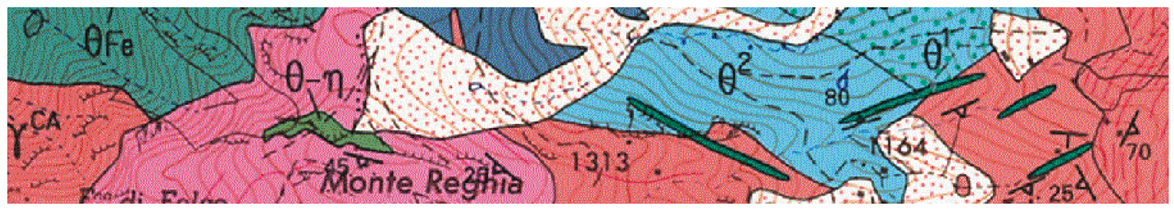
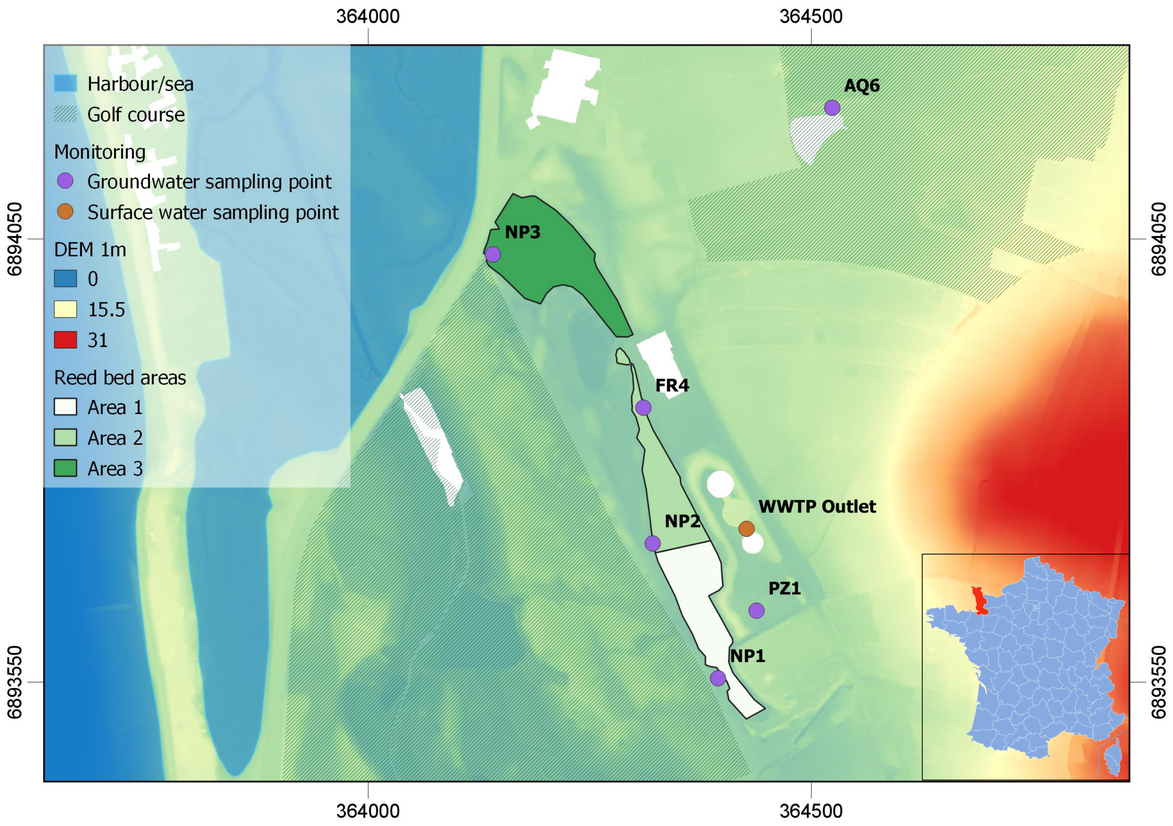


Managed Aquifer Recharge and Soil Aquifer Treatment : processes inducing removal of trace organic contaminants

