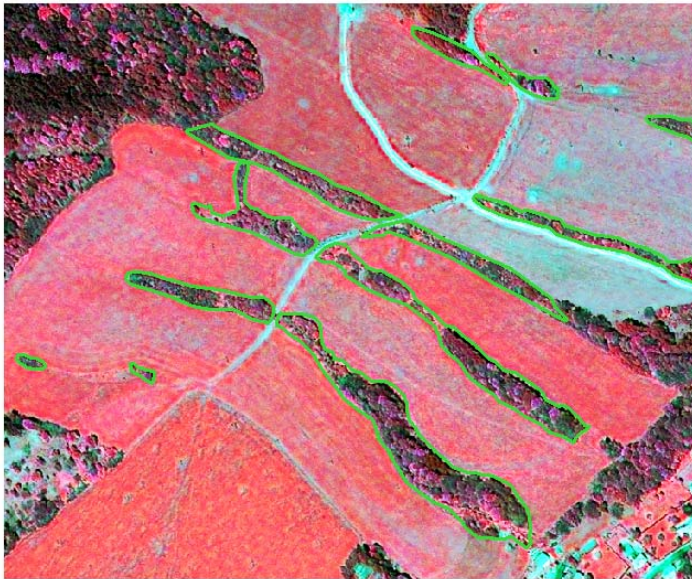
## Satellite VHR data: IKONOS images

- Pan + R G B NIR
- NDVI (per pixel)
- Texture measures (Haralick - homogeneity, Sobel edge filter - NIR)

Auxiliary data: LPIS (DAIFOR project)



# LF manual extraction

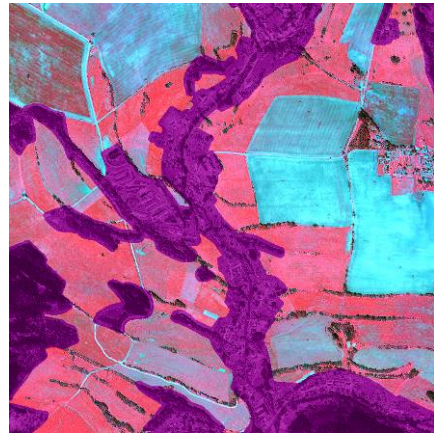
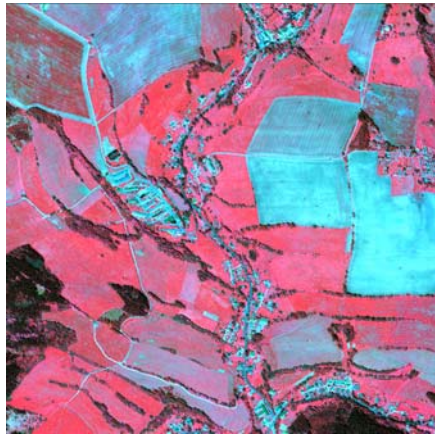


# Automatic extraction

Object oriented image processing (Definiens Professional v. 5, Definiens Developer v. 7)

- Segmentation
  - Find the right image segments
- Classification
  - Object-based fuzzy logic classification
- Post-processing
  - Cleaning the classification result
  - Extraction of object statistics
  - Exporting the object shapes
- Accuracy assessment

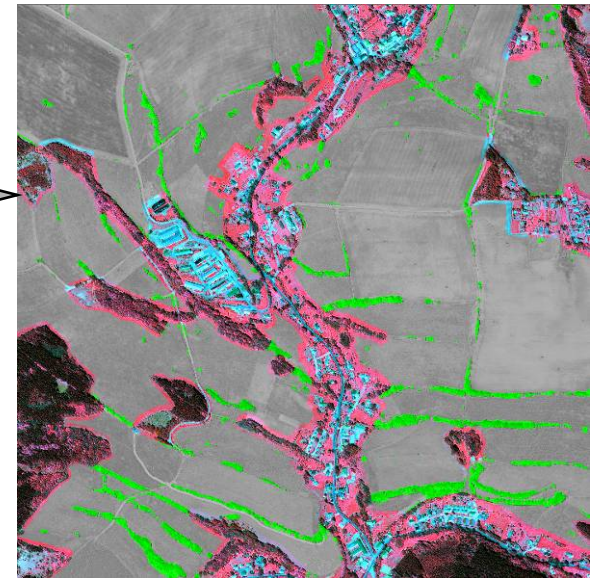
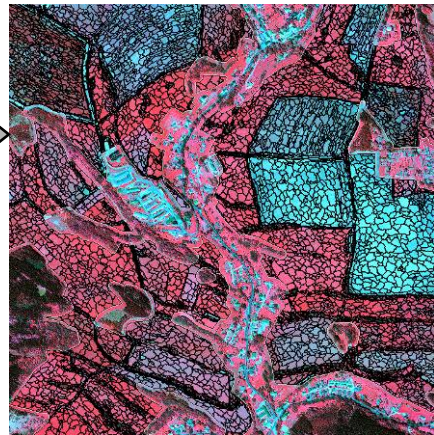
# Automatic extraction



