

# Variations of ecosystem services during vegetation succession following agricultural abandonment in the Massif central region (France)

Magali Weissgerber<sup>1</sup>, Laine Chanteloup<sup>2</sup>, Anne Bonis<sup>1</sup>

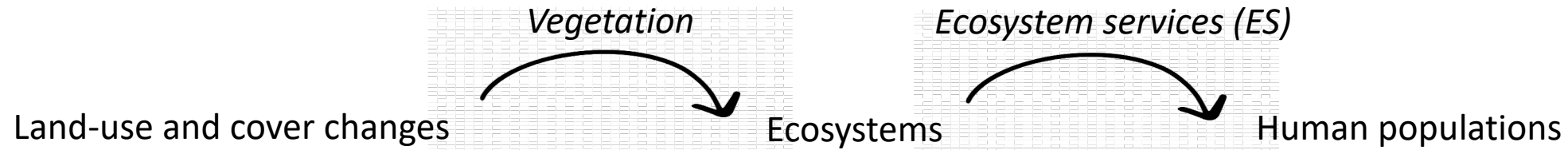
1. GEOLAB, Université Clermont Auvergne

2. UNIL, Université de Lausanne

Novembre 23th 2022



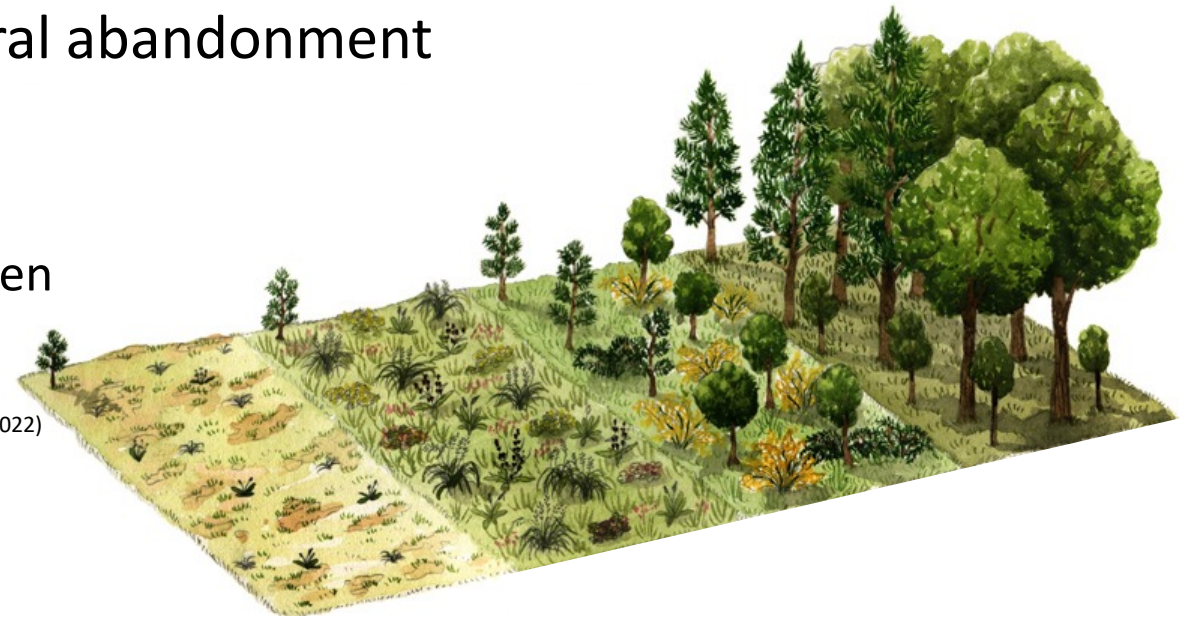
# Introduction



## Vegetation succession following agricultural abandonment

### Global trend

- 150 millions ha of croplands abandoned between 1700 and 1992 (Ramankutty and Foley 1999)
- 60 millions ha between 2003 and 2019 (Potapov et al., 2022)

