10 juin 2016

Journée Technique

Avancées, apports et perspectives de la télédétection

pour la caractérisation physique des corridors fluviaux

Une méthodologie automatisée et multi-scalaire pour la caractérisation de l'hydromorphologie à l'échelle régionale

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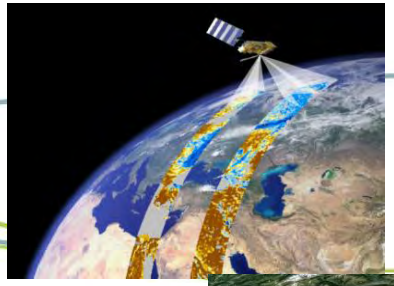
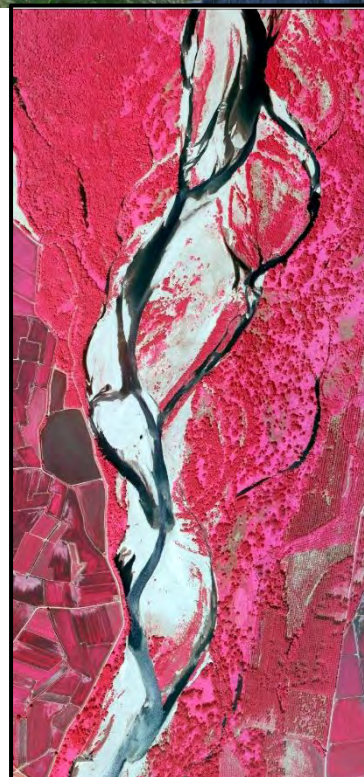
REGIONE PIEMONTE

Objective



Applied RS method to support large-scale Hydromorphological characterization

1) Automated RS classification of **riverscape units**
2) Regional **Hymo characterization** based on RS mapping:
   - River types classification/identification
   - River processes understanding (regional)
   - Local scale fluvial analysis



Planning regional strategies or local geomorphic analysis

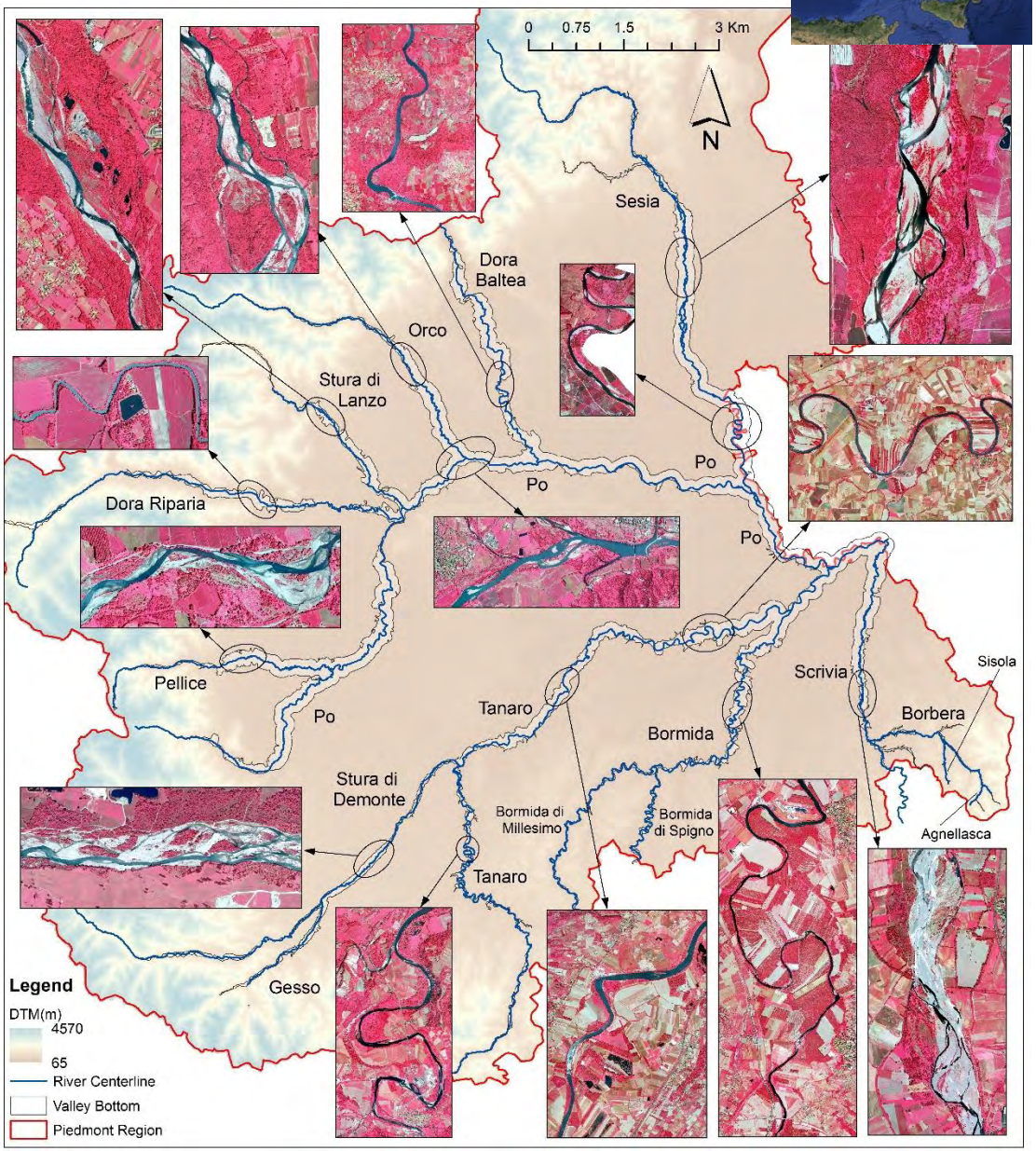
Implementing river management strategies ➔ large-scale cost-effective rehabilitation plans

Characterizing Hydromorphology at the regional scale

Piedmont Region (North west Italy)
-18 major rivers,
-tot 1200 km channel length
- for 1700 km^2 of river floodplains

Input RS data
(regional db, 2009-2010):
- Near infrared imagery (VHR, 0.4 m)
- LiDAR (0.4 pts/m^2) (DTM at 5 m)

Different river types represented
→ heterogeneous fluvial forms



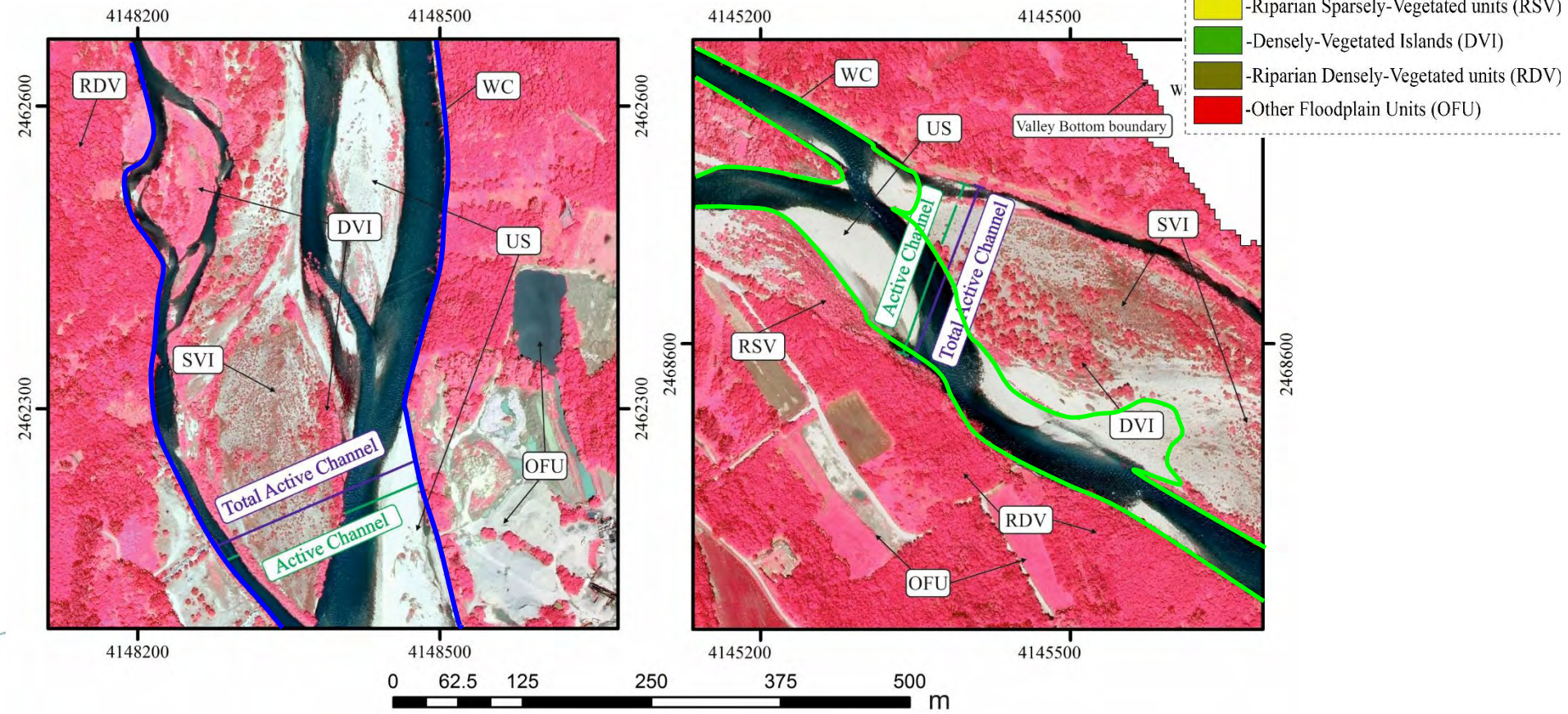
Riverscape units

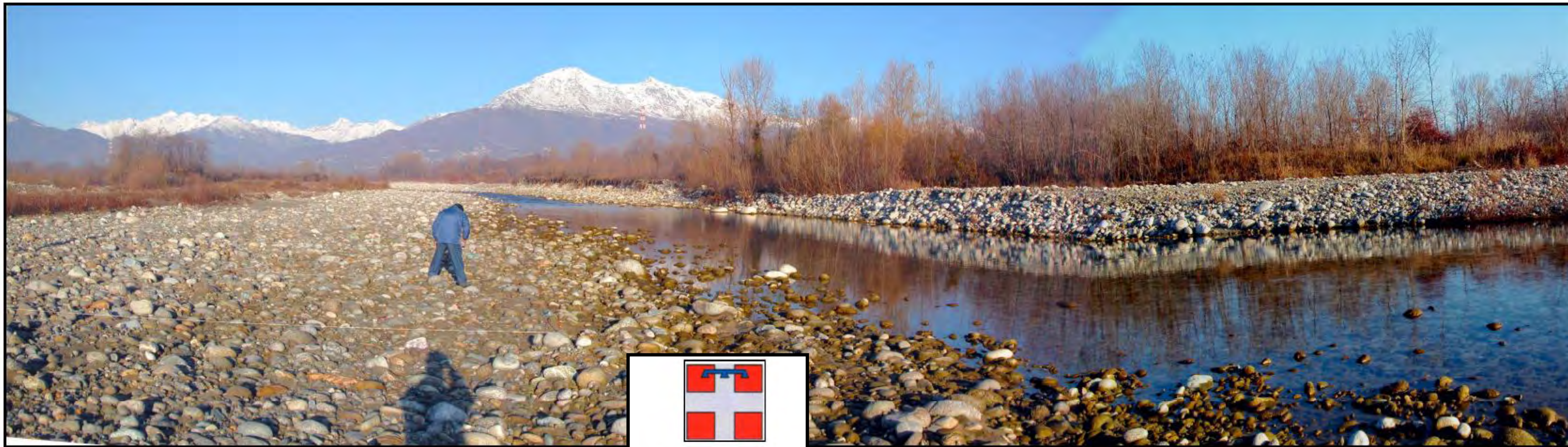
What do we want to measure with a (semi)-automated procedure?

