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## Forest connectivity and water stress: characterization and mapping of the impact of channel incision on riparian forest status through remote sensing

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Julien Godfroy, Jérôme Lejot, Luca Demarchi, Kristell Michel, Hervé Piégay. Forest connectivity and water stress: characterization and mapping of the impact of channel incision on riparian forest status through remote sensing. RIPA-1 : First International Conference on Riparian Ecosystems Science and Management, COST-CONVERGES, Apr 2022, Bratislava, Slovakia. hal-04081252

**HAL Id: hal-04081252**

**<https://hal.science/hal-04081252>**

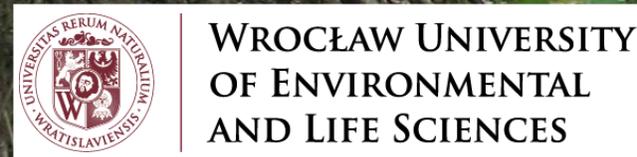
Submitted on 25 Apr 2023

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# Forest connectivity and water stress: characterization and mapping of the impact of channel incision on riparian forest status through remote sensing

J. Godfroy, J. Lejot, L. Demarchi, K. Michel, H. Piégay



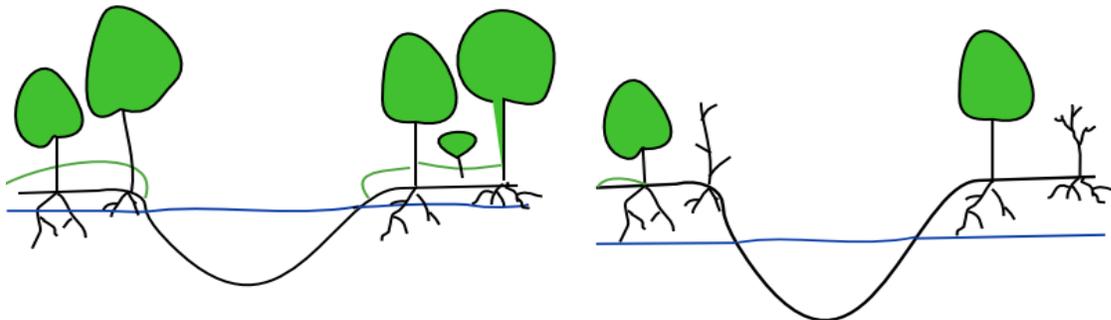
# Study Site & Contextualisation

- Lower Ain River Basin:

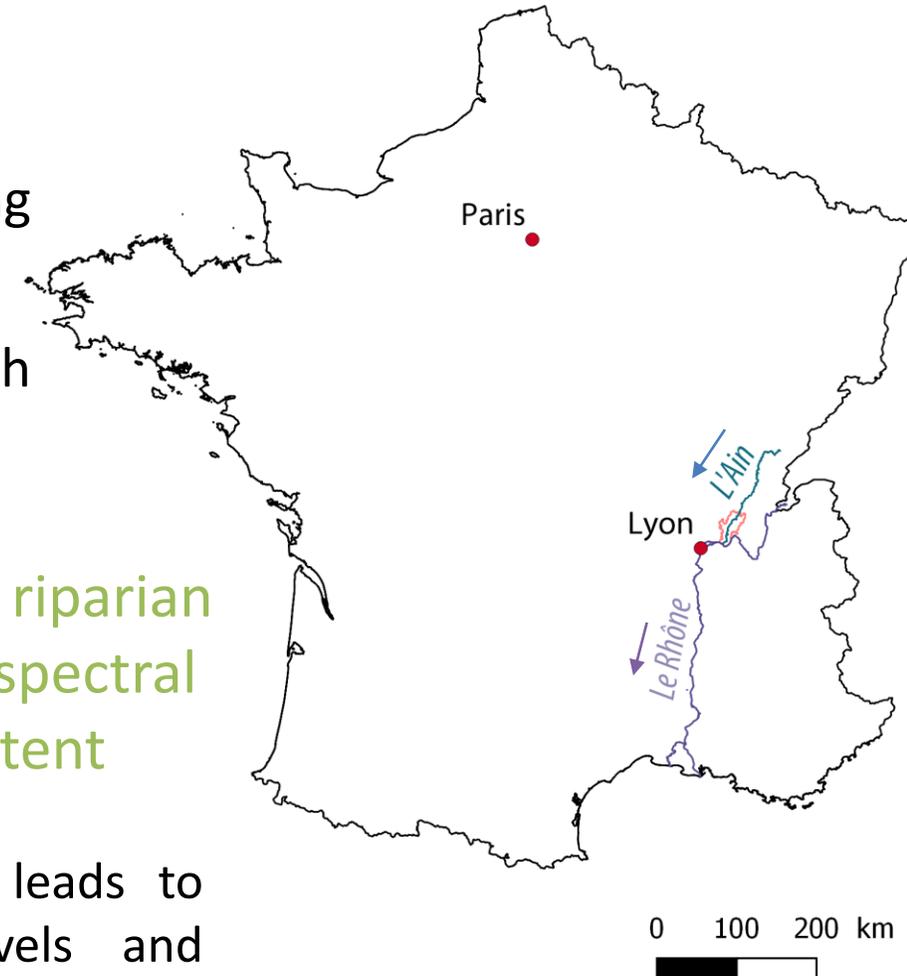
- Downstream propagation of channel incision following damming

