



Institut national de recherche  
en sciences et technologies  
pour l'environnement et l'agriculture

# Macroinvertebrates community structure in a highly glacial catchment

Réalisé sous la direction de  
Sophie CAUVY (CR2)

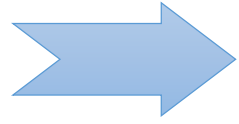
Laboratoire dynamique, et modèle en éco hydrologie

Institut nationale de recherche en sciences et technologies pour l'environnement et l'agriculture - laboratoire DYNAM

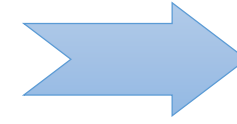
5 rue de la Doua, 69100 Villeurbanne

# Introduction

Human activities  
Climate change



Alpine ecosystems  
= sensitive



Aquatic  
ecosystems



Glacier 'Mer de Glace'

# Water source

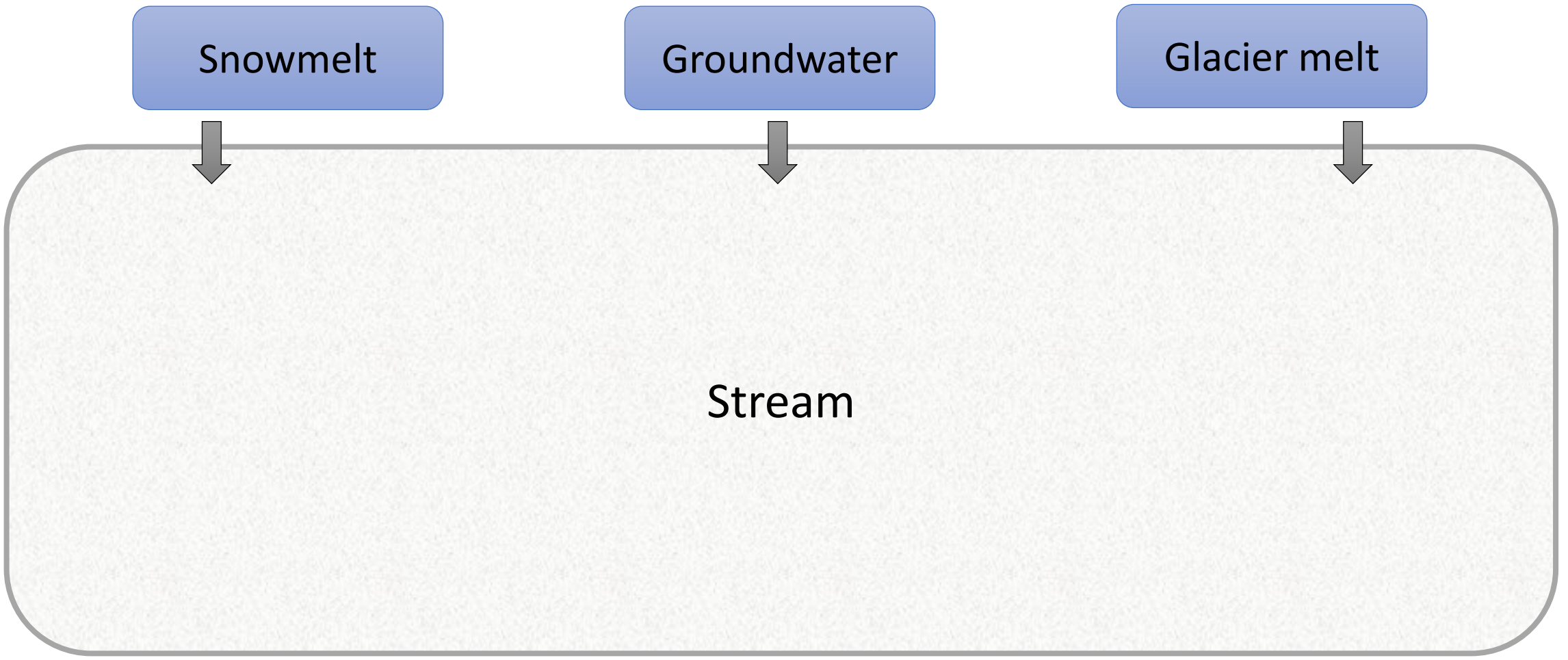


Fig 1. Simplified model of the environmental variables influencing benthic communities (modified from Brown, 2003)

# Water source

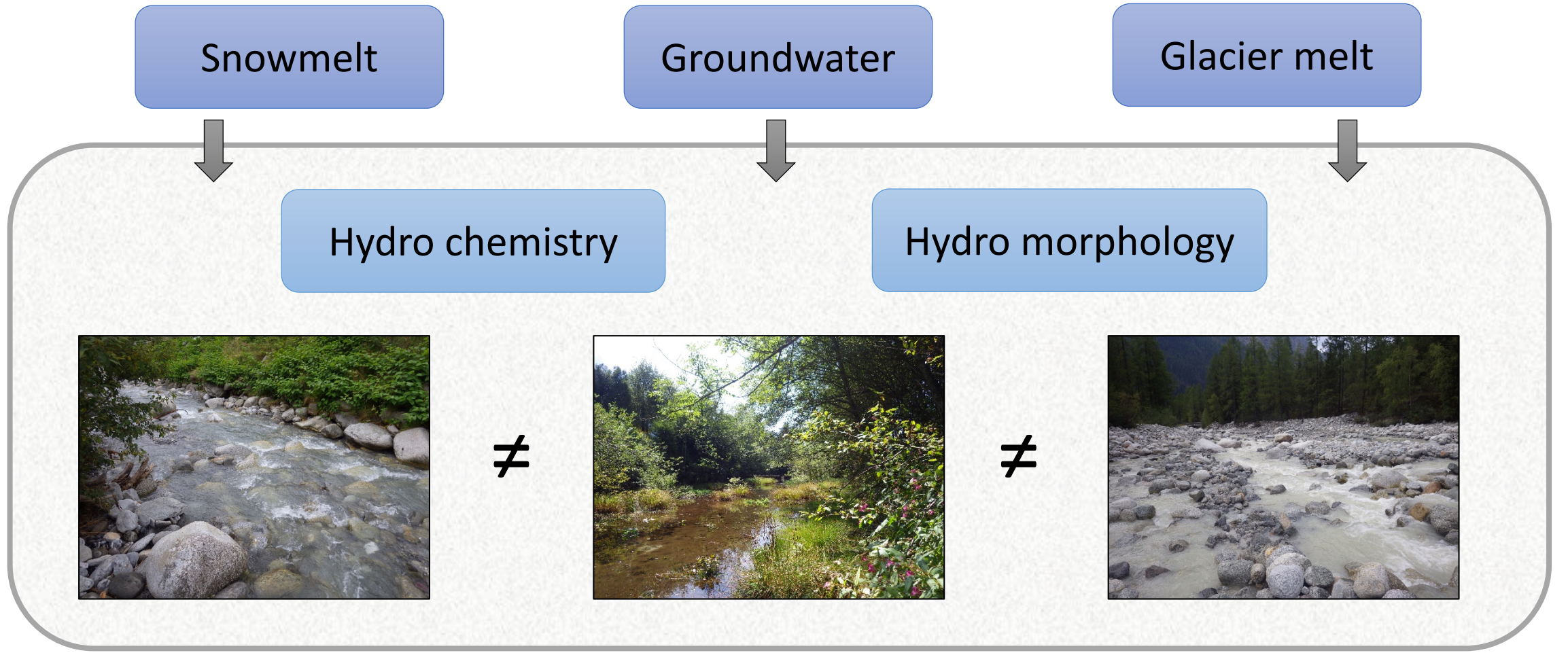


Fig 1. Simplified model of the environmental variables influencing benthic communities (modified from Brown, 2003)

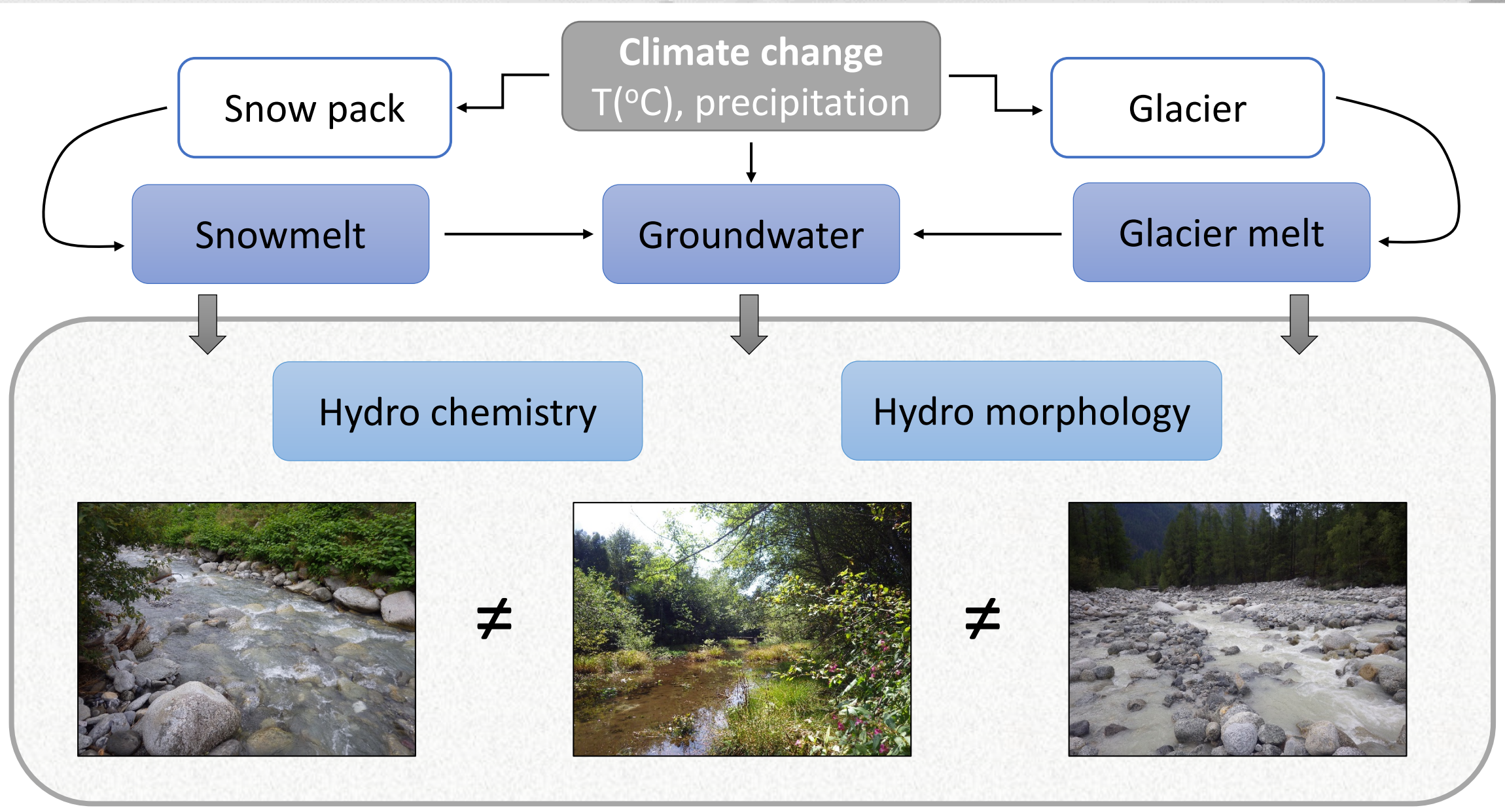


Fig 1. Simplified model of the environmental variables influencing benthic communities (modified from Brown, 2003)