Urban and Forest  
mask

Landscape  
Features  
classification

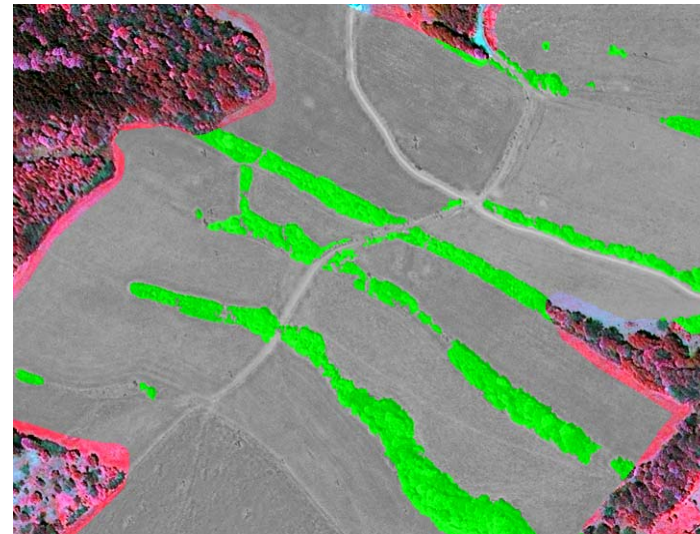
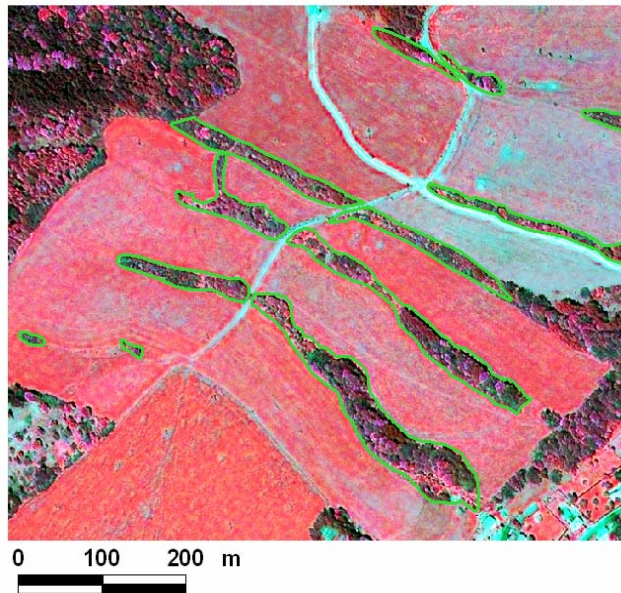
Segmentation



# Post-processing

## Cleaning the classification result

- filtering the gaps
- reshaping resulting polygons (border optimisation, application of mathematical morphology algorithms; testing by generic shape futures)



