ECWS-5

Pesticide distribution in pond sediments from an agricultural catchment (Auradé, SW France)

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Laboratoire d'écologie fonctionnelle et environnement

