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

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

International Symposium of LabEx DRIIHM
Inter-Disciplinary Research Facility on Human-Environment Interactions - ANR-11-LABX-0010
June 20th-22th, 2022 – Nantes (France)

Ecosystem Services (ES) _ Mountains

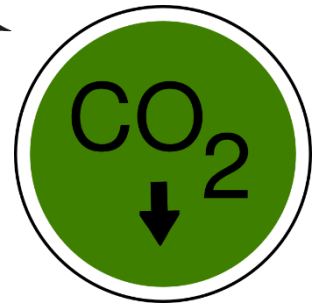


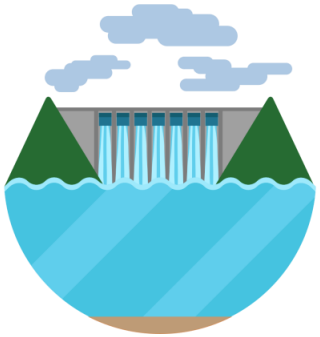
- 3% of Europe > 20 % of plant diversity
- topographical and geological complexity, climatic constraints, **historical trajectories** (current and past land-cover change)
- numerous ecological functions > production of ecosystem services (ES) Martin-Lopez et al. 2019.











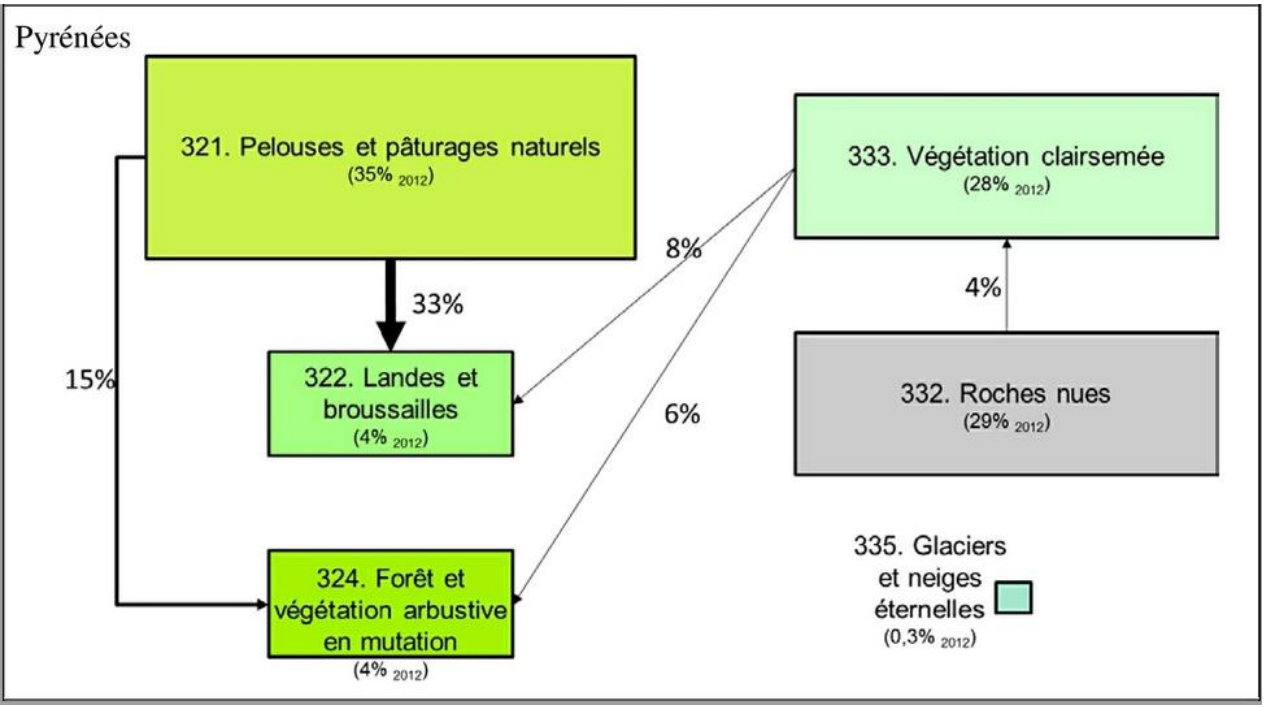
- **ES** threatened by changes in **land use**

Grêt-Regamey et al. 2014, Lavorel et al. 2017

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

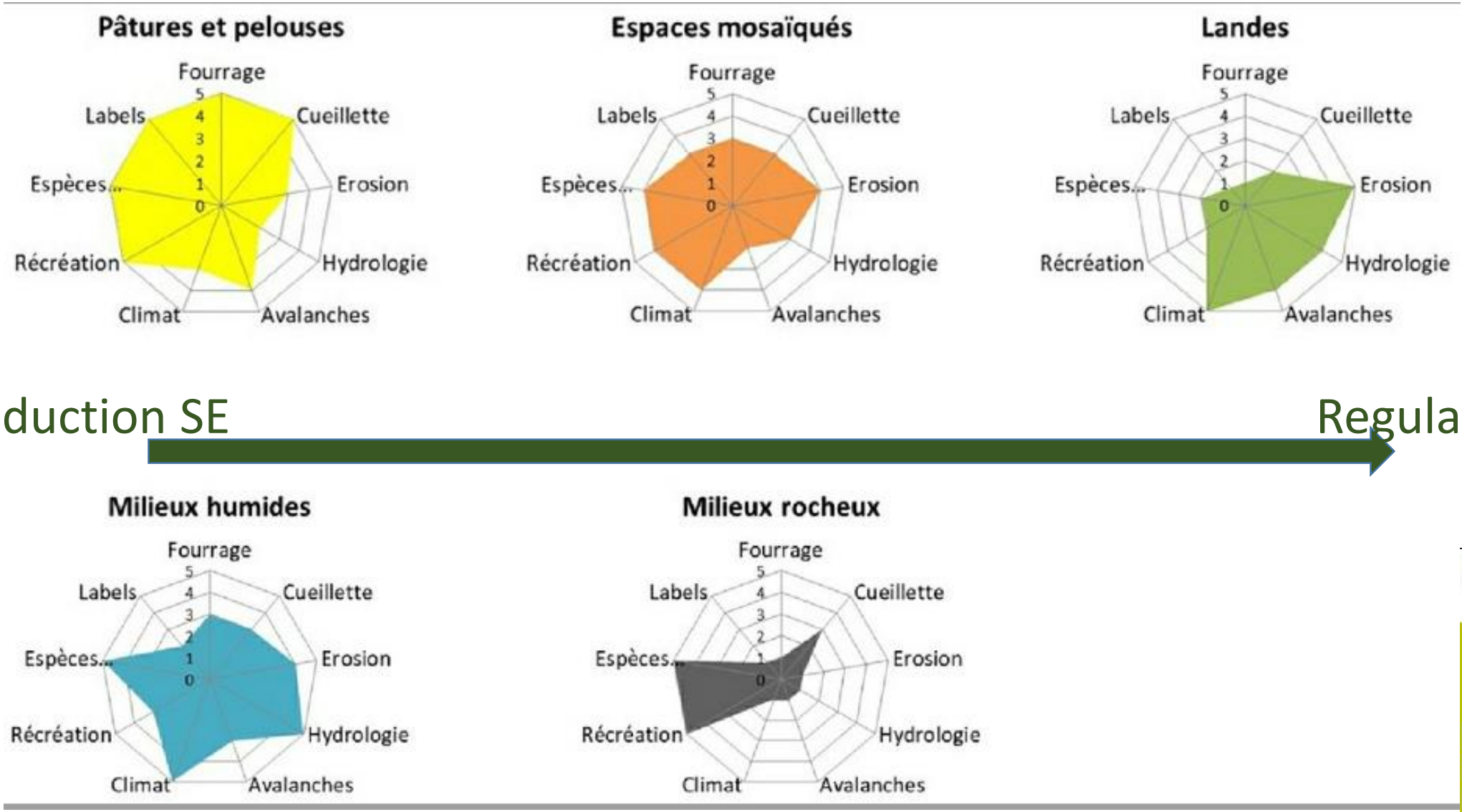


Rapport EFESE, 2018



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 peu denses	Végétation clairsemée et roches	Milieux 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

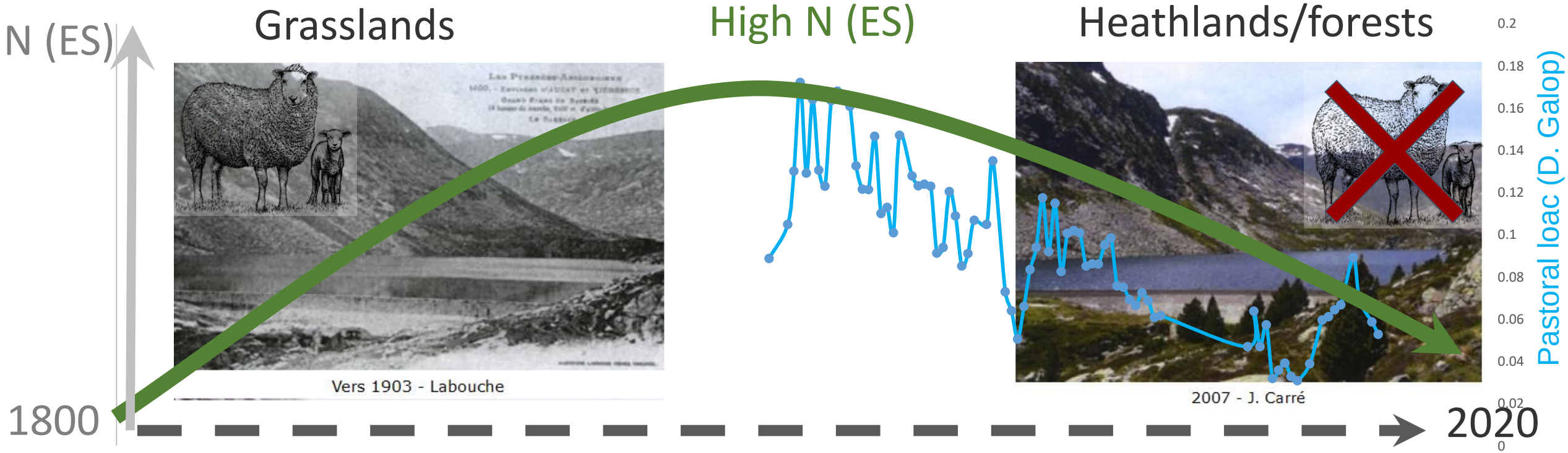
≠ very limited empirical evidence for historical trajectories of multiple ES and their relationships with trajectories of land use. Rare studies explored their relationships with landscape heterogeneity *Lavorel et al. 2017, Mengist et al. 2020*

