The OZCAR Critical Zone Observatory Network: an opportunity to enhance hydrological research through sites, data and model sharing

Poster P1-G8-Hydro-26

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1. THE OZCAR RI 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
- A critical interface where rocks, soil, water, air and living organisms interact using the sun's energy and the Earth's internal energy to transform their environment
- 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. 1)

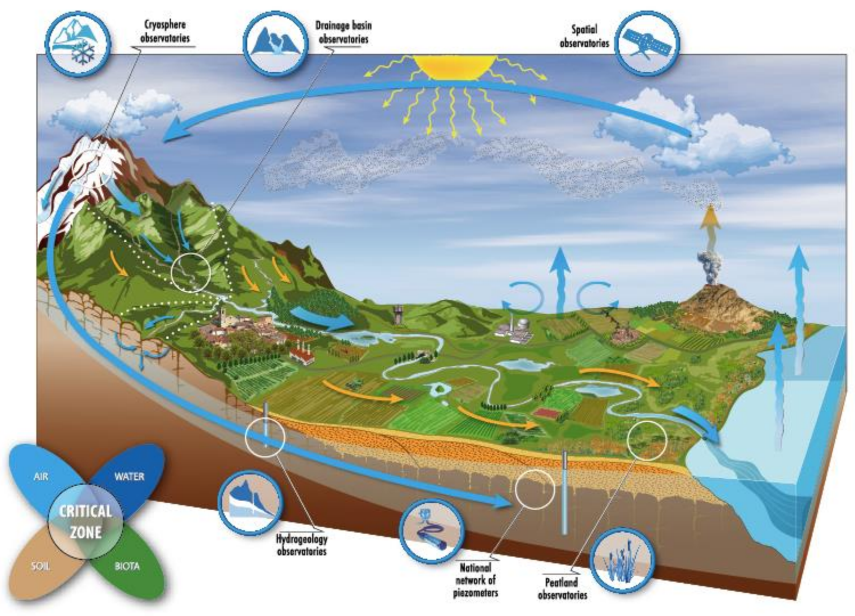

Figure 1: Schematic view of the critical zone with the various sampled compartments and objects @ Joël Dion, IPGP

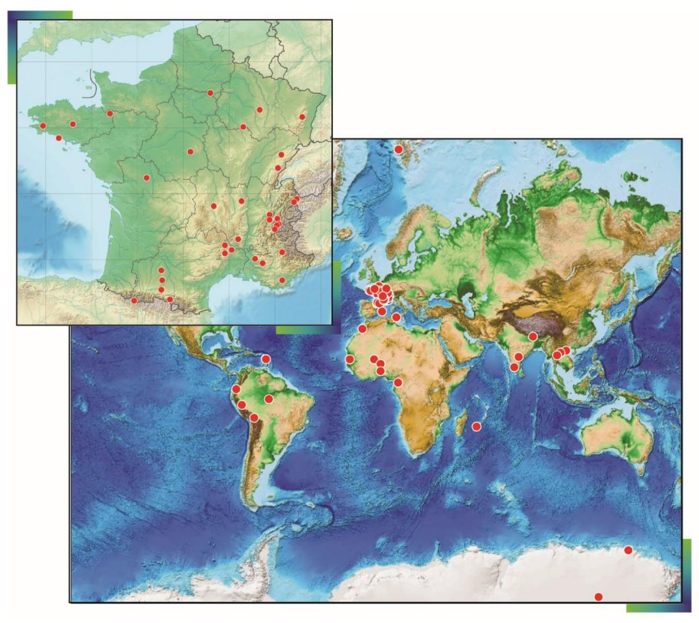

Figure 2: Location of the OZCAR RI observation sites (Gaillardet et al., 2018)

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 60 sites in the world (Fig. 2)
- Facilities open to the scientific community and beyond
- Keywords: water resources, soil (quantity and quality), natural hazards (floods, droughts, avalanches, contamination), territories

2. WP1: TOWARDS A UNIQUE ACCESS TO DATA

More than 300 measured variables (see one example in Fig. 3)

- Point time series: meteorology, hydrology, hydrogeology, glaciology, surface energy balance, sediment fluxes, geochemical elements and contaminant concentrations
- Soil cores, 2D geophysical profiles, Maps (raster or vector) characterizing the sites: land use, DTM, soil physical properties, Surveys: crop rotations

Figure 3: An example of monitored variables in the Kamech watershed (Tunisia, OMERE observatory)

