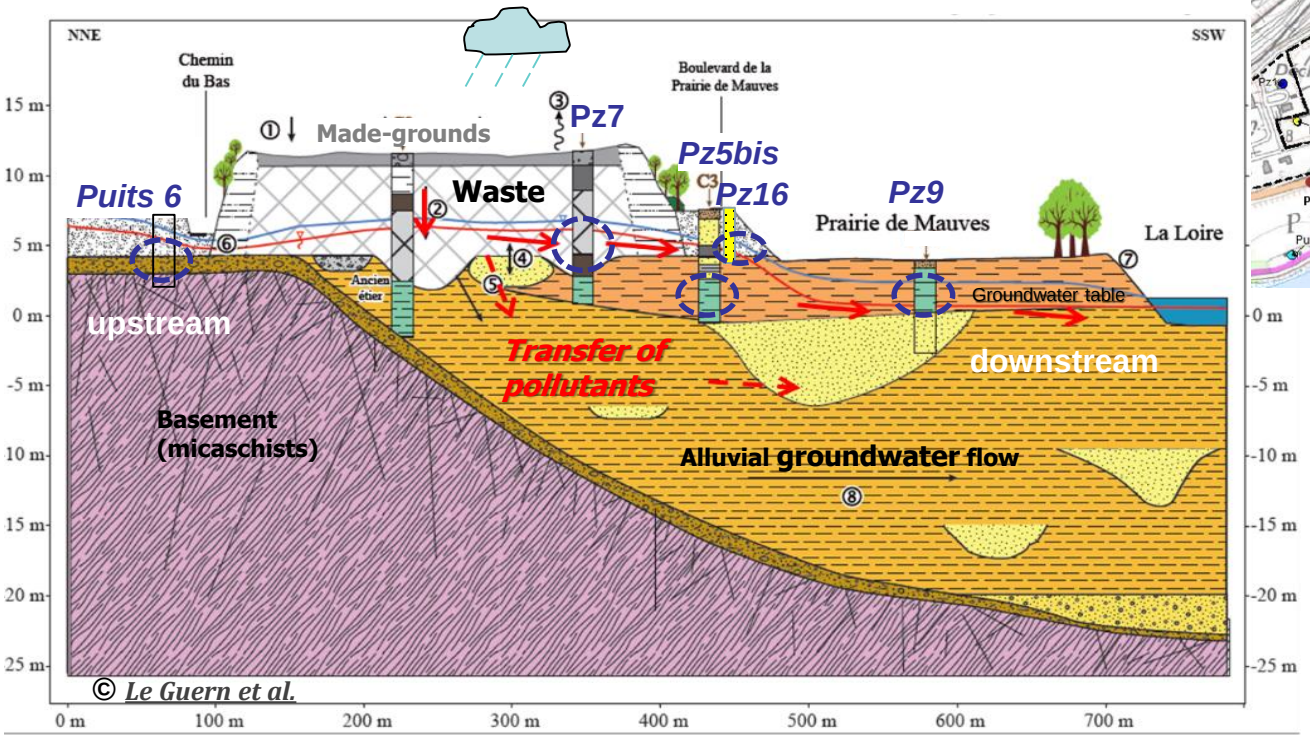
EGU General Assembly 2020
Vienna | Austria | 3–8 May 2020
Session HS2.3.6: Micropollutants and pathogens in the soil-groundwater-river continuum: modeling and monitoring

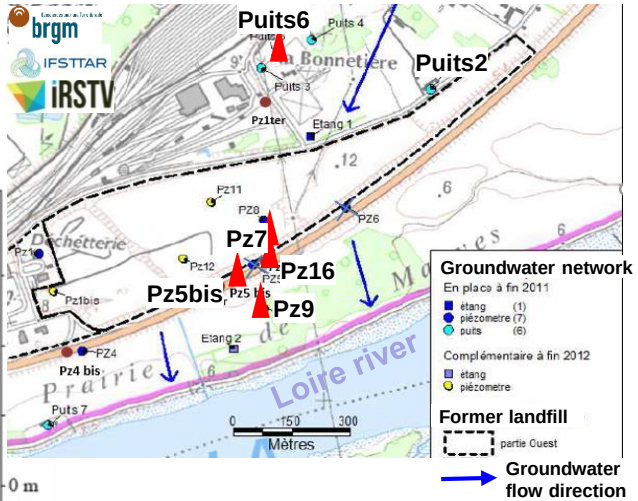
D62 | EGU2020-11743

Fate of antibioresistance, pharmaceuticals and endocrine disruptors from a former municipal landfill

Long term Observatory (ONEVU) Nantes, France (since 2009)

Landfill (1969-1987)
Waste including:
- **Domestic**
- **Hospital**





Fate of contaminants and bacteria?

