Karstic ecology : How spring hydrogeomorphology structure macroinvertebrate fauna in the Haut-Doubs Valley, Jura Mountains, France ?

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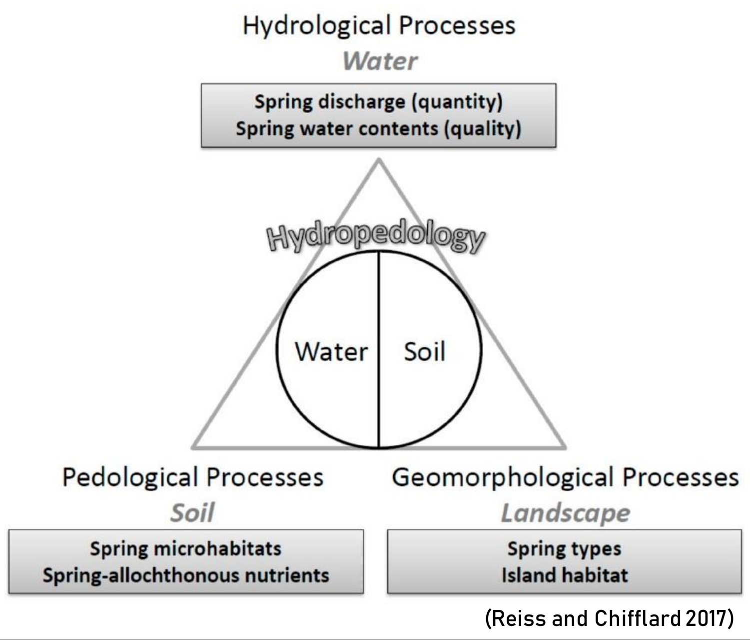
Springs: ecosystem where interact hydrological, geomorphological and geochemical processes

Springs = Ecotone between ground-, superficial waters and riverbank ➔ rich ecosystems.

➔ Enable the survival of rare species (Sabatino et al. 2003 ; von Fumetti et al. 2006).

➔ Structure the upstream area of the river continuum (Vannote et al., 1980)

➔ Jura mountains geomorphology favours variability of spring habitats. How does this variability shape biocenose distributions?



(Reiss and Chifflard 2017)

Material and Methods

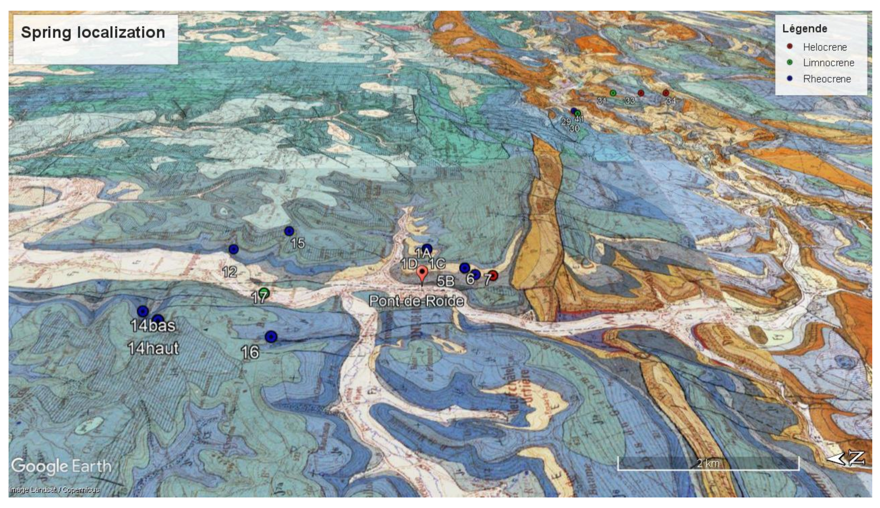
1) Sampling during winter and summer : Determination of surrounding environment (Forest/Grasslands), spring's morphology (Rheocrene/Limnocrene/Helocrene).