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

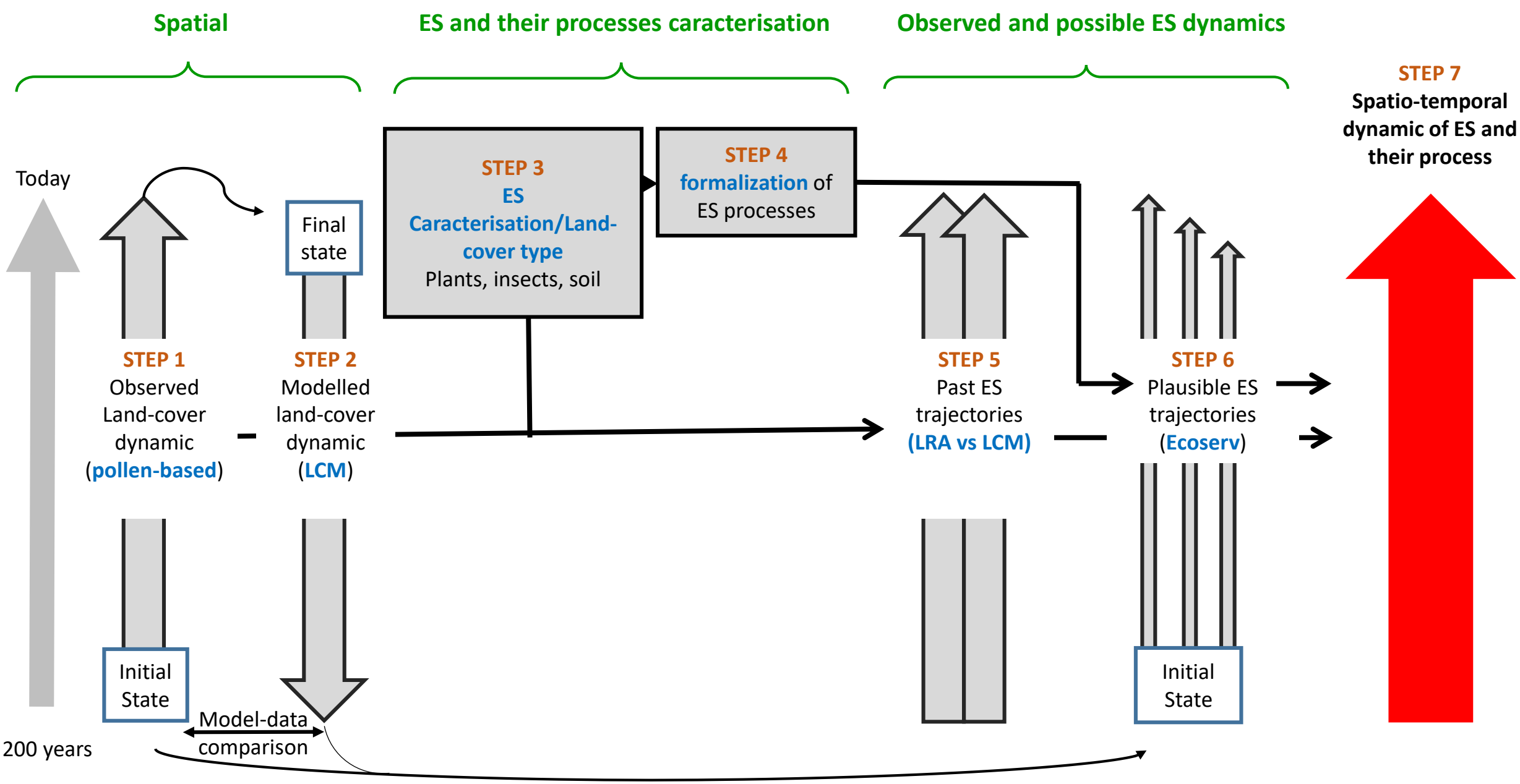
- Mapping distributions of species and land-cover type (finer-grained maps and description)
- Biogeochemical and hydrological cycles in high mountains_ a priority, effect of land-cover. *EFESE, 2018*