Water sampling in piezometers
- Upstream : Puits 6/Puits 2
- Leachates: Pz7
- Immediate downstream:
  - Pz5bis (alluvial gw),
  - Pz16 (leachate lateral flow)
- Far downstream: Pz9 (=Pz9bis)

Looking for joining international project building

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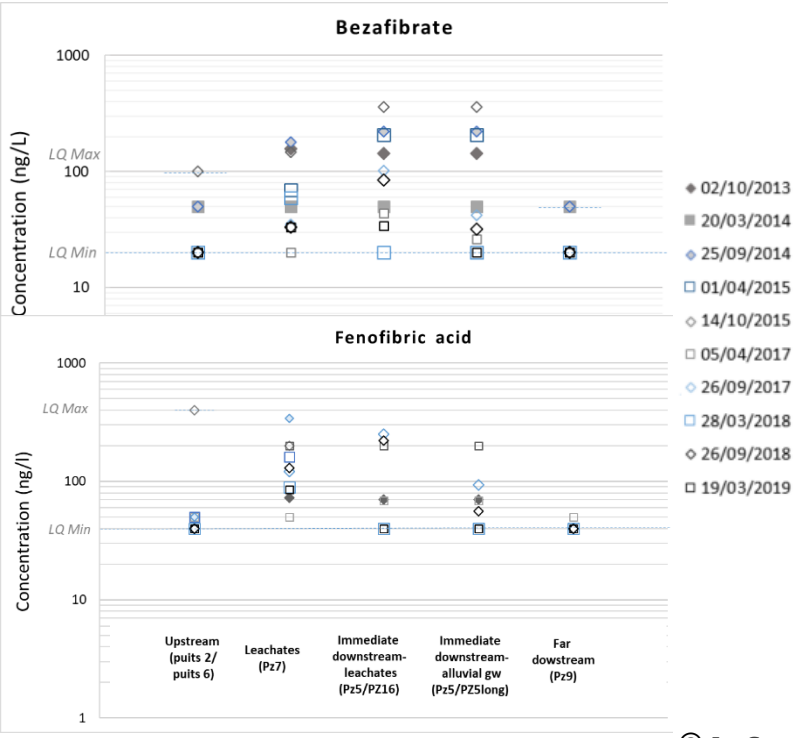
Fate of pharmaceuticals and endocrine disruptors



Drug active molecule

Metabolite derived from drug active molecule

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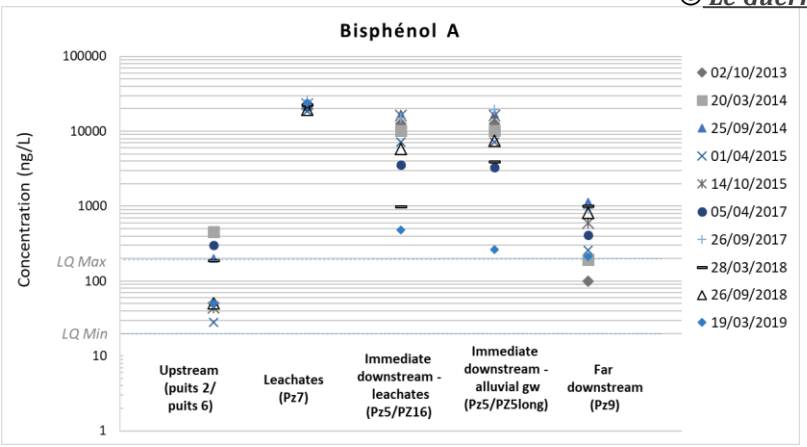
	Pz7	Literature	
Maximum concentration (µg/L)	**Leachates study site**	**Other leachates**	**French GW**
Fenofibric acid (6)	0,531		0,15
Bezafibrate (6)	0,180	0,0258	NV
Carbamazepine (4)	0,108	0,136/0,556/ 2,59	0,083
Clotrimazole (8)	0,086	0,0015	NV
Diclofenac (1)	0,956	0,38	0,024
Diazepam (2)	0,035	0,0351	NV
Furosemide (3)	0,451		0,19
Gemfibrozil (6)	0,303	0,277/0,751	0,008
Ibuprofene (1)	5,763	0,0575/0,988/ 3,1/6,88/23,2/ 705	0,067
Ketoprofene (1)	1,096	NV	0,35
Methylparabene (7)			
O-desmethylnaproxene (1)	4,981		NV
Benzotriazole (9)	1,670		
Bisphenol A (10)	180	0,84/25,2/ 6380	11,99
Tolyltriazole (9)	0,87		0,66
Triclosan (10)	0,104	/0,21/42,3	NV

