Réponses structurelle et fonctionnelle des communautés benthiques et piscicoles aux modifications long-terme des paramètres abiotiques du Rhône.

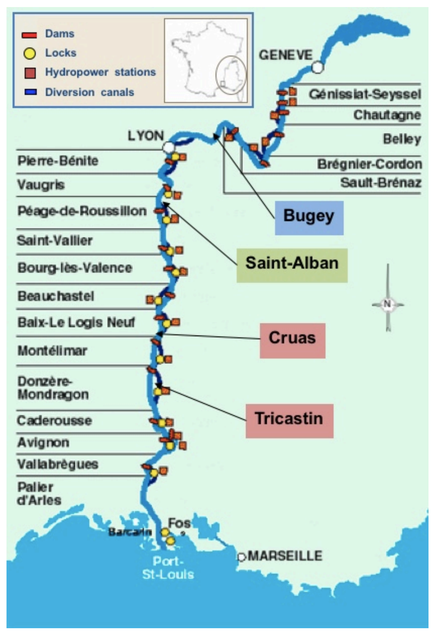
Structural and functional responses of benthic macroinvertebrate and fish communities to long-term modifications of the abiotic parameters of the Rhône River.

Objectives

Long-term monitoring of the Rhône River has been undertaken by EDF since the early 80s to study the effects of nuclear power plant discharges. This monitoring also provides insight into the functioning and evolution of the hydrosystem subject to **multiple disturbances** (physical, chemical, toxic, etc.), including climate change. We have chosen to focus on the contemporary period (2000-2019). This poster focuses more specifically on the **functional responses of communities**, through biological traits, to changes in physical chemistry and hydroclimatology.

Data

Sectors (3) and sampling sites (4) on the regulated Rhône River.



Data organization.

Organisation des données

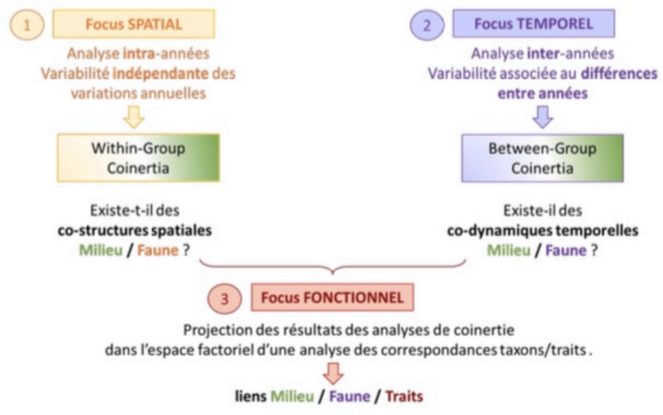
* 3 secteurs (Haut-Rhône - Bas-Rhône 1 - Bas-Rhône 2)
* 4 sites (Bugey - Saint-Alban - Cruas - Tricastin)
* 2 stations / site (amont - aval)
* 20 ans de données considérés (2000-2019)
* 22 variables environnementales (Hydrologie - Thermie - Physico-chimie)
* 2 descripteurs biologiques (macroinvertébrés et poissons)
* 101 taxons invertébrés
* 68 taxons poissons (33 espèces, dont certaines divisées en classes de taille)
* 22 traits biologiques macroinvertébrés et 13 traits poissons

Environmental variables and biological descriptors.