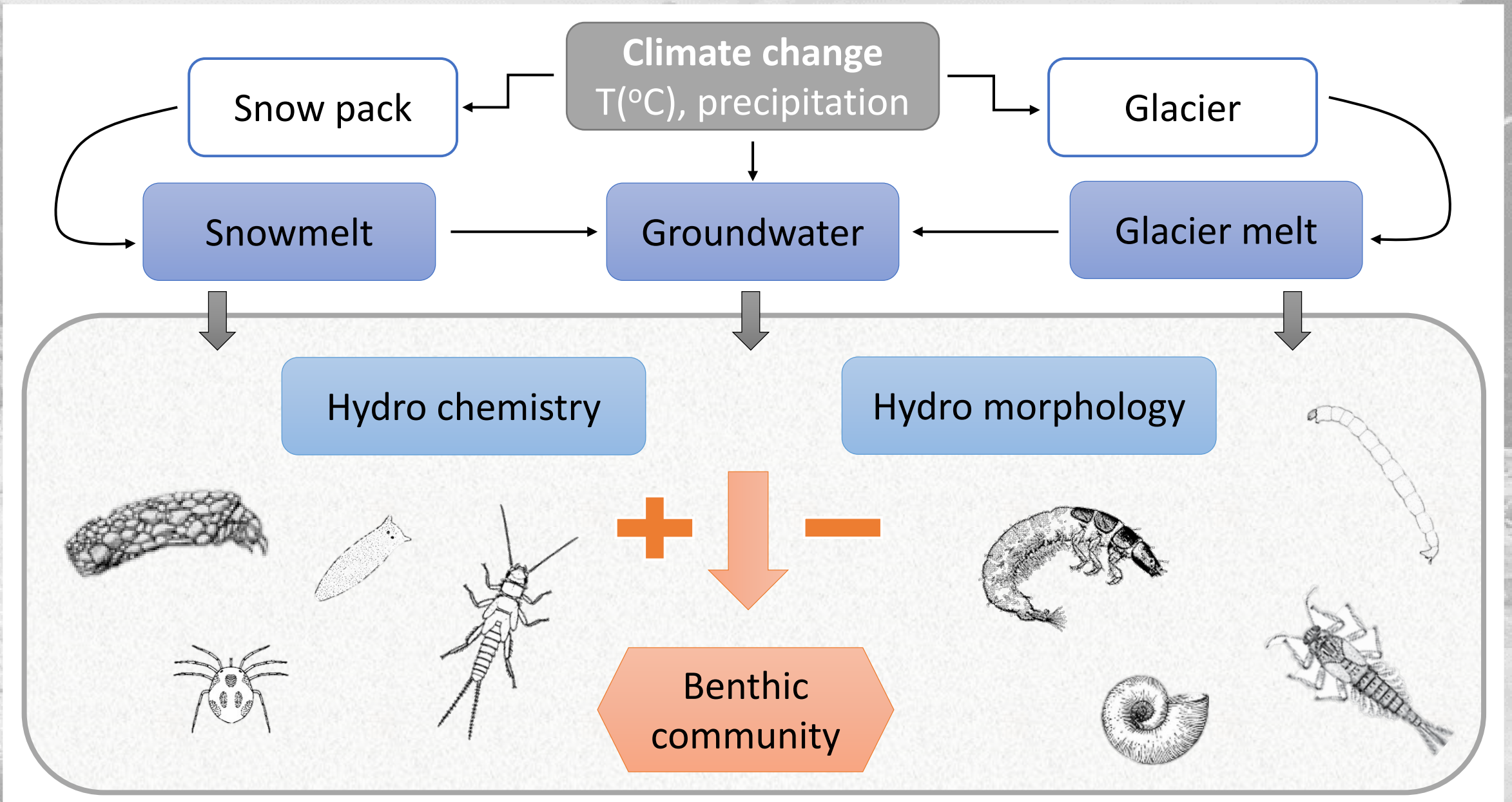
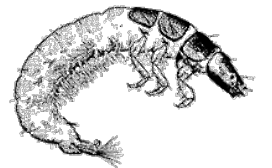
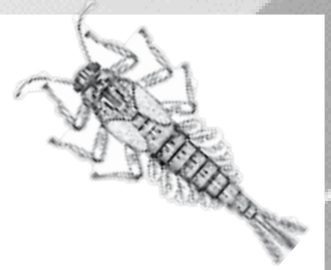


Fig 1. Simplified model of the environmental variables influencing benthic communities (modified from Brown, 2003)

# Objectives

**Describe the community structure and identify the main(s) factor(s) in shaping the macroinvertebrate community structure**

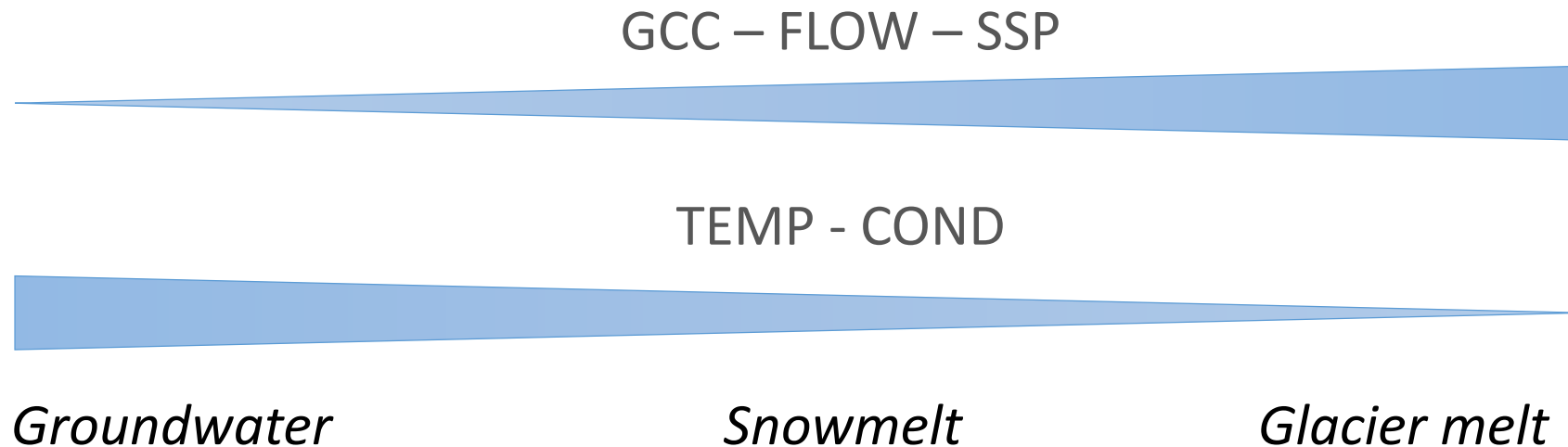


# Objectives

(1) To describe the environmental conditions of the different types of alpine stream

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$\mathcal{H}$ : Differences in environmental parameters according to the water source

