

# Groundwater contamination by pesticides and metabolites in an alluvial aquifer: timeframe and trend

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# Context, Aims of the presentation

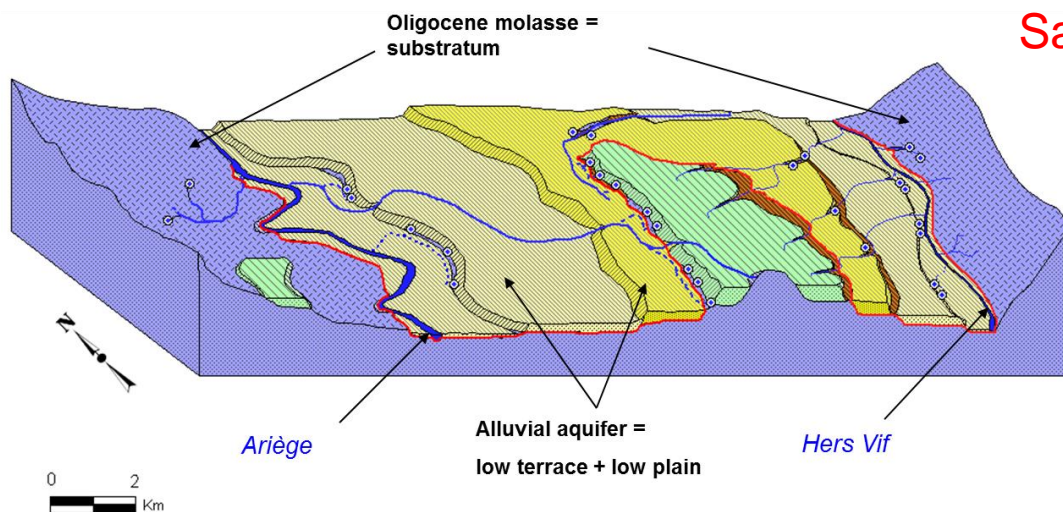
- ✓ European Water Framework Directive : What do represent the existing groundwater monitoring ? (list of substances, frequency,...)
- ✓ Lack of surveillance of metabolites of pesticides (less than 10%)
- ✓ Long-term groundwater quality monitoring
  - 5 years with high frequency of measurements (monthly)
  - Alluvial plain under intensive agriculture
    - Understand spatial and temporal variability of groundwater contamination
    - Characterize pesticides and metabolites transfer into groundwater (typology)
    - Link hydrodynamic functioning, land uses and pesticide properties

# Geological setting

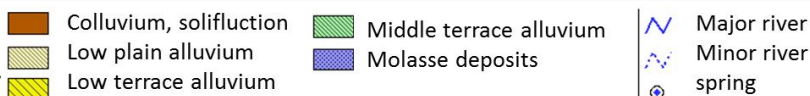


- > Alluvial aquifer in the valley of the Ariège and Hers Vif rivers with a surface area of **about 538 km<sup>2</sup>**
- > This water body (N° 5019) is classified as sensitive to pesticide pollution and presenting a high risk of not reaching the good water-quality objectives set for 2021
- > Due to pesticide and nitrate contamination, wells for drinking water supply have been progressively abandoned (2 exploited on 17)

