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Drying-out fish ponds as a key agroecological practice to promote ecosystem services?

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Pond Aquaculture

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Introduction

Ponds for fish production, the case of the Dombes region (France)

Originally a wetland, transformed during the Middle Ages by monastic communities to create ponds (Avocat, 1975; Guichenon, 1650 cited in Sceau, 1980).

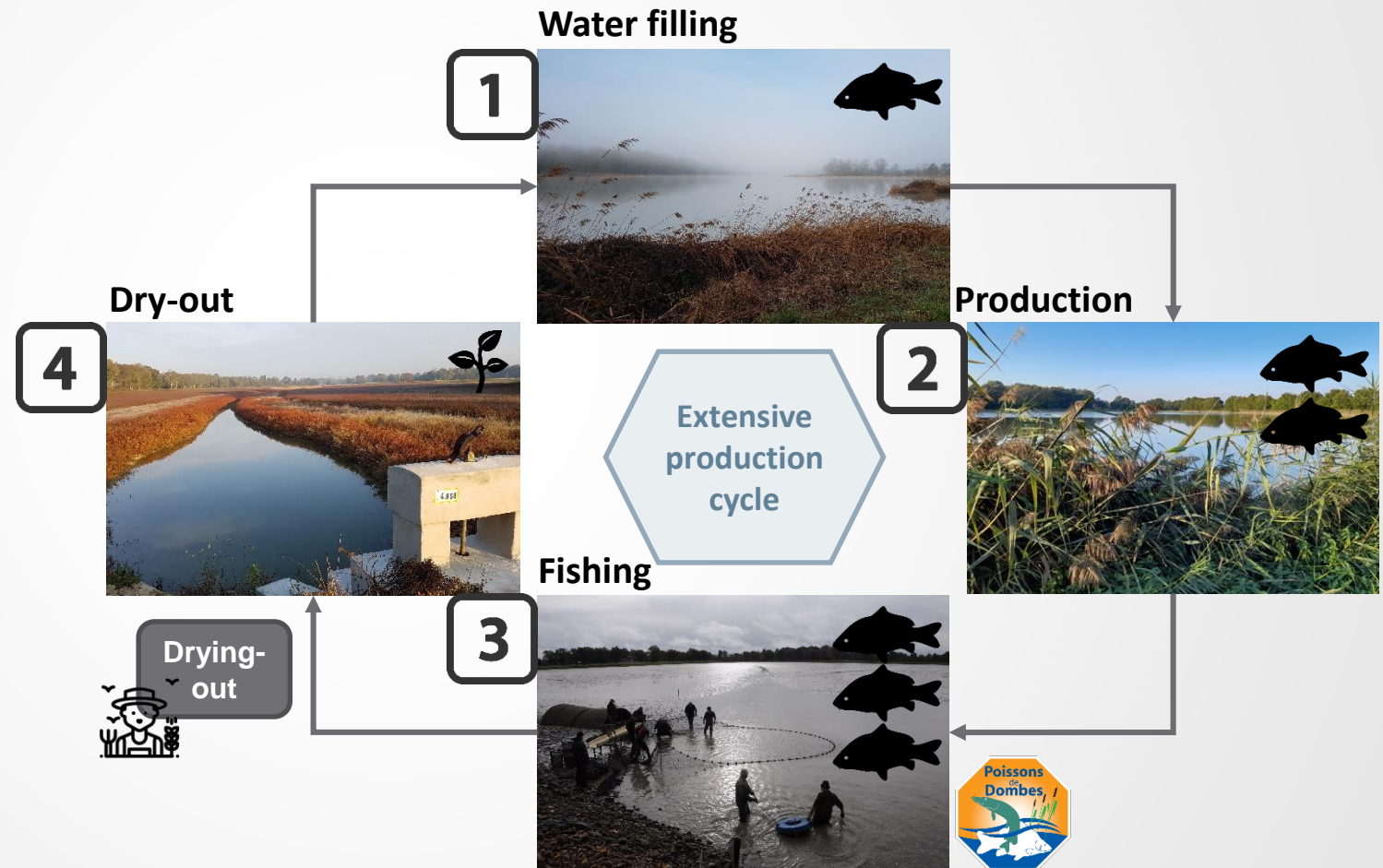
Several objectives:

- Drain areas to cultivate land
- Create ponds to produce fish
- Sanitation and diseases control

A “productive pondscape”:

Around 1,100 ponds for 10,000 ha of water (average of 10 ha and 80 cm deep)
Between 600 and 1,000 tonnes of fish produced per year

- Artificial and managed environments (Hansson et al., 2005)
- But also with significant biodiversity (Wezel et al., 2014; Robin et al., 2014)



➔ Drying-out, a **historical practice** but also a major **disturbance** for the ecosystem

How drying-out affect ecosystem services provided by fish ponds ?

