Environmental drivers of plant diversity of chalk grasslands in north-western France

SUR-PAS Project

(SURveillance de l'état de conservation des habitats agro-PAStoraux)

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https://geolab.uca.fr/geolab/actualites/projet-de-recherche-surpas--155637.kjsp?RH=1542017095519

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CONTEXT

Chalk (calcareous) short grasslands:

- In north-western France, such hillside habitats are called « larris »

Plateau

River

Acon valley (Somme), France

CONTEXT

- Ecosystems of high conservation interests:
  - *hotspots* of biodiversity (Willems *et al.* 1993; Karlík and Poschlod 2019)
  - terrestrial island habitats (Chabrerie 2002 ; Joly 2003)
  - unique and thermophilic ecosystems, hosting several species of interest (Chabrerie and Alard 2005)

Gentiana germanica

Gymnadenia conopsea

Polygala calcarea

Aceras anthropophorum

CONTEXT

- Ecosystems of high conservation interests:

- Very old ecosystems, resulting from ancient anthropic deforestation and maintained open by centuries of agro-pastoralism (Bush 1993, Poschlod & WallisDeVries 2002)

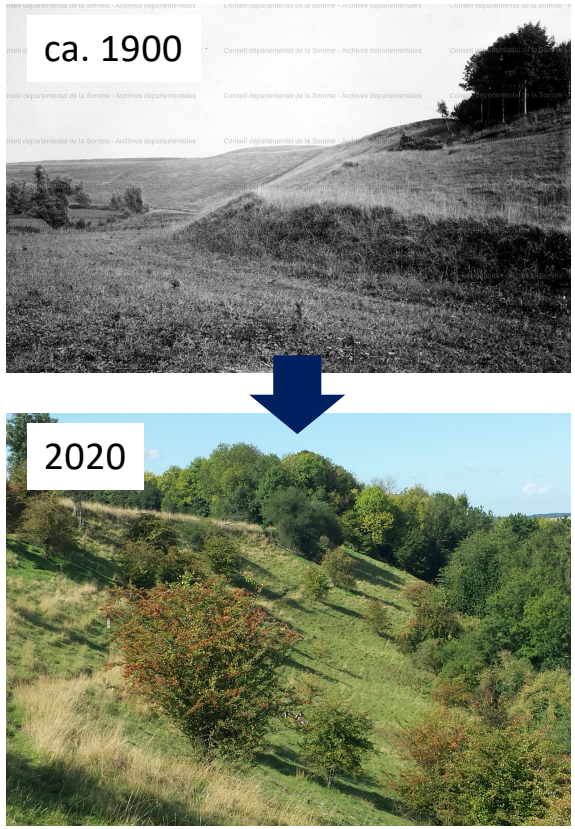
Sheep grazing in Acon valley (Somme), France

CONTEXT

- Vulnerable habitats: fragmented, in small (few hectares), narrow, serpentiform patches

- Threatened by:
  - agricultural abandonment (van Dijk *et al.* 1991; Dutoit 1996 ; Poschlod and WallisDeVries 2002)
  - nitrogen inputs from atmospheric deposition and fertilization from adjacent field crops (Gaujour *et al.* 2012)

=> Shift in species composition and loss of species richness
(Diekmann *et al.* 2014 ; Ridding *et al.* 2020)



Acon valley (Somme), France

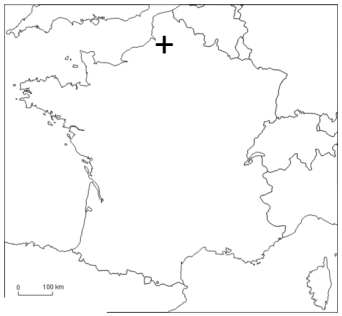
AIMS OF THE STUDY

Identify :

- ✓ the main factors driving plant composition and richness
- ✓ the relative importance of these later factors depending on the spatial scale of observation
- ✓ the factors and the conditions threatening but also promoting the conservation of the chalk grassland habitats