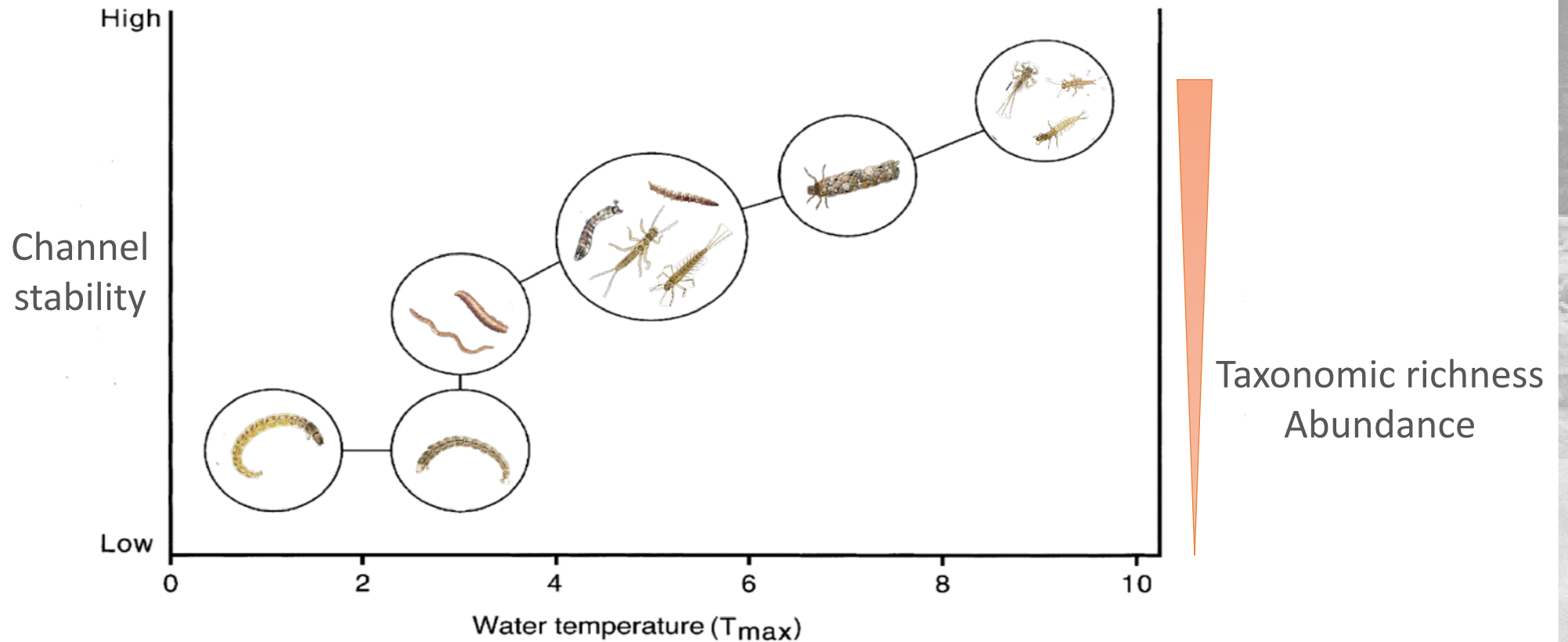




# Objectives

(2) Examine the aquatic-invertebrate community structure

$\mathcal{H}$ : Differences in communities according to the water source



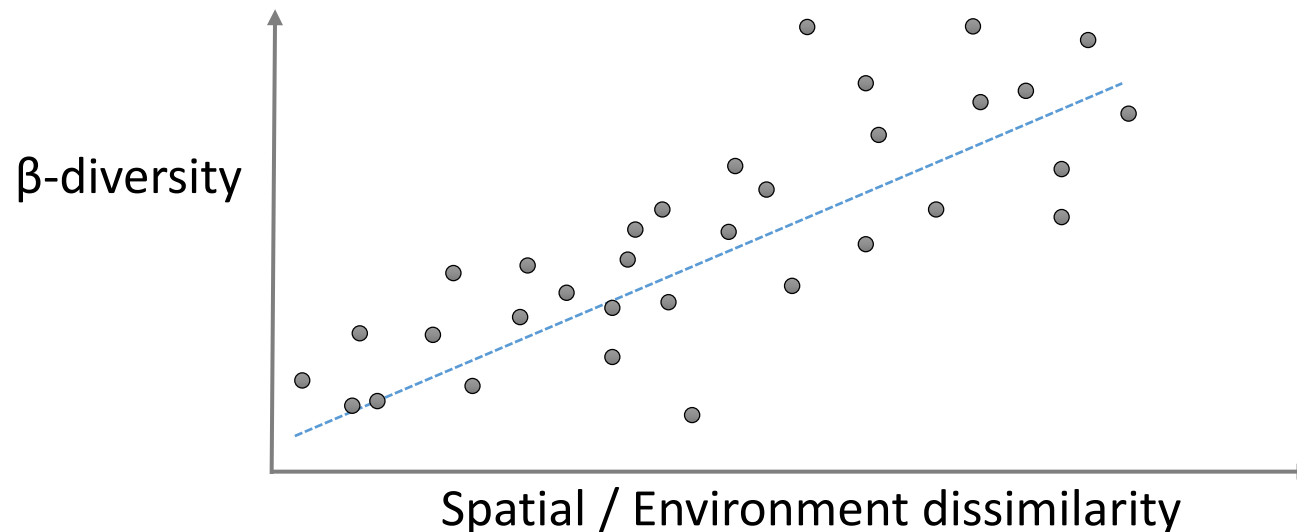
# Objectives

(3) Identify the relationships between the community with spatial and environmental parameters

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$\mathcal{H}_1$ : influence of spatial parameters

$\mathcal{H}_2$ : influence of environmental parameters



# Materials

Study area

French Alps – watershed of 'Arve'  
Summer 2017

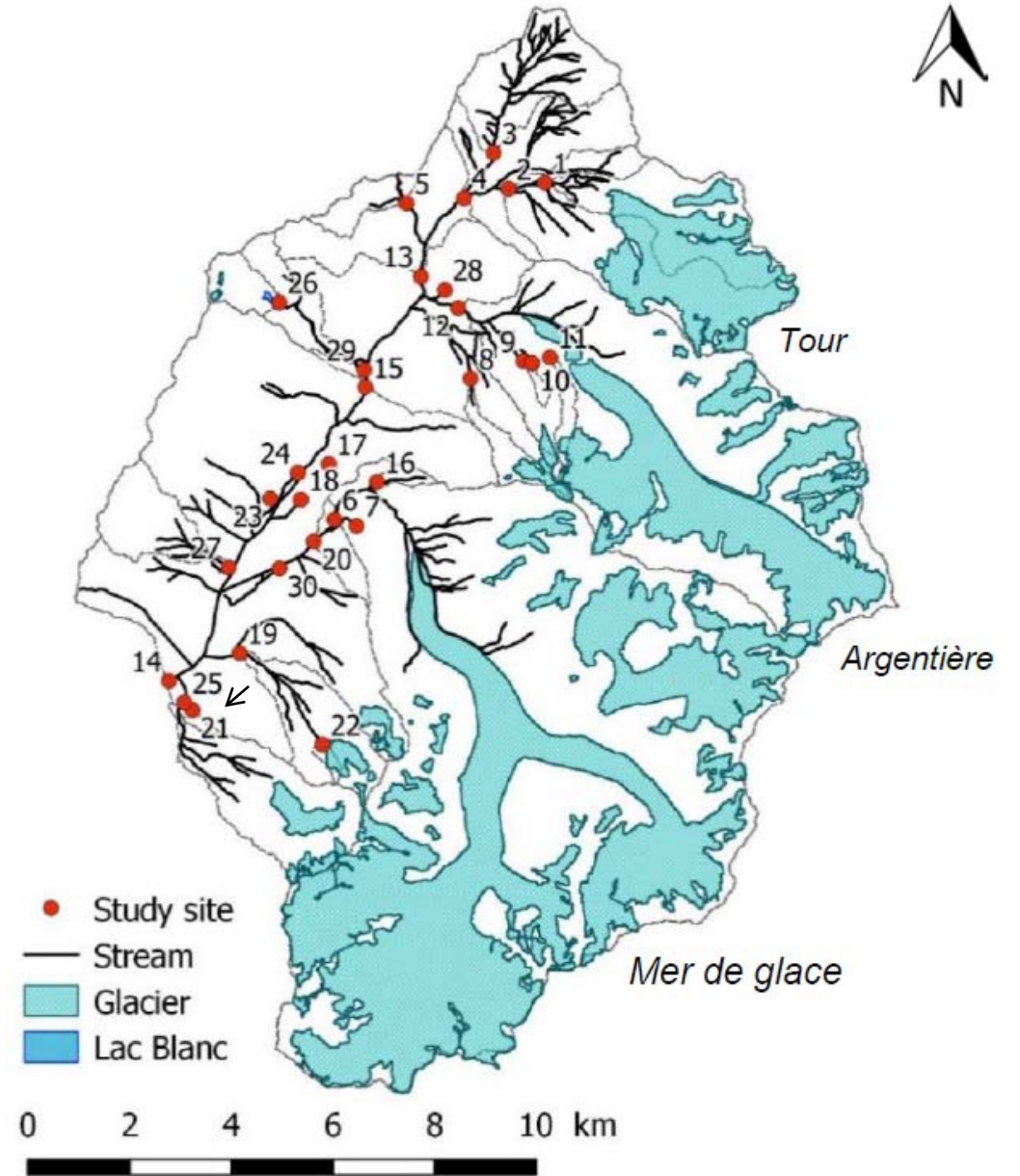
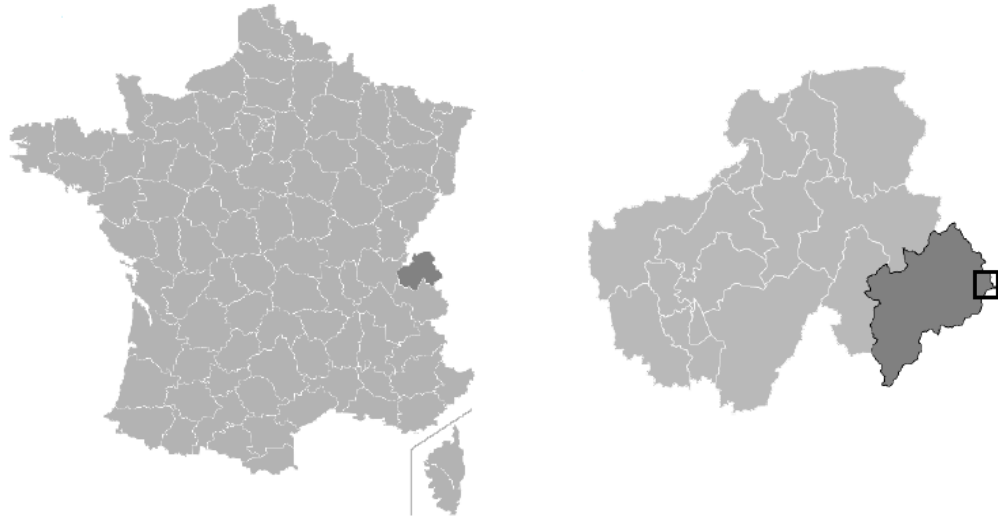


