Infiltration of urban stormwater runoffs: consequences on groundwater ecosystems

F. Mermillod-Blondin[1], J. Voisin[1], L. Volatier[1], A. Vienney[1], L. Guillard[1], F. Vallier[1], B. Cournoyer[2], L. Wiest[3], P. Marmonier[1]

1- Ecologie des Hydrosystèmes Naturels et Anthropisés, CNRS- Université Lyon1-ENTPE
2- Laboratoire d'Ecologie Microbienne, CNRS-Université Lyon1-VetAgroSup-INRA
3- Institut des Sciences Analytiques, CNRS-Université Lyon1-ENS Lyon

Colombian - French Conference on Urban Water Systems
30th November – 1st December 2017, INSA Lyon, France

Main questions

Impacts of stormwater infiltration on groundwater ecosystems

1- Impacts on the chemical quality of groundwater?

2- Water purification processes during infiltration through the soil and the vadose zone ?

3- Impacts on the ecology of groundwater ecosystems and consequences on water purification processes?

→ Need of a specific methodology to address these three points

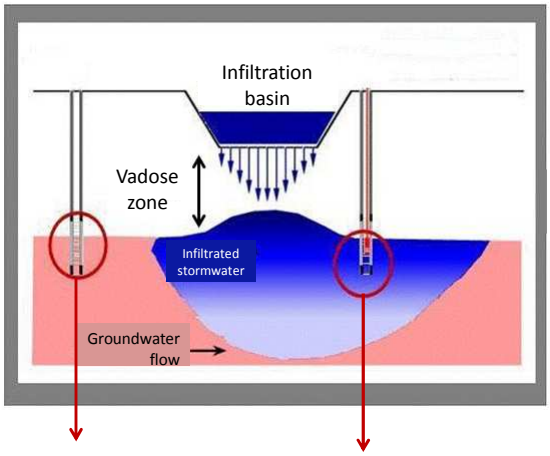
Methodological approach in the field

Stormwater runoff

Soil of infiltration basin

Vadose zone

Groundwater

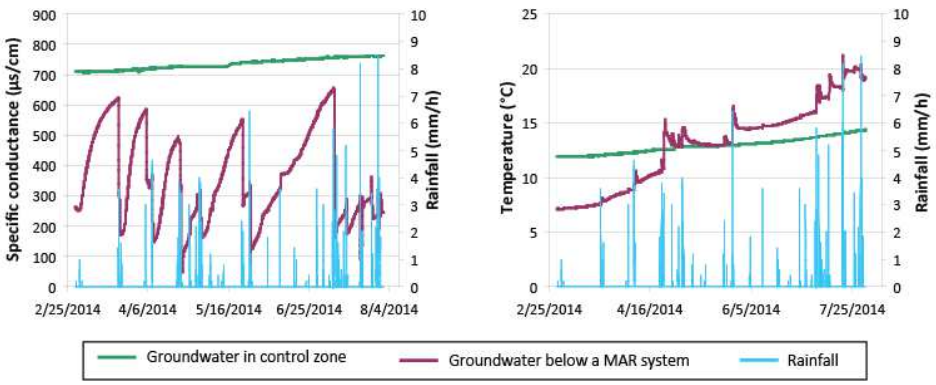


Control well
- non-impacted GW-

Impacted well
-Impacted GW-

Physical and chemical dynamics below infiltration systems

Impact of stormwater infiltration on specific conductance and temperature in groundwater