2) Evaluation of physico-chemical (T°, pH, Eh, O_2), pedological (sediment texture distribution), nutritive (Tot. Org. C [TOC]) parameters + water-rock interaction (WRI) (Ca, Mg, HCO3) and environmental (Cl, NO_3, Na, K, SO_4) elements

3) Identification of fauna (annelids, arthropods, molluscs) and biodiversity indicators (Shannon / Pielou)

4) Multi Factorial Analysis (MFA) with fauna and biodiversity indicators as a supplementary data

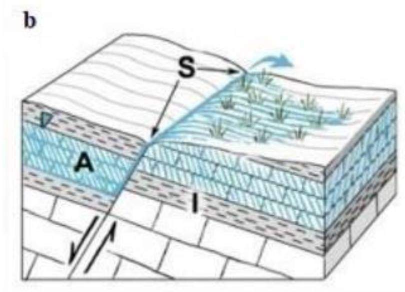
The upper Doubs : an incised tabular and folded karstified structure



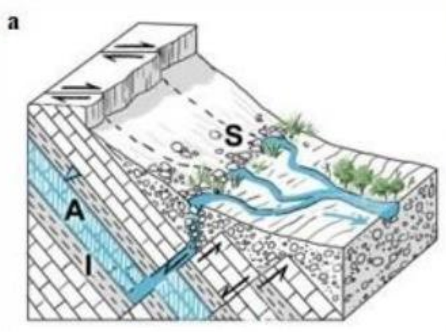
The area features succession of calcareous and marls lithologies mainly occupied by grassland and forests

3 main spring geomorphologies are found over the area, classified according to Springer and Stevens (2009)