**Unsaturated zone : few meters**  
**Saturated zone: 10-15 m**



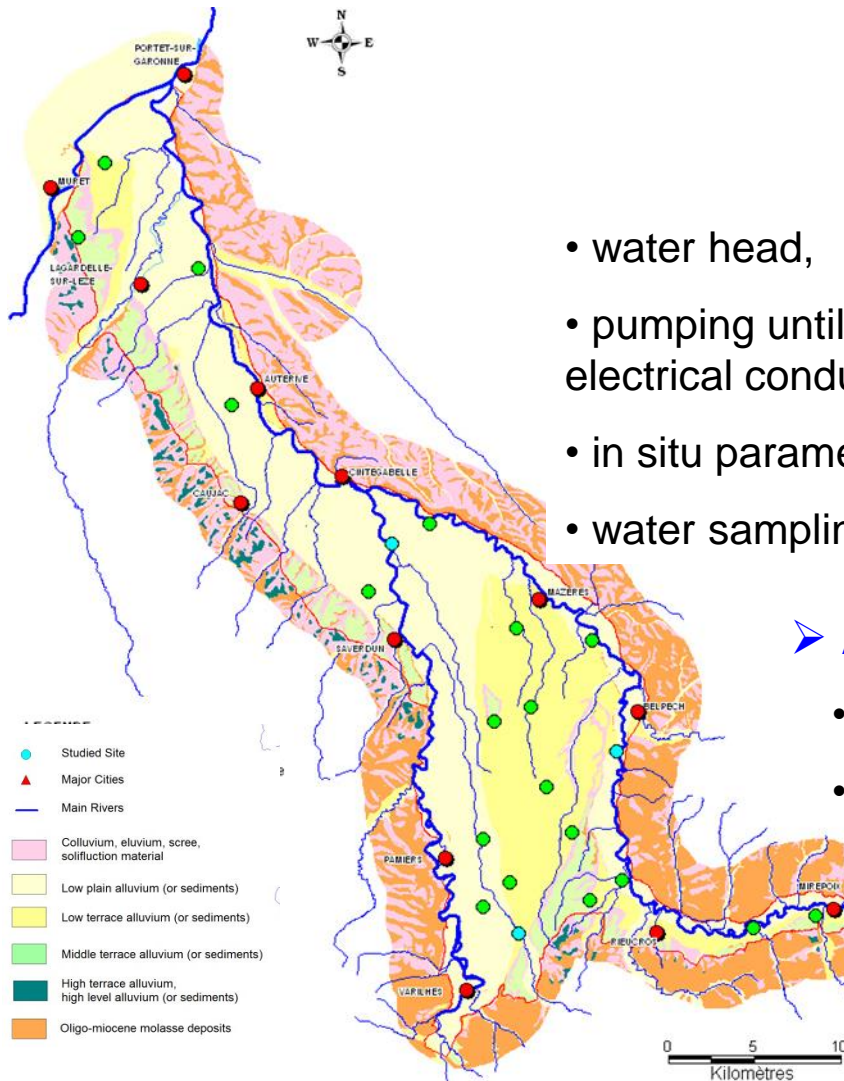
Adjacent terraces:  
 Highest elevation : Middle terrace  
 Low terrace  
 Low plain  
 Molasse = substratum



# Monthly sampling campaign : 17 wells or springs

March 2009 – May 2011

March 2012 - November 2014



- water head,
- pumping until parameters stabilization (pH, electrical conductivity)
- in situ parameters measurements
- water sampling