Materials and Methods

(Wezel et al., 2013)

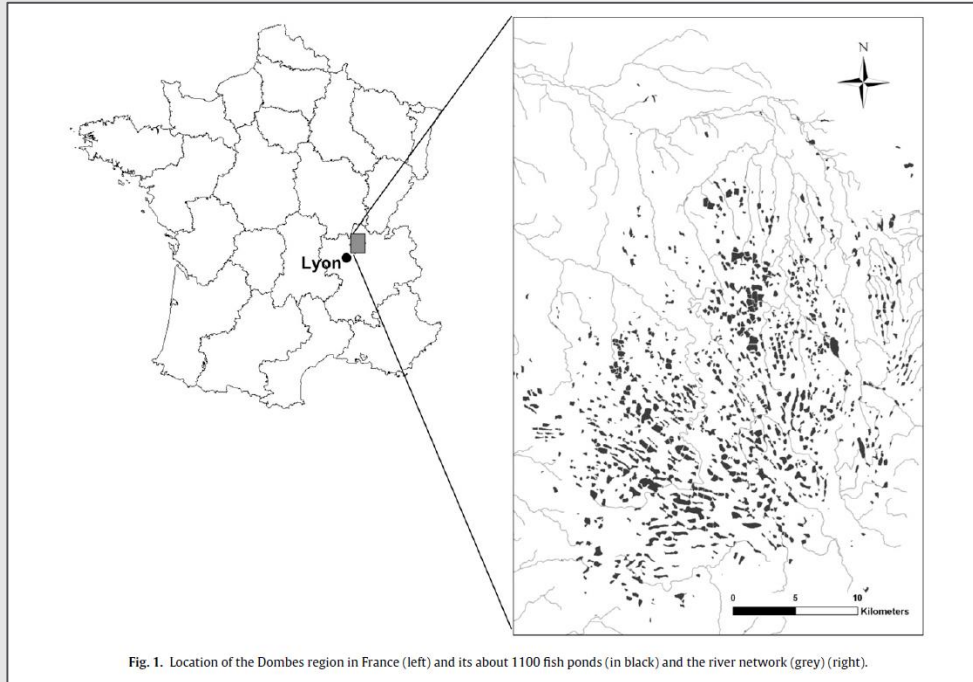


Fig. 1. Location of the Dombes region in France (left) and its about 1100 fish ponds (in black) and the river network (grey) (right).

Dombes



(Dombes Tourisme)

➔ Historical database of 85 fish ponds from the Dombes region (2007-2014)