Environnement	Faune
Hydrologie (5 variables)	**Invertébrés (22 traits biol.)**
Qstd (Q moy m^3/s)	e.g.
Hydraul_H	taille max (a)
Hydraul_P	cycle (b)
Hydraul_E	nb générations (c)
Hydraul_A	reproduction (e)
	dispersion (f)
Thermie (6 variables)	résistance (g)
Tstd (T moy °C)	respiration (h)
C12spring (°C)	locomotion (i)
C12autumn (°C)	trophie (q)
SDJ12 (nb jours)	salinité (r)
C18spring (°C)	température s)
DC18 (nb jours)	origine (v)
	…
Physico-chimie (11 param.)	**Poissons (13 traits biol.)**
Conductivité (µs)	Température (Temp)
O2 (mg/l)	O2 tolérance (02tot)
pH	Habitat dégradation (Htot)
SO4 (mg/l)	Alim régime (Atroph)
Cl (mg/l)	Alim habitat (Fehab)
MES (mg/l)	Courant tolérance (Hab)
DBO5 (mgO2/l)	Habitat frai (Habsp)
NH4 (mg/l)	Reproduction (Repro)
NO2 (mg/l)	Ponte nb (Reprob)
NO3 (mg/l)	Soins parentaux (Pc)
PO4 (mg/l)	Migration (Mig)
	Origine biogéo (Orig)
	L tot max (Lmax)

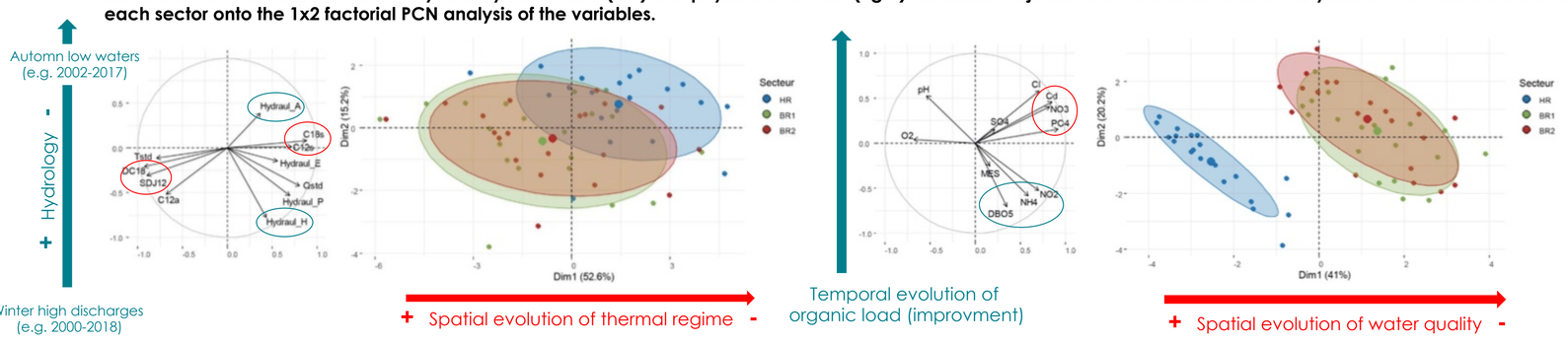
Organization of the Fauna x Environment tables.

Different steps of analysis.