Fig 2. Map of the study site

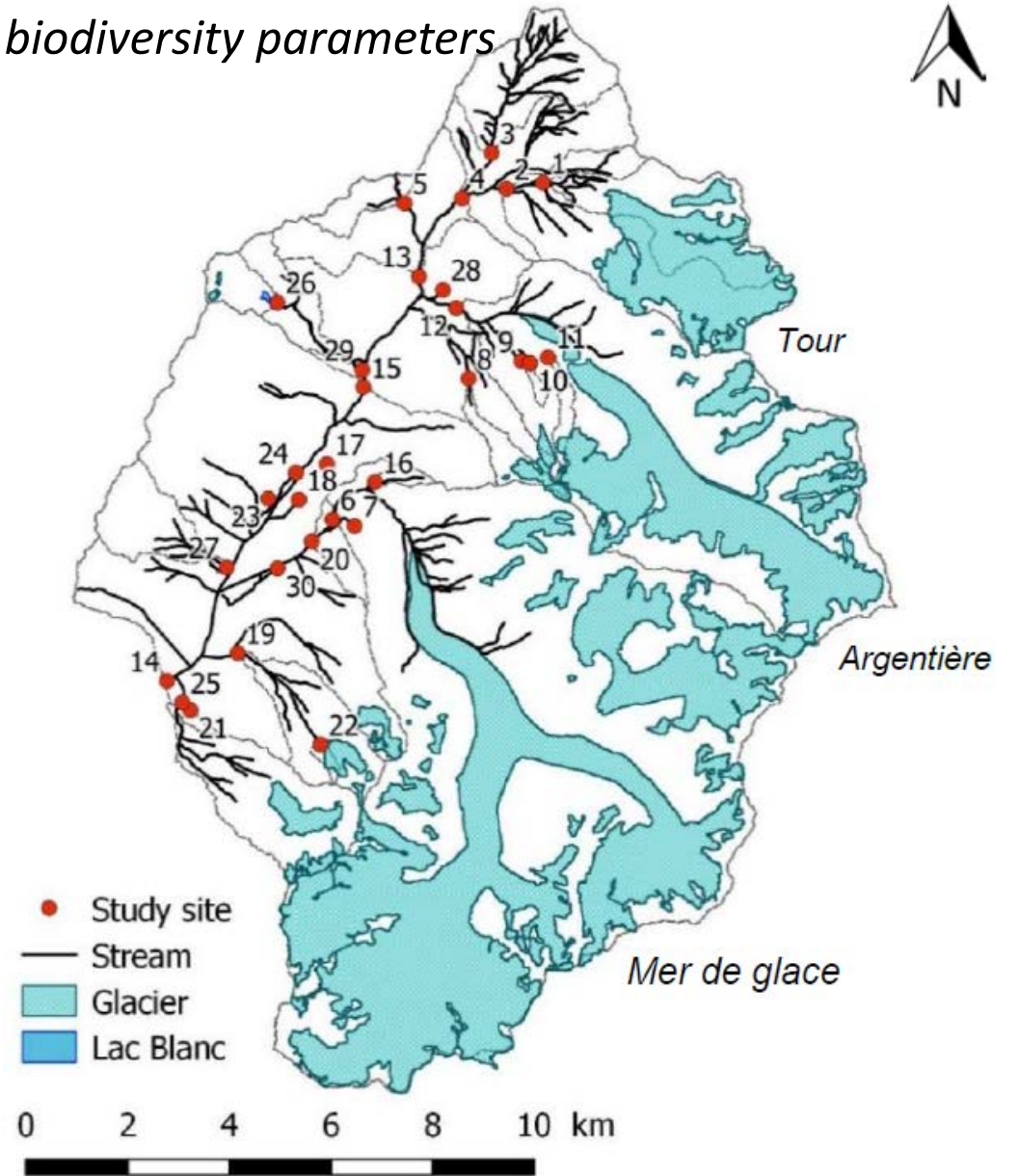
# Materials

30 sites

## Environment

- COND
- PH
- TEMP
- ALT
- SSP
- FLOW
- OXY

*Environmental and biodiversity parameters*



# Materials

*Environmental and biodiversity parameters*

30 sites

## Environment

- COND
- PH
- TEMP
- ALT
- SSP
- FLOW
- OXY
- **GCC**

$$\%GCC = \frac{\text{glacier area}}{\text{watershed area} + \text{topography}}$$

<b>A</b>	Groundwater (GCC = 0)
<b>B</b>	Snowmelt (GCC = 0)
<b>C</b>	Mix influence (GCC < 20%)
<b>D</b>	Medium glacial influence (GCC < 40%)
<b>E</b>	High glacial influence (GCC > 40%)

# Materials

*Environmental and biodiversity parameters*

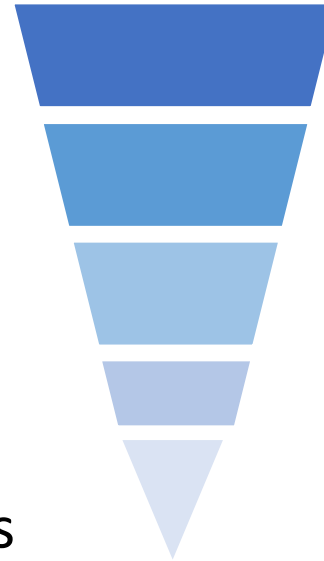
30 sites → 5 surber → 150 samples

## Environment

- COND
- PH
- TEMP
- ALT
- SSP
- FLOW
- OXY
- GCC

## Macroinvertebrates

- Class
- Order
- Family
- Genus
- Species

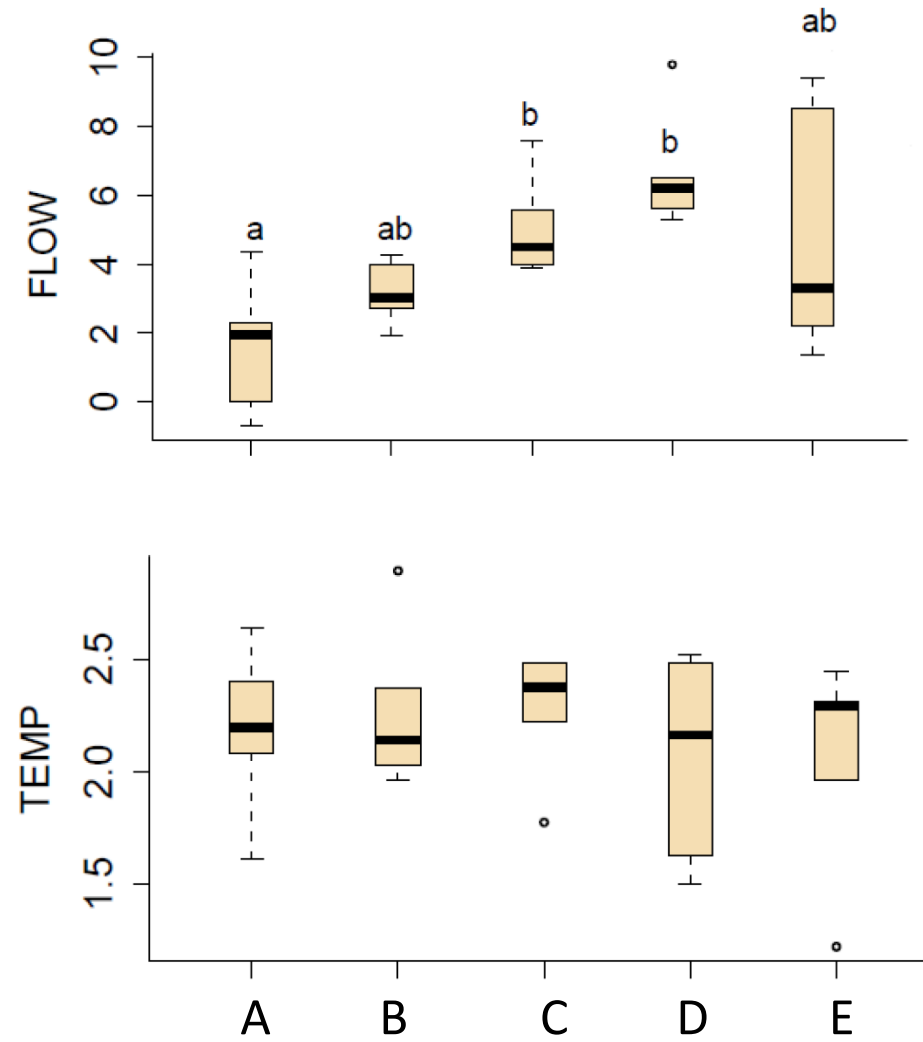
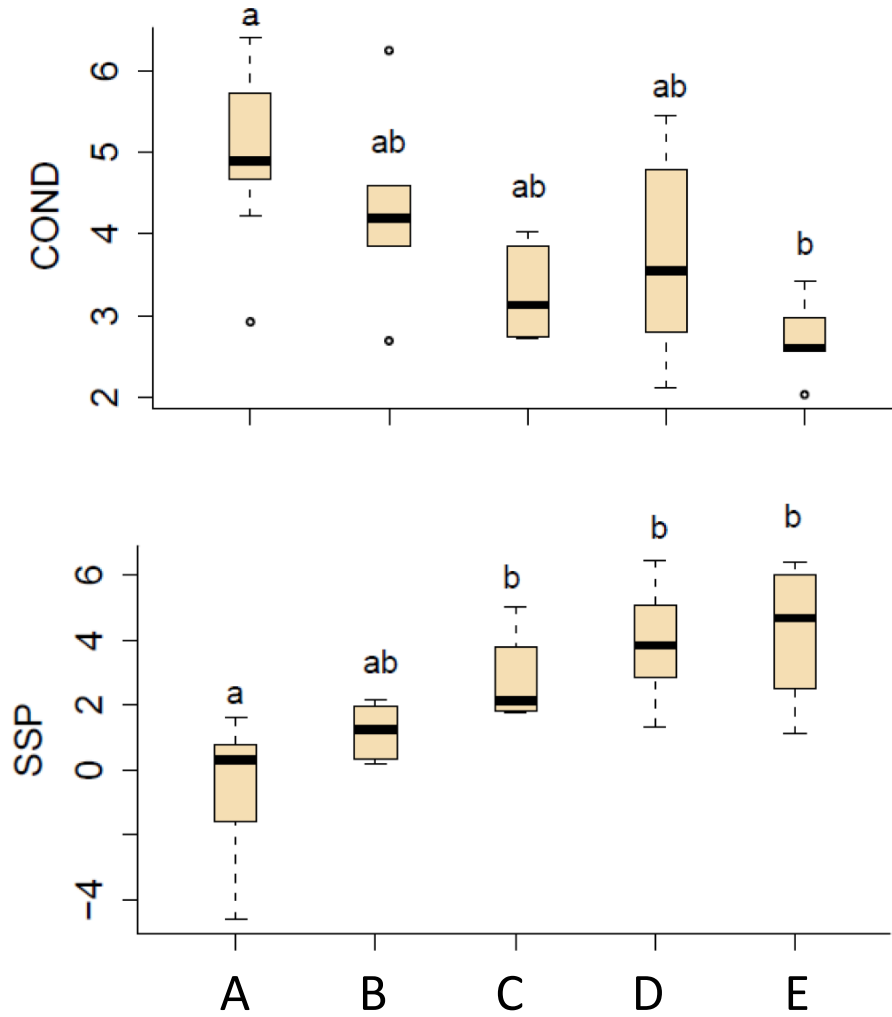


## Biodiversity

- Taxonomic richness
- Total abundance
- Shannon
- Evenness
- Beta-diversity

# Results

## (1) Environmental conditions



# Discussion

(1) *Environmental conditions*

- ✓ Significant differences of GCC / SSP / FLOW / COND  
-> *exceptions => water drainage*

↳ = GCC  $\Rightarrow$   $\searrow$  FLOW  $\Rightarrow$   $\searrow$  SSP  $\Rightarrow$   $\nearrow$  TEMP

