Flooding: a key factor driving terrestrial arthropod assemblages

The exemple of the Loire Valley (France)

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Introduction

Arthropods and flooding in major rivers

- Particularly well studied in the Amazon (Adis, Junk and col. 1989). **Flood pulse concept**
- Many studies worldwide (Europe: River Oder, Elbe; Meuse; Australia: Barmah Forest; …)

In large tropical rivers (regular, long floods):

- specific physiological and phenological adaptations;
- but most of them use r-strategy (high reproduction and dispersion capacity, re-immigration after flooding).

In large European rivers (stochastic, short floods):

- no specific adaptations;
- r-strategy.

But:

Most studies:

- assessed indirectly and in long term flooding impact;
- don't estimate its relative importance.

So we used predator arthropods (spiders and carabid beetles) to:

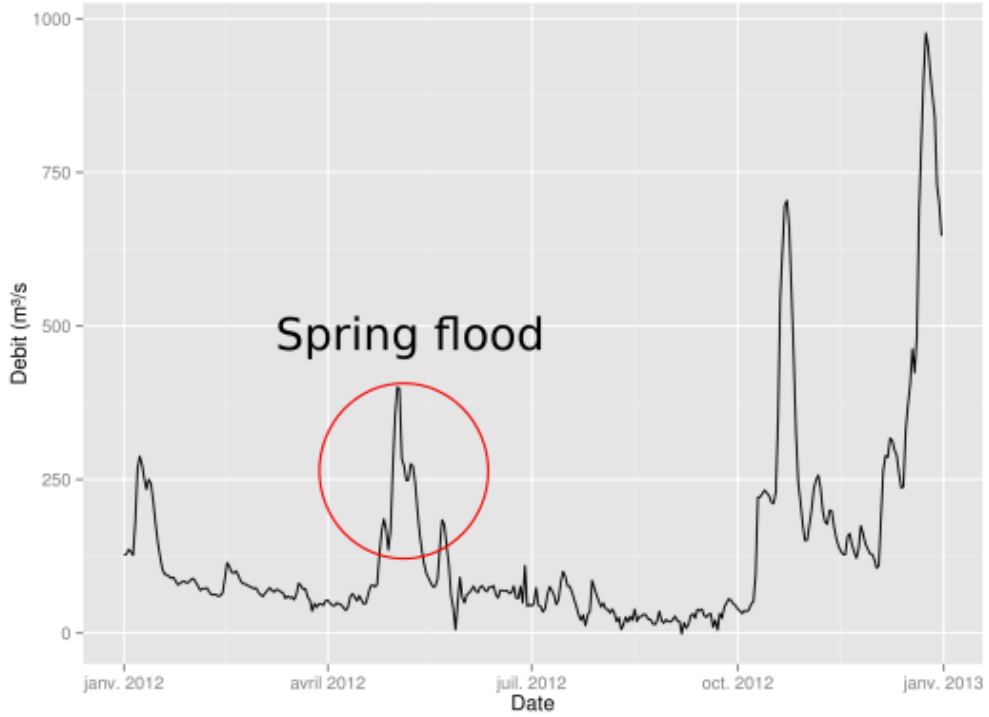
- assess short term resilience of grasslands arthropods
  → Lafage et al.2015| Ecohydrology
- assess importance of flooding regarding management and classical variables
  → Lafage & Petillon 2016|Basic and Applied Ecology
  → Lafage & Petillon 2015|Ecological research

