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## Dynamics of ecosystem services and plant diversity over the past 200 years

Florence Mazier, Yael Schwartz, Stéphane Binet, Cédric Gaucherel, Didier Galop, François Gillet, Thomas Houet, Emilie Lerigoleur, Jérôme Molina, Clara Plancher, et al.

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# Dynamics of ecosystem services and plant diversity over the past 200 years

HERITSERV  
SOPAST DYNAM  
PASTSERV  
GEOSPAT  
PALEOPAYS

**F. Mazier, Y. Schwertz, S. Binet, C. Gaucherel, D. Galop, F. Gillet, T. Houet, E. Lerigoleur, J. Molina, C. Plancher, M. Philippe, C. Sirami**

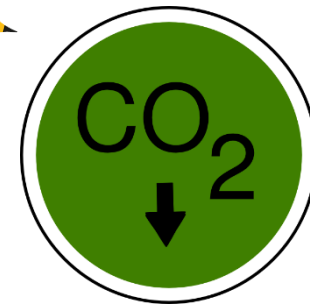


**"2012-2022: ten years of OHM results" Session**

# Ecosystem Services (ES) \_ Mountains



- 3% of Europe > 20 % of plant diversity
- topographical and geological complexity, climatic constraints, **historical trajectories** (current and past land-cover change)
- numerous ecological functions > production of ecosystem services (ES)  
[Martin-Lopez et al. 2019.](#)

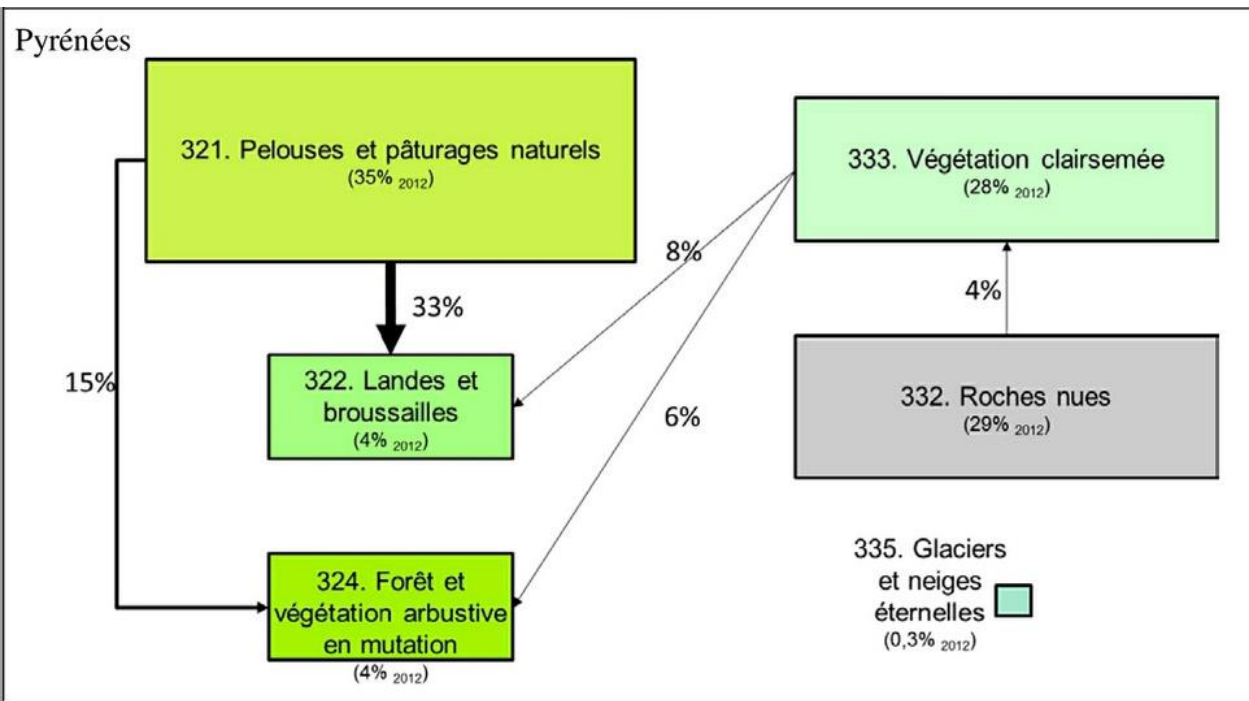


- **ES** threatened by changes in **land use**  
[Grêt-Regamey et al. 2014, Lavorel et al. 2017](#)

# Past land-cover change 1990\_2012 (Corine Land Cover)

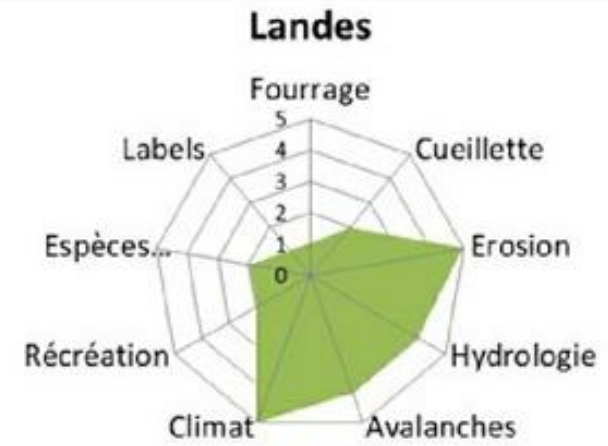
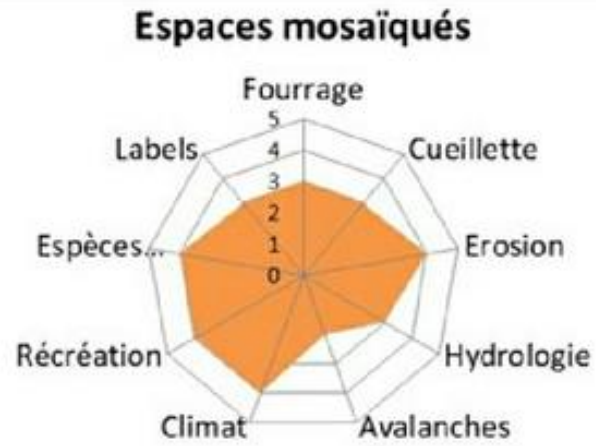
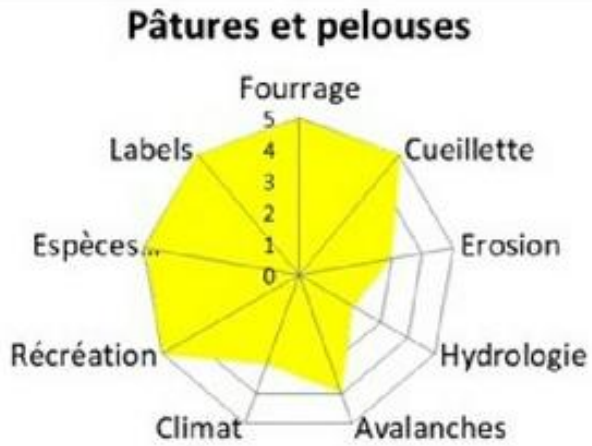


## Rapport EFESE, 2018



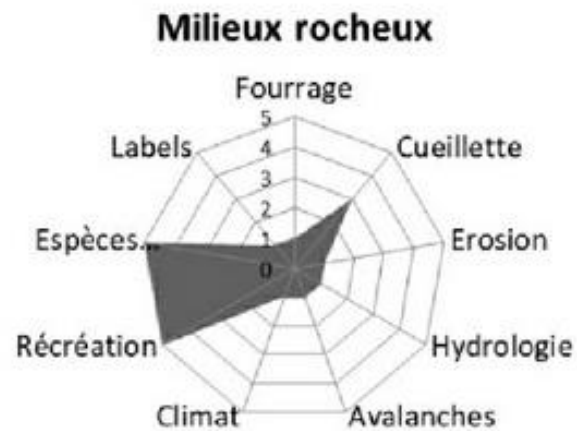
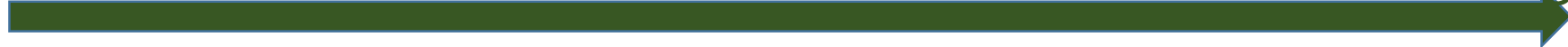
Catégorie	Variable	Fourniture par type de milieu d'altitude					Tendance d'évolution	Degré de confiance
		Pelouses et pâturages naturels	Landes et formations buissonnantes	Formations arborées très peues	Végétation clairsemée et roches	Milieus humides		
Biens produits	Production de fourrage	***	*	**	*	**	↘	***
	Cueillette de plantes sauvages	**	**	*	**	*	↘	*
Services de régulation	Régulation du climat global – Stocks de carbone	***	**	**	*	***	↗	**
	Contribution des écosystèmes à la régulation hydrologique	*	**	*	*	***	→	*
	Contribution des écosystèmes au contrôle de l'érosion des sols	**	**	**	*	**	↗	***
	Rôle des écosystèmes dans la protection contre les risques naturels	**	**	**	*	*	↗	**
Services culturels et récréatifs	Attractivité des écosystèmes pour les activités sportives de pleine nature	***	**	*	***	**	↗	***
	Aménités paysagères	***					↘	***
	Chasse récréative	**	*	**	*	*	↘	*
	Soutien aux activités de recherches scientifiques							
Patrimoine naturel	Espèces patrimoniales	***	*	**	***	**	↘	***
	Paysages patrimoniaux	***					↘	***
	Labels de reconnaissance patrimoniale							
	Inspiration pour l'art et la littérature							

# Impact of land-cover change on ES bundles in Mountain areas



Production SE

Regulation ES



# Contribution of PASTSERV/SOPAST to ES studies

-> Longer time scale (200 years, periodicity 20-10 years, 13 TW)

≠ Short-term studies, insufficient hindsight to understand i) slow socio-ecological dynamics (forest regrowth) and/or ii) response of ecological systems to environmental perturbation (human activities) *Jeffers et al. 2015*

-> Fine spatial scale \_ temporal dynamics of ES production will integrate landscape composition AND heterogeneity

≠ very limited empirical evidence for historical trajectories of multiple ES and their relationships with trajectories of land use. Rare studies explored their relationships with landscape heterogeneity *Lavorel et al. 2017, Mengist et al. 2020*

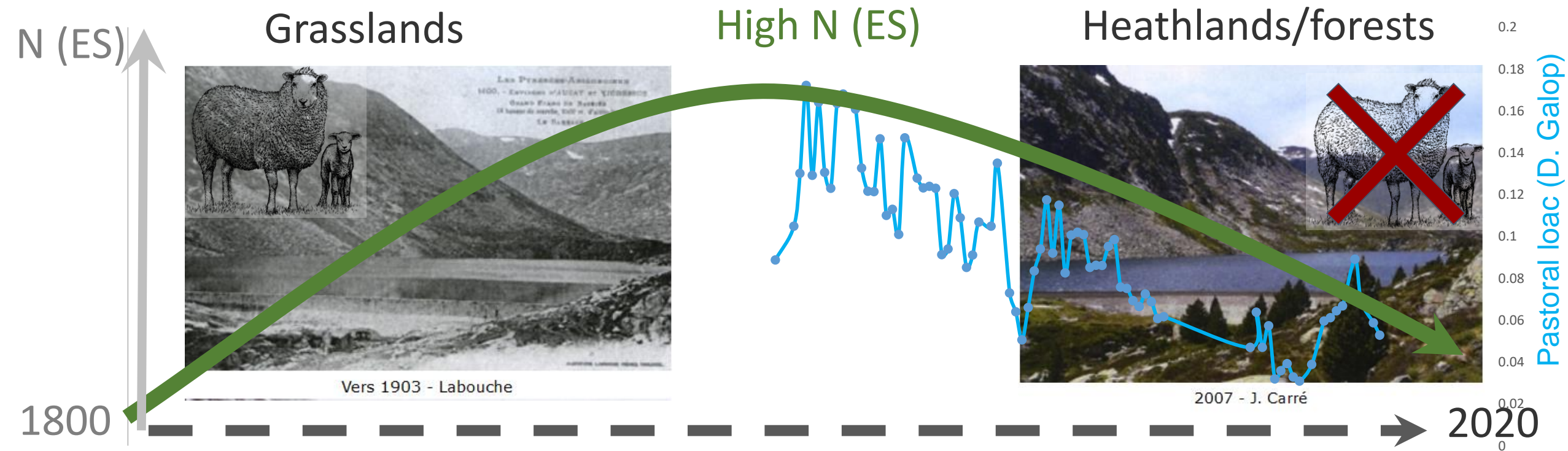
-> Not limited to "open" land and redefining ES

- Mapping distributions of species and land-cover type (finer-grained maps and description)
- Biogeochemical and hydrological cycles in high mountains\_ a priority, effect of land-cover.

