# Depicting vegetation dynamics along the Tagliamento river bars: a remote sensing approach to monitor biodiversity in alpine rivers

**Giacomo Boscarol**[1], Giacomo Trotta[2,1], Maurizia Sigura[1], Valentino Casolo[1,3], Elisa Pellegrini[1], Giorgio Alberti[1,3], Marco Vuerich[1,3], Daniel Moro[2,1], Sara Gargiulo[2,1], Edoardo Asquini[4,1], Paolo Cingano[2,1], Daniéle Lagnaz[5], Florent Jouy[6], Jana Chmieleski[7], Michał Habel[8], Dawid Szatten[8], Marta Brzezińska[8], Francesco Boscutti[1,3]

1 UNIVERSITÀ DEGLI STUDI DI UDINE

2 UNIVERSITÀ DEGLI STUDI DI TRIESTE

3 NATIONAL BIODIVERSITY FUTURE CENTER

4 UNIVERSITÀ DEGLI STUDI DI PALERMO

5 Zurich University of Applied Sciences zhaw

6 Eberswalde University for Sustainable Development

7 Nationalpark Unteres Odertal

8 KAZIMIERZ WIELKI UNIVERSITY BYDGOSZCZ

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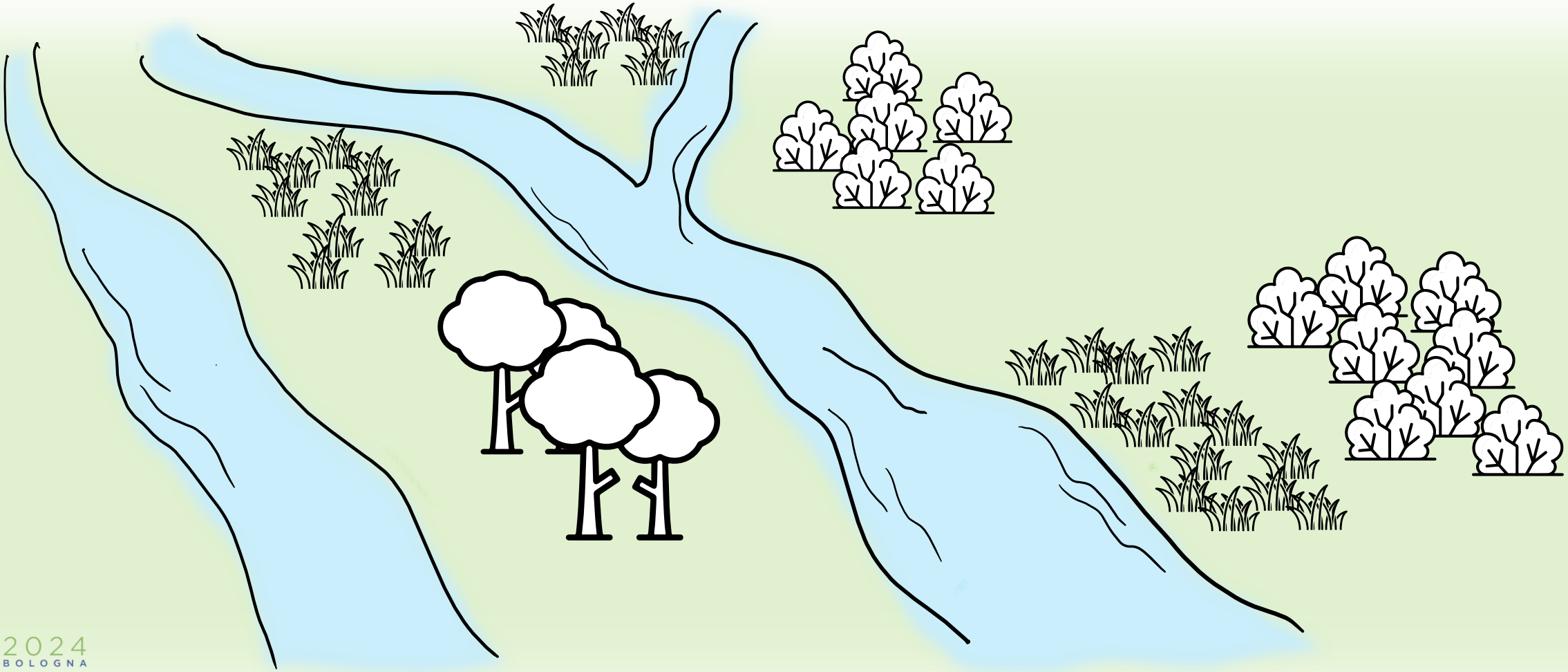
ECCB 2024 BOLOGNA