- The age of the riparian forest is varied along the reach due to rejuvenation on a few actively shifting reaches

=> Our aim is to characterize the physical disconnection of riparian vegetation following channel incision by combining hyperspectral and LiDAR indicators of forest structure and water content



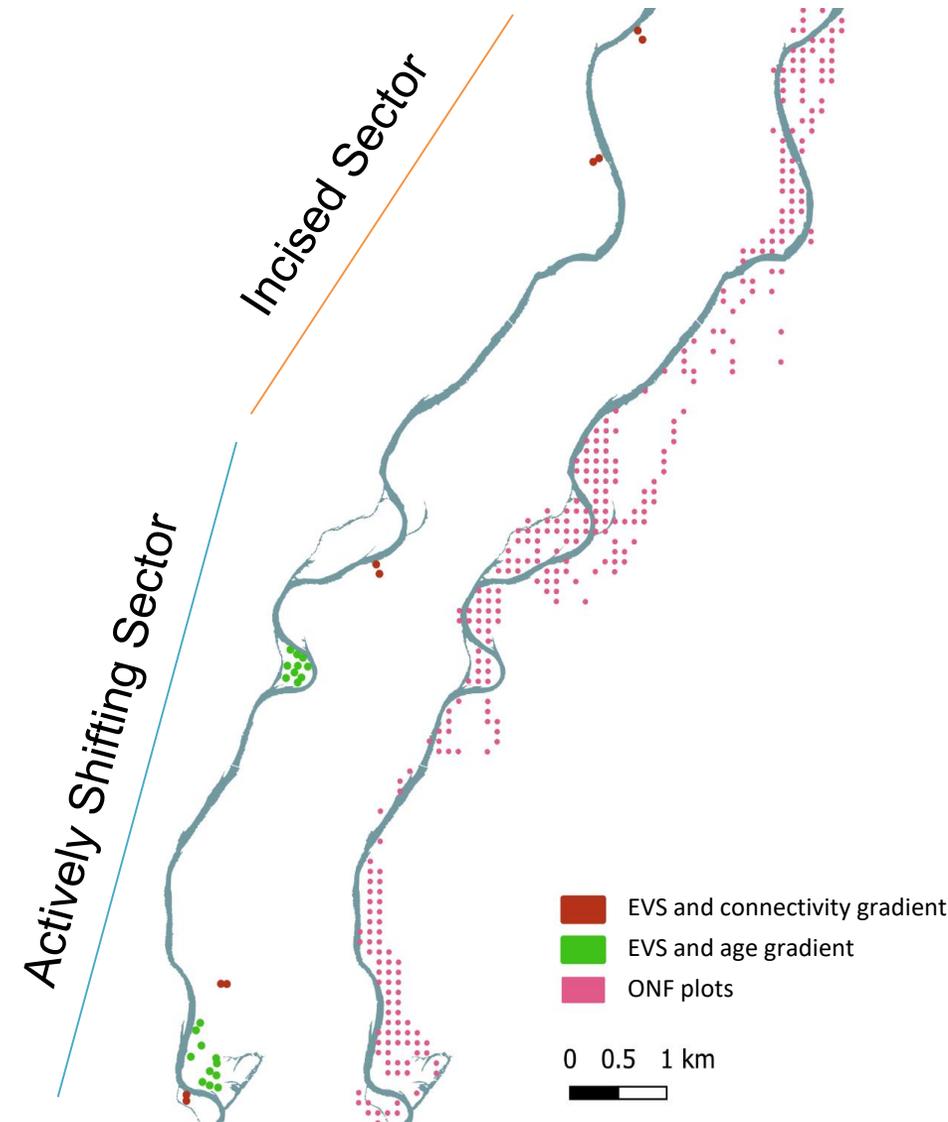
Channel incision leads to lower water levels and limits access of the riparian forest to groundwater