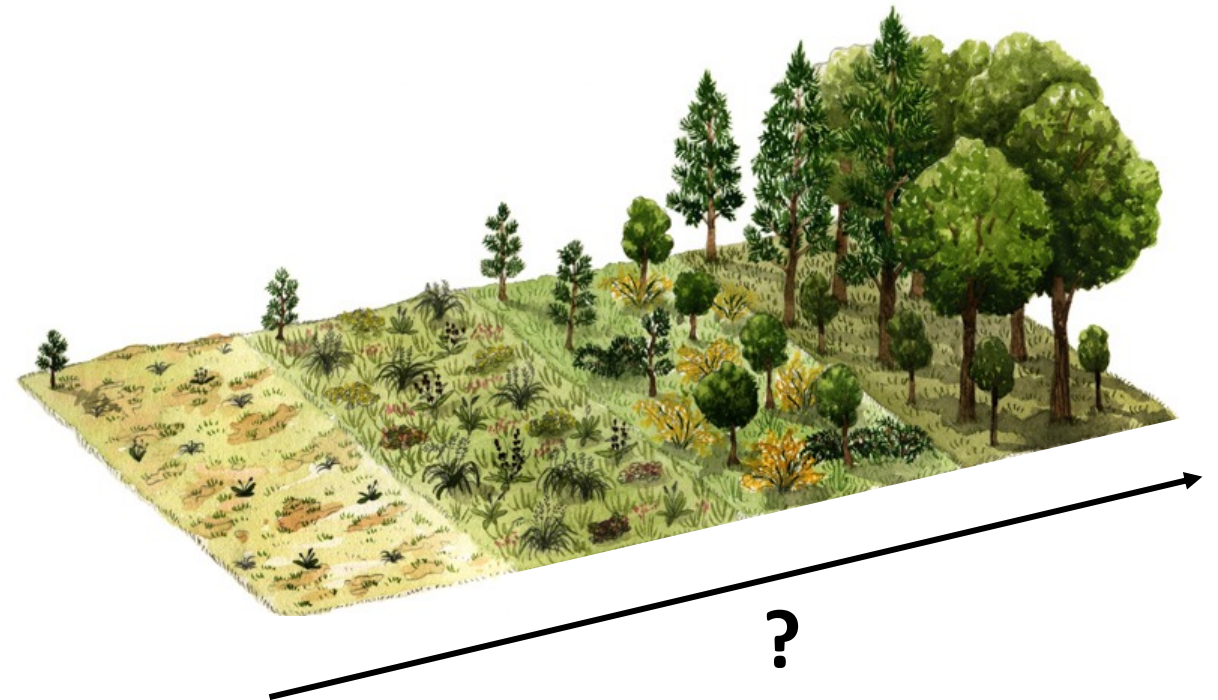


# Introduction

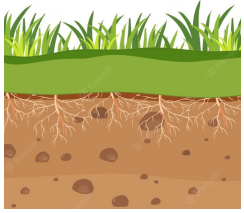
## Vegetation succession following agricultural abandonment

### Consequences

- Vegetation communities (Lepart et Escarré 1983)
- Ecosystem functioning ? (Piché et al. 2015, Buscaldo et al. 2019)
- Ecosystem services ? (Ustaoglu et al. 2018)
  - Soil quality (2.2.4.2 CICES)
  - Carbon stock (2.2.6.1 CICES)
  - Erosion limitation (2.2.1.1 CICES)



# Introduction

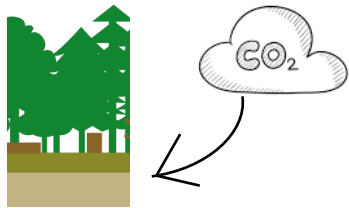


## Soil quality :

- Effects of past agricultural activities (Cramer & Hobbs, 2007; Peco et al., 2017; Heydari et al., 2020)
- Future agricultural production ? (Fayet et al., 2022)

→ Increase in organic matter and nutrient content

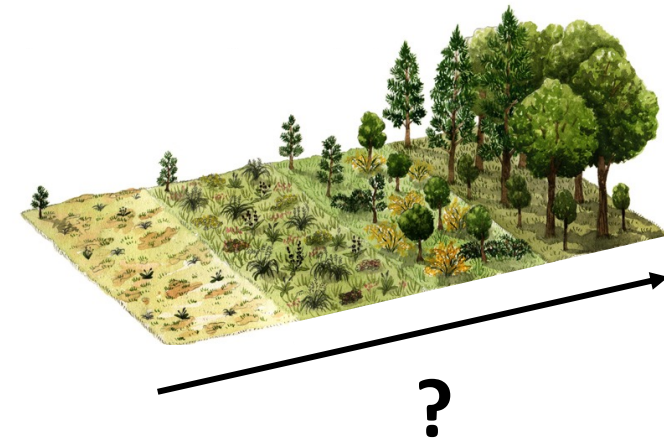
(Foote and Grogan, 2010) (Lasanta et al., 2020)



## Carbon stock :

- Sequestration of CO<sub>2</sub> (Bastin et al., 2019)

→ Increase along the vegetation succession (Badalamenti et al., 2019)