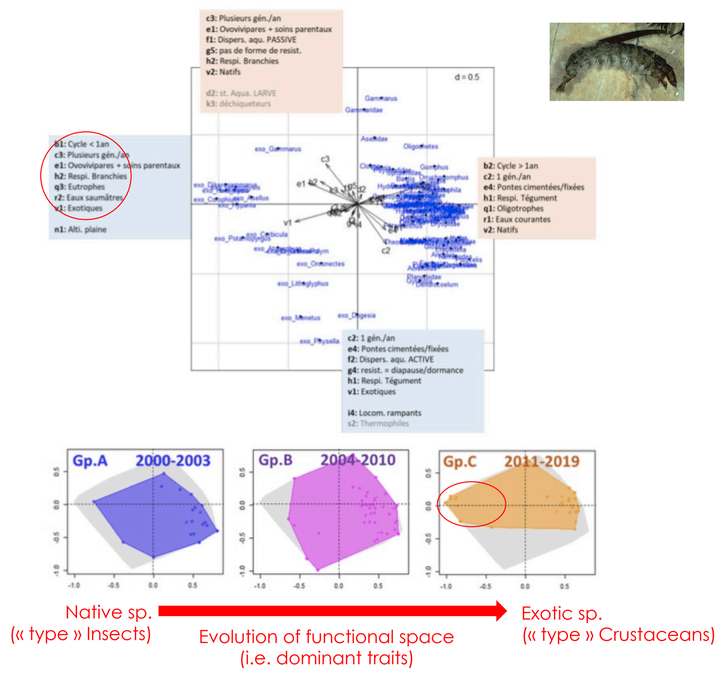


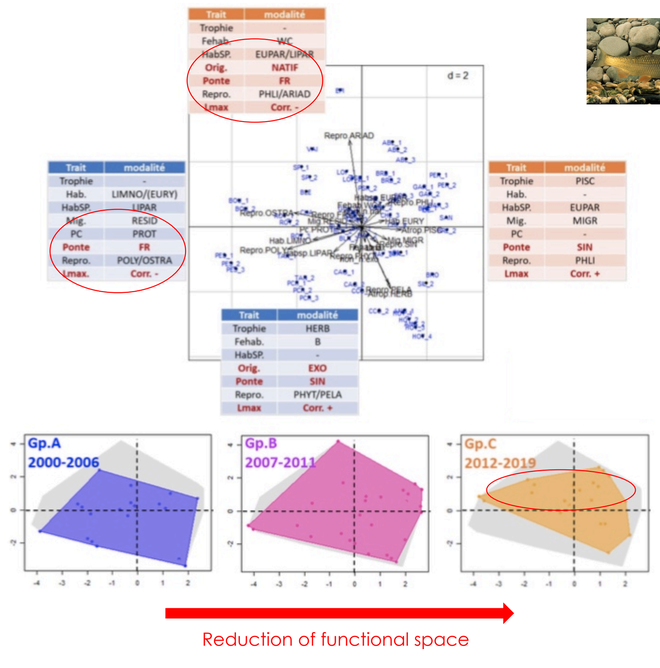
Results

Correlation circles from the PCN analysis of hydroclimatic (left) and physico-chemical (right) variables. Projections of the coordinates of the years of the historical data for each sector onto the 1x2 factorial PCN analysis of the variables.



1x3 factorial axes from the fuzzy-coding CFA (macroinvertebrates – left) and 2x3 from the Smith and Hill analysis (fish – right) visualizing the correspondences between taxa and contributing traits. Projection of the "temporal" clusters resulting from the hierarchical classification based on the taxa scores from the inter-year co-inertia analysis.





Conclusions : relevant biological models.

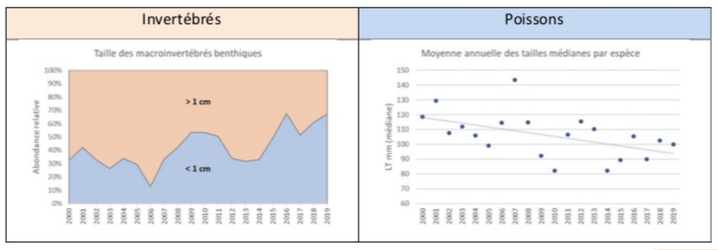
=> **Parallel functional responses** of the two biological compartments to environmental changes in the river over the last two decades:

- Changes in **phenology**: decline of single-spawning fish species in favor of multiple-spawning species; decline of invertebrate taxa with one generation/year and a cycle >1 year in favor of taxa with more than one generation/year and a cycle <1 year.
- Changes in **current affinity**: increase in the numbers of limnophilic fish species; decline of rheophilic invertebrates.
- **Reproductive traits**: increase in fish species that protect their spawn or juveniles and invertebrate taxa in the "ovoviviparous with parental care" category.
- Decrease of **average size** for fish and increase for macroinvertebrates with a size <1 cm (see Figure).

The temporal evolution of trait structure appears to be primarily driven by water quality and trophic processes for macroinvertebrates, and by thermal regime and hydrology for fish.

These changes reveal increasingly **opportunistic** (small size, early maturation, reproductive efforts) and **competitive** global strategies, reflecting **unstable and disturbed environments** (i.e. r-strategy taxa). This confirms the **importance of bioecological traits** in researching and predicting the responses of aquatic species to climate change.

Global evolution of the size of organisms.



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