# Data – Field Survey

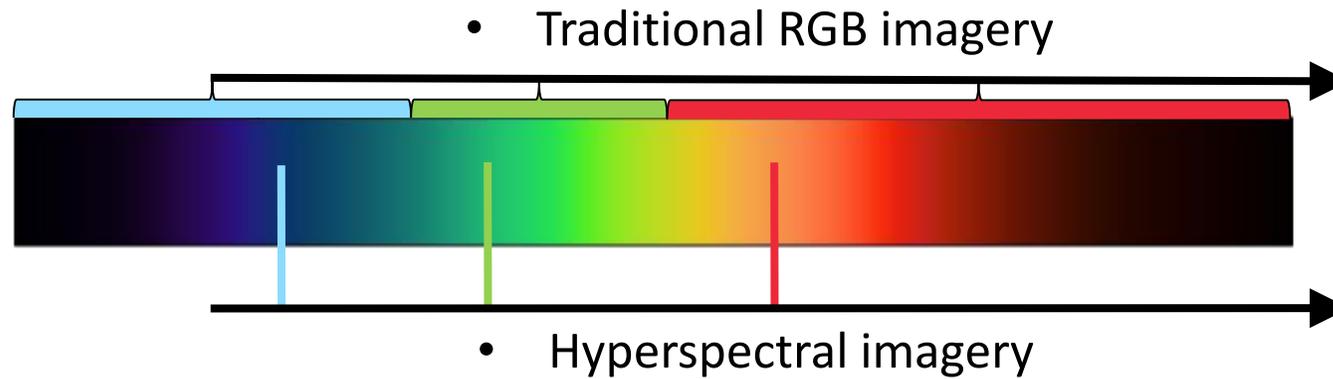
- Field Survey of Forest patches by EVS staff (2015)
  - Age gradient in young riparian forest
  - Connectivity gradient in the mature poplar forest
- Survey by the National Forestry Office (2017)
  - Systematic grid sampling of mostly mature poplar and hardwood forest cover

=> An exhaustive information about species distribution on the lower Ain River basin

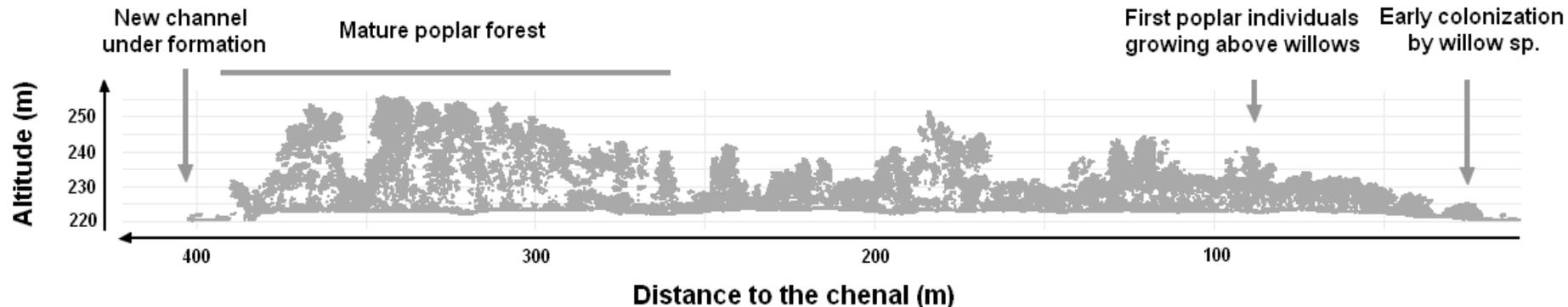


# Data – Remote Sensing

- Hyperspectral Imagery (2015 ; 361 bands 380 – 2500 nm)



- LiDAR data (2015 ; 18.6 pts/m<sup>2</sup> + 2007 ground only)