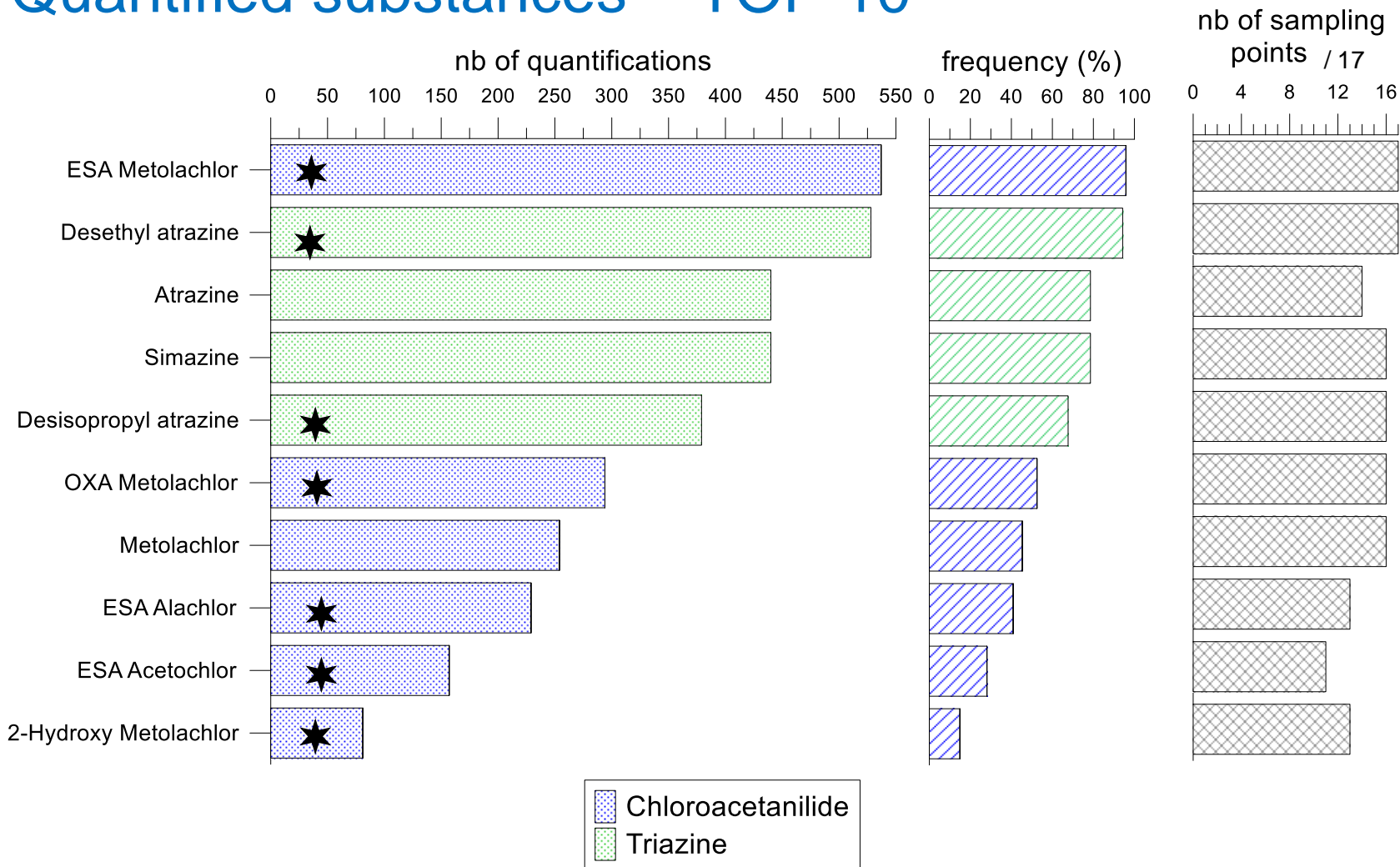


## ➤ Analyses performed

- anions and cations
- pesticides and metabolites



# Quantified substances – TOP 10

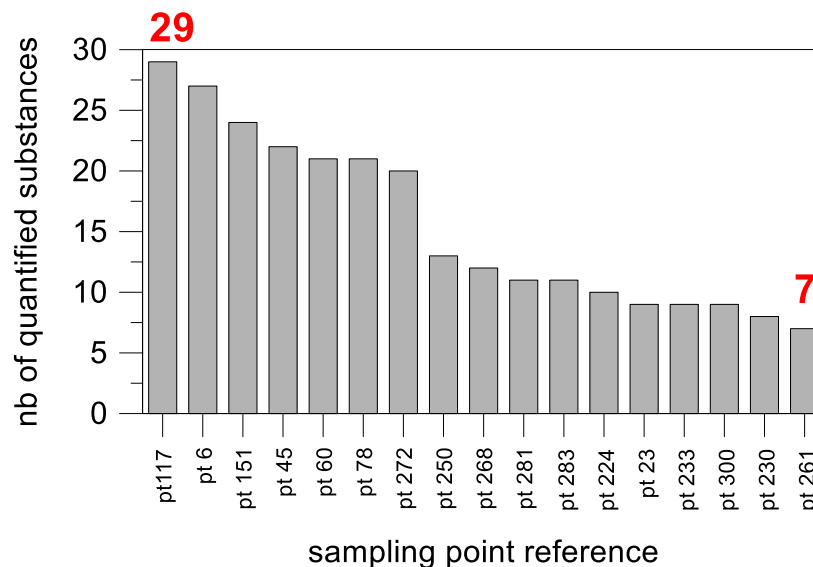


*40 molecules quantified / 55*

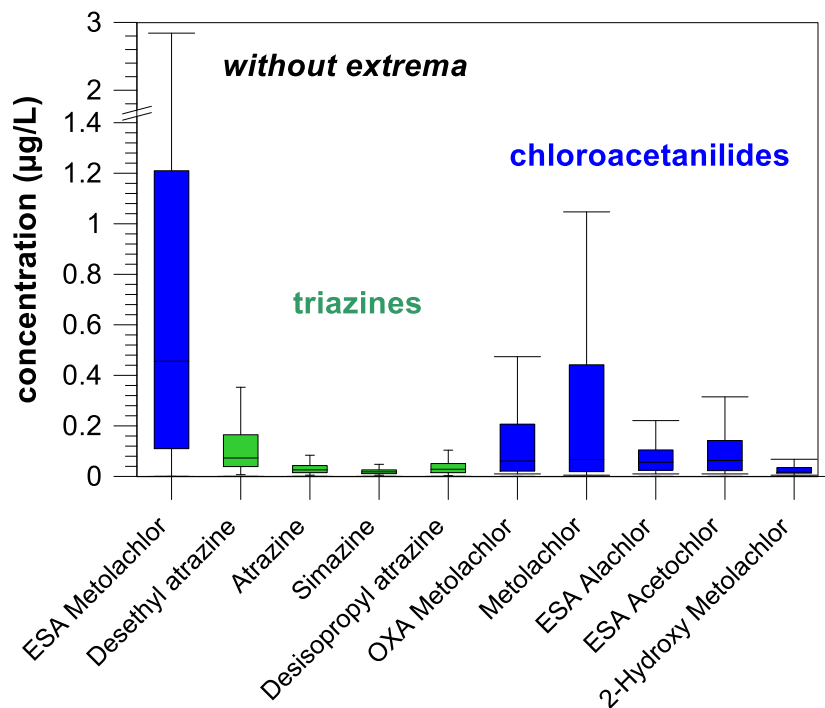
*Predominance of metabolites ★ vs. active substances*

# Quantified substances – general statistics

*By sampling points*



