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Connections, disconnections and reconnections in socio-hydrosystems: Towards a better integration of the vertical dimension?

Anne-Lise Boyer, Postdoctoral Fellow, CNRS Labex DRIIHM, IRL iGlobes at the University of Arizona – 2023 AAG Annual Meeting, Denver, CO

Abstract:

The relationship between societies and their hydrosystems can be understood as a series of connections and disconnections that occur in all domains (e.g., hydrological, geomorphological, ecological, etc.) and dimensions (e.g., longitudinal, vertical, lateral). The use of watercourses creates material and symbolic connections which leads to also consider the sociological, political, aesthetic, and spiritual dimensions of the socio-hydrosystem.

Technical progress and the multiplication of infrastructures have contributed to the invisibilization of water resources. The issue of visibility is to be understood as lying at the intersection of relations of perceptions and relations of power which shapes decision-making.

As a result, recent water and environmental policies emphasize the importance of connectivity between the various compartments of the socio-hydrosystems, and focus especially on reconnections at all levels. Successfully restoring the socio-ecological connectivity is tied to (in)visibility dynamics that must be taken into account. The objective is to analyze the impacts of the (in)visibility of challenges such as emerging pollutants and hydrological changes in the context of climate change.

A network of Human – Environment Observatories:

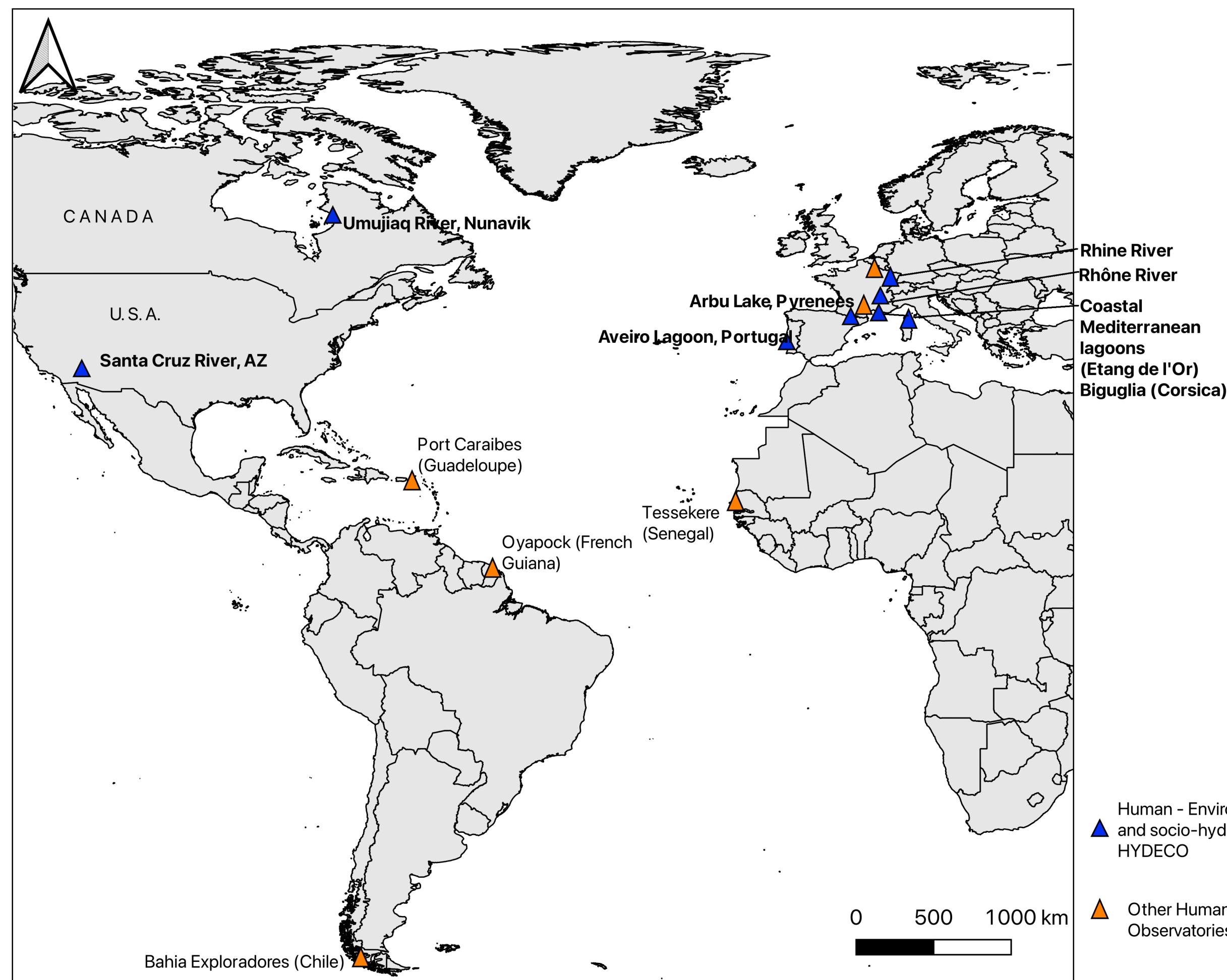
To respond to the complexity of the socioecosystemic crises that increasingly affect an anthropized and globalized planet, the **Human-Environment Observatories (OHM)** are a research infrastructure created by the Institute for Ecology and Environment of the CNRS (France). The first one was created in 2007. Today there are 13 OHM, spread across metropolitan France (6), overseas (2) and abroad (5). All OHMs are built upon:

- a founding event triggering of human origin that disrupts the entire functioning of an ecosystem;
- the convergence of Earth, Life, Human and Social Sciences in an interdisciplinary approach to address the complexity of the socio-ecosystems under study;
- the development of scientific research to understand the mechanisms at play and to better inform political and economic decision-makers and citizens in their choices for the resolution of ongoing environmental crises.

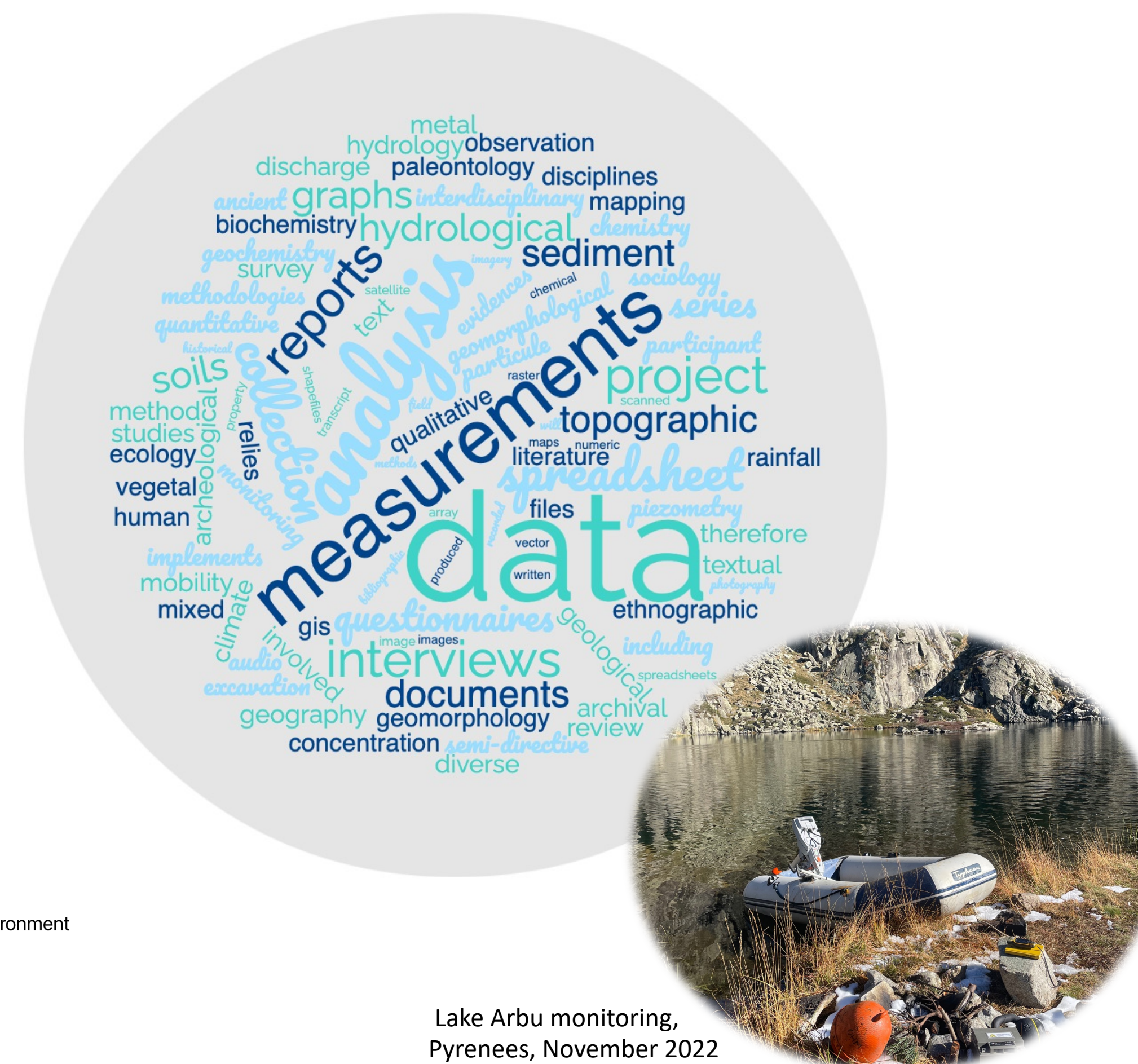


HYDECO: an interdisciplinary research project 2022 – 2024

Monitoring the evolutions of 8 socio-hydrosystems in the face of climate change



Materials and Methods:



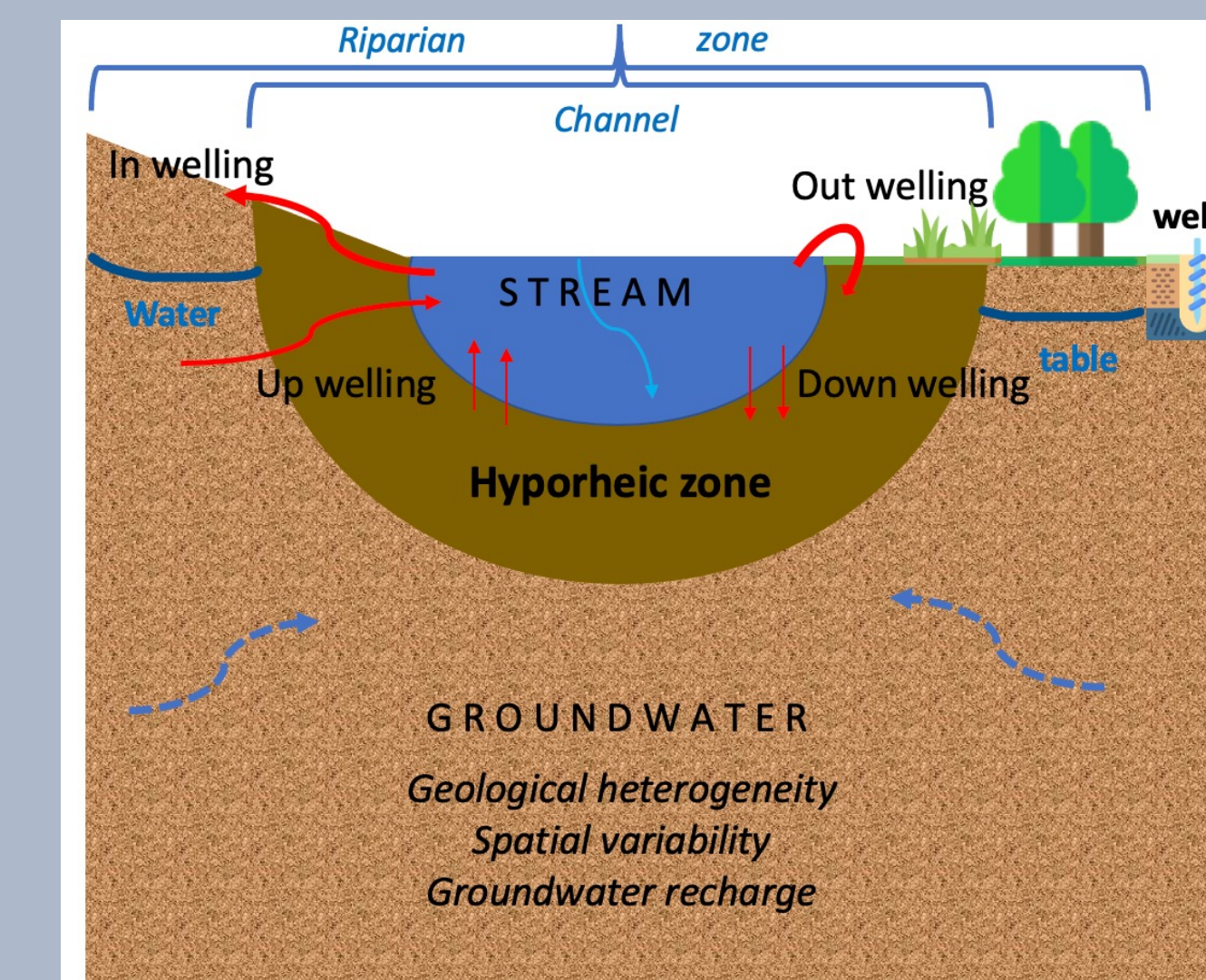
The social connectivity of invisible subsurface flows: towards a better integration of the vertical dimension in socio-hydrosystems studies