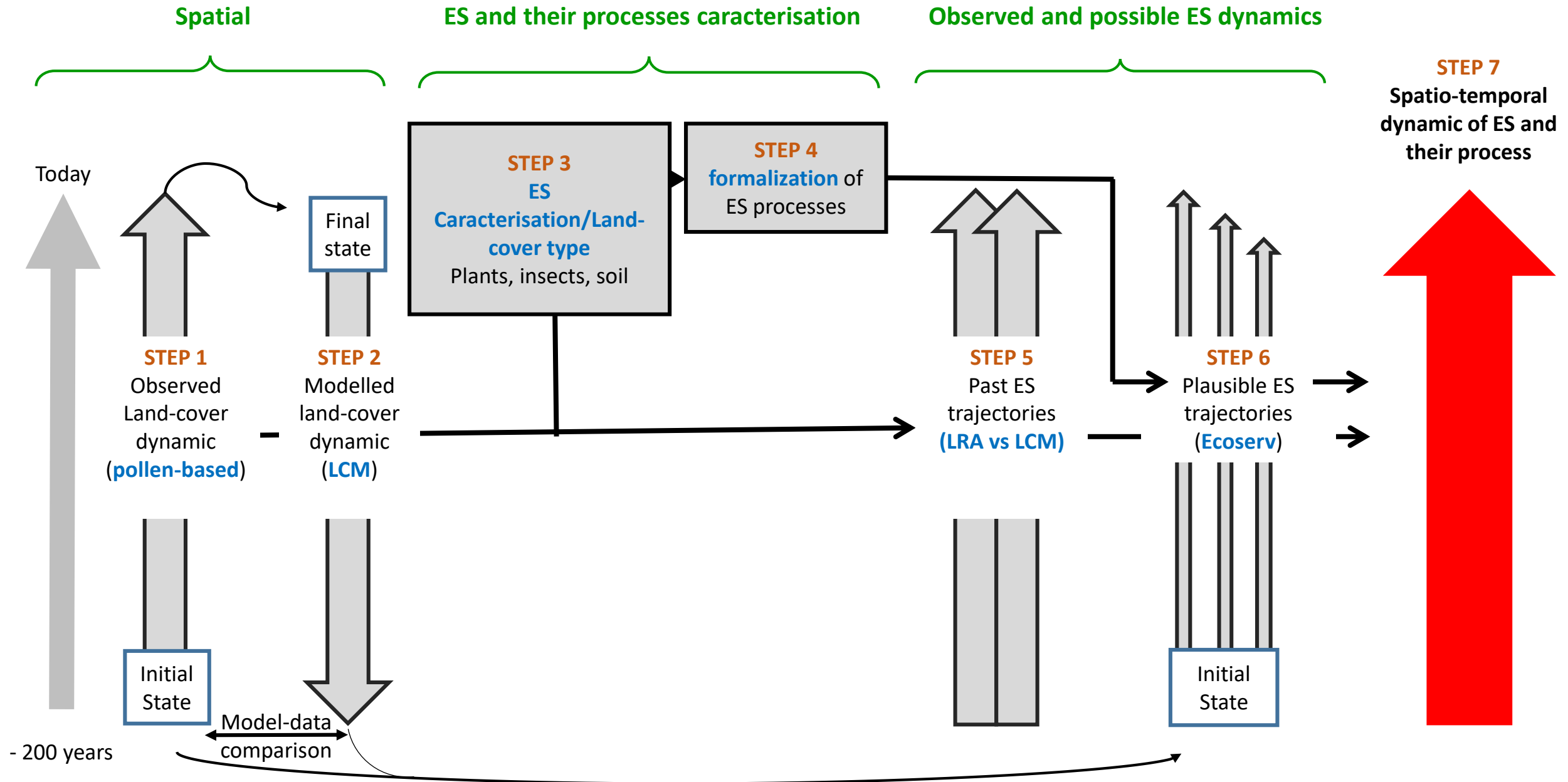
*EFESE, 2018*

# OHM Projects \_ Impact of past pastoral activities on

- Landscape composition and heterogeneity
- Dynamic of ES bundles, ES sustainability, synergies, interactions and time lags
- Land-use legacy effects on plant diversity