METHODS

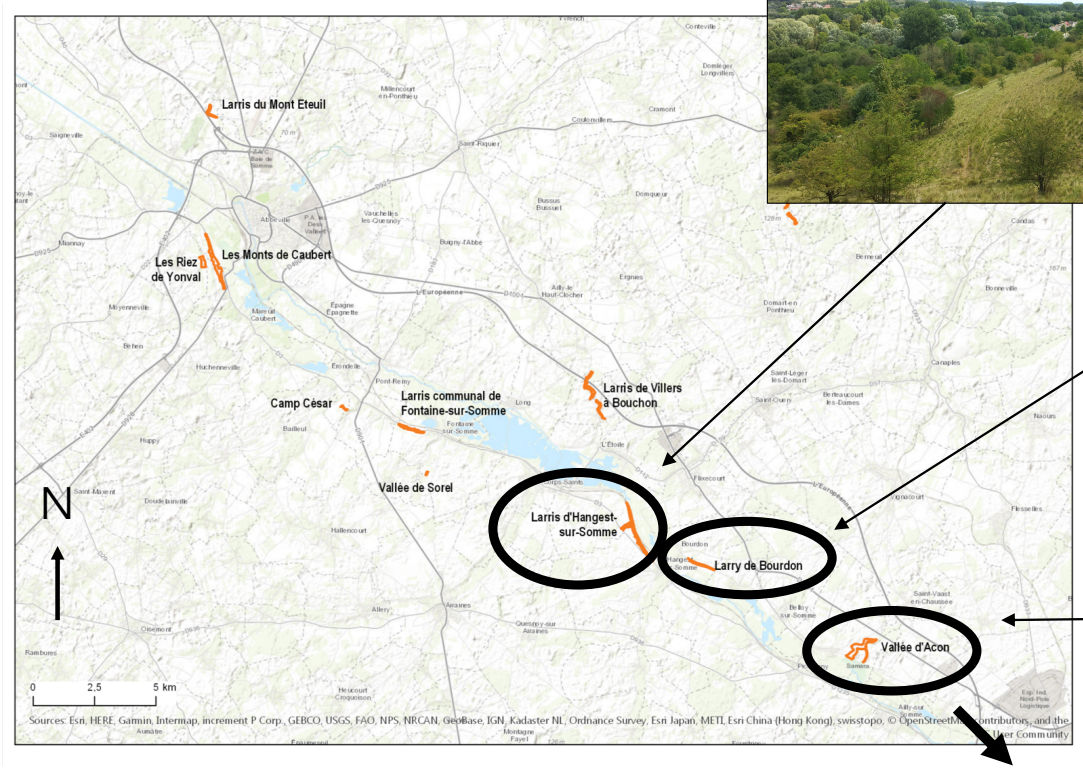
4 sites, protected by the European Council Directive 92/43/EEC on the conservation of natural habitats and managed by “Conservatoire des Espaces Naturels Hauts-de-France”



Hangest-sur-Somme (exposure East)

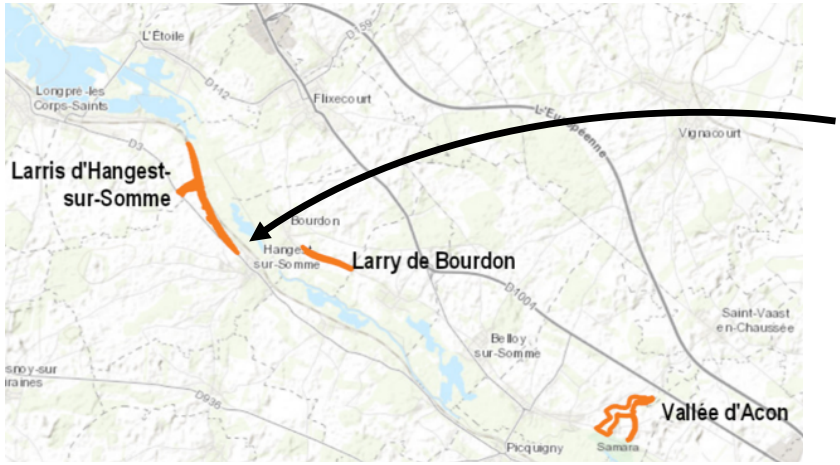
Bourdon (exposure South)