## Erosion limitation :

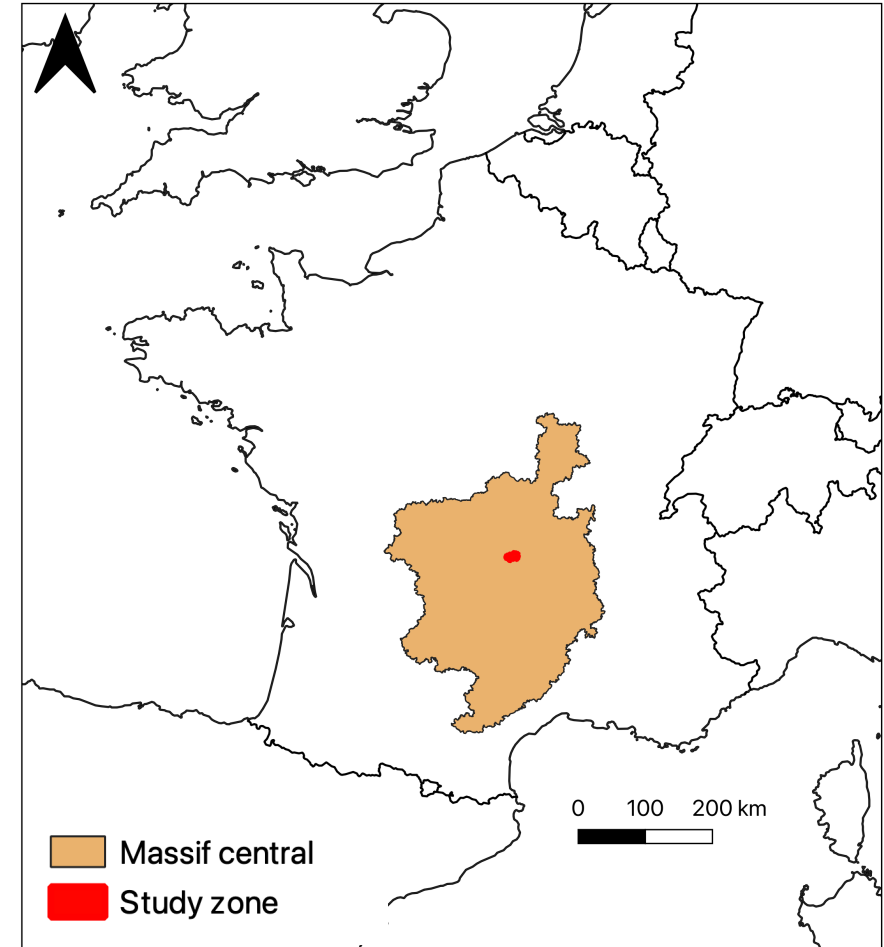
- Effects of past agricultural activities (Morgan, 2005)
- Modifications du to vegetation succession (García-Ruiz & Lana-Renault, 2011)

→ Change in erodibility and stratified vegetation cover

# Study region

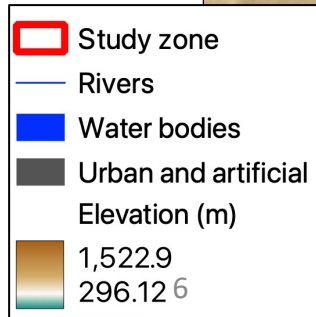
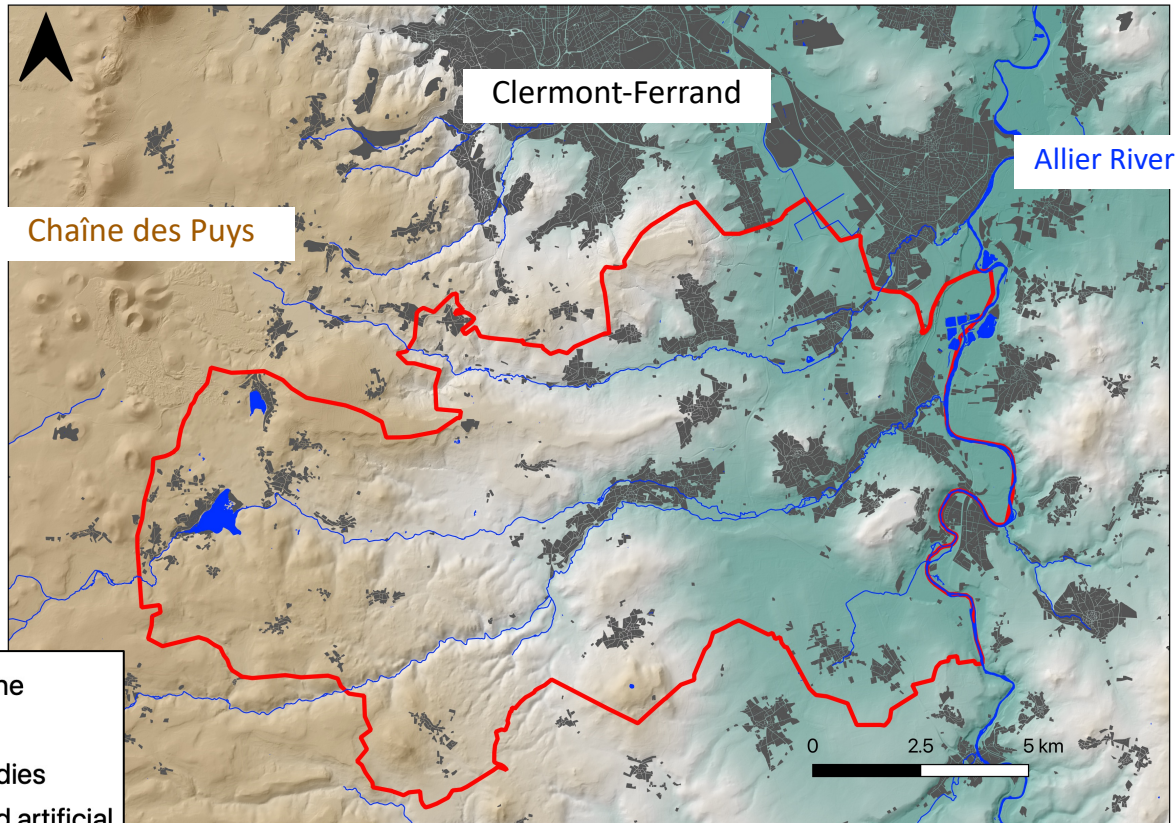
Massif central region

History of rural depopulation, changing agricultural practices and landscapes (Diry et al. 2000)