7th European Congress of Conservation Biology

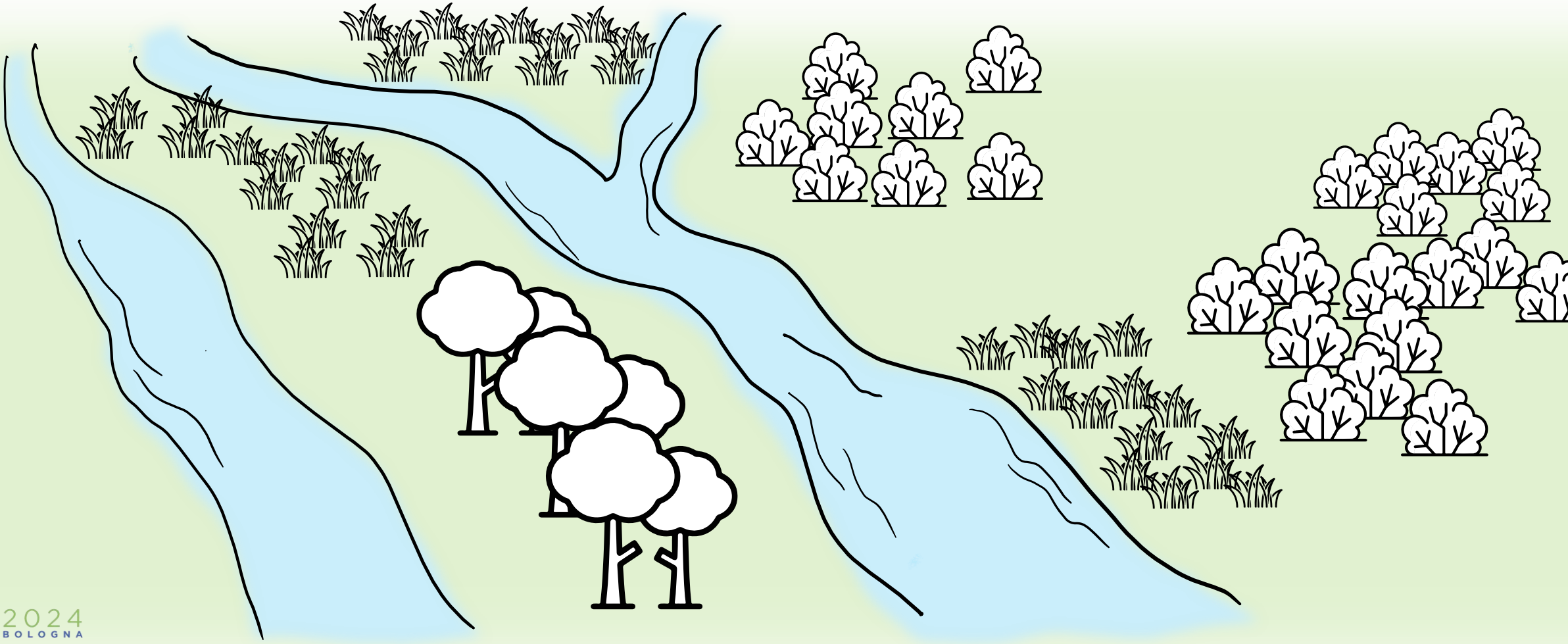
# RIVER DYNAMICS

Initial state – grasslands, shrublands and woodlands



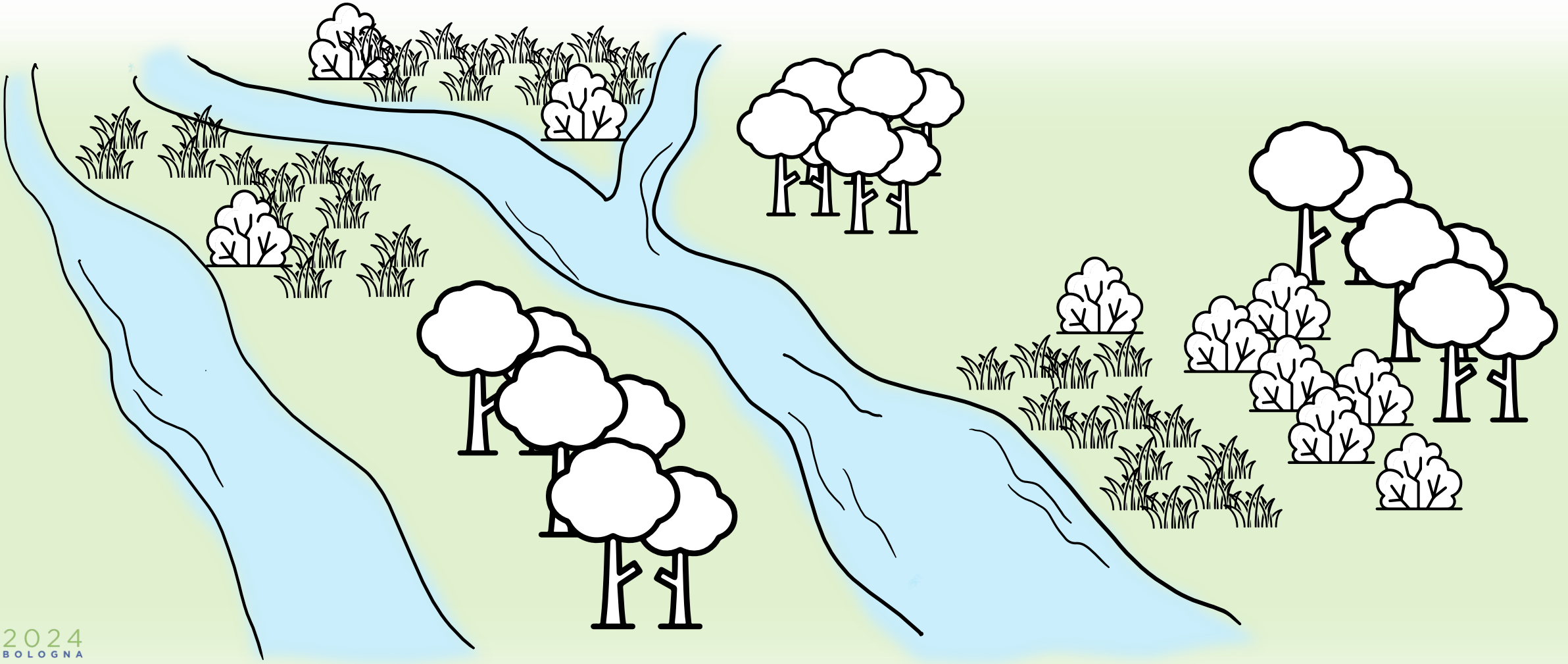
# RIVER DYNAMICS

Vegetation dynamics – spatial growing



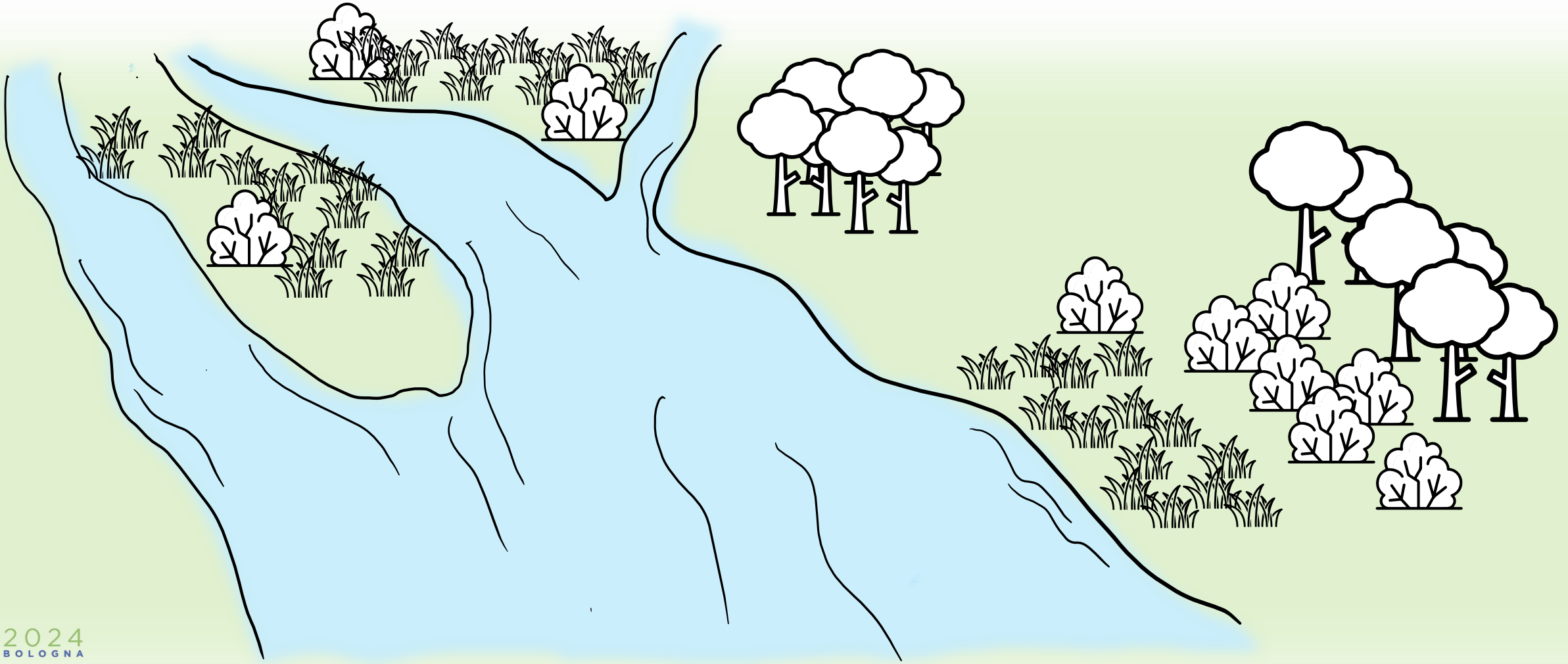
# RIVER DYNAMICS

Vegetation dynamics – ecological successions



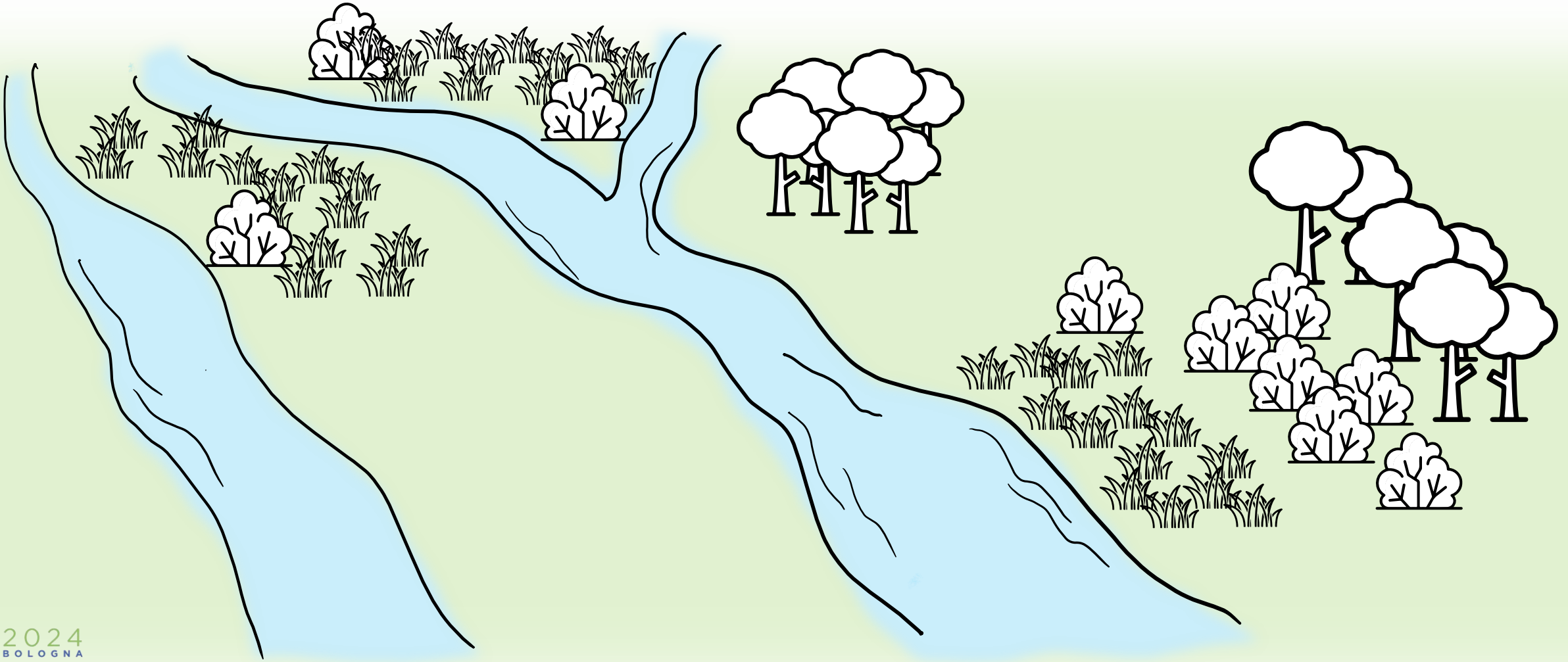
# RIVER DYNAMICS

River dynamics – flood event



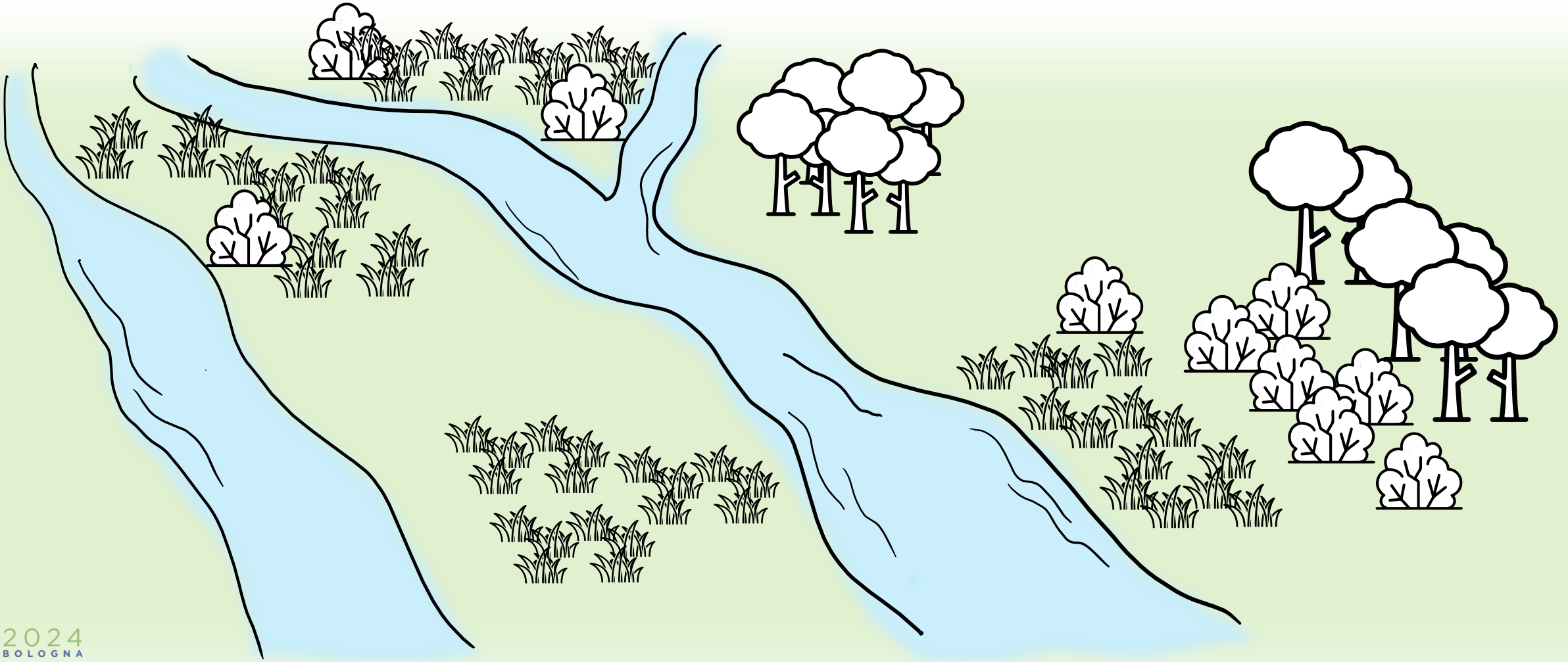
# RIVER DYNAMICS

River dynamics – returned to bare soil



# RIVER DYNAMICS

River dynamics – the ecological succession starts over



# STUDY AREA:
## Tagliamento river

In the N-E part of Italy

One of the **most well-preserved** river in Europe

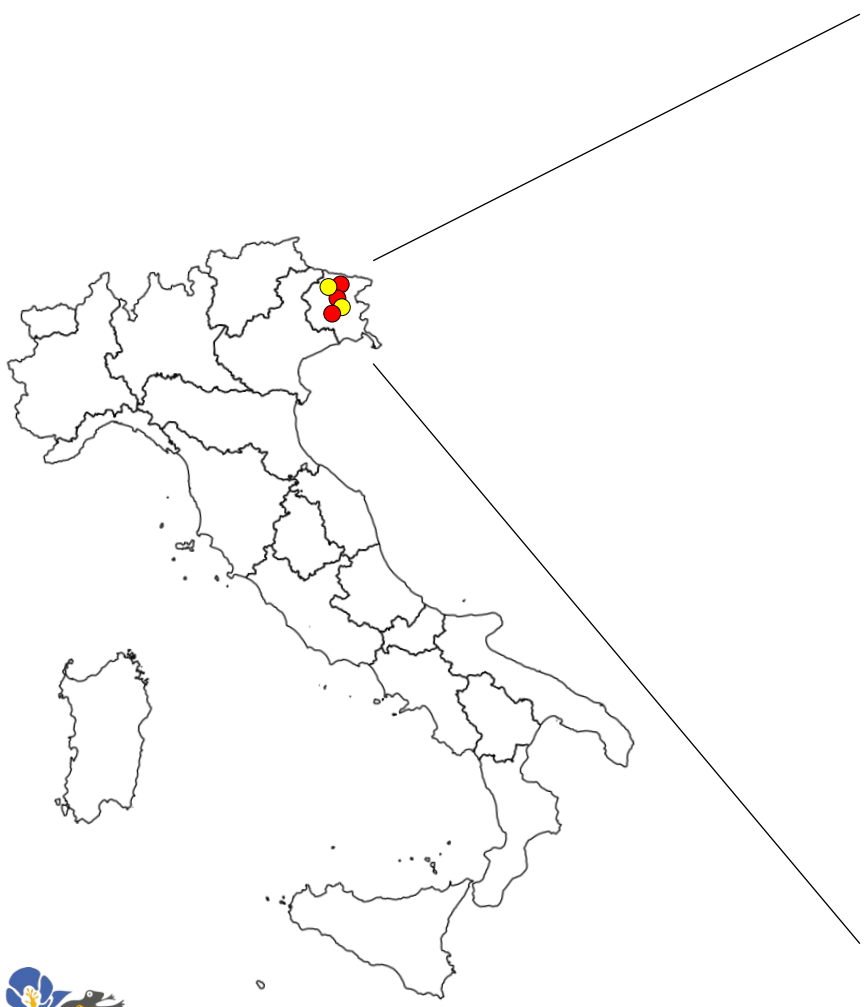
Characterized by:

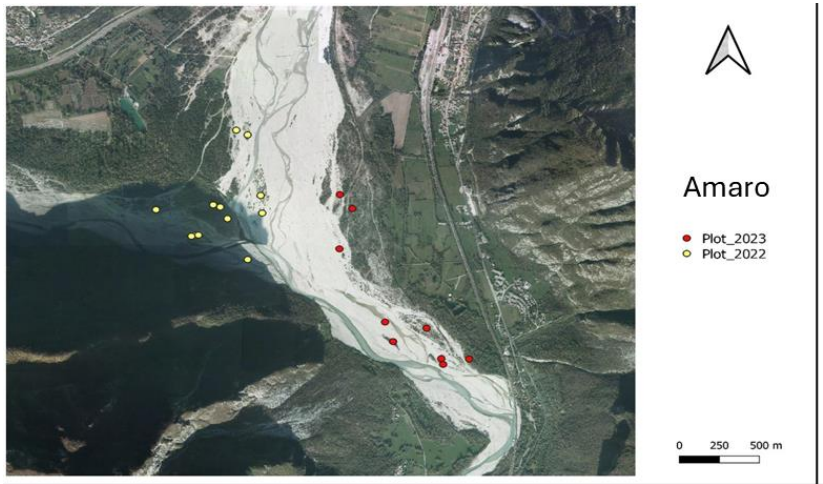
- a **wide** pristine gravel-bed
- frequent **flood** events
- **river bars** with complex habitats

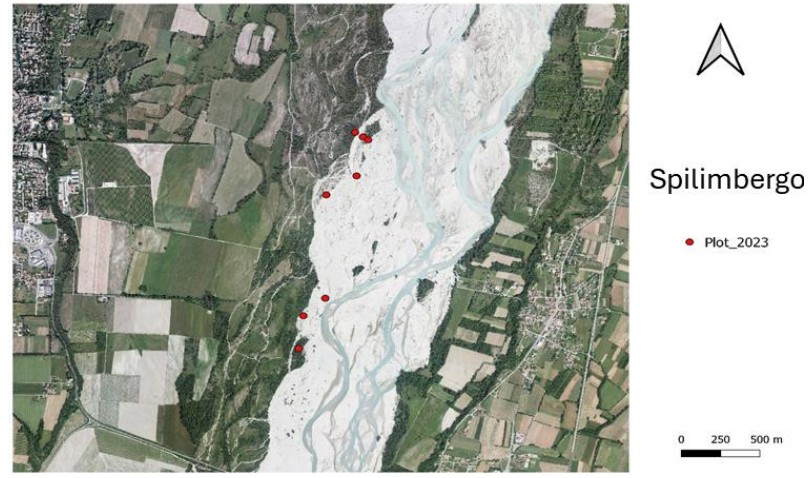
Subjected to nature conservation initiatives

# STUDY AREA

Identified 51 plots of 100m$^2$ each in 4 consecutive parts of the Tagliamento river (N-E Italy)





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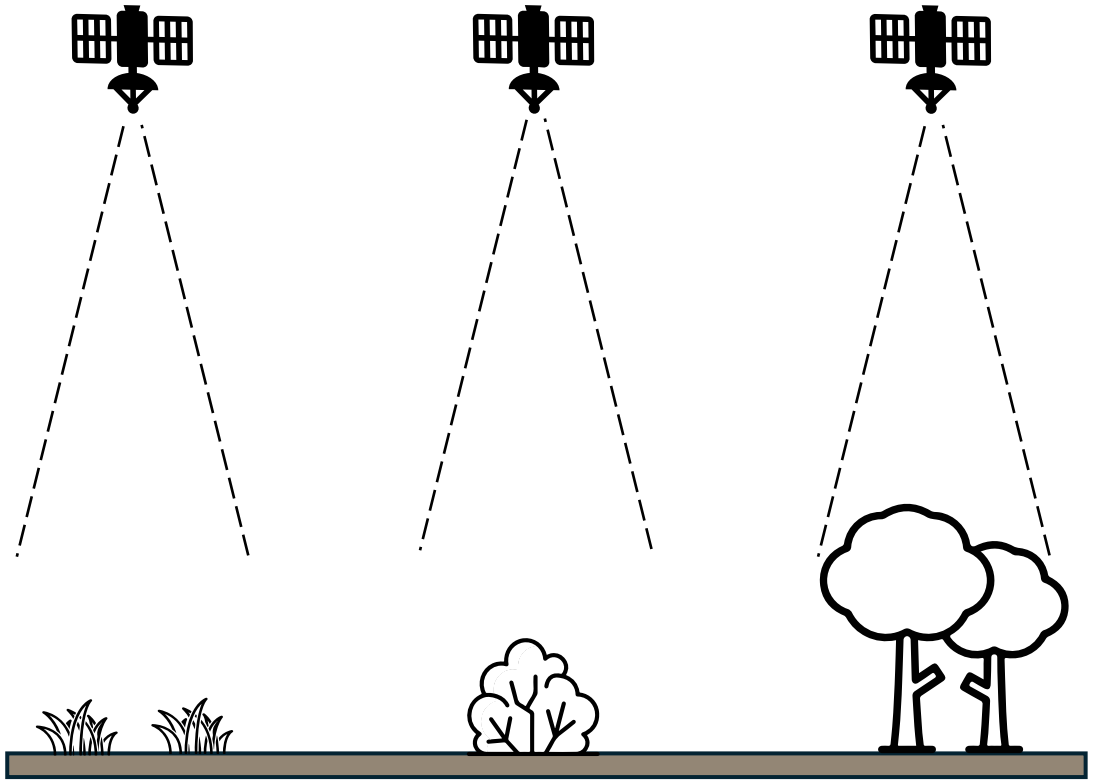
# AIM OF THE STUDY

Understand how satellites recognize different **vegetation stages**

A useful tool for implementing effective conservation strategies



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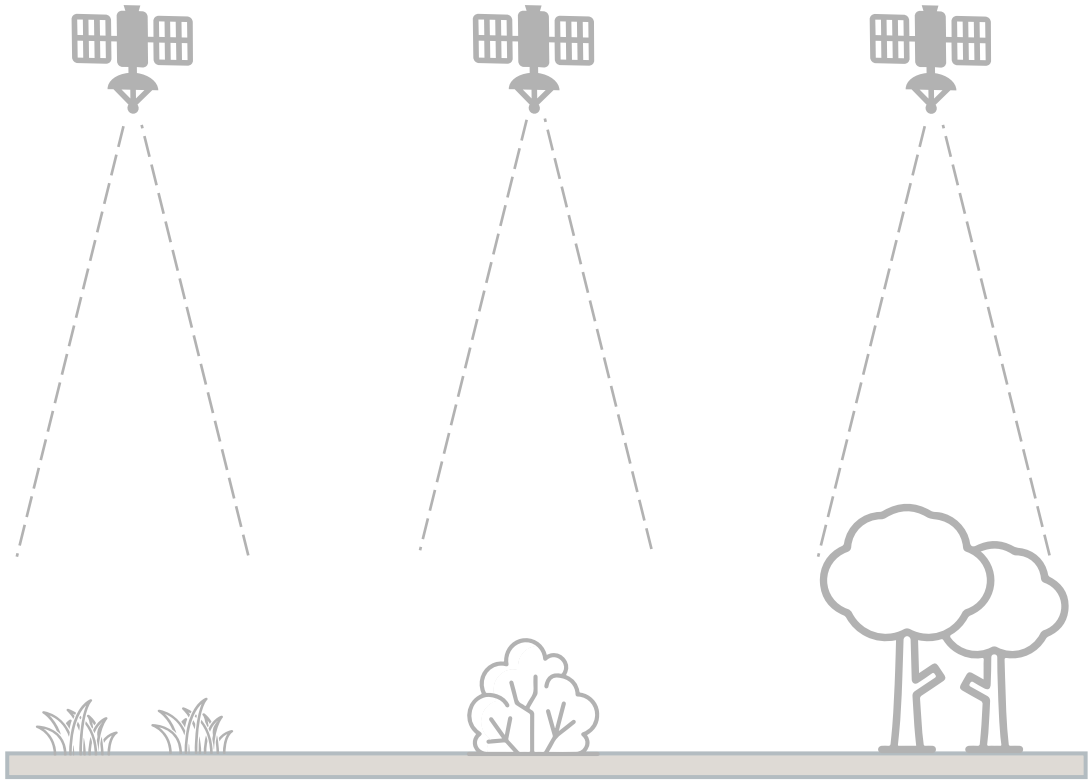
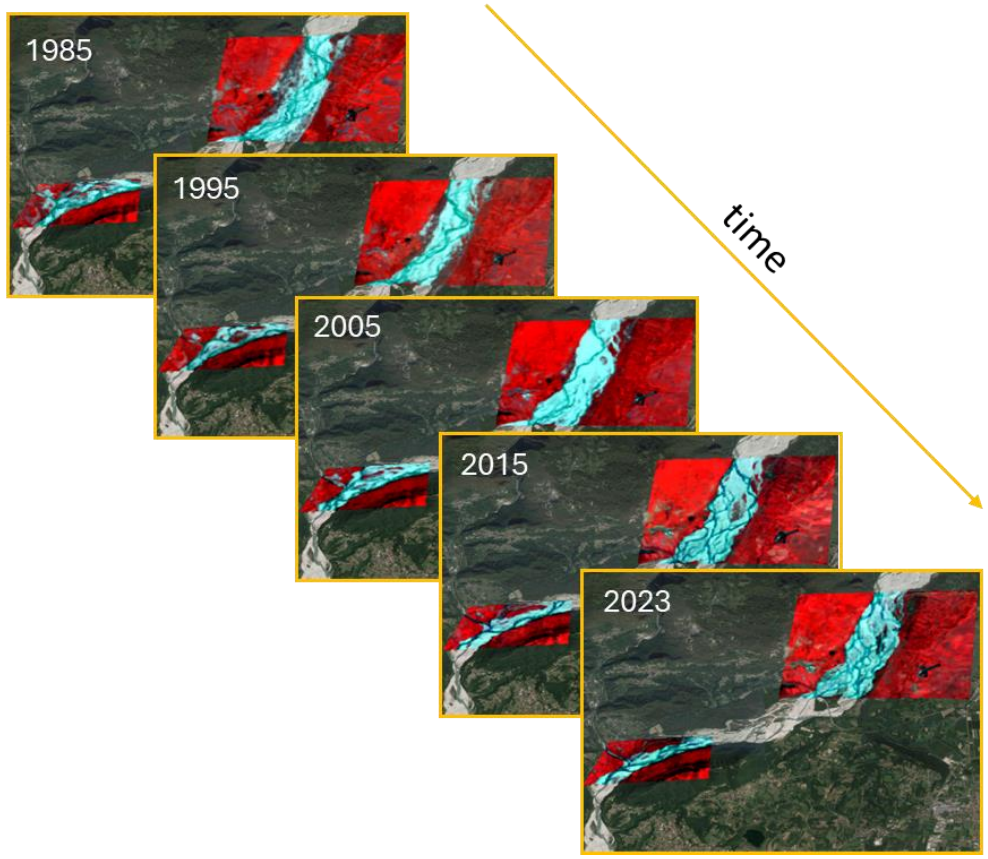
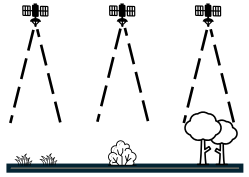