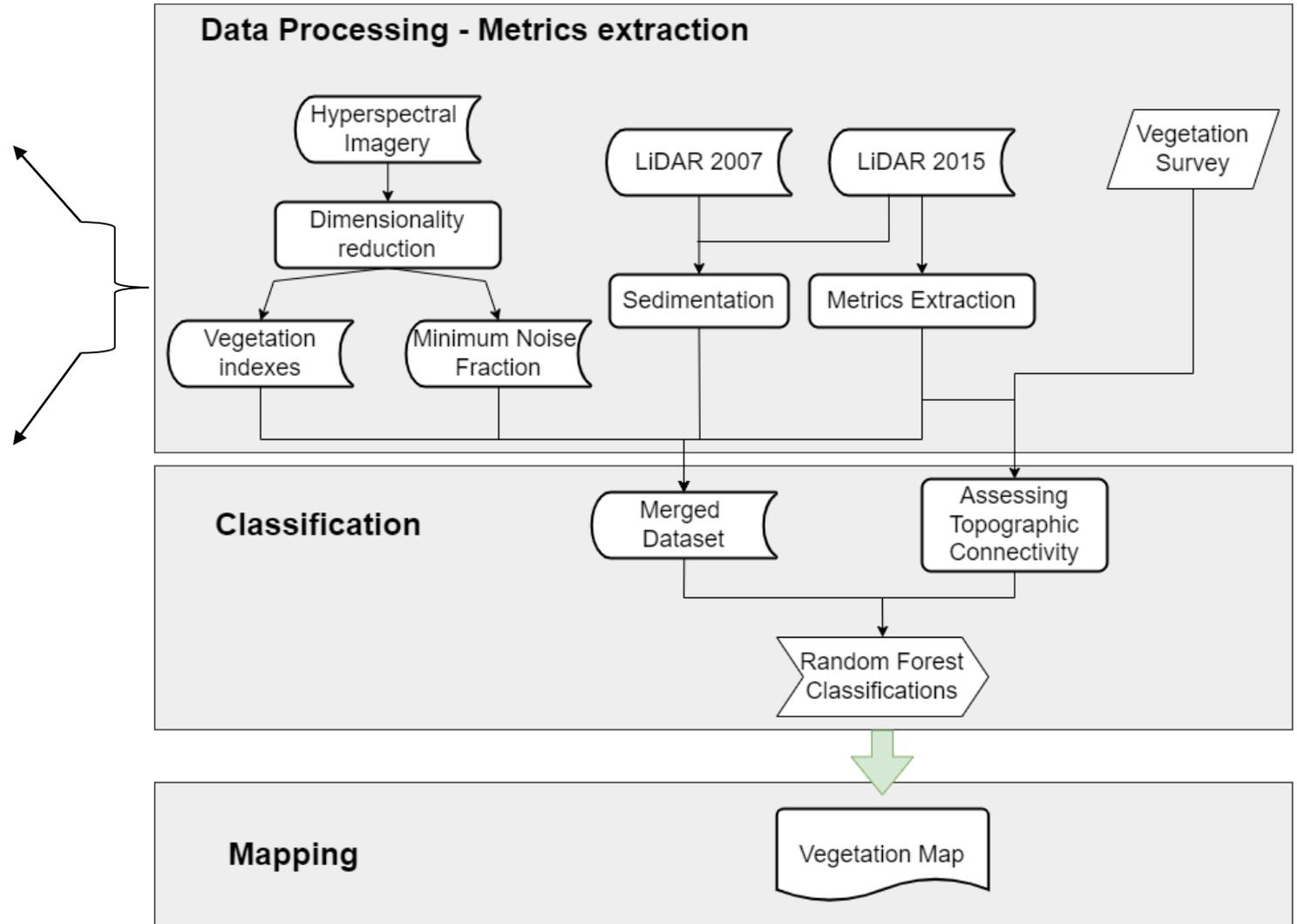
=> Novel remote sensing data covering 400 ha of riparian forest

# Methodology

1° - Assessing the impact of the age gradient on the riparian forest

2° - Identifying the vertical connectivity gradient for a given age

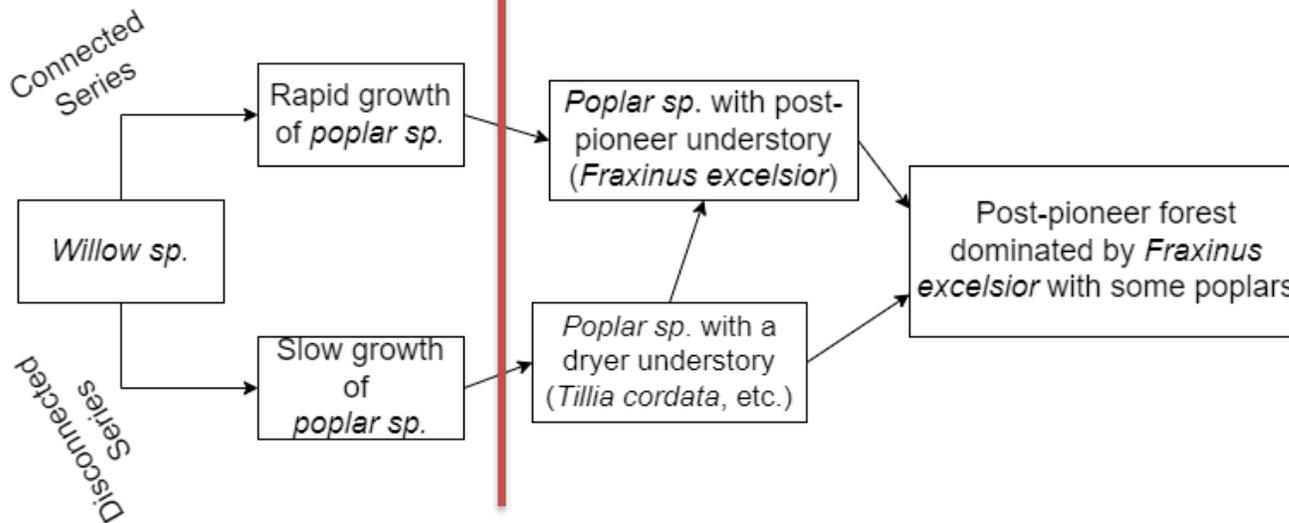
3° - Mapping connectivity through random forest classification