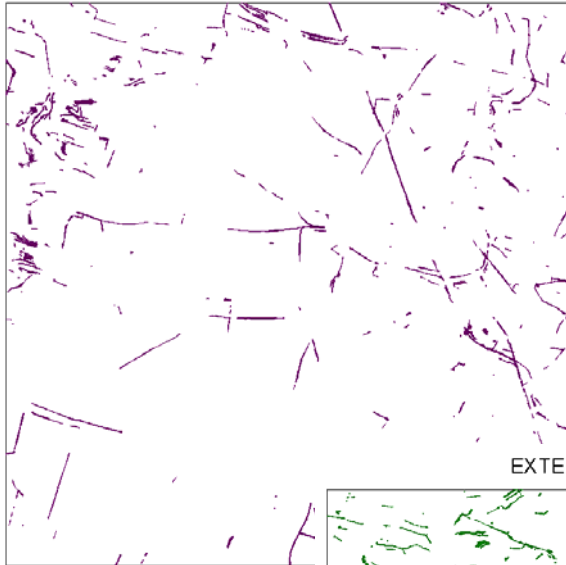
# Post-processing

Extraction of object statistics and exporting the object shapes

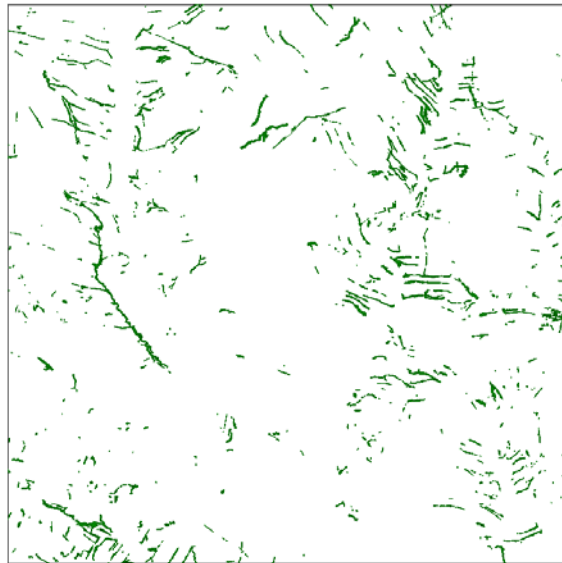
- LF stock and typology (object-oriented)
  - Total area
  - Total perimeter
  - Length/width ratio
  - Min, max, median area
  - Size distributions
- LF breakdown according LPIS mask (object-oriented)
  - stock and typology inside and outside LPIS borders
- Proximity to linear features in the landscape (ArcGIS)
- LF breakdown according the proximity of pasture or arable land (object-oriented)

# LF distribution and basic statistics

INTENSIVE AREA



EXTENSIVE AREA



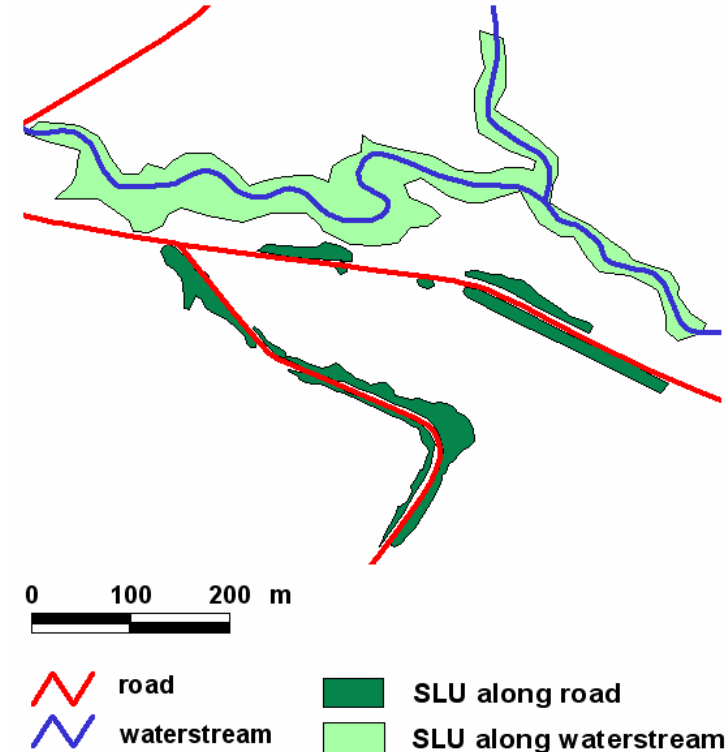
	INTENSIVE area	EXTENSIVE area
<b>agricultural land</b>	<b>84,4 %</b>	<b>50,7 %</b>
<b>number of SLUs</b>	<b>584</b>	<b>1266</b>
<b>total area</b>	<b>111.8 ha</b>	<b>202.8 ha</b>
<b>avg. area</b>	<b>0.19ha</b>	<b>0.16 ha</b>
<b>min. area</b>	<b>15.3 m2</b>	<b>12.9 m2</b>
<b>max. area</b>	<b>3.7 ha</b>	<b>7.8 ha</b>
<b>area median</b>	<b>0.089ha</b>	<b>0.049 ha</b>
<b>area modus</b>	<b>0.004ha</b>	<b>0.005 ha</b>
<b>total perimeter</b>	<b>232 km</b>	<b>278 km</b>
<b>perimeter median</b>	<b>231 m</b>	<b>113 m</b>