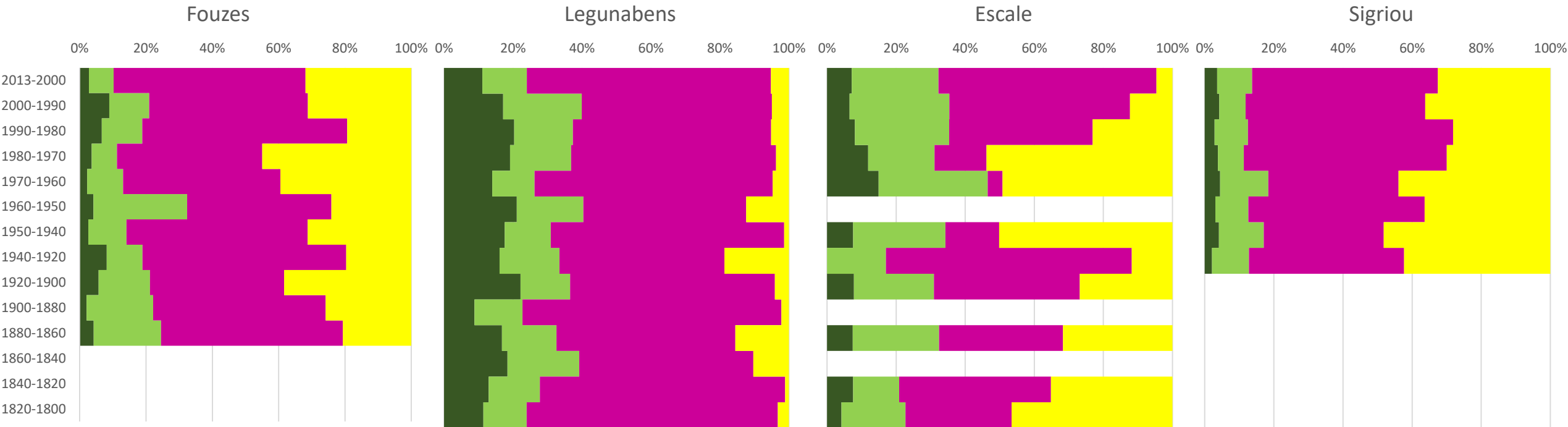
# PASTSERV and SOPAST FLOWCHART



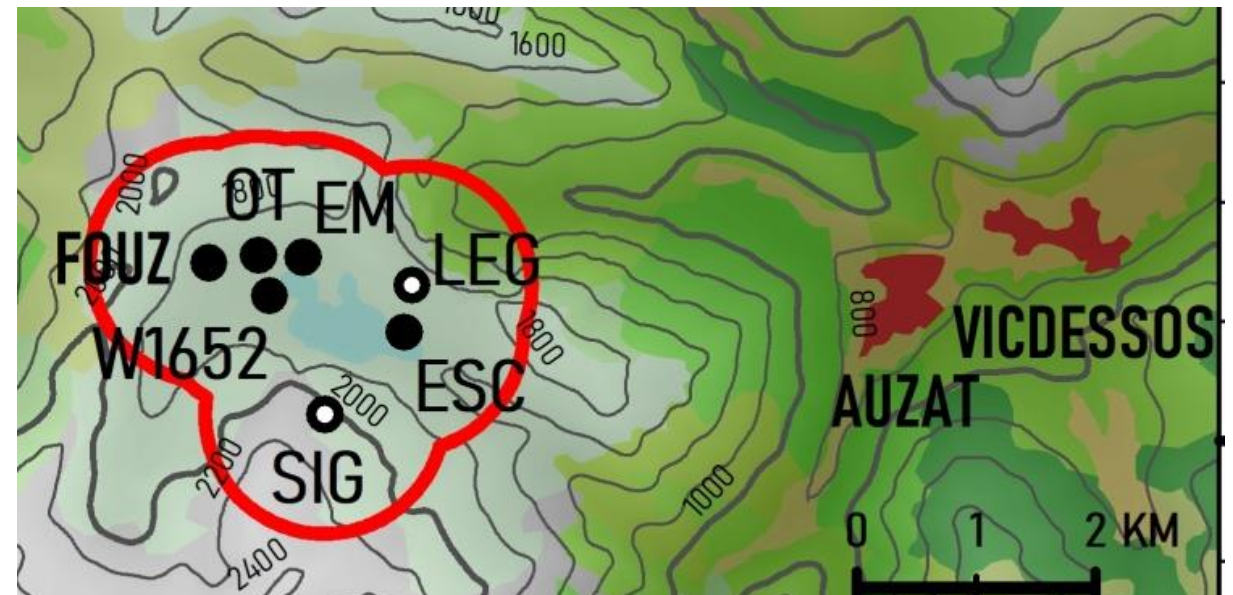


# Pollen-based past land-cover change\_200 years

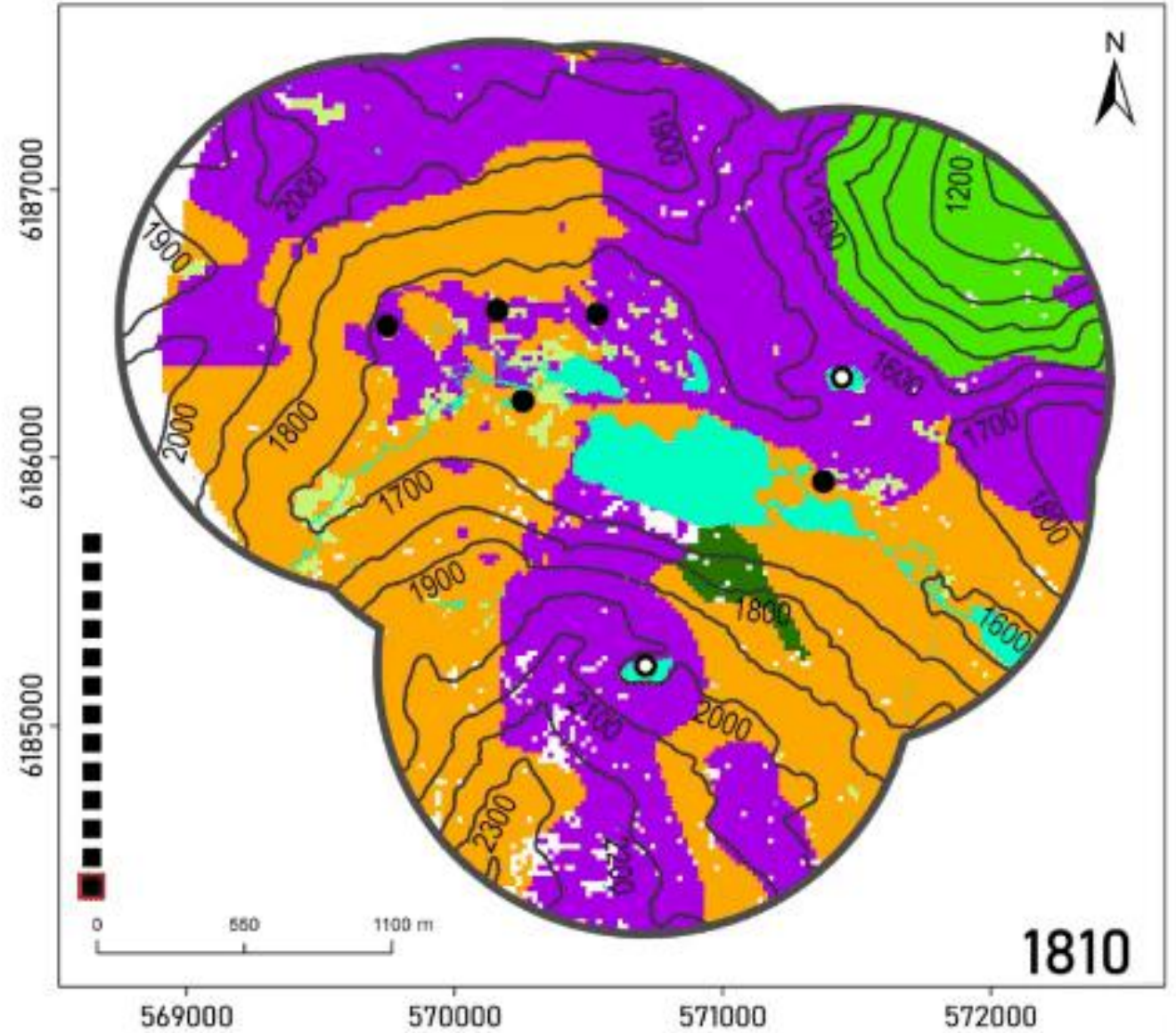
PhD thesis C. Plancher



Site ARBU Allen et al. 2020. CATENA  
Plancher et al. Sub QSR

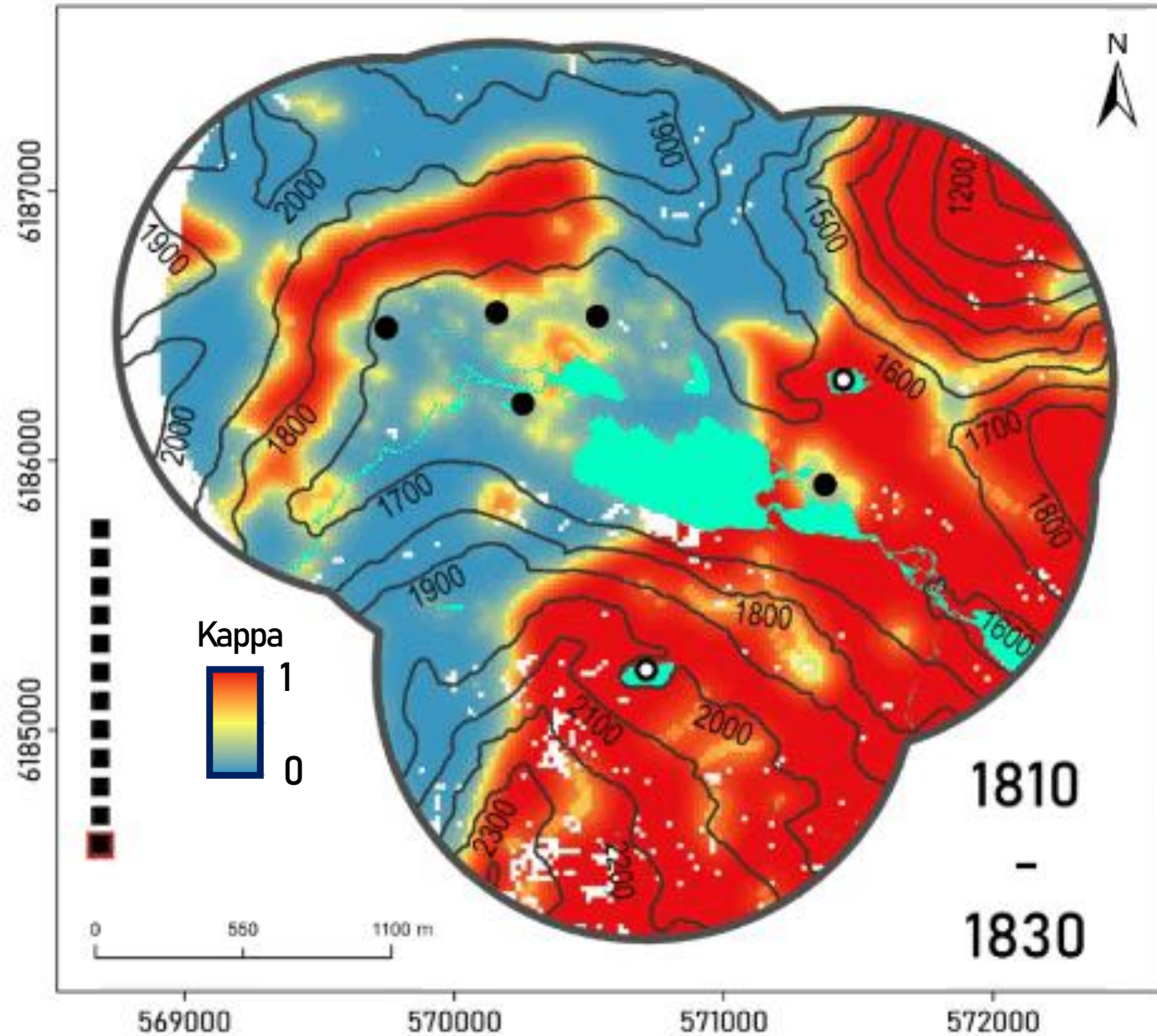


# Atlas of past land-cover change\_ 200 years



- Other grassland (OG)
- Festuca grassland (FG)
- Rhododendron heathland (RH)
- Mixed heathland (MH)
- Calluna heathland (CH)
- Mixed forest (MF)
- Broadleaved (BF)
- Conifers (C)