➔ PONDERFUL 2022 and 2023 fish ponds database on carbon balance

➔ Macrophyte species richness and cover

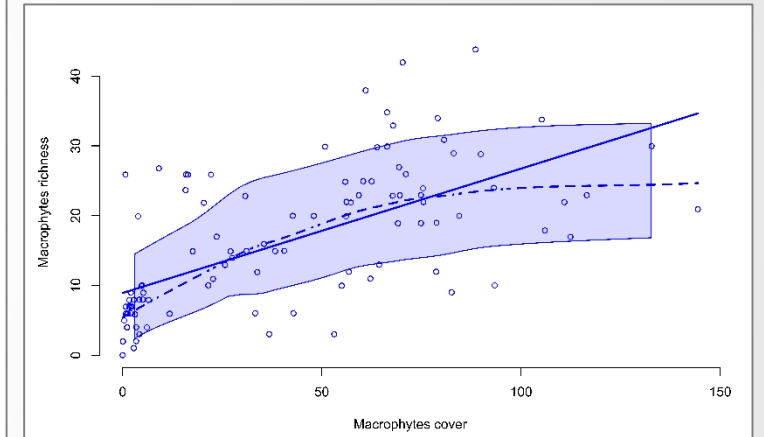
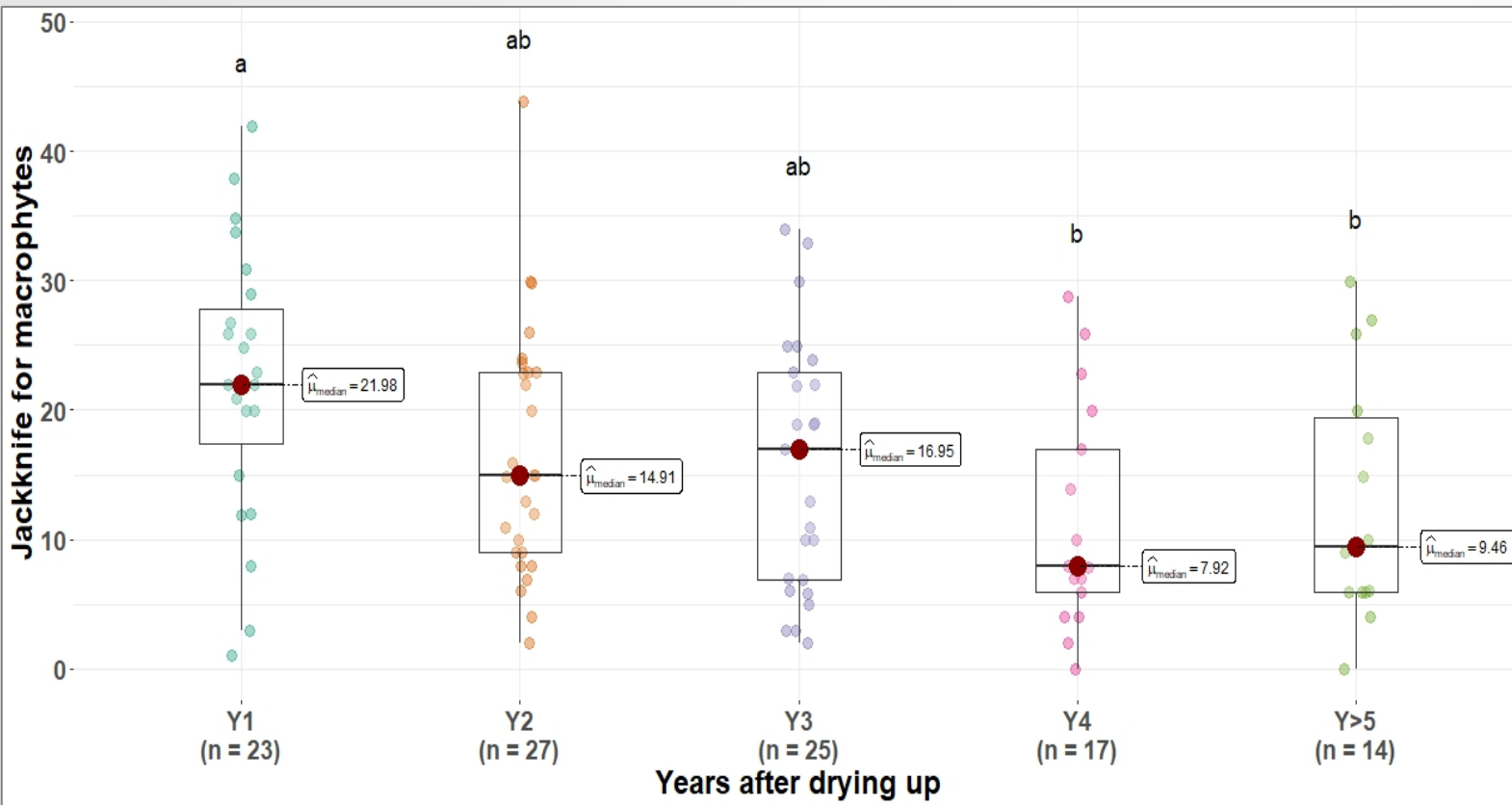
Greenhouse gas emissions and carbon storage

Management data (distance to the last dry-out and fish yields)



