# Spatial and temporal evolution of antibiotics in the Baix Fluvià alluvial aquifer and its impact on groundwater resources quality

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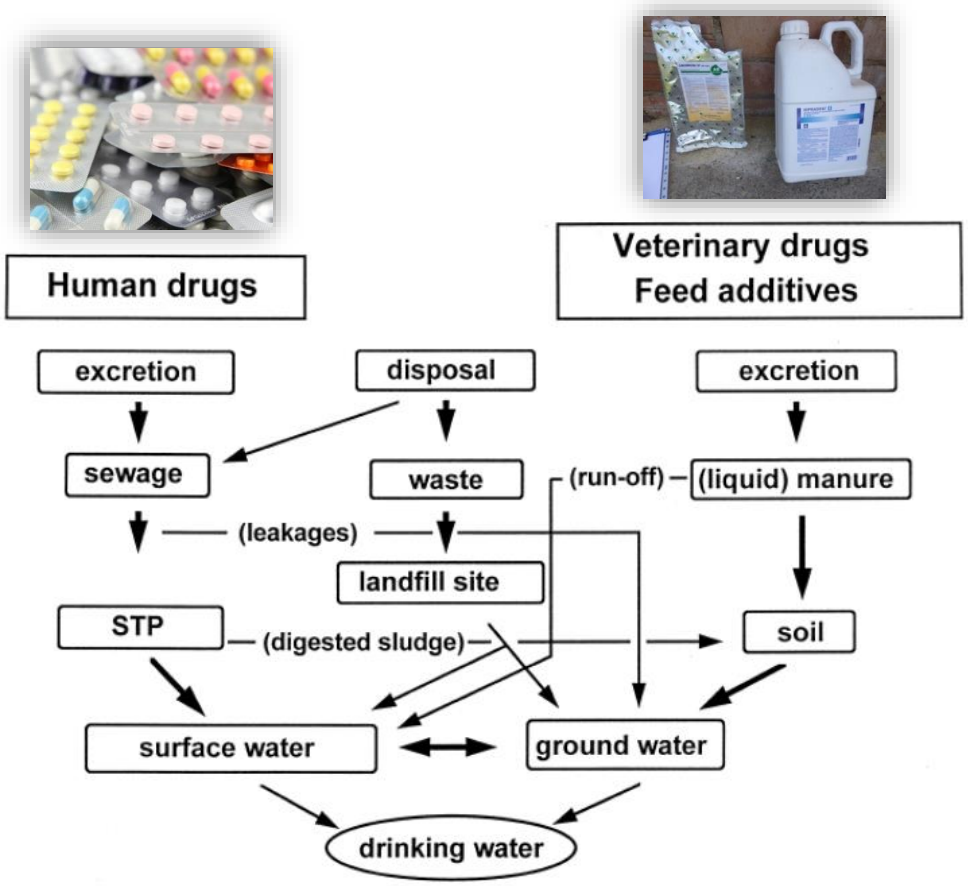
*Montpellier – 27th September 2016*

# Antibiotics pathways in the environment



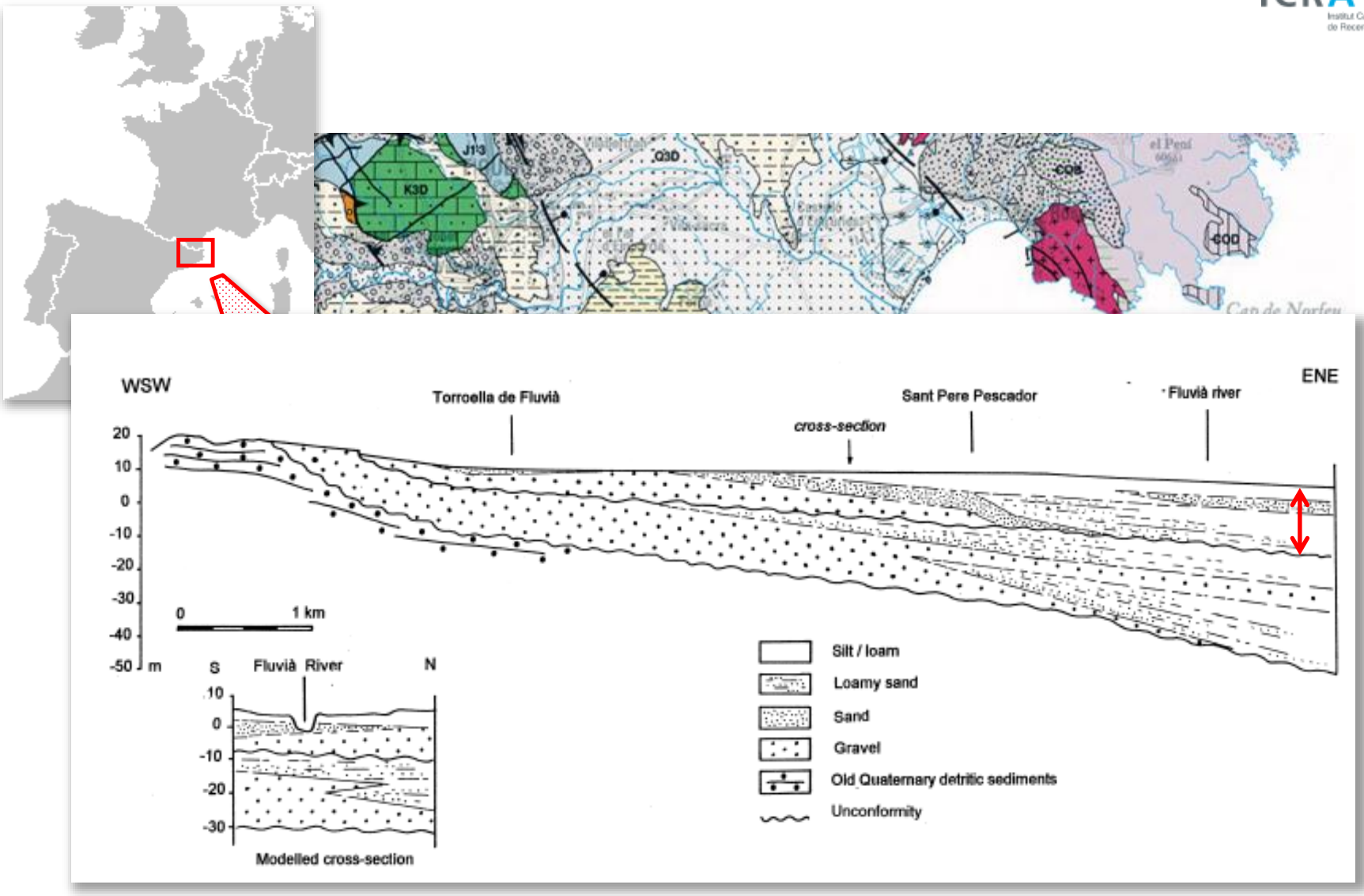

Source: Ternes, 1998

- **Environmental and public health concern** →development of **antibiotic resistant organisms**.
- **Not regulated** by environmental policies.
- Fate and persistence of pharma-ceuticals and antibiotics are **not yet well known in GW**.