Find out which are the vegetation's **dynamics** over the last **40 years**

What satellites can tell us about **time trends** of dynamic systems



# MATERIALS AND METHODS



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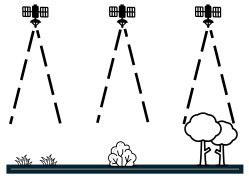

Erasmus+

Funded by Erasmus+ Programme KA1-Blended Intensive Programme project: "Monitoring Alpine River Dynamics from a biodiversity and landscape perspective"

In the 51 plots:

Performed floristic surveys (species name and habitus)

Collected soil data (analyses are still ongoing)

In 2022 and 2023

Erasmus+ program involving

4 European countries

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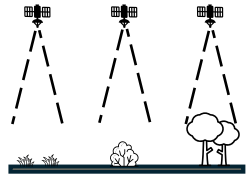

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(1994, 2000, 2003, 2007, 2011, 2020)

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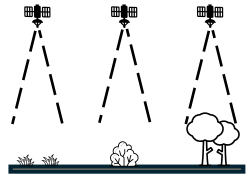

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$$NDVI = \frac{(NIR - Red)}{(NIR + Red)}$$

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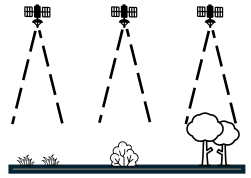

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Created models between NDVI in 2023, bar age, habitat, habitus, species richness

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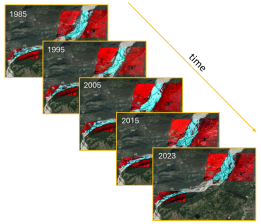

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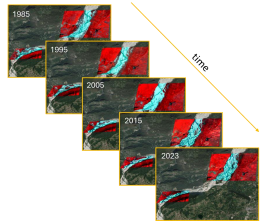


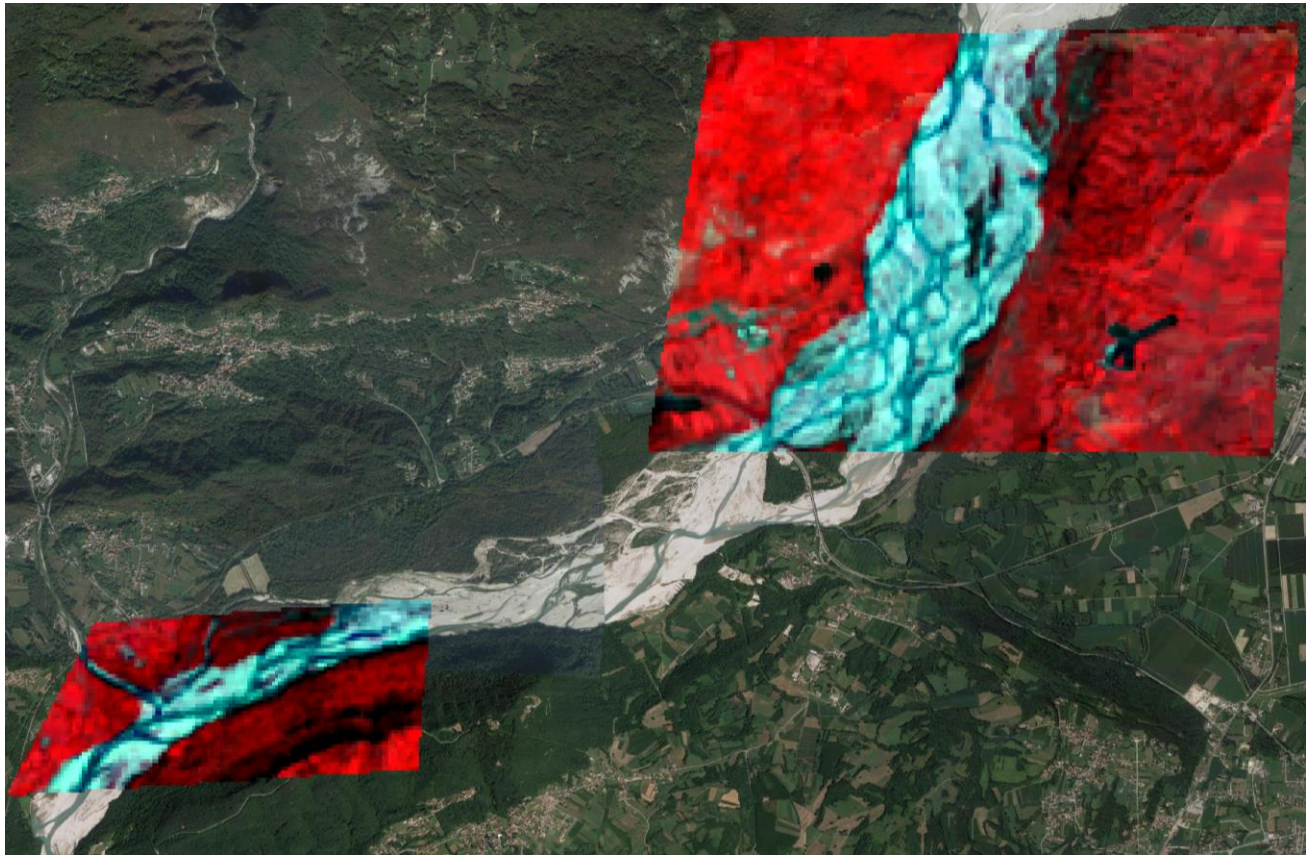

Annual NDVI index from Landsat images

Spatial resolution: 30x30m per pixel

| *Time interval* | *Satellite* |
|---|---|
| 1988 – 2011 | Landsat 5 |
| 2013 – 2023 | Landsat 8 |

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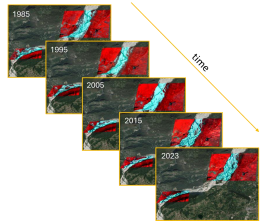


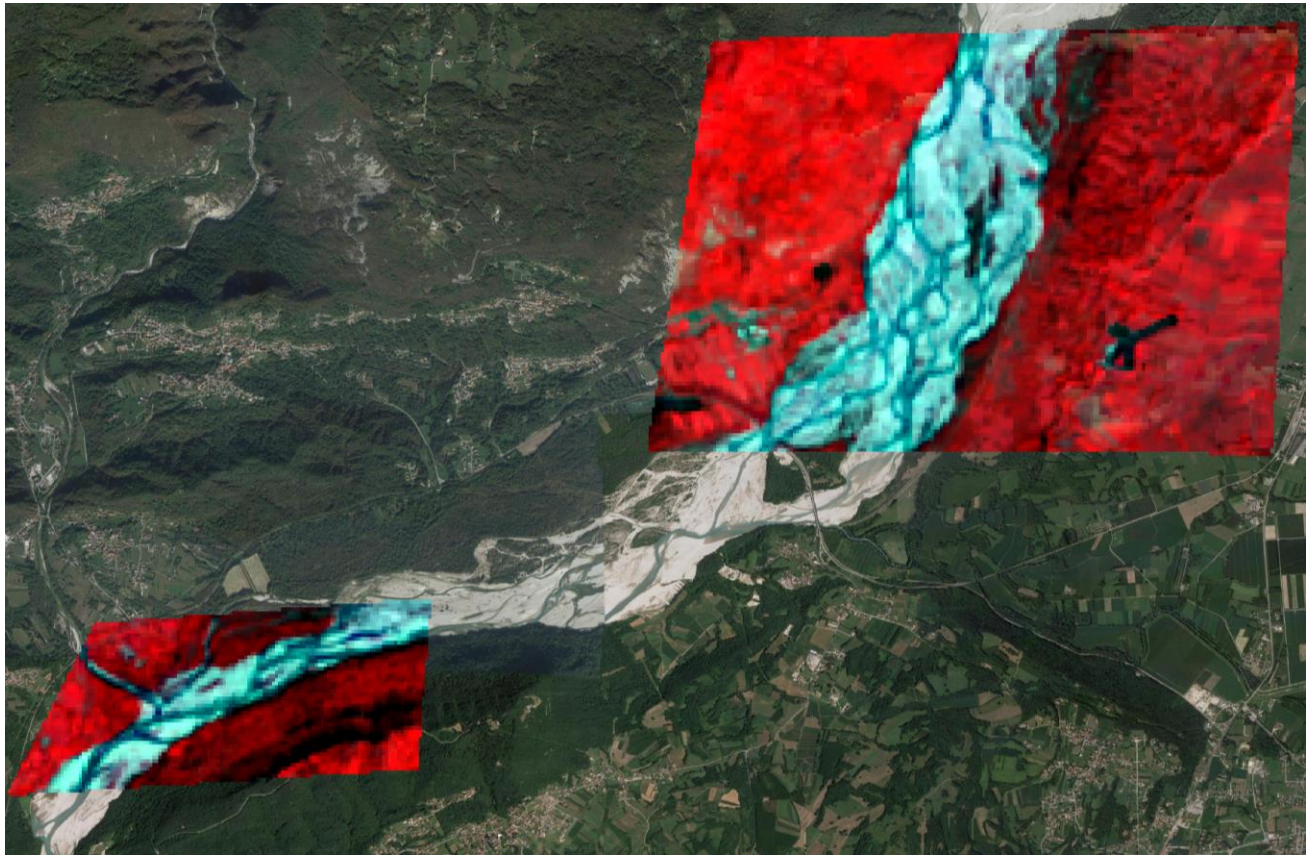

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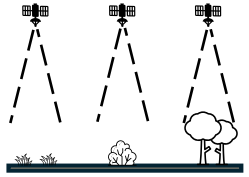
Created models between annual NDVI and bars age

# RESULTS: NDVI ~ community structure



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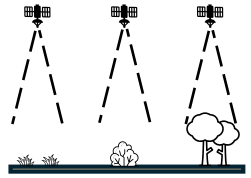

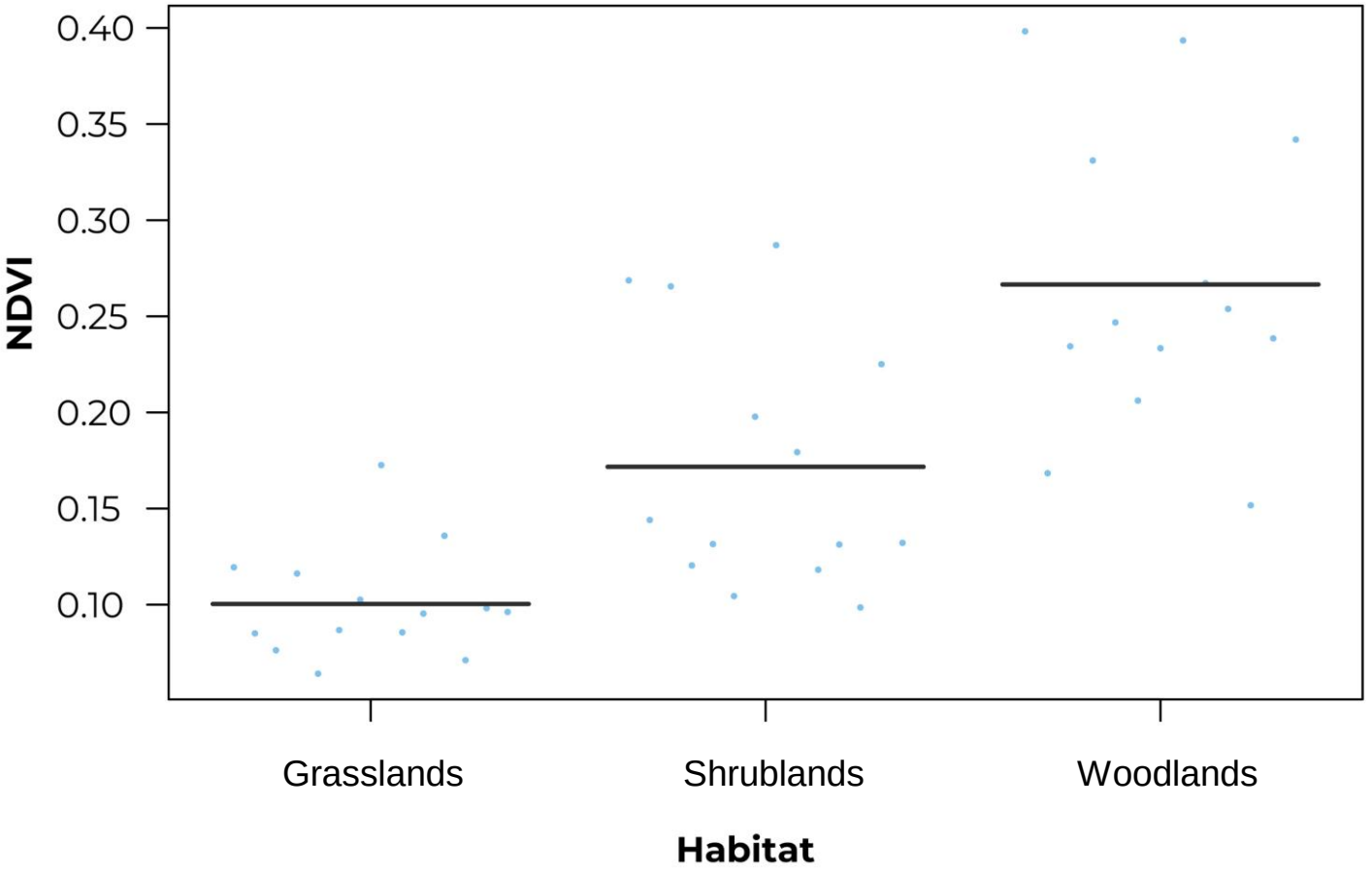


Direct proportionality between the progression of the ecological succession and NDVI