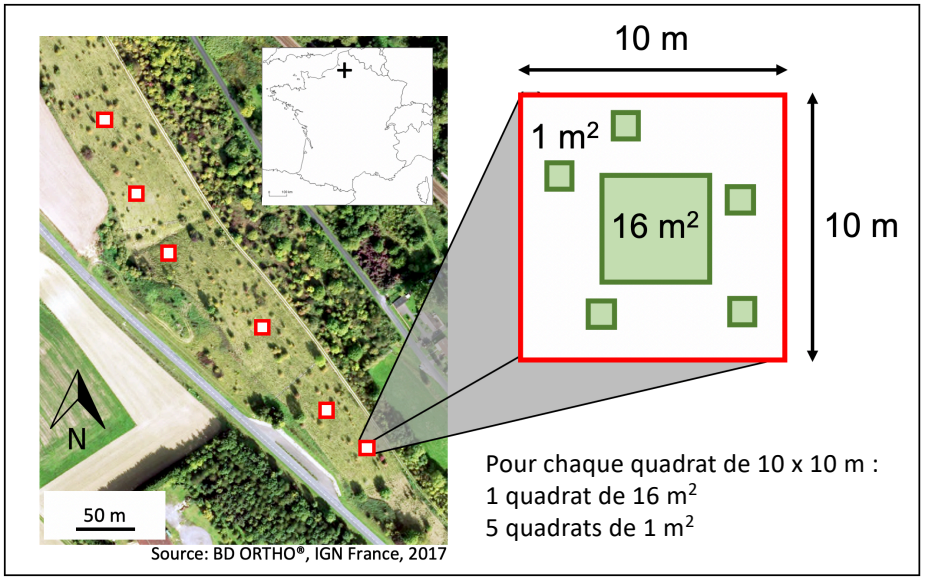
2x Acon valley (exposure North and West)



to Amiens

METHODS





Field measurements:

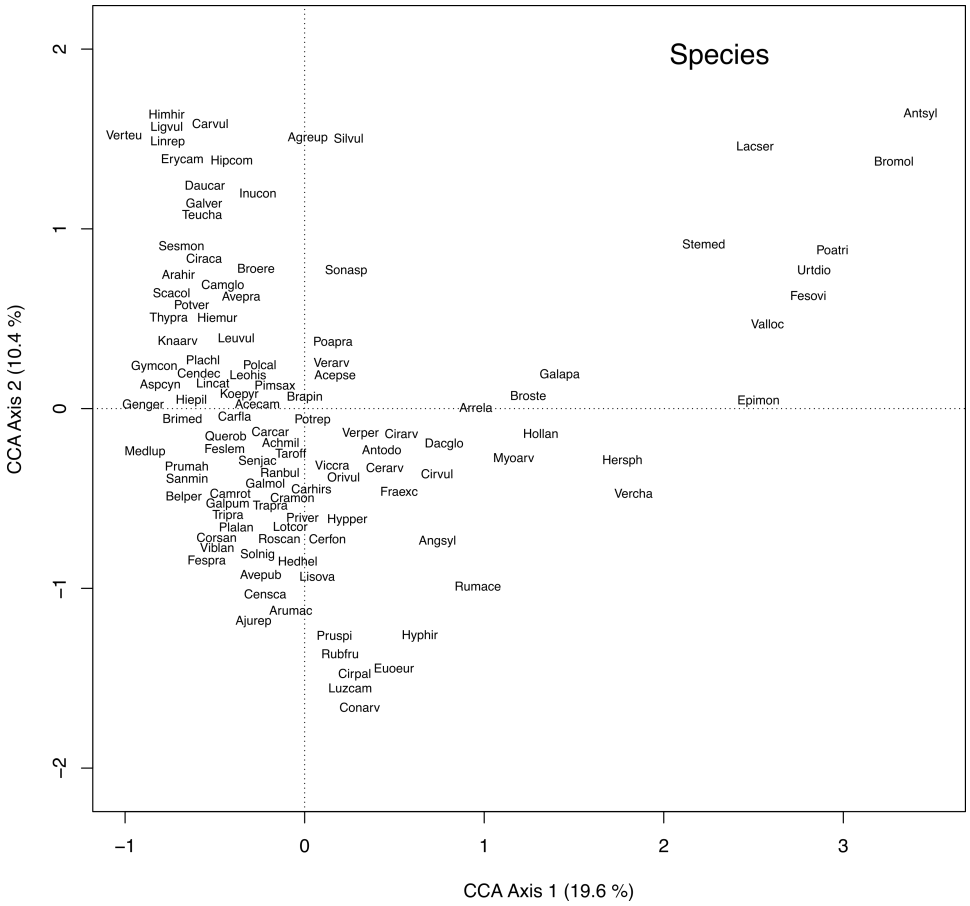
- Species composition (botanical surveys), sp. richness and community structure
- Fodder quality and litter traits (N and lignin contents)
- Environmental variables (topography, soil...)