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

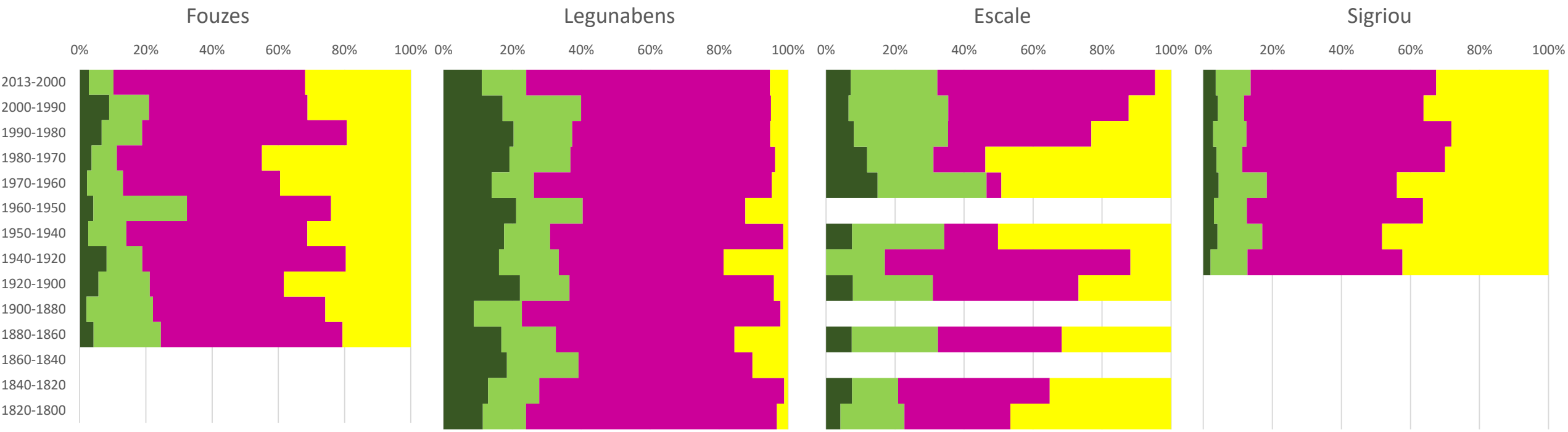


PASTSERV and SOPAST FLOWCHART



Pollen-based past land-cover change_200 years

PhD thesis C. Plancher

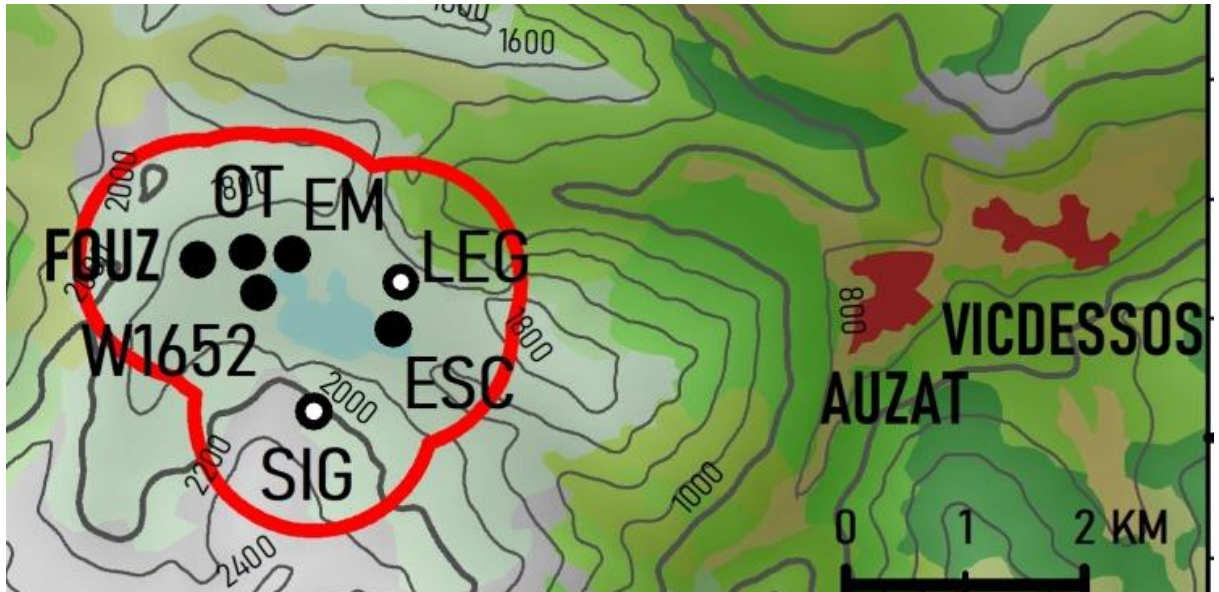


Conifers

Heathlands

Deciduous

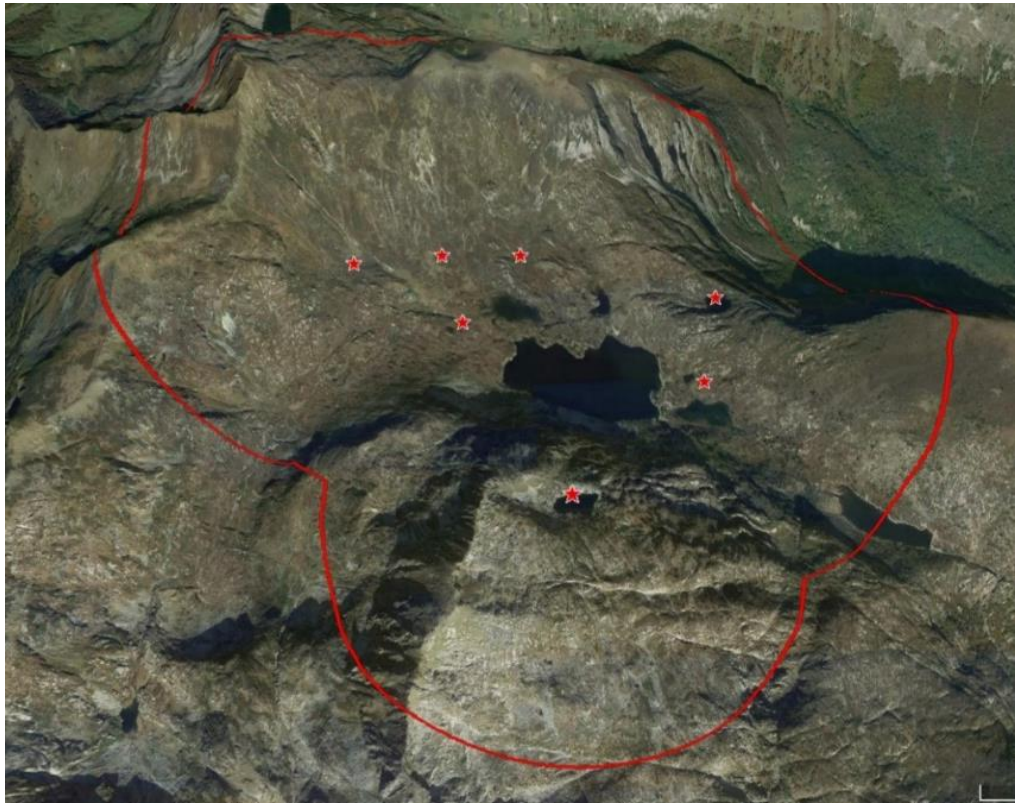
Grasslands

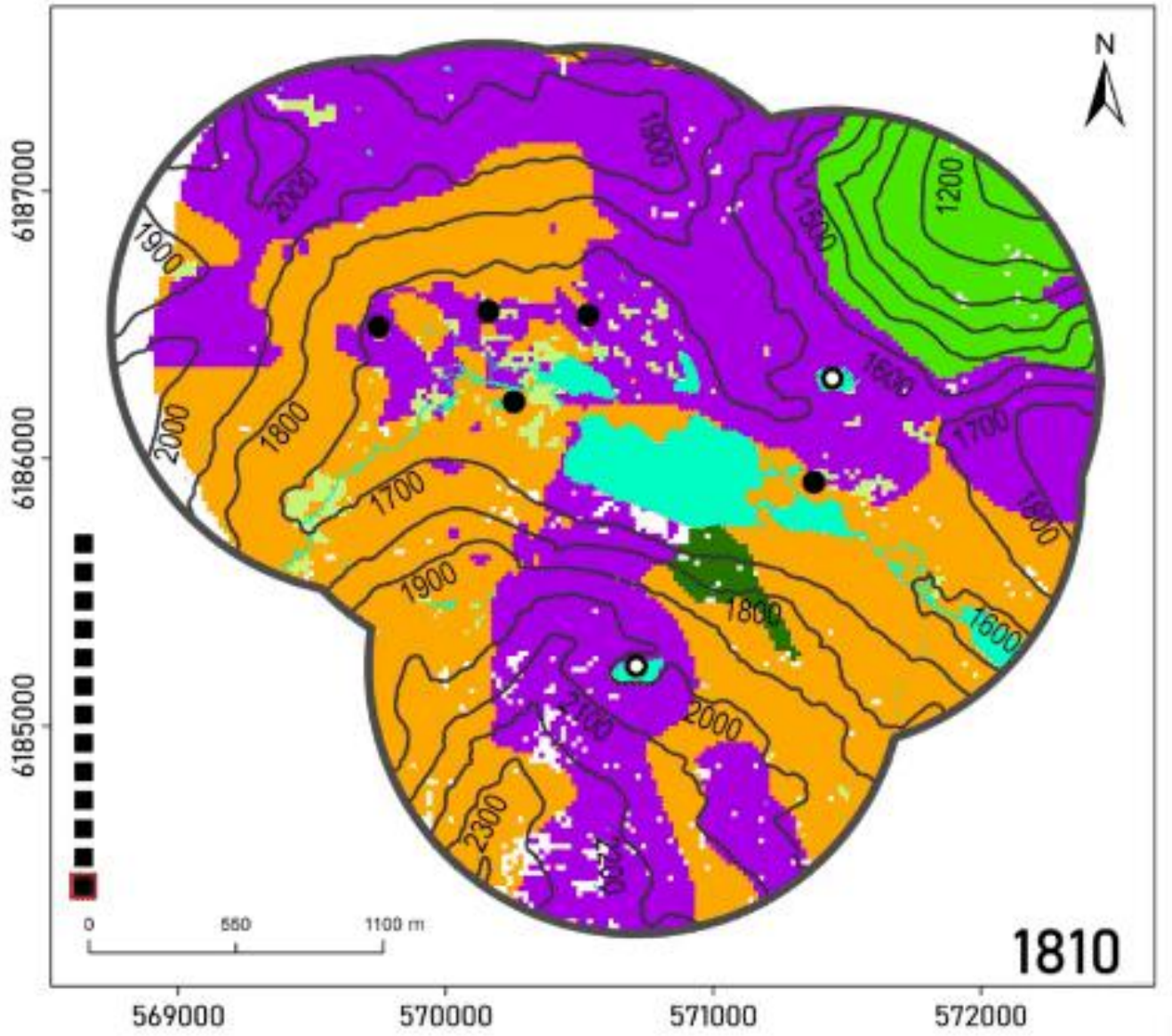


Site ARBU Allen et al. 2020. CATENA

Plancher et al. Sub QSR

Atlas of past land-cover change_ 200 years

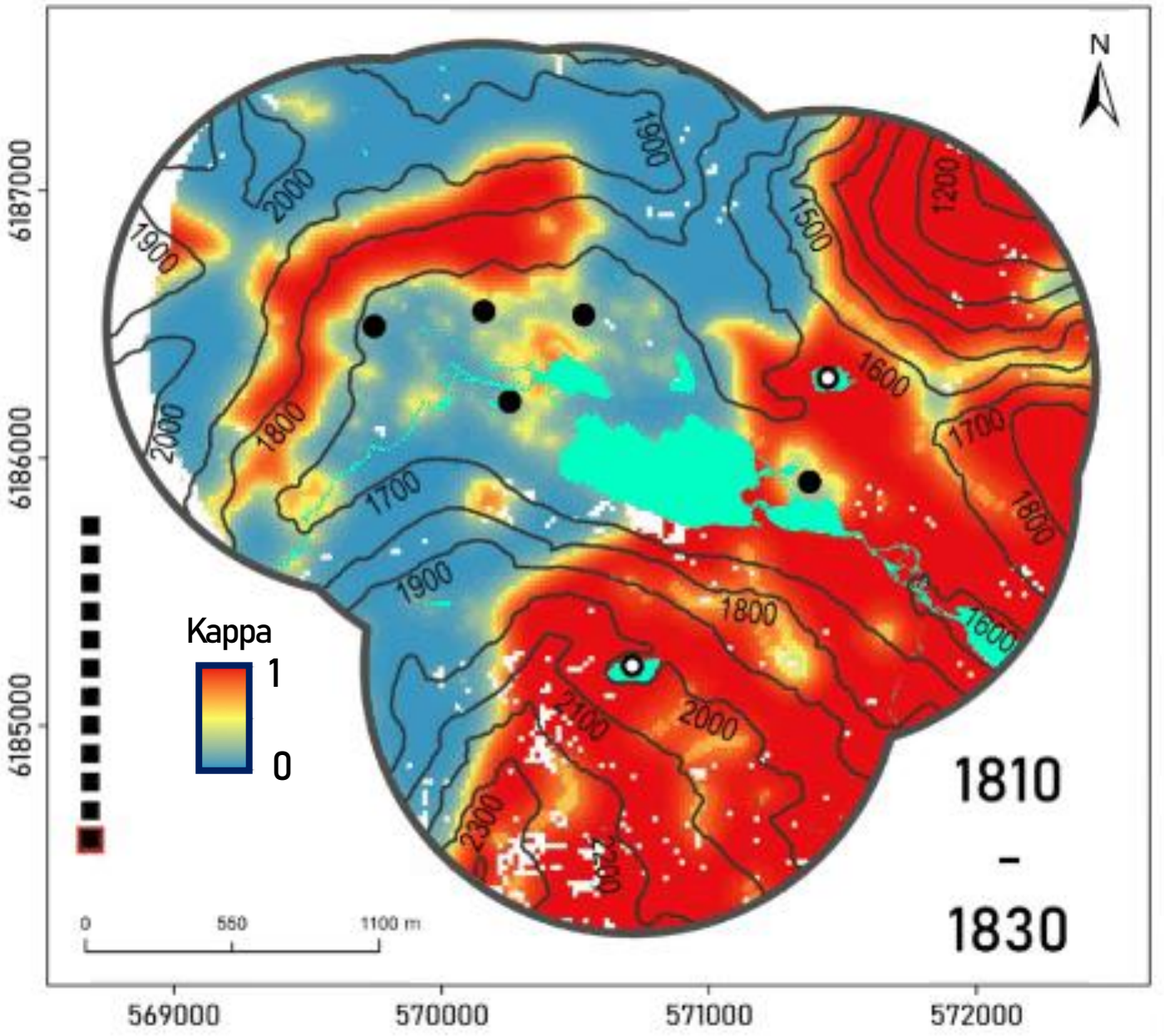




- Other grassland (OG)
- Festuca grassland (FG)
- Rhododendron heathland (RH)
- Mixed heathland (MH)
- Calluna heathland (CH)
- Mixed forest (MF)
- Broadleaved (BF)
- Conifers (C)

