ESR 7: Basin-region hydromorphological alteration links to biodiversity

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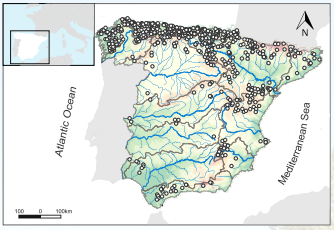

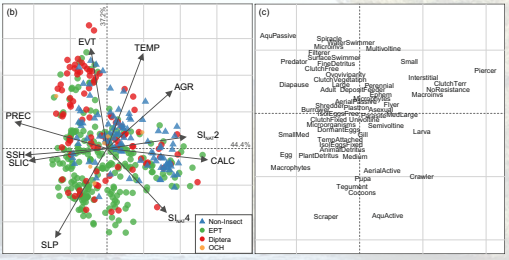

Fig. 1: (a) Continental Spain (505,000km²) and selected sampling sites (177 for diatoms, 441 for macroinvertebrates, 264 for fish). (b) RLQ ordination on macroinvertebrate communities and coefficients for key environmental variables; (c) coefficients for macroinvertebrate functional traits.

Chapter 1&2 - National scale

Flow alteration caused by dams and reservoirs, as well as climate and land use changes, severely **threaten freshwater ecosystems**. We selected freshwater diatom, macroinvertebrate, and fish communities surveyed in minimally disturbed streams throughout continental Spain (Fig. 1, a), a country with heterogeneous environmental conditions (e.g., xeric to temperate climates).

Using multivariate ordination methods, we identified **community shifts associated with global change-related factors,** e.g., increases in motile diatoms, multivoltine, small-sized macroinvertebrates, and non-migratory fish associated with higher catchment urbanisation and agriculture; decreases in pioneer diatoms and piercer macroinvertebrates linked to dam-induced flow alteration (Fig. 1, b,c).

We also assessed the contribution of spatial factors to the taxonomic and trait-based community variability of diatoms and fish. Distance-decay analyses indicated that fish communities presented a stronger spatial dependency compared to diatoms due to their weaker dispersal abilities. Besides, landscape-scale environmental variables better described fish communities.

Chapter 3&4 - Regional scale

Looking at the **regional scale**, we selected 19 streams in northern Spain (Fig.2, a), in a control-impact study design. We compared the effects of dam operational scheme (irrigation and hydropower dams) on diatom, macroinvertebrate, and fish communities.

In general, **irrigation dams** presented significantly lower nutrient concentrations and **inversion of the seasonal flow patterns**, while hydropower-impacted sites had significantly **higher water temperatures** and more frequent changes in the flow regime patterns. Flow regulation was linked to **important community shift, favouring generalist and disturbance-tolerant traits**, which was more pronounced in streams affected by irrigation dams (Fig. 2, b,c).

Besides recognising the role of **multi-scale approaches**, **our study emphasises the use of species traits, multiple biotic groups, and spatial components** when assessing potential dam-related impacts on freshwater ecosystems. These approaches can underpin conservation strategies and research directions under current and future global change scenarios.

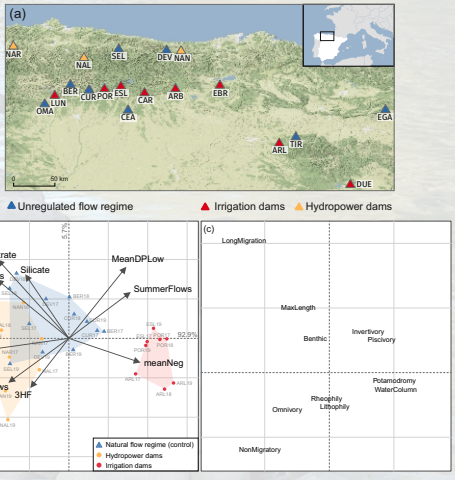

Fig. 2: (a) 19 streams selected in northern Spain, classified according to flow regime (i.e., unregulated and irrigation/hydropower dam impact). (b) RLQ ordination on fish communities and coefficients for key hydrological and local variables; (c) coefficients for fish functional traits.

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