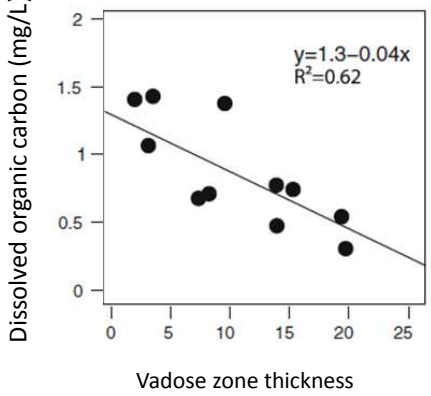


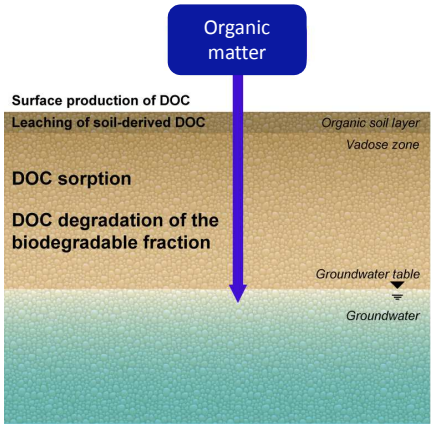
→ Infiltration = increase of environmental instability in groundwater ecosystems

Contamination of groundwater by chemicals?

Negligible fractions of heavy metals and PAHs reach groundwater → abiotic and biotic retention of these pollutants in the soil and vadose zone

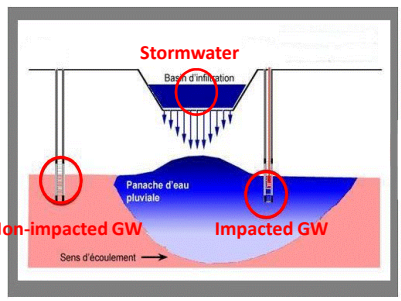
… but we measured significant transfers of dissolved organic matter that depend on the thickness of the vadose zone.

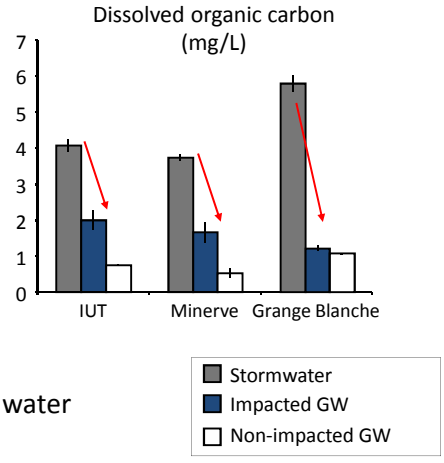




Organic matter processing during transfer

Quantification of the DOM transfer during rainfall events in three sites with infiltration basins



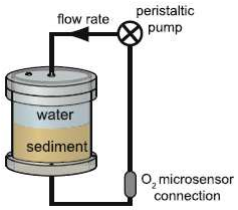


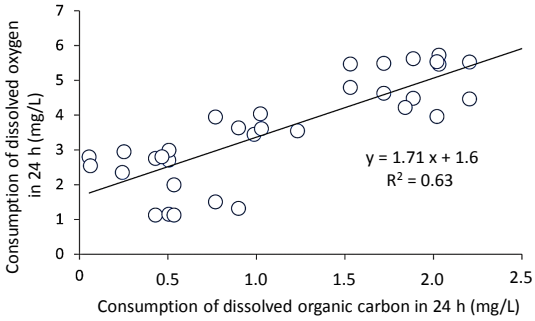
→Very high retention of DOM during water infiltration

Laboratory approaches: decrypting mechanisms explaining field results

SEDAQUA

Organic matter retention



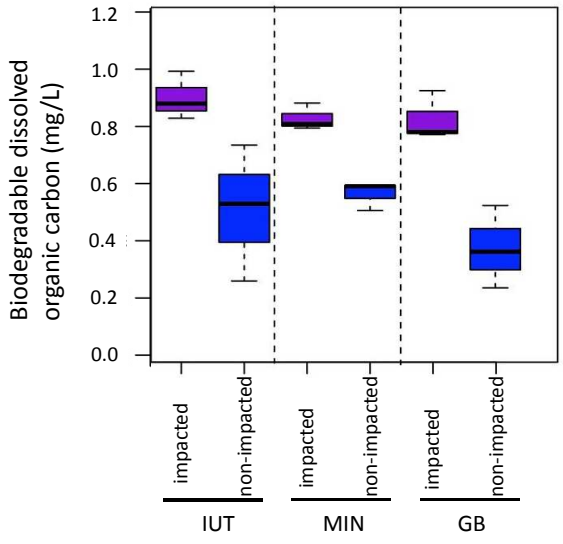


+ Retention of dissolved organic carbon

+ Microbial respiration

→ DOM retention linked to biological activities

But an enrichment of organic matter available for micro-organisms in aquifers



⇨ BDOC enrichments in 3 basins with VZ thicknesses < 3 m

⇩

Consequences on micro-organisms living in a C-limited environment?

