Critical analysis of the eLTER France OZCAR compliance with the Whole System Approach concept of eLTER Research Infrastructure

Session 2: Long term environmental observation for understanding the Earth system in the Anthropocene
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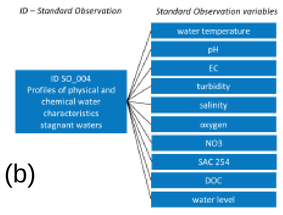
1. eLTER RESEARCH INFRASTRUCTURE AND eLTER STANDARD OBSERVATIONS

- eLTER (Integrated European Long-Term Ecosystem, critical zone and socio-ecological Research, https://elter-projects.org/) is a European Research Infrastructure currently under construction. Its aim is to provide researchers with access to long term instrumented sites and LTSER (Long Term Socio-Ecological Research) platforms across Europe, to establish and offer harmonized and standardized data, services and training useful to citizens and experts in their joint efforts to find sustainable solutions to environmental challenges such as biodiversity losses, water resources and ecosystems degradation, food production under global changes.

(a)



(b)

Figure 1: (a) The five spheres considered in defining the eLTER RI Standard Observations: (b) An example of Standard Observation

eLTER Standard Observations (Zacharias et al., 2022)

- Based on the Whole System Approach for in-situ research on Life Supporting Systems in the Anthropocene (WAILS) that promotes interdisciplinary research
- Definition of a set of core variables, the Standard Observations, to document ecosystems and the critical zone functioning, covering five spheres (Fig. 1a): the atmosphere, biosphere, geosphere, hydrosphere and social and economic spheres
- Proposition of a set of variables (see one example in Fig. 1b) per typical ecosystem habitats (wetland, grassland, forest, agricultural, inland standing or running waters) with two levels of complexity: basic and prime methods and an evaluation of associated costs (installation, operation)

The questions that we addressed with the French OZCAR critical zone network as a case study

⇒ **How to select sites within existing observations networks to upgrade them towards eLTER RI standards when they were not designed for the WAILS approach?**

⇒ **What will be the cost of this upgrade?**

2. THE eLTER-FR OZCAR CRITICAL ZONE NETWORK

The critical zone:

- The thin layer of the Earth's surface, from the un-weathered bedrock up to the top of the atmospheric boundary layer with processes acting from the second (biological processes) to the million years (geological processes)
- A Critical Zone for humanity, because it's where we live and where we draw our vital resources (water, soil, air)
- Diversity of objects of Interest (watersheds, rivers, aquifers, glaciers, peatland, land surface) and observations (water, energy, chemical elements, nutrients cycles) (Fig. 2)

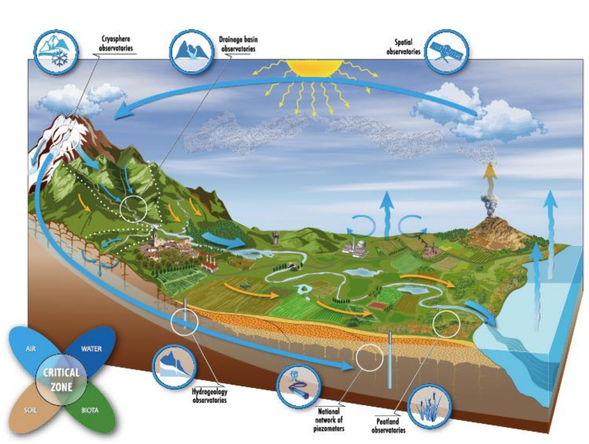


Figure 2: Schematic view of the critical zone with the various sampled compartments and objects @ Joël Dion, IPGP

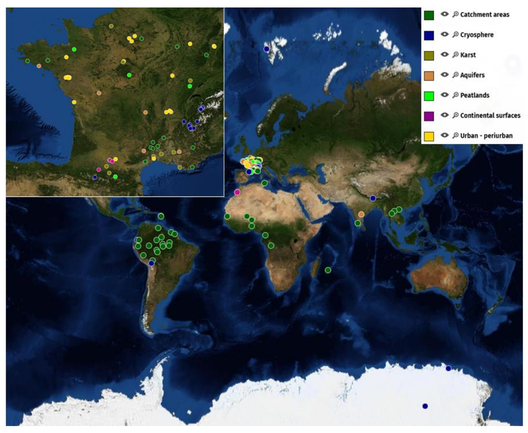


Figure 3: Location of the OZCAR RI observation sites (OZCAR RI, 2023)