*By substances*



High spatial and temporal variabilities of the groundwater contamination

What are the explaining factors of this variability ?

# Available data

> Piezometric map + hydrodynamic model of the whole groundwater body

⇒ Delineation of the catchment of each sampling point (wells/springs)

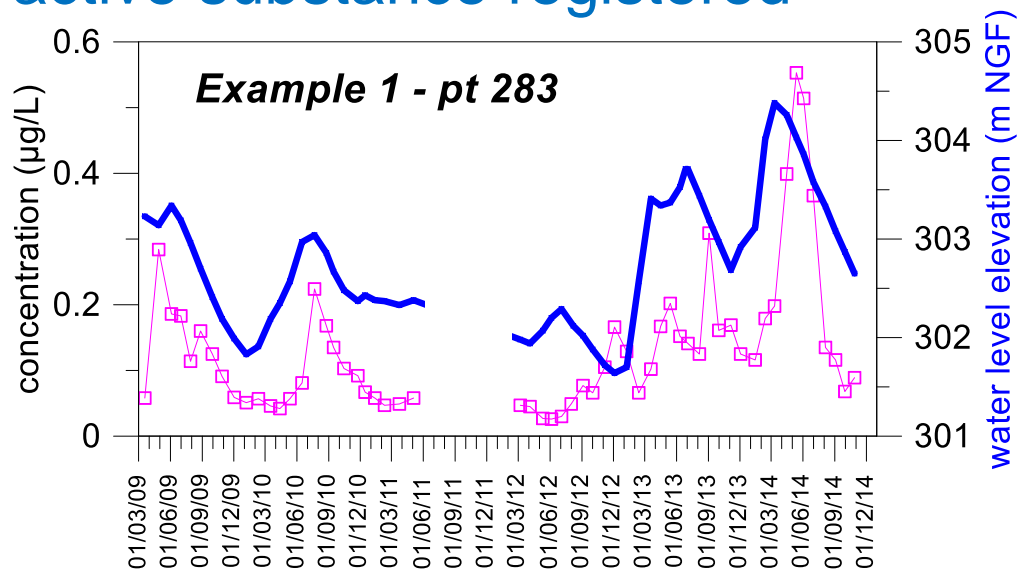
> Agricultural land-uses declarations from 2006