# Maps of Land-cover differences



# Rates of past land-cover change

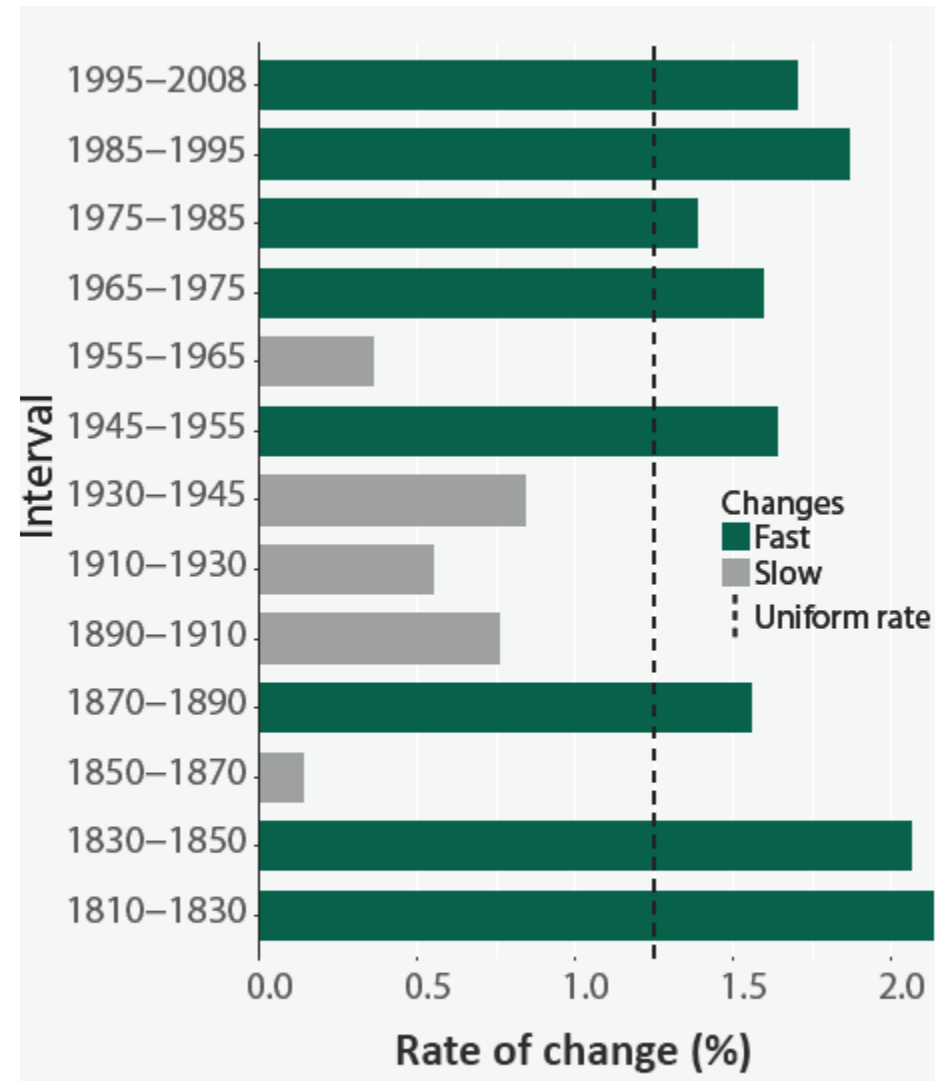
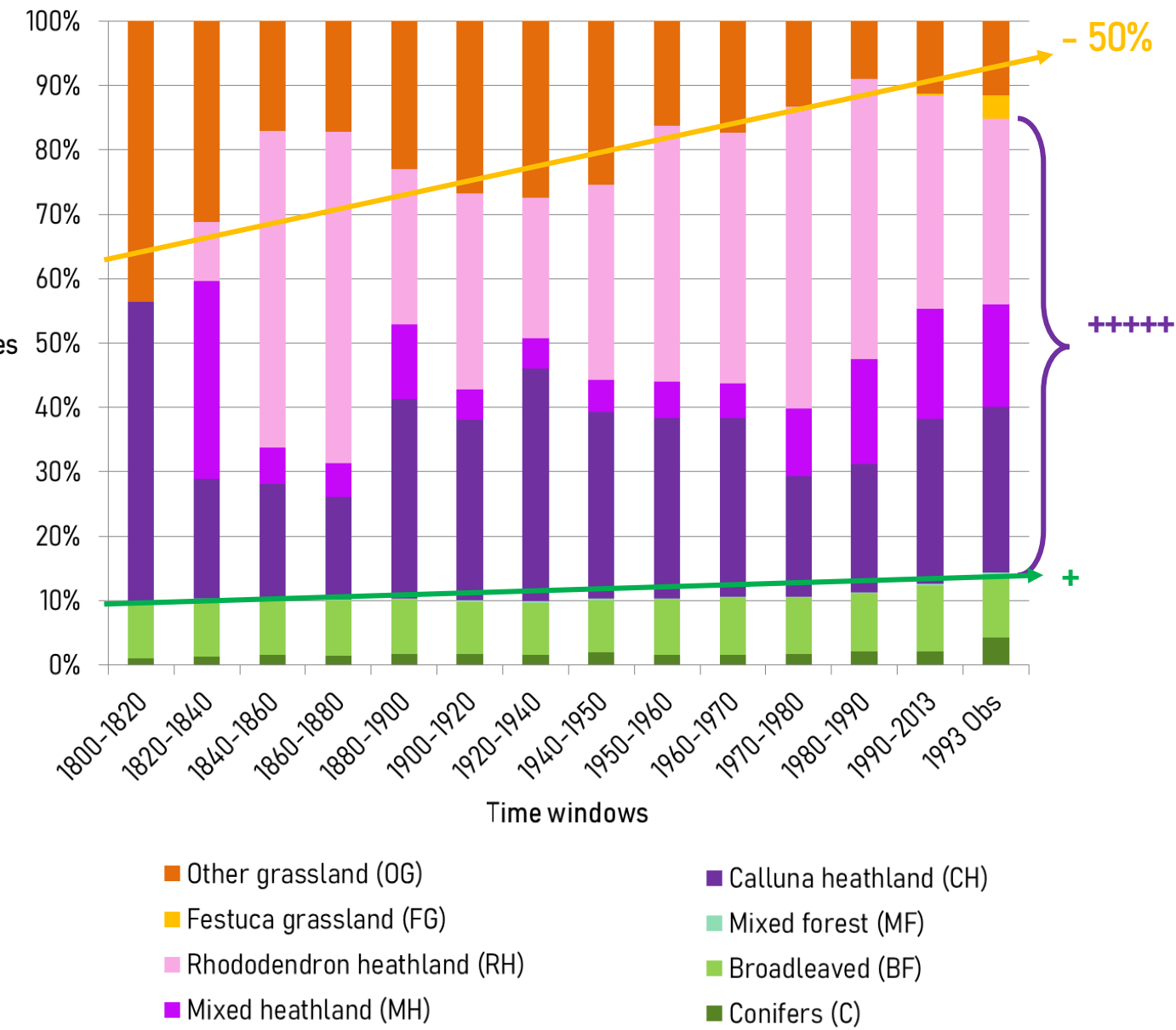
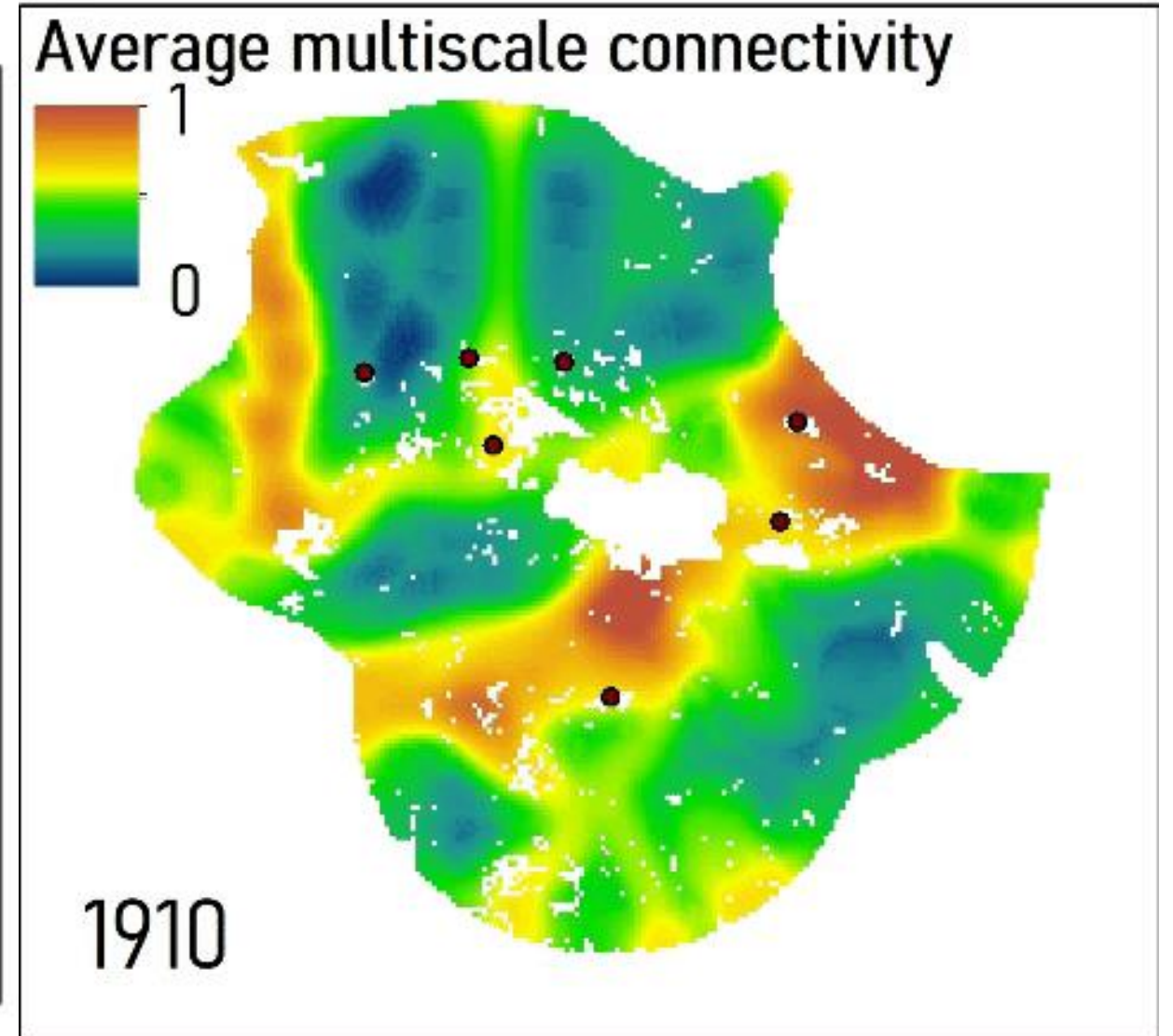
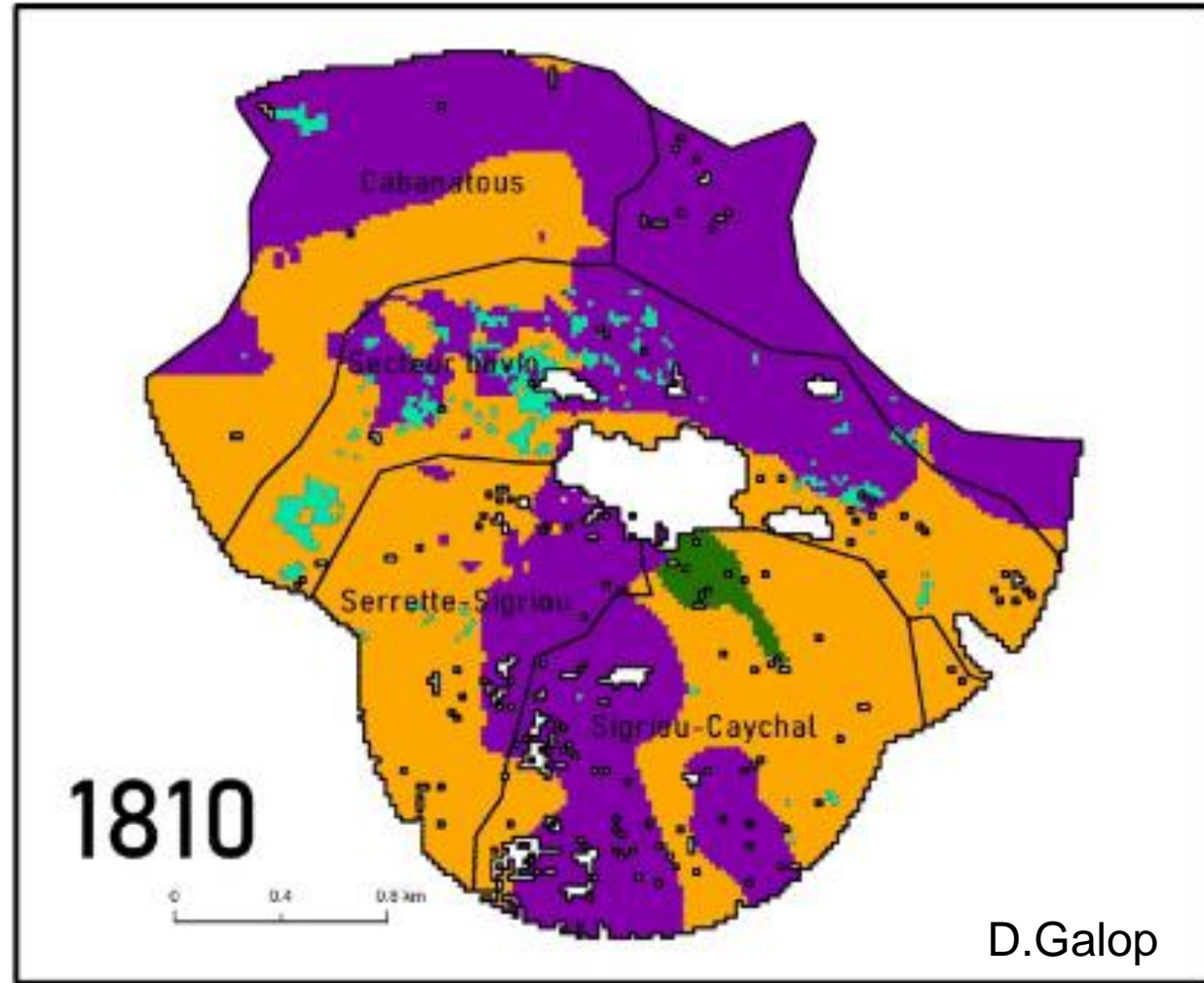
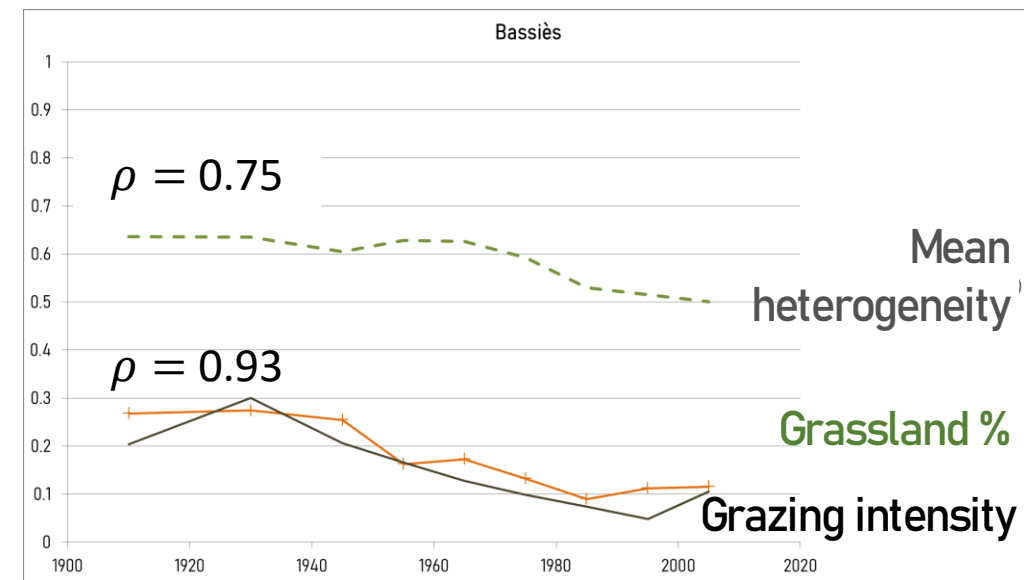