OZCAR-RI (https://www.ozcar-ri.org/):

- A network of 22 long-term observatories for the understanding and integrated simulation of the evolution of the Critical Zone and its various compartments in the Anthropocene with more than 80 sites in the world (Fig. 3)
- Observation sites built to answer specific scientific questions (acid rain, floods, water resources, intensive agriculture, etc..) leading to sites with a disciplinary focus

=> Need for a diagnostic tool to assess the suitability of sites to move towards the WAILS approach and a eLTER RI labelling

3. Materials and methods

- Establishment of a list of sites, generally fields or small catchments included in the analysis
- Survey of the measured variables within these sites, including the acquisition frequency and the period of measurements (Fig. 4)
- Identification of the measured variables that are included in the eLTER RI Standard Observation lists of Zacharias et al. (2022)
- Production of synthesis graphs per sites, e.g. number of measured variables per sphere (Fig. 5), graphs providing a synthesis of the frequency and length of the measurement period (Fig. 6)

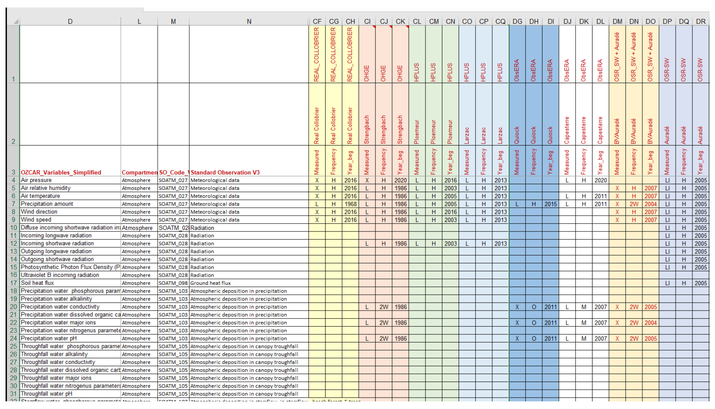


Figure 4: Partial view of the file used to survey the measured variables per site

Figure 5: Pie chart of the measured variables for two sites located in an intensive agriculture context. (a) A catchment with a focus on hydrosphere and (b) A ICOS site with a focus on atmosphere and the land surface. Both sites are located close to each other. The analysis shows that they are complementary and could be combined to become a eLTER RI site

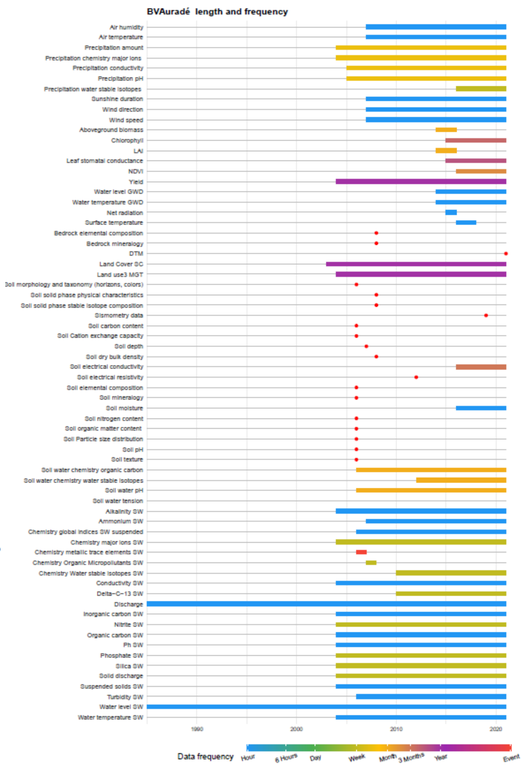


Figure 6: Synthesis view of the measured variables in the site presented in Fig. 5a showing the length of the time series and the frequency of the measurements (colors)

4. Results of the analysis

- Comparison of the various sites to asses those with the better potential to be upgraded to comply with eLTER standards, including the possibility to combine several sites (Fig. 7)