> Geographical information system – geoportail

> 70 farmers interviewed in 2008

Assumptions  
on uses

# FIRST CASE : Very mobile metabolite (ESA – metolachlor) active substance registered



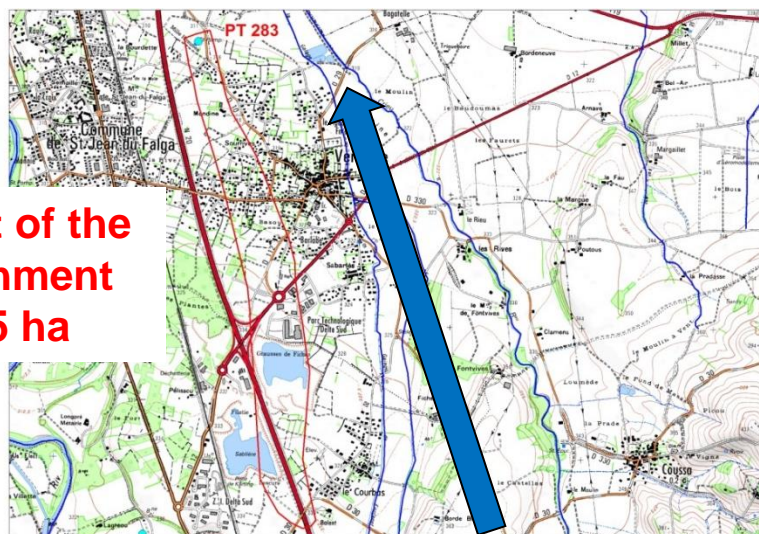
Similar trends for ESA – metolochlor concentrations and piezometric level

corn = 2 % from 2008 to 2012

⇒ **Impact of land use – repeated applications**

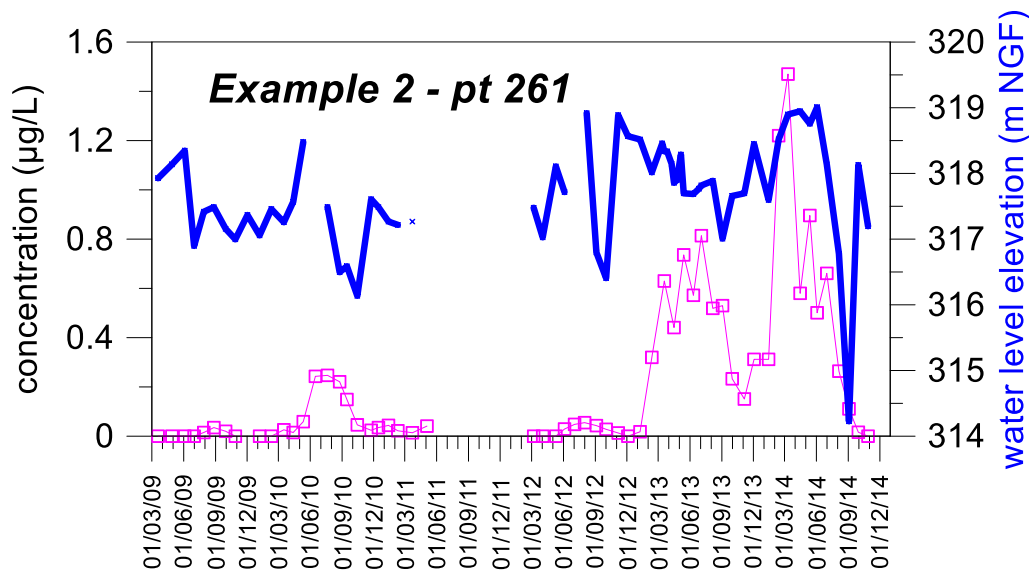
⇒ **Impact of the recharge on groundwater contamination**