# LF breakdown - linear features

## Linear features considered

- *water streams*
- *paths*
- *roads*
- *railways*

All SLUs which are crossing the line  
or are within a distance 10m from the line

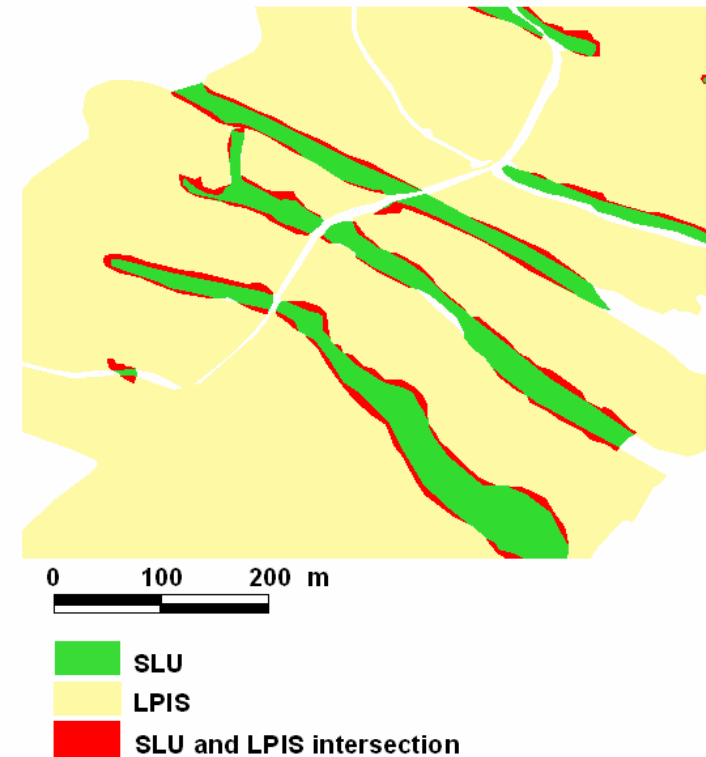


SLU category	<i>intensive area</i>		<i>extensive area</i>	
	area (ha)	area %	area (ha)	area %
<i>SLU along waterstreams</i>	20,6	<b>18%</b>	44,1	<b>22%</b>
<i>SLU along paths</i>	27,3	<b>24%</b>	58,3	<b>29%</b>
<i>SLU along roads</i>	26,6	<b>24%</b>	9,1	<b>4%</b>
<i>SLU along railways</i>	9,9	<b>9%</b>	2,8	<b>1%</b>
<i>SLU_total</i>	111,8		202,8	

# LF breakdown according to LPIS

Location considered: outside and inside LPIS

- 10 m buffer inside LPIS border was used



	<i>Inside LPIS (%)</i>	<i>More than 10m inside (%)</i>
Intensive area	18,58	0.55
Extensive area	23,50	1.81