- ✗ No significant differences of TEMP

-> *Source vs glacial stream = same temperature*

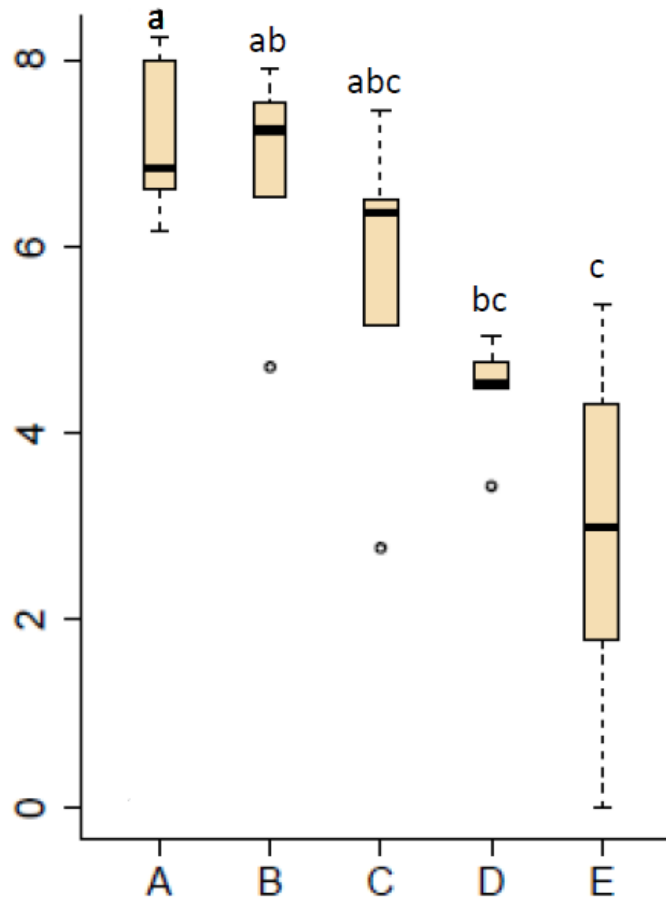
-> *end of summer  $\nearrow$  TEMP*



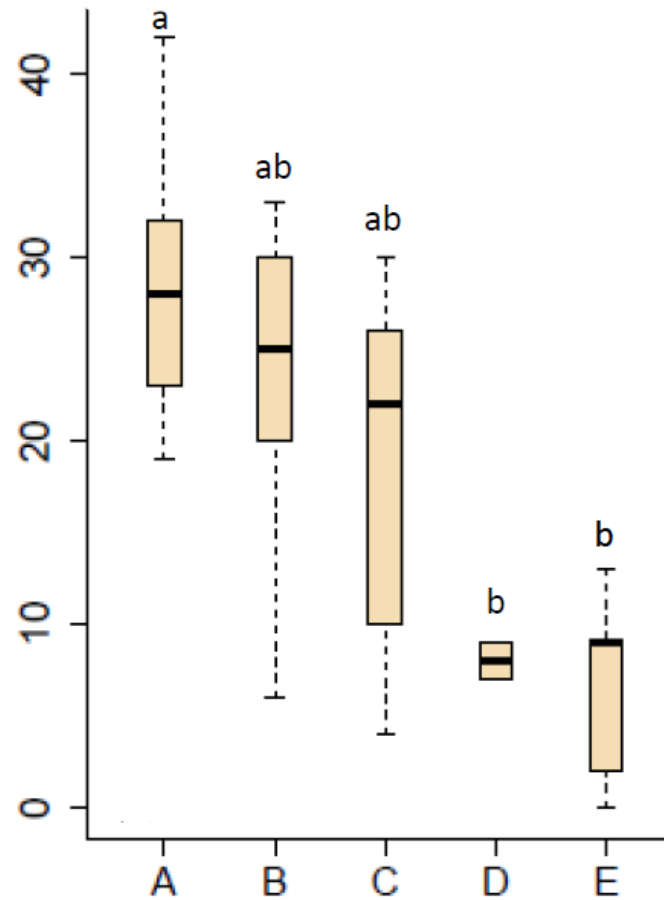
# Results

## (2) Macroinvertebrate community structure

Log(Abundance + 1)



Taxonomic richness



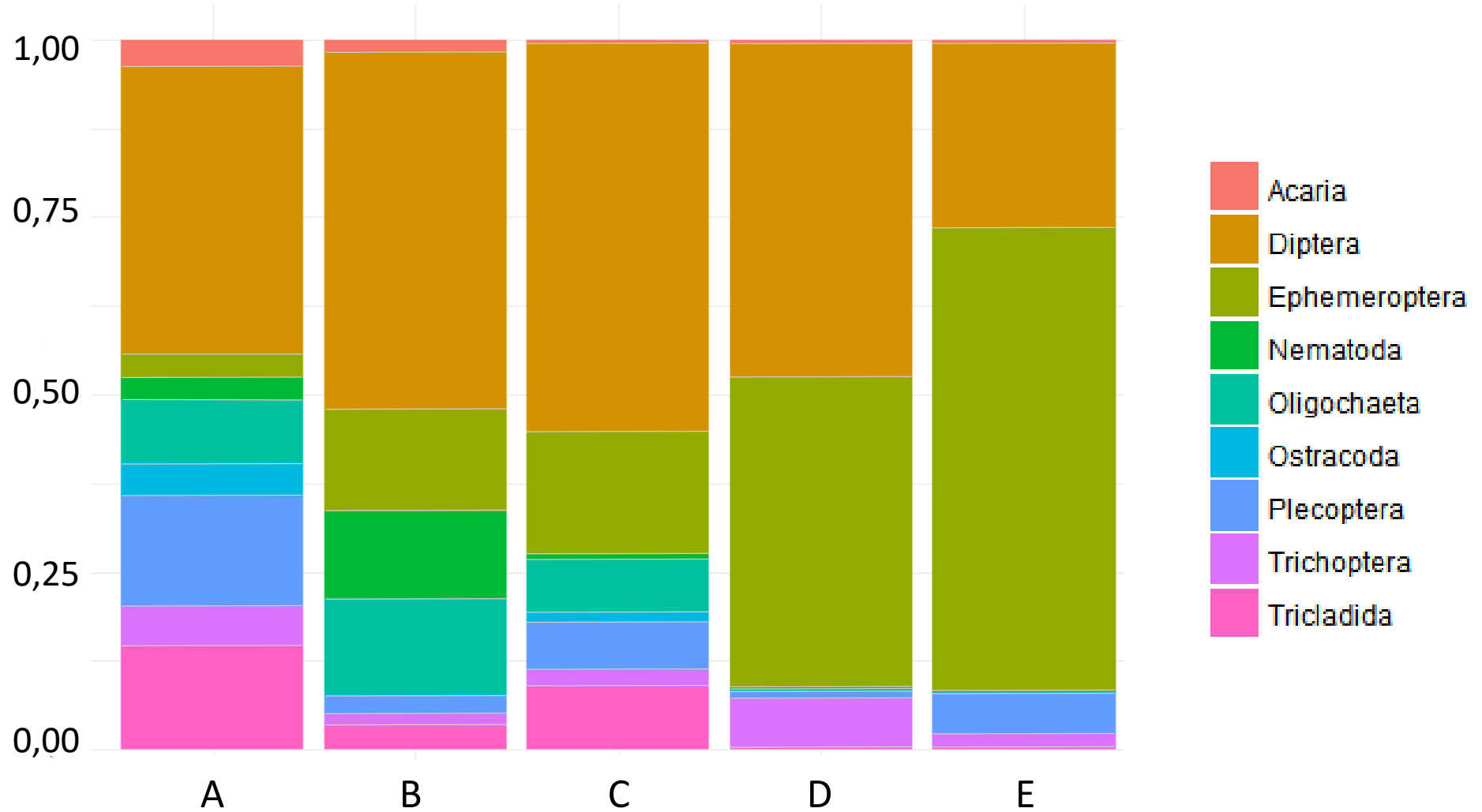
Shannon & Evenness

→ Not significant

# Results

## (2) Macroinvertebrate community structure

Order  
proportion



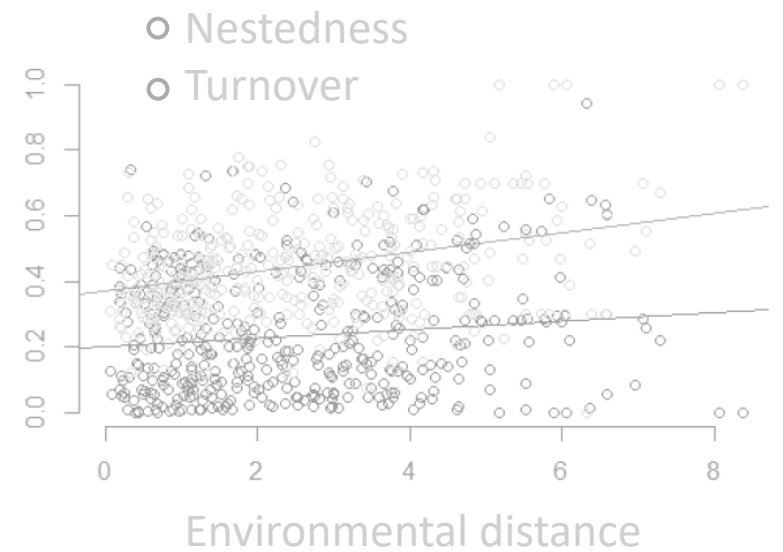
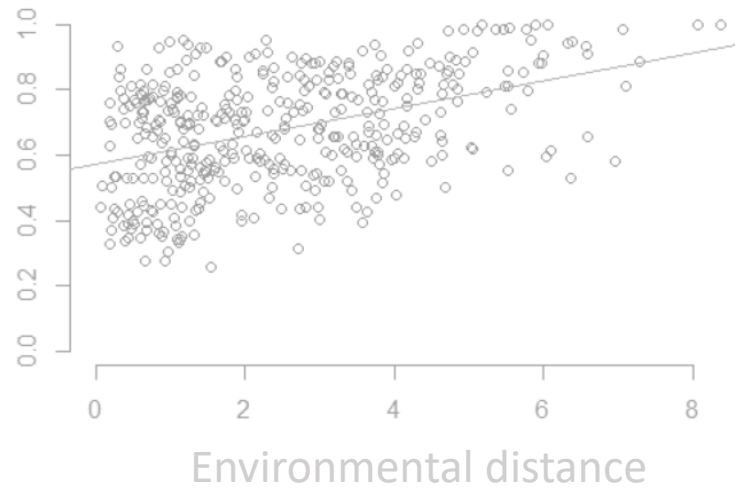
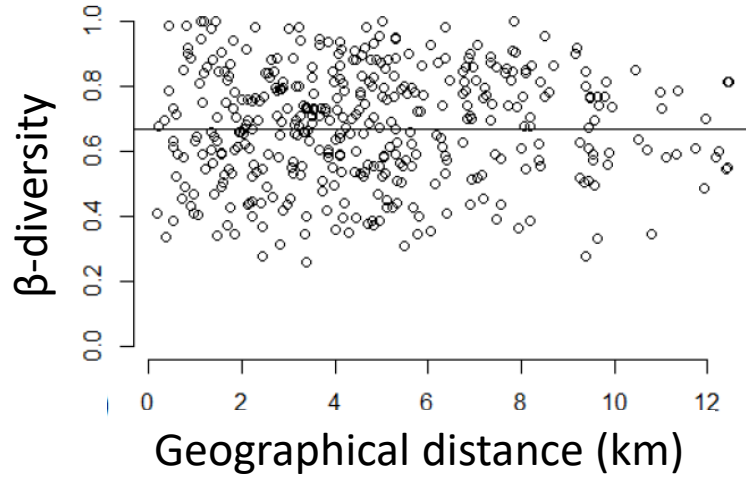
# Discussion