Short-term recolonisation

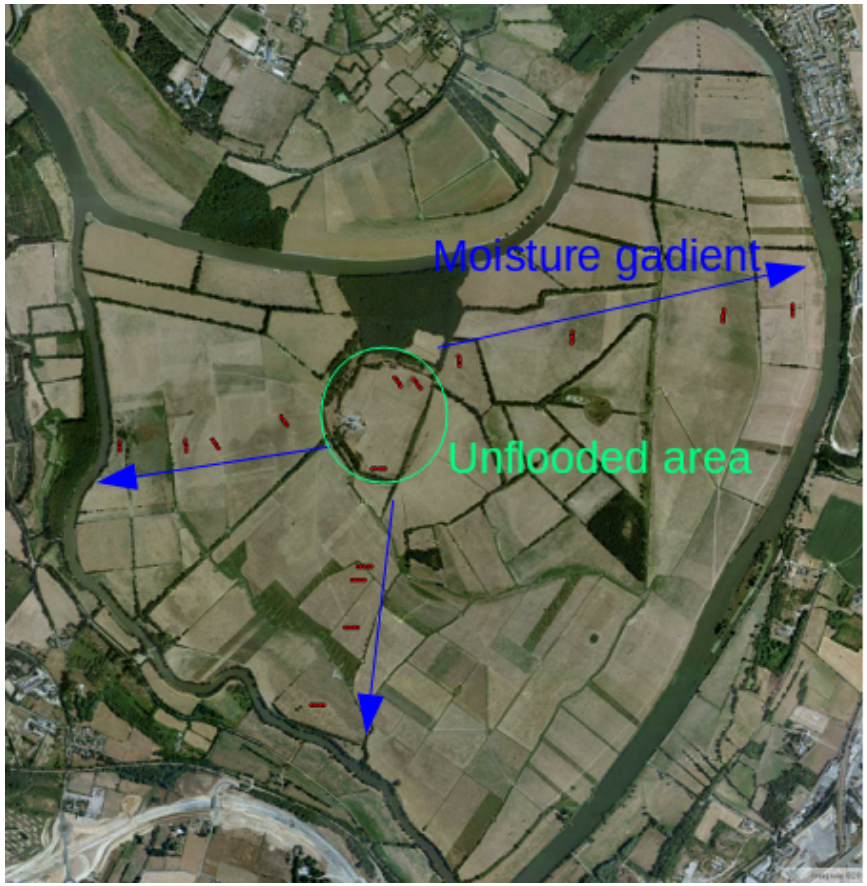
Site

- Study site:
  - ouest of France;
  - Loire Valley;
  - 700 ha island;
  - extensively managed natural grasslands
- Almost completely flooded in spring 2012

Flooding…


1000
750
500
250
0
Debit (m³/s
Spring flood
janv. 2012
avril 2012
juil. 2012
oct. 2012
janv. 2013
Date

Methods

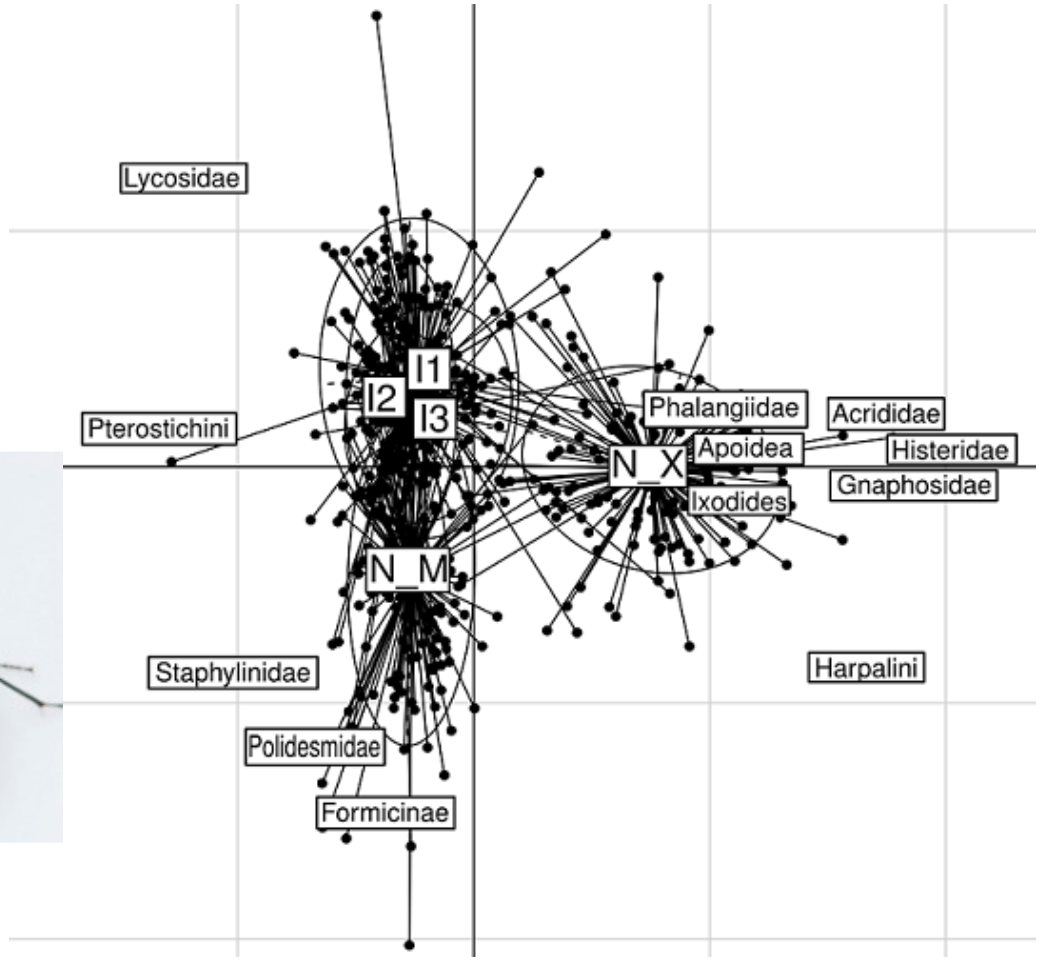


Sampling design

- Plots:
  - 6 unflooded grasslands (refuges?);
  - 9 flooded grasslands.
- Arthropod sampling:
  - 5 pitfall traps per plot, emptied every 3 days;
  - sampling started as soon as water receded and until cutting took place.