Results

Effects of drying-out on macrophyte richness and cover



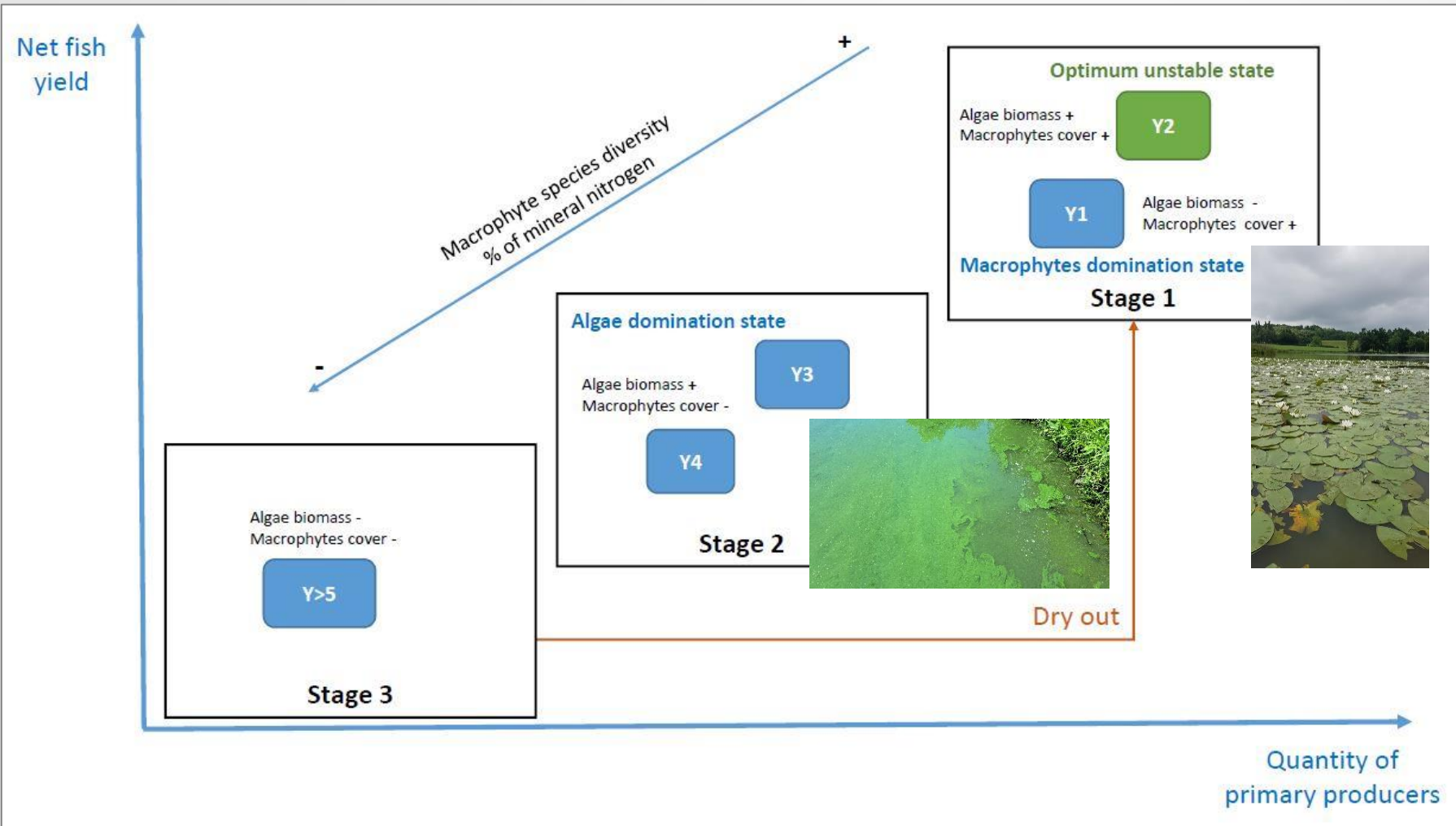
$(R^2 = 0.732, p < 0.0001)$

Same trends for species richness and cover

➡ Drying out encourage **macrophyte recolonization**

➡ Phytoplankton gradually dominate in following years, but the two primary producers are little present after 5 years and more

Results and Discussion



An **unstable state, optimal for fish production and the diversity of primary producers**, favored by the practice of drying-out



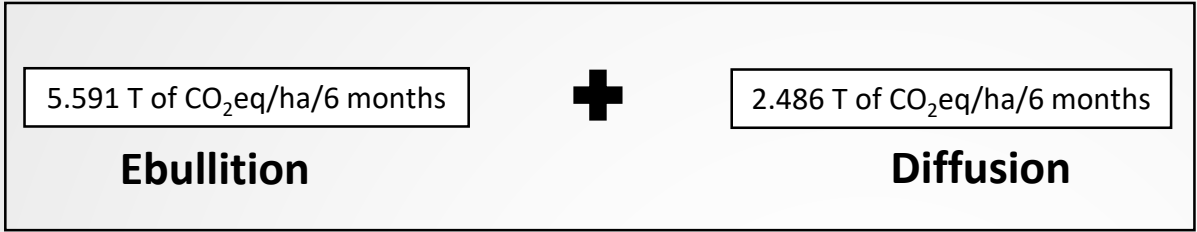
A **major agroecological practice** for extensive pond fish farming