## (2) Macroinvertebrate community structure

- ✓ Abundance and taxonomic richness decreasing with increasing glacial influence
- ✓ Different communities among the different categories
- ✓ Globally, follow the conceptual model of Milner *et al.* (2001)

# Results

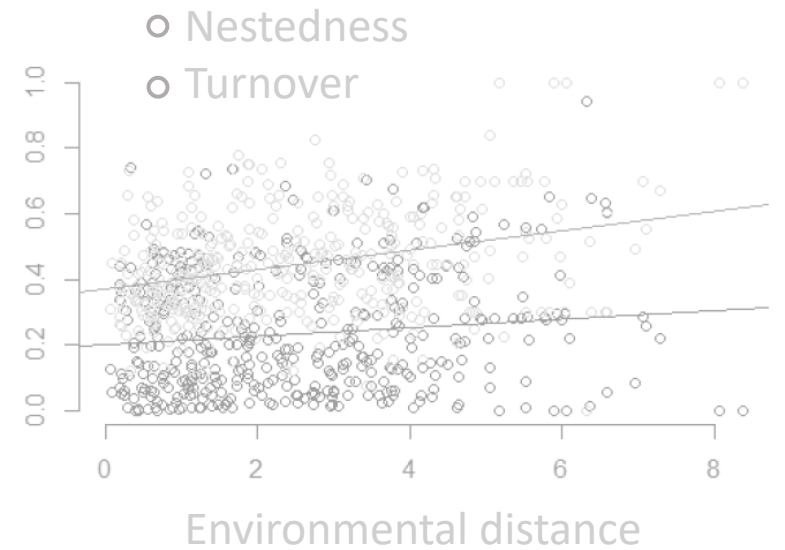
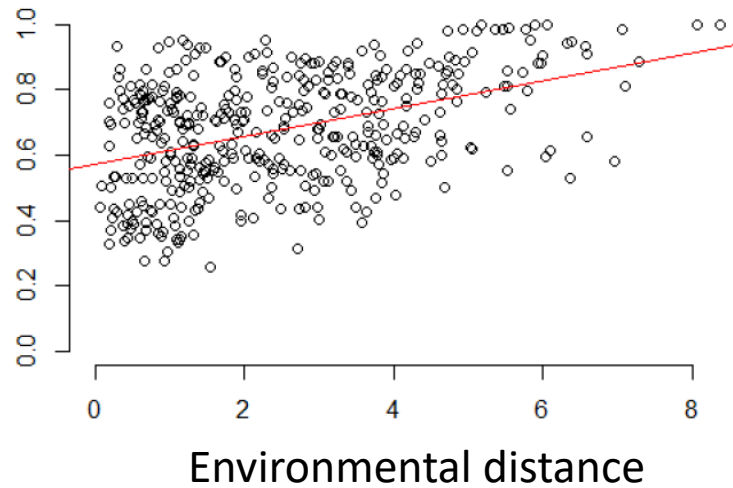
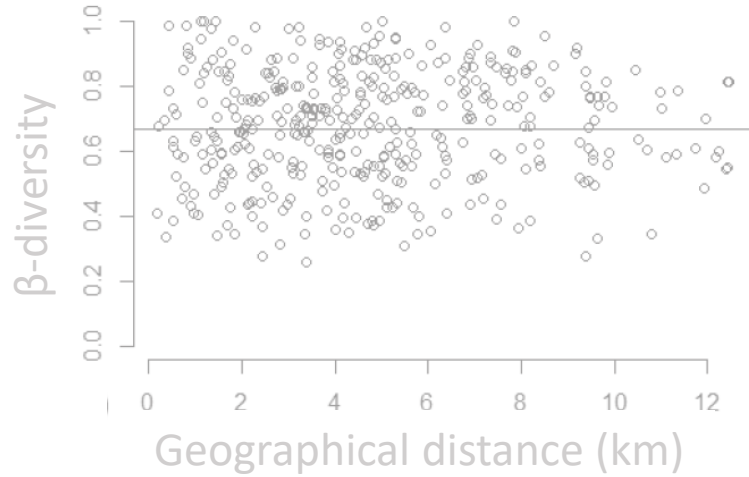
## (3) Spatial processes and environmental filtering



❖ Same trend for the Sorensen index

# Results

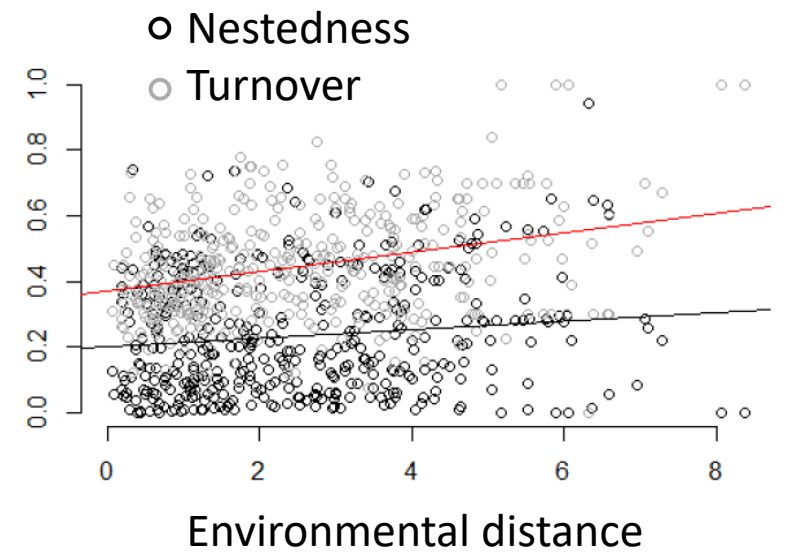
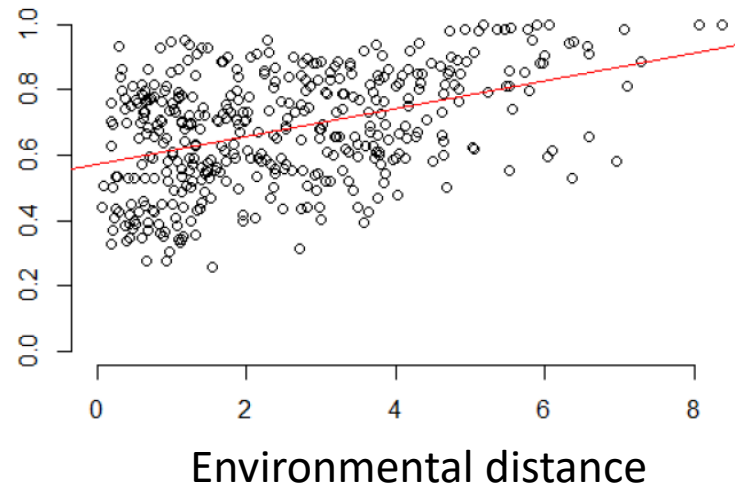
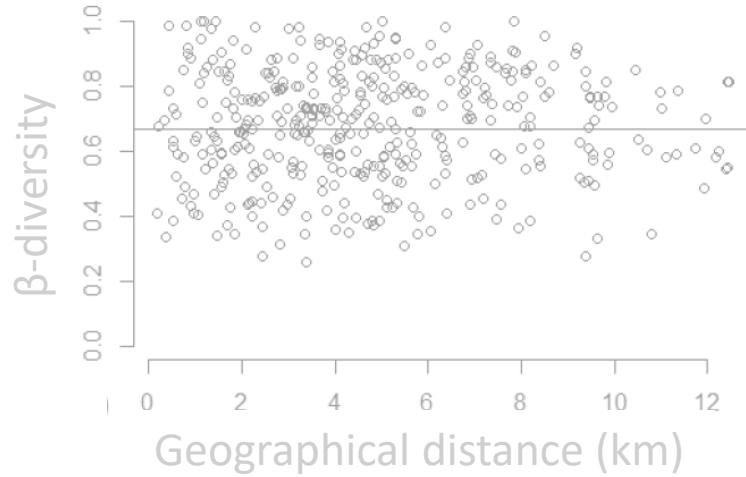
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# Results

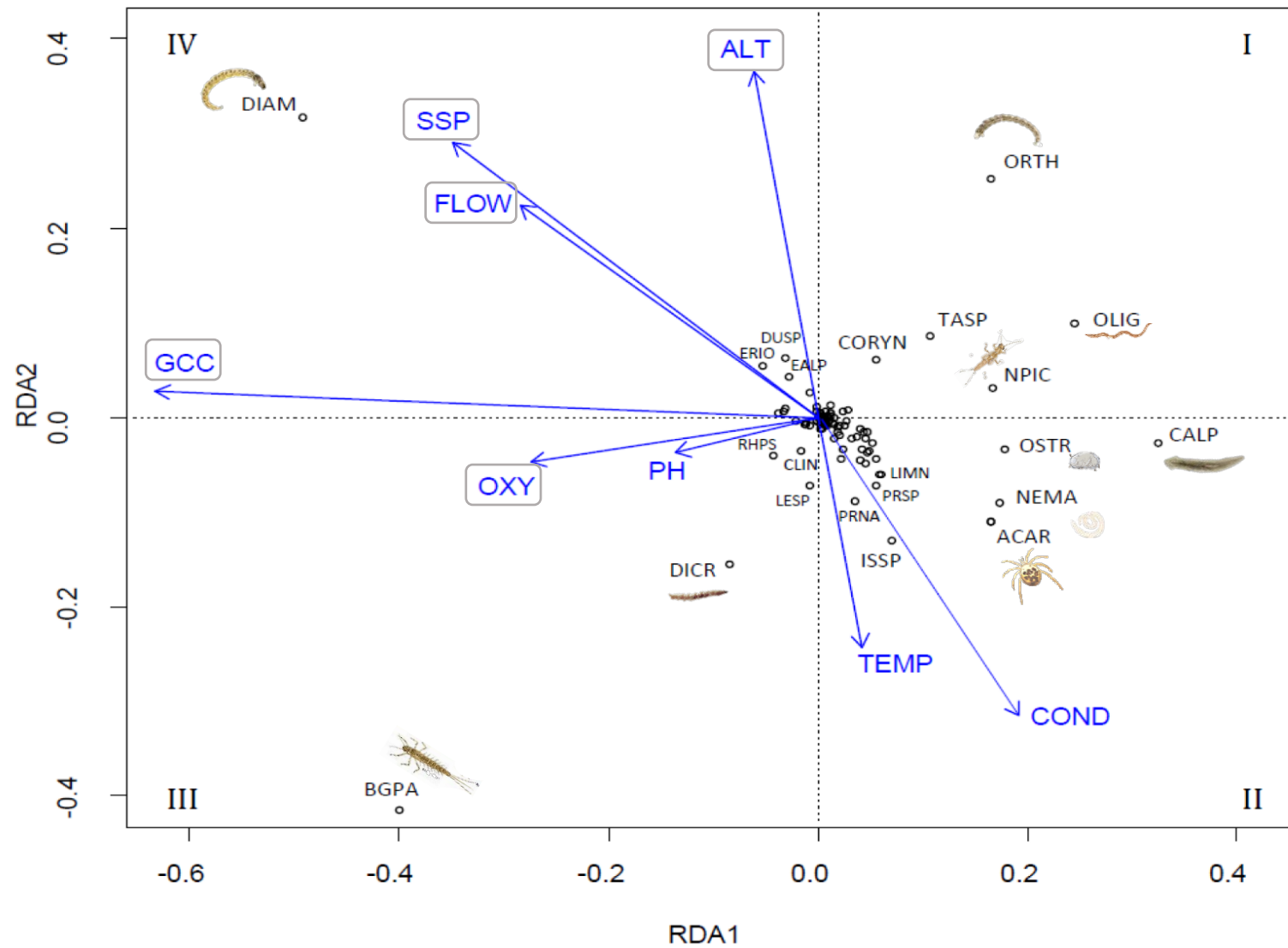
## (3) Spatial processes and environmental filtering