⇒ **Impact of the transmissivity / renewal of water**





# ESA - metolachlor



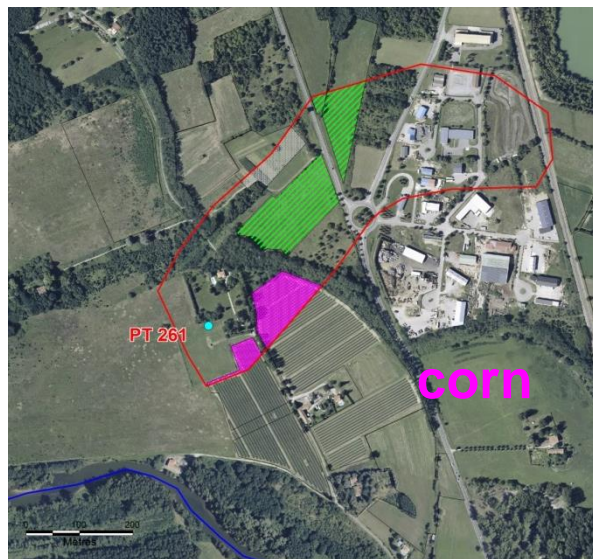
Increase of ESA –metolochlor concentrations AND annual variations (period of recharge)

Substitution of a pasture by corn close to the well

⇒ Impact of both land-use (new application) and recharge