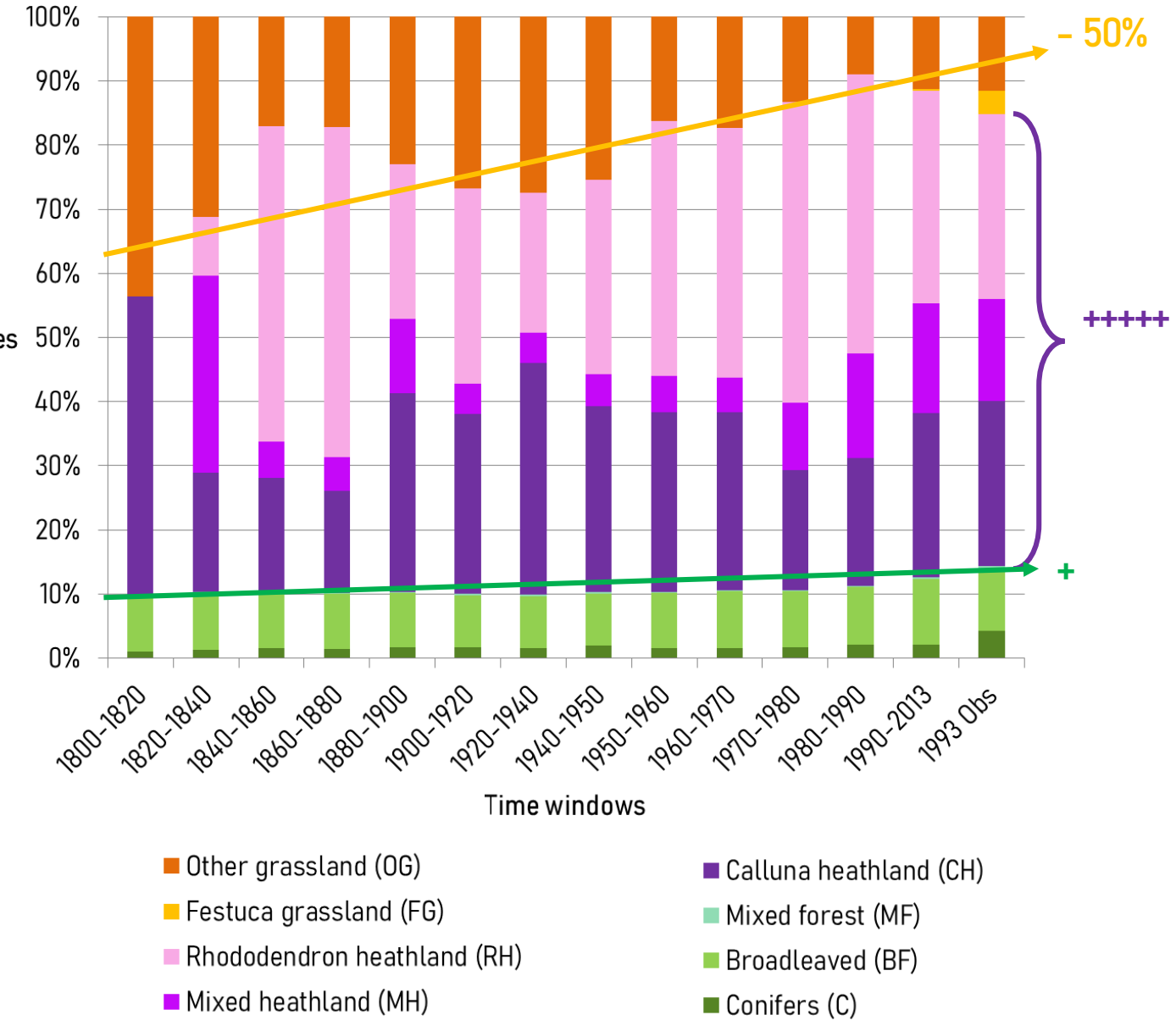
C. Plancher

Maps of Land-cover differences



C. Plancher

Rates of past land-cover change



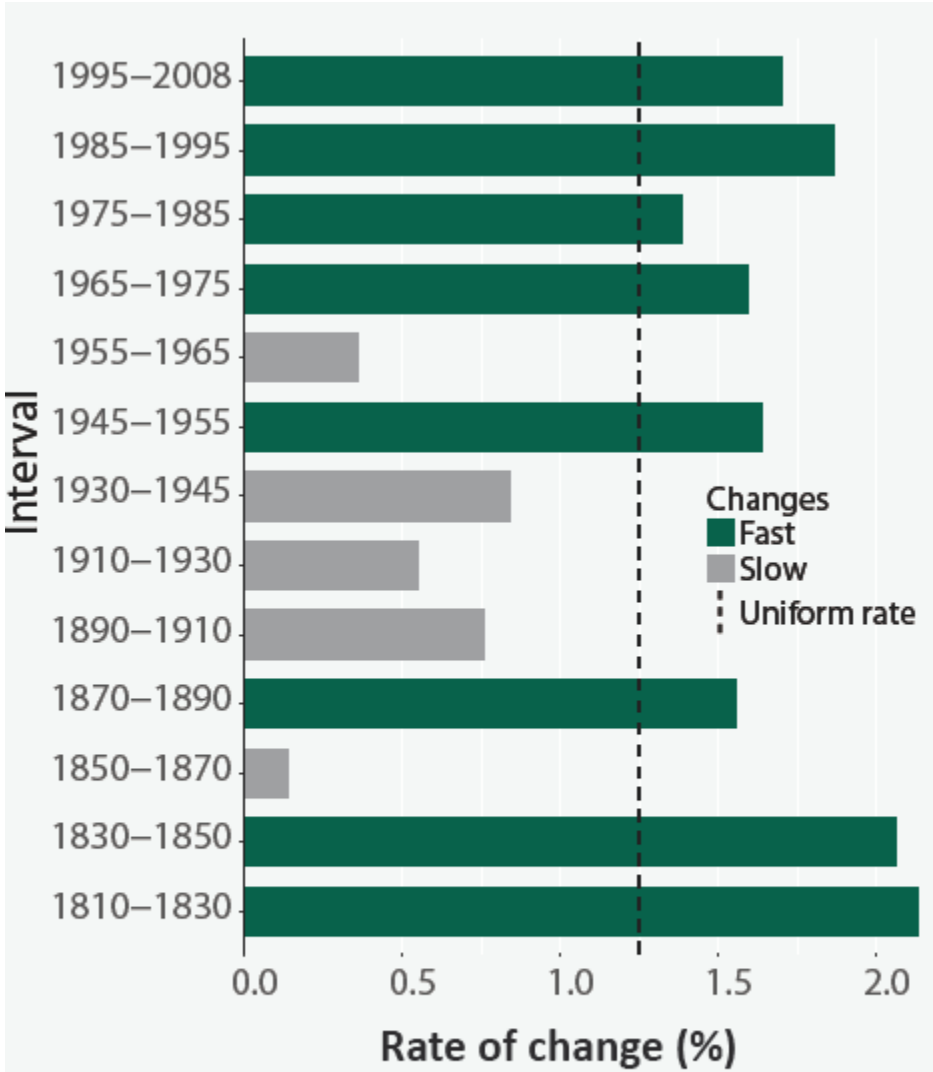
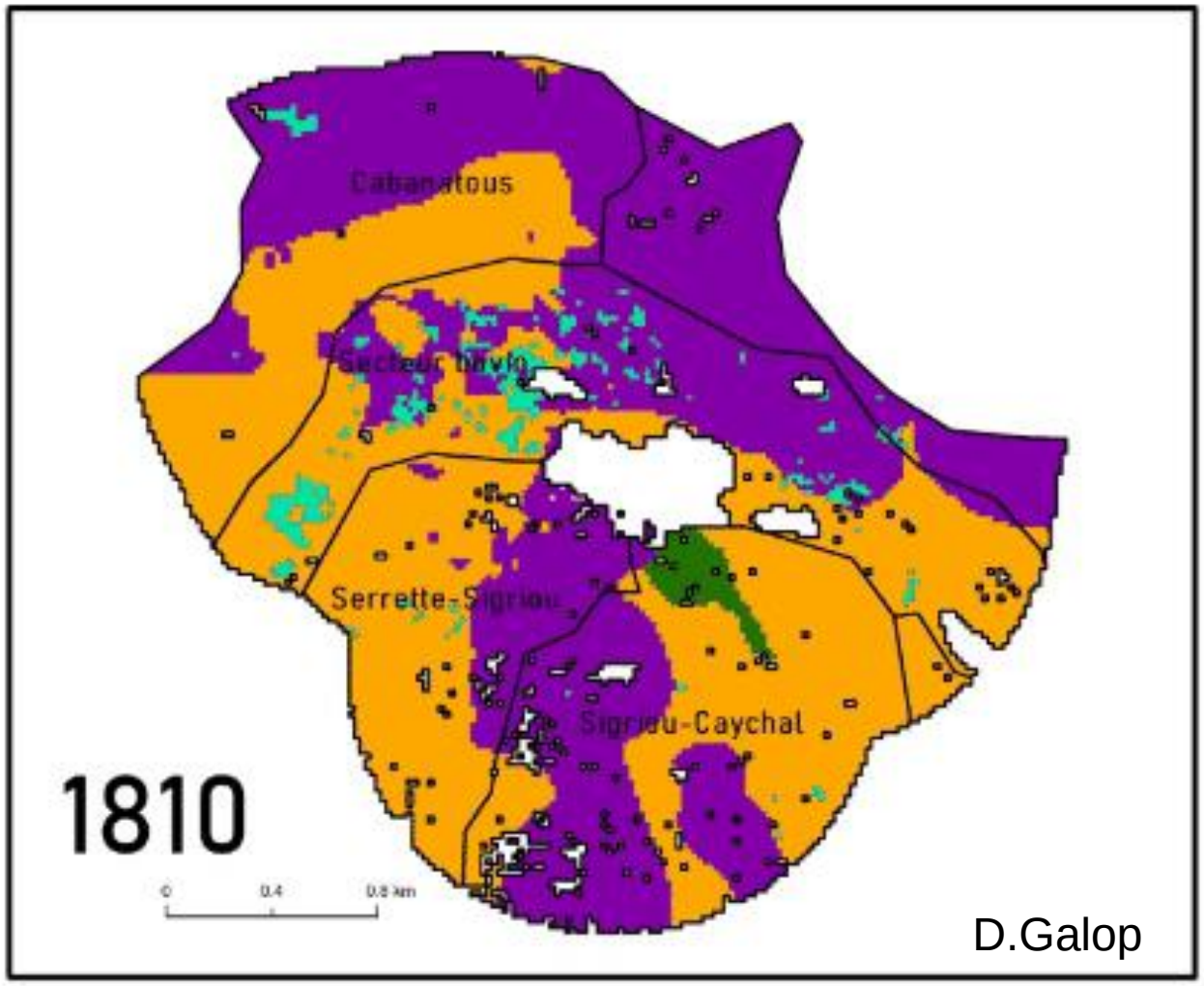
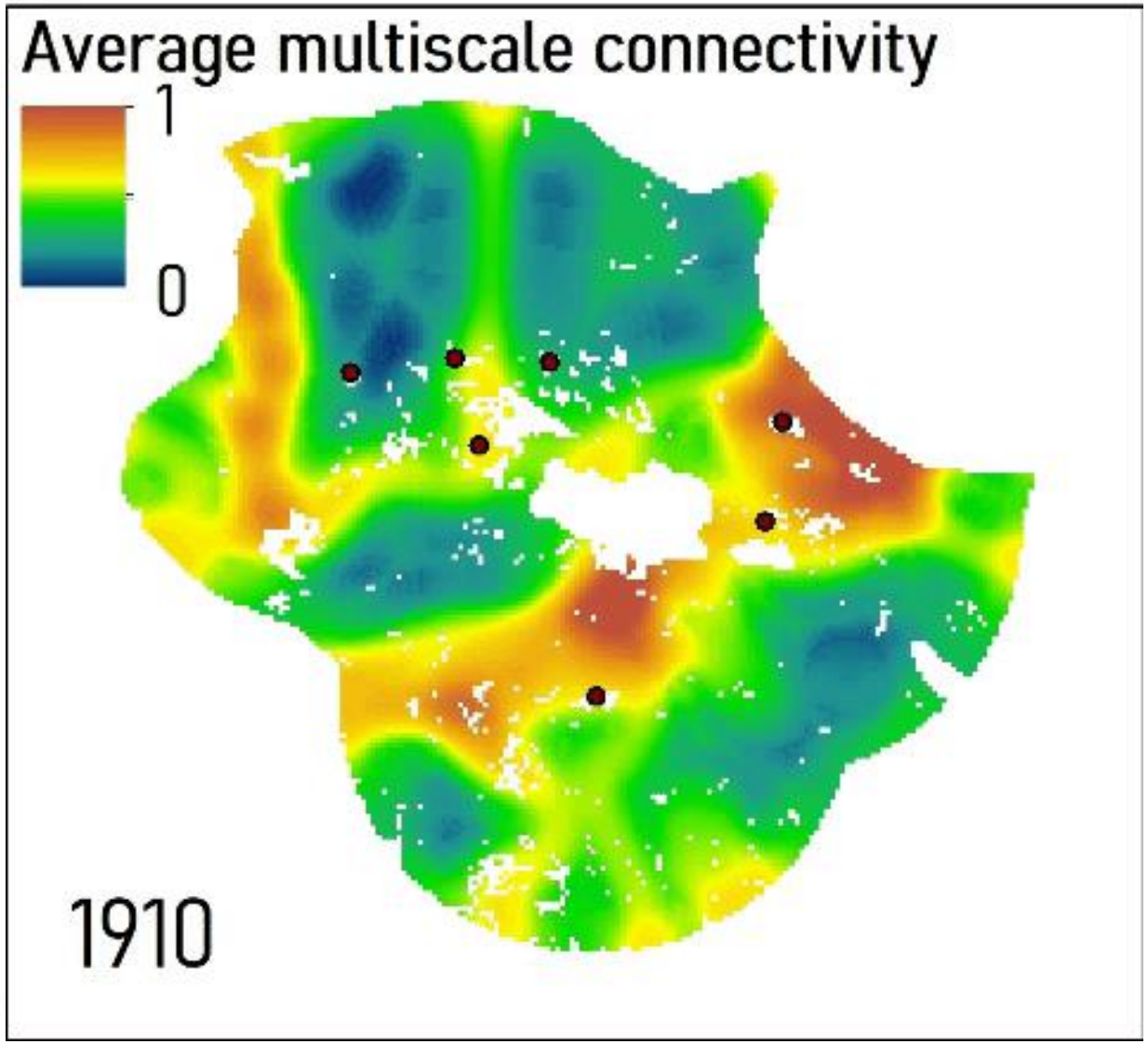