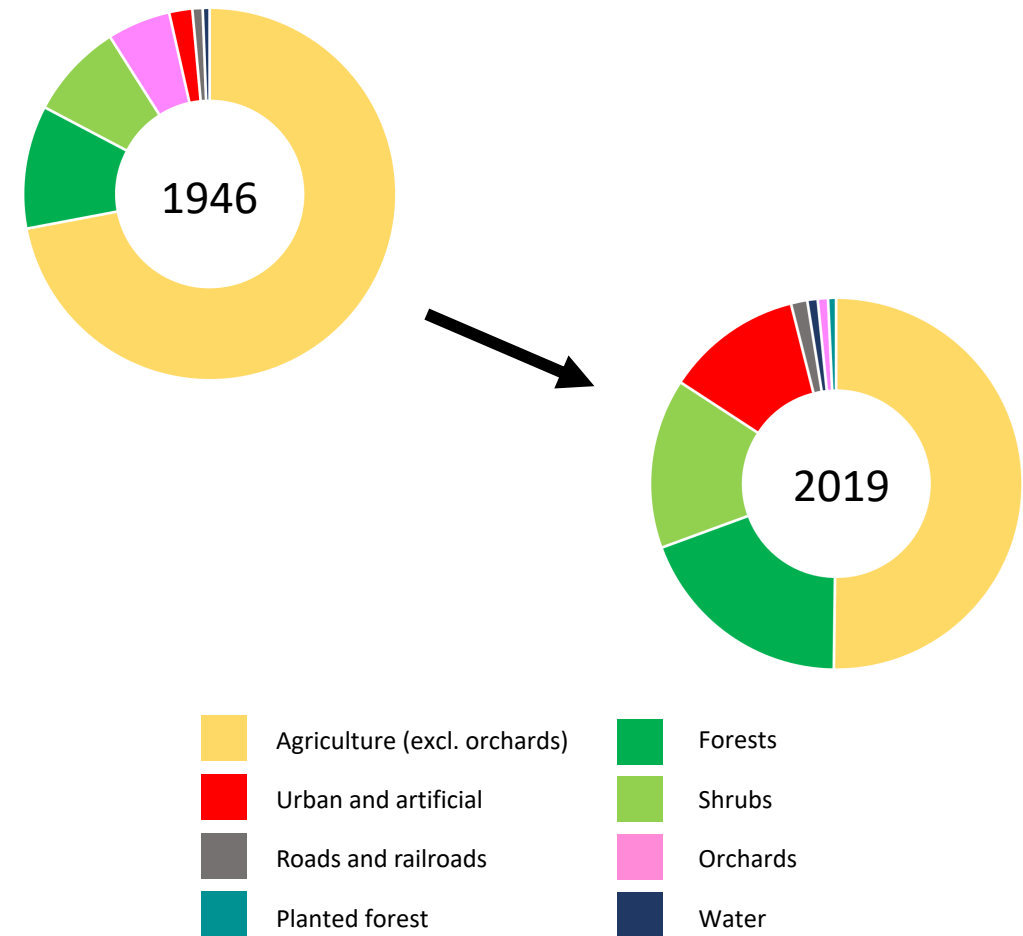


# Study zone

## Between mountains and plain



## Land-use and land-cover changes



# Sampling based on vegetation changes



0



1



2



3



4



5

Grasslands under  
agriculture use

Forest since 1946



# Sampling based on vegetation changes



0



1



2



3



4

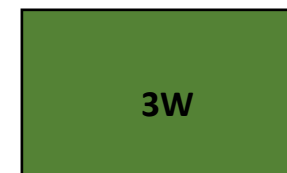
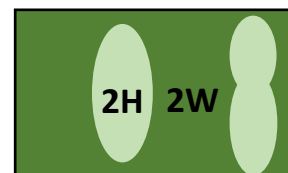
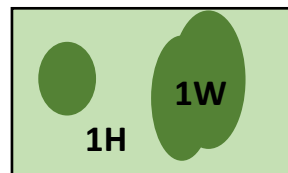
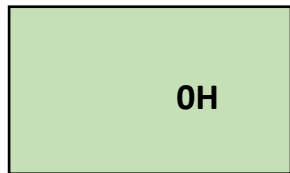


5

x5 plots = 30



Vegetation survey : plant species and their respective cover  
ES and ES proxies measures