Q. Guillemoto[1,2], G. Picot-Colbeaux[1], M. Pettenati[1], D. Valdès[2], N. Devau[1], W. Kloppmann[1], J-M. Mouchel[2]

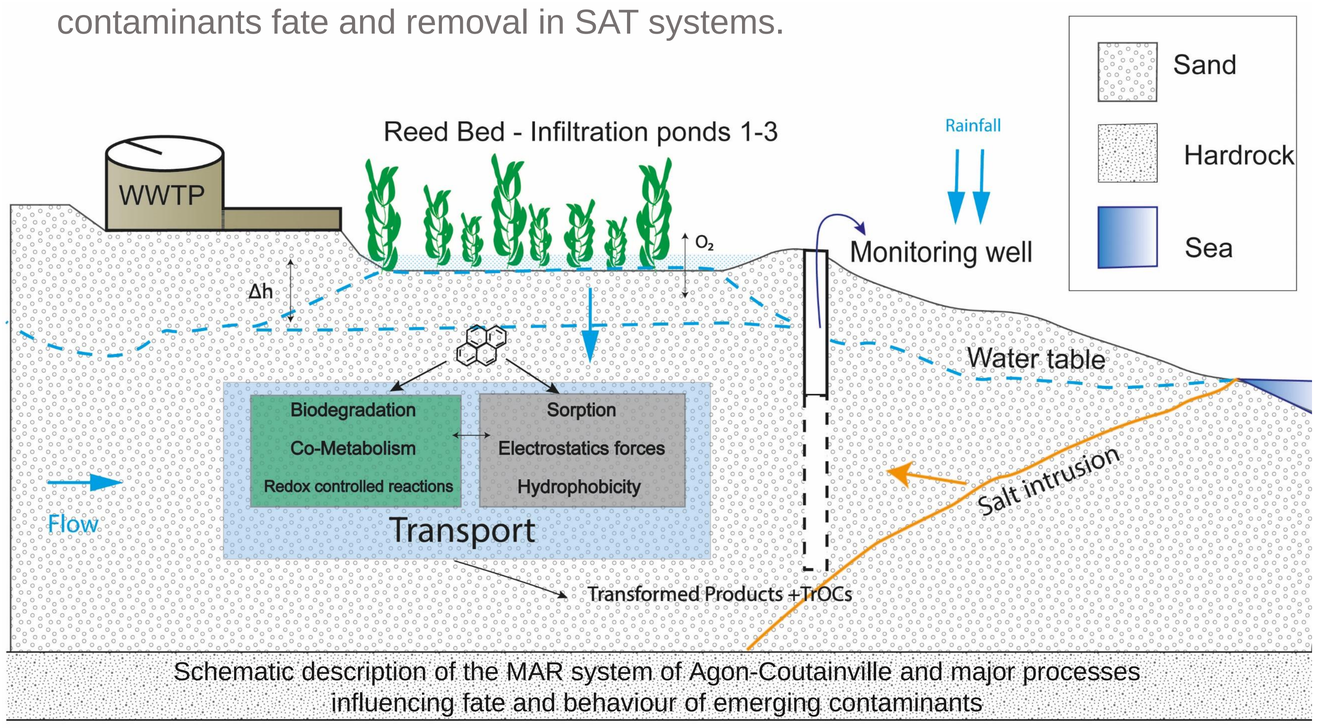
Managed aquifer recharge for preservation of the coastal areas in Agon-Coutainville (France)

- The **managed aquifer recharge (MAR)** can be an efficient protection against **Trace Organic Contaminants** (TrOCs) and bacteria (Amy and Drewes, 2007) to preserve coastal ecosystems and conservation area in addition to human activities: bathing, shellfish aquaculture
- MAR prevents the progression of the salt front in the coastal areas and improves the potential for freshwater usages
- The site potentially takes advantage of **Soil Aquifer Treatment (SAT)** with surface spreading method . A reed-bed is fed with treated wastewater from a conventional biological wastewater treatment plant (WWTP)
- The water is infiltrated in a sandy coastal aquifer.