# Objectives

- Describe the **sources, occurrence and migration of antibiotics** in the continuum of surface water-groundwater.
- Assess **spatial** and **temporal variability** of antibiotics.
- Evaluate the prevalence and abundance of **Antibiotic Resistance Genes** (ARGs) in groundwater.
- Derive, assess and communicate **water management strategies** for polluted groundwater resources.

# Geological setting: the Baix Fluvià alluvial aquifer

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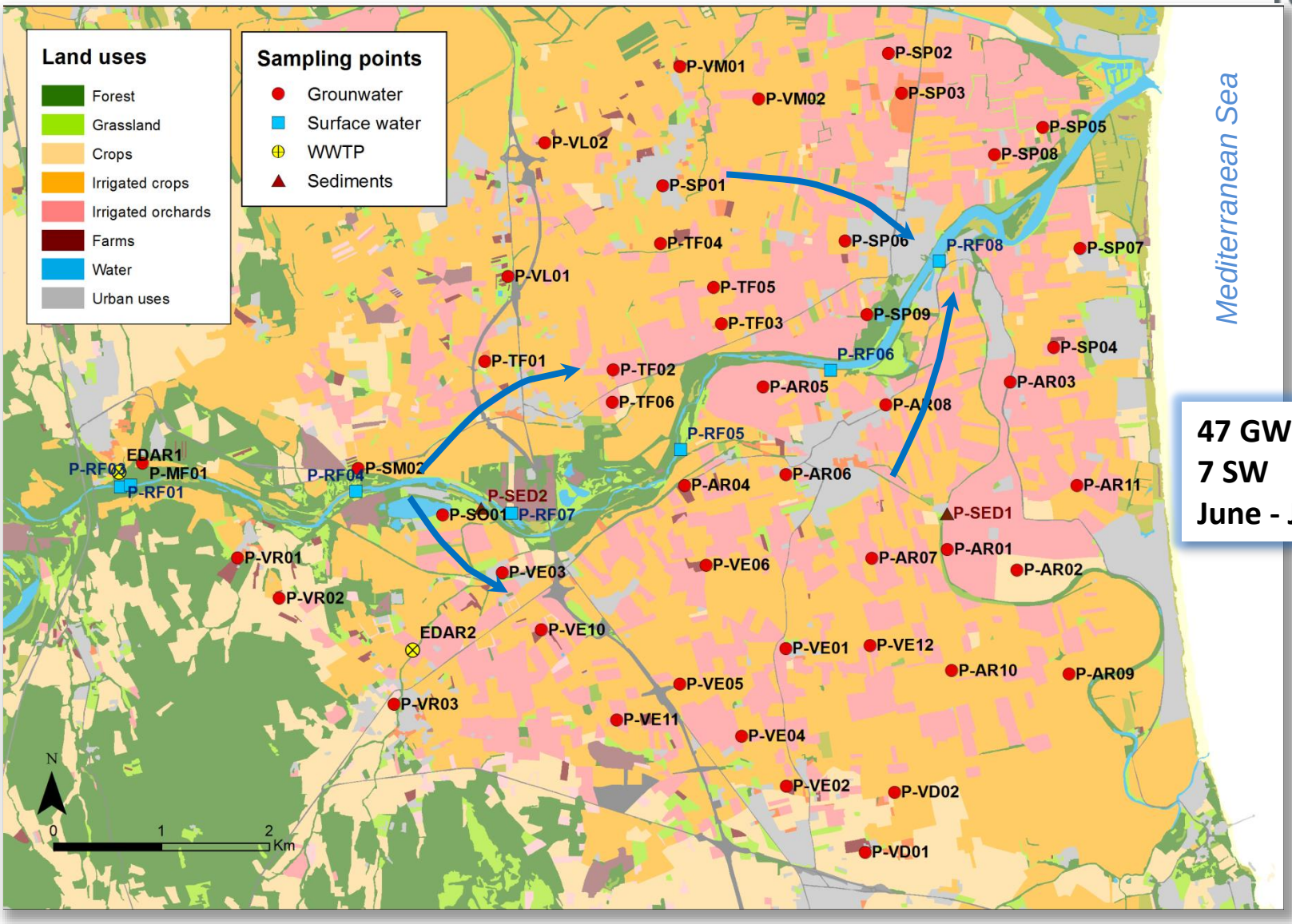
# Study site and sampling points




**47 GW**
**7 SW**
**June - July 2015**

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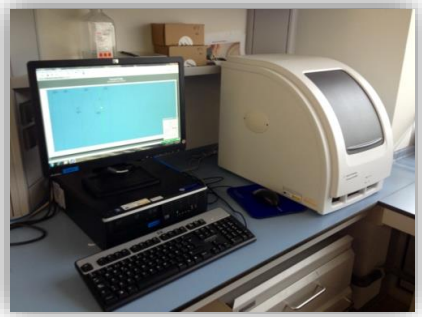
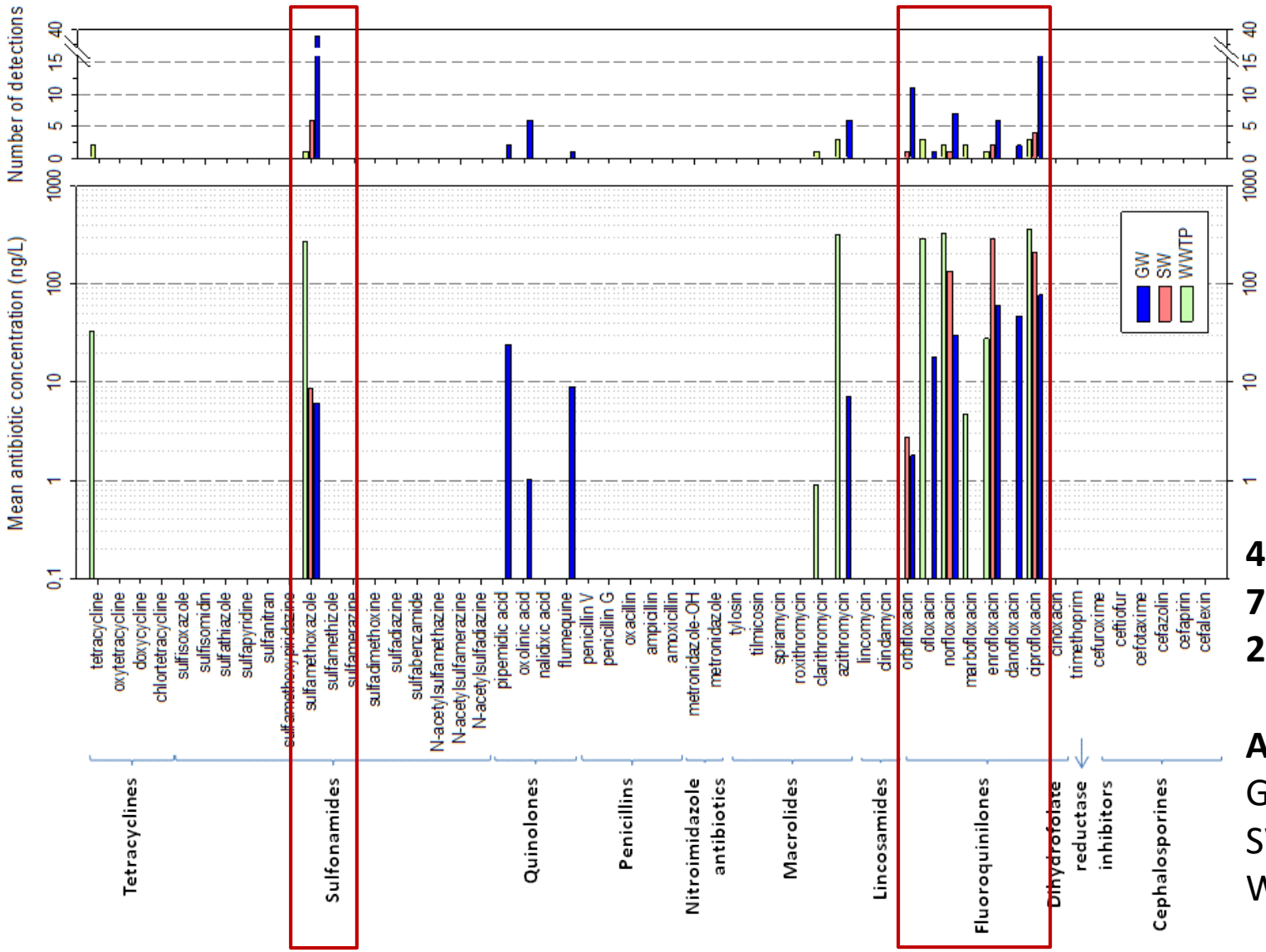
# Methodology