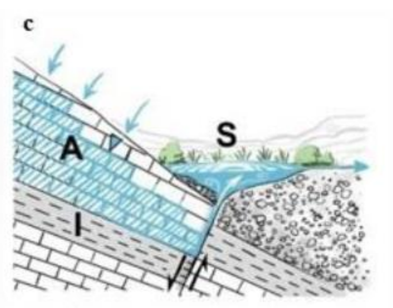
Helocrene springs




Rheocrene springs



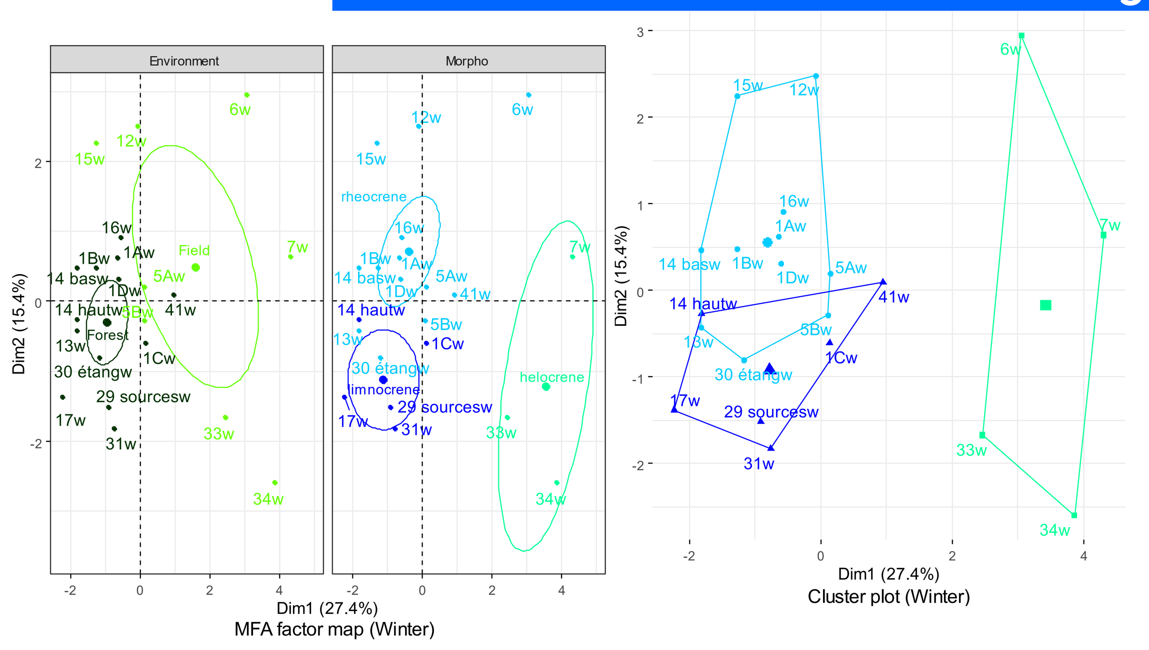

Limnocrene springs




Environmental and geomorphological patterns

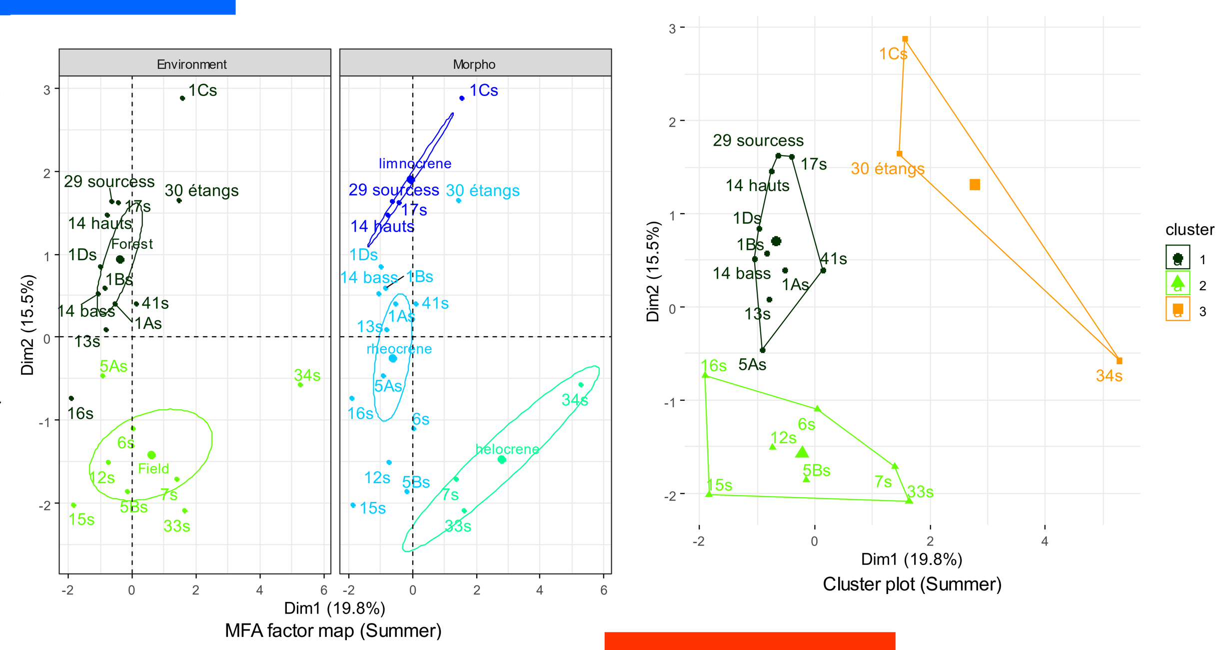
Hierarchical Clustering favors grouping sites according to spring's morphology in the factor map.

➔ Spring's morphology better discriminates springs in winter than their close environment.



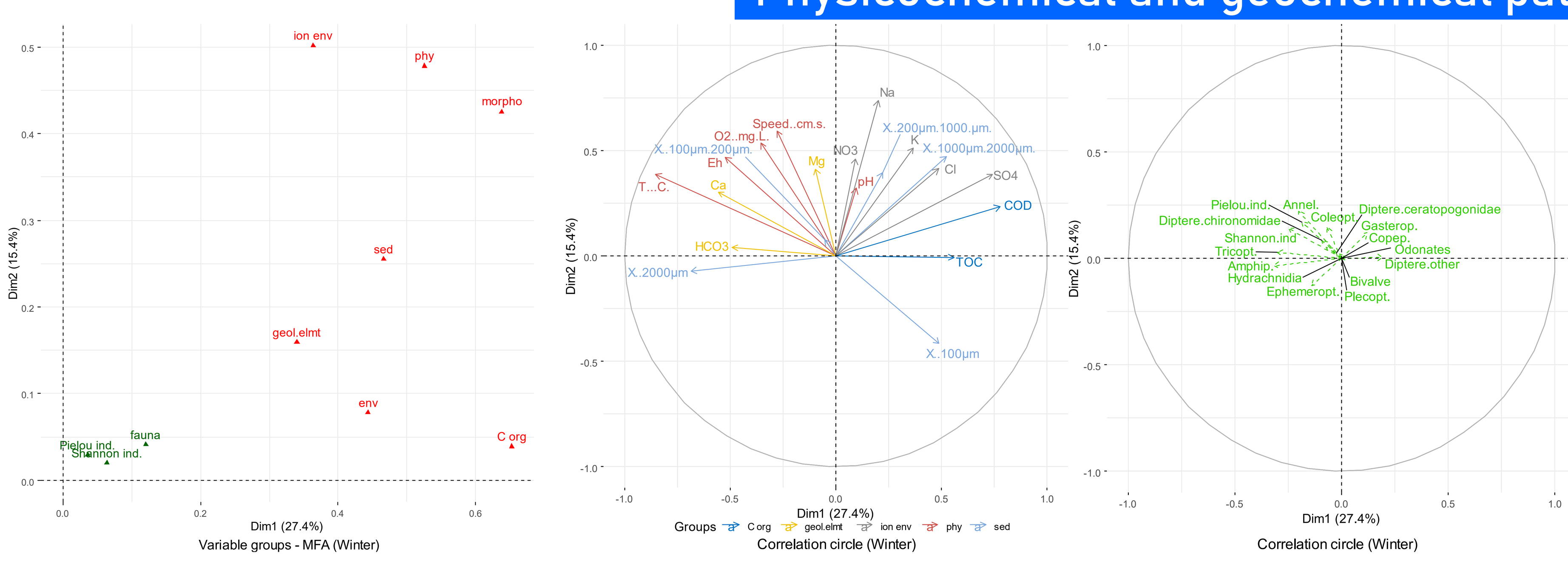
Hierarchical Clustering leads to spring's repartition based on the spring's environment