Figure 4 : Rates of land-cover changes between time windows midpoint

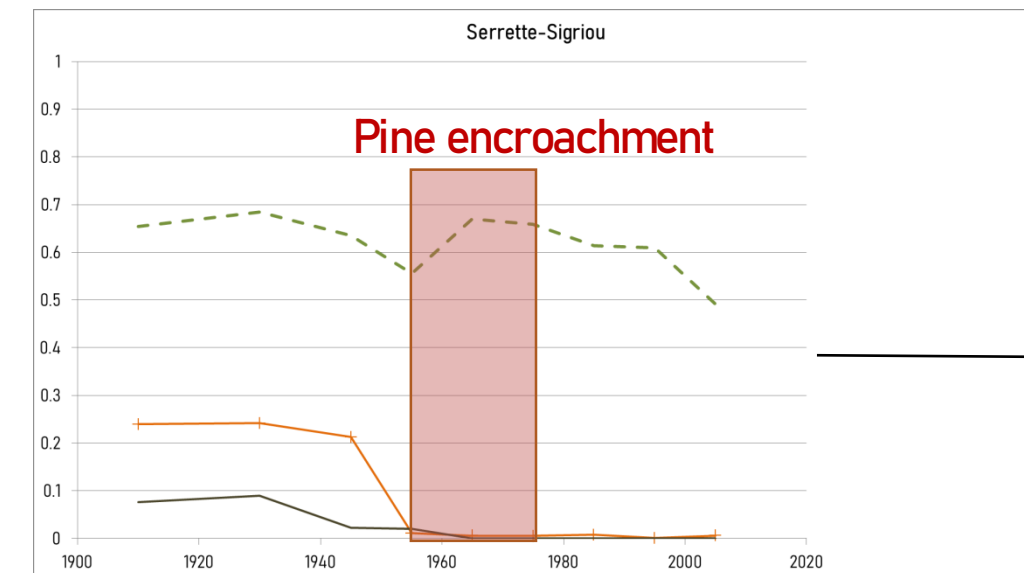
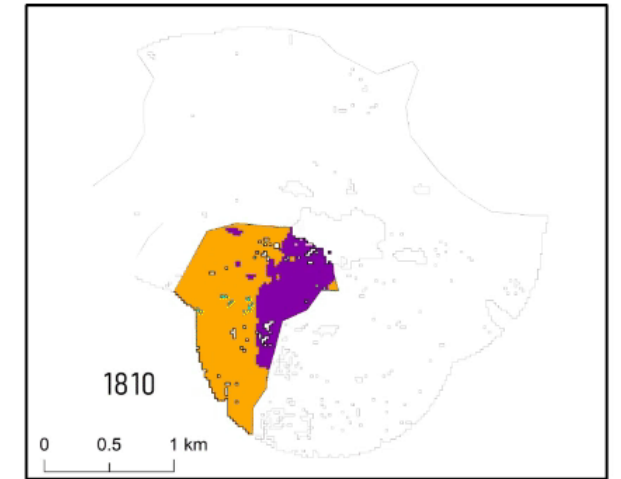
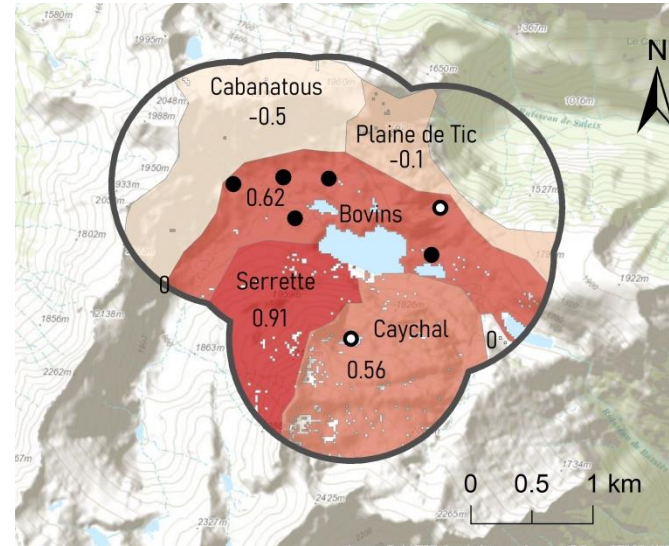
# Impact of pastoral abandonment on landscape composition and herogeneity



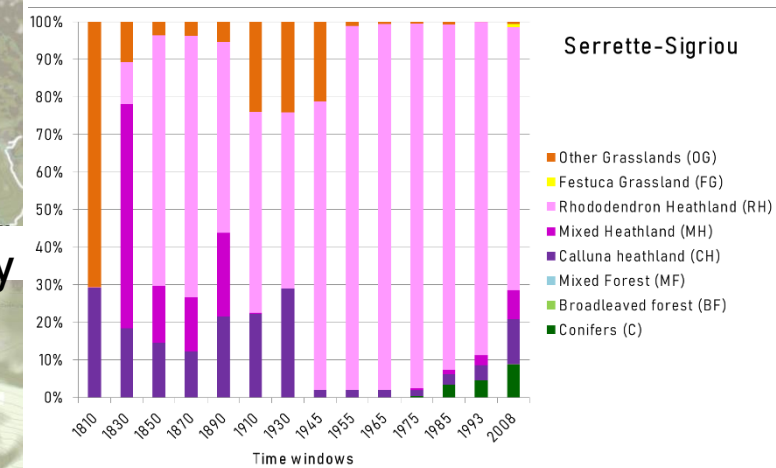
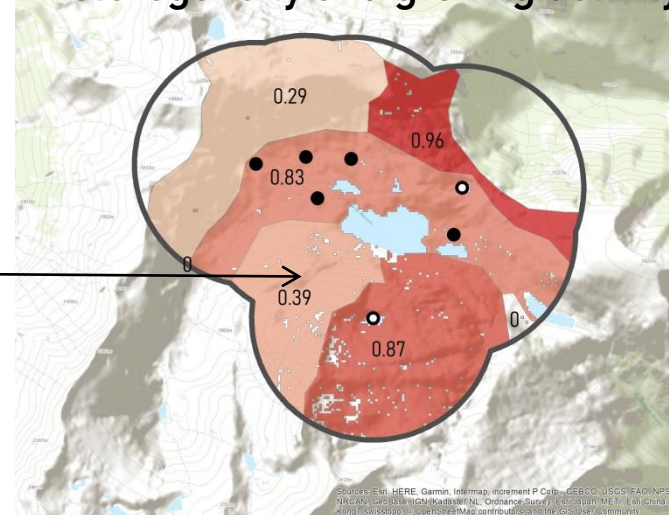
# Impact of pastoral abandonment on landscape composition and heterogeneity