Transfer/ Retention

© *Le Guern et al., 2016*



Probably from plastics, including waste bags

Numerous molecules, including metabolites

Various behaviours, probably linked to
- Adsorption on organic matter (Koc/Kow)
- (Bio)degradation

Some dilution in alluvial groundwater (GW)

No antibiotics detected
=> any antibioresistance though ?

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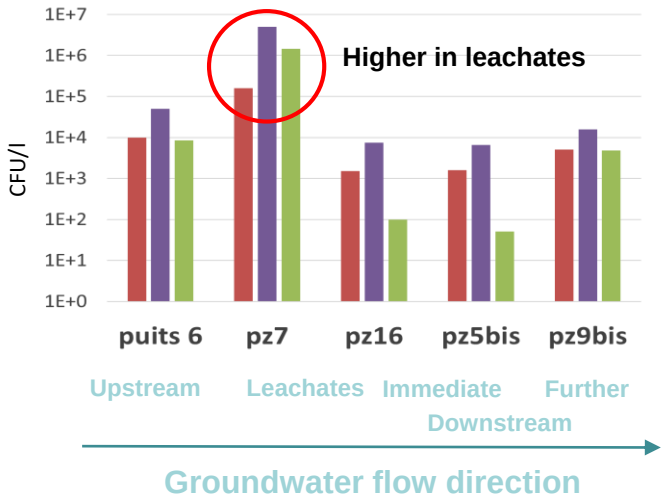
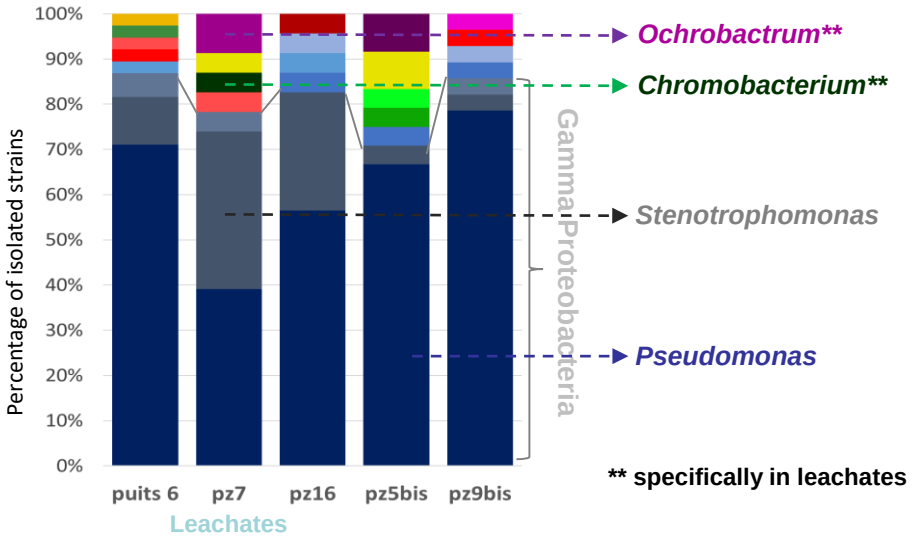
Fate of antibioresistance

Abundance of antibioresistant bacteria → Identification of isolated strains

3 culture media: ***drigalski/ceftazidime***, ***ESBL***, ***CARBA***



From Aujoulat et al. 2019



- **Leachates: highest antibioresistant bacteria abundance**, whatever the culture medium.
- **Antibioresistant bacteria abundances: very much lower downstream**, including immediately on the side of the landfill.
- **Diversity of the total communities** (16S metabarcoding): a specific community for the lixiviates with few OTUs shared with the upstream and downstream samples. Some genera specifically isolated in the leachates.