Resilience of families

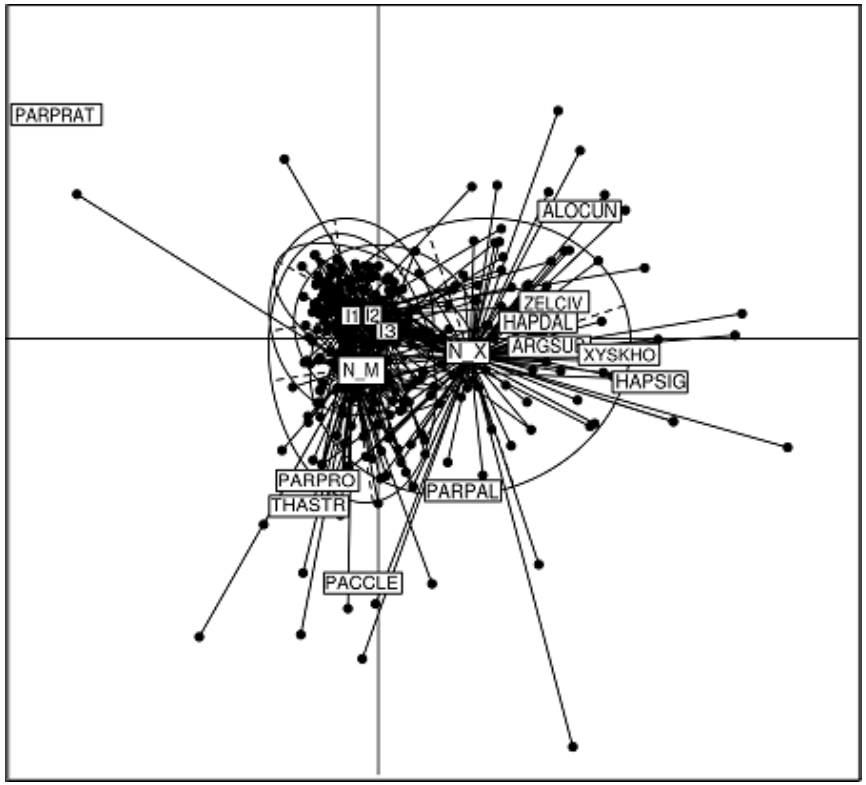
- CDA + ANOSIM:
  - ≠ assemblages;
  - Lycosidae and Pterostichini first colonisers;
  - ants absent from flooded sites!



CDA on arthropods

Resilience of spiders

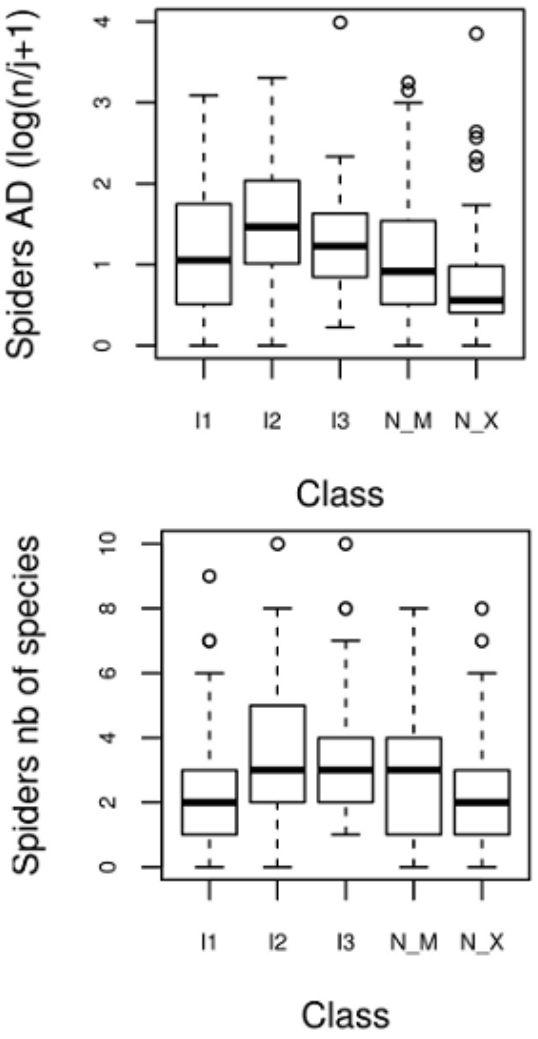
- CDA + ANOSIM:
  - ground dwelling species = first colonisers;
  - *P. prativaga* very quick coloniser;
  - assemblages back to normal after 20 days;
  - xerophylous sites not used as refuge.