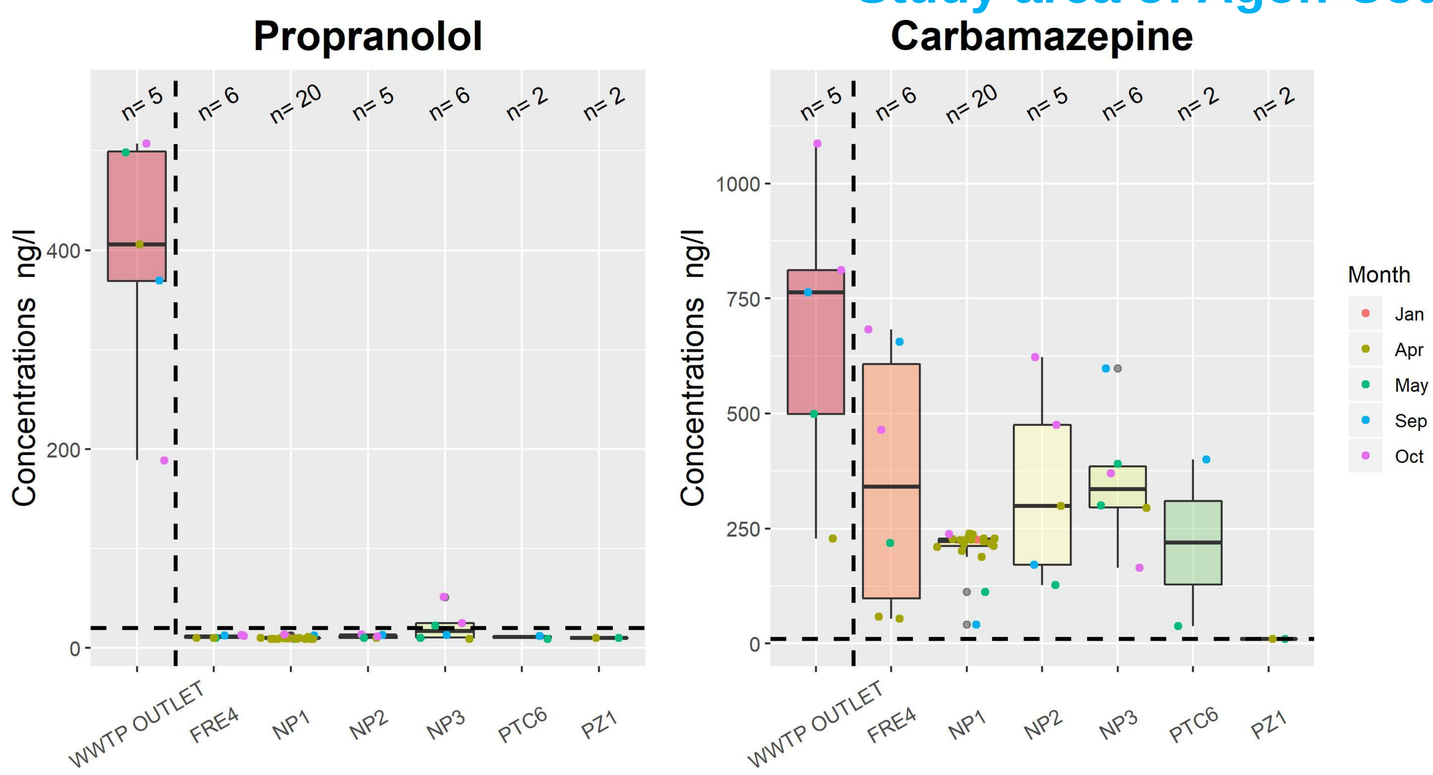
Processes inducing removal of trace organic contaminants in SAT

- Not all pharmaceutical and trace organic contaminants are fully degraded during SAT (Drewes et al., 2002)
- Multiple processes processes are involved in the saturated and unsaturated zone that affect mobility and biodegradation of trace organic compounds. Two major processes are **biodegradation and sorption** to organic ligands (organic matter) or onto solid surfaces (oxides, clay minerals)
- There is, up to now, no complete thermokinetic-hydrogeological model describing all processes involving degradation and mobility of pollutants in MAR/SAT systems
- Degradation kinetics estimated in different systems appear very different (Greskowiak et al., 2017) and majors processes involved are condition dependent and not transferable. There is a necessity to develop tools to predict emerging contaminants fate and removal in SAT systems.