Figure 4: The Theia/OZCAR data portal giving access to metadata

The Theia/OZCAR Information System (IS) to make data FAIR:

- Objective: make data from OZCAR RI FAIR and build a single entry point to access data by making the best use of existing IS (Braud et al., 2020)
- Harmonization of metadata using a pivot data model and a thesaurus of variables
- Organization of data flux between observatories IS and Theia/OZCAR IS (Figure 5) that provides services (search portal (Fig. 4), cataloguing web service, ..)
- Access to data in harmonized formats (in progress)

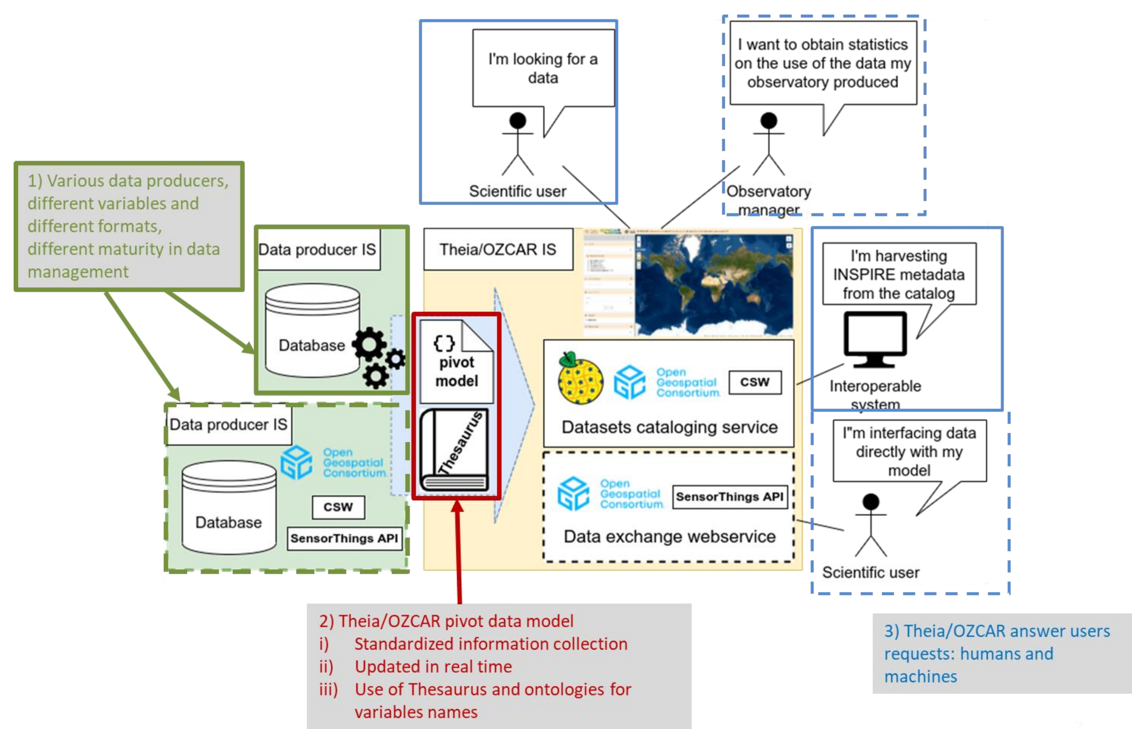

Figure 5: Principles of the Theia/OZCAR IS: different data producers (green rectangles) with different types of databases exchange information with the central Theia/OZCAR IS (yellow rectangle). A continuous information flux is organized through the implementation of the pivot data model and using controlled vocabulary (red rectangle). Users (either humans or machines) can consume the services provided by the Theia/OZCAR IS for different purposes (blue rectangles, plain line: already implemented, dotted line, in progress).

The tools:

- Pivot data model: https://github.com/theia-ozcar-is/data-model-documentation
- Thesaurus and controlled vocabulary following the I-ADOPT framework for the naming of variables: https://in-situ.theia-land.fr/skosmos/theia_ozcar_thesaurus/en/
- Data portal: https://in-situ.theia-land.fr

3. WP2: DATA MODELS INTERFACE

Objectives: favour the use of data into models

- Incentive through the work of one postdoc addressing a common scientific question on several sites: which impact of critical zone heterogeneity on the critical zone functioning?
- The same model (E_cH_2O-Iso, Kuppel et al., 2018), with water age tracing, applied to three sites with contrasting geology, land use and climate at the hourly time step over a 8-year period
- Input files fed by a diversity of in situ data (meteo, pedology, geophysics) and satellite measurements (vegetation) (Fig. 6)
- Model evaluation using a large diversity of variables (discharge, piezometers, soil moisture, evapotranspiration) and water transit times (Fig. 7)
- Access to internal variables not accessible by observation (e.g water storage and age in all compartments, Fig. 7). Possibility to run scenarios of climate and/or land use change