CDA on spiders

Resilience of spiders

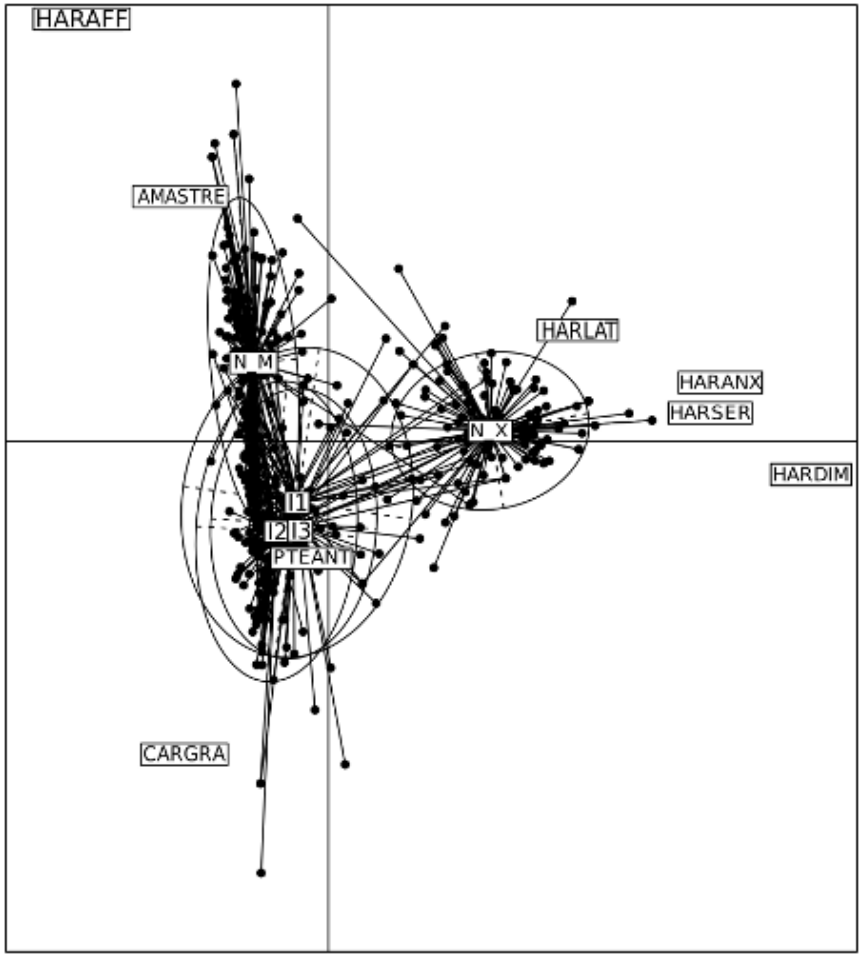
- Activity-density > than in unflooded grasslands:
  - fast re-immigration;
  - probably from hedgerows.
- Species richness back to normal after 20 days



CDA on spiders

Resilience of carabids

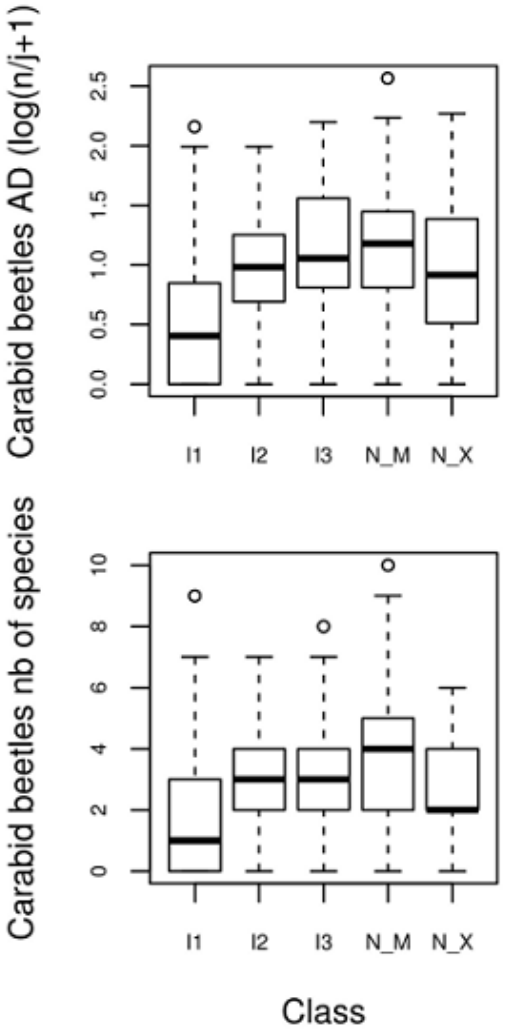
- CDA + ANOSIM:
  - species composition **not** normal after 30 days;
  - xerophylous sites not used as refuge.