➔ Spring's close environment better discriminates springs in summer than their morphology.



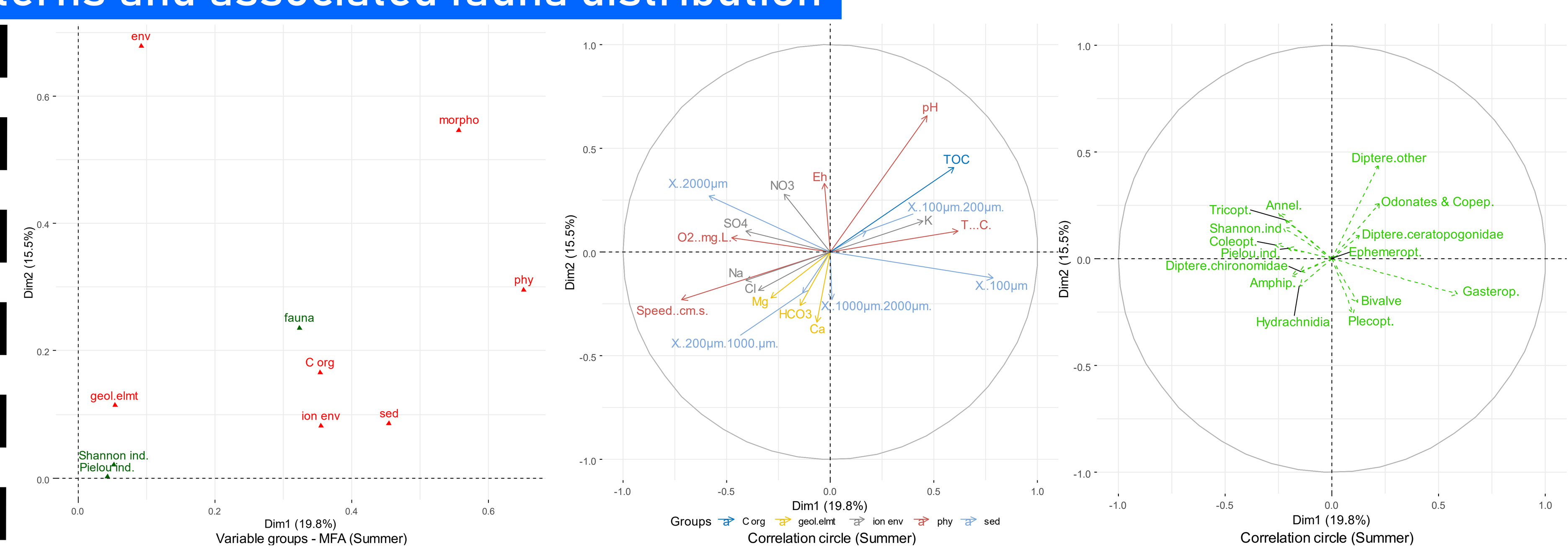
Physicochemical and geochemical patterns and associated fauna distribution

Winter



- Opposition between physical variables (T°, pH, speed…), elements from water rock interaction (Ca, Mg, HCO3) and environmental related elements (Na, K, Cl…) and TOC
- Biodiversity's variables are poorly represented ➔ probably due to a lack of data in winter
- Biodiversity indicators positively but weakly correlate with physical variables (pH, T°, speed and O2) and Ca

Summer



- Opposition between pH, T°, TOC, fine grained substrates and the other abiotic variables
- Particular faunistic groups may dominate and are correlated with abiotic variables (e.g. gastropods) ➔ Greater T, TOC, and fine substrate should allow a greater gastropod colonization
- Biodiversity indicators are preferentially linked with O_2, coarse substrate, and greater current's speed, conditions likely found in forest springs in summer