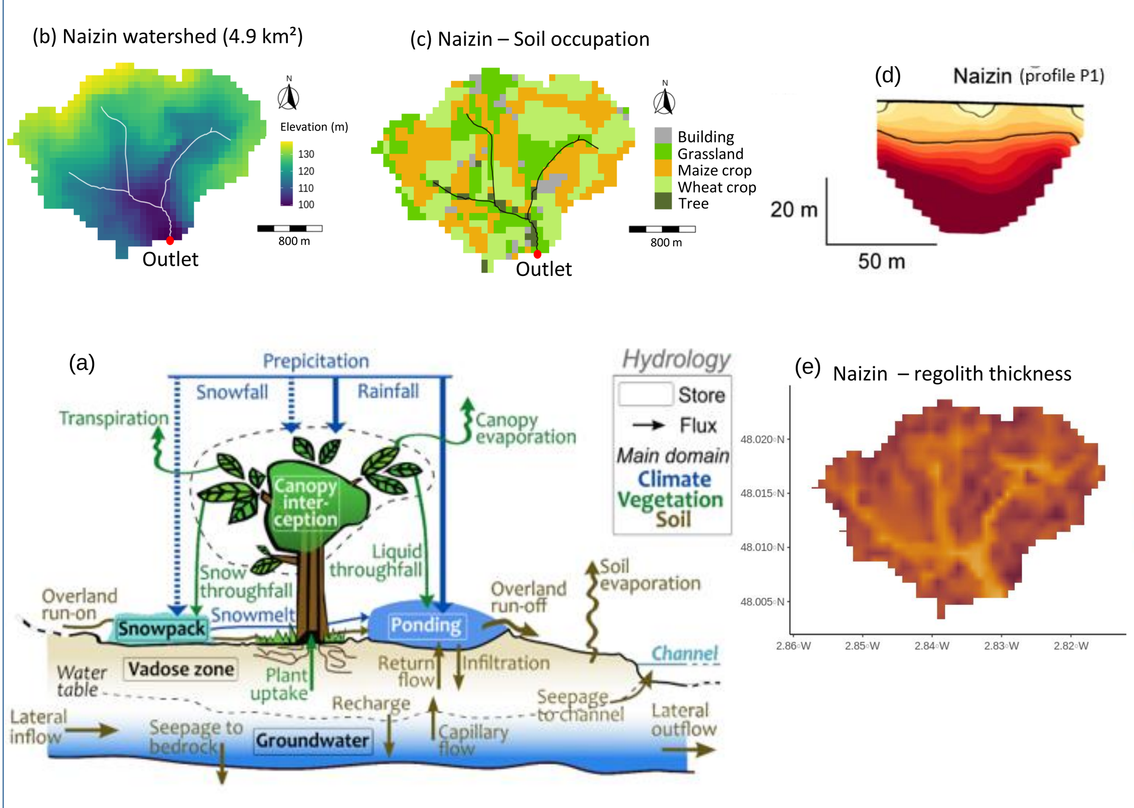

Figure 6: (a) Scheme of the E_cH_2O-Iso model (Kuppel et al., 2018 and of the input data for the Naizin watershed (AgrHys observatory): (b) topography, (c) land use, (d) a resistivity profile that was used to define the regolithe depth (e) (figures from Ackerer et al., in preparation)