Statistical analyses:

- Canonical Correspondence Analysis (CCA)
- Linear mixed (LME) model regression of env. variables as a function of the sp. richness

1. Environmental and anthropic factors related to community composition

Plant community structure



RESULTS

1. Environmental and anthropic factors related to community composition

Thermophilic short-grasslands

Short-grasslands of high conservation interest

Mesophilic grasslands with ligneous species colonization

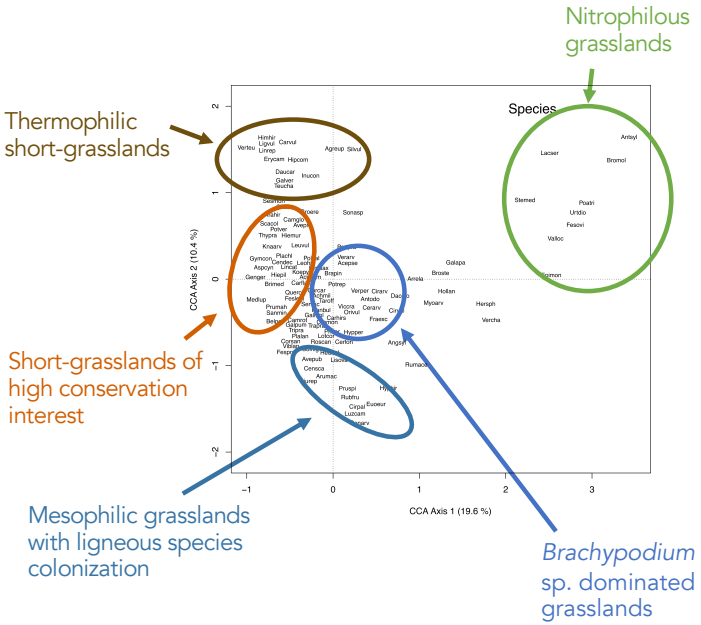
Nitrophilous grasslands

Brachypodium sp. dominated grasslands

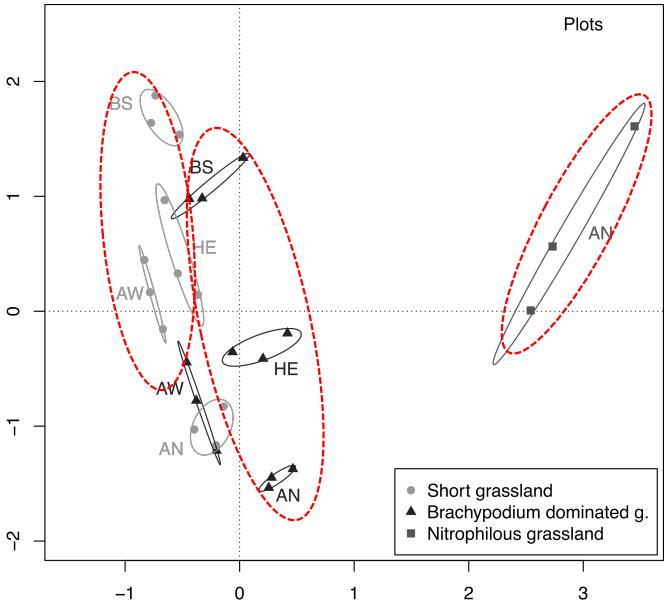
RESULTS

1. Environmental and anthropic factors related to community composition

Plant composition



Sites and vegetation types



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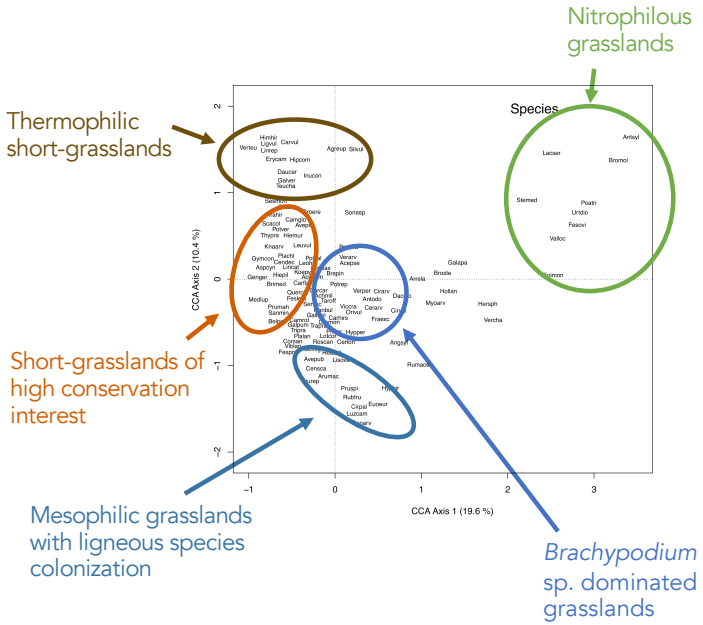