Influence of organic matter transfer on groundwater micro-organisms?

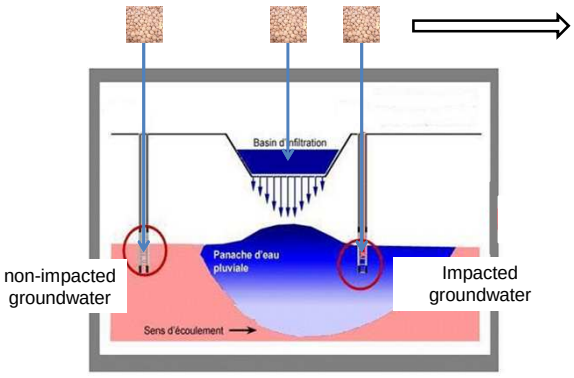
Use of artificial substrates to sample micro-organisms in aquifers

Growth and activity on micro-organisms on artificial substrates (glass beads, gravels, clay beads)

+ without sediment collection

+ more time-integrative than collection of water

Influence of organic matter transfer on groundwater micro-organisms?

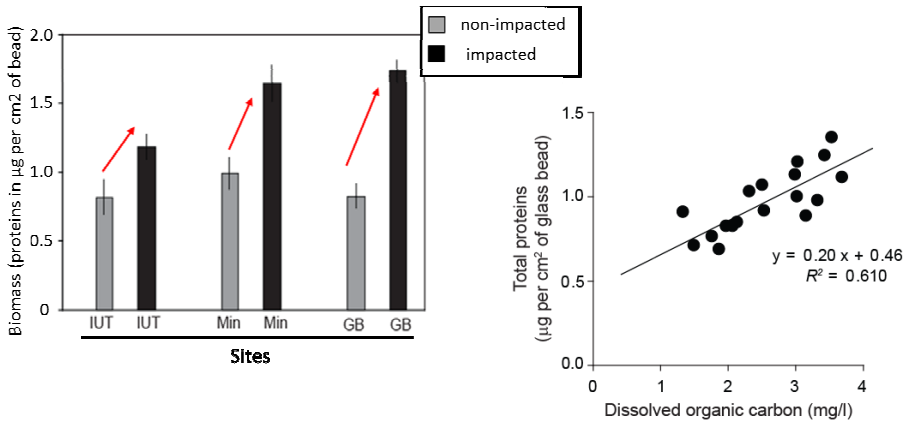


Collection of artificial substrates after incubation

- Biomass of micro-organisms
- Microbial activities
- Analyses of bacterial diversity by metabarcoding (based on DNA)

Influence on microbial biofilm

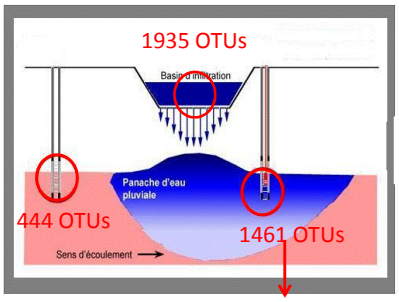
Differences between impacted and non-impacted groundwater in 3 sites



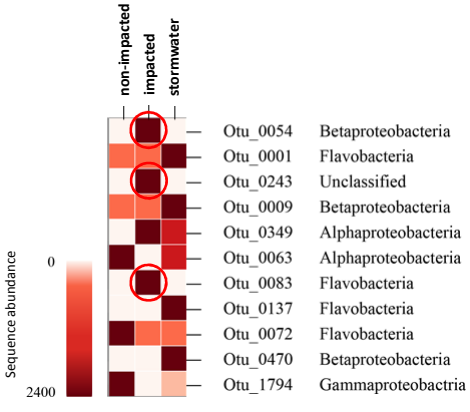
→ Higher biofilm biomass in impacted groundwater
→ Linked with the quantity of dissolved organic matter
→ Monitoring tool to evaluate OM enrichment in aquifers