Figure 4 : Rates of land-cover changes between time windows midpoint

C. Plancher

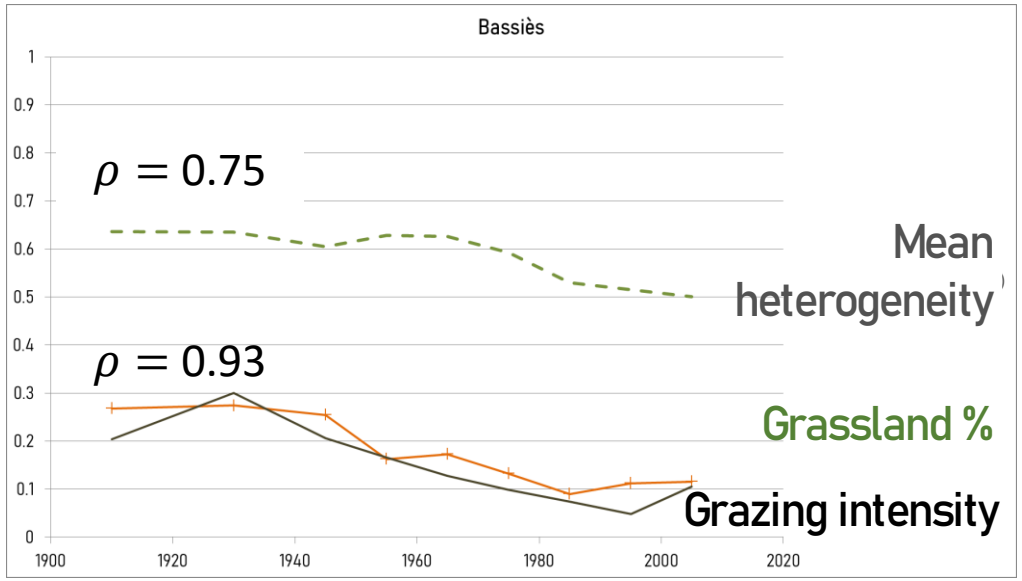
Impact of pastoral abandonment on landscape composition and herogeneity