$R^2 = 0.56$

| | *NumDF* | *DenDF* | *F-value* | *p-value* |
|---|---|---|---|---|
| *Intercept* | 1 | 36 | 350.695 | <.0001 |
| *Habitat* | 1 | 36 | 253.844 | <.0001 |

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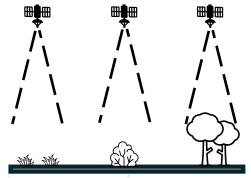

Positive linear relation between the age of the bars and NDVI

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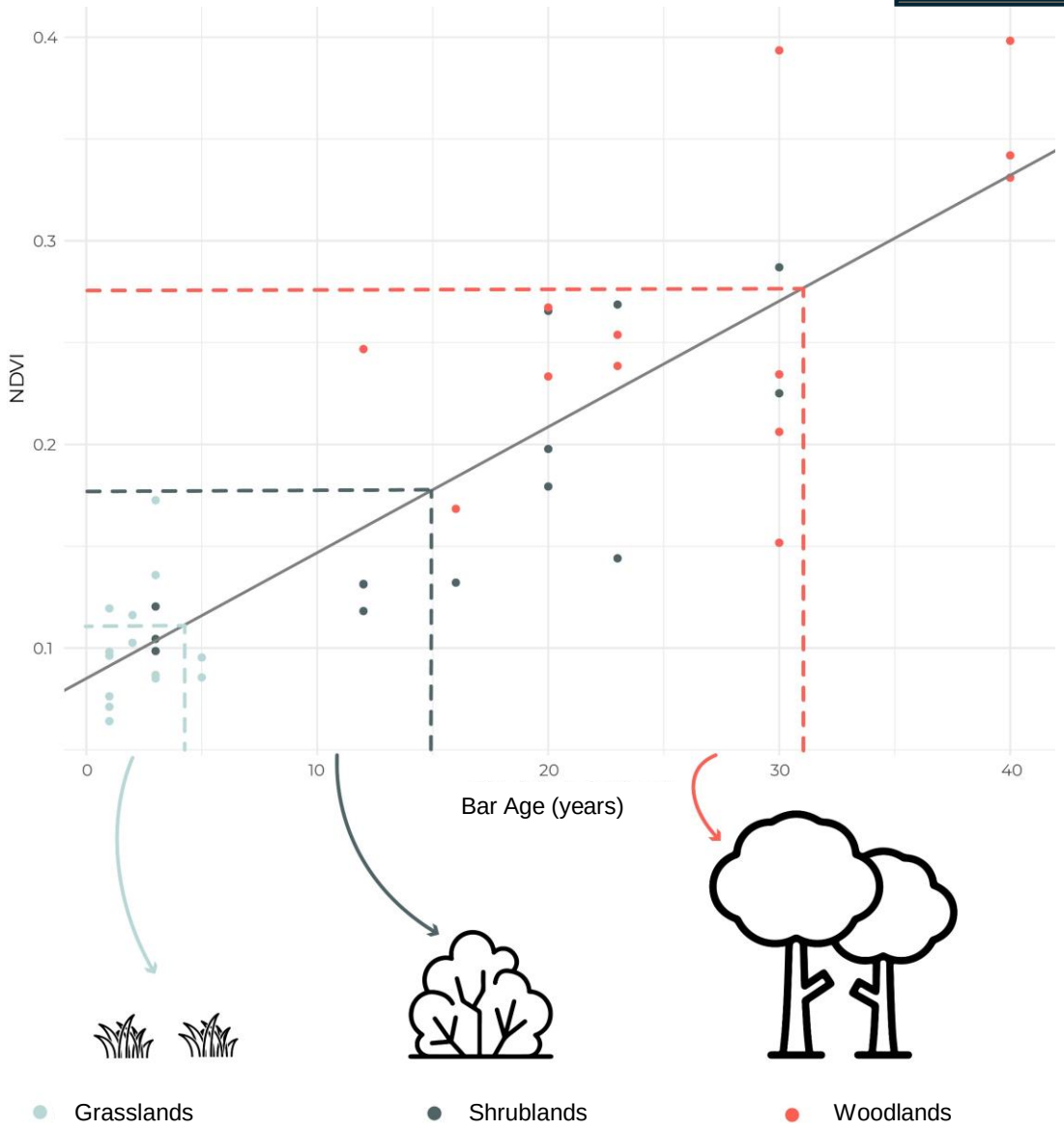

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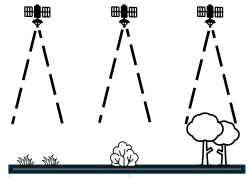

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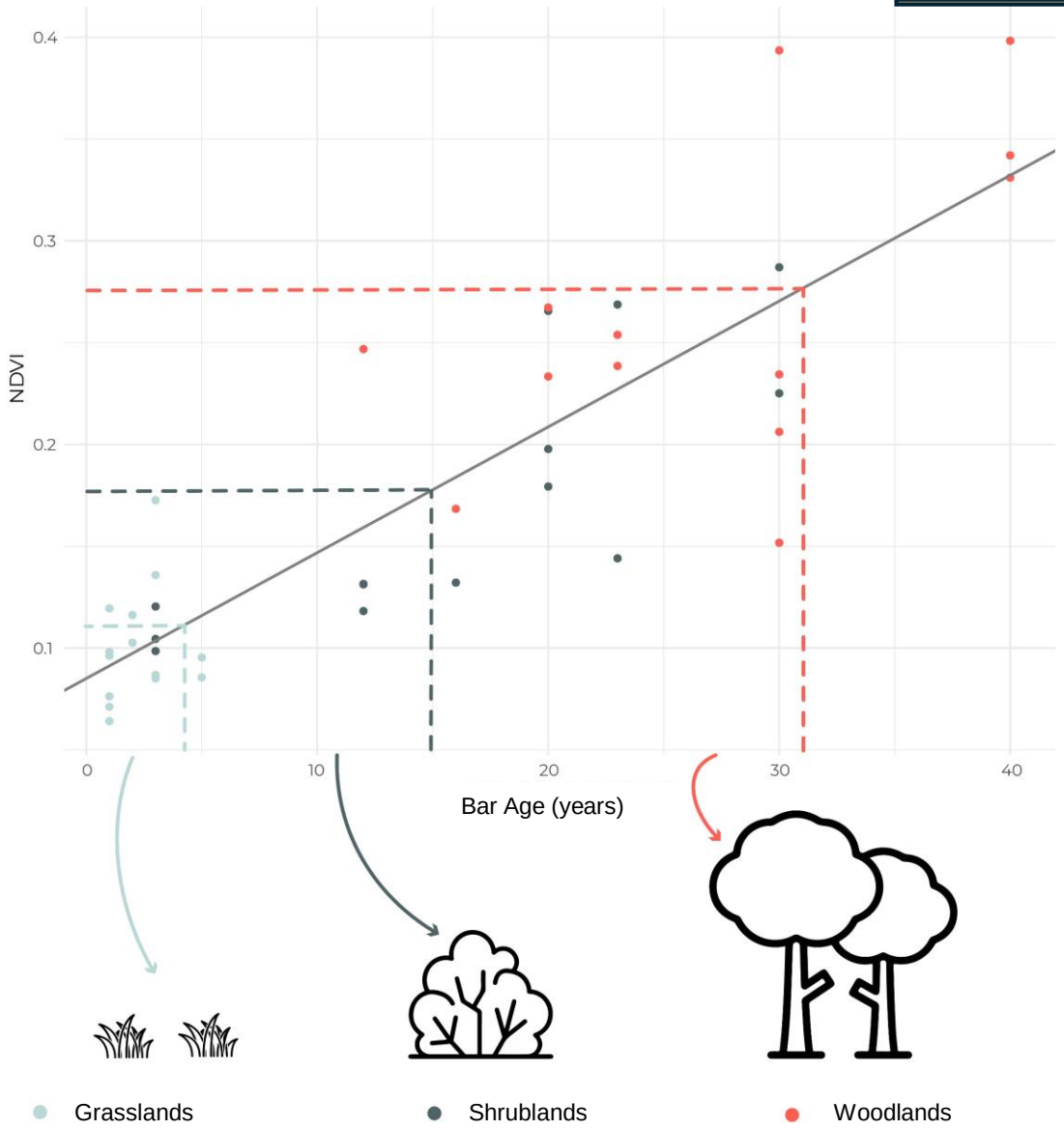
NDVI as a **proxy** of bar age



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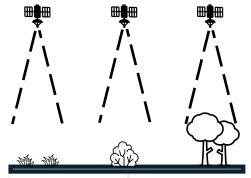