- **Hydrochemistry** and **isotopes.**
- **53 antibiotics** covering **10 chemical groups**, by ultra-high-performance liquid chromatography coupled to quadrupole linear ion trap tandem mass spectrometry (UHPLC–QqLIT), *Gros et al. 2013*.
- **Antibiotic resistance genes (ARGs)** conferring resistance to the analyzed antibiotics families.
- **Bacterial community** composition.



# Antibiotics results of the general campaign




**47 wells**
**7 river points**
**2 WWTP**

**ABs detected:**
GW: 11/53
SW: 5/53
WWTP: 9/53

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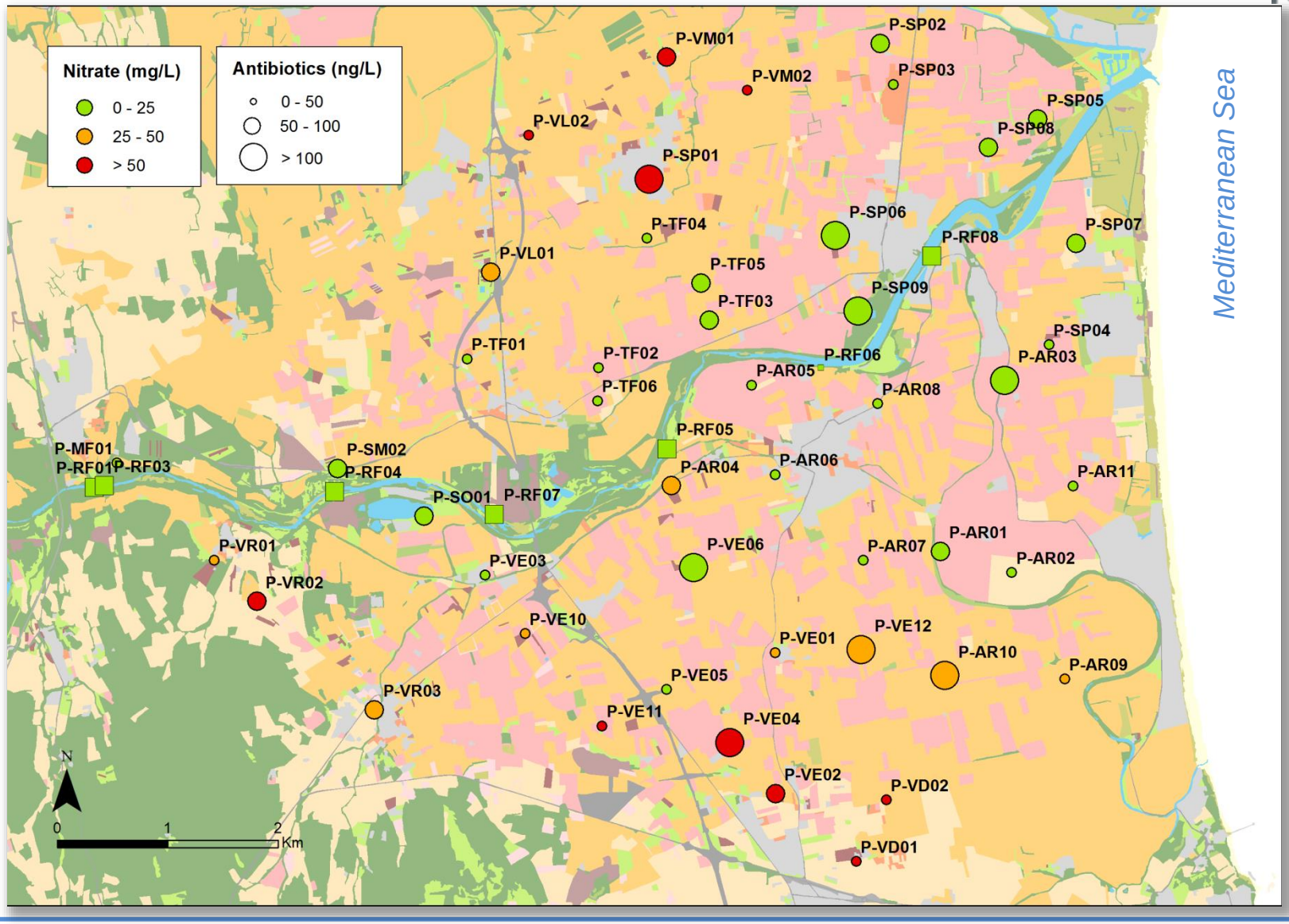
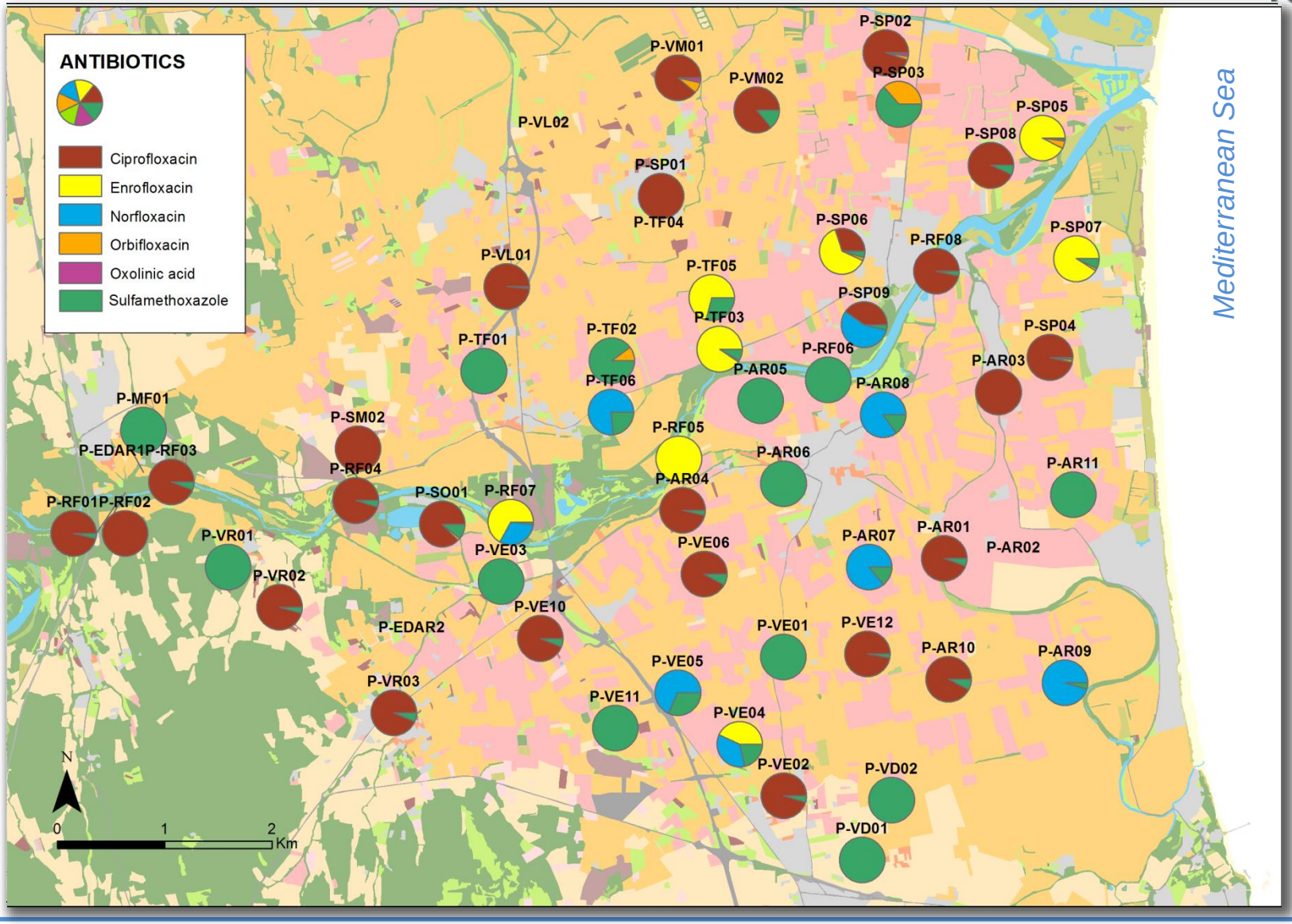
# Total antibiotics and nitrate concentrations