**Grassland % and grazing activity**



**Heterogeneity and grazing activity**

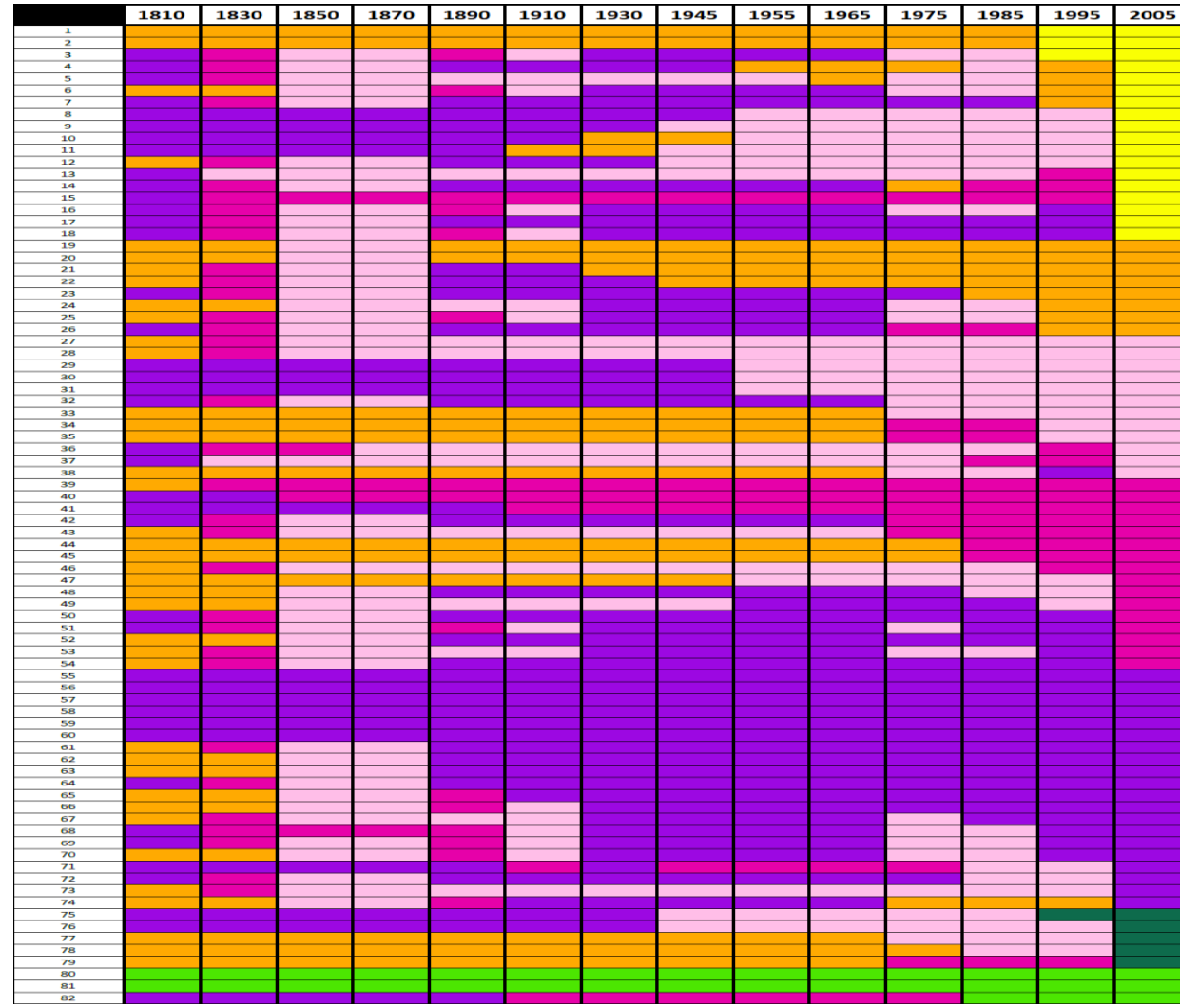
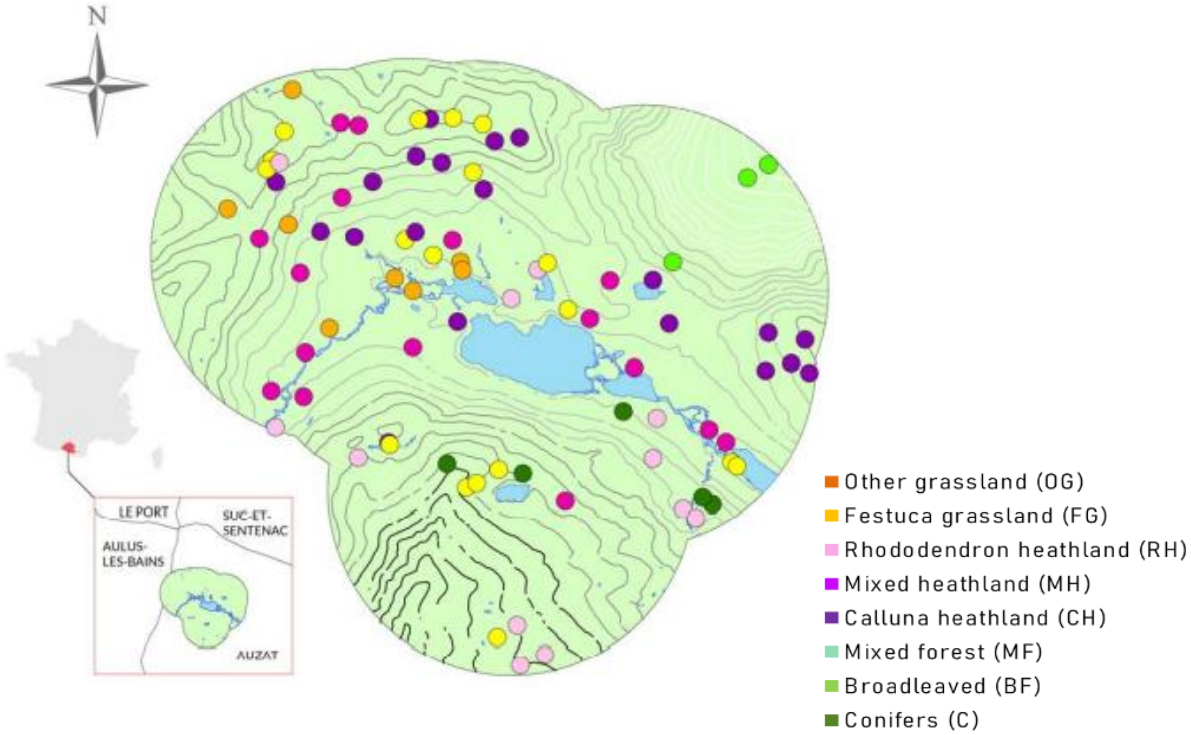


C. Plancher

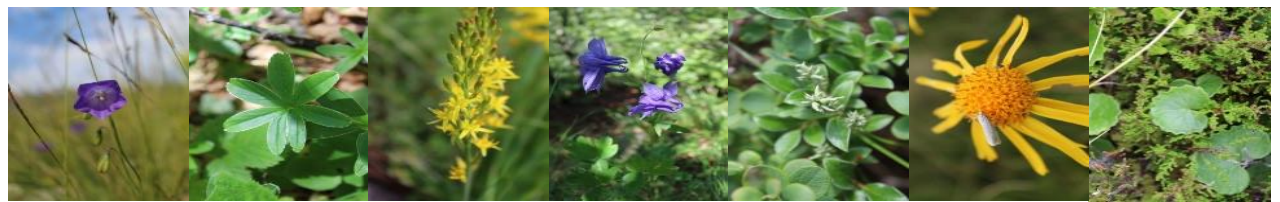
Mattias Burgi

# Land-cover legacy effects on plant taxonomic and functional diversity

M2 Hugo Belly, 2021



- ❖ 82 sites (2015 et 2020, Haunold, 2015 & Plancher et al. sub)
  - ❖ 8 Land-cover types
  - ❖ Percentage cover of 187 species
- FAIR DATA SO-DRIIHM

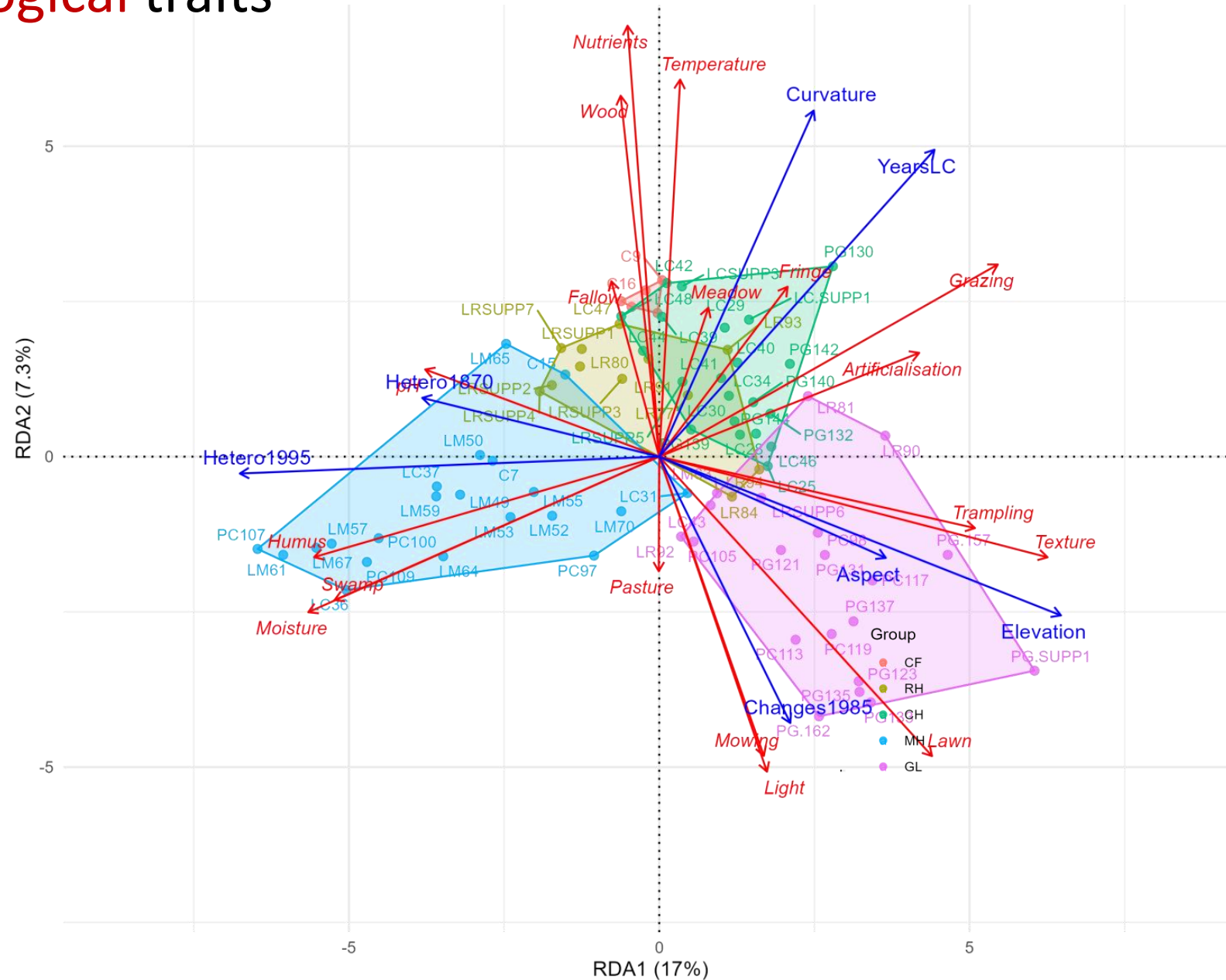


# RDA on scaled CWMs of ecological traits

forward selection of explanatory variables

6 explanatory variables selected:

- Curvature
- Elevation
- North aspect
- Average spatial heterogeneity in 1870
- Total past duration of current land-cover

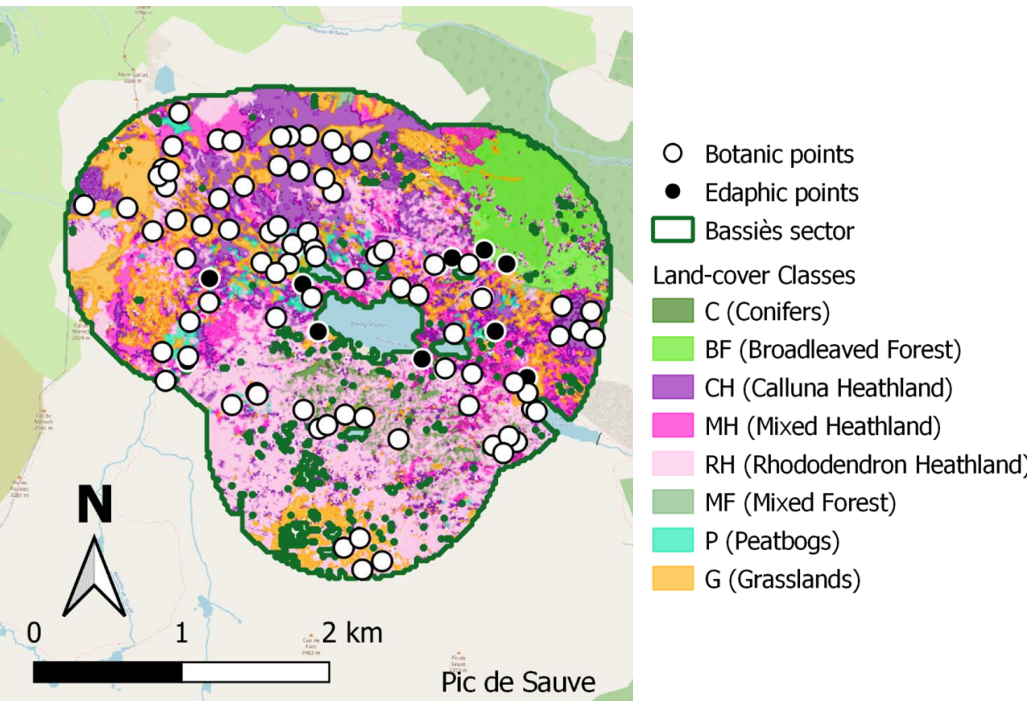


$R^2 = 0.276333$   
 $adjR^2 = 0.2160274$



# Selection of ES proxies relevant in mountains

M2 Yaël Schwertz, 2022, Dir C. Sirami & F. Mazier  
Schwertz et al. 2022, hal-03754602