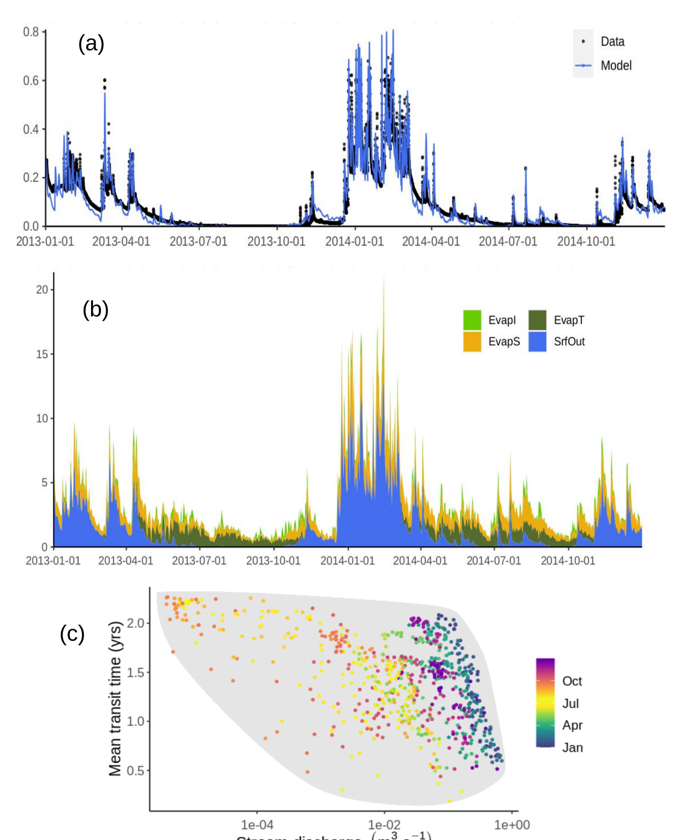

Figure 7: Simulated (a) discharge (b) water balance (c) water storage versus discharge for the Naizin watershed (figures from Ackerer et al., in preparation)

4. WP3: INSTRUMENTATION

Objectives: develop innovative instrumentation for the spatial and temporal exploration of the critical zone

- Two investment programs funded by the French government: CRITEX (2012-2022) and TERRA FORMA (2021-2029)
- CRITEX: Geophysical devices for describing the structure and monitoring the critical zone (electric resistivity, seismic sensing, RMP, gravimetry); RiverLab for high frequency geochemistry of rivers; optic fibre to monitor heat tracers and describe preferential flow; mobile laboratory for monitoring chemical species and microbiology properties during tracing experiments; scintillometry, hydrosedimentary platform (Fig 8)
- TERRA FORMA: towards low cost sensors and their communication network (Fig. 9)

Figure 8: Examples of instrumentation developed or deployed during the CRITEX program (a) RiverLab; (b) Gravimetry; (c) Hydrosedimentary station; (d) Mobile laboratory for monitoring chemical species; (e) geophysical monitoring

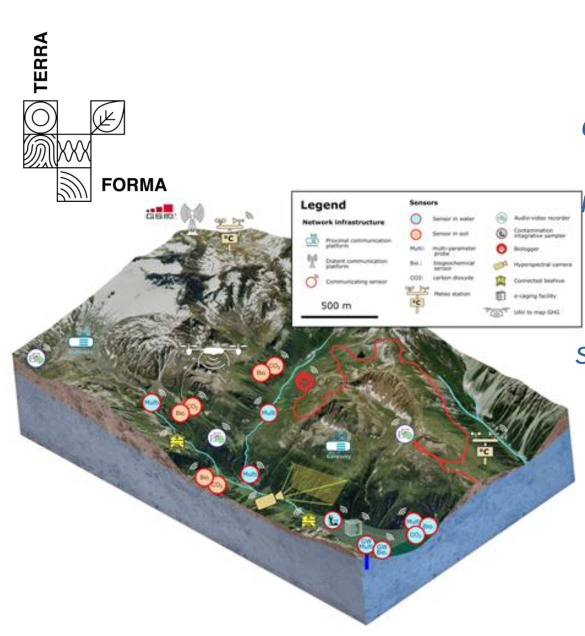

Figure 9: TERRA FORMA: "Designing and testing a smart observatory of socio-ecological systems in the Anthropocene" in order to monitor the complex humans and the geo-ecosystems interactions. Development of innovative sensors for the critical zone and living organisms Progress in data transfer and communication networks Place-based research with interactions with stakeholders Deployment on pilot sites

5. Conclusions

- OZCAR RI and its observatories: a network of sites and data for improving critical zone and hydrological processes understanding.
- Access to a richness of sites in various contexts and to their data, shared instrumentation
- Possibility to use sites to develop and test models and new instrumentation
- Sites for interdisciplinary research
- Networking facilities, capacity building (summer schools, OZCAR days, conferences)

6. Perspectives

- Contribution to the eLTER (Integrated European Long-Term Ecosystem, critical zone and socio-ecological ResearchEuropean Reseach Infrastructure (https://elter-projects.org/)
- Improvement of sites to monitor the various compartments and apply a Whole System Approach

References:

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Galileo Conference 2023
A European Vision for Hydrological Observation and Experimentation