# Spatial variability: most detected antibiotics

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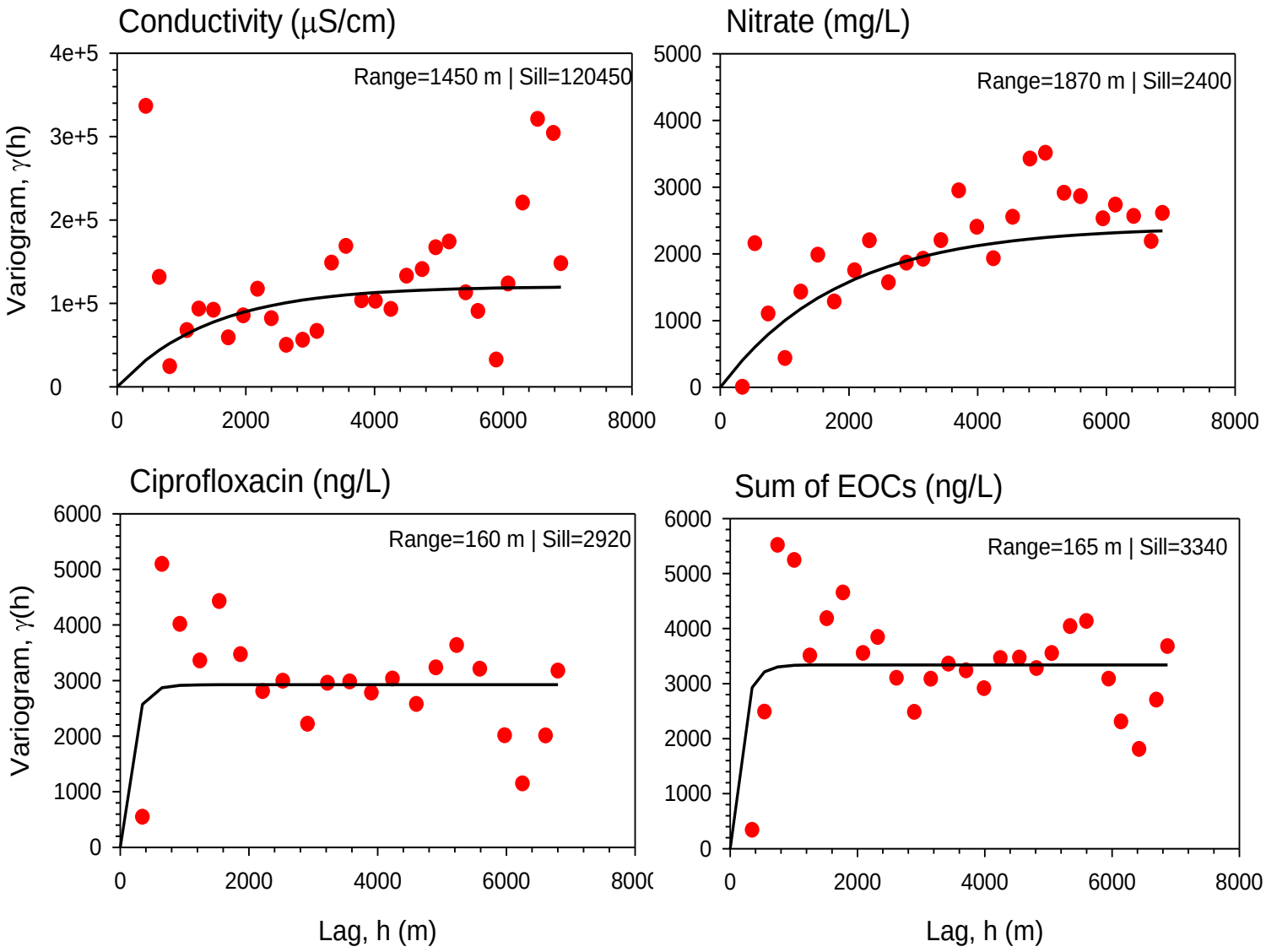
# Spatial correlation: variograms