CDA on carabids

Resilience of carabids

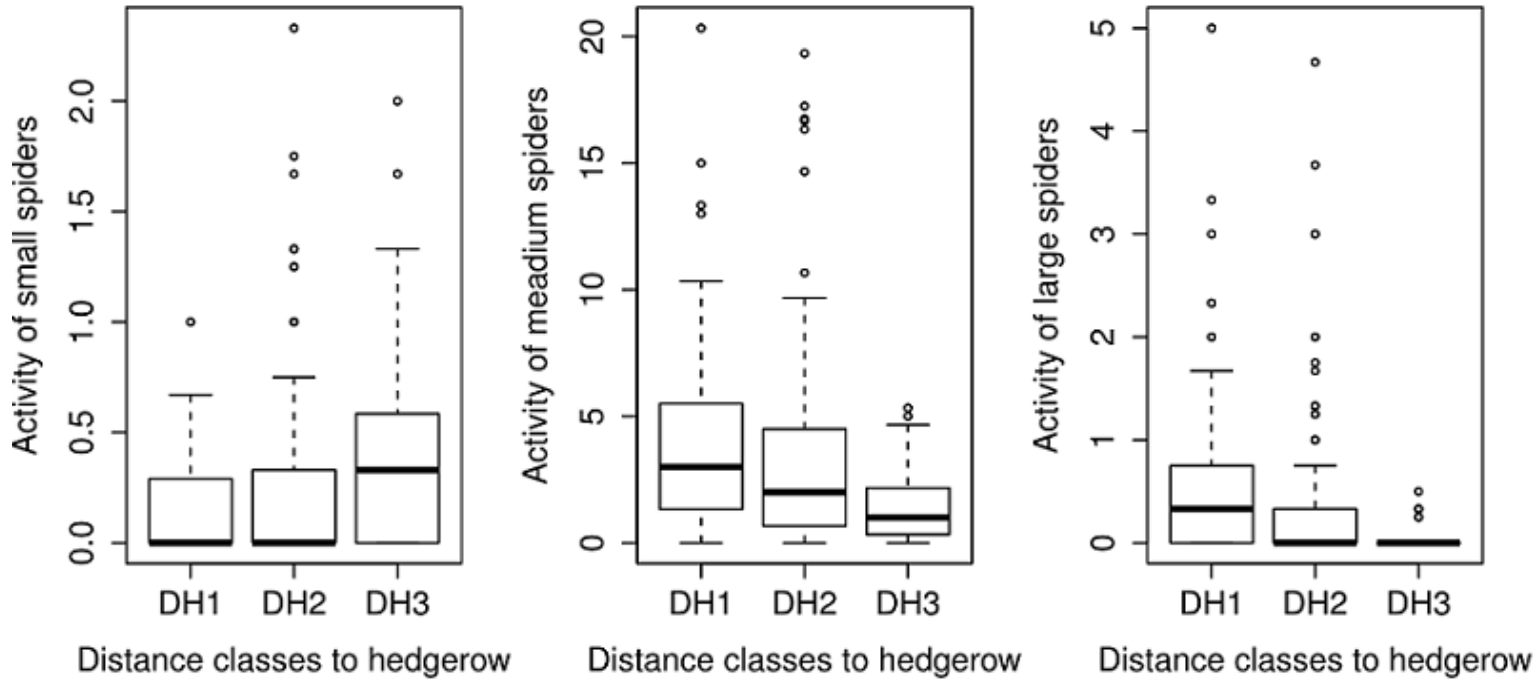
- Activity-density almost normal after 30 days
- Species richness stays inferior



CDA on spiders

Landscape role

- Test impact of distances to nearest: hedgerow, woodland, unflooded site, refuge
- On body lengh and dispersion traits
- Importance of hedgerows and woodlands: larger spiders and carabids near



Partial conclusions

- Among arthropods resilience varied greatly
- Groups supposed less mobile (wingless) can be first colonisers and recover first
- Non suitable habitats not used as refuge
- Hedgerows probably used as refuge

Research questions

- Why spiders colonize so fast?
  - competitor free habitat?
  - aquatic organisms consumption?
- Why such a difference with carabids?
- Hedgerows seem important in open habitats. What is the impact of clear cuts in forest?