Schematic description of the MAR system of Agon-Coutainville and major processes influencing fate and behaviour of emerging contaminants

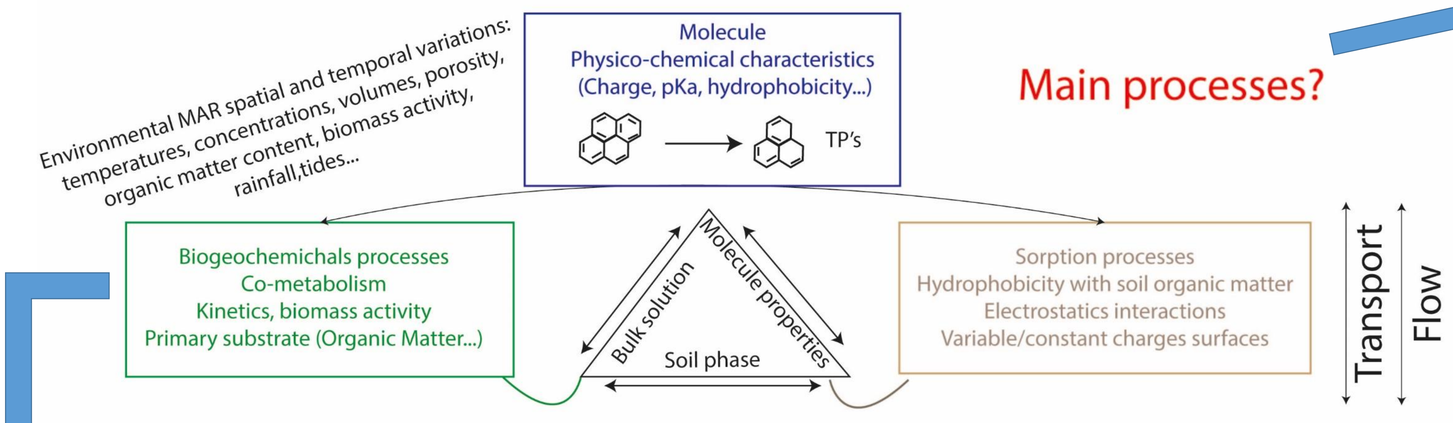
Study area of Agon-Coutainville



Monitoring of groundwater:
A Bi-annual sampling campaigns were performed at the site between 2016 and 2019. Analysis has been carried out for 31 emerging contaminants (with different behavior in soils) by target analysis, trace metallic elements, major elements, pH, Eh and temperature, in addition to key chemical parameters required by French water legislation.

Different behavior of TrOCs:
Example of two different behaviors in the Agon-Coutainville SAT: propranolol is highly biodegradable and carbamazepine is persistent in natural environments. Biodegradability of the molecules depends on the environmental conditions, the availability of a primary substrate, and its physico-chemicals characteristics.

MAR/SAT Conceptual model



Main processes?

Experiments

The objective is to **enhance system understanding and support modeling:**

- **A laboratory experiment based on real on-site substrate** ; a tool to identify major mechanism of contaminant removals
- **MAR scale experiment :** tracer test to validate transport, retention and degradation parameters.

Useful to identify main theoretical concepts and validate numerical tool.

Numerical tool

The objective is to develop a new modeling tool to assess the fate of environmental emerging trace contaminants in context of SAT: **flow and reactive transport modelling (MARTHE-PHREEQC).**

Amy and Drewes, (2007). Environ. Monit. Assess. 129, 19–26.
Drewes, Heberer, Reddersen, (2002). Water Science and Technology, 46(3), 73–80.
Greskowiak, Hamann, Burke, Massmann, 2017. Water Research 126, 122–133.
Thiéry, (1990) - Software MARTHE. Modelling of Aquifers BRGM 4S/EAU n° R 32548.
Parkhurst, Appelo (1999). User's guide to PHREEQC. Water-resources investigations report, 99(4259), 312.

This project is supported by the European JPI WATER H2020 project EVIRAN

1 :BRGM (French Geological Survey) ; 2 :Paris Sorbonne University