○ The importance of vertical connectivity for the sustainability of groundwater-dependent ecosystems

- two-way exchanges between the surface and water located in the underground, e.g., surface water infiltration into the alluvial aquifer or exfiltration of phreatic water from the hillslopes aquifer to supply the stream and other floodplain water bodies.
- Lagoons but also rivers and their adjacent areas (e.g., alluvial plain) are considered groundwater-dependent ecosystems : about 30% of streamflow comes from groundwater

○ Groundwater, shallow groundwater, and the hyporheic zone

- The existing hydrologic exchanges between the different water bodies and the vertical linkages are not always fully appreciated: difficulties to assess groundwater volumes, recharge rates and sources
+ **low recognition of the linkages between groundwater and many surface water ecosystems.**
- Groundwaters are **heterogeneous** and **ubiquitous** because of their extensive distribution , “both on top of and within the earth with a varying degrees of **connectivity** that depends on **geology** [e.g., shallow aquifer, deep aquifer, fossil aquifer, etc.] and human action [e.g., withdrawals]” (Walsh, 2022)
- **The hyporheic zone:** the region of sediment and porous space beneath and alongside a stream bed, where shallow groundwater and surface water mix



Cienega Creek, Empire Ranch, Las Cienegas Conservation Area (Southern Arizona, April 2022)



Wellfield of the Crépieux Charny water production facility (Lyon, FR, September 2019)

○ Verticality, the subsurface, and why it matters in the Anthropocene

- The “vertical turn” and “**volumetric thinking**” in social sciences: the close articulation of horizontality and verticality + **integration of variables of depth, height, and distance.**
- Groundwater-dependent socio-hydrosystems face a particularly volumetric challenge: **groundwater depletion and contamination, and their consequences on the surface** (e.g., subsidence, drinking water supply availability, irrigated agriculture and food production, social conflicts, and land use transformations, etc.)
- In the Anthropocene, as interests in **conserving and restoring the subsurface flows** and their interactions with the surface strengthen, verticality comes to matter in the process of making sense of this continuum between surface and subsurface by **articulating with existing geomorphic, hydrologic, and ecologic analyses but also with current modes of governing and policing resources and people.**

○ Reclaiming the hyporheic zone: the social connectivity of subsurface flows

- Different factors for a **social recognition** of the hyporheic zone and the importance of shallow groundwater:
 - the presence/ absence of a **healthy riparian forest**: wildlife refuges, important recreation areas, or just shade in desert cities parched by the urban heat island effect.
 - **dry and wet participatory surveys**, efforts are made to recover the loss of **socio-cultural connectivity** to “the rhythm of rivers” (Wantzen, 2022).
 - materializing waterscapes with a focus on the interface between groundwater and surface water to **disrupt the loose regulation of extractive exploitation of streams and groundwater** (Wölflé-Hazard, 2022).
 - **integration of unconventional research methods and traditional knowledge, environmental justice** issues and research related to health and livelihood.

DISCONNECTIONS

Hydroelectric dam on the Rhine River



- **Hydrological connectivity** : “the water-mediated fluxes of material, energy, organisms within and amongst components (Kondolf et al., 2006)

- In 5 dimensions: longitudinal, lateral, and vertical dimensions
 - + over time
 - + **social connectivity** : communication and movement of people, goods, ideas, and cultures along and across rivers

➡ **Disconnections = lost linkages**



Salinity control gate, Etang de l'Or, FR

RECONNECTIONS

Rice fields, Aveiro, Portugal



➡ **Reconnection** : recovery of lost linkages over time, e.g. restoration projects and the responses they trigger in the system.

➡ **Attachment and stronger emotional reactions**, e.g. mourning and grieving in the face of environmental changes



Waterfront in Lyon, Rhône River, FR

Kondolf, G. M., et al. "Process-based ecological river restoration: visualizing three-dimensional connectivity and dynamic vectors to recover lost linkages." *Ecology and society* 11.2 (2006).

Walsh, C. (2022). Beyond rules and norms: Heterogeneity, ubiquity, and visibility of groundwaters. *Wiley Interdisciplinary Reviews: Water*, 9(4), e1597.

Wantzen, Karl Matthias. "River culture: How socio-ecological linkages to the rhythm of the waters develop, how they are lost, and how they can be regained." *The Geographical Journal* (2022).

Wölflé-Hazard, C. (2022). *Underflows: Queer trans ecologies and river justice*. University of Washington Press.