Extent and topographic variability of riverscape units

Total Active Channel

Active Channel



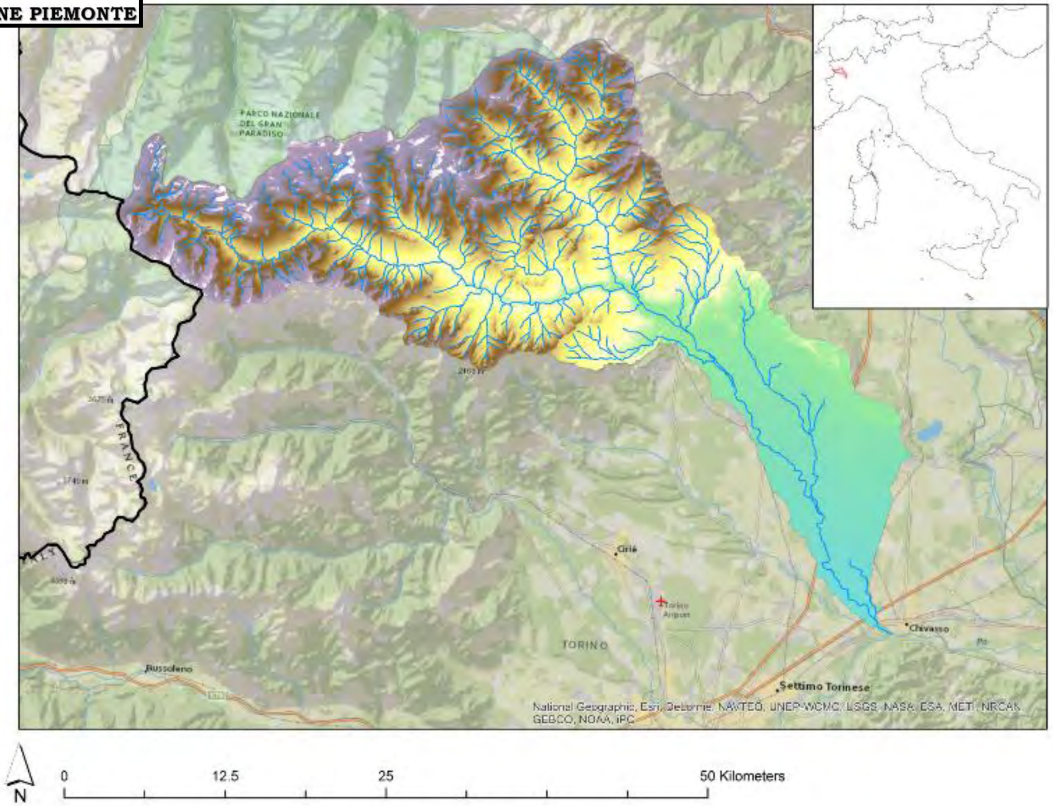


REGIONE PIEMONTE

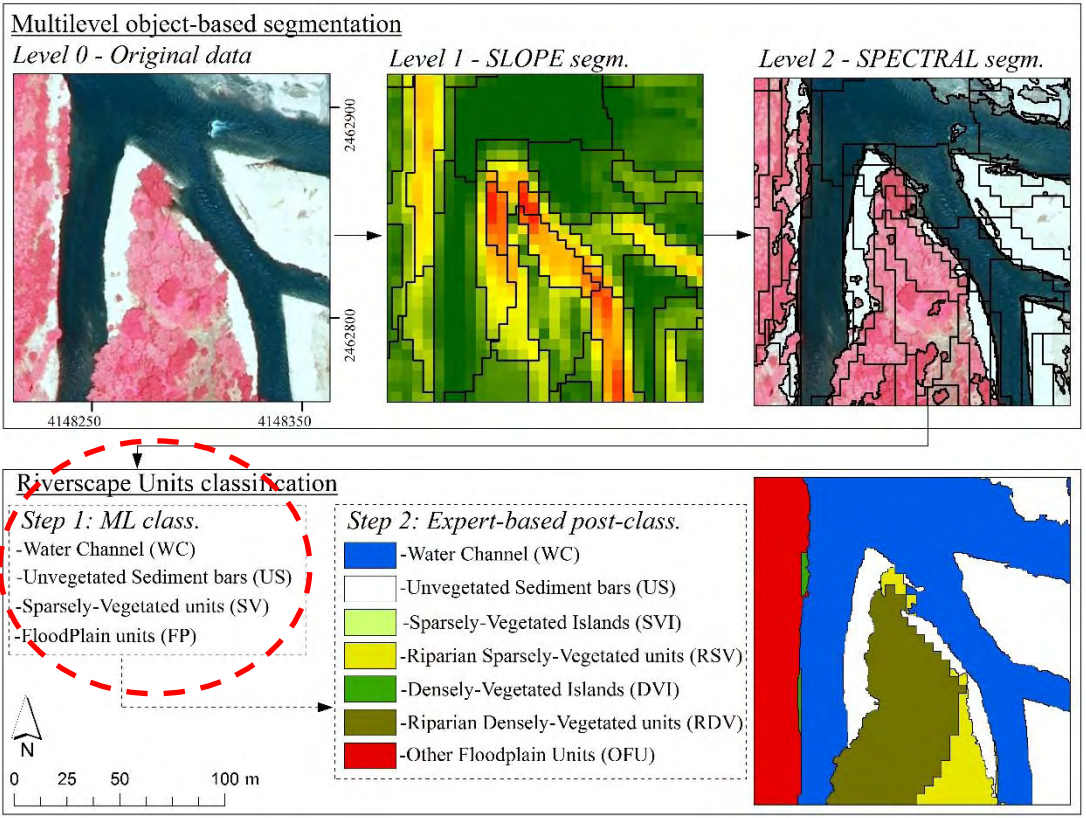
Methodology development: the Orco river case study

- 40 km of Orco River, Piedmont Region, north of Italy

Input RS data
(regional db, 2009-2010):
- Near infrared imagery (VHR, 0.4 m)
- LiDAR (0.4 pts/m^2) (DTM at 5 m)



Multilevel object-based approach (GEOBIA)



Developed **for the Orco River** in Demarchi *et al.*, 2016

remote sensing

MDPI

Article

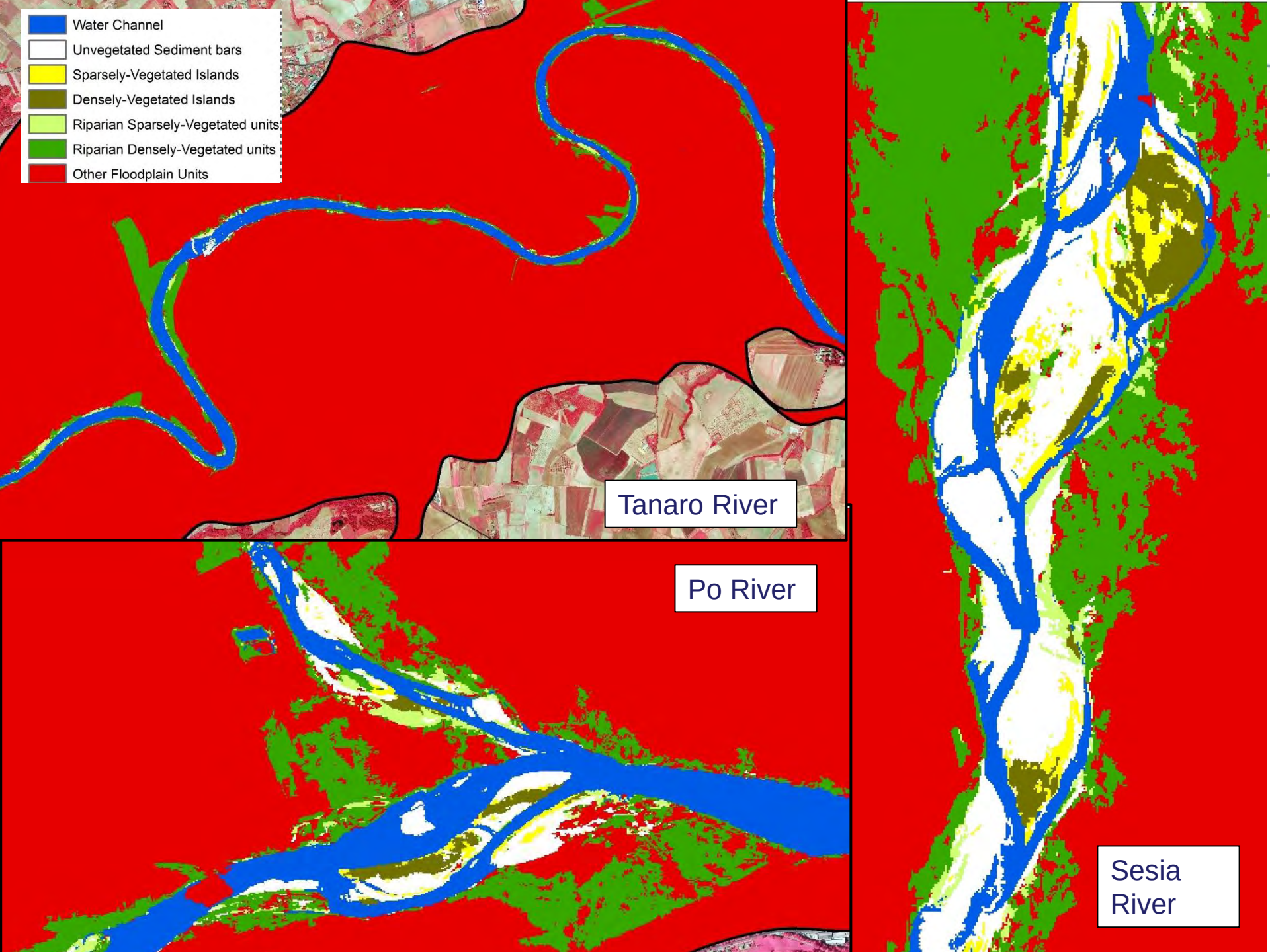
Hierarchical Object-Based Mapping of Riverscape Units and in-Stream Mesohabitats Using LiDAR and VHR Imagery

Luca Demarchi [1,*], Simone Bizzi [1] and Hervé Piégay [2]

Applying the methodology at the regional scale automatically (262 image tiles to analyze, covering **1700 km²** of river FP)

Challenge !!
Building a regional classifier able to classify all the region
➔ different geographic contexts