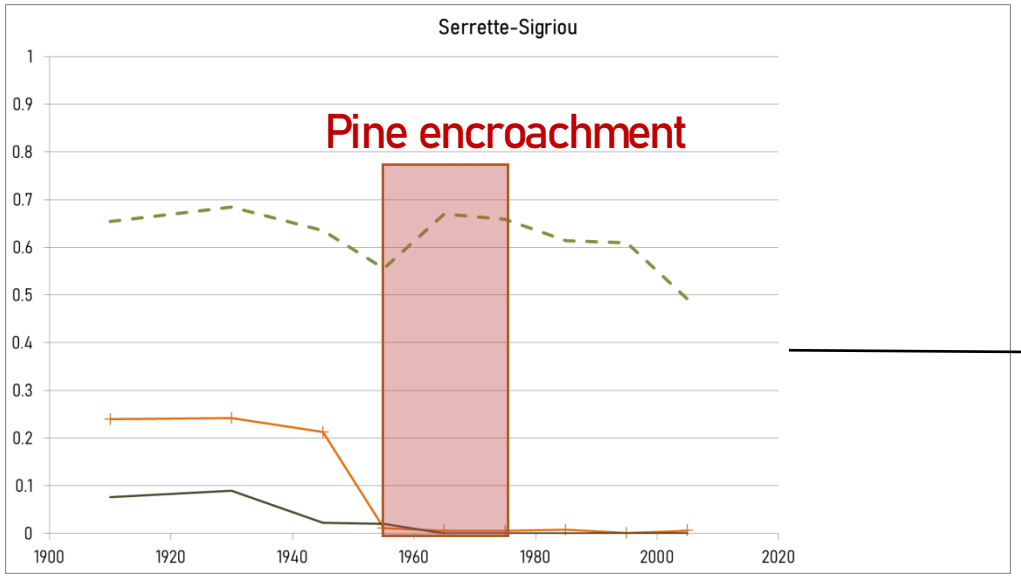




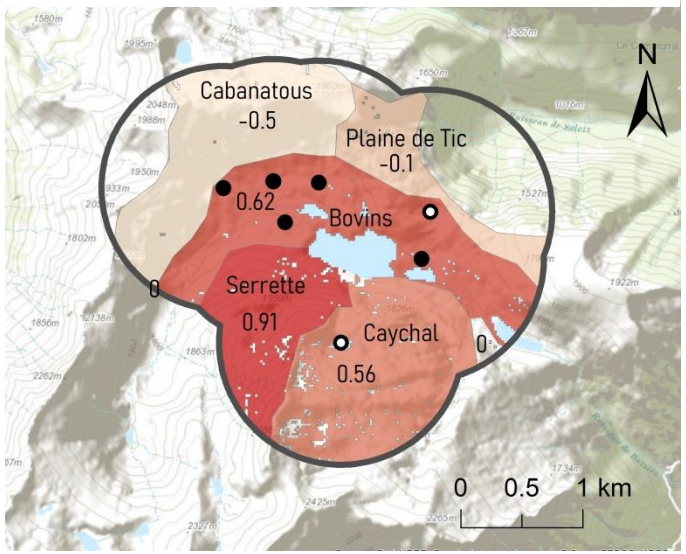
C. Plancher

Impact of pastoral abandonment on landscape composition and herogeneity

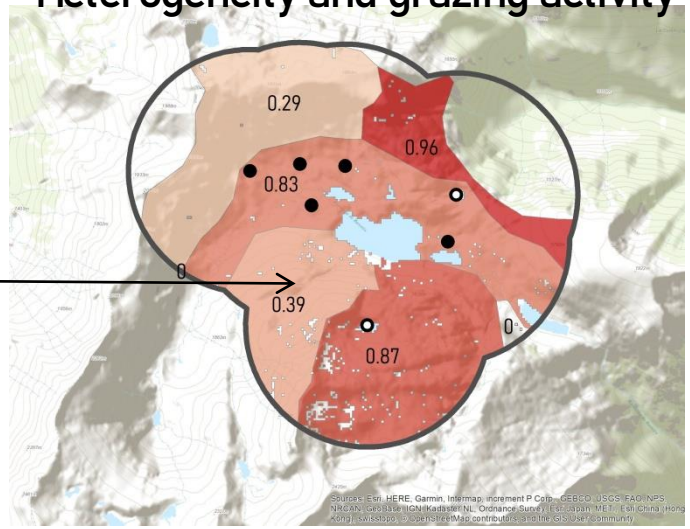


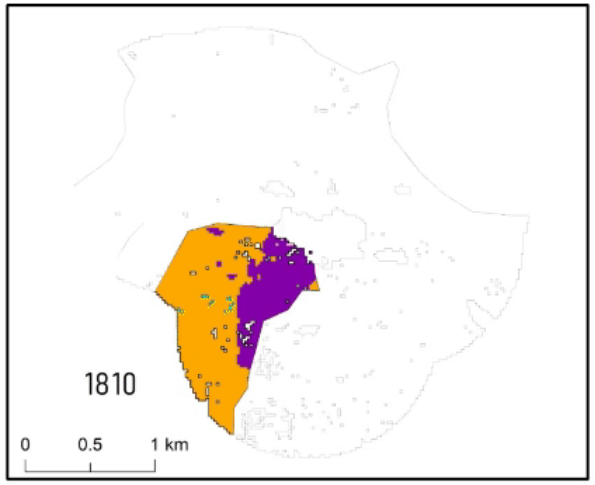


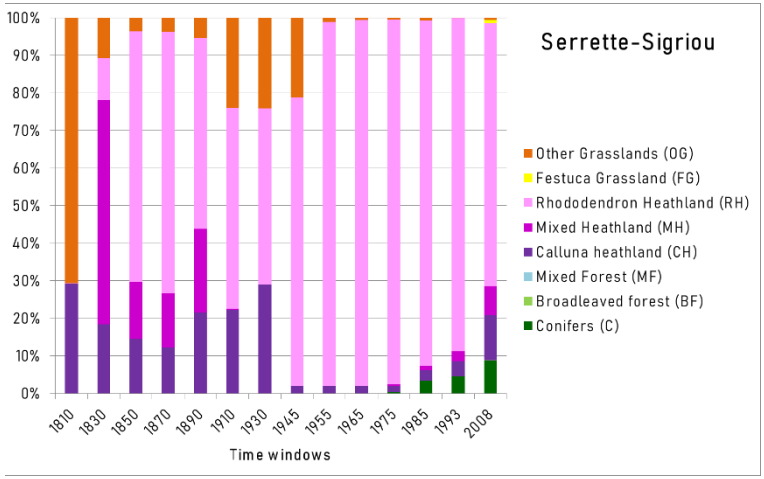
Grassland % and grazing activity



Heterogeneity and grazing activity







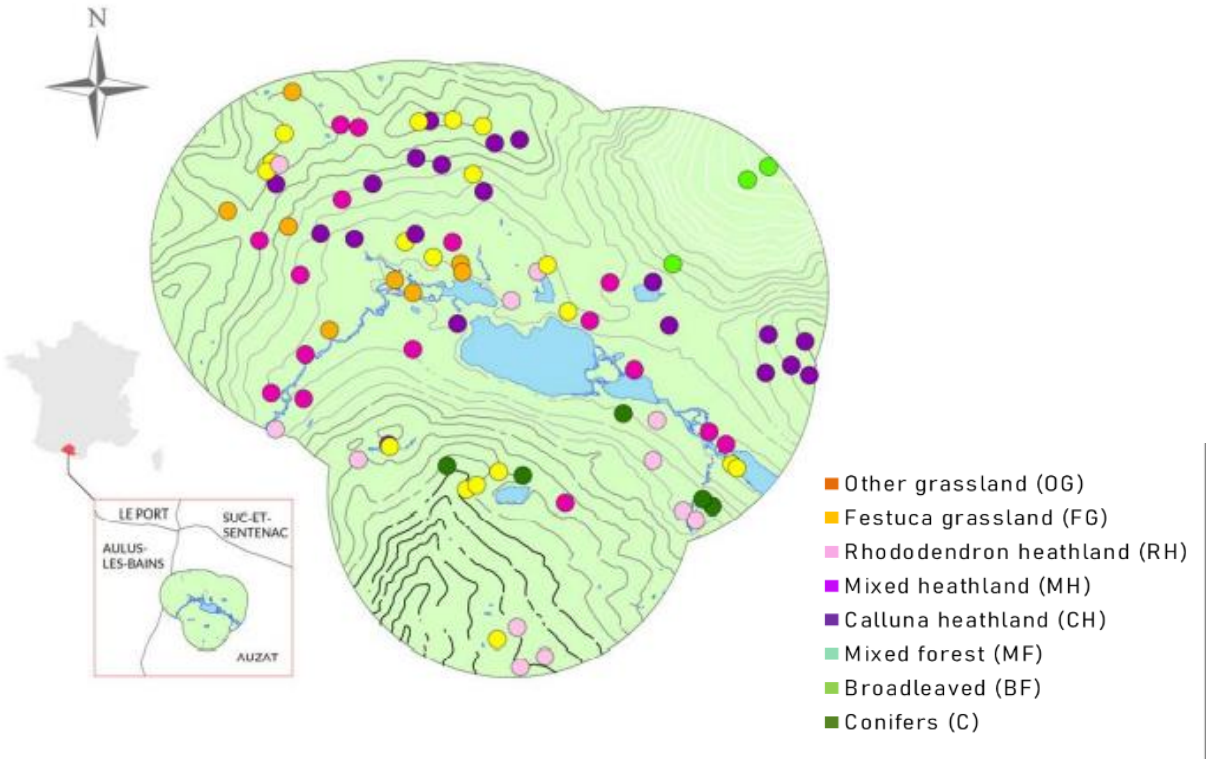
C. Plancher

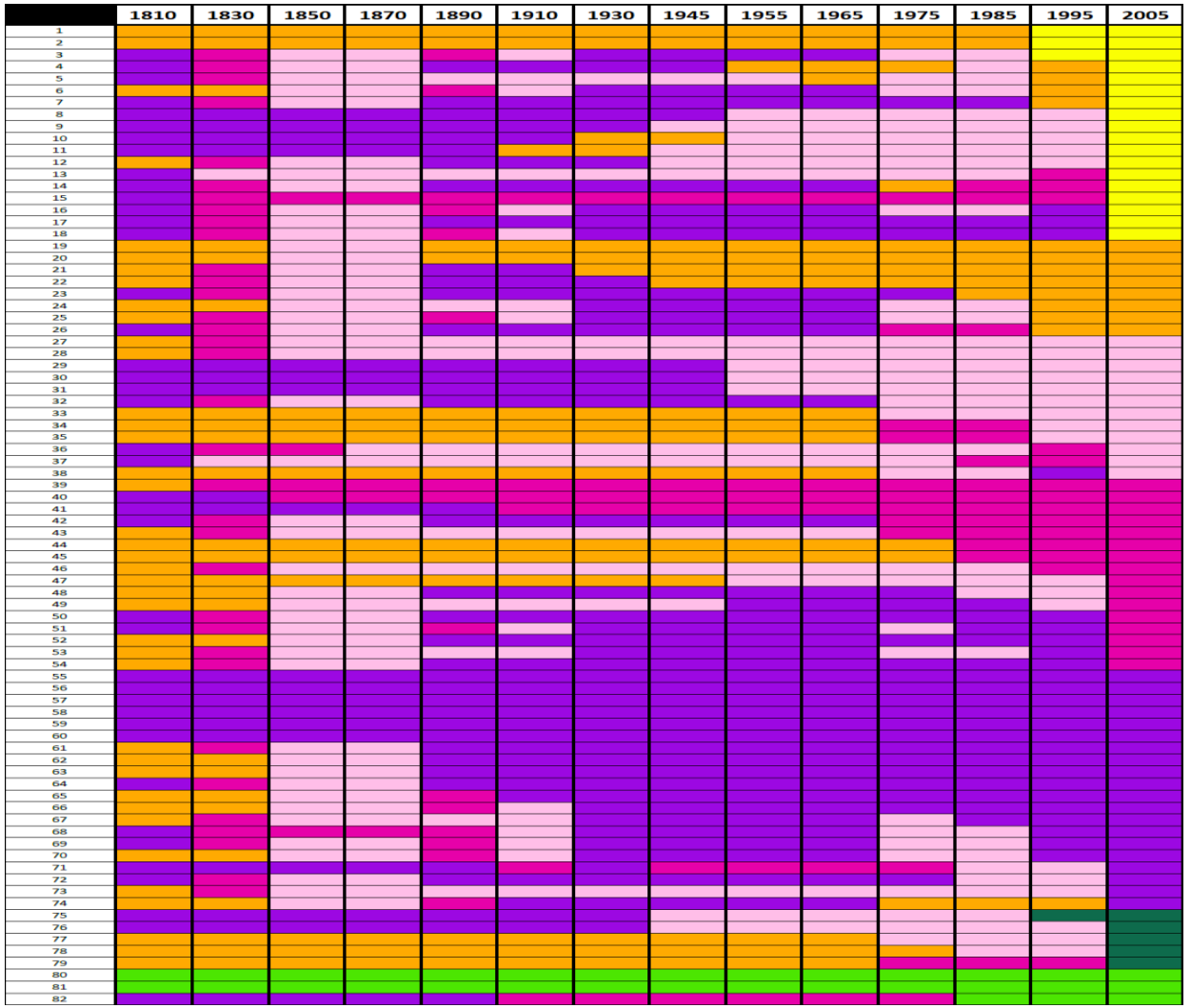
Mattias Burgï

Institut fédéral de recherches sur la forêt, la neige et le paysage WSL

Land-cover legacy effects on plant taxonomic and functionnal 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**



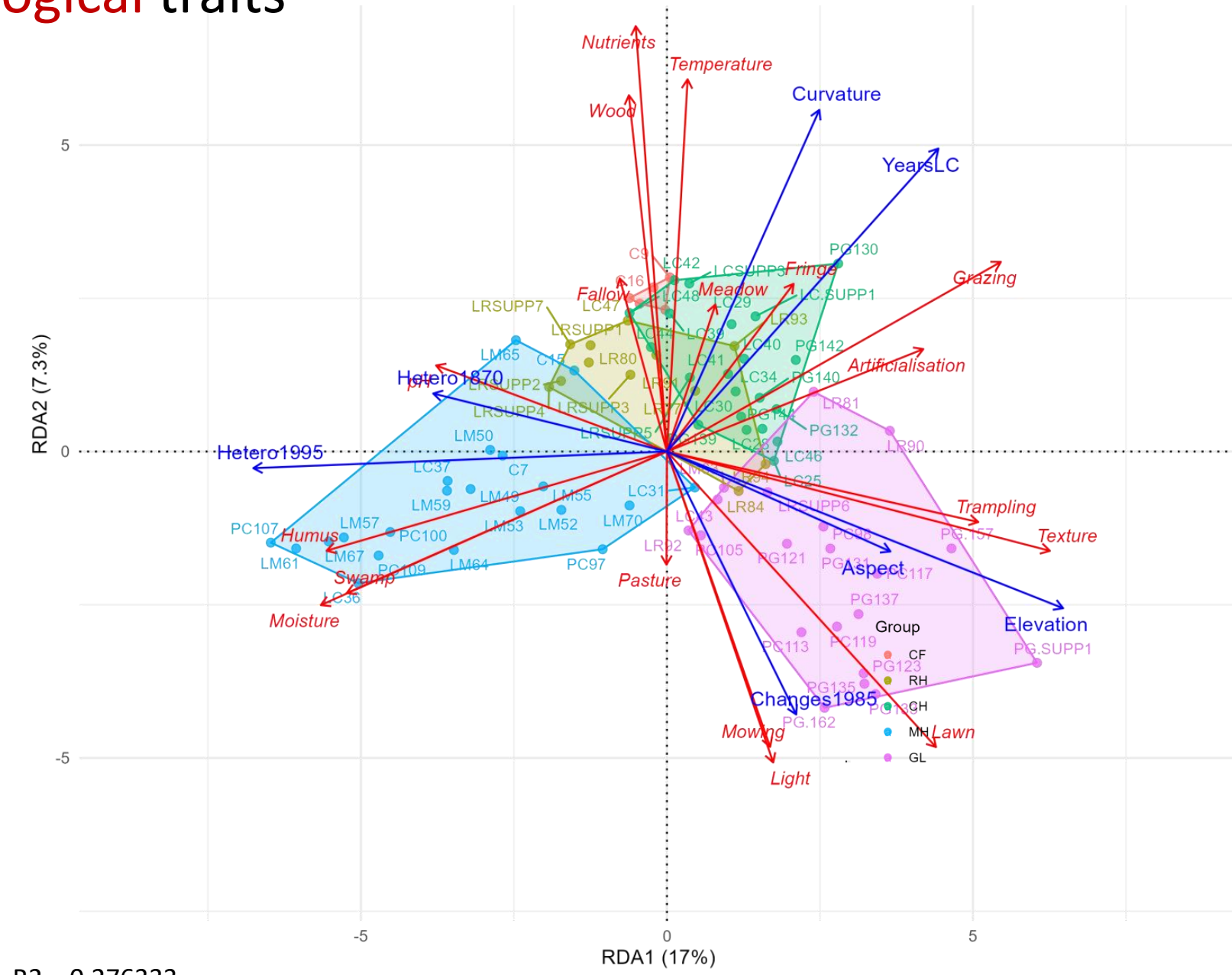
C. Plancher

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



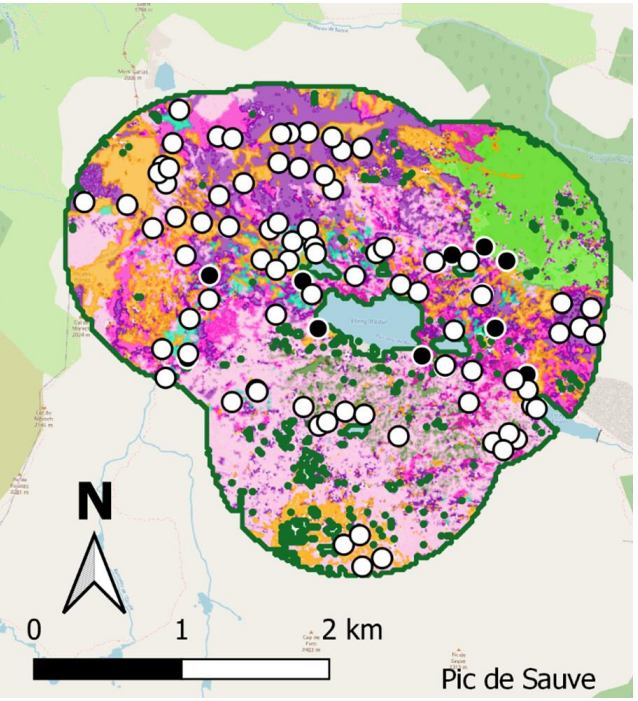
R2 = 0.276333
adjR2 = 0.2160274

François Gillet

CHRONO ENVIRONNEMENT

Selection of ES proxies relevant in mountains

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

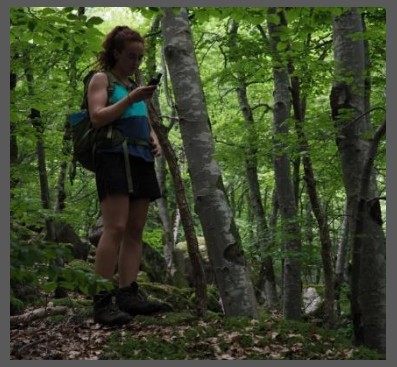


- Botanic points
- Edaphic points
- Bassiès sector

Land-cover Classes

- C (Conifers)
- BF (Broadleaved Forest)
- CH (Calluna Heathland)
- MH (Mixed Heathland)
- RH (Rhododendron Heathland)
- MF (Mixed Forest)
- P (Peatbogs)
- G (Grasslands)