= 158 sub-plots

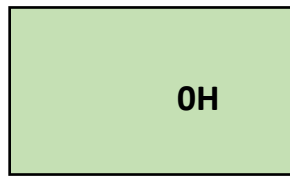
H = herbaceous, W = woody



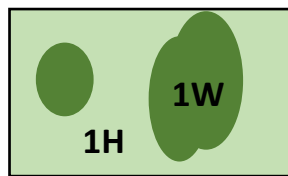
# Sampling based on vegetation changes



0



1

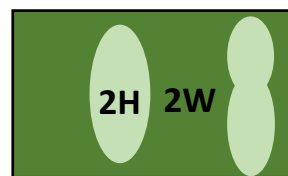


Meadow brome  
*Bromus erectus*

Tor-grass  
*Brachypodium pinnatum*



2



Bloody dogwood  
*Cornus sanguinea*



3



4



European ash  
*Fraxinus excelsior*



5



Pedunculate oak  
*Quercus robur*

Silver fir  
*Abies alba*



# Ecosystem services: methods, results and discussion

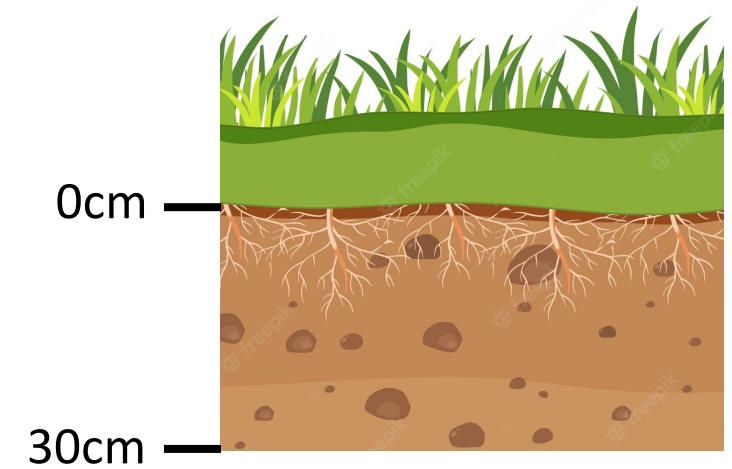
## 3 ecosystem services

- Soil quality
- Carbon stock
- Erosion limitation

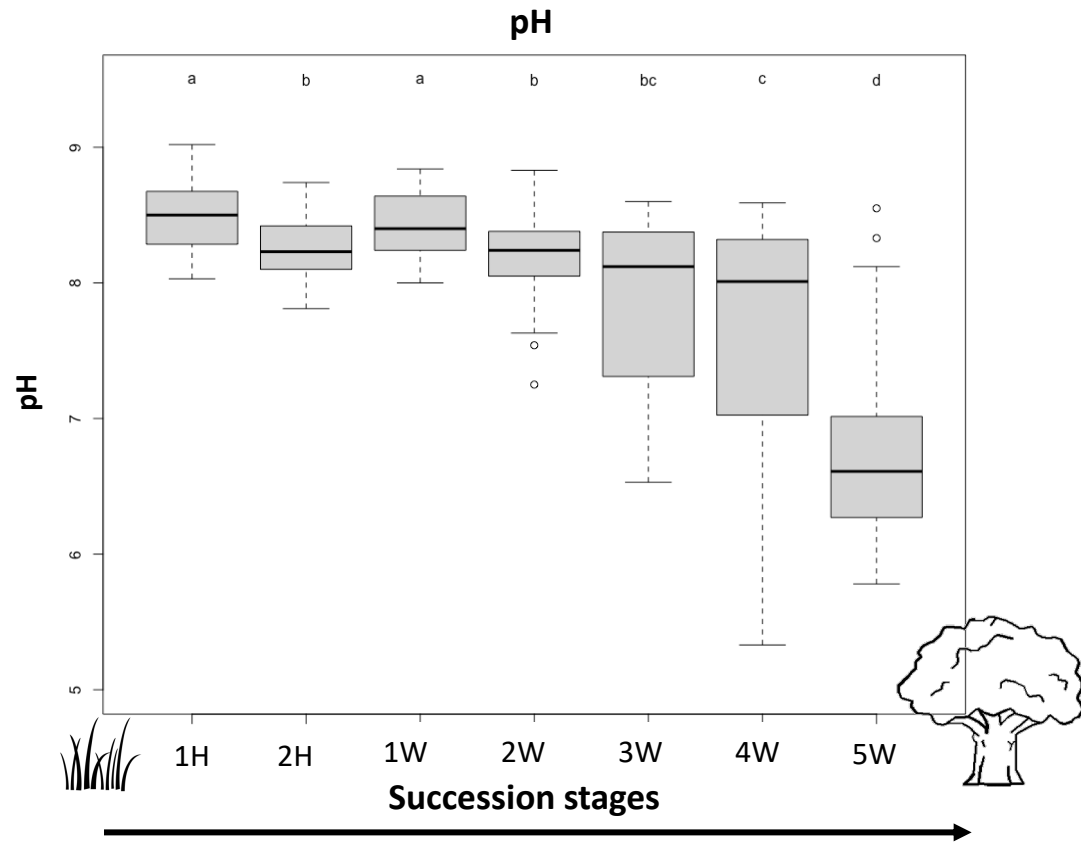
## Soil quality

Multifactorial:

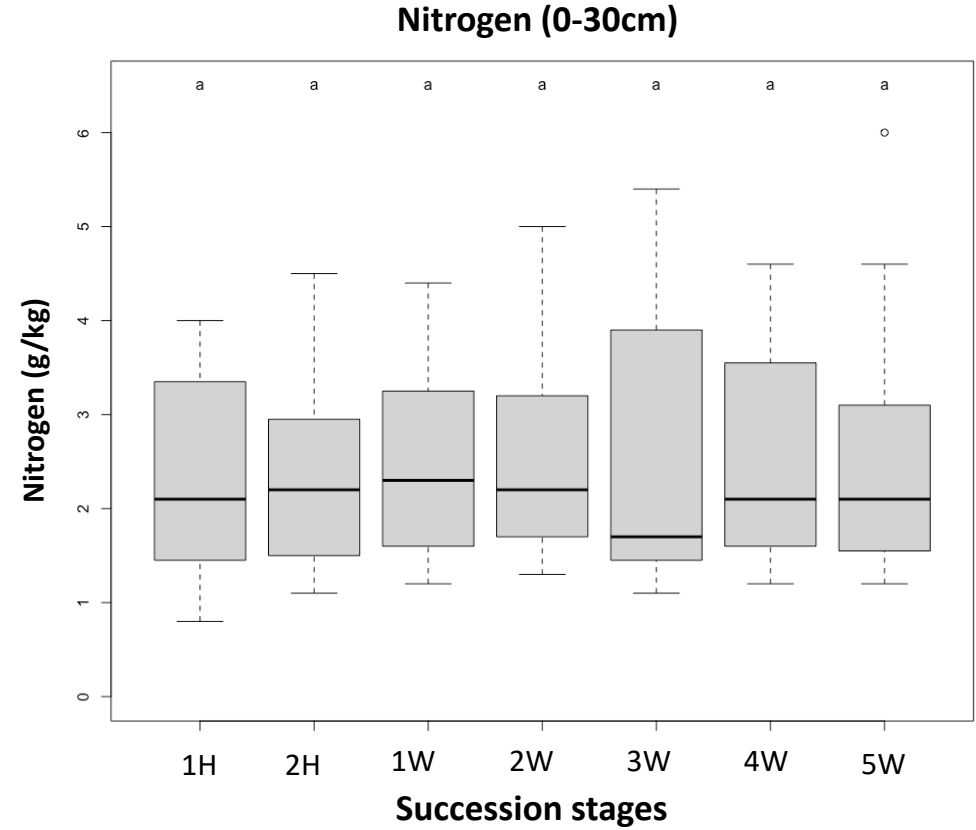
- pH
- Soil nutrient content (C, N, P, Mg, Ca, Na, K)
- Texture (clay, silt, sand)



# Soil quality



Expected decrease

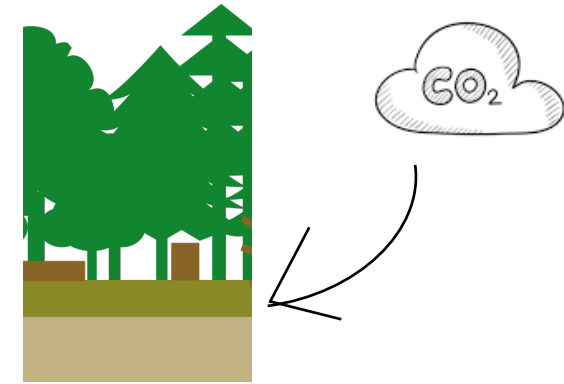


Unexpected absence of increase

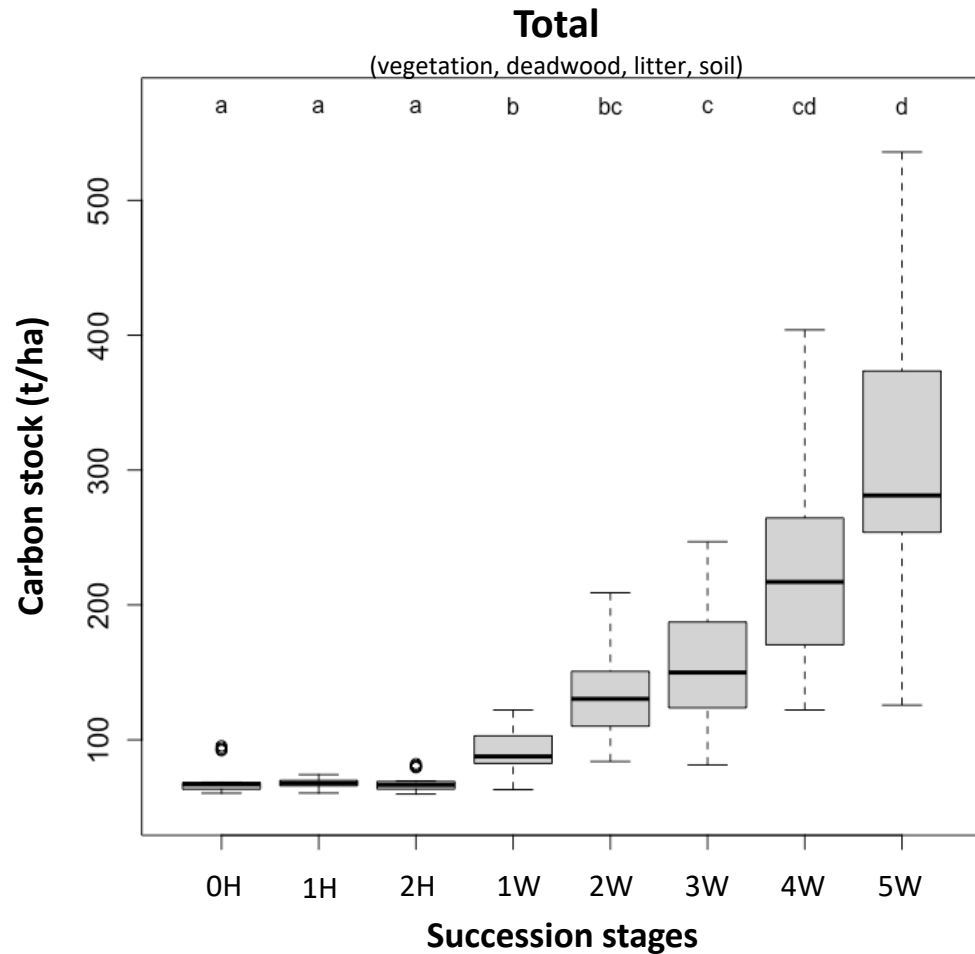
Plot agricultural history ?  
Microbial activity ?