❖ Same trend for the Sorensen index

# Results

## (3) Relation to environmental variables



# Discussion

(3) *Relation to environmental variables*

- ✗ No influence of spatial variables
  - > environmental heterogeneity
  - > short distance between very different communities
- ✓ GCC + ALT (OXY) + FLOW + SSP = main factor in shaping the communities
  - > harsh conditions  $\Rightarrow$  hard to establish  $\Rightarrow$  endemism



# Conclusion

- ➔ Importance of the glacial influence in structuring macroinvertebrate communities
- ➔ Loss of endemic species & homogenization
- ➔ Importance of taking both environment and bioindicator in defining the alpine rivers

# Perspective

- ➔ Improve identification (ADN) + increase environmental parameters

# Thank you for your attention

## Acknowledgement

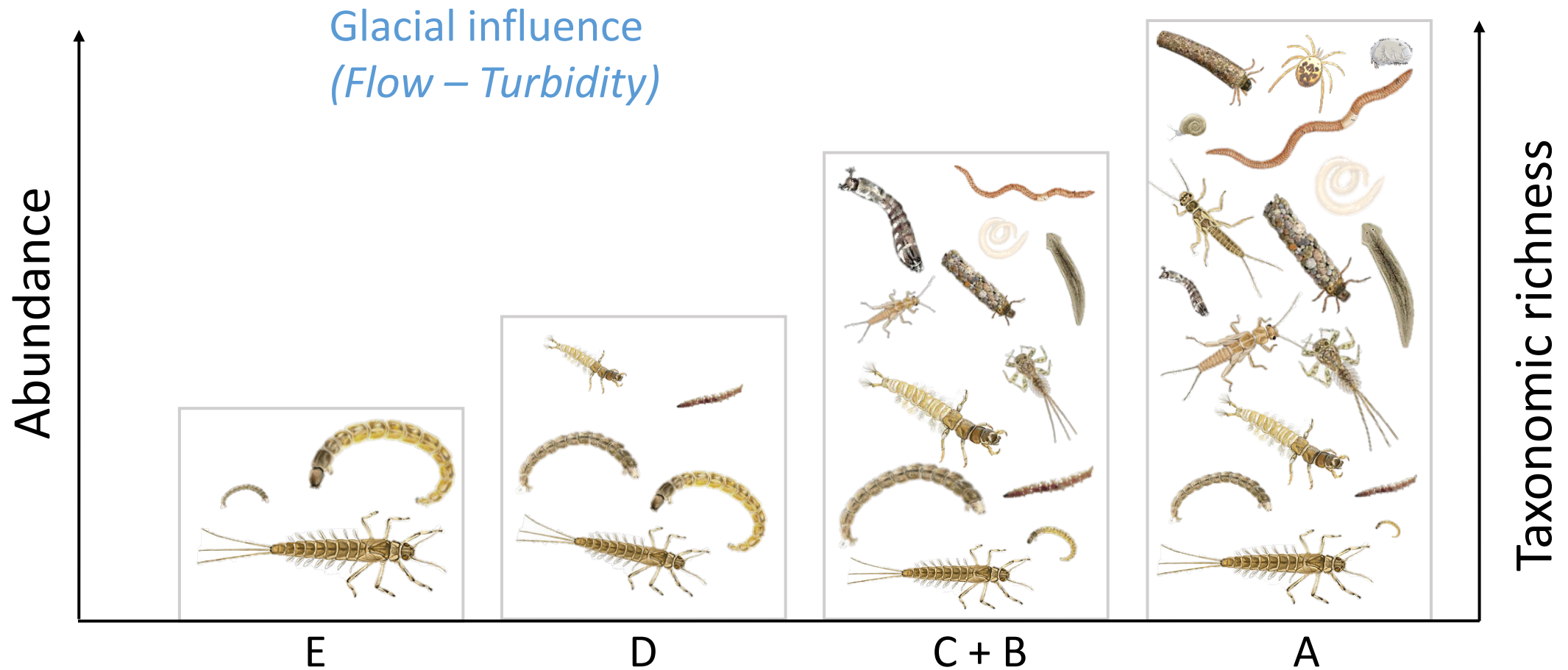
- Dr. Sophie Cauvy-Fraunié  
Supervisor
- Maxence Forcellini,  
Bertrand Launay,  
Guillaume Le Goff
- Team DYNAM