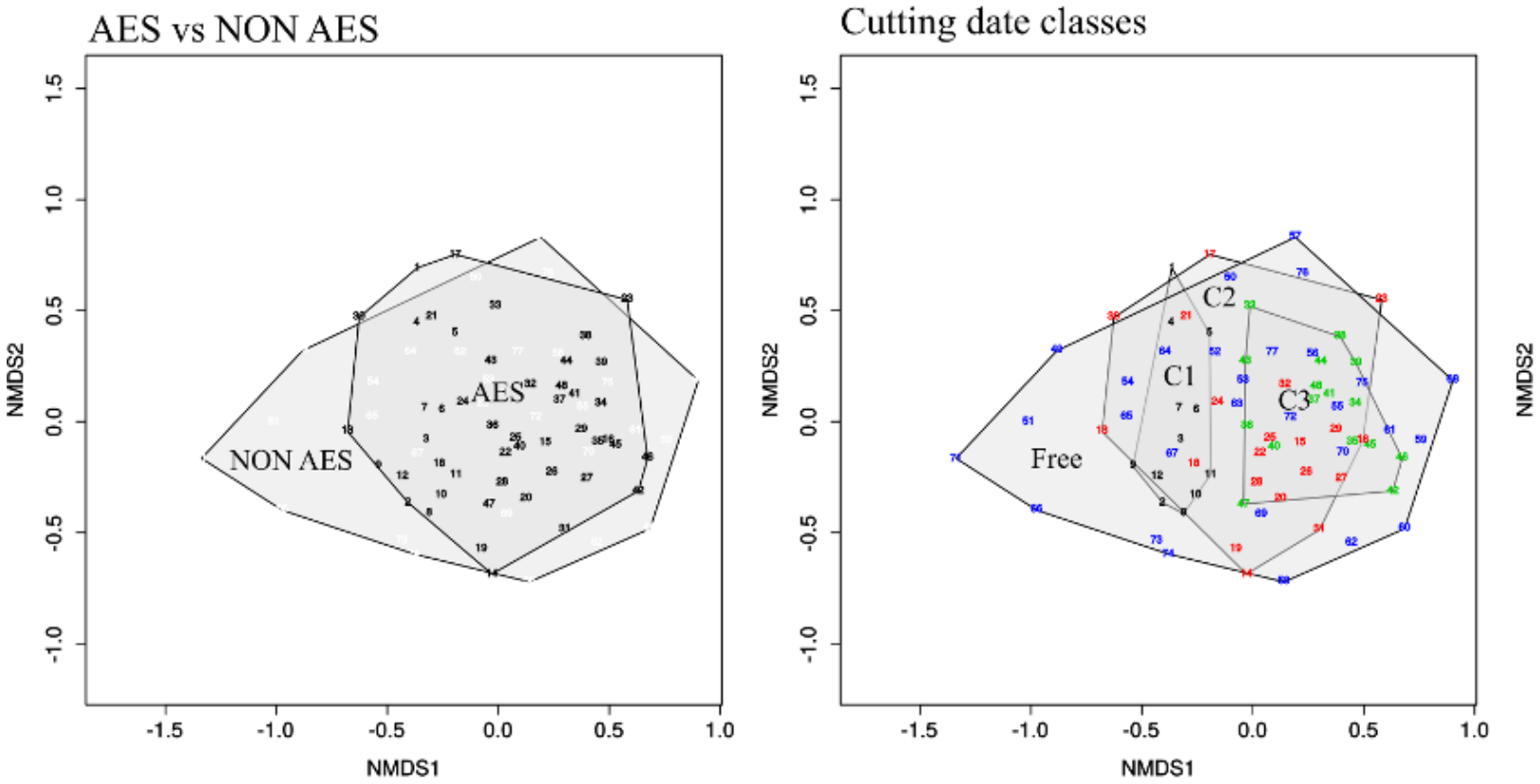
Flooding vs management

Sampling sites

- 82 paired hay meadows under/not under Agri-envrionmental scheme
  - variations in cutting dates and fertilisation
  - variations in wetness (due to flooding and underwater level)

Assemblages vs management prescriptions

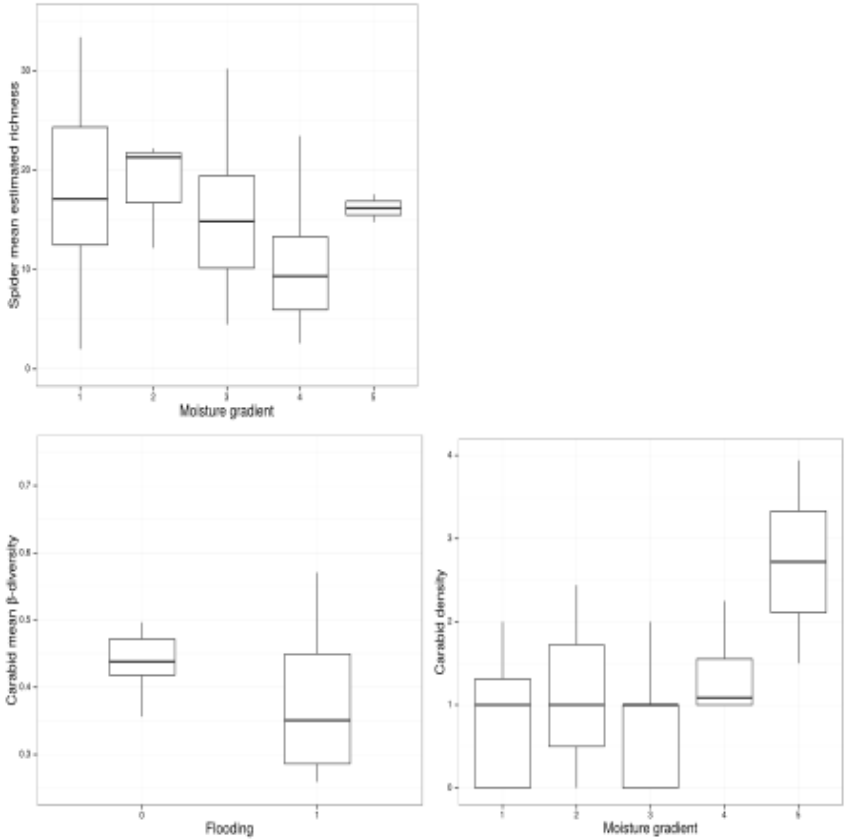
- No difference in species composition or density
- No difference in species diversity except a **positive impact of fertilisation** on spiders!