## Carbon stock

- vegetation + deadwood and litter + soil (Bartholomé et al. 2018)
- Total stock of carbon (t/ha)

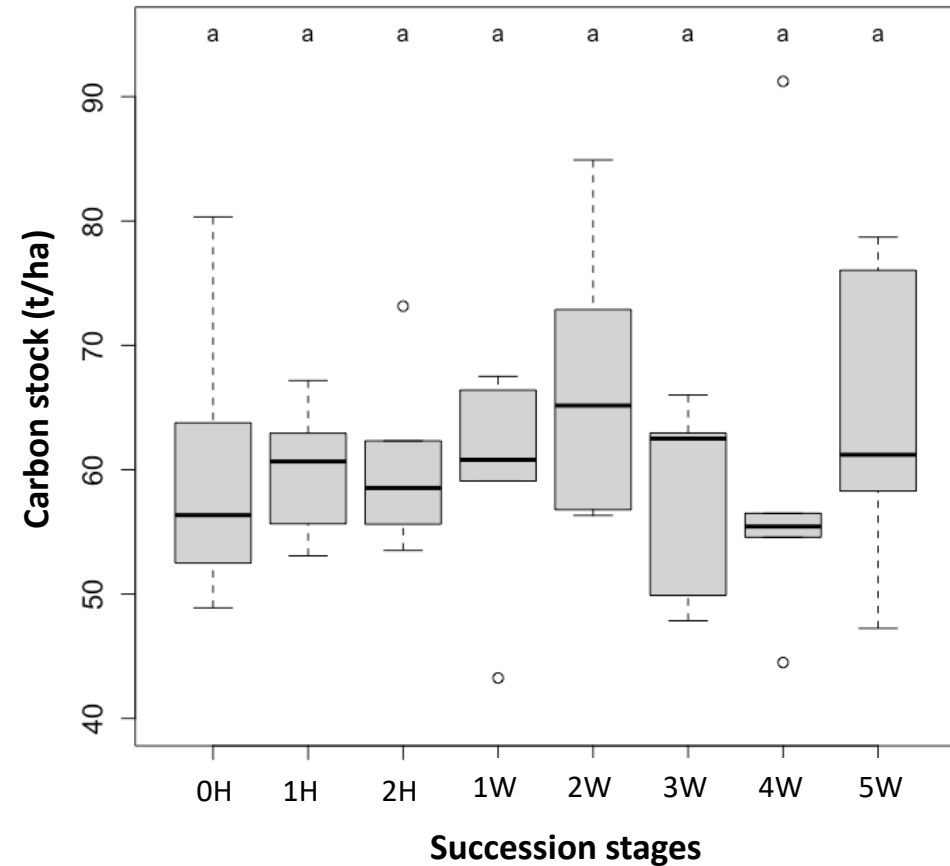


## Carbon stock



Expected  
increase

## Soil organic carbon (SOC)



Unexpected  
absence of  
increase

(Foote and Grogan, 2010)  
(Piché and Kelting, 2015)  
(Badalamenti et al., 2019)  
(Lasanta et al., 2020)

GLMM (C concentration) :

- % clay
- Vegetation PCA dim 1

## Erosion limitation

Multifactorial :