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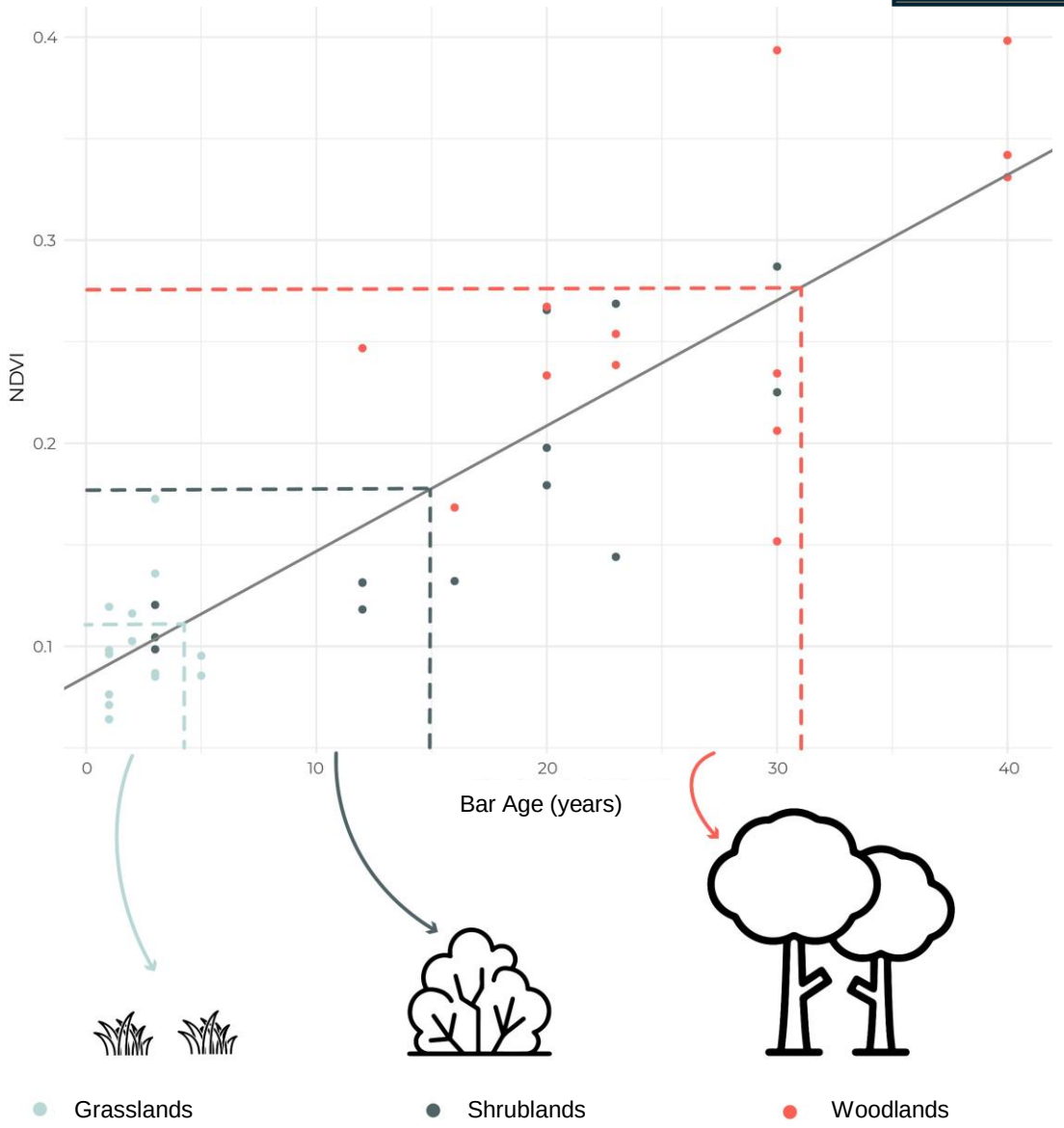
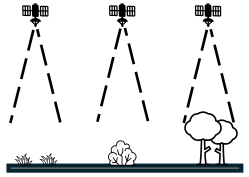
NDVI as a **proxy** of bar age

| *Bar Age (years)* | *NDVI* |
|---|---|
| < 5 | 0.03 – 0.17 |
| 5 – 10 | No bars detected |
| 10 – 30 | 0.12 – 0.28 |
| > 30 | > 0.3 |



# RESULTS: species richness ~ NDVI and habitus



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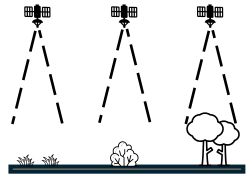
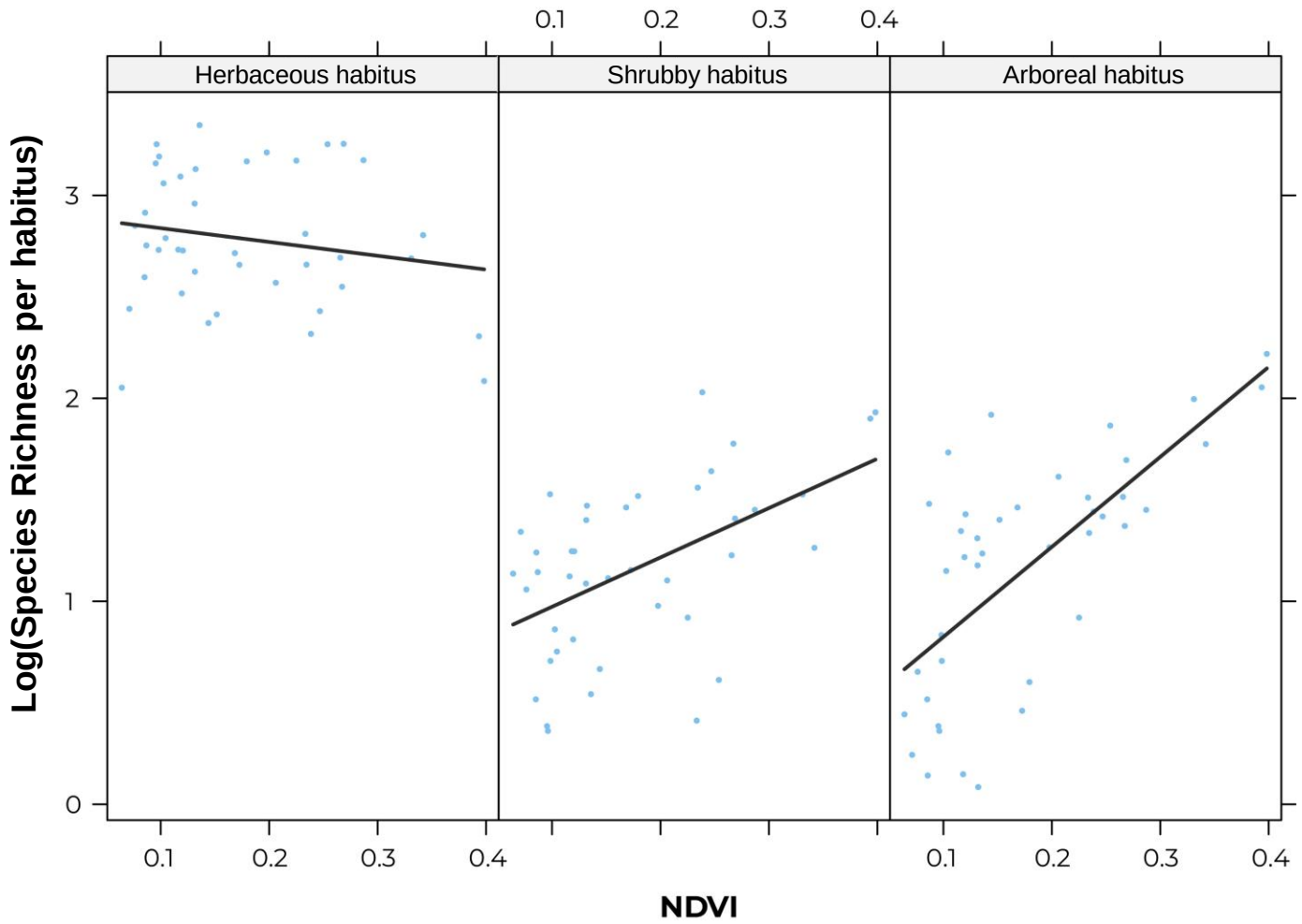


Habitus = growing form of a species

It reflects the ecological succession: species richness increases in time (proxy: NDVI)

$R^2 = 0.69$

| | *NumDF* | *DenDF* | *F-value* | *p-value* |
|---|---|---|---|---|
| *Intercept* | 1 | 78 | 723.677 | <.0001 |
| *NDVI* | 1 | 39 | 253.844 | .0006 |
| *Habitus* | 2 | 78 | 196.191 | <.0001 |
| *NDVI:Habitus* | 2 | 78 | 11.854 | <.0001 |



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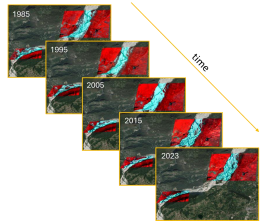

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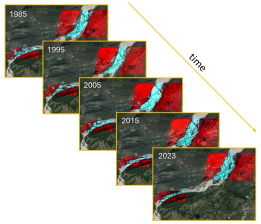
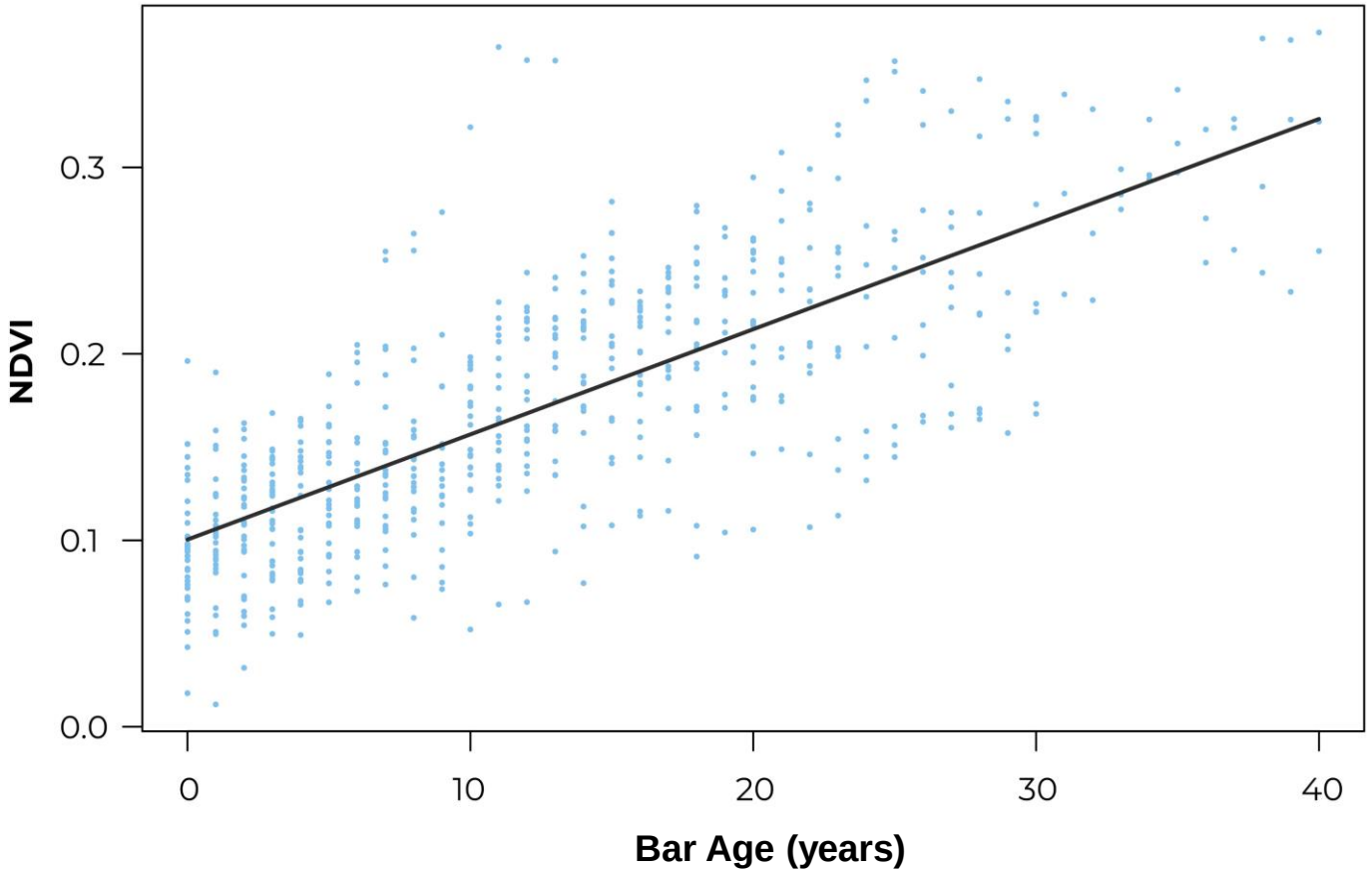



