Main knowledge gaps in critical zone processes and behaviour: Extracting information from water quality time-series data

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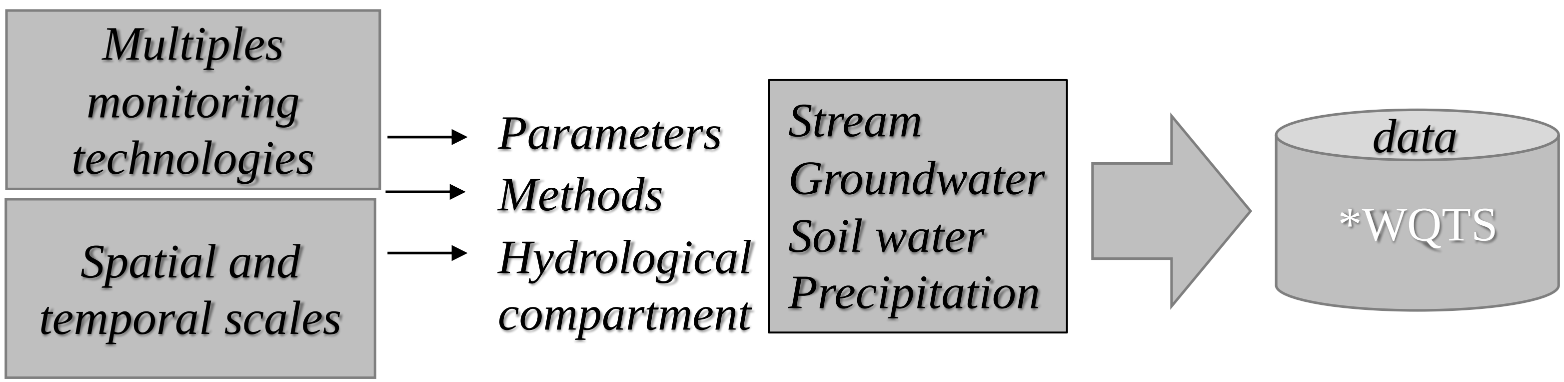
- Long-term catchment observatories have been strengthened to gain insight into hydrological and biogeochemical processes.

Water quality through hydrological compartments



- Networks are usually established for a specific purpose which is changing with time and the questions the network is trying to answer

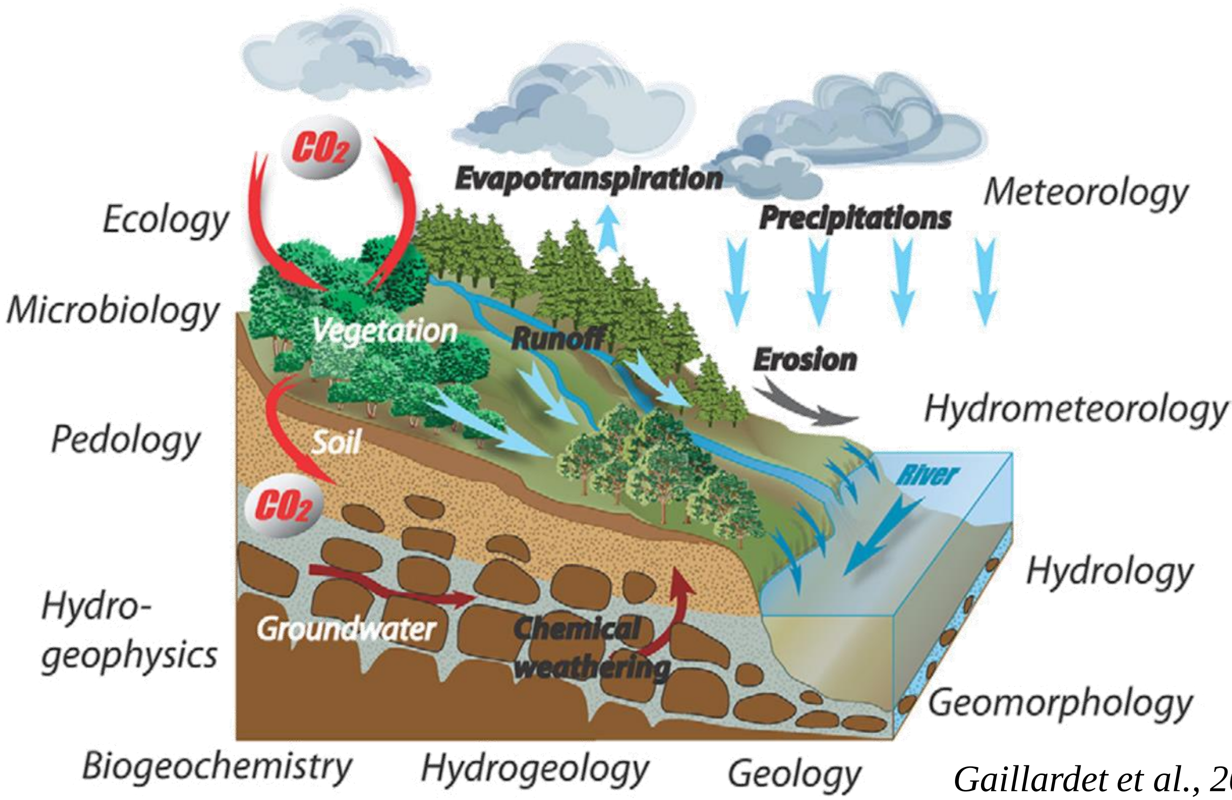
- The issue of spatial and temporal flexibility?