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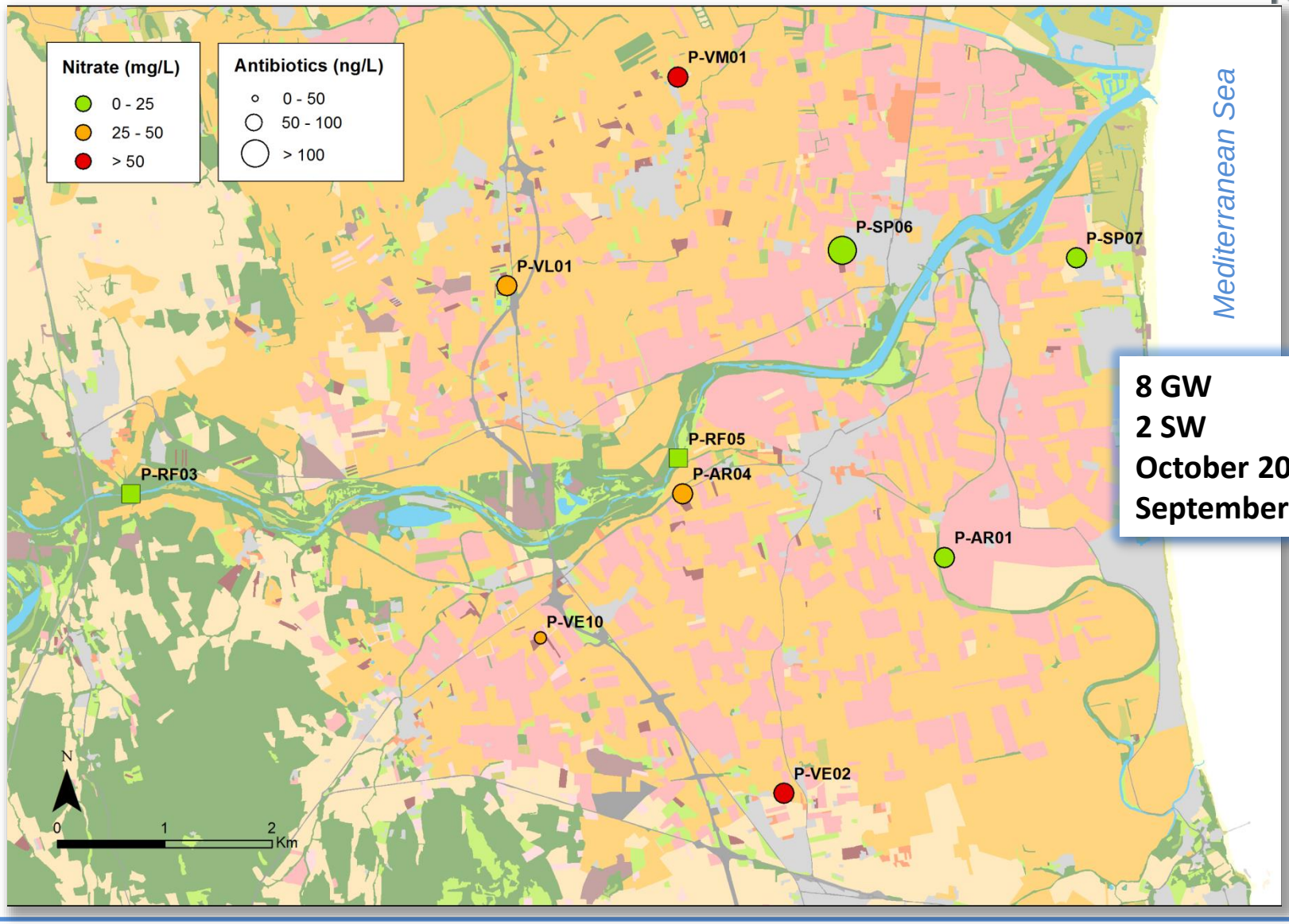
# Antibiotic spatial variability

1. **Hydrogeology and hydrochemical properties:**
   - surface water-groundwater interaction
   - pH, redox conditions, organic carbon
2. **Physical-chemical properties and processes** of antibiotics:
   - solubility
   - sorption: $K_d = f(K_{OW}, pK_a)$
   - degradation (half-life $t_{1/2}$)
3. Uncertainty in the **inputs**: *what, how much,* where, when?

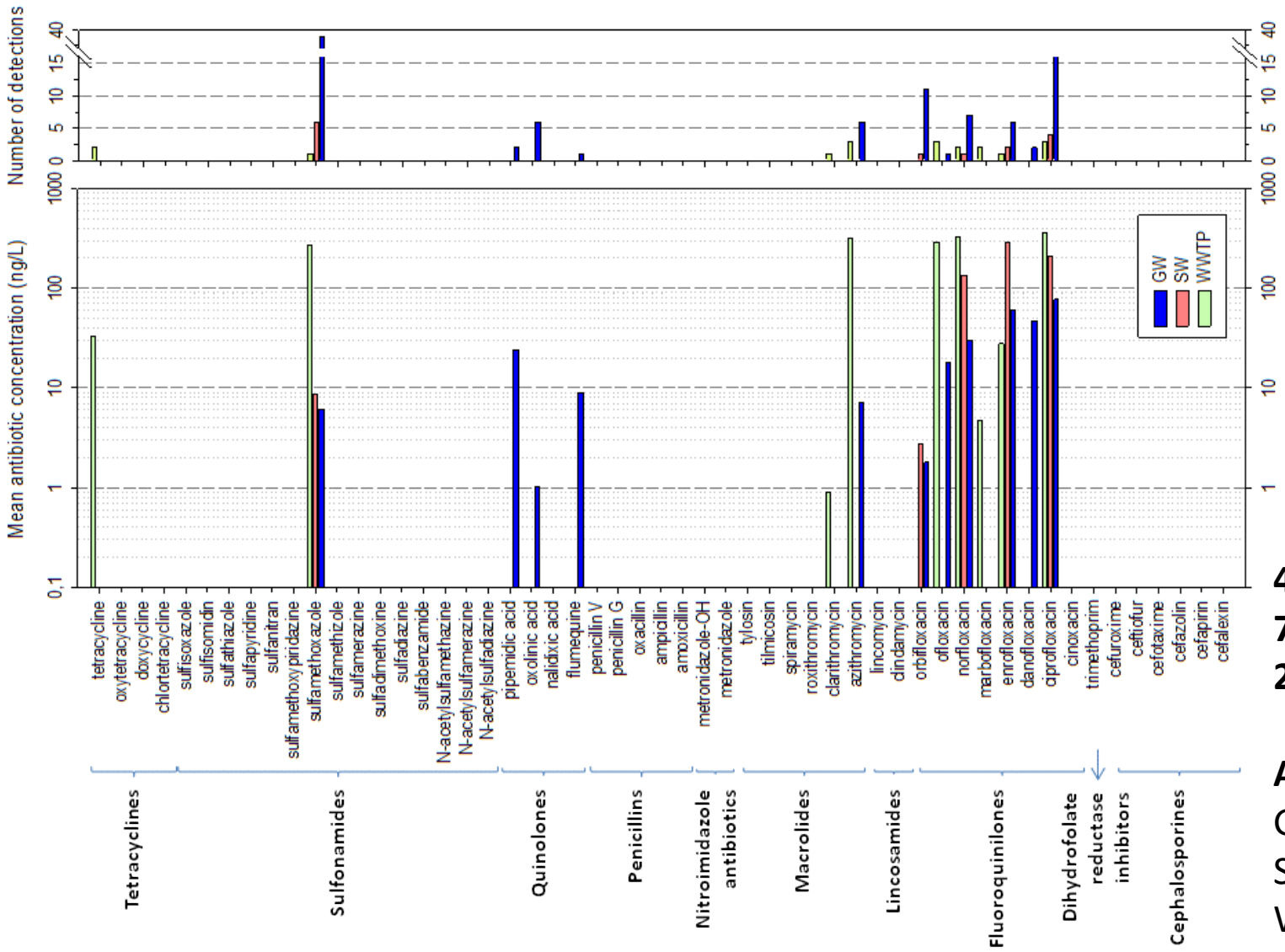
…and what did we observe **over time**?