Time series: 1988 – 2023

Strong positive relation between bars' age (from 1988 to 2023) and annual NDVI

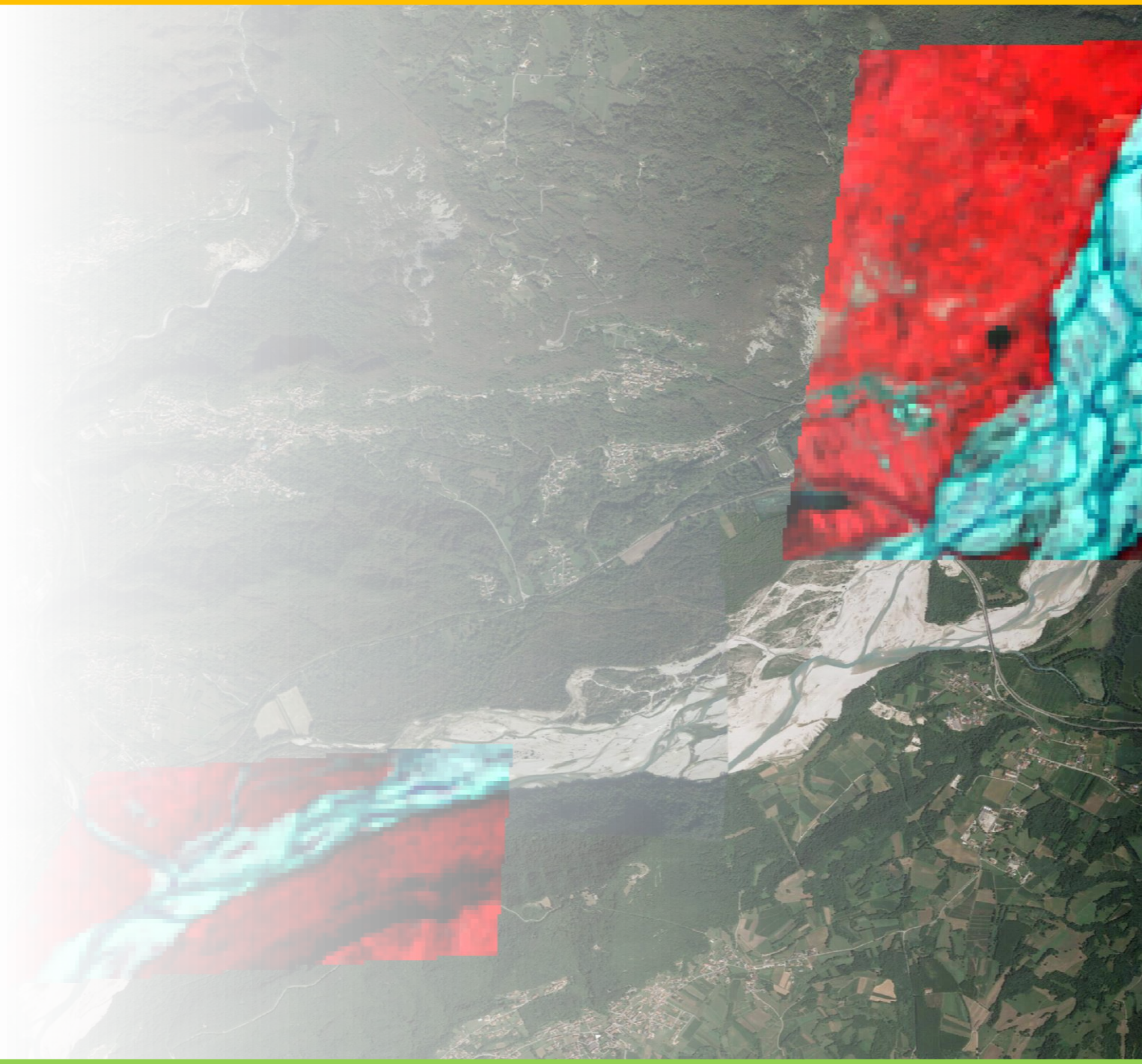
$R^2$=0.52

| | *NumDF* | *DenDF* | *F-value* | *p-value* |
|---|---|---|---|---|
| *Intercept* | 1 | 580 | 276.754 | <.0001 |
| *Age* | 1 | 580 | 5.136 | <.0001 |

Low number of «old» bars (dynamic system)

# CONCLUSIONS

NDVI has been confirmed to be a good indicator of the **bar age** and the **ecological succession's stage**



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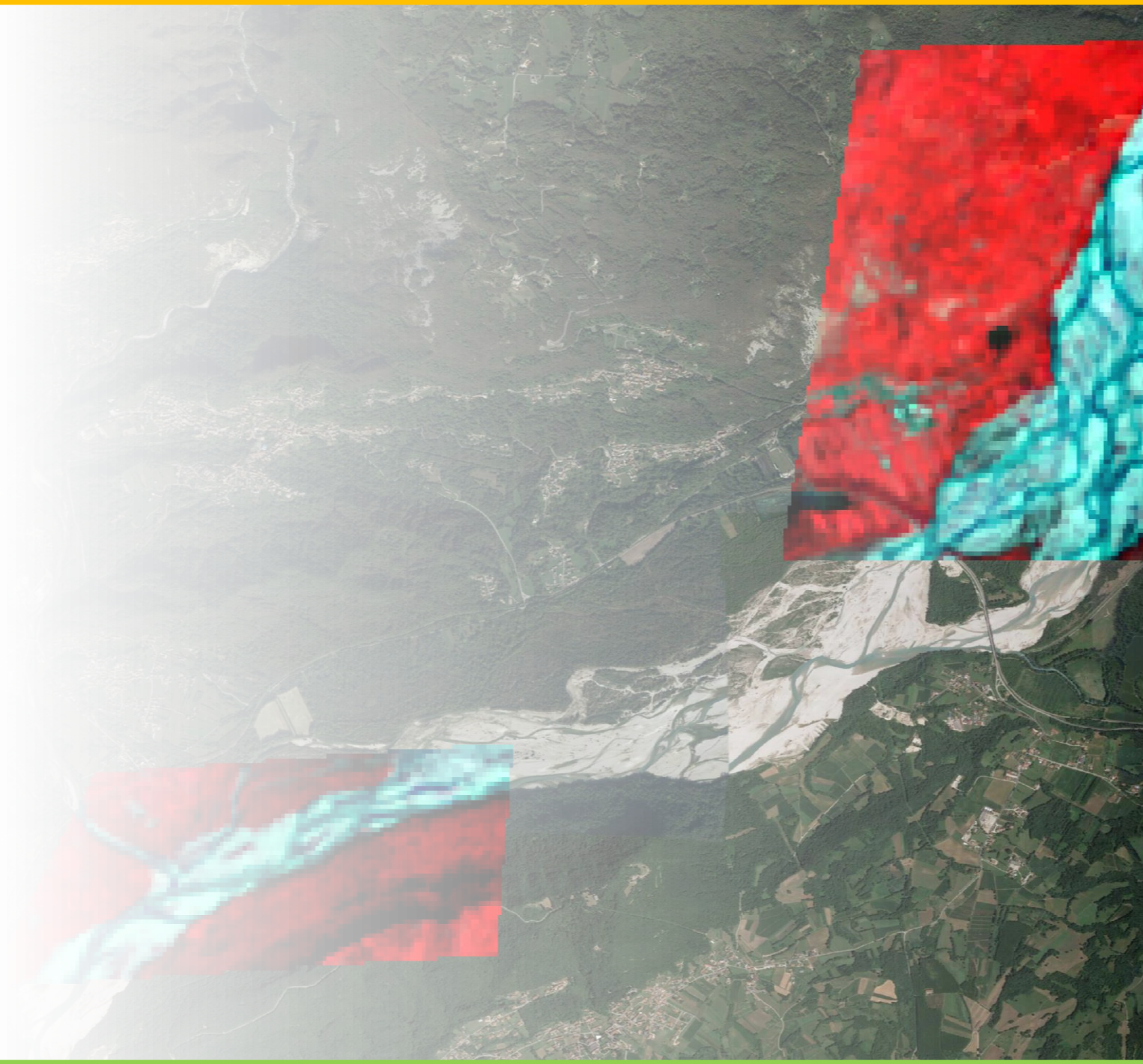
NDVI can be used as **indicator** of the **species richness** only within the habitus, while it is less useful when the 3 habitus are considered together



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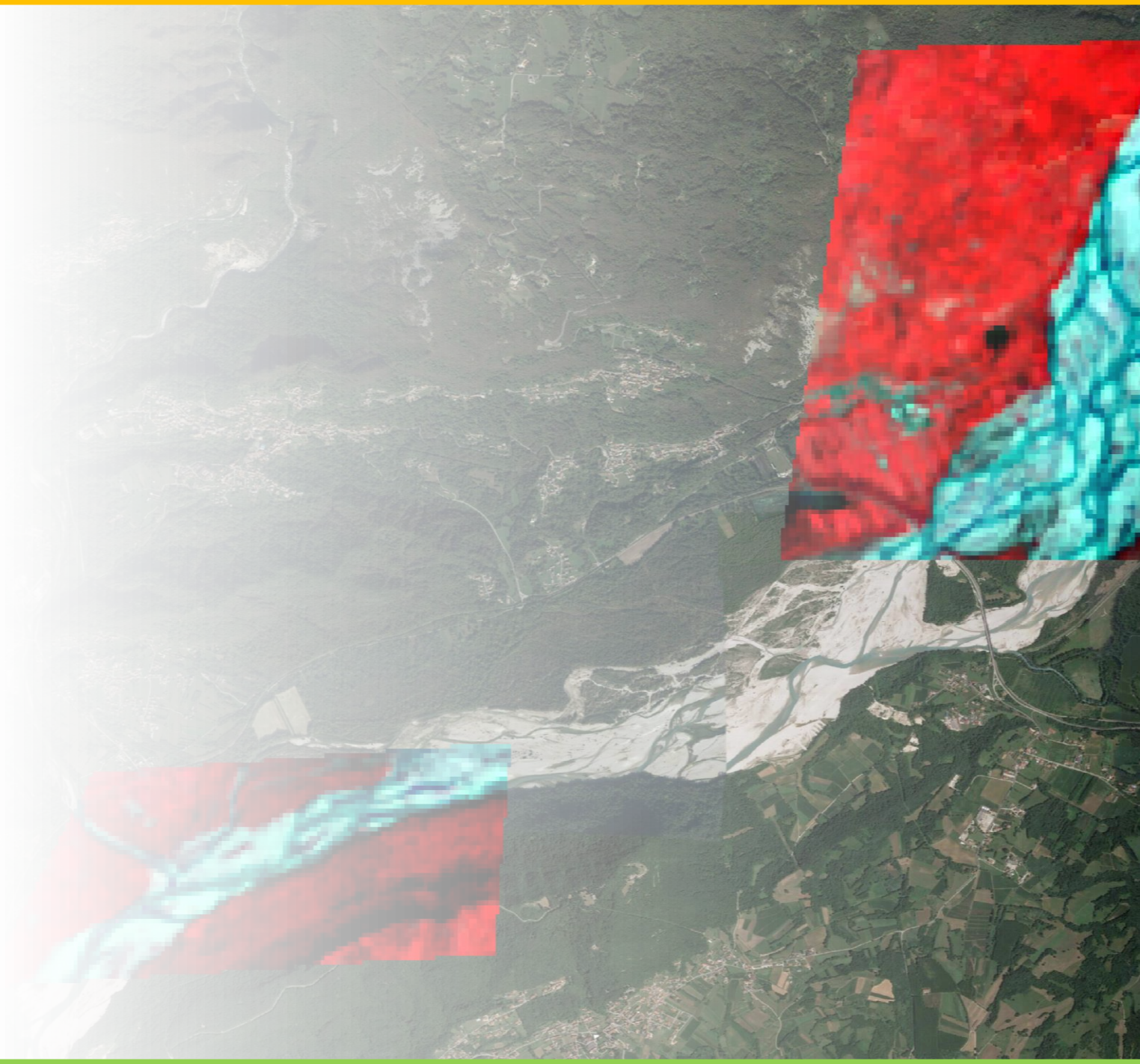
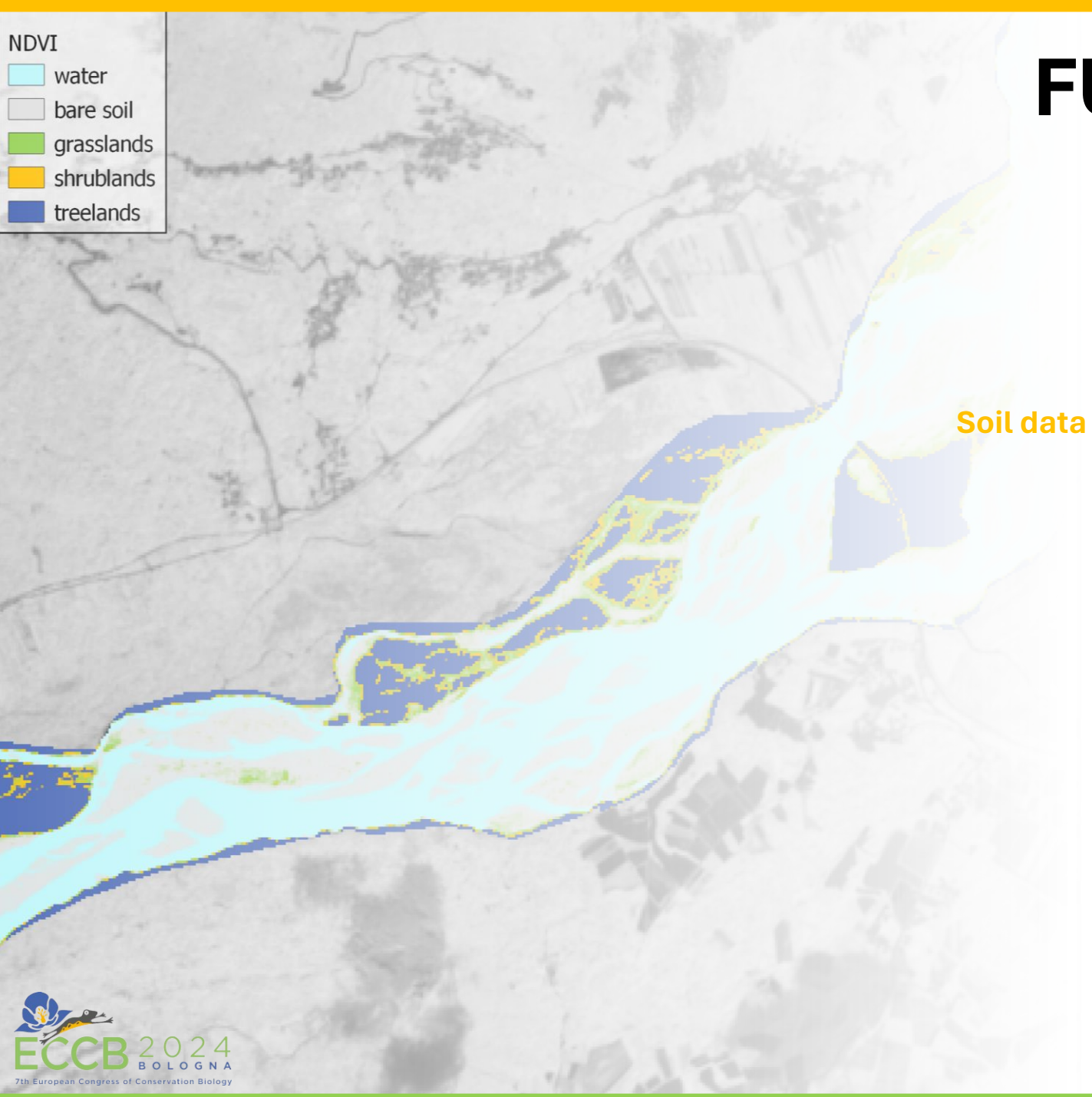
NDVI can be used as **indicator** of the **species richness** only within the habitus, while it is less useful when the 3 habitus are considered together