Hyper-eutrophic

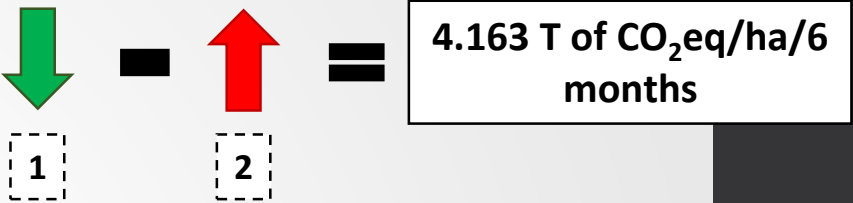
Eutrophic

8.077 T of CO₂eq/ha/6 months

2 Emissions

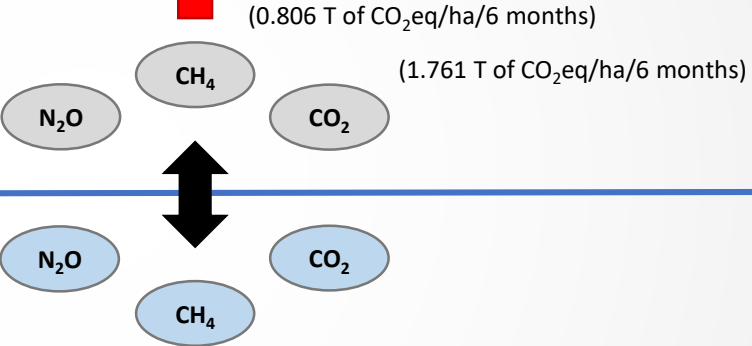


Carbon Balance :