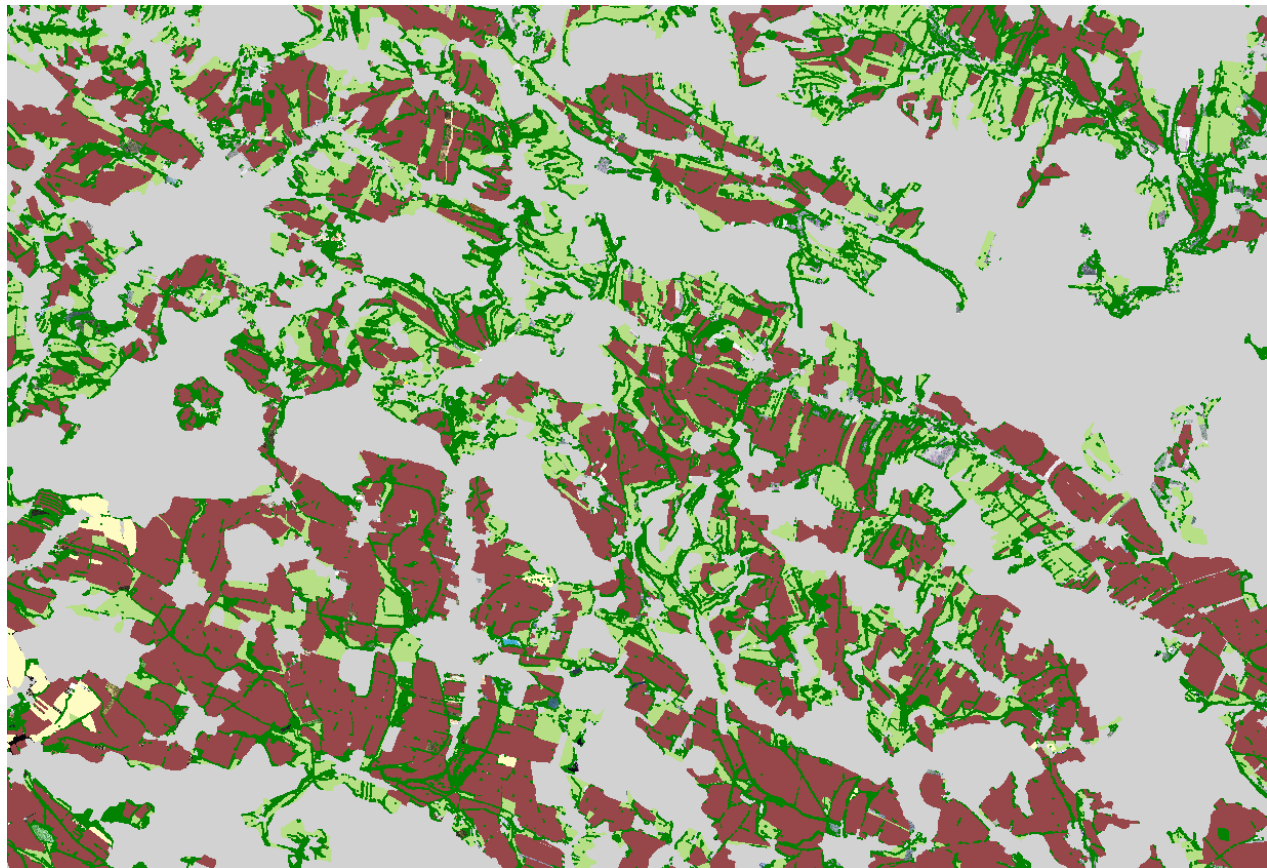
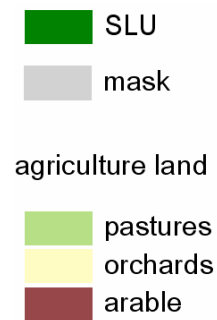
# Accuracy assessment

- irregular shapes - low level of generalisation - improved
- good delineation of single trees, tree clusters
- separation inside - outside LPIS
- objective selection of all vegetation LF-objects (small and large trees, shrubs) and non-LF objects (open spaces in tree group, grass)
  