OTU : operational taxonomic unit

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Discussion: Potential subjects of collaboration (1/2)

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> Novel sampling and monitoring concepts and devices

- Passive sampling tested, but difficulty to link with punctual concentration measurements
- Network of 20 groundwater piezometers, 6 used for chemical characterization

Study-site ready for testing new devices : followed for 10 years, network of piezometers

> New analytical methods, new detection methods for DNA, pathogens, micropollutants, non-target screening

- **Pathogens**: MSLA in progress, biofilms would need to be studied, survey should be continued (but financial support needed)
- **Non-target screening**: BRGM equipped with LC-TOF
- **Colloidal transport** studied for trace elements, how about other substances ?

Partners equipped with some new methods (LC-TOF, antibioresistance, DNA…)
=> could be involved on other study-sites

Possibility of testing new analytical methods on this study-site

> Experimental studies and modelling approaches to quantify diffuse and point source inputs

- First modelling attempts => to be continued
- Mechanisms of transfer/retention: **cocktail effect, role of biogeochemical interactions**
- Which input on river located downstream ?
- Transfer of PCDD, PCDF, PFAs?

Lots of data acquired within 10 years

Partners interested in deepening their first modelling attempts

Partners skills :
- **reactive transport modelling**
- **field or lab experiments**

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Discussion: Potential subjects of collaboration (2/2)

> **Comparative fate studies on parent compounds and transformation products**
  - Lots to do on **pharmaceuticals and endocrine disruptors**

→ **Partners interested in pursuing efforts on developing characterization skills on transformation products of pharmaceuticals and other emerging components (BRGM)**

> **Others**
  - Geophysical characterization of study site and its environment (including plume)
  - Transfer of microplastics?

→ **Lots of other potential subjects**

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Fate of antibioresistance, pharmaceuticals and endocrine disruptors from a former municipal landfill

Abstract

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Antibioresistance may develop in different contexts (e.g. hospitals, wastewater treatment plants, animal farming) through various processes. Because municipal landfills may have received medication waste coming from citizens but also from hospitals, they may represent a source of antibioresistance disseminating in the natural environment. Together with the fate of pharmaceuticals and endocrine disruptors, we studied the fate of antibioresistance from a former municipal landfill located in Nantes, France. Both municipal and hospital waste were deposited in this landfill between 1969 and 1987. The total volume of waste is around 2 million cubic meters.

We sampled leachates from the landfill, as well as groundwater upstream and downstream the landfill. Extraction (SPE or liquid/liquid) on frozen or fresh samples allowed quantifying 30 pharmaceutical molecules and 8 other emerging by LC/MSMS, UPLC/MSMS or GC/MSMS. The abundance of total cultivable communities was determined by counting on non-selective medium. Culture media used in clinical microbiology (drigalski / ceftazidime, Msuper CARBA and ESBL) were used to determine the proportion of the bacterial community that is resistant to antibiotics. Eventually, the diversity of the total communities was studied by PCR-TTGE and by 16S metabarcoding (MiSeq Illumina).

Over of the whole substances sought, 11 pharmaceutical molecules (not antibiotics), have been quantified in the leachates and 2 endocrine disruptors (bisphenol A and triclosan). Most substances were also recovered in groundwater immediately downstream the site (including carbamazepine) at concentrations ranging between 0.1 µg/L and 10 µg/L. The number of detected substances was lower a few hundred meters far from the landfill. More especially bisphenol A and diclofenac show lower concentrations ranging from 0.1 to 1 µg/L and about 0.1 µg/L respectively). Similar observations were shown for antibioresistance. The bacteria from leachates show a more important antibioresistance than in the other groundwater samples. The transfer of antibioresistant bacteria seems limited downstream the landfill, with nevertheless higher content at the immediate downstream. The natural attenuation may be explained by several processes, some being the same as for metals and PAH.

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