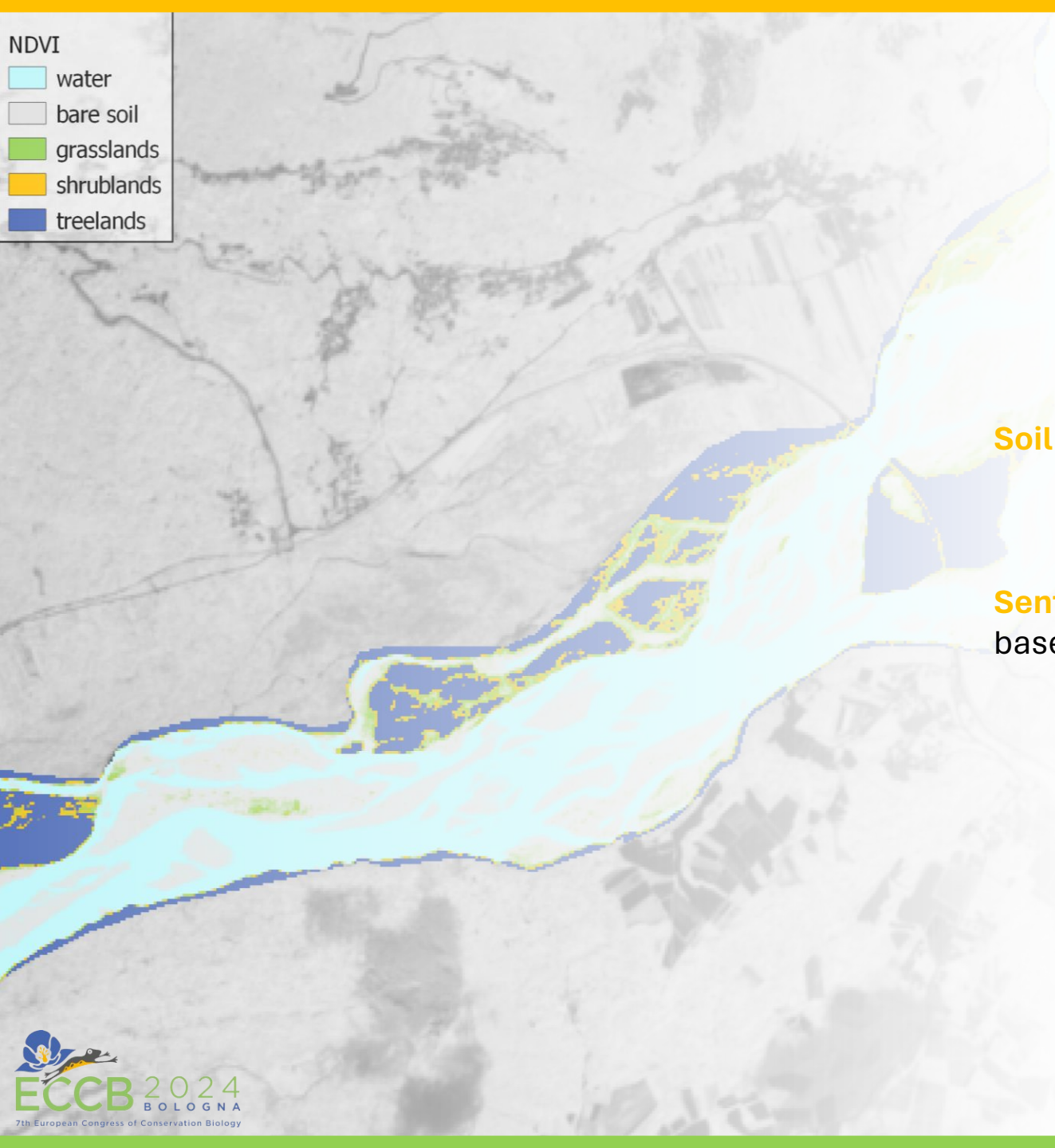
NDVI can be used to graph the multispectral **history of the bars** and to understand how the **fluvial dynamics** influences it






# FUTURE PERSPECTIVES

**Soil data** have been collected but are currently under analysis

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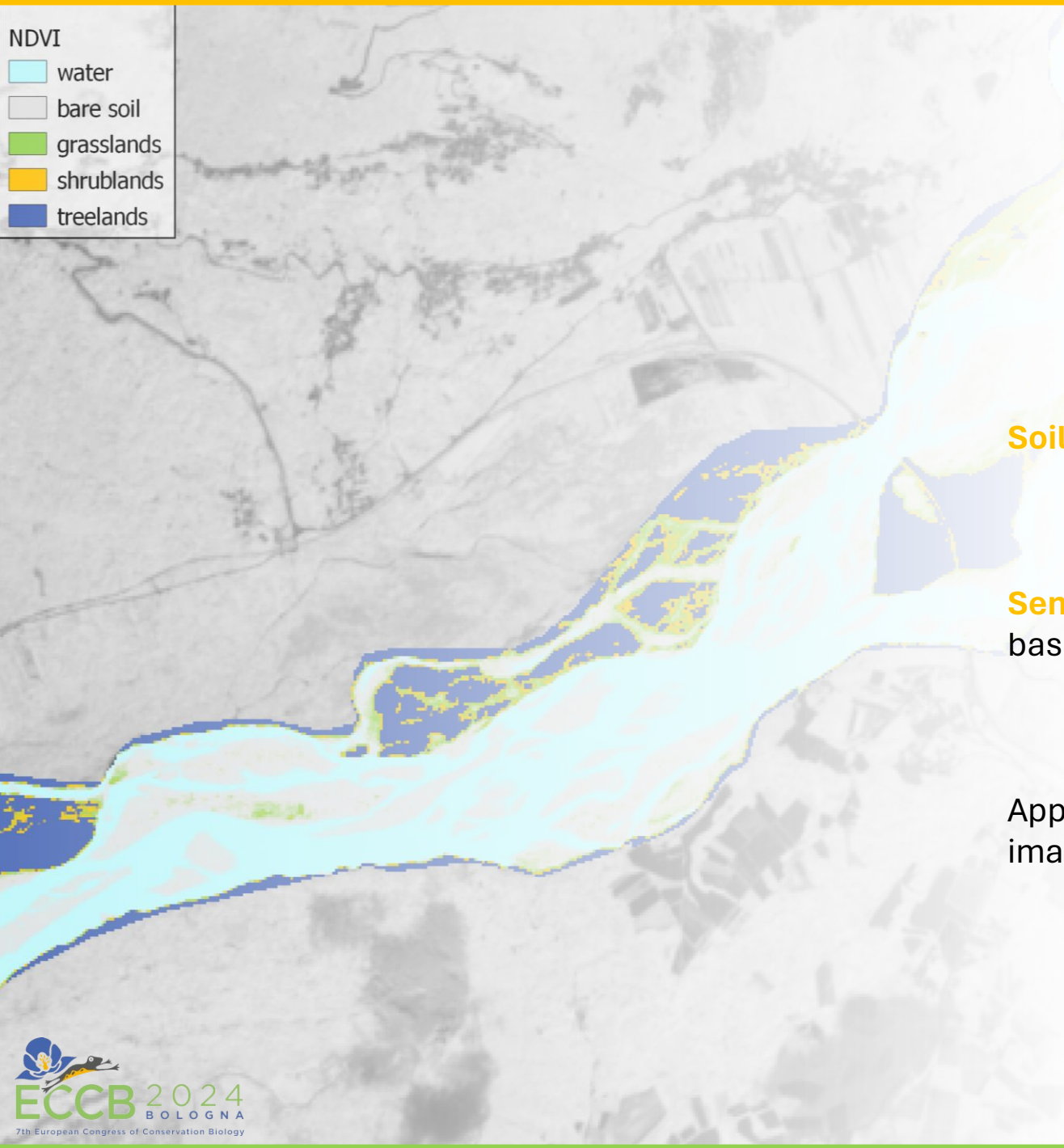
**Sentinel-2 images** (10x10m) could be used to classify river bars based on NDVI classes, with random on-site confirmation surveys




# FUTURE PERSPECTIVES

**Soil data** have been collected but are currently under analysis

**Sentinel-2 images** (10x10m) could be used to classify river bars based on NDVI classes, with random on-site confirmation surveys

Apply an **automatic classification algorithm** trainend on satellite images to classify the river bars and follow them in time

# THANK YOU FOR LISTENING

ECCB 2024 BOLOGNA
7th European Congress of Conservation Biology