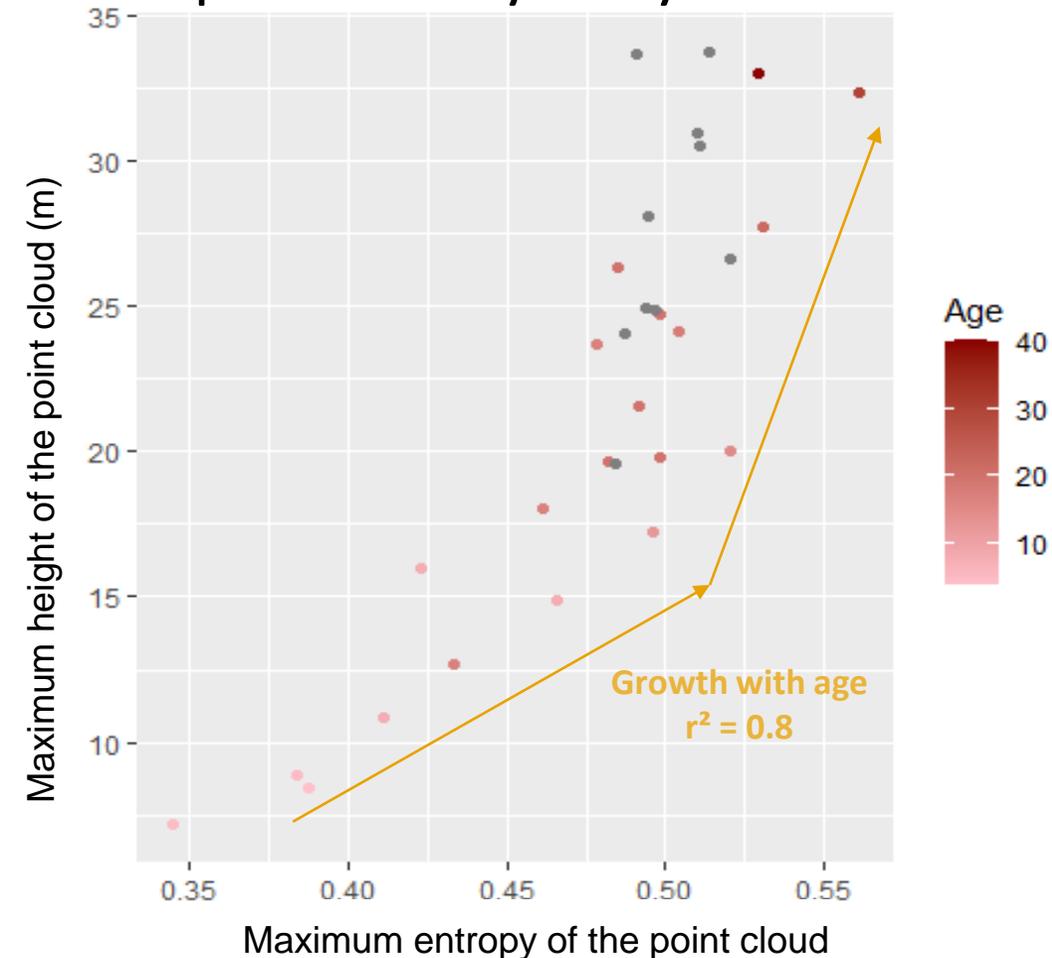
# Age gradients inside the riparian forest

- With age, the forest grows and changes
  - Tree growth after colonization is correlated to age
  - Successional stages lead to the implantation of an understory and of hardwood species