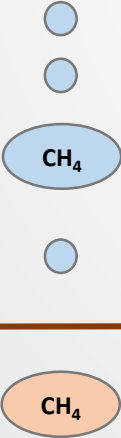
Atmosphere

Water



12.241 T of CO₂eq/ha/6 months

Sediments



Results

Effects of drying-out on carbon balance

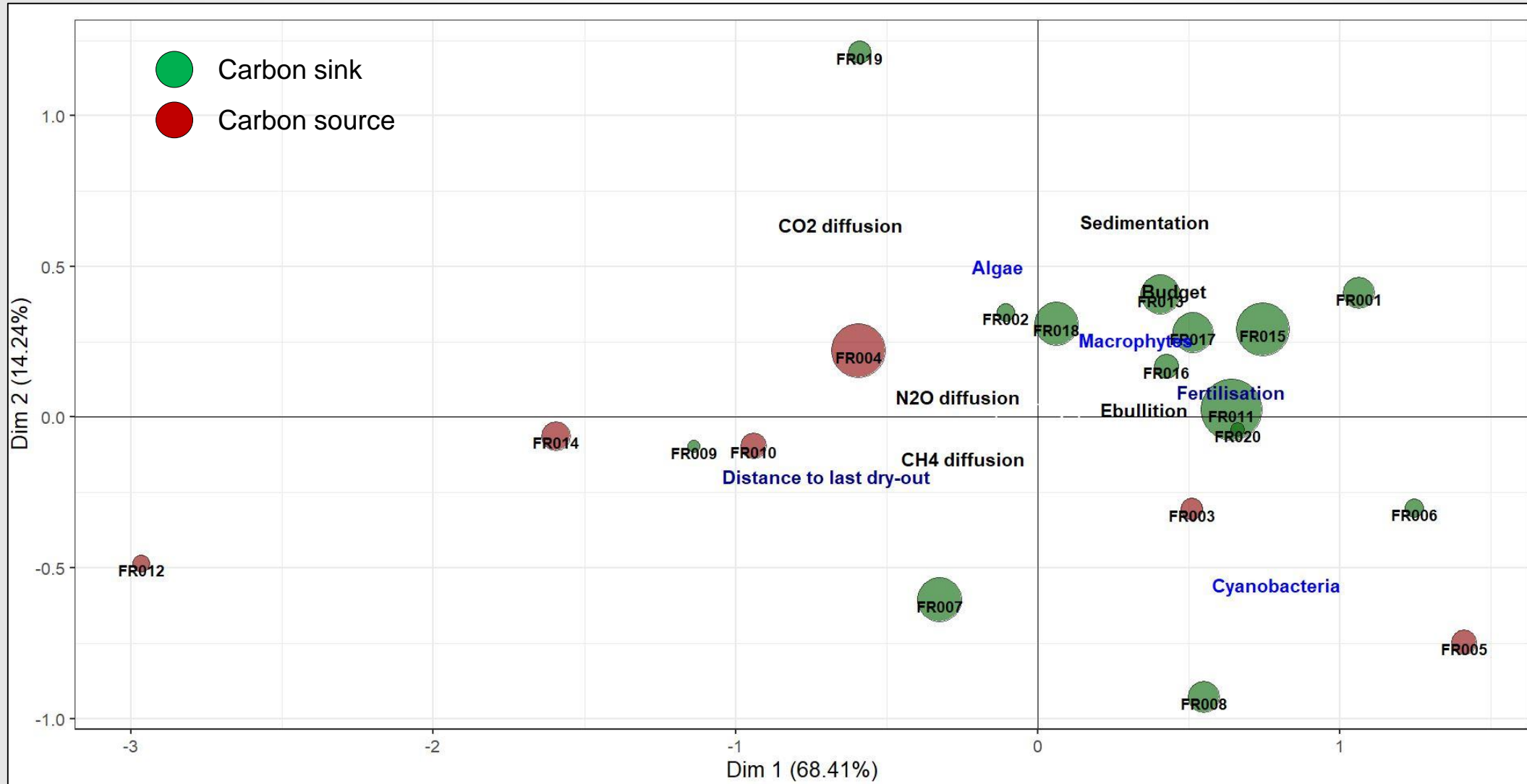
| Tonnes of CO ₂ eq | Mean | Median | Min | Max | SD | |
|------------------------------|---------------|---------------|---------------|---------------|--------------|---------------|
| Year 1 | 6.80 | 4.91 | 3.12 | 12.38 | 4.91 | 19.14 |
| Year 2 | 7.20 | 7.27 | -4.63 | 18.33 | 8.40 | |
| Year 3 | 2.12 | 2.86 | -7.68 | 12.66 | 8.93 | |
| Year 4 | 5.82 | 14.25 | -18.40 | 21.61 | 21.29 | |
| Year 5 | -2.79 | -2.44 | -6.30 | 0.36 | 3.35 | |
| Dry year | -23.89 | -25.35 | -19.43 | -27.19 | 3.16 | -23.89 |



- ➔ On average, fish ponds are better sinks in year 2
- ➔ High variability in year 4
- ➔ Mainly sources in year 5
- ➔ Significant emissions during the dry year

Results

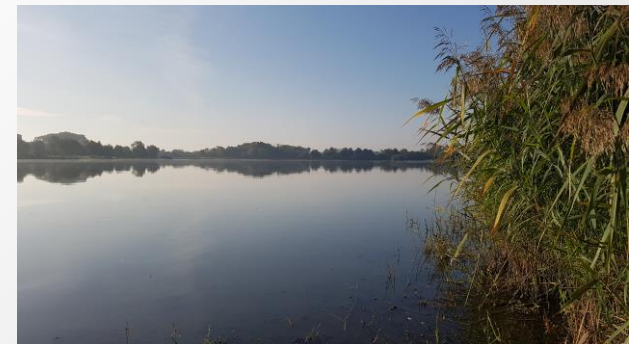
Effects of drying-out on carbon balance



Discussion and Conclusion

- Drying-out allow the **recolonization of macrophytes** and provide an **“optimum unstable state”** during the **second year** of the cycle
- Drying-out is a **major agroecological practice** for extensive pond fish farming
- **Essential to maintaining these environments** and the **ecosystem services** they can provide:
 - Biodiversity conservation (support services)
 - Extensive, agroecological fish production (provisioning services)
 - Carbon storage (regulating services)
- But also a **major disturbance**, associated with **significant emissions of greenhouse gas** (to be studied in details on the entire dry year)

➔ A need for future research to rethink about the hierarchy of desired ecosystem services



Thanks for your attention!



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Questions?

*Thanks to all colleagues and partners from Isara, Aarhus University and PONDERFUL.
Thanks to all fish farmers and pondscape stakeholders.*