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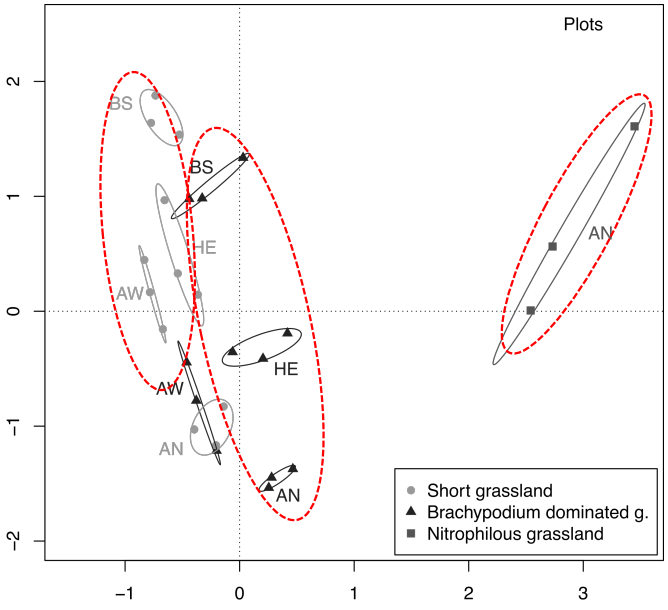
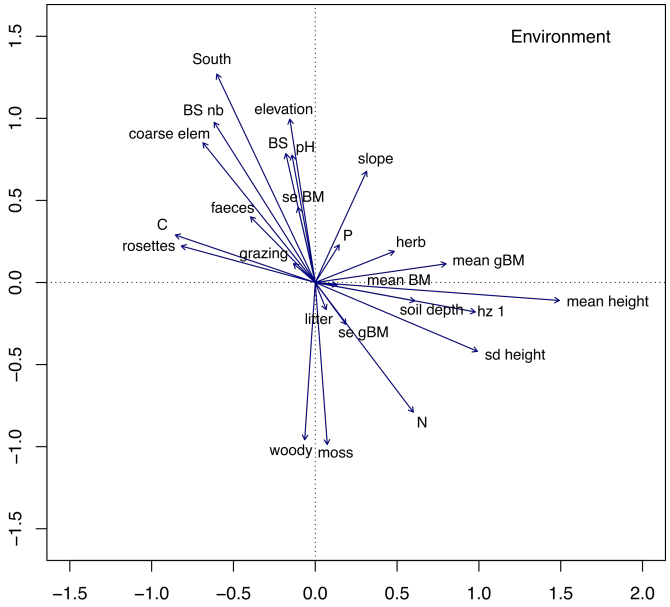


Environmental variables



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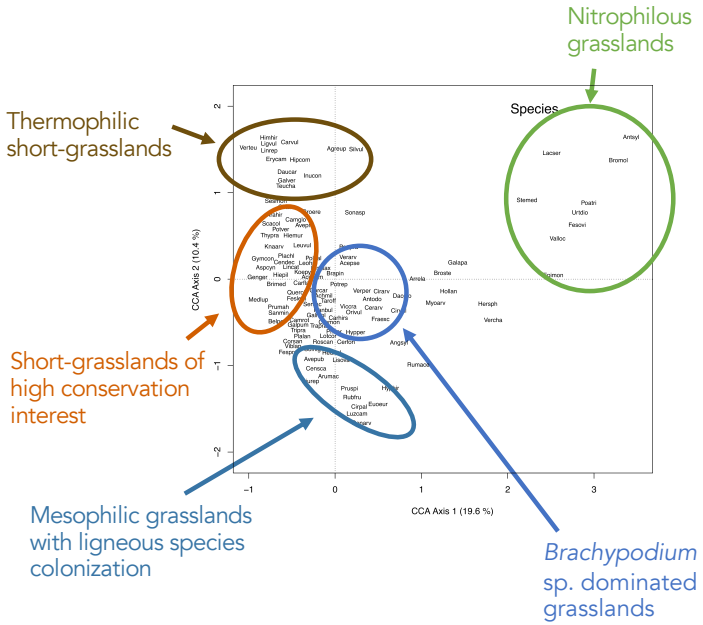