## Early poplar forest | Later successional stages



## Structure vs. Age for plots surveyed by EVS staff



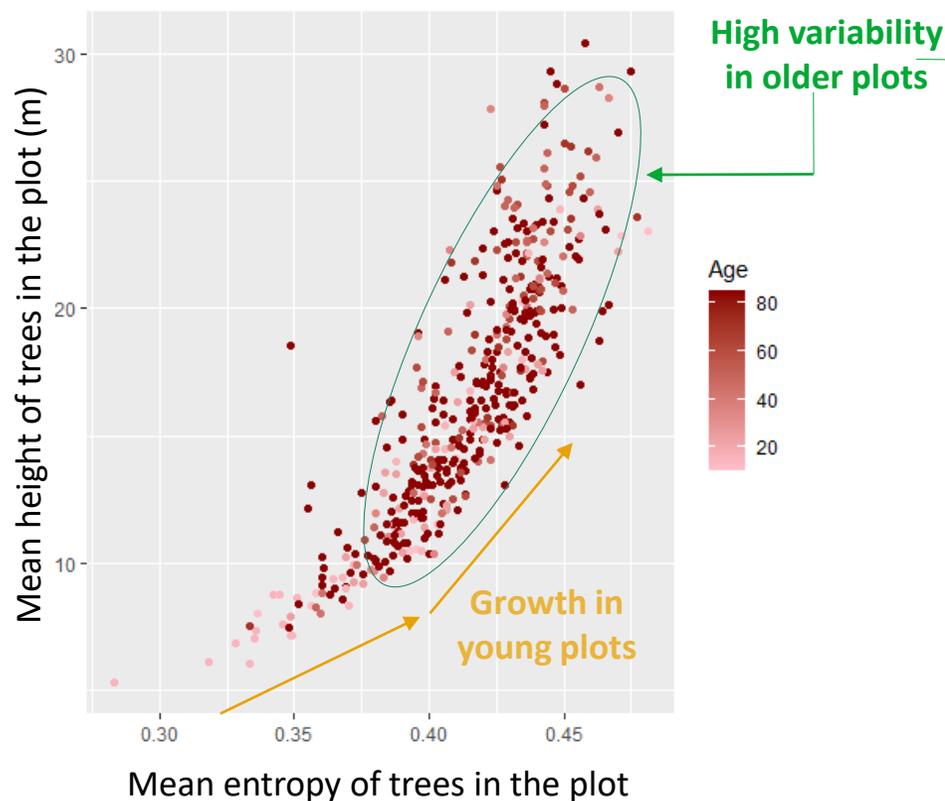
# Limitations of age-based gradients

- Most of the riparian forest is old (> 50 y.o.)

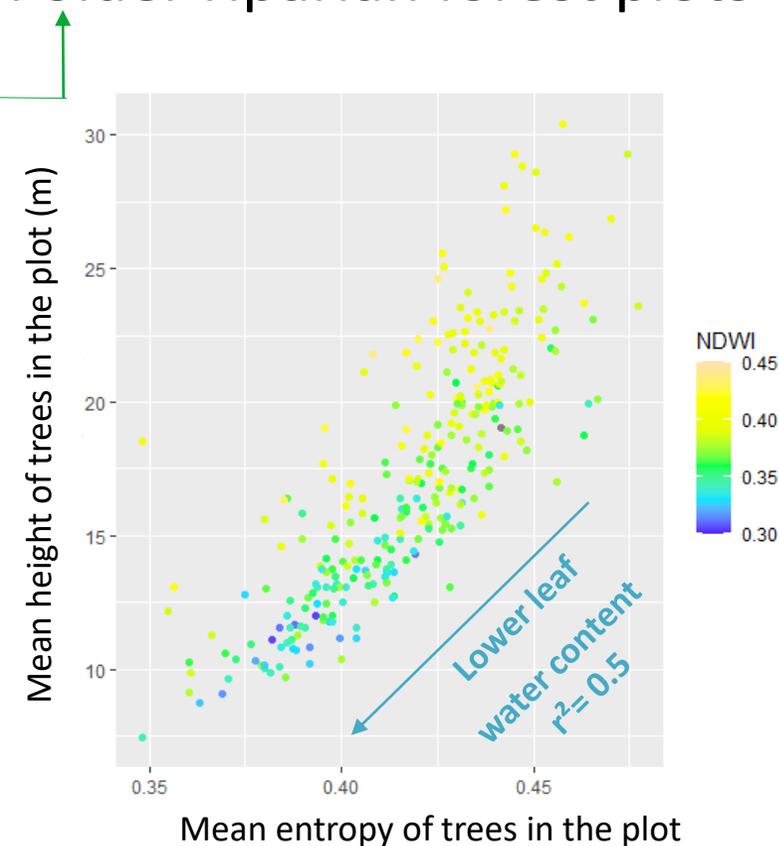
→ Structure of riparian vegetation varies a lot in older plots