NMDS on spiders

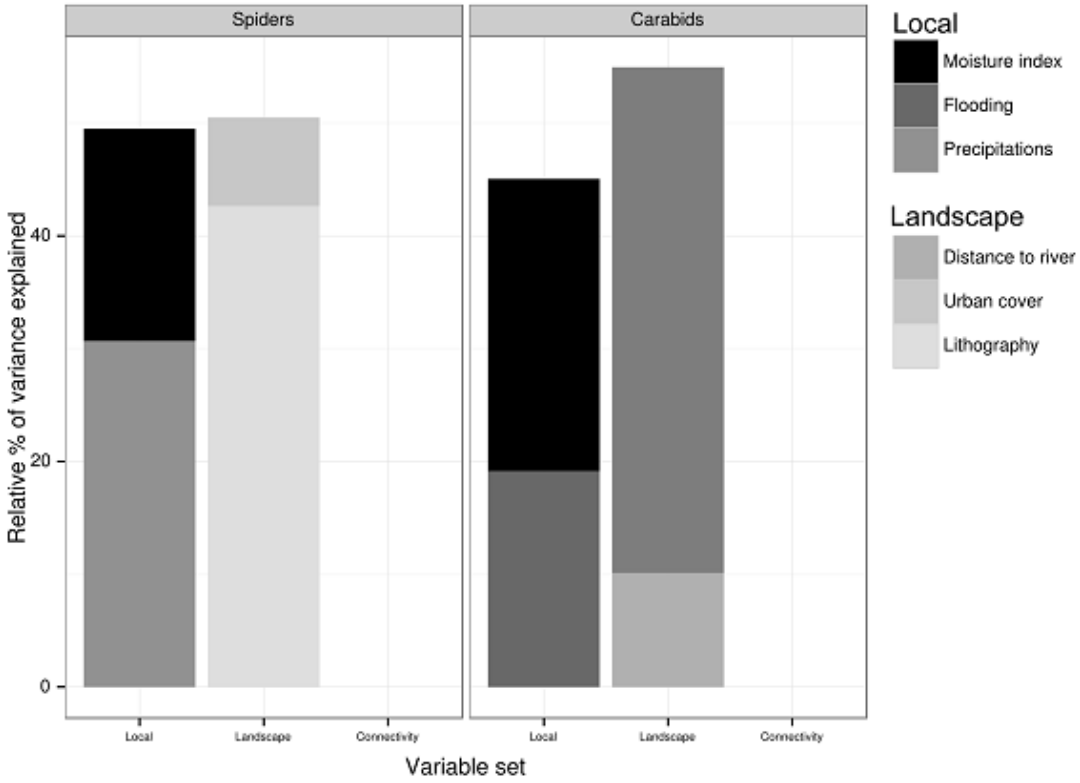
Why?

- Quasi-systematic effect of flooding related variables:
  - Spider α-diversity, and assemblages explained by moisture (GLM and CCA)
  - Carabid abundance and β-diversity explained by moisture and flooding (GLM and CAP)



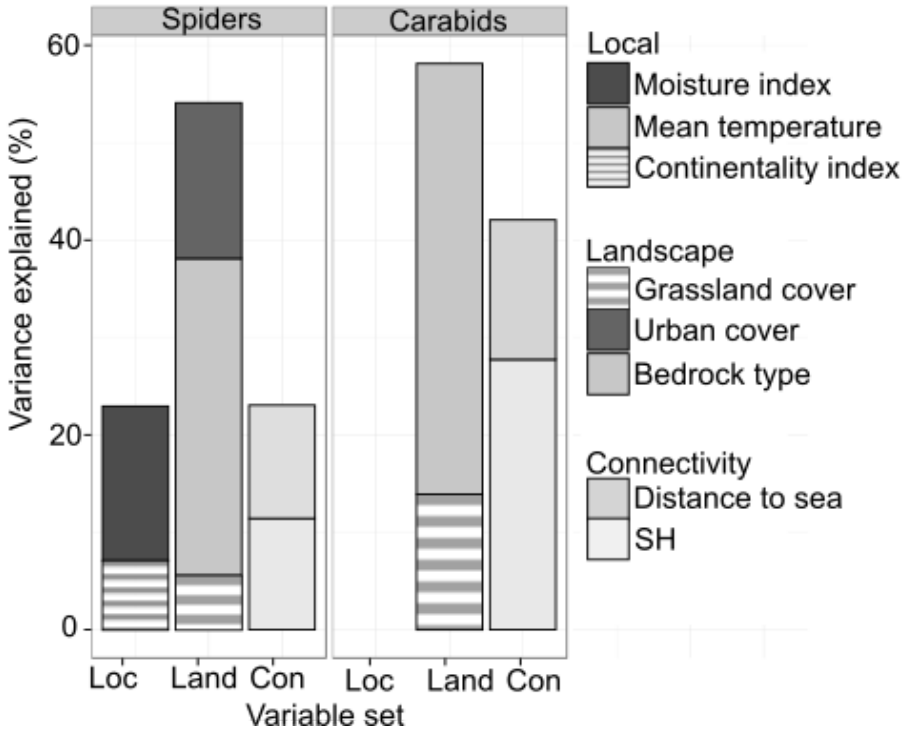
What about scale?!

- Let's include landscape and connectivity and try to assess their relative importance:
    - **abundances**: mostly explained by local factors