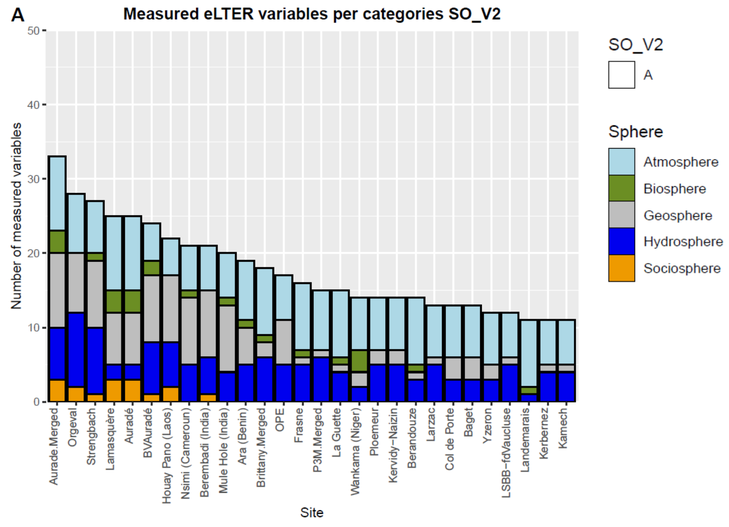


Figure 7: Number of measured variables per sphere, according to the list of eLTER Standard Observations (Zaccharias et al., 2022). Sites with "merged" combine the measured variables of several nearby sites

⇒ Identification of the sites with the highest potential (larger number of measured variables, largest number of monitored spheres) for complying with eLTER standards

⇒ Identification of the value of combining several sites located close to each others

- Assessment of the costs to comply with eLTER Standard Observations measurements for the different proposed habitats (Fig.8)
- Assessment of the additional cost to be invested to comply with eLTER requirements (Fig. 9)

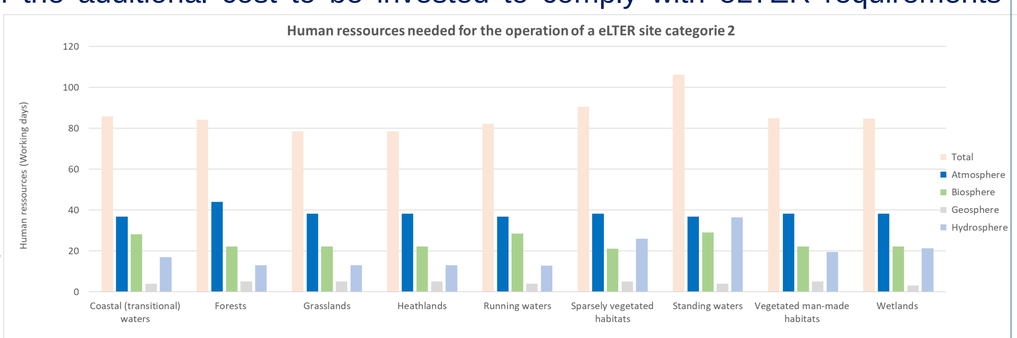


Figure 8: Human resources (in working days per year) required for the operation of a eLTER site (category 2 – basic methods) for the various habitats. Also available investment and operation costs

(a)

Category 2 Basic method	Vegetated man-made habitats			
	Investment		Operation (per year)	
	EUR	WD	EUR	WD
Total	**18 610**	**14**	**14 290**	**71**
Atmosphere	8 850	9	8 450	29
Biosphere	760	3	4 060	19
Biosphere (hc	760	3	4 060	19
Geosphere	0	0	40	5
Hydrosphere	9 000	2	1 740	18

Figure 9: (a) Costs of a category 2 sites for the vegetated man-made habitat if the observation starts from scratch
(b) Evaluation of the additional costs (when existing measured variables are accounted for) for the first site of Fig. 7

(b)

Category 2 Basic method	Vegetated man-made habitats			
	Investment		Operation (per year)	
	EUR	WD	EUR	WD
Total	**3 310**	**5**	**4 570**	**42**
Atmosphere	300	0	50	15
Biosphere	960	3	4420	17
Biosphere (hc	50	1	100	6
Geosphere	50	1	100	6
Hydrosphere	2000	1	0	4

5. Conclusions

- A methodology to analyze the compliance of existing observation networks to move towards a more holistic and systemic approach (WAILS)
- Visualization tools to quickly see the measured variables in different sites and compare various evolution hypothesis in terms of costs
- Data collection must be very precise and complete to get precise information and must involve sites PIs

6. Perspectives

- Discussion with the sites PIs about the potential of their sites, their motivation to evolve towards a WAILs approach and of the required resources
- Possibility to compare various scenario in terms of sites evolution and labeling
- Objectives elements to discuss with funders

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