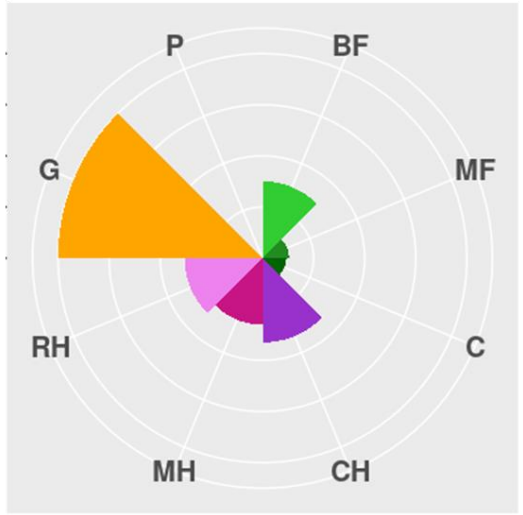
Production	Pastoral value	Total cover of plants with pastoral value (%)
	Plant picking	Abundance of picked plants (%)
Cultural	Patrimonial value	Abundance of patrimonial plants (%)
	Flowers Aesthetics	Total cover of forbs flowers (%)
	Butterflies Aesthetics	Abundance of butterflies (occurence)
Regulation (pollination)	Pollination	Abundance of entomogamous plants (%)
Regulation (Carbon Cycle)	Organic C fixation	Labile organic matter stabilizing factor
	Organic C stock	SOC* (kgC/m²)
	Inorganic C fixation	Capture CO^2 (g/m²/year)
Regulation (Water cycle)	Water retention	Useful Water Supply (mm)
	Water infiltration	Water flux (L/m²/year)
Regulation (Environnement quality)	Organic matter recycling	Biodegradation rate (g/day)
	Nutrient supply	Cation Exchange Capacity (cmol/kg)
	Biological activity	microbial biomass (µg/g)