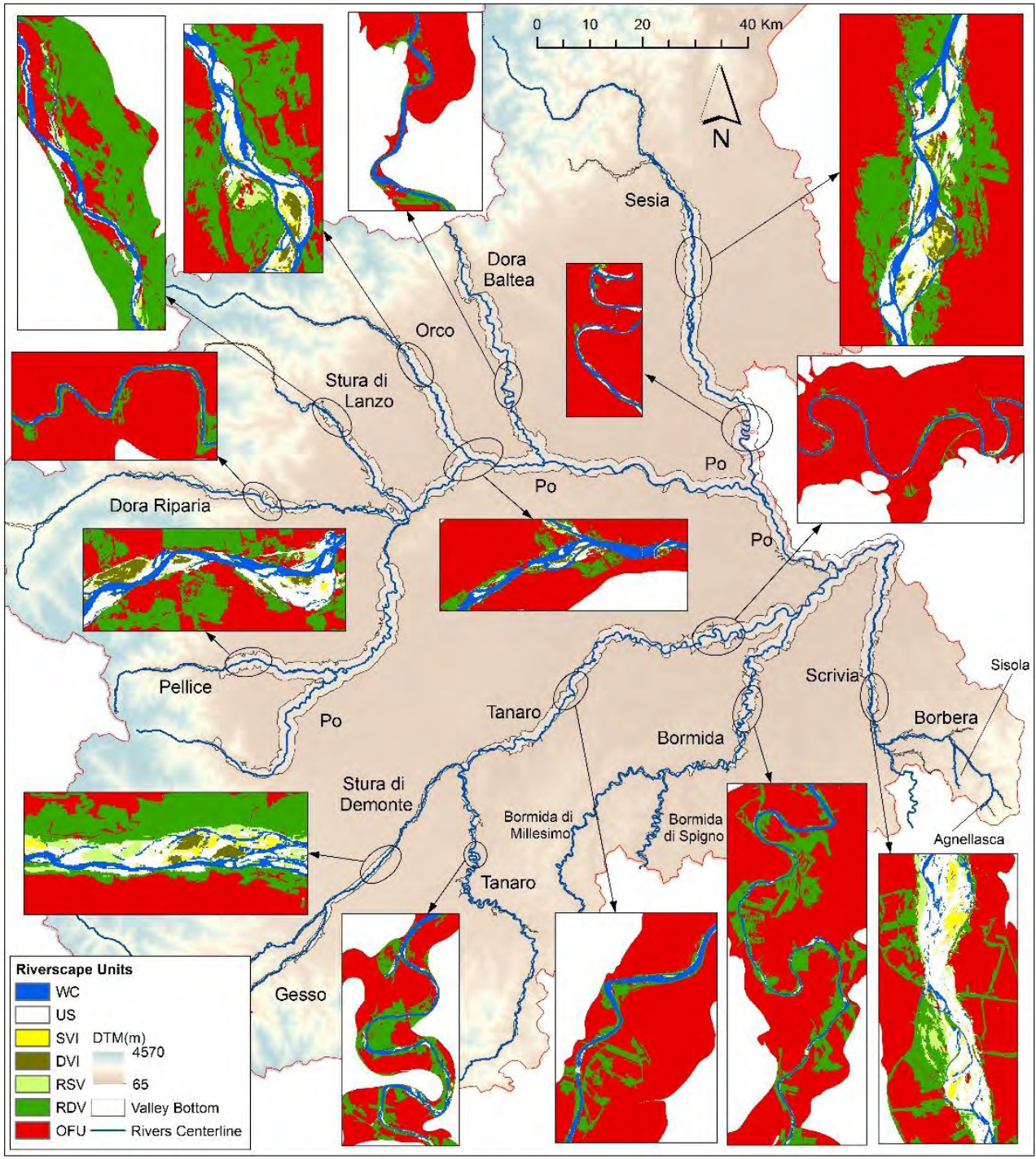
	PA	UA
WC	93.42	91.14
US	86.26	86.15
SV	**81.66**	**84.45**
FP	98.74	98.75


Water Channel
Unvegetated Sediment bars
Sparsely-Vegetated Islands
Densely-Vegetated Islands
Riparian Sparsely-Vegetated units
Riparian Densely-Vegetated units
Other Floodplain Units
Tanaro River
Po River
Sesia River

Riverscape units classification

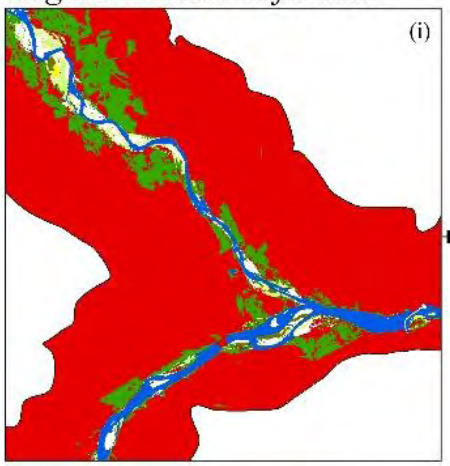
- 1200 km of river length continuously mapped at 40 cm spat. Resolution
- Different fluvial forms are recognizable
- **Topographic** and areal information per class

How do we analyse these data for regional Hymo characterization?

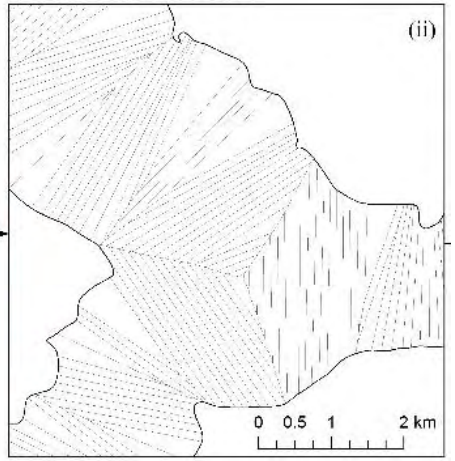


Regional Hymo DB for river types classification

Regional RS classification



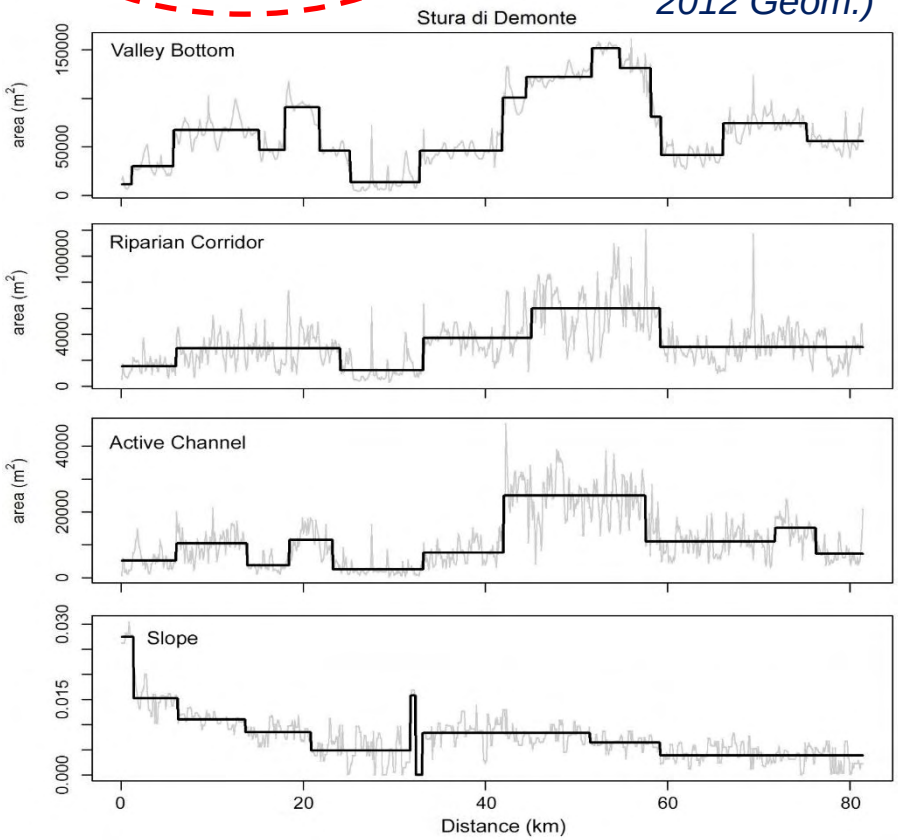
DGO calculation



Hymo indicators (per DGO) (iii)

WC_area	Water Channel area
US_area	Area of Unvegetated Sediment bars
US_hgt	Height of Unvegetated Sediment bars
SVI_area	Area of Sparsely-Vegetated Islands
SVI_hgt	Height of Sparsely-Vegetated Islands
RSV_area	Area of Riparian Sparsely-Vegetated units
RSV_hgt	Height of Riparian Sparsely-Vegetated units
DVI_area	Area of Densely-Vegetated Islands
DVI_hgt	Height of Densely-Vegetated Islands
RDV_area	Area of Riparian Densely-Vegetated units
RDV_hgt	Height of Riparian Densely-Vegetated units
OFU_area	Area of Other Floodplain Units
OFU_hgt	Height of Other Floodplain Units
AC_area	Active Channel area
TAC_area	Total Active Channel area
RC_area	Riparian Corridor area
VB_area	Valley Bottom area
Slope_DGO	Water surface Slope

(Leviandier et al. 2012 Geom.)



- DGO=spatial Disaggregated Geographical Objects, of 100m each
  - ➔ 12,000 DGOs to analyse
- Hubert Segmentation based on 4 indic.:
  - ✓ VB area
  - ✓ RC area
  - ✓ AC area
  - ✓ Slope

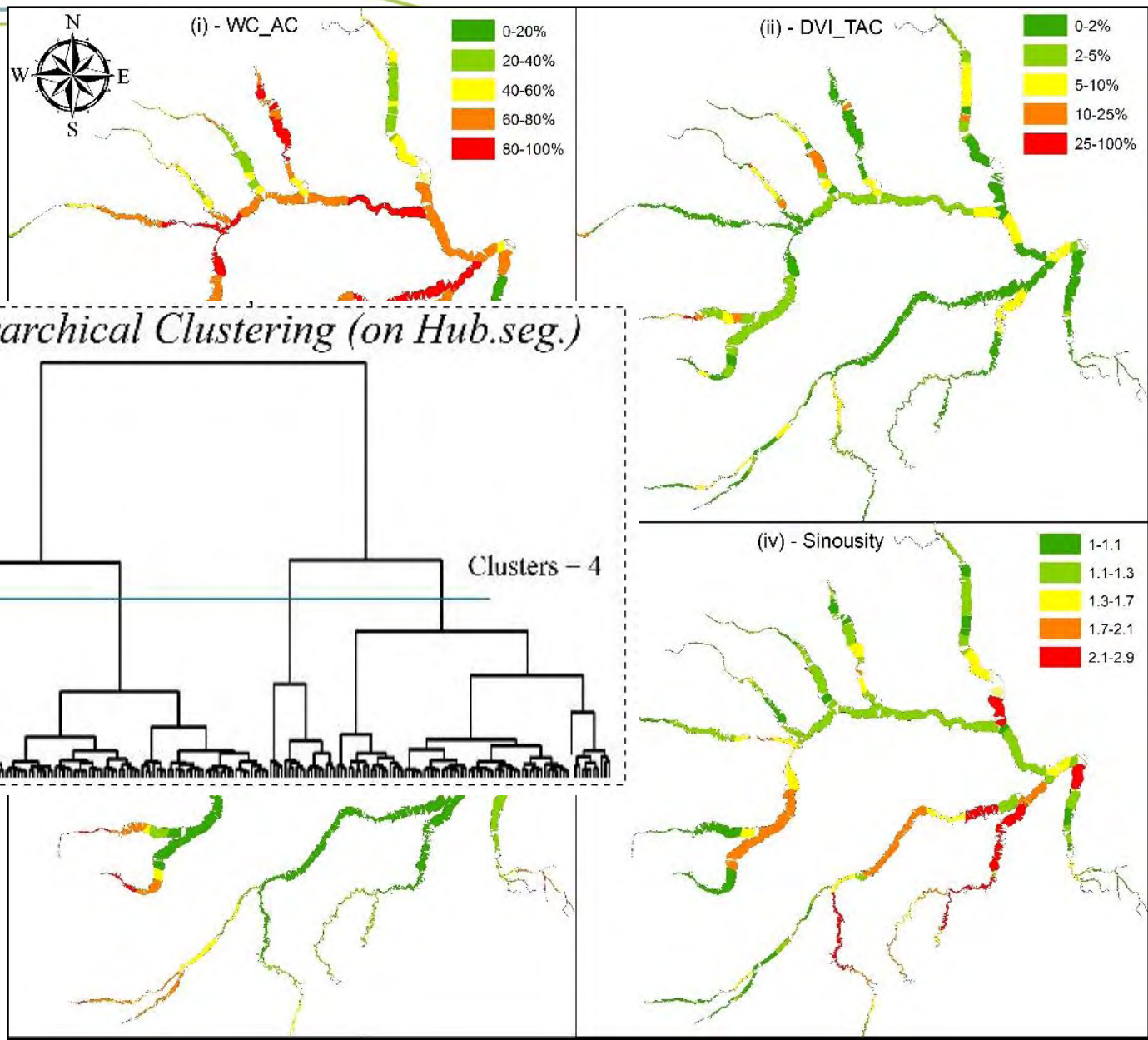
- Only segments > 1km
- Total of 183 segments to be classified