- user accuracy: > 75 %
- producer accuracy: > 80%
  
- Visual interpretation:
  - pros: simple, „accurate“*
  - cons: time consuming*

# Application

- *Case study Ikonos: 380 km<sup>2</sup>, foothill region*  
*12 % LF*

*80% outside  
of LPIS*



# Application

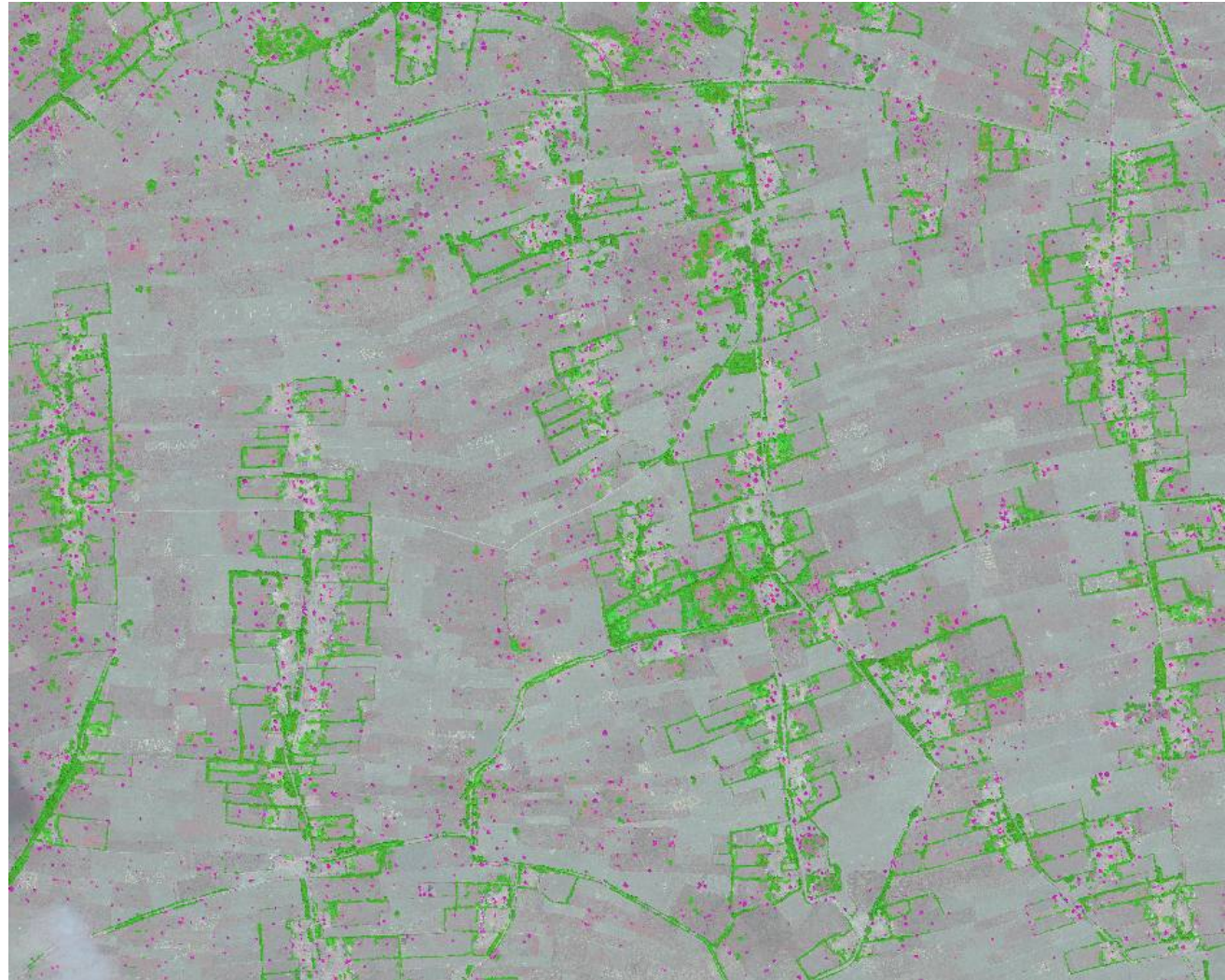
- *QB - Ethiopia, Alaba*

Hedgerows along fields structure - to protect against erosion and single trees



# Application

- Lines of LF
- Single trees



# Conclusions

- *Automatic detection of all LF - good*
- *Extraction of final LF possible - lower generalisation level than LPIS*
  - > *some more development possible*
- *Improvement: initial masking of forest and urban*
- *Final product: need of post-classification editing*
- *Future: classification performed on aerial orthophotos*