# Highlights

Snowmelt

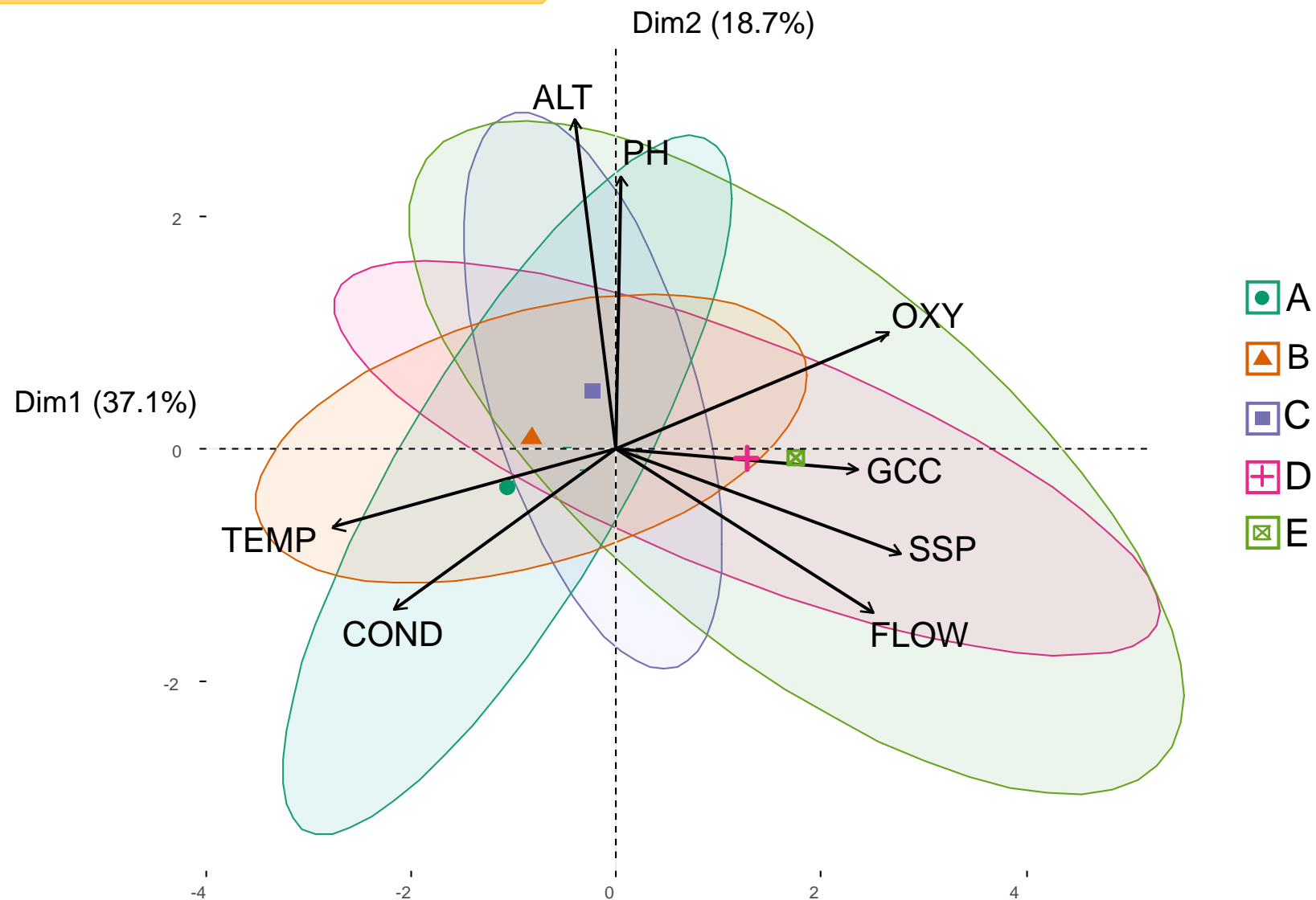
Groundwater



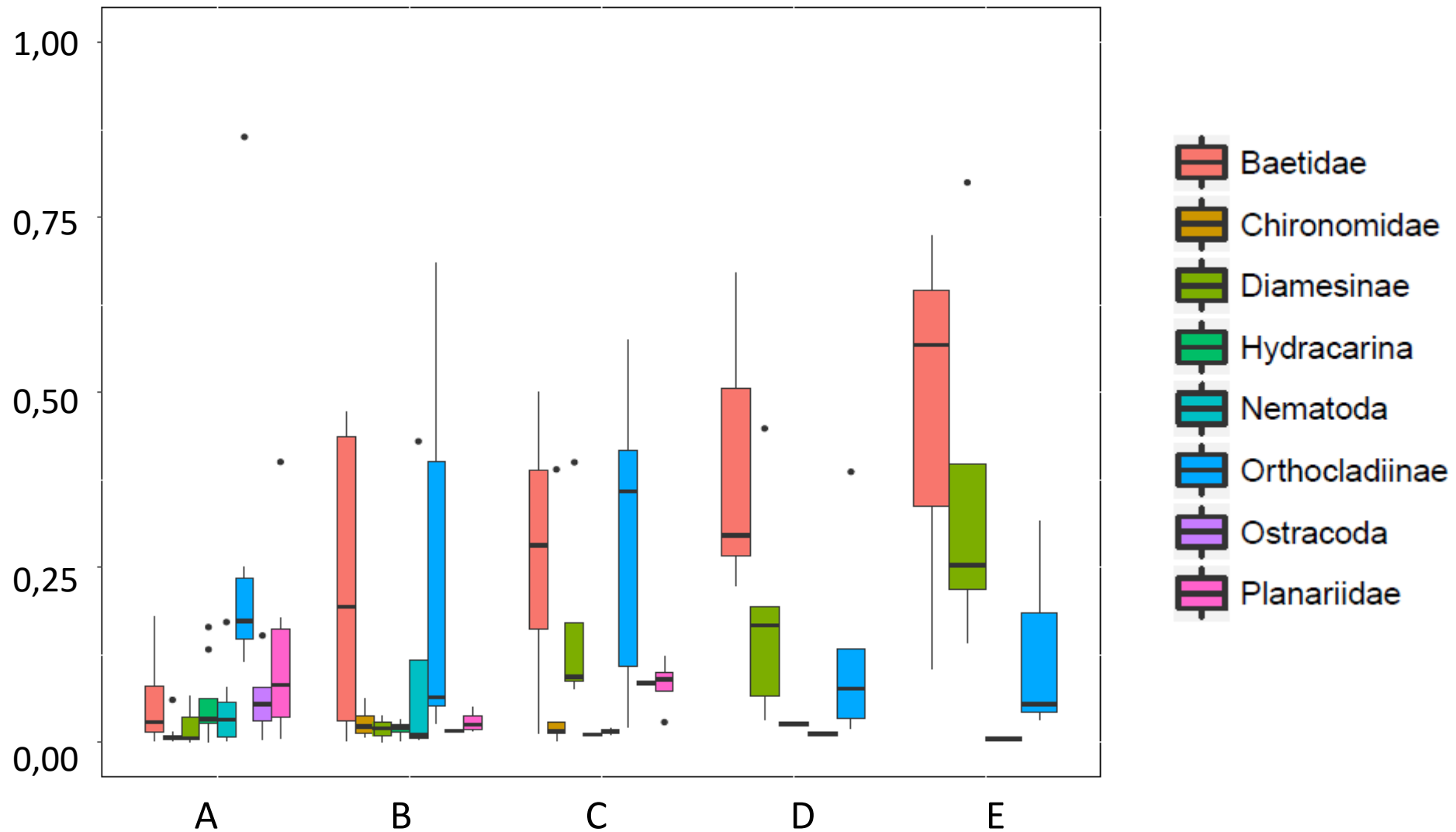
# References

- **Milner, A. M., Brittain, J. E., Castella, E., & Petts, G. E.** 2001. Trends of macroinvertebrate community structure in glacier-fed rivers in relation to environmental conditions: a synthesis. *Freshwater Biology*, 46(12), 1833-1847.
- **Brown, L. E., Hannah, D. M., & Milner, A. M.** 2003. Alpine stream habitat classification: an alternative approach incorporating the role of dynamic water source contributions. *Arctic, Antarctic, and Alpine Research*, 35(3), 313-322.

# Supplementary information

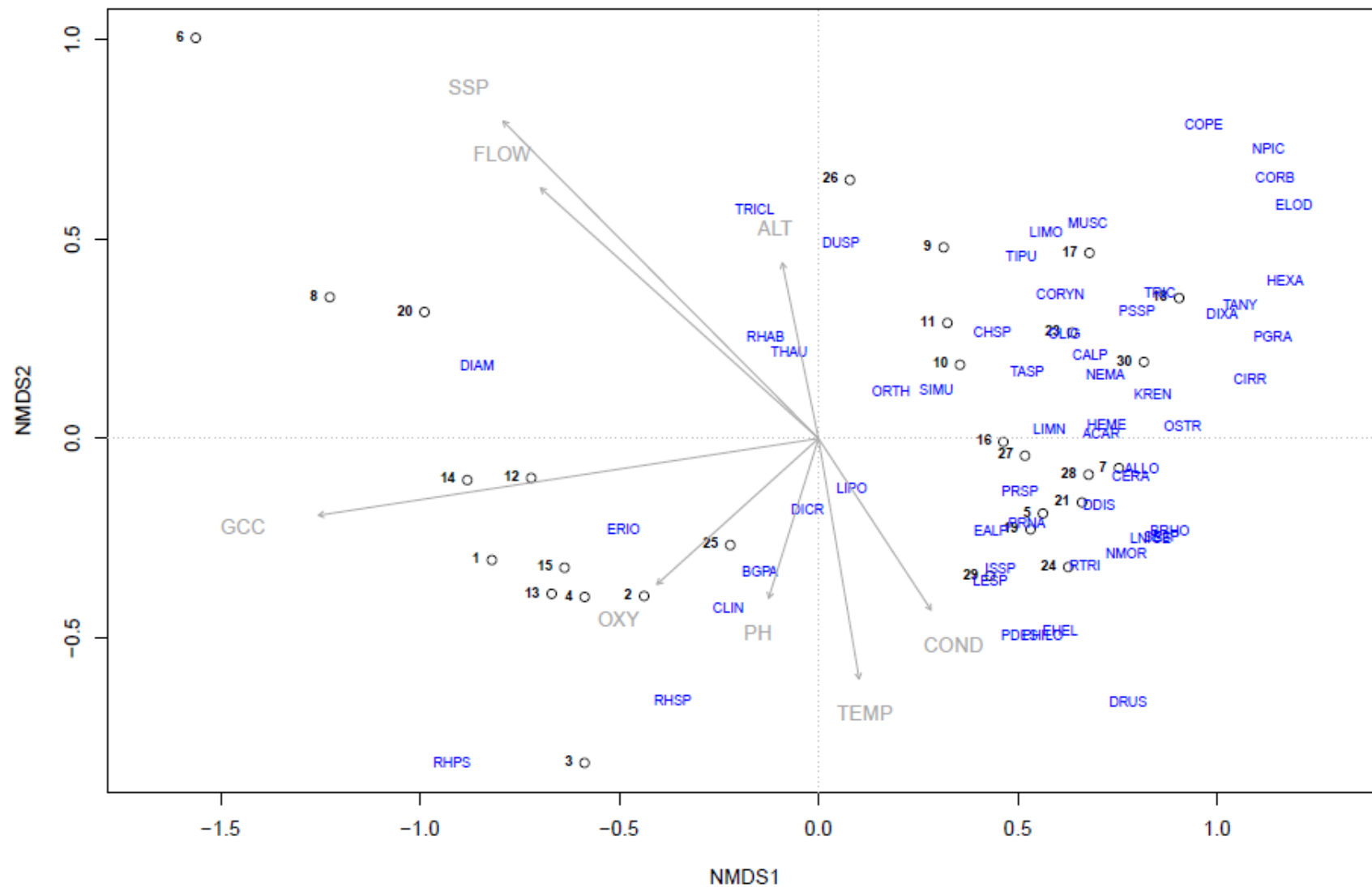


# Supplementary information



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NMDS/Bray - Stress = 0.083



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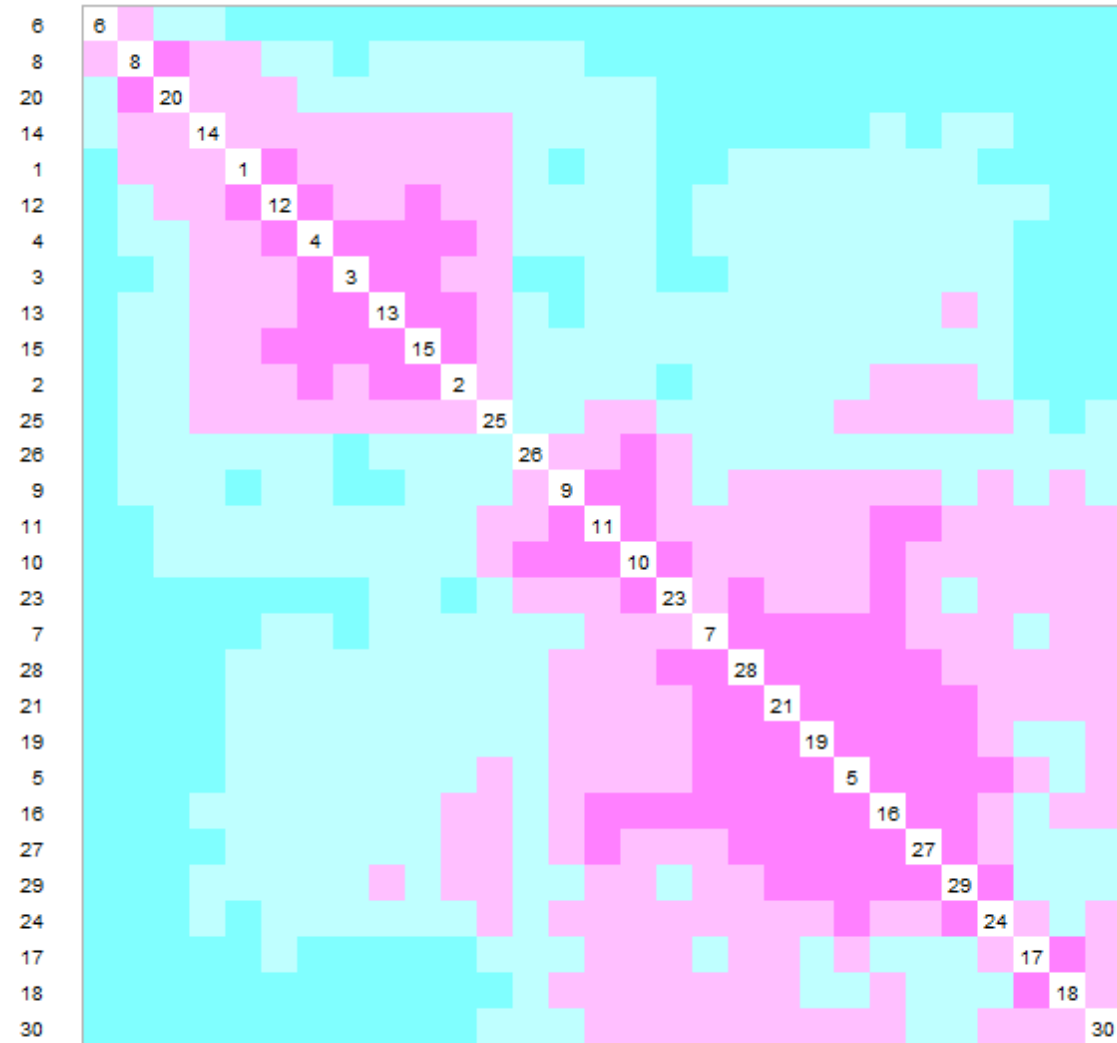
Community cluster:

-> High glacial influence

-> Medium glacial influence

-> Mix influence

-> Sources



Bray-Curtis dissimilarity 'heat map'





# Supplementary information

'Guttman effect'