Assemblages…

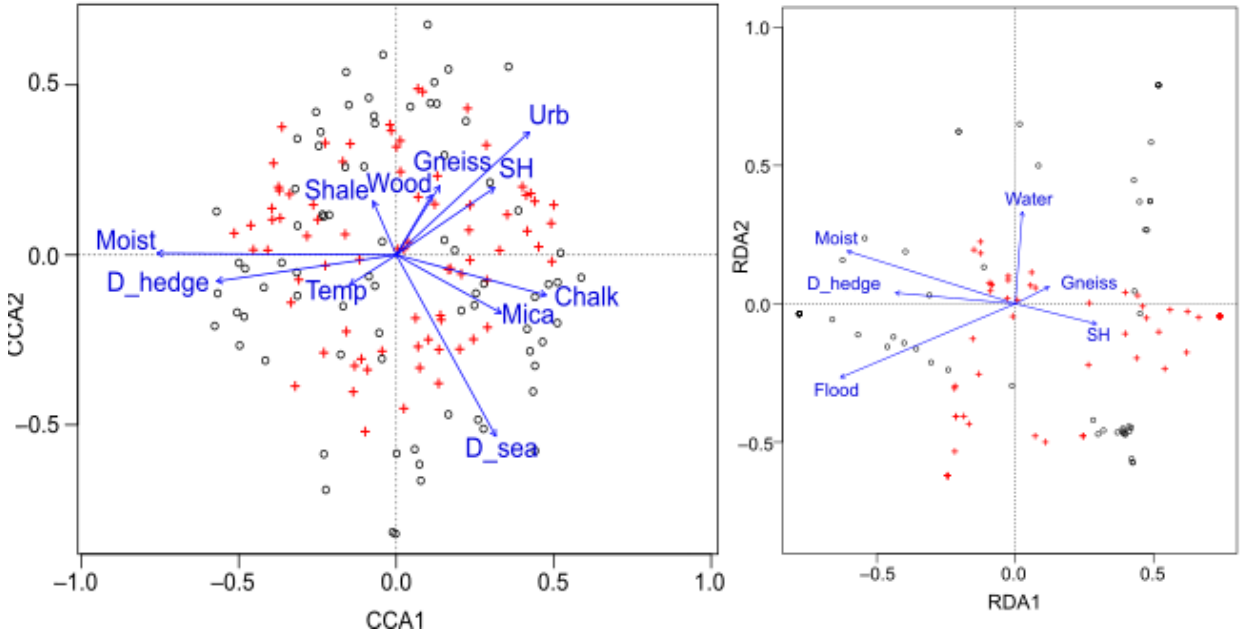
- α-**diversity**:
  - mostly landscape factors;
  - but moisture explained 16% for spiders.
- β-**diversity**:
  - mostly landscape factors;
  - but moisture, precipitations and flooding = main local factors.



Variance partitioning for α-diversity

Assemblages…

- Species composition: moisture = main explicative variable

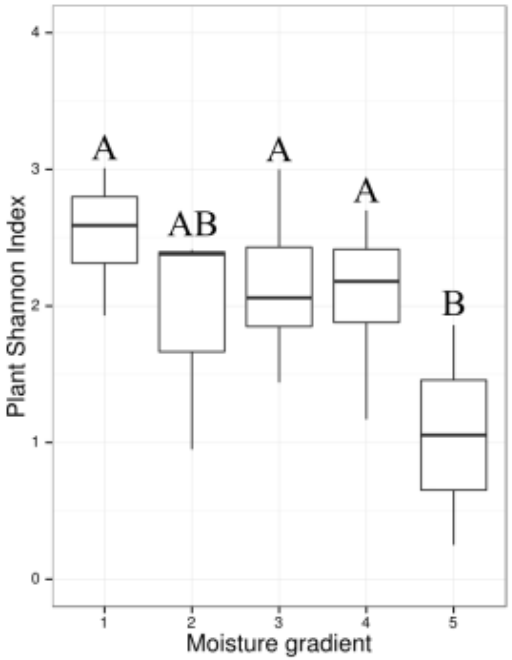


Partial conclusions

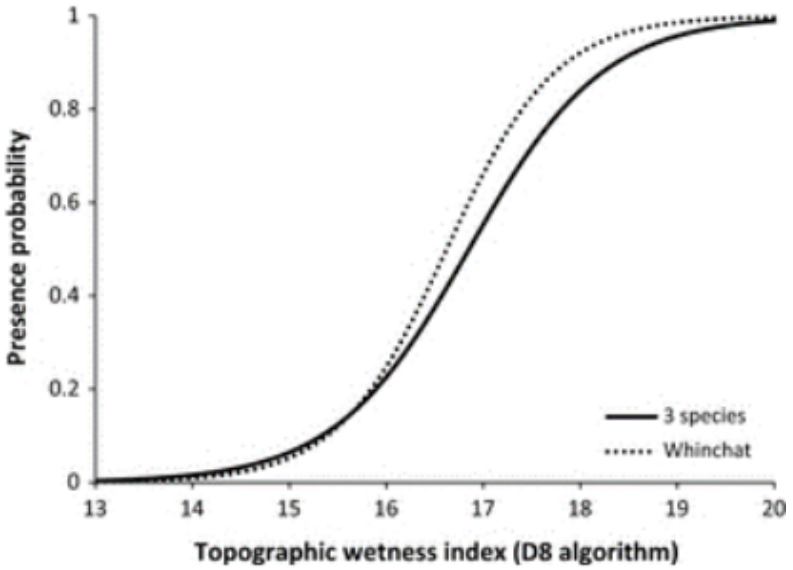
- At local scale, moisture and flooding are main drivers
- Flooding is more important than extensive management improvement
- Landscape and connectivity are main drivers of diversity at large scales

And for other groups ?

Plants



Grassland nesting birds



Besnard et al. 2013

Some research questions

- What would be the results:
  - in less diversified landscapes (forests)?
  - in different climatic conditions?
  - with intensive management?
- How do we improve the management?
- Use of remote sensing to predict diversity ?

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