# Sampling points monthly campaign




**8 GW**
**2 SW**
**October 2015 – September 2016**

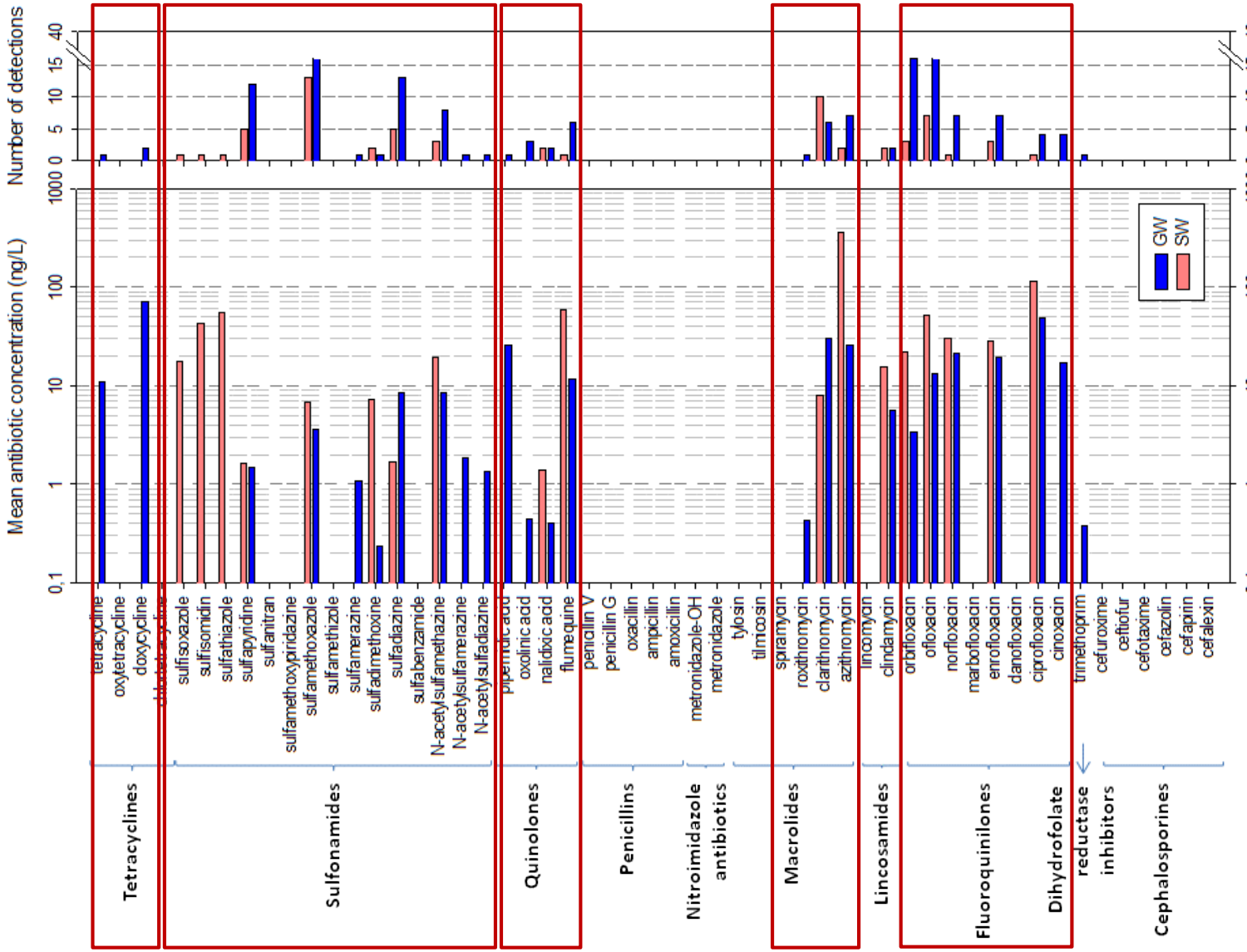
# Antibiotics results of the general campaign