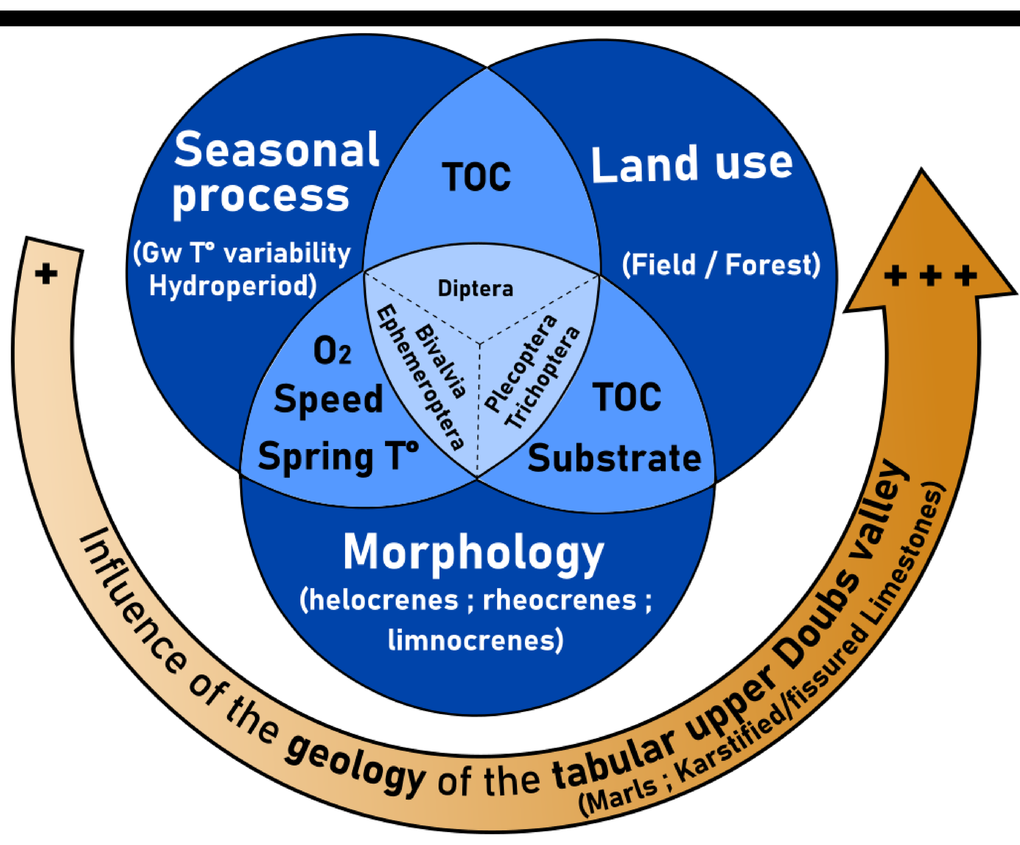
Synthesis and Perspectives

Winter

- ❑ Correlation of Environmental elements, org C, and helocrene ➔ due to weak ability to export organic matter due to marshy area ?
- ❑ Rheocrene in grassland are related with environmental elements such as Na ➔ Anthropogenic impact
- ❑ Food (TOC) and O_2 are hardly concurrently favoured in the same springs as morphological aspects mainly controls physico-chemical conditions in winter : For instance, Rheocrene in grassland present greater oxygenation (related to speed, itself probably related to local slope).

Summer

- ❑ Biodiversity indices greater in forest's springs (especially with rheocrenes) ➔ due to less anthropogenic disturbances, more stable hydrological and physico-chemical conditions, presence of ecological corridors
- ❑ Rheocrene in grassland are associated with environmental ions (e.g., Na, Cl), O_2 and speed ➔ influence of the local slope + land uses
- ❑ Food (TOC) and O_2 may be concurrently present in the same springs as surrounding environmental conditions controls these parameters in summer. Combined with substrate constraints, this leads to either specific domination (e.g., gastropods for fine substrate) or to greater biodiversity, especially in forest springs



Perspectives

- ❑ Specific marls and calcareous lithologies alternation and related land use patterns structured spring ecosystem variability
- ❑ Seasonality of hydrological processes and related parameters are expected to increase with climate changes => Future Fauna adaptation/ changes?
- ❑ Land uses is currently impacted as well by climate changes with repeated severe droughts affecting forests => Future Impacts over summer biodiversity?
- ❑ Morphology diversity is highly dependent of private owner's care and vulgarization of the interest of these socio-ecosystems should be carried => Greater preservation of these hotspots of biodiversity feeding the river corridor?

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