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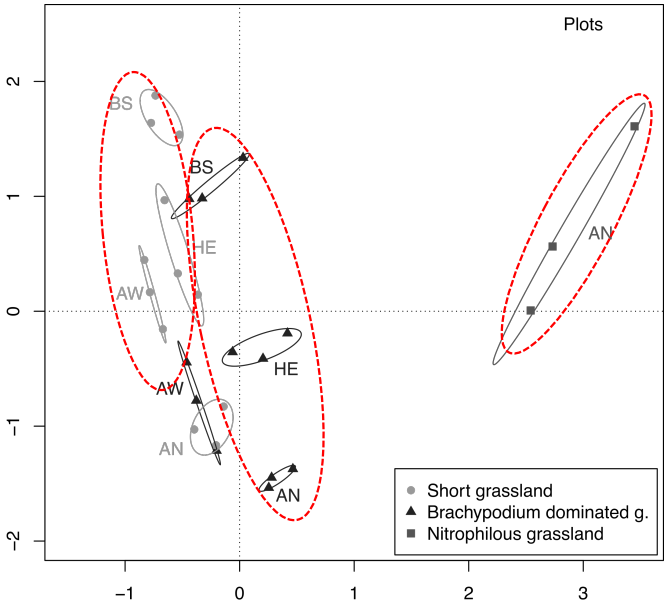

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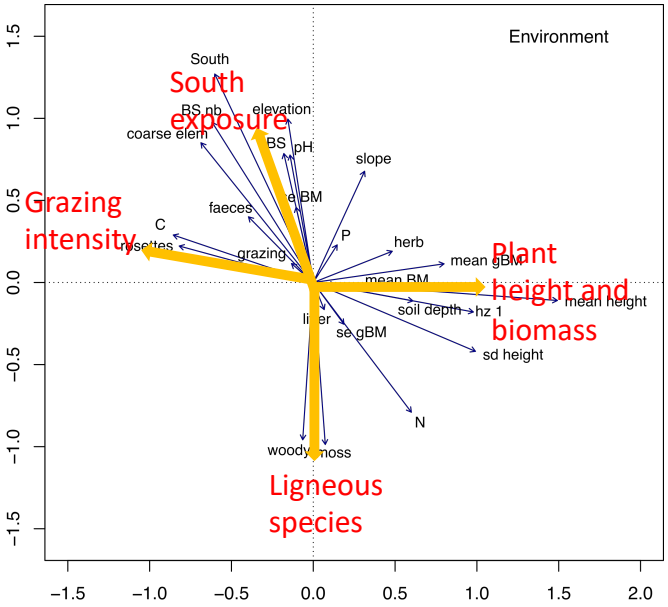
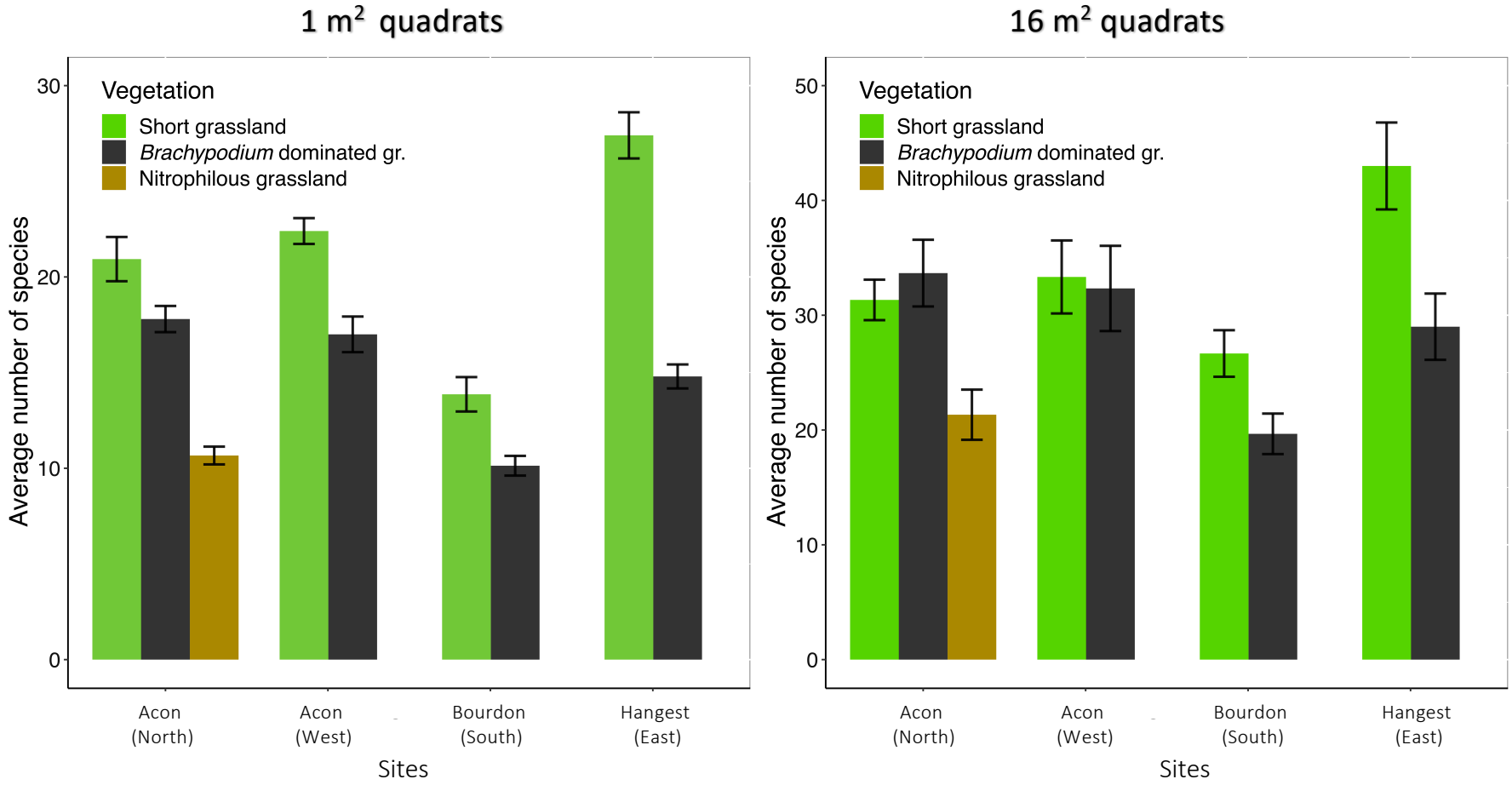