**47 wells**
**7 river points**
**2 WWTP**

**ABs detected**
GW: 11/53
SW: 5/53
WWTP: 9/53

# Antibiotics results of 8 monthly campaigns




**8 wells**
**2 river points**

**EOCs detected**
GW: 25/53
SW: 18/53

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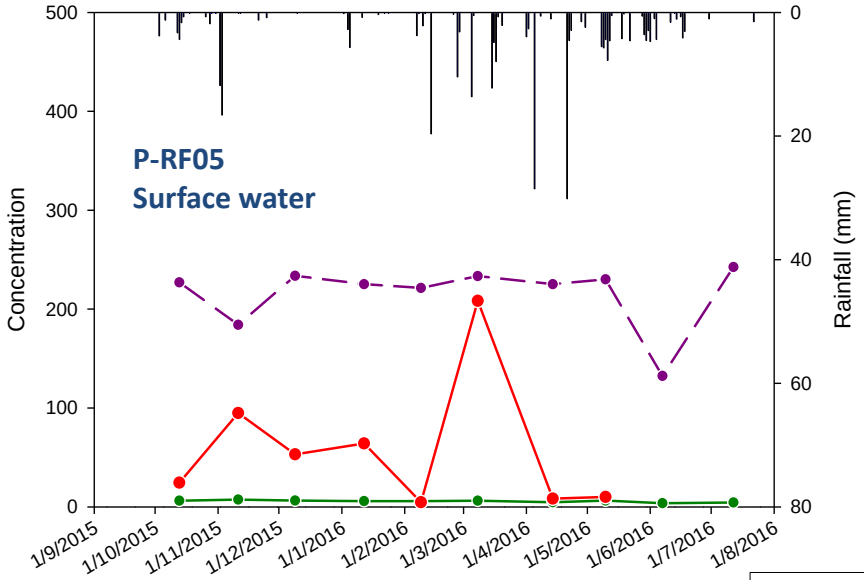
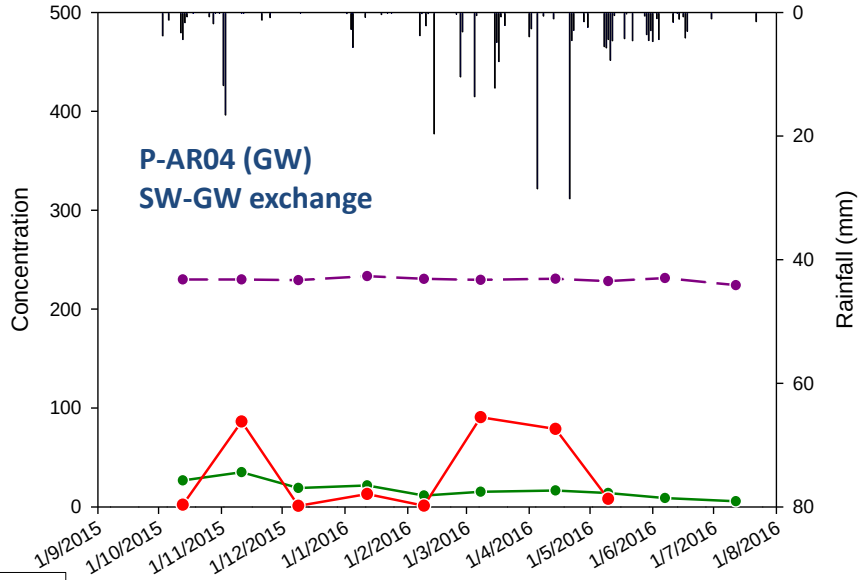
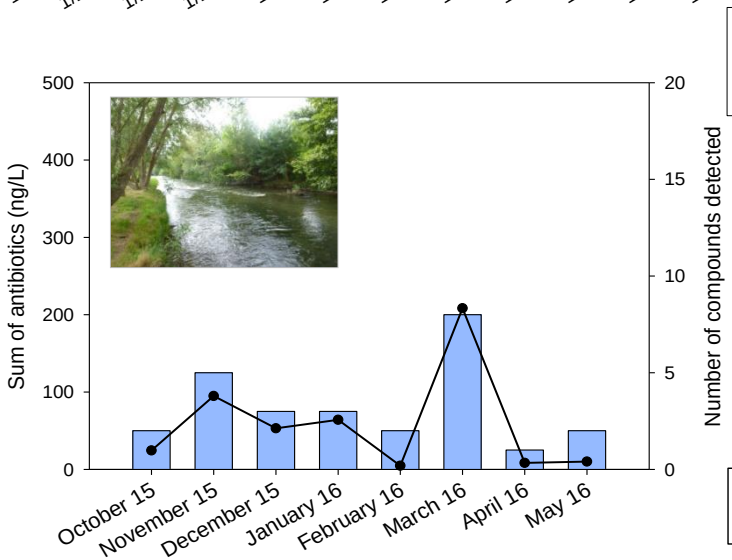
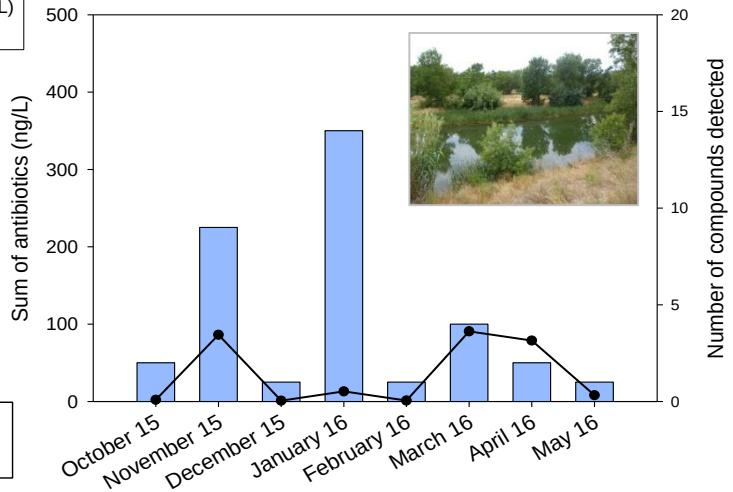
# Monthly results