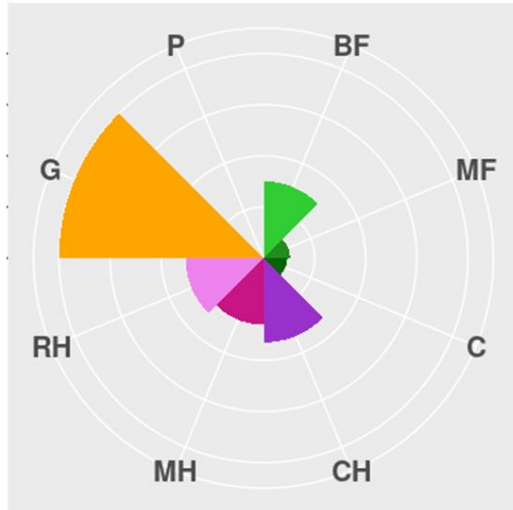


<b>Production</b>	Pastoral value	Total cover of plants with pastoral value (%)
	Plant picking	Abundance of picked plants (%)
<b>Cultural</b>	Patrimonial value	Abundance of patrimonial plants (%)
	Flowers Aesthetics	Total cover of forbs flowers (%)
	Butterflies Aesthetics	Abundance of butterflies (occurrence)
<b>Regulation (pollination)</b>	Pollination	Abundance of entomogamous plants (%)
<b>Regulation (Carbon Cycle)</b>	Organic C fixation	Labile organic matter stabilizing factor
	Organic C stock	SOC* (kgC/m <sup>2</sup> )
	Inorganic C fixation	Capture CO <sup>2</sup> (g/m <sup>2</sup> /year)
<b>Regulation (Water cycle)</b>	Water retention	Useful Water Supply (mm)
	Water infiltration	Water flux (L/m <sup>2</sup> /year)
<b>Regulation (Environnement quality)</b>	Organic matter recycling	Biodegradation rate (g/day)
	Nutrient supply	Cation Exchange Capacity (cmol/kg)
	Biological activity	microbial biomass (µg/g)