2. Species richness



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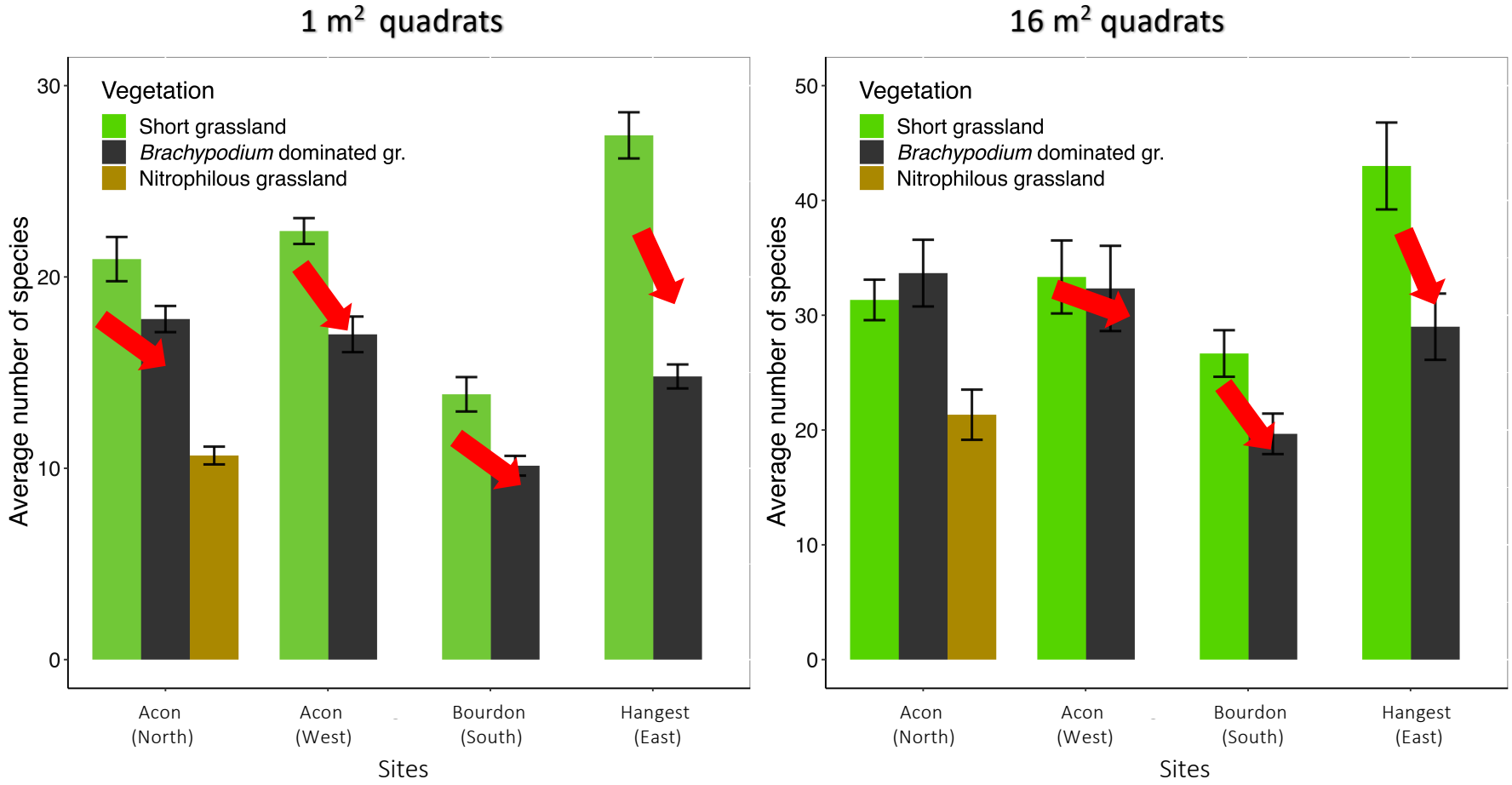