→ Plot development is related to leaf water content

## Structure vs. Age for ONF plots



## Structure vs. Leaf Water Content in older riparian forest plots

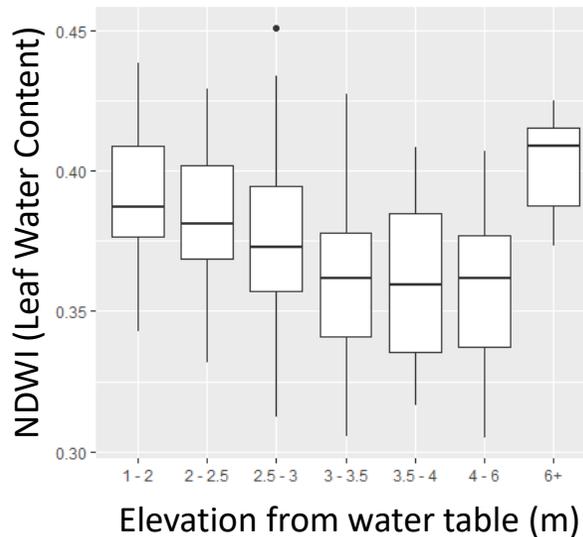


=> Access to the water resource impacts the structure of riparian forests

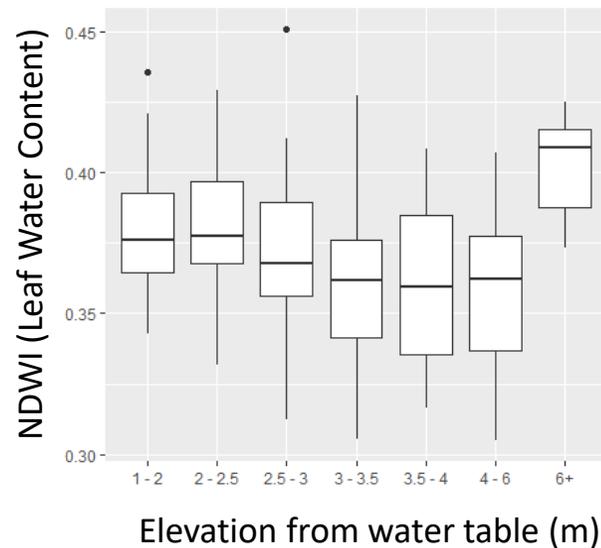
# Vertical connectivity gradient

Leaf water content drops with elevation  
from low flow water table

50+ y.o.

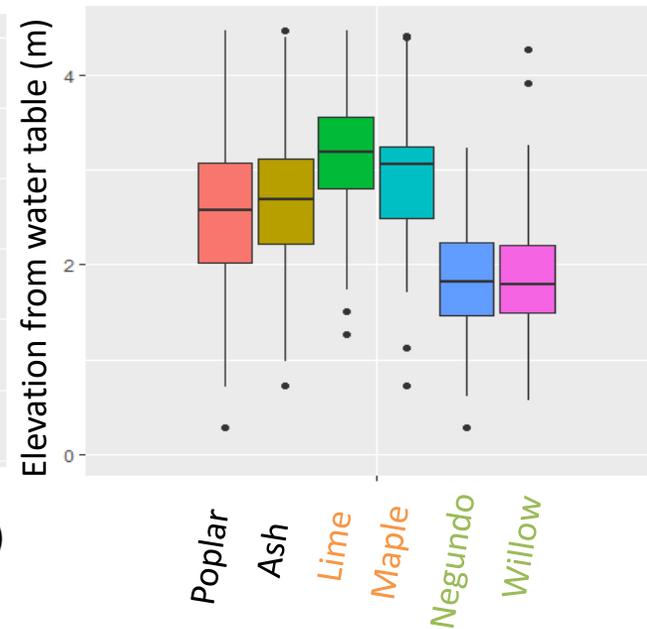


80 y.o.

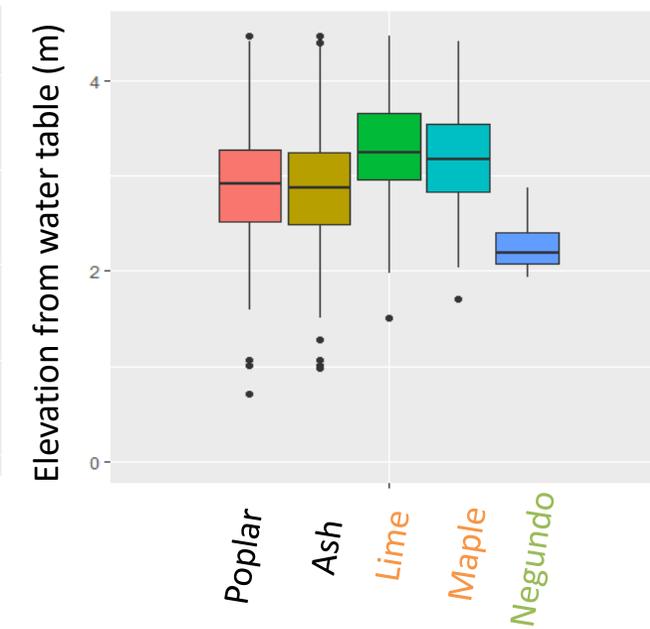


Species distribution depending on altitude  
above the water level at low flow

50+ y.o.