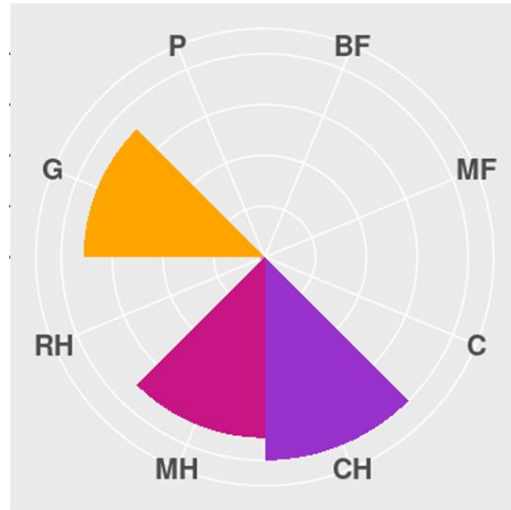


# ES bundles are land-cover type dependant

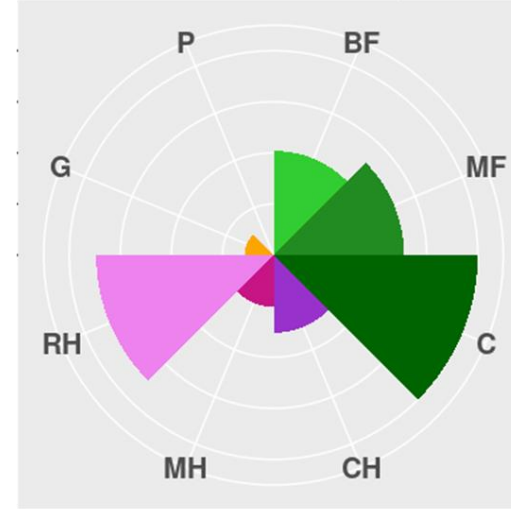
Pastoral value



Patrimonial value



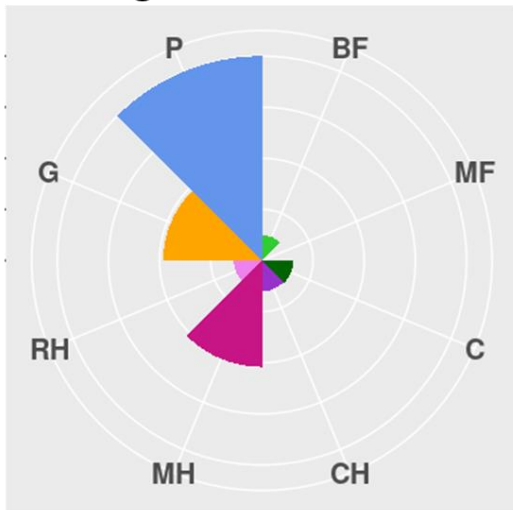
Plant-picking



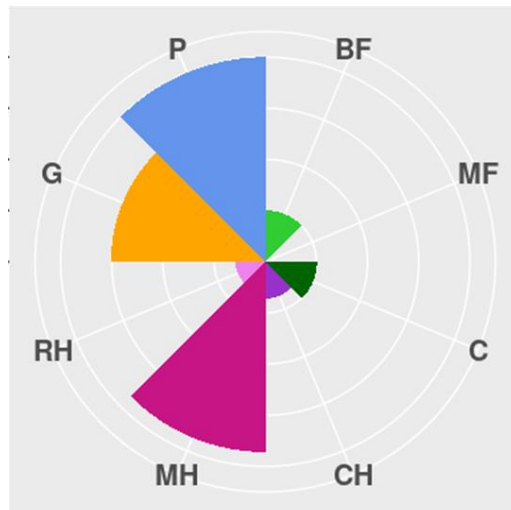
Flowers Aesthetic



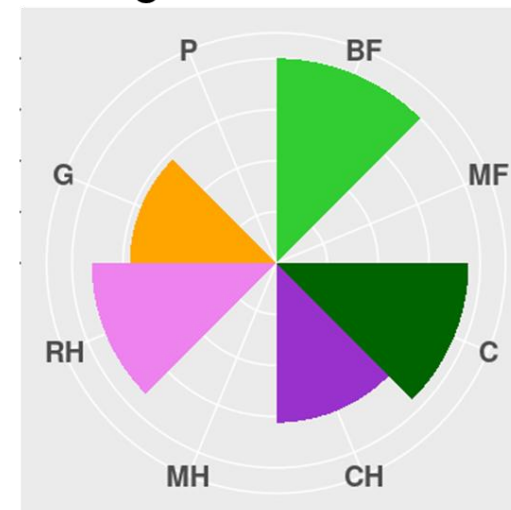
Inorganic C fixation



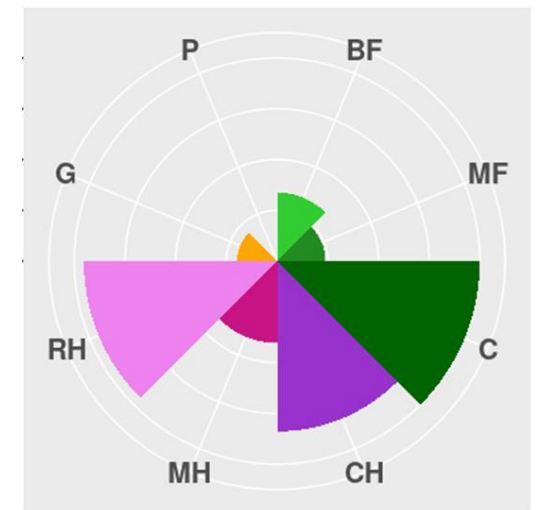
Water Infiltration



Organic C fixation

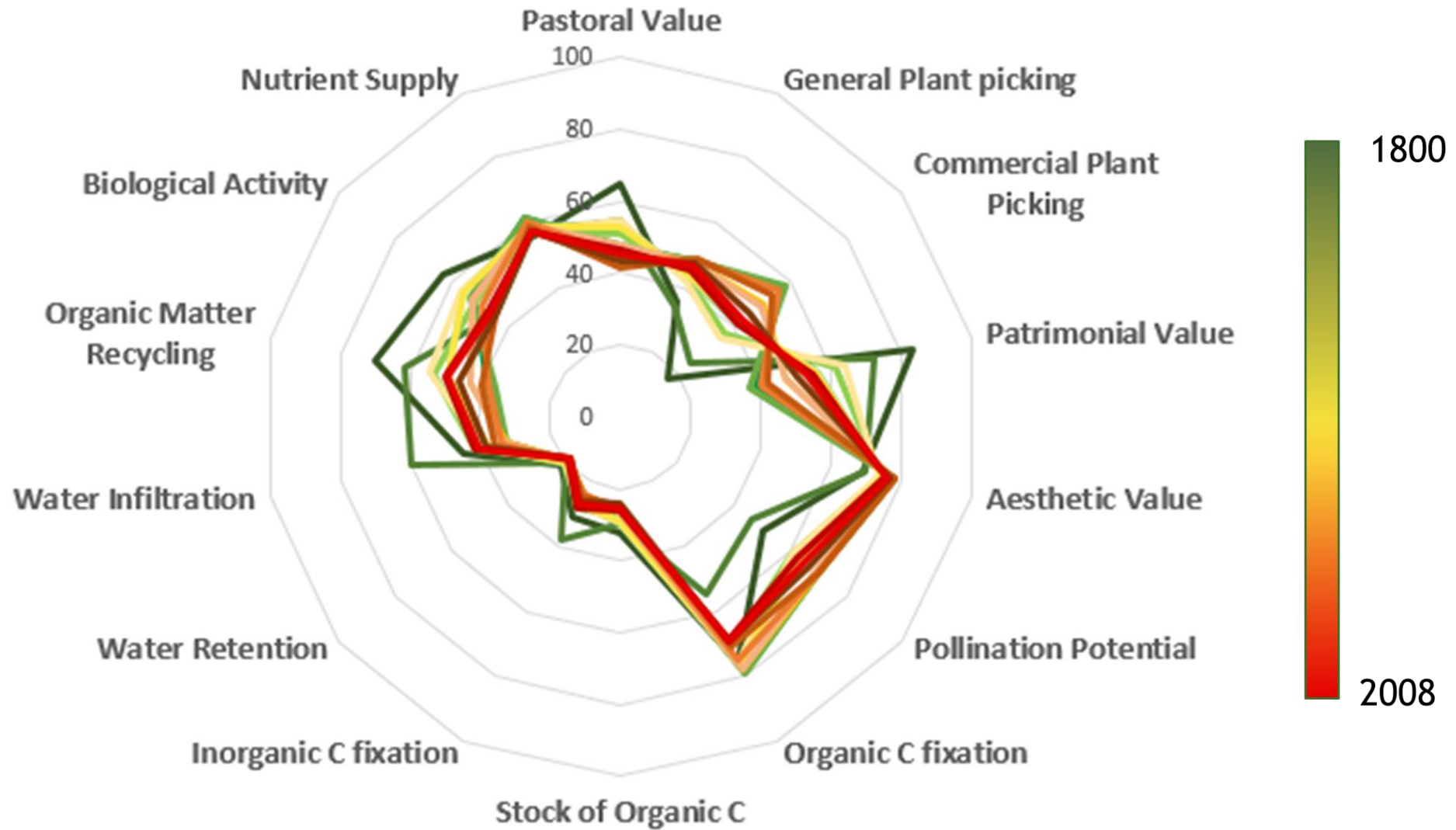


Pollination Potential



See POSTER OHM HV

# Temporal variability of ES production level

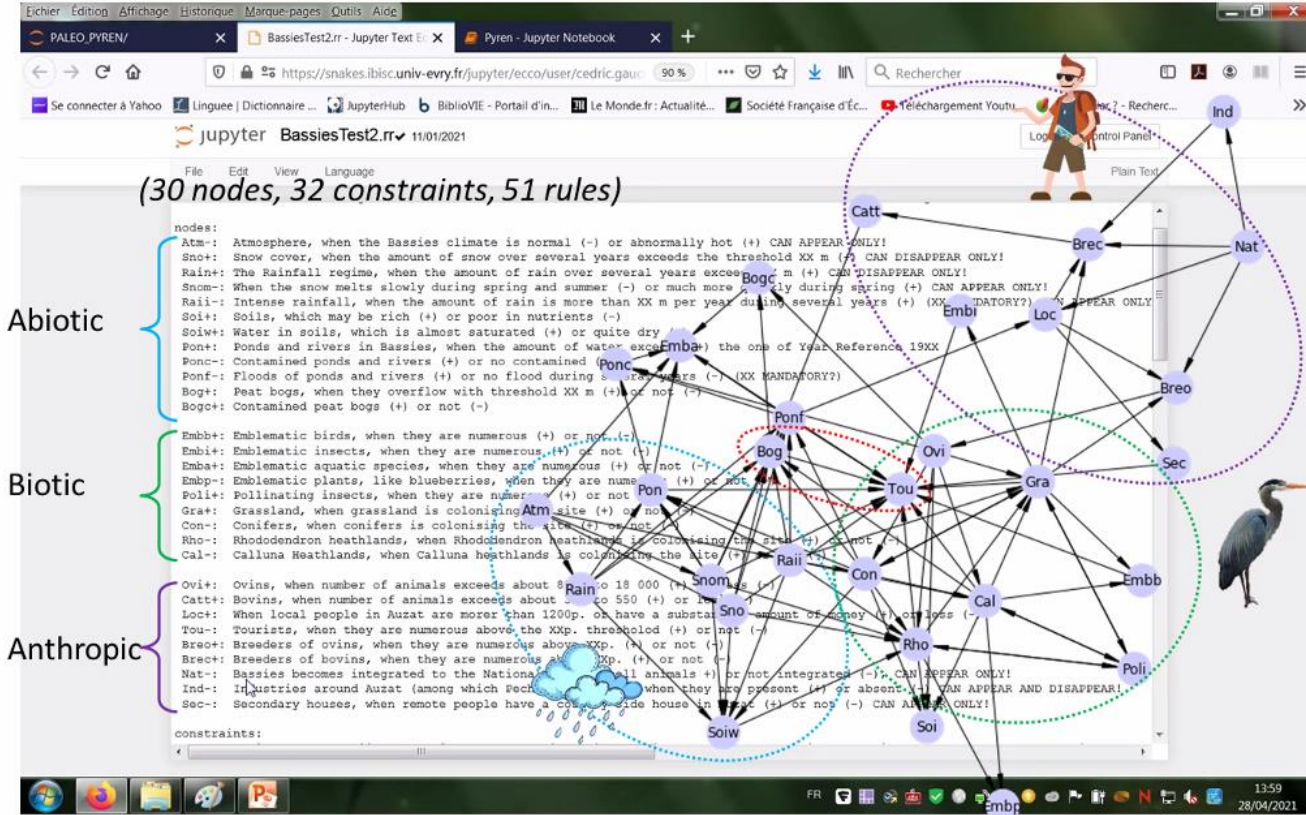


See POSTER OHM HV

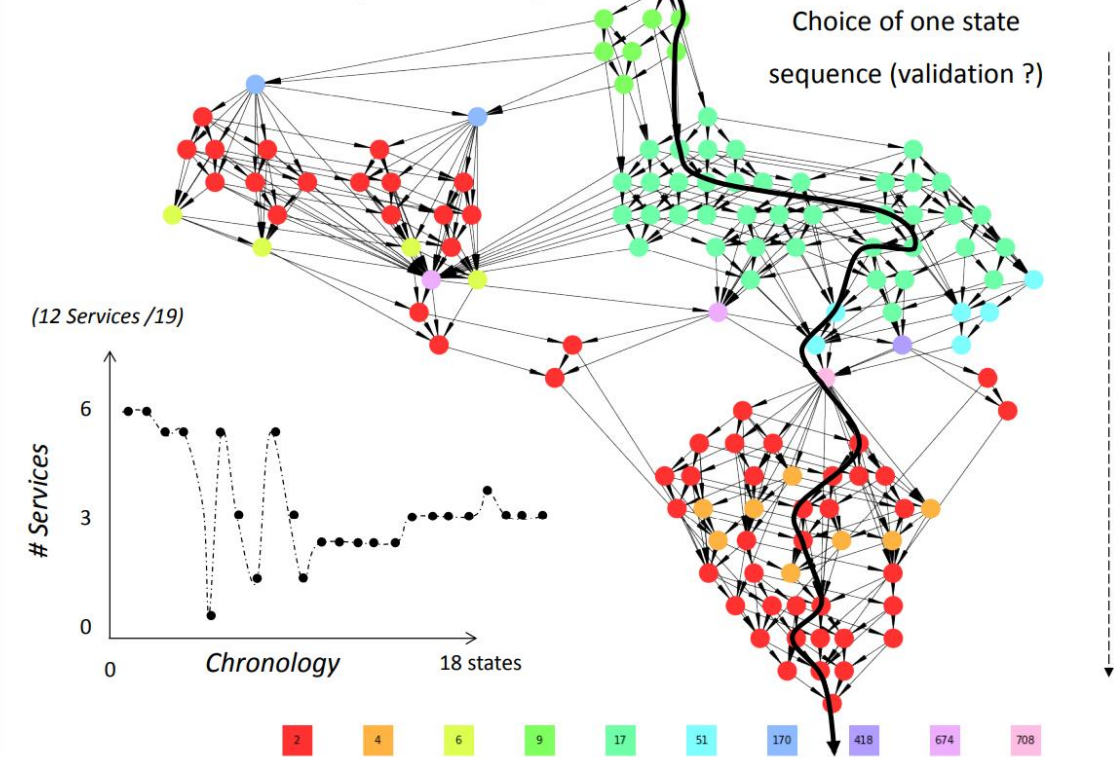
# Socio-ecosystem of Bassiès

## Bassiès version 2.0

Ecosystem Network



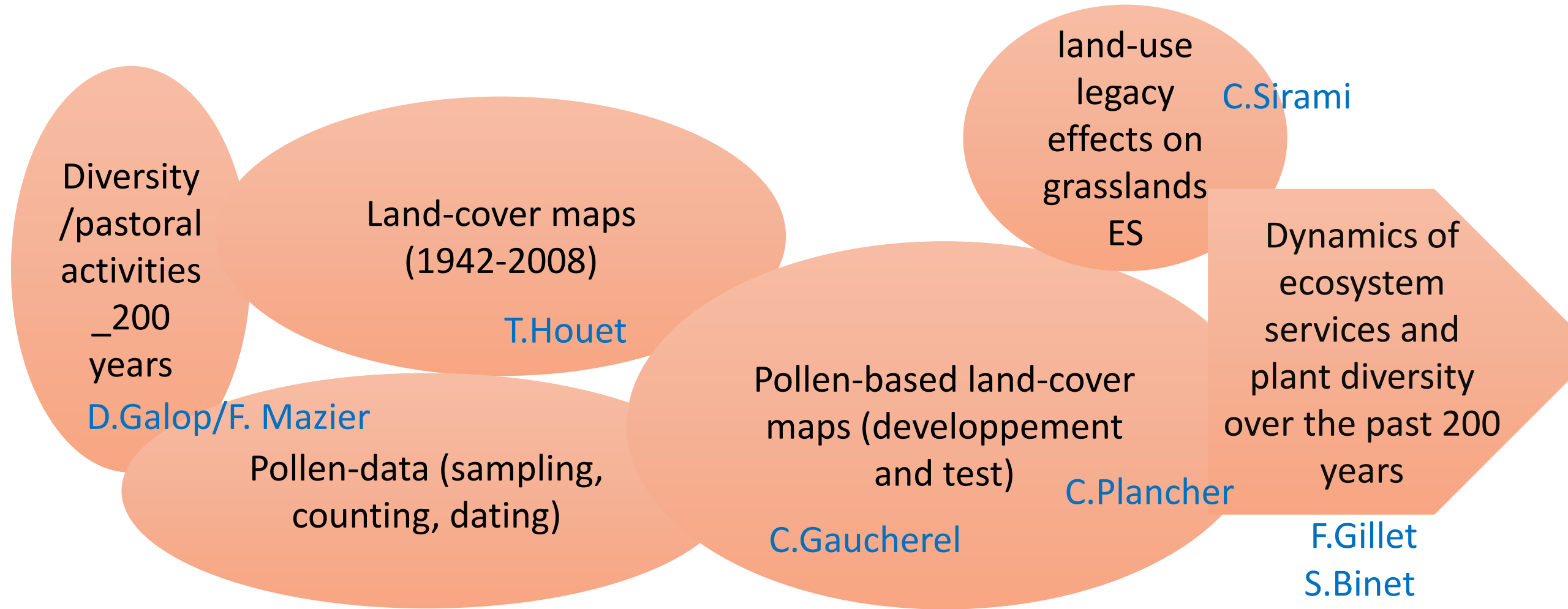
## One trajectory



Gaucherel & Pommeau, 2019. Gaucherel et al. 2020



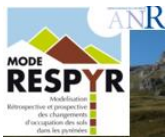
# Construction of an interdisciplinary research\_Role of OHM HV



# Thanks for listening



Gaucherel  
Philippe  
Chaibi  
Mazier  
Dupuis  
Houet  
Sirami  
Belly  
Haunold  
Lebeaud  
Gillet  
Galop  
Binet  
Lerigoleur  
Paschal Laout  
Herb  
Bonnet  
Plancher  
Schwertz  
Molina



BIOPAST  
POPEYE

>10 papers

Master Students 6 M1, 3 M2, 1PhD, 1 postdoc