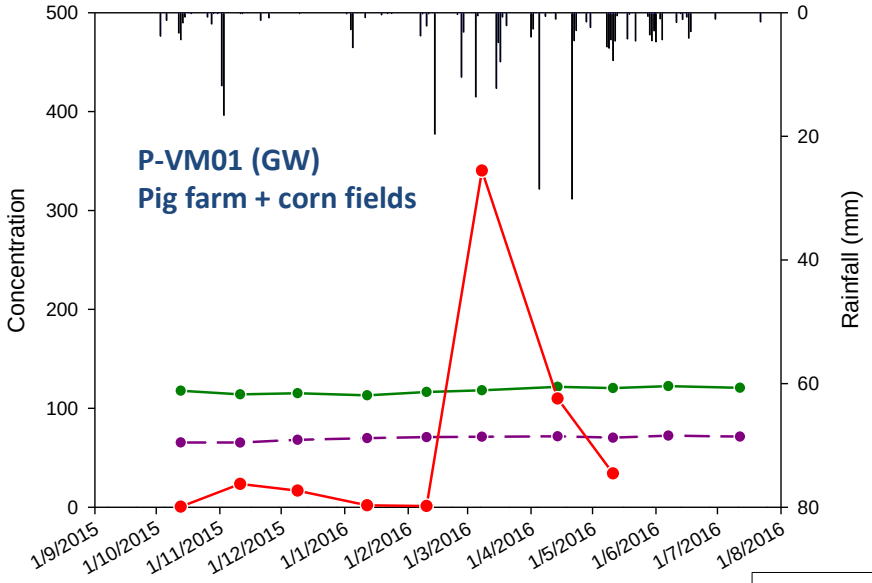


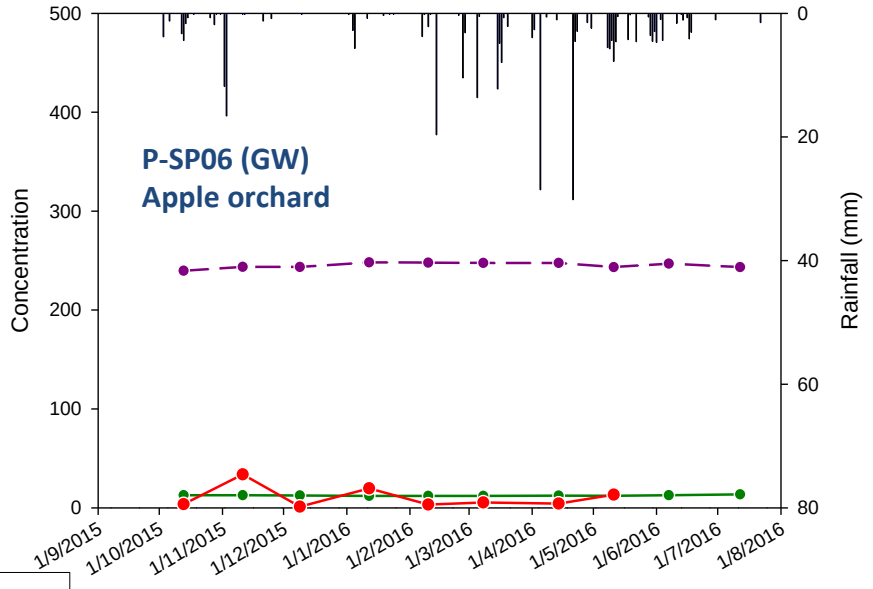



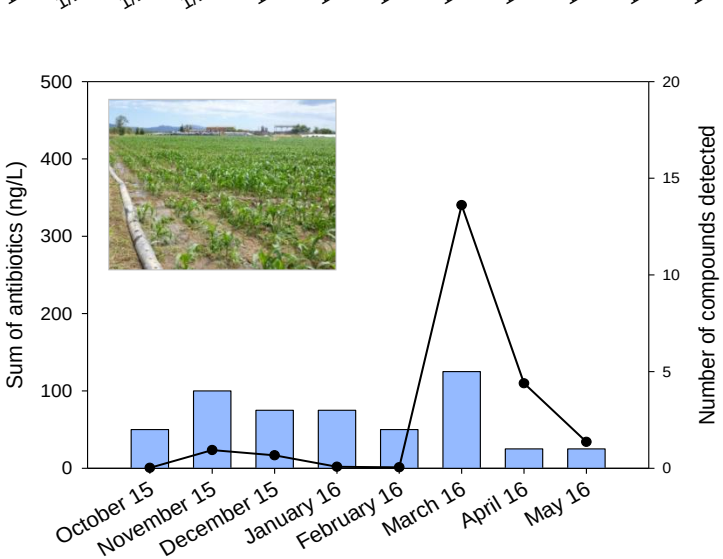



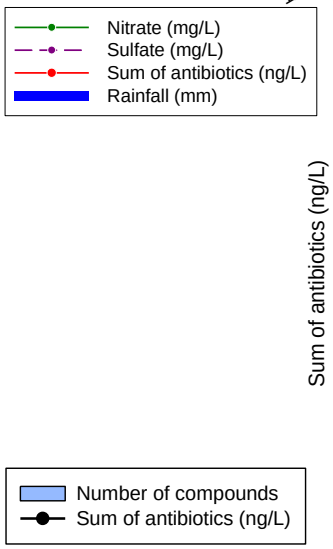



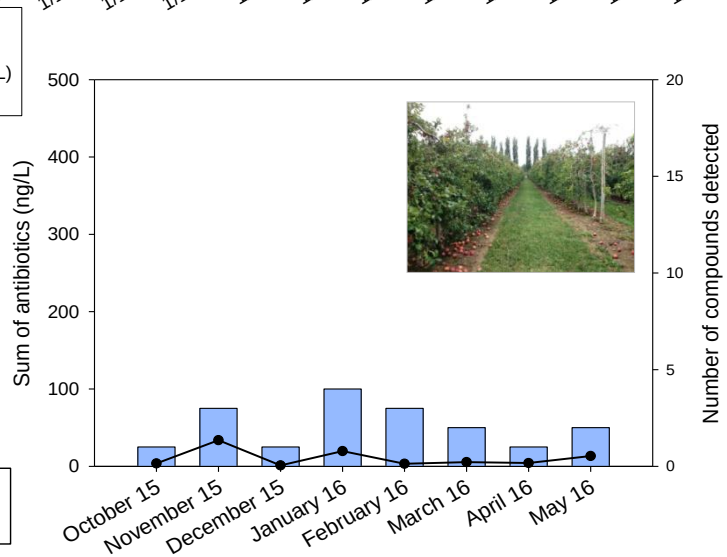
# Monthly results

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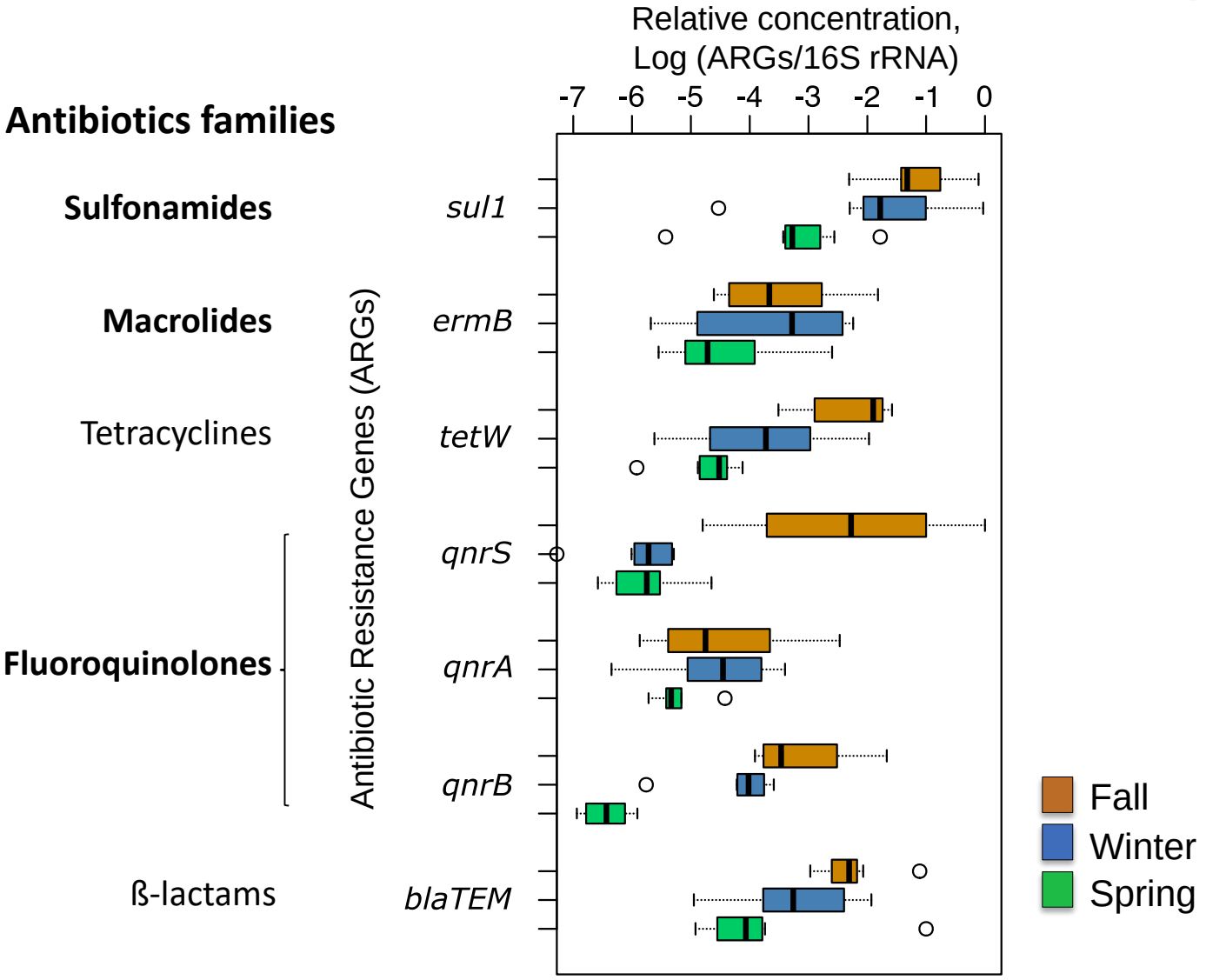
# GW resistome: quantification of ARGs



# Conclusions

1. **Concentrations** of antibiotics in GW are in the order of **ng/L**.

2. Up to **25 antibiotics** out of a screening of 53 antibiotics were detected **in GW → cocktail of antibiotics**.

3. **Sulfonamides, fluoroquinolones and macrolides** were the most widely detected chemical groups in GW.

4. **Antibiotics spatial and temporal distribution,** showing both a large variability, **depends on hydrological dynamics, biogeochemical processes, and input characteristics.**

5. **Seasonal changes** are observed on the **microbial community resistome.**

# Thank you!



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