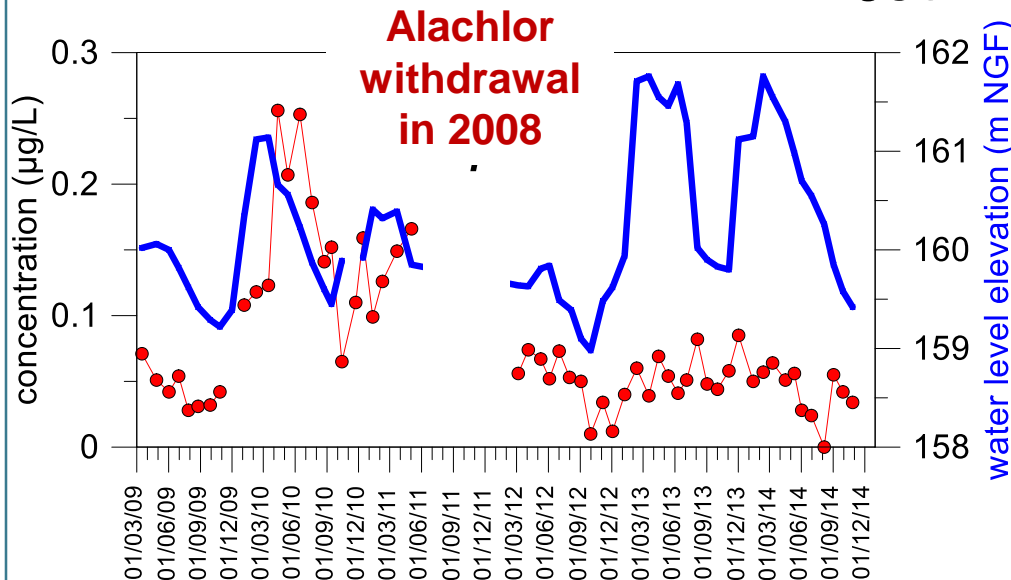
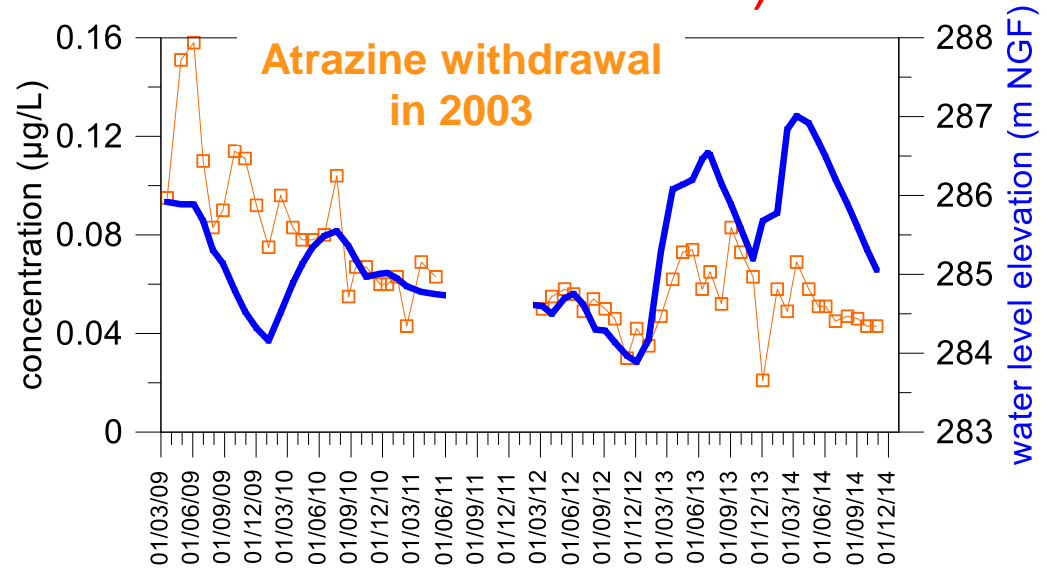


Pasture until 2009



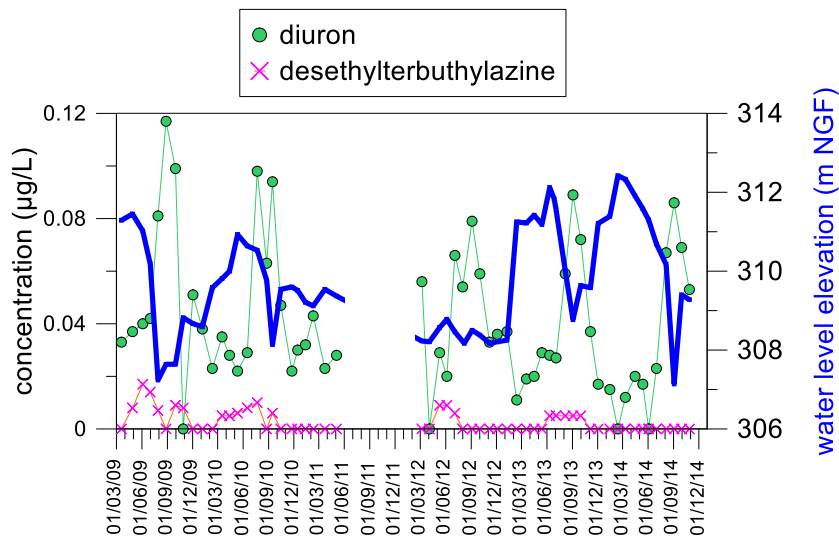
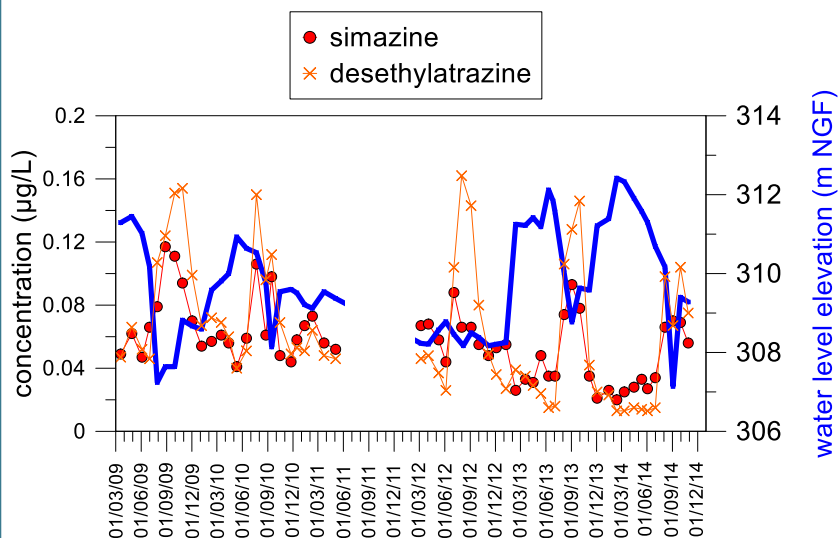
# 2nd CASE: Very mobile metabolites - active substances withdrawn (Desethylatrazine = DEA / ESA-alachlor)