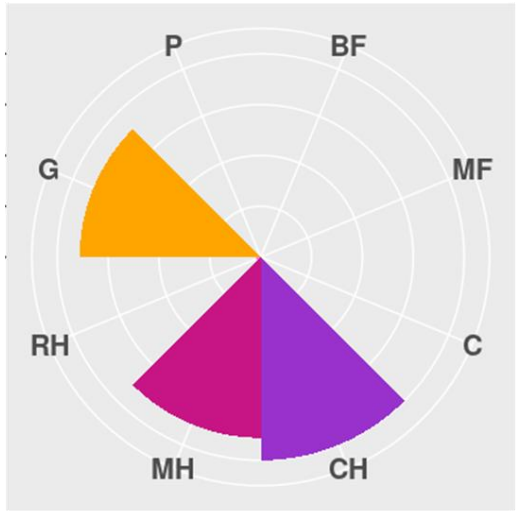



ES bundles are land-cover type dependant

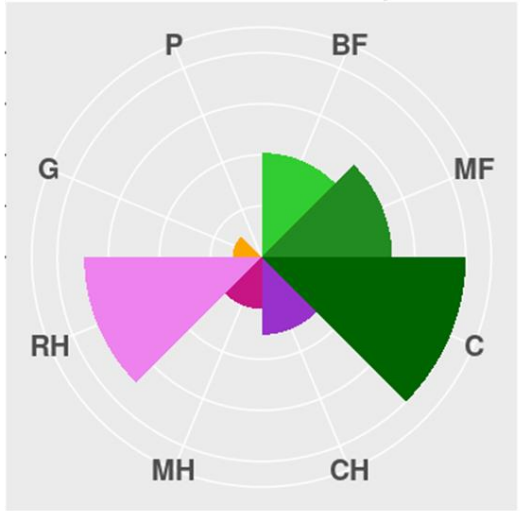
Pastoral value



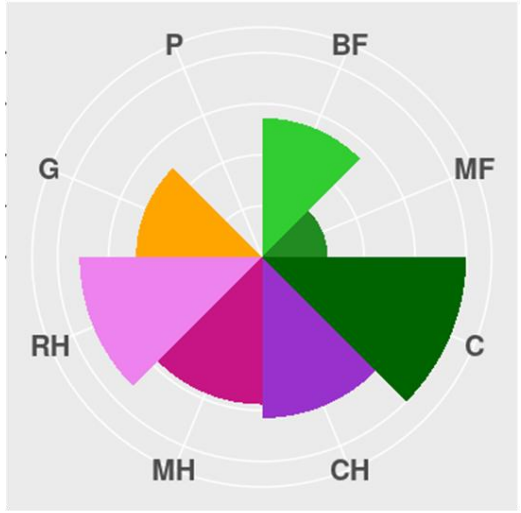
Patrimonial value



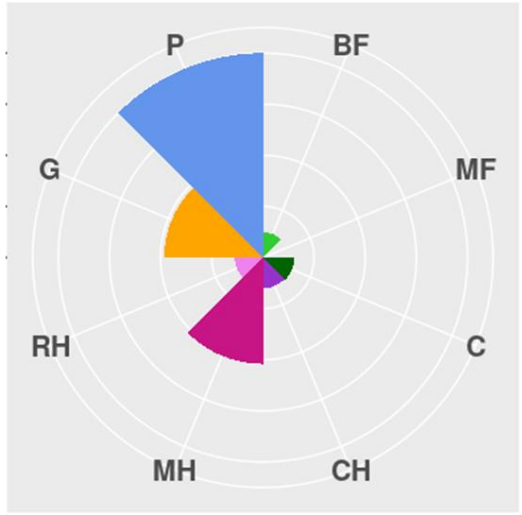
Plant-picking



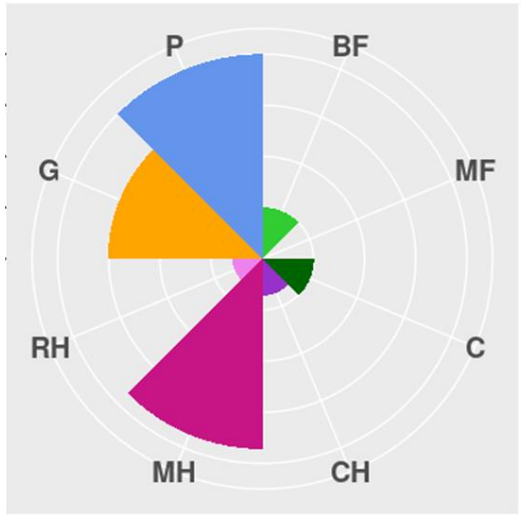
Flowers Aesthetic



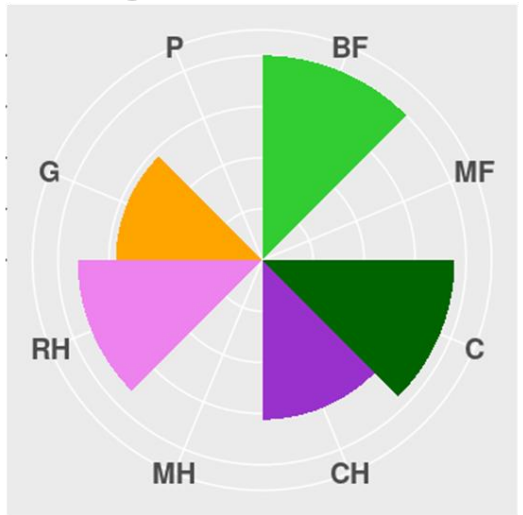
Inorganic C fixation



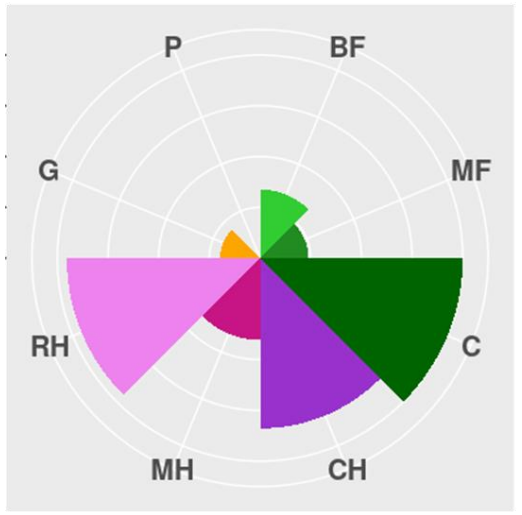
Water Infiltration



Organic C fixation

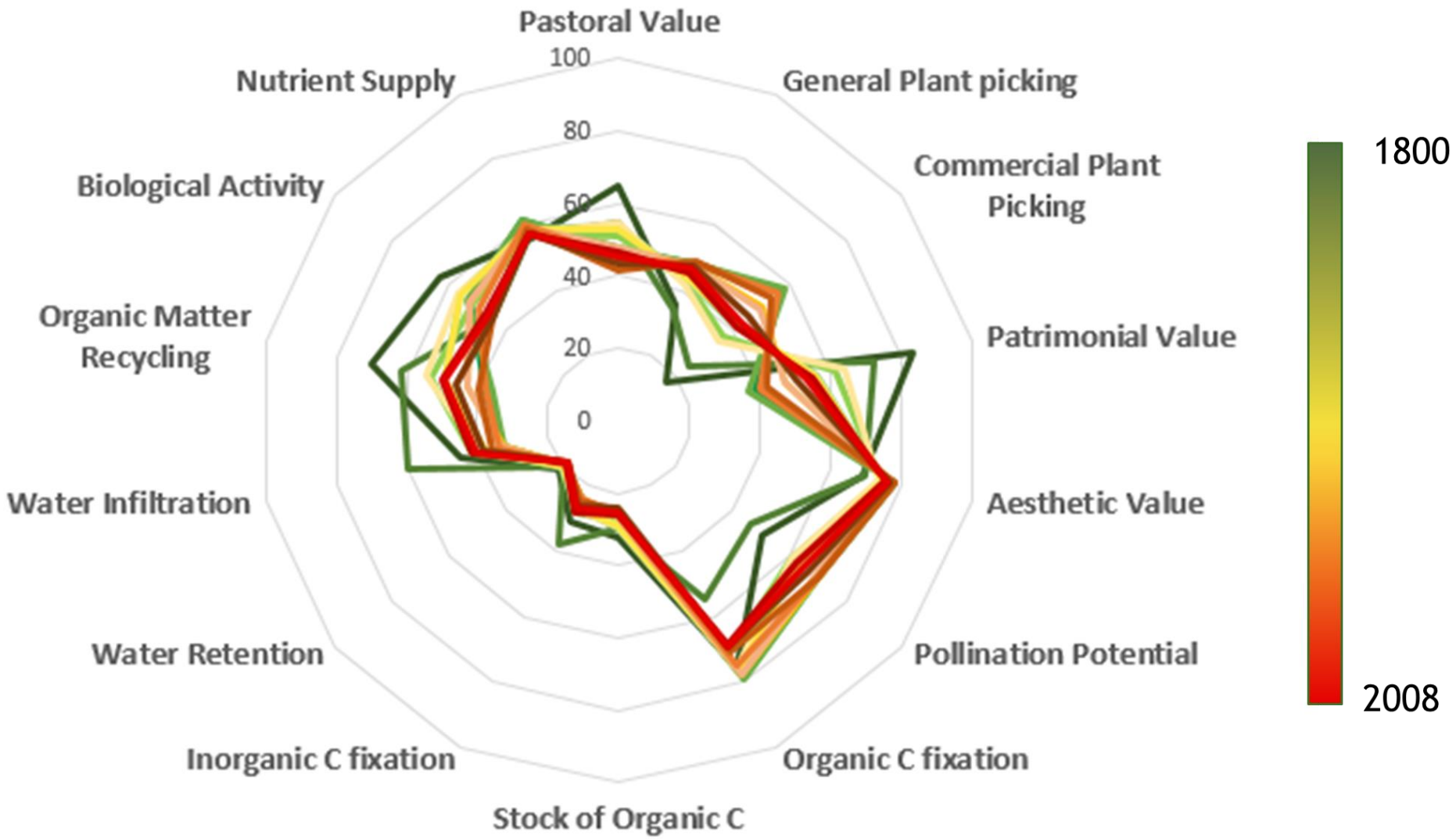


Pollination Potential



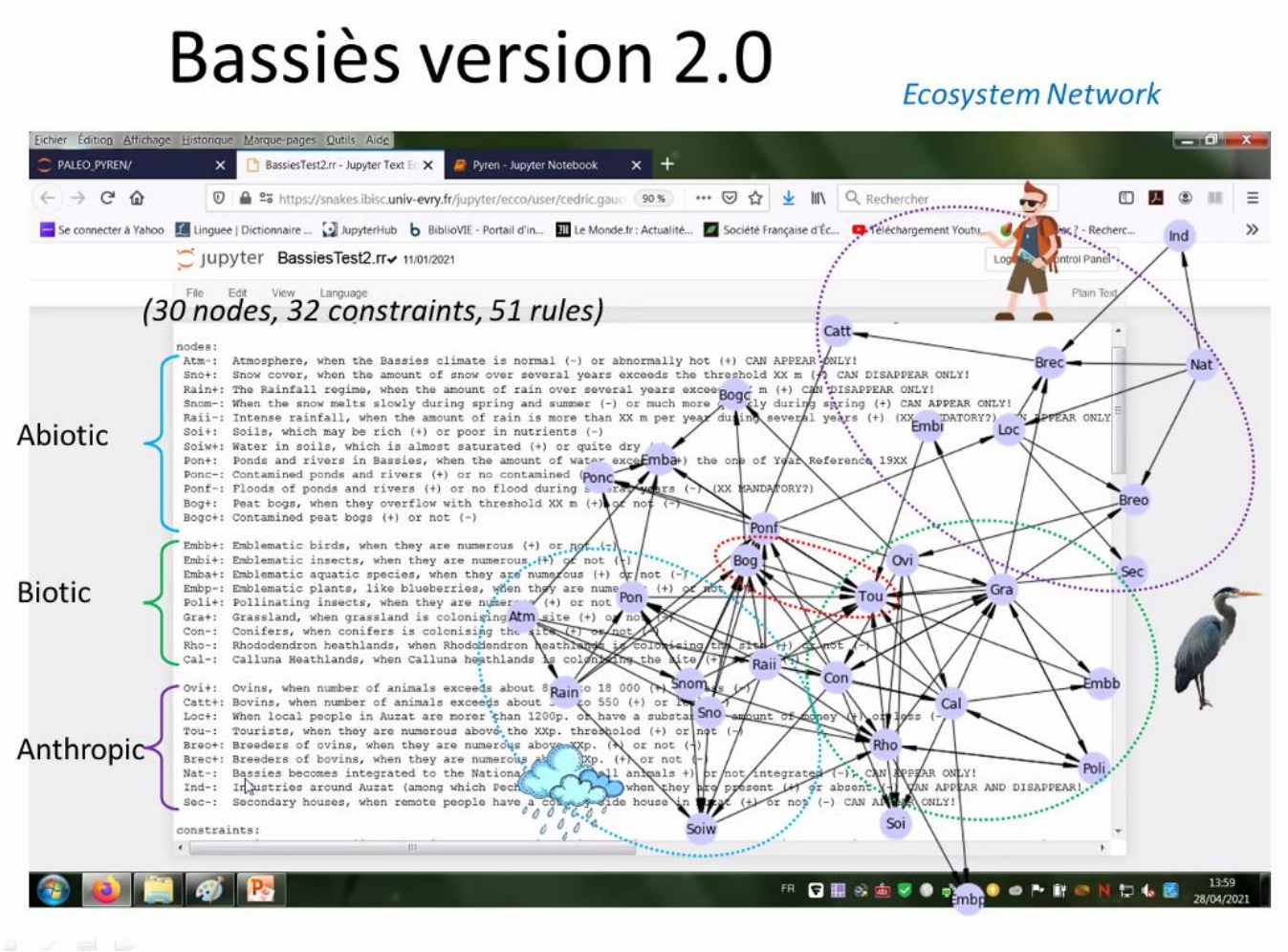
See POSTER OHM HV

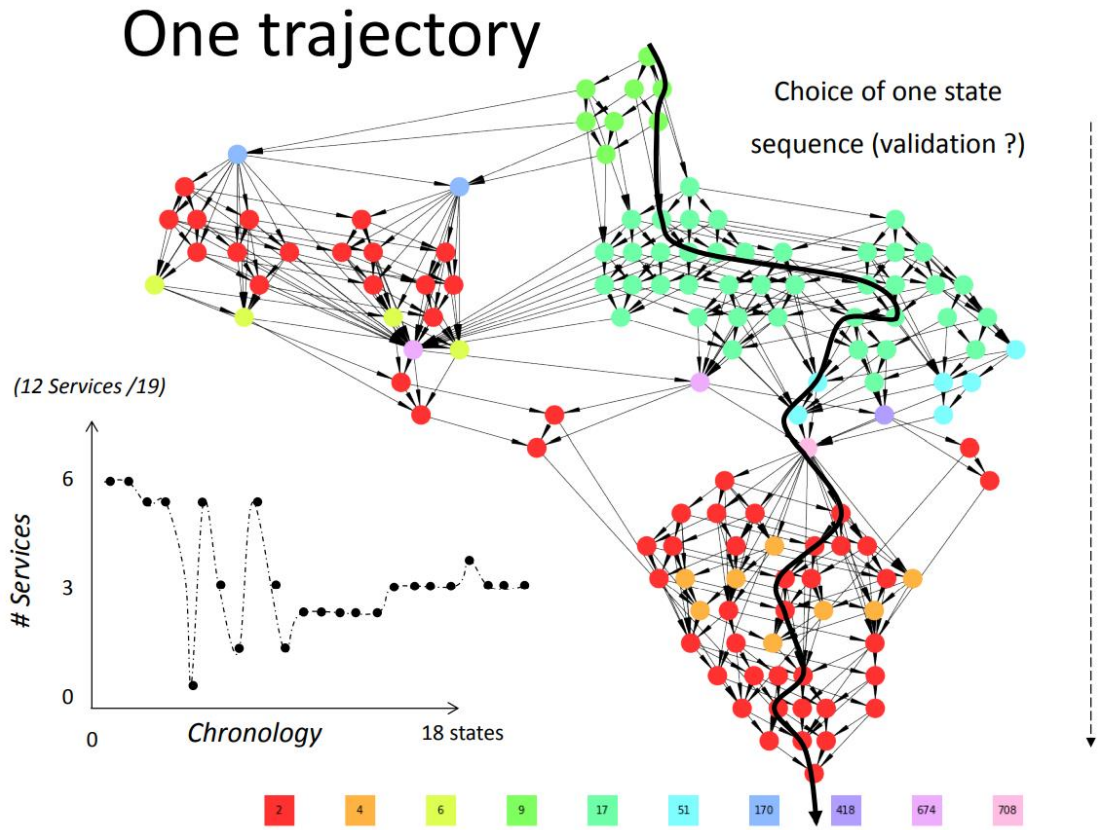
Temporal variability of ES production level



See POSTER OHM HV

Socio-ecosystem of Bassiès



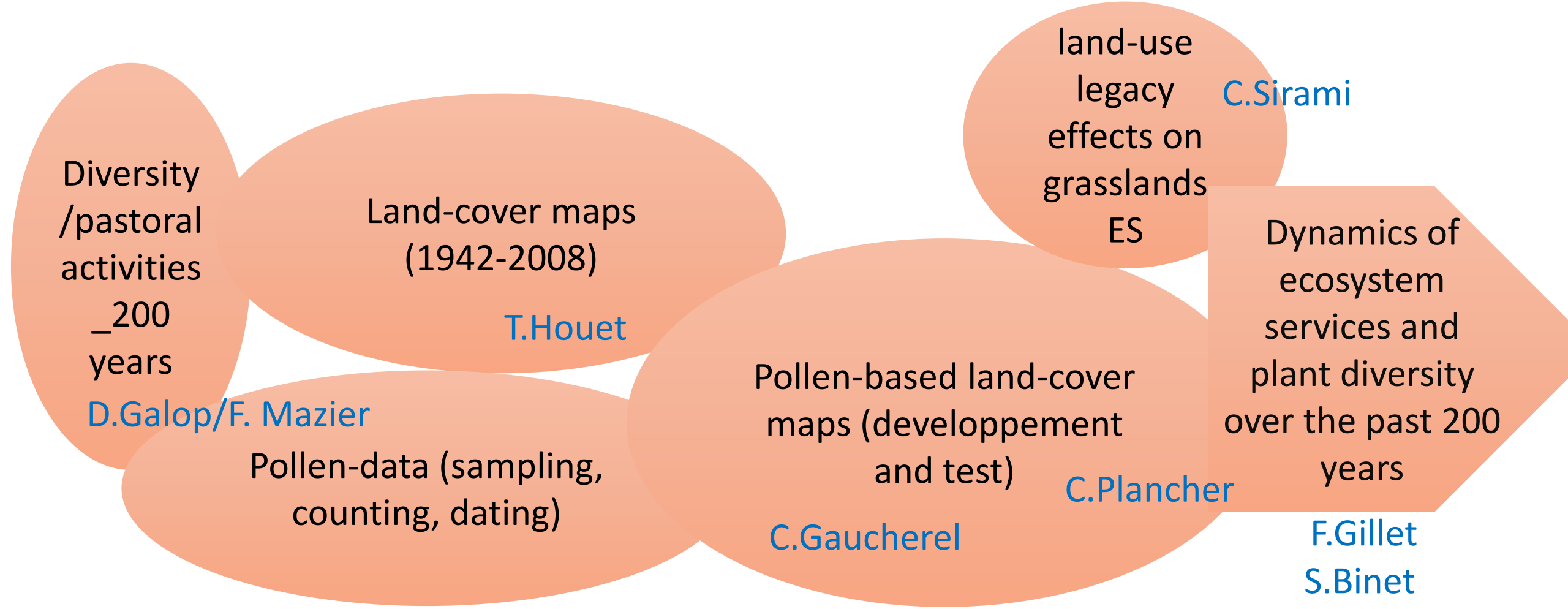


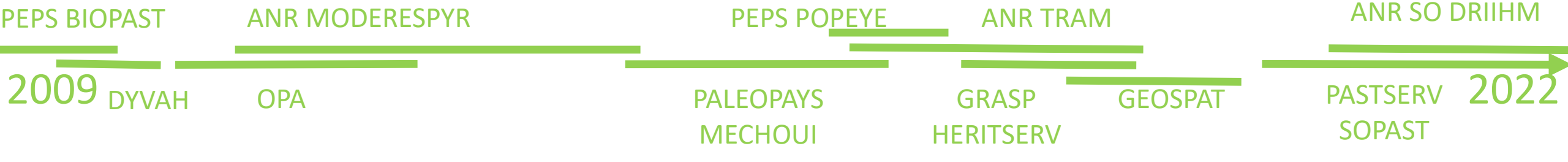
Gaucherel & Pommeau, 2019. Gaucherel et al. 2020

M2 2023, OHM HV SOPAST, Dir Cédric Gaucherel

AMAPlab

Construction of an interdisciplinary research_Role of OHM HV





Thanks for listening



Observatoire Homme Milieu Pyrénées HAUT-VICDESSOS

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

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CHRONO ENVIRONNEMENT

Institut des Sciences de la Terre d'Orléans ISTO