Regional Hymo analysis for river types classification

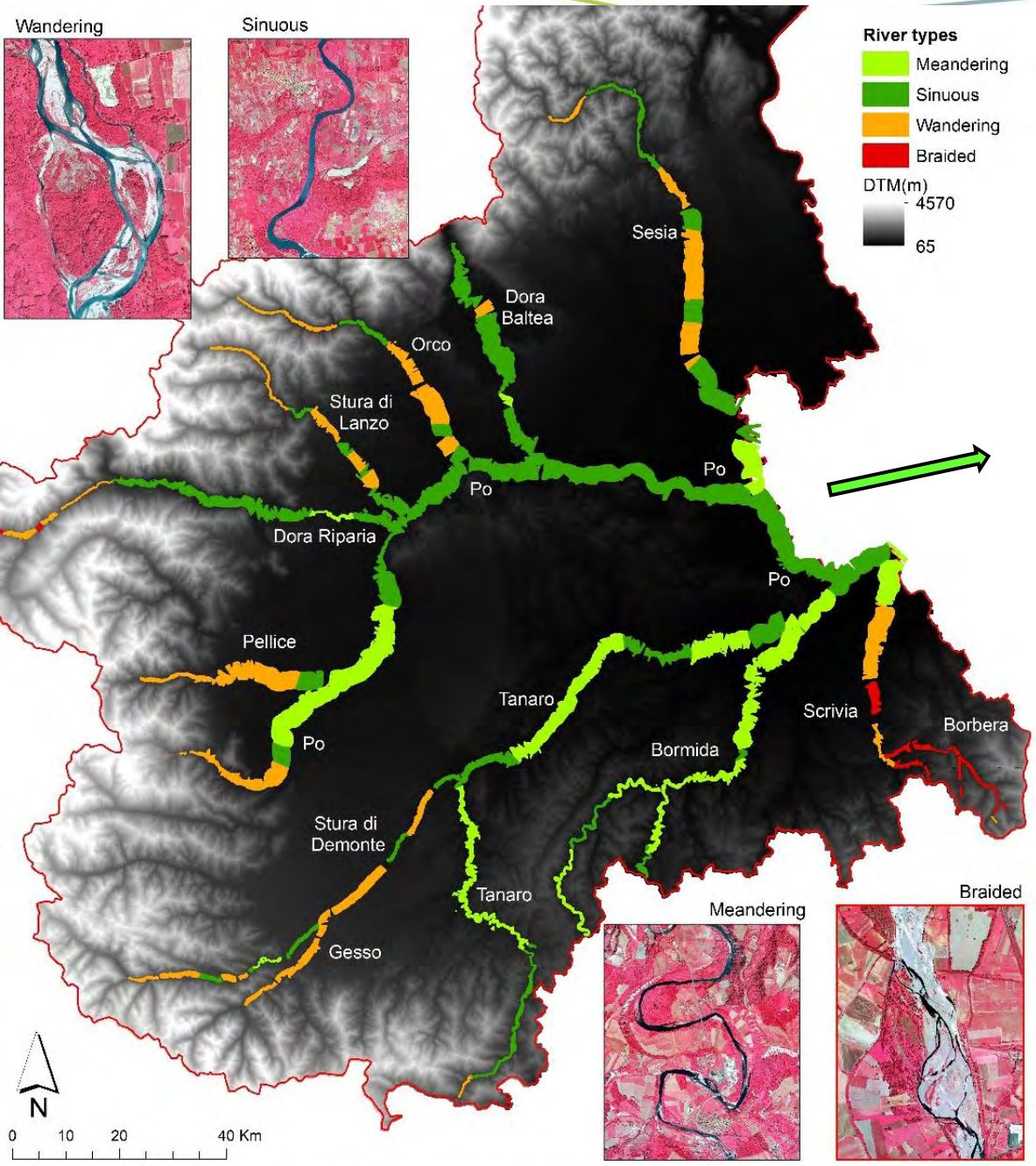
Drivers used to describe main planforms of **river types**:

- ✓ WC_AC
- ✓ DVI_TAC
- ✓ Slope
- ✓ Sinuosity
- ✓ AC_norm
- ✓ Conf

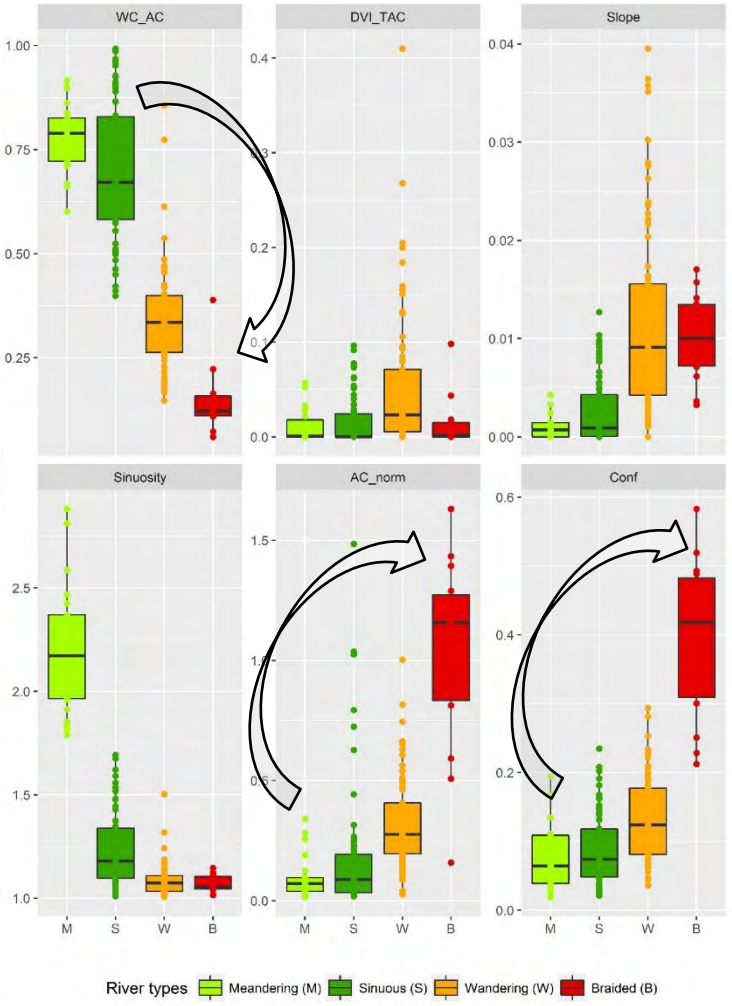
Mapping Hymo indicators



River types classification results

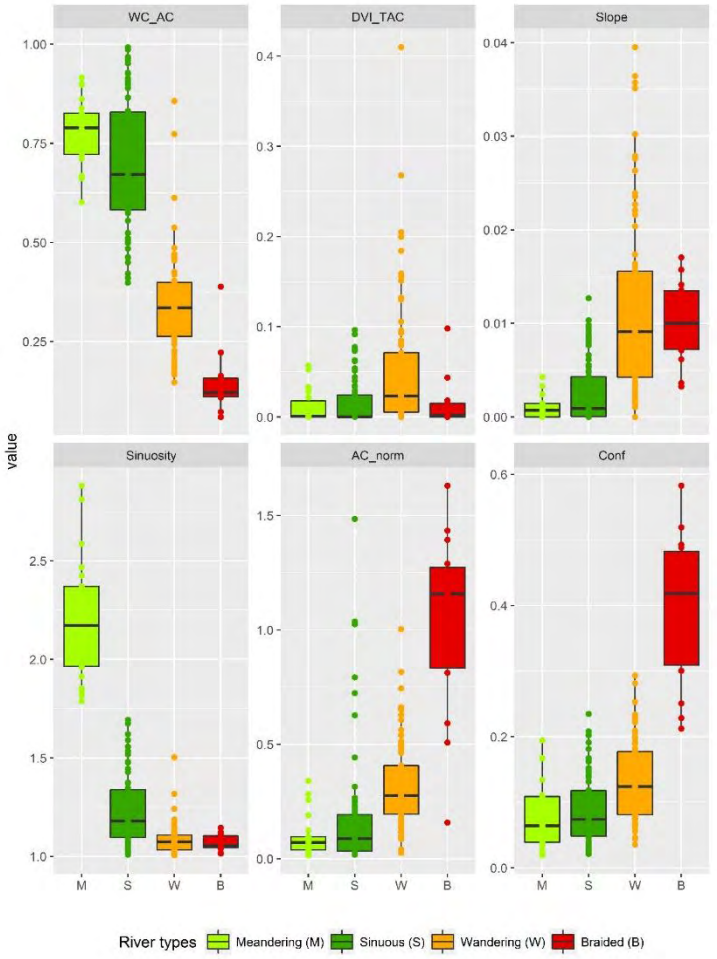


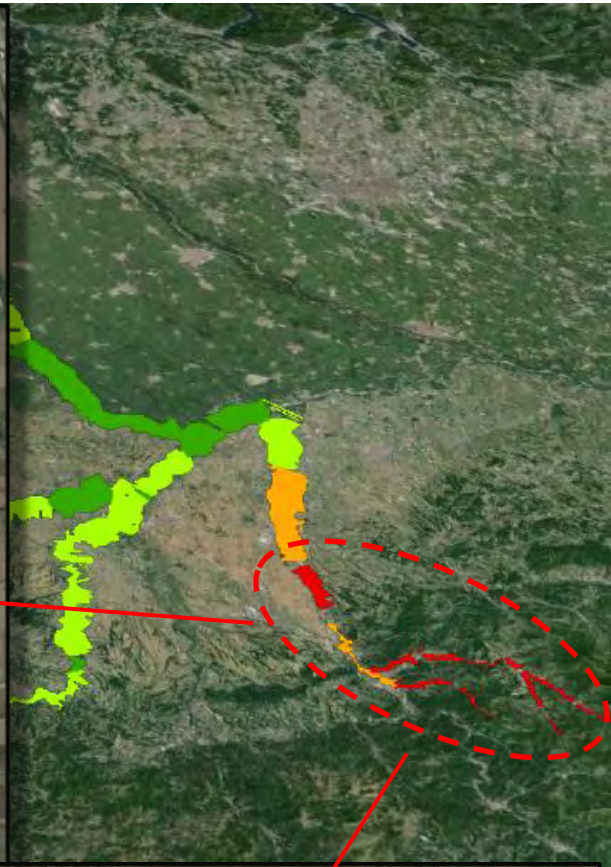
Stat. variability of Hymo indicators



Channel transition:
meandering → sinuous →
→wandering → braided

River types classification results

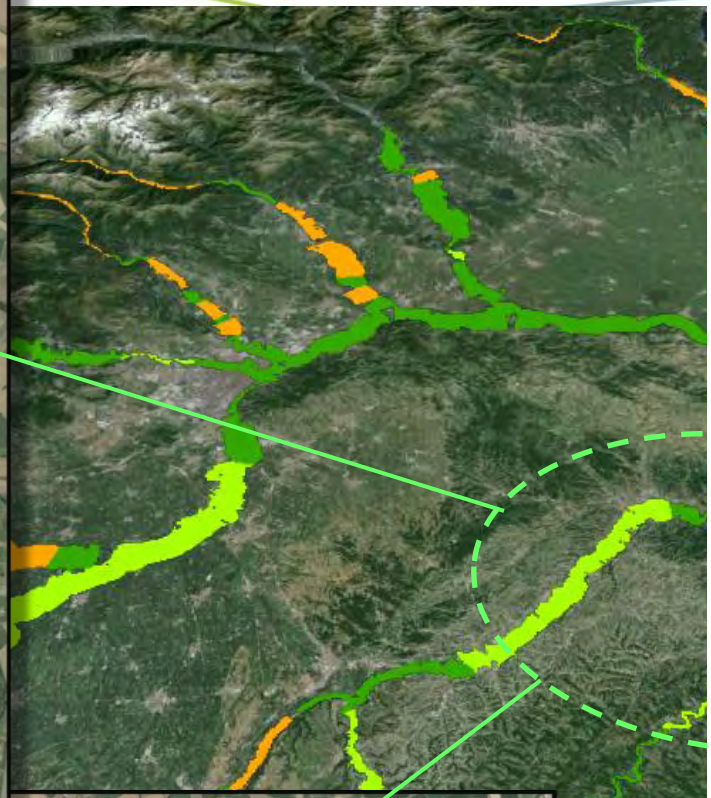


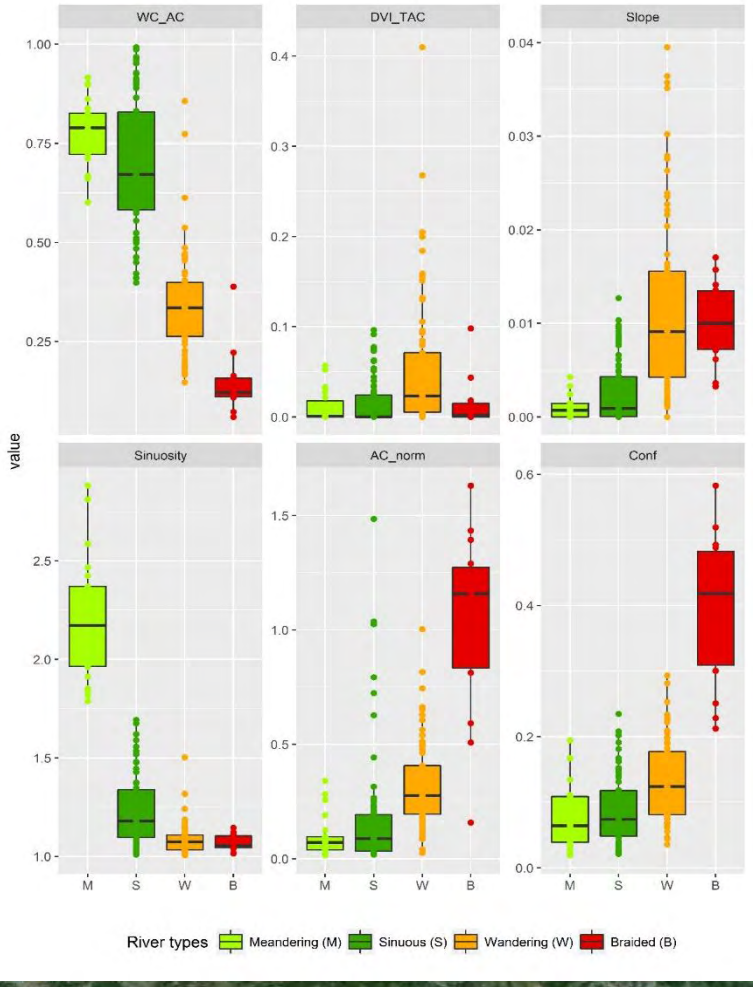


-steep channel gradient, high confinement, high AC
-low WC and sinuosity

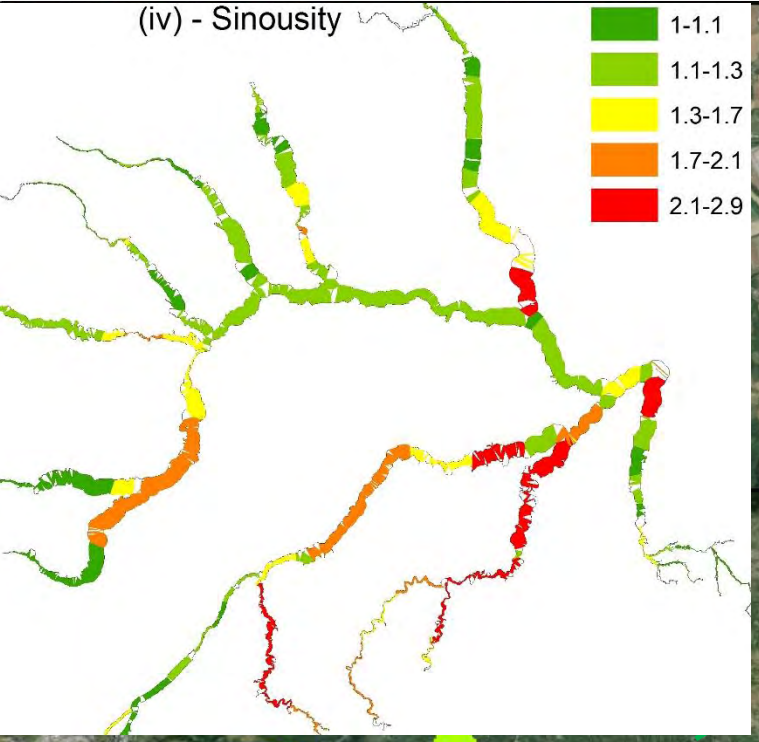
Meandering

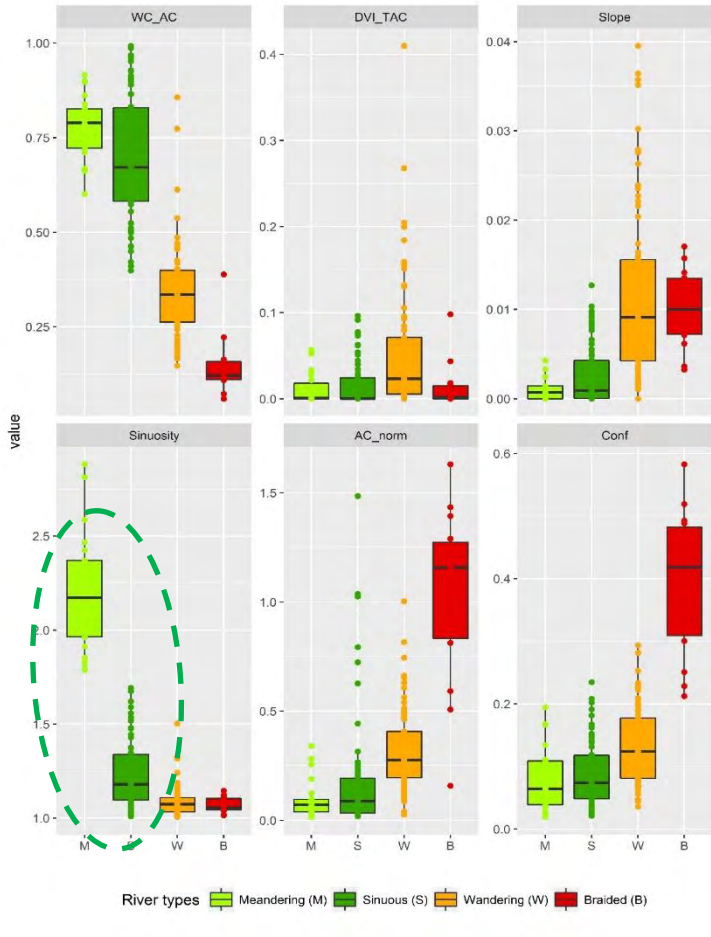
assification results

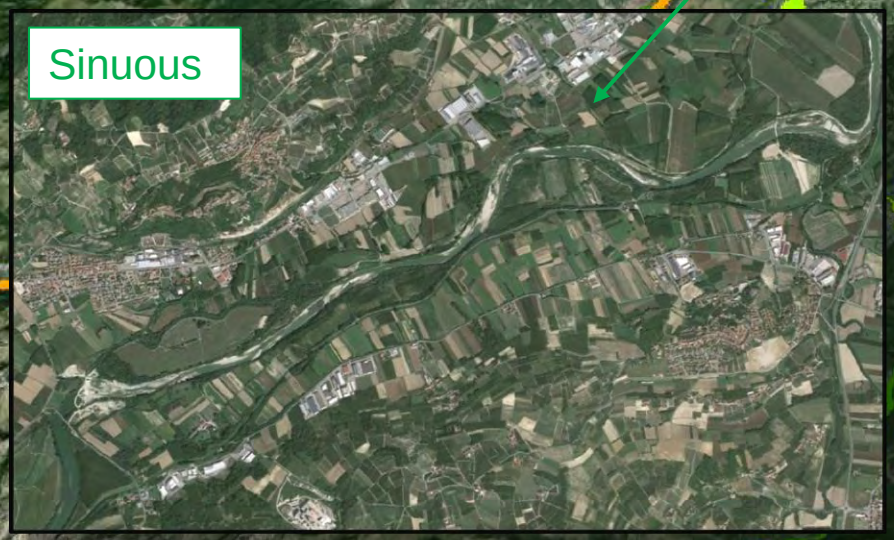




-mostly WC, few in-channel bars
-high sinuosity
-gentle slope and conf.