- Multi purpose network and the use of network to support model development

**WQTS: Water quality time series*

- A review of methods used for analysing temporal water quality signals, based on a panel of examples from few but densely monitored environmental research observatories.

- Give an insight into critical zone (CZ) research that help to build a transdisciplinary community to identify the main knowledge gaps in CZ processes and behaviour.

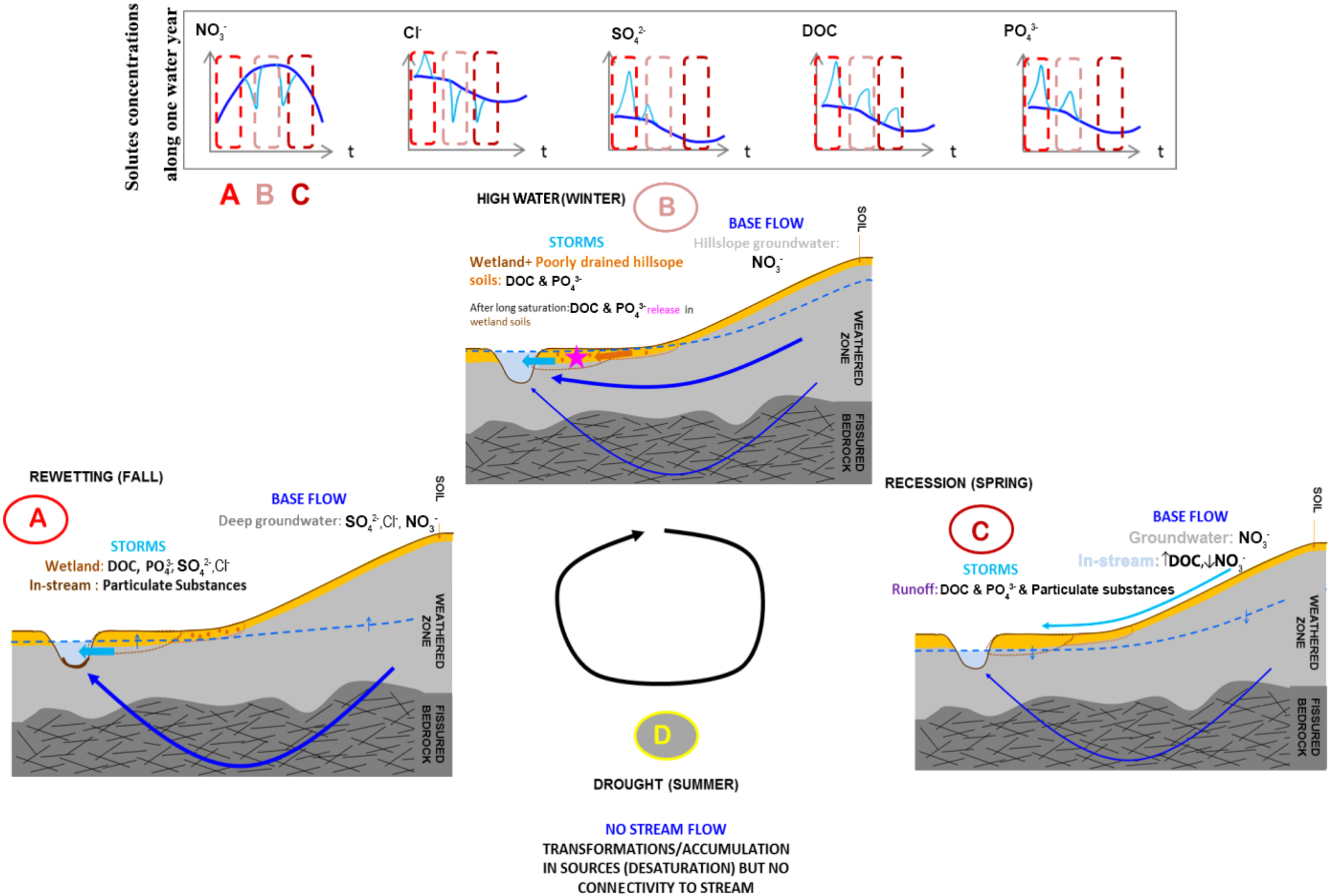


Gaillardet et al., 2018 (VZJ)

The critical zone is defined between the lower atmosphere and the impermeable bedrock layer. Here the authors listed different scientific communities involved in CZ research.