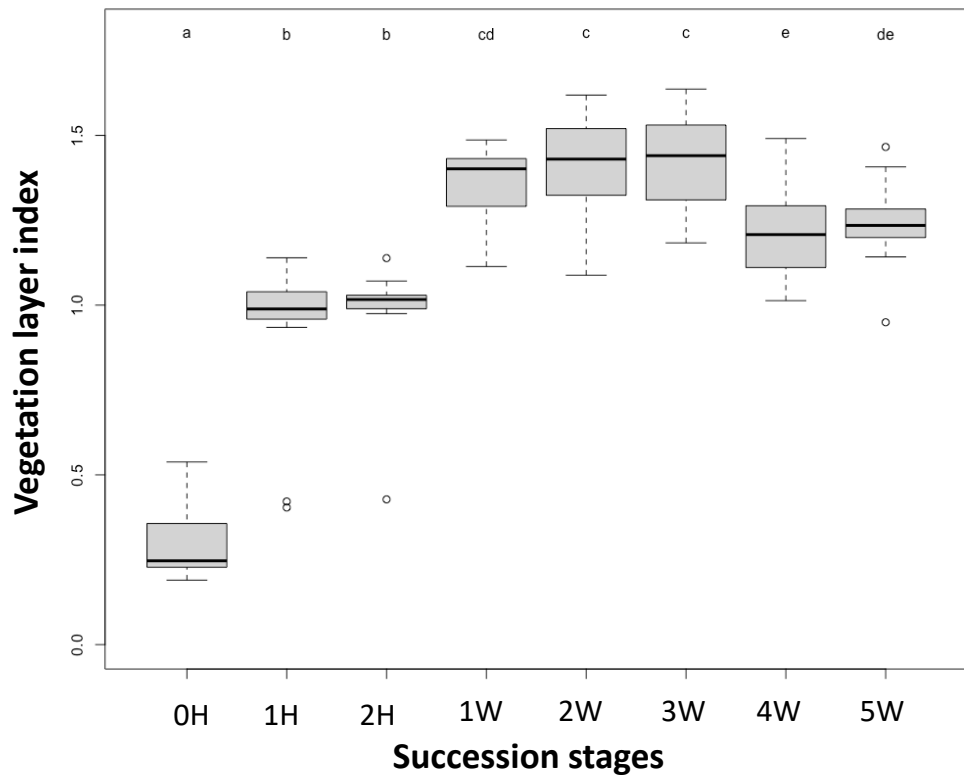
- Vegetation protection  
→ Stratified vegetation cover index (Zhongming et al. 2010)
- Susceptibility of soil to erosion  
→ Erodibility factor (based on soil texture) (RUSLE equation)

(Renard et al. 1997, Chen et al. 2011)



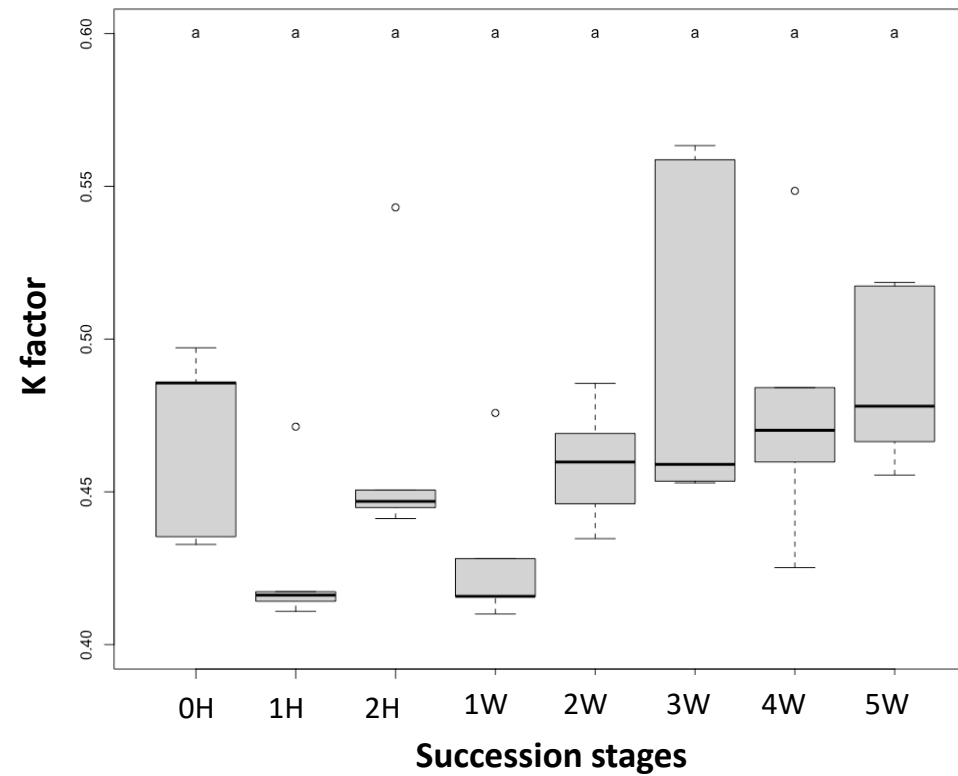
# Erosion limitation

## Vegetation protection



Expected trend

## Soil erodibility (texture)

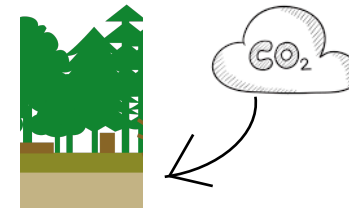
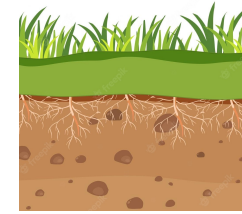


?



# Conclusion

- **Soil quality** : small variations
  - Plot history ?
  - Texture ?
- **Carbon stock** : clear increase but heterogeneity
- **Erosion limitation** : slight increase



Measures *in situ*

## Perspective

- Multiple succession stages : different ES levels  
→ Landscape approach
- Measure additional ES  
→ Trade-offs and synergies

**PhD perspective:** perception of vegetation succession and its effects on cultural ecosystem services?



# Thank you for you attention

Magali Weissgerber<sup>1</sup>, Laine Chanteloup<sup>2</sup>, Anne Bonis<sup>1</sup>

1. GEOLAB, Université Clermont Auvergne
2. UNIL, Université de Lausanne

[magali.weissgerber@gmail.com](mailto:magali.weissgerber@gmail.com)

<https://magali.weissgerber.fr/>



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