Similar fluctuations of DEA and ESA-alachlor concentrations and piezometric levels at the beginning of the monitoring



- ⇒ Impact of recharge and uses change
- ⇒ Release of metabolite from vadose zone
- ⇒ Conditions of remobilisation ?

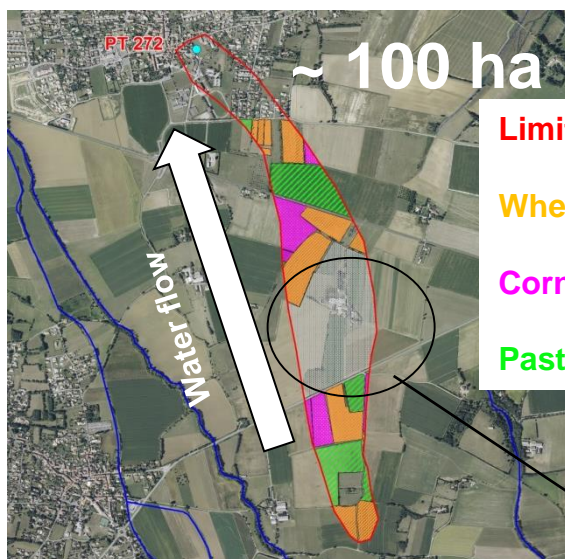
# 3th CASE : Impact of regional flux



Anticorrelated fluctuations of concentrations and water levels

Past uses : Terbutylazine + diuron = trees, vineyards....

⇒ Impact of land-use in the middle/upper part of the catchment and of transfer time in the saturated zone,



High density of trees

# Conclusions and lessons

✓ **According to the European Water Framework Directive or others monitoring, questions appear**

- *What is the representativeness of the selected observation wells?*
- *What is the representativeness of a unique measurements done?*

✓ **This long-term monitoring** allowed a better characterization of trends and timeframes of metabolites that were not routinely investigated in France in groundwater

⇒ *Implementation of list(s) of surveillance*

⇒ *New tracers useful for hydrogeological studies?*

# Conclusions and lessons

- ✓ **Recommendations for the monitoring and interpretation – implementation of the programme of measures**
  - Needs of knowledge on
    - land-uses/practices
    - hydrogeological context and dynamics i.e. transfer time in the unsaturated zone AND in the saturated zone
  - High frequency of measurements to describe intra-annual fluctuations AND long term monitoring i.e. several hydrological AND cultural cycles !
    - 5 year-monitoring in an alluvial plain

This work was supported by



Thank you for  
your attention !