Approach type	Method	A priori hydrology expertise	Required time series specifications	Examples
Time series aggregation	Classical statistics: Correlation analyses & explanatory methods (principal component analysis, autocorrelation analysis)	No a priori expertise is required for such data-driven approaches for interpreting covariability in terms of probable causality	Multi-parameter time series (including time series non-related to water quality)	Dupas et al., 2018 Wade et al., 2012 Bhurtun et al., 2019 Outram et al., 2014
	Aggregation on time: average and percentiles	High a priori expertise for identifying the functional aggregation units/variables	Frequency can be low but over long-time period that contains enough variability	Molenat et al., 2008 Aubert et al., 2013 Humbert et al., 2015
	Variables aggregation (C-Q relationships and variability ratios			Lefrancois et al., 2007 Aubert et al., 2013 Thomas et al., 2016a
	Clustering storm events	For interpreting storm typology Expertise to delineate storms	Multi-elements and numerous events	Aubert et al., 2013 Dupas et al., 2015
Time series decomposition	Hydrograph separation	A priori expertise to define the end-members	Multi-elements and water discharge time series but no constraint on the frequency	Durand and Juan Torres, 1996 Morel et al., 2009 Lambert et al., 2014
	Statistical decomposition, Change detection, Non-stationary oscillations	No a priori expertise is required for such data-driven approaches	Regular sampling, frequency lower than those of the temporality of interest	Dupas et al., 2016 Abbott et al., 2018
	Spectral analysis	No a priori expertise is required for such data-driven approaches	Highest frequency as possible on the longest period as possible	Aubert et al., 2014 Godsey et al., 2010 Kirchner et al., 2000

Summary of the reviewed approaches for water quality time series analyses. Examples referred here are the ones used to illustrate such approaches on different Critical Zone Research Observatories.



Unified conceptual model of seasonal functioning

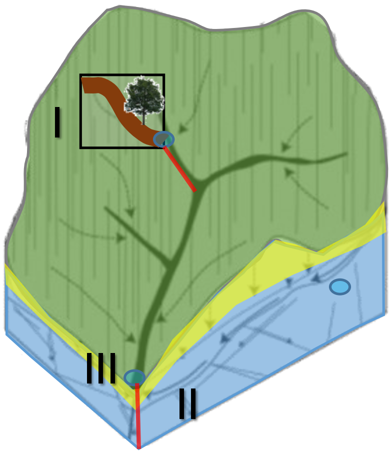
Compilation from Aubert et al. 2013, Humbert et al. 2015 and Dupas et al. 2015

☞ Kervidy-Naizin catchment, AgrHyS Observatory

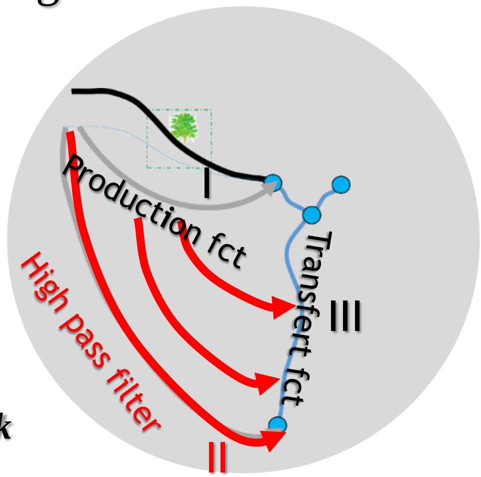
- **WQTS + proper approaches for extracting information:**

→ *Important insights into hydrological research* ➔

- ✓ Water and solutes
- ✓ Particles flowpaths
- ✓ Storages and transformations



I: Hillslope
II: Groundwater
III: stream network



Improving processes understanding
→ Coupling with model development which could be seen as a "theoretical" monitoring network.

- **Communities in hydroinformatics are now booming to deal with WQ issues, associating more and more informatics and statistics to water quality scientific communities:**

→ This trend will probably increase in the coming decades, dealing with big data issues in hydrochemistry

- **Highlights some principle gaps relying on WQTS themselves and some perspectives to fill the gaps.**