Alternation meand/sinuous:
Spatial var. of sinuosity

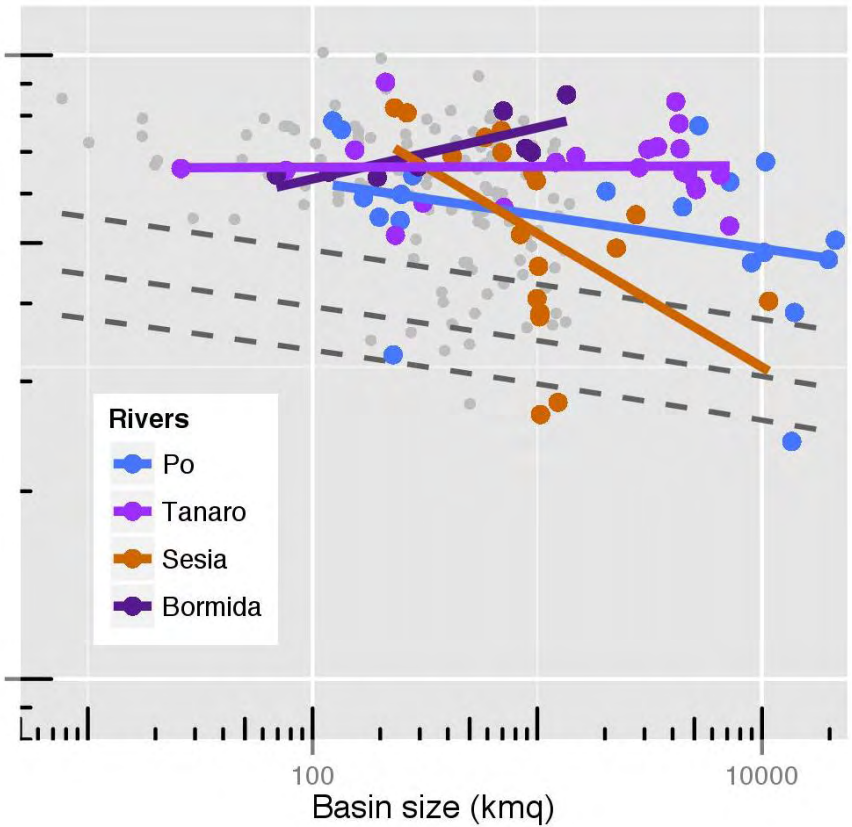
Higher degree of Human pressures??

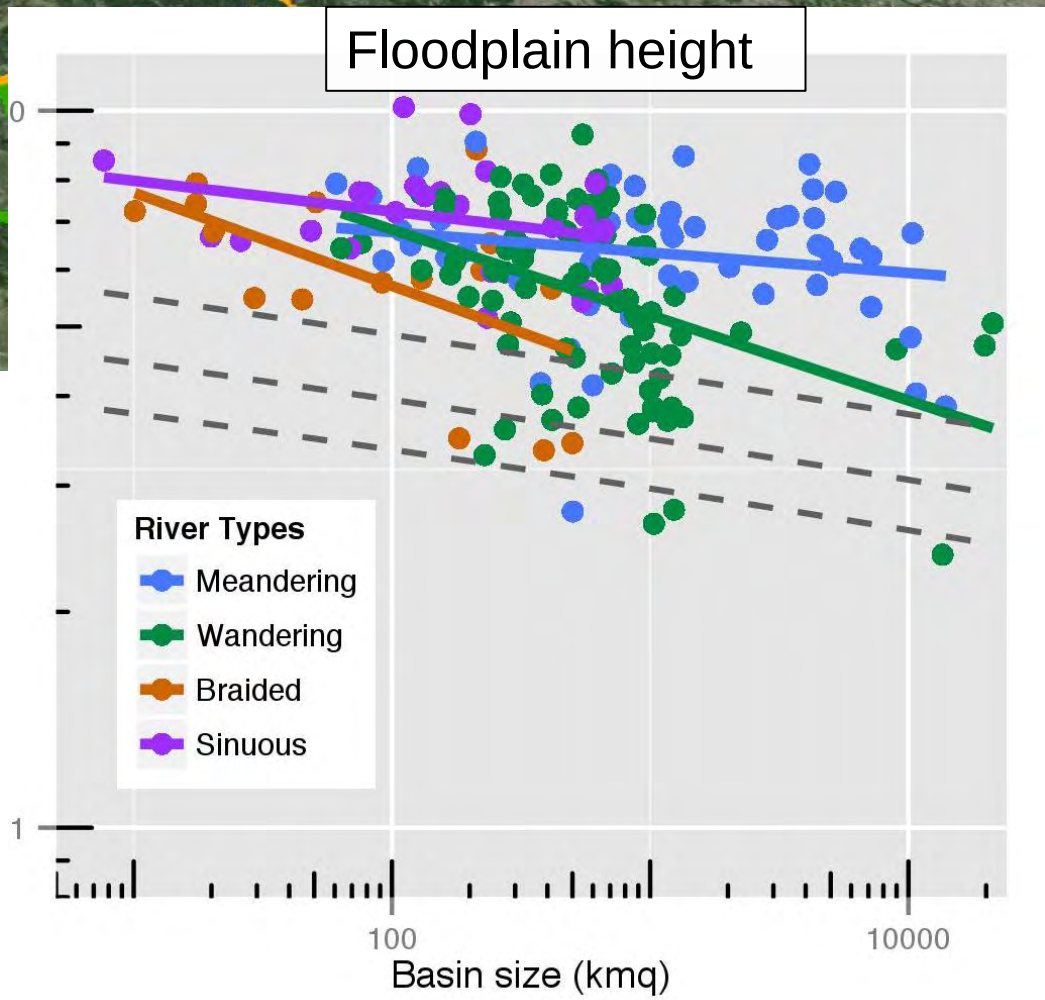
River types classification results

Topographic information available regionally

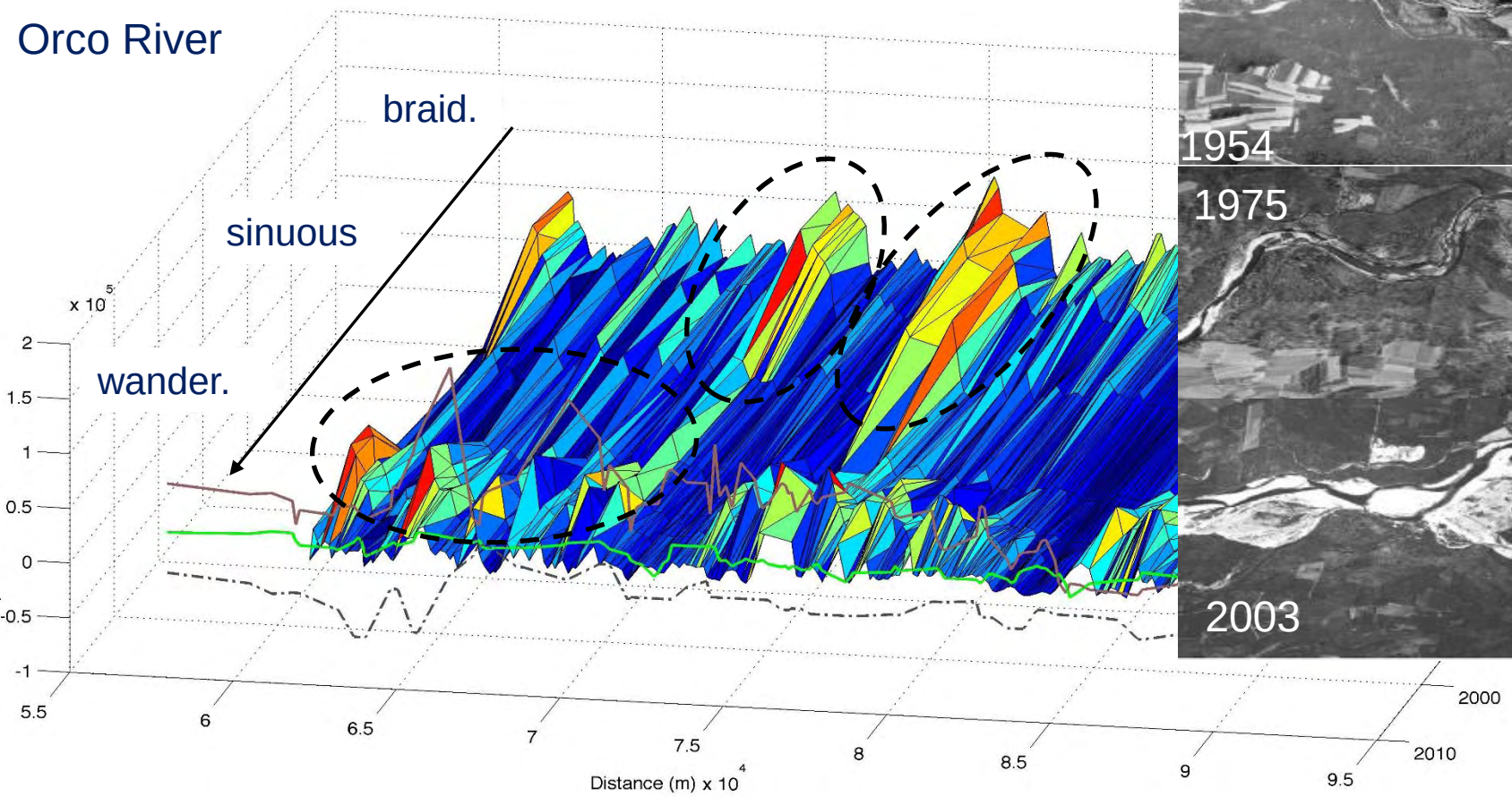
Heterogeneity of floodplain topographic patterns at the regional scale

- Topogr. data allow investigating patterns or river processes and assess entity of alterations!!





A DB useful for reach scale diagnosis



Local information (field measures and aerial photos archives) vs. RS-derived database:

- ✓ Spatial and temporal interpolation of AC areas, every DGO (100 m)
- ✓ Orco River: braided (‘50s)➔sinuous (‘60s-’90s)➔wandering (from 2000)
- ✓ High AC area in the ‘50s ➔ RC high today (vegetation encroachment)
  - ➢ High Incision ‘75-2003
- ✓ Embedding local understanding based on historical information, with new Hymo variables available at the regional scale

Local scale enhancement

Reach-scale Hymo characterization of Ain River:

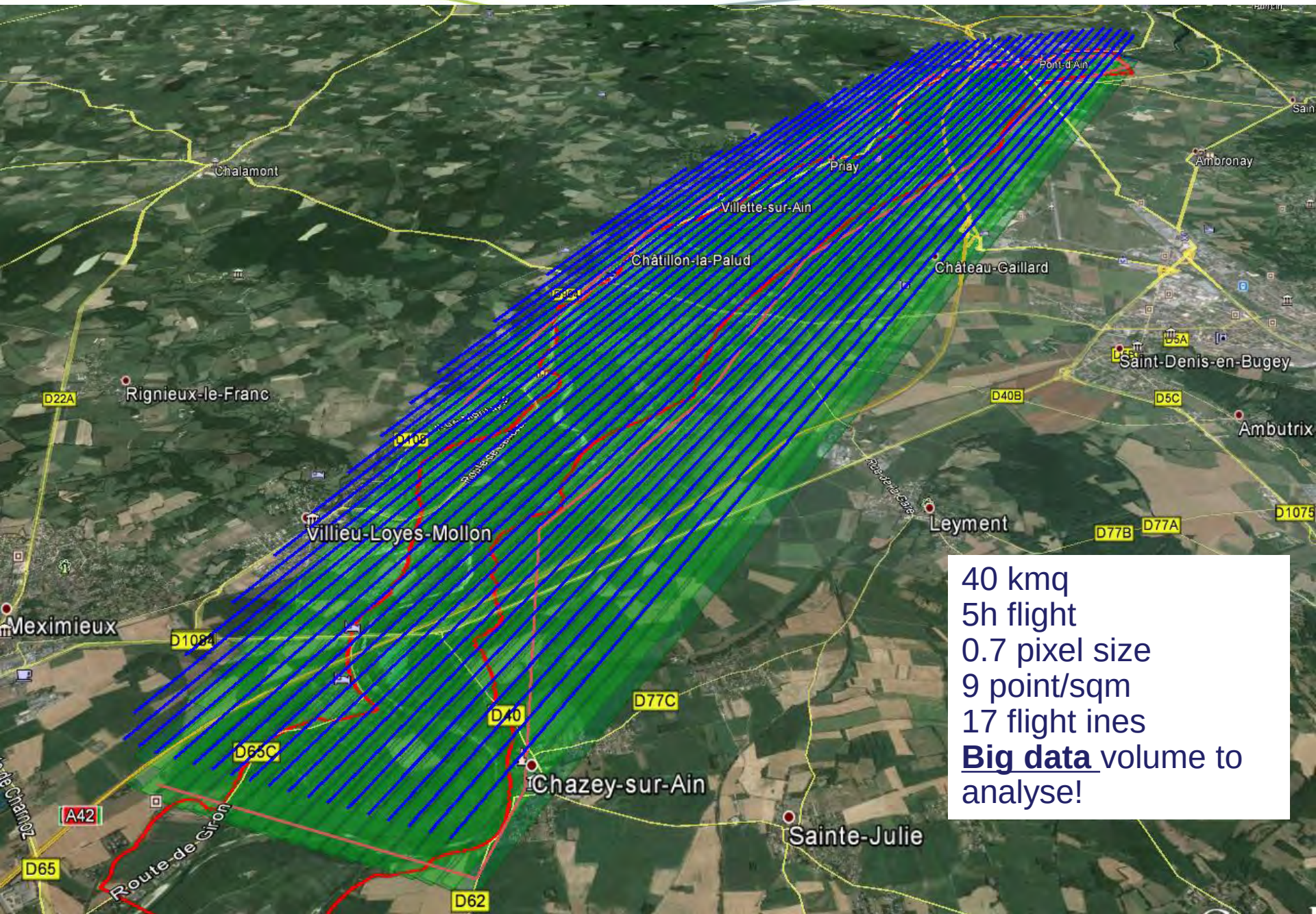
<u>High spectral and spatial RS data:</u>

1. <u>Airborne Hyperspectral + LiDAR</u>: 0.7m and 8 points/m^2
2. <u>UAV with Hyperspectral + RGB</u>: up to 5 cm spatial resolution

<u>Focus</u>:

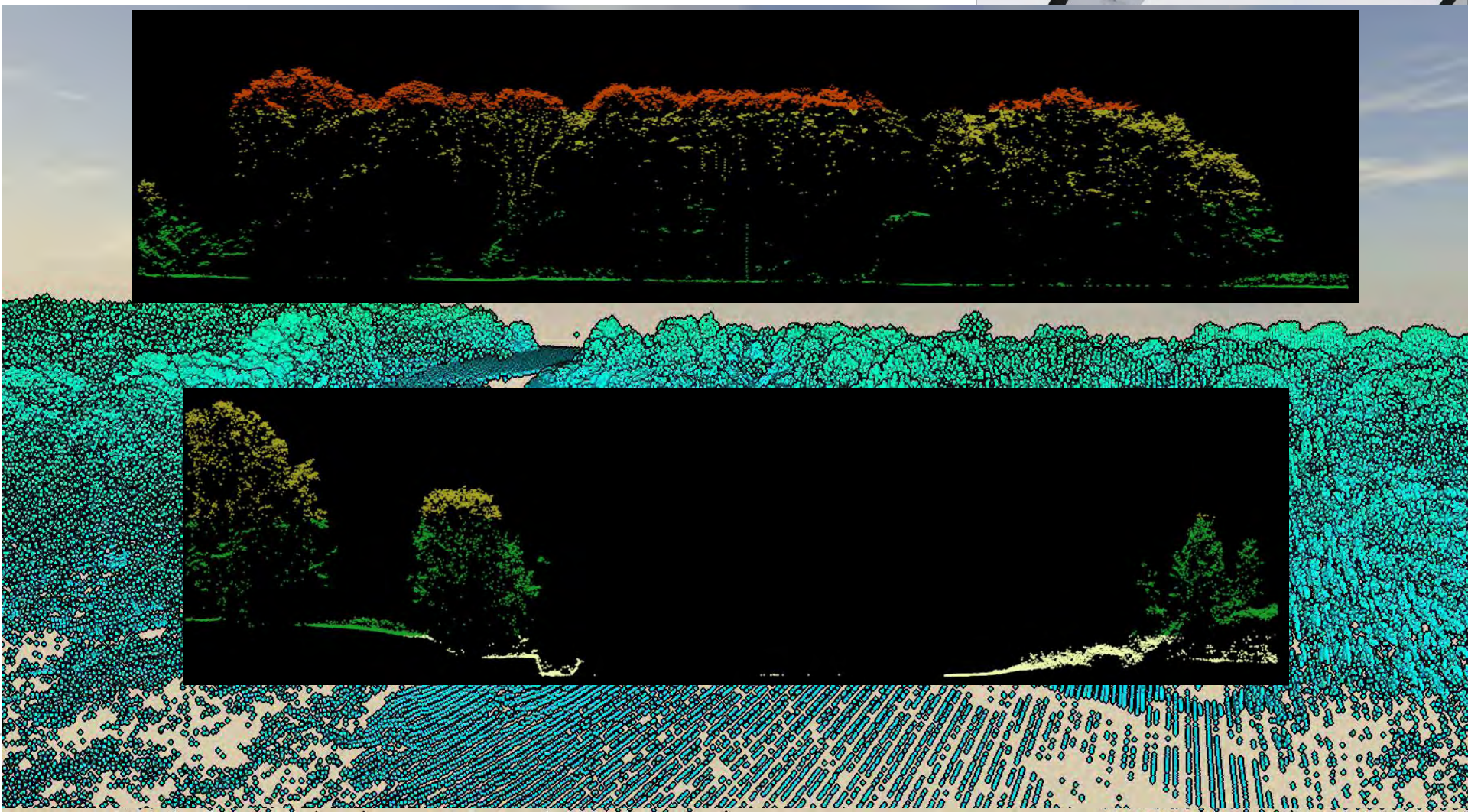
1. Aquatic compartment:
   - In-stream mesohabitats
   - Habitat attributes (water depth, velocity, etc..)
2. Vegetation compartment:
   - Species identification
   - Ecological condition

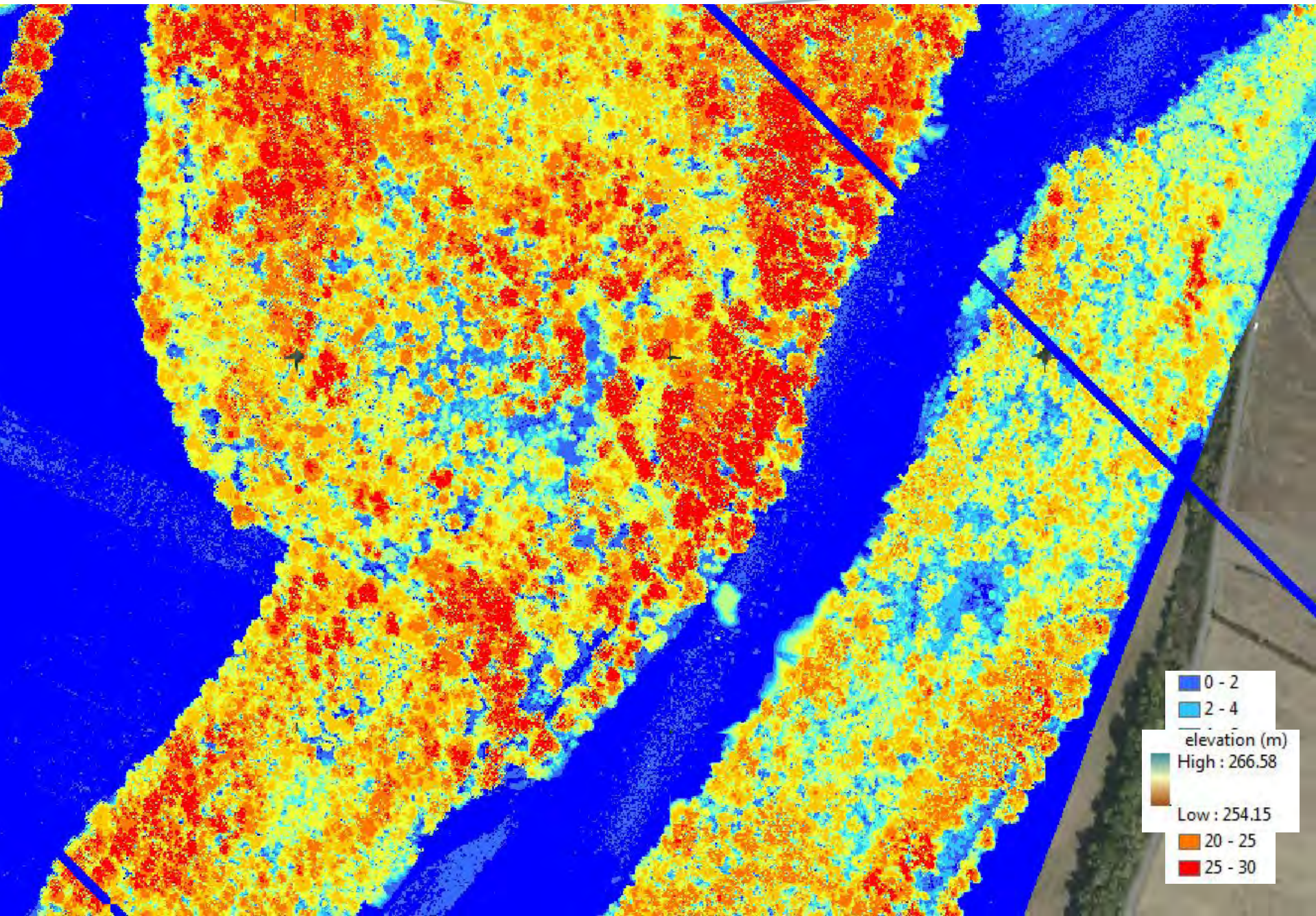
Flight plan (LiDAR+Hyper.)

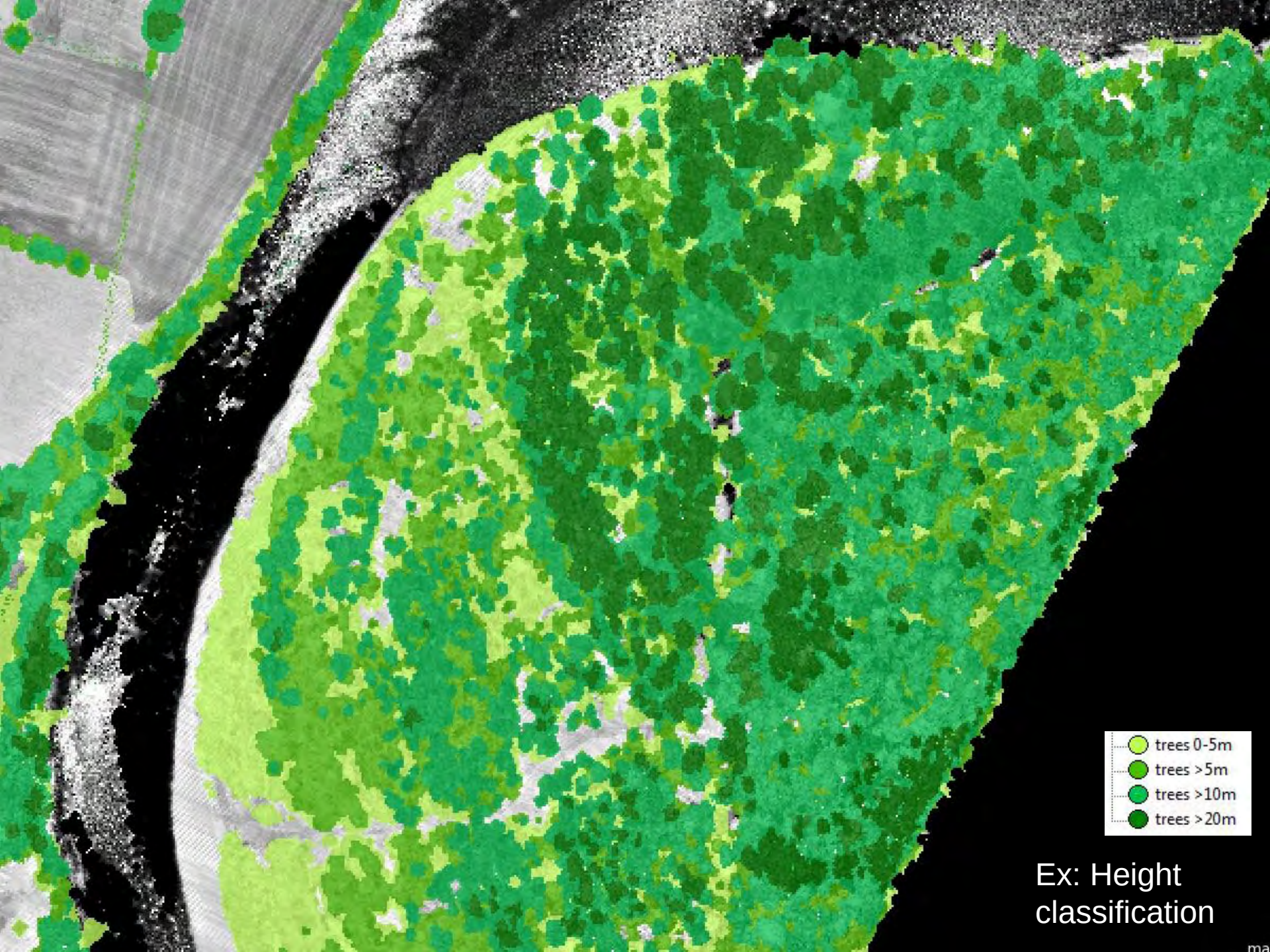


Airborne LiDAR

Point density = 9 /m^2

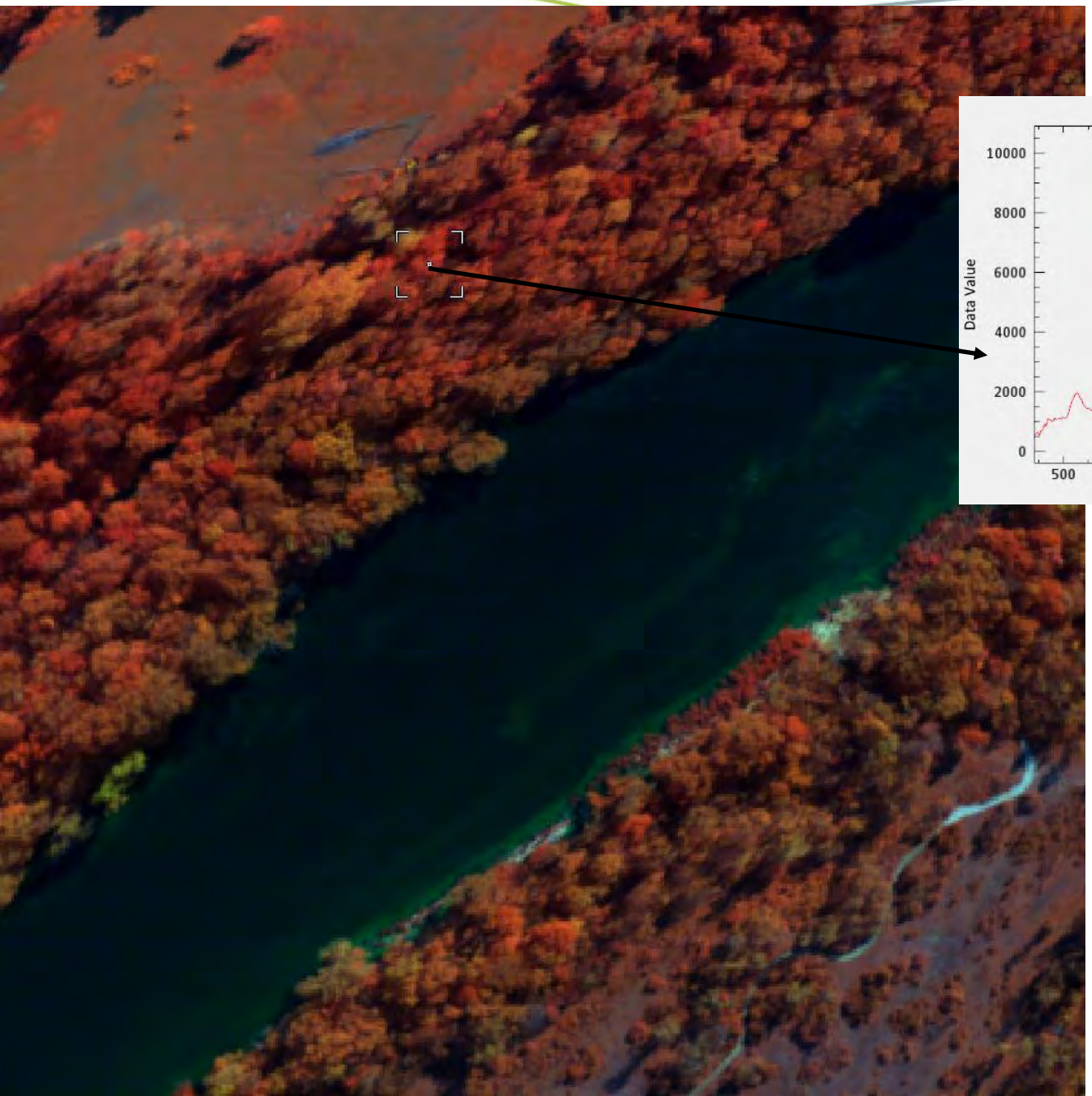


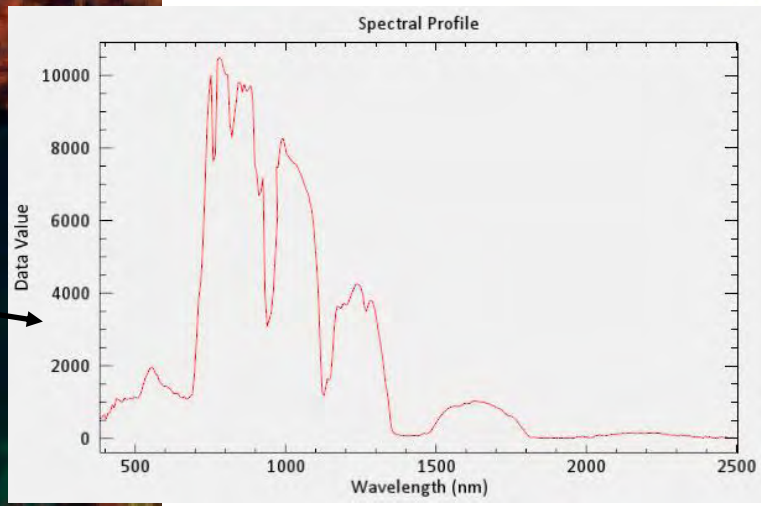

0 - 2
2 - 4
elevation (m)
High : 266.58
Low : 254.15
20 - 25
25 - 30



Ex: Height classification

Airborne Hyperspectral



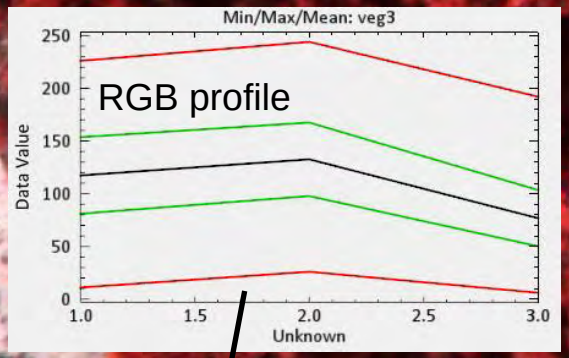


pixel size = 0.7 m
272 spectral bands

Ideal for species recognition, vegetation health, water depth/velocity, ecc.

UAV RGB
(5 cm)

UAV HS
(10 cm)


Min/Max/Mean: veg3
RGB profile
Data Value
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150
100
50
0
1.0
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2.5
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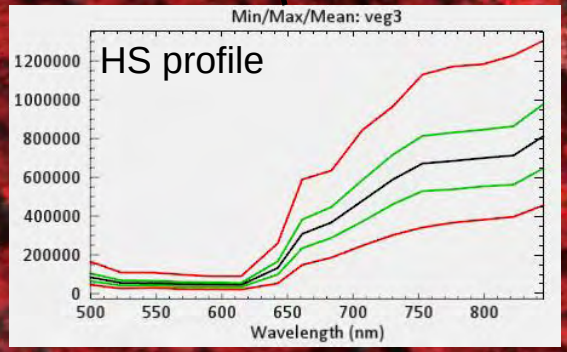
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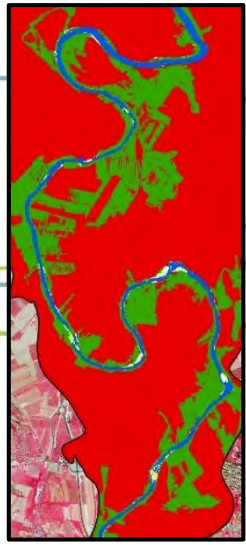
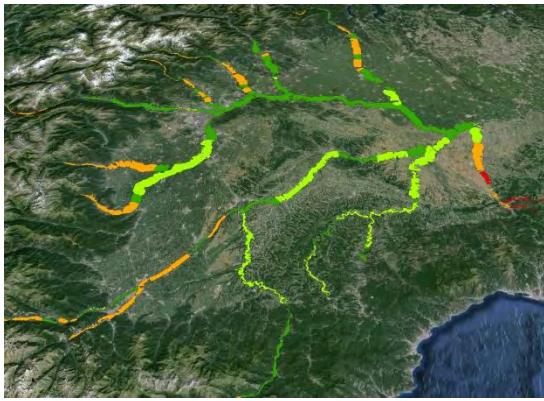
500
550
600
650
700
750
800
Wavelength (nm)

Conclusions



- RS-GEOBIA➔ **continuous, objective and repeatable** Hymo mapping at large scales (**1700 km²)**
- 1st time regional HYMO DB on continuous areal and **topographic** variables ➔ quantitatively assess **spatial + statistical variability** of Hymo indicators



- Automatizing river type classification with **quantitative Hymo drivers**:
  - Potential to quantify the **entity of alterations**
  - Enhancing river processes understanding
- Planning strategies at **regional scale** and detailed geomorphic diagnosis at the **local scale**
- Future RS acquisitions at large scales and maybe at higher resolutions:
  - ➔Hymo trajectories, **fluvial processes monitoring**
  - ➔To set restoration targets, design cost-effective rehabilitation plans

Thanks for your attention

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demarchi.luca.ld@gmail.com

Demarchi L, Bizzi S, Piégay H. ***(minor revision)****. Regional hydromorphological characterization with continuous and automated remote sensing analysis based on VHR imagery and low-resolution LiDAR data.* ***ESPL special issue****.*

Demarchi L, Bizzi S, Piégay H. ***2016****. Hierarchical object-based mapping of riverscape units and instream mesohabitats using LiDAR and VHR imagery.* ***Remote Sensing 8****:97*