3. Relationships between environmental variables and species richness

Linear mixed model regression of environmental parameters as a function of the species richness

parameter	estimate	s.e.	d.f.	t-value	p-value	
(A) 1 m^2 quadrats *(AIC = 709.749, AICc = 709.843, BIC = 715.484)*						
Intercept	-8.312	4.499	27.8	-1.848	0.075	.
South exposure	-0.049	0.010	23.9	-4.794	< 0.001	***
Soil C content	0.221	0.034	26.3	6.427	< 0.001	***
Grazing intensity	20.759	3.579	23.4	5.801	< 0.001	***
Litter thickness	-1.372	0.407	117.1	-3.374	0.001	**
(B) 16 m^2 quadrats *(AIC = 178.146, AICc = 178.746, BIC = 180.417)*						
Intercept	40.674	6.302	23	6.454	< 0.001	***
South exposure	-0.060	0.019	23	-3.123	0.005	**
Rosettes abundance	0.169	0.039	23	4.346	< 0.001	***
Moss abundance	-0.141	0.067	23	-2.096	0.047	*

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CONCLUSION

Highly contrasted chalk grassland communities, spread along two main gradients:

- **1st gradient :**

Short grasslands ⟷ *Brachypodium* sp. dominated g. ⟷ Nitrophilous grassland

Grazing

N inputs

Gradient related to agricultural practices:

- Locally intensive grazing reduces competition by dominating grasses such as *Brachypodium pinnatum* and allows the presence of a large number of dicotyledon rosette species
⇒ high richness of rare species

- The presence of nitrophilous grasslands can be explained by the proximity of intensive openfield crops and nitrogen leaching from fertilization

CONCLUSION

- **2nd gradient :**

Grasslands colonized by shrub saplings ⟷ Thermophilic short-grasslands, on the top of chalky slopes and facing south

Gradient related to topographic and site factors

- **Main factors related to species richness:**

- South exposure (at both 1 m^2 and 16 m^2 scales)

- at 1 m^2 scale: soil carbon content, grazing intensity, litter thickness

- at 16 m^2 scale: moss and rosette species abundance

To be continued...

French national project SURPAS: monitoring and evaluation of agro-pastoral systems

From multiple local sites to a global scale :

- Selection of indicators to assess and monitor the conservation status of habitats
- Define a frame of reference for conservation status
- Existence of a trade-off between environmental quality and fodder quality/quantity? Using which indicators? Does this trade-off change along the soil and climate gradients?

AKNOWLEDGEMENTS

Thank you

EDYSAN team:
Alexandre Fruleux
Emilie Gallet-Moron
Fabien Spicher
Jeanne Piednoël
Justine Pavis
Mathilde Peiffer
Nicolas Lamotte
Pierre Jesupret
Yvelise Fourdrain

Conservatoire des Espaces Naturels Hauts-de-France (http://cen-hautsdefrance.org), especially:
Guillaume Meire
Gratien Testud
Clémentine Coûteaux