Evaluation of changes in microbial diversity

Bacterial communities collected in Django-Rheinhardt basin
(1 taxon = 1 OTU = 1 Operational Taxonomic Unit)



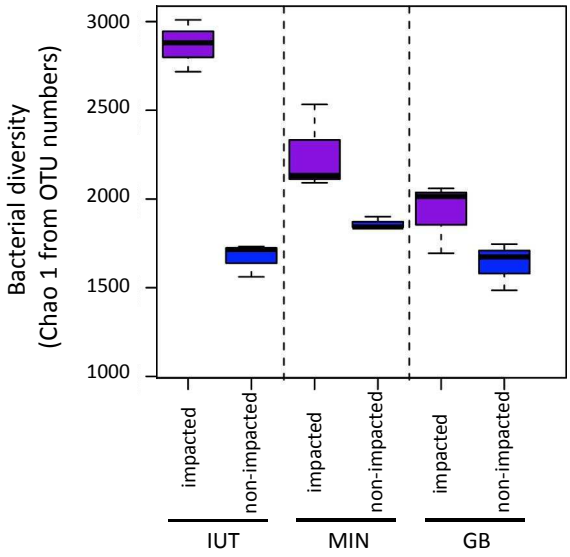
More than 75% found only in impacted groundwater



PhD thesis of Jérémy Voisin collaboration LEM - LEHNA

→ Infiltration of stormwater runoff leads to specific bacterial communities in groundwaters

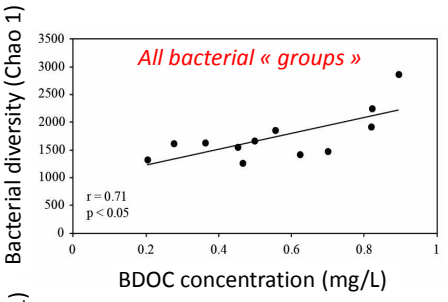
Evaluation of changes in microbial diversity

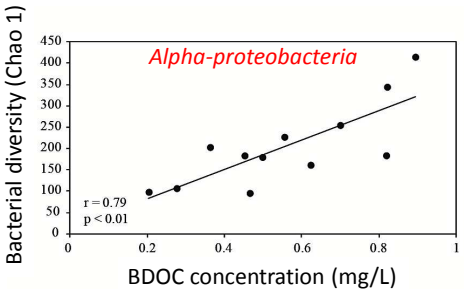


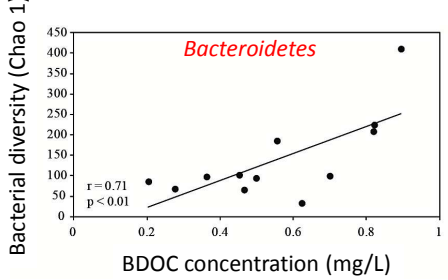
Increased bacterial diversity

Due to BDOC enrichment?

Links between BDOC enrichment and bacterial diversity







YES → organic matter enrichment enables more bacterial taxa to develop in aquifers

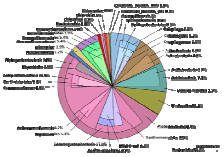
Perspectives

Project: Functional Responses Of Groundwater ecosystems to stormwater infiltration in urban areas

1- Organic matter transfers:
Are they associated with a transfer of organic pollutants?

Passive samplers for organic contaminants (Chemcatchers)

2- Bacterial diversity changes:
Are they associated with the presence of pathogens?



⇨ Pathogens?

3- Responses of bacterial communities to perturbations associated with stormwater infiltration:
Vulnerability of bacterial functions playing key roles on water purification processes?

Thanks!