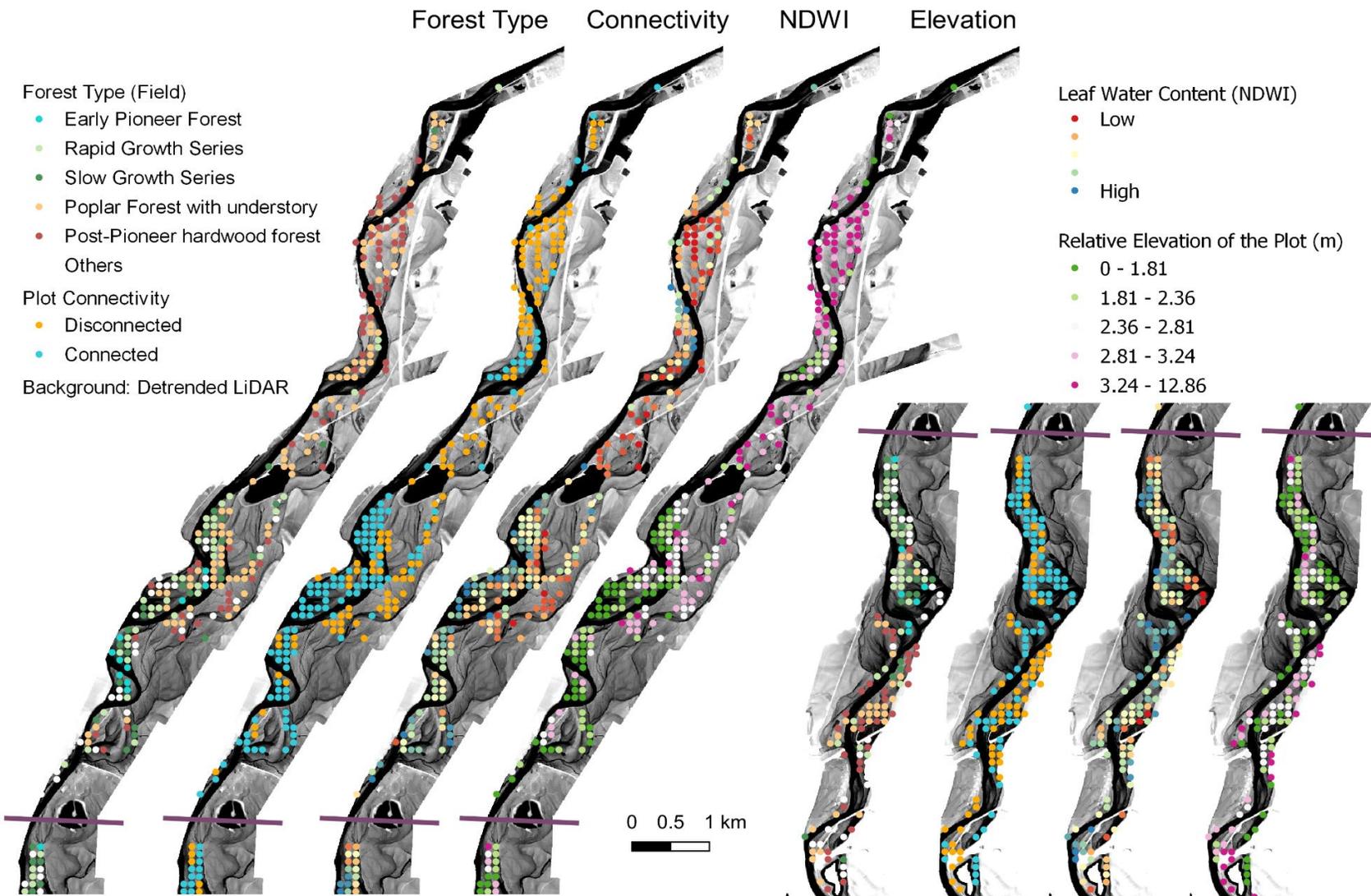
80 y.o.



=> Classification to predict vertical connectivity

Accuracy : 25% for cut-off at 2.5m

# Mapping hydrological connectivity



- Forest plots affected by groundwater drop are identified

→ Clear upstream – downstream gradient of disconnectivity related to progressive channel incision due to sediment starvation

→ (Dis)-connection of old lateral channels depending on elevation

# From indicating to monitoring

- Combining hyperspectral and LiDAR information is useful to identify potential drought effects on riparian vegetation
- Towards monitoring riparian forests
  - Sensitivity to seasonal variations and reproducibility?
  - Linking hyperspectral with in-field eco-physiological measurements of leaf water and water-induced stress at the tree level
  - Working at the individual tree level (e.g., crowns) rather than on forest plots



A wide river flows through a landscape with a rocky bank in the foreground. The background is filled with a dense forest of trees, many of which have turned yellow and orange, indicating autumn. The sky is a clear, pale blue. The water in the river is calm, reflecting the trees and the sky. The text "Thank you for your attention!" is overlaid in the center of the image in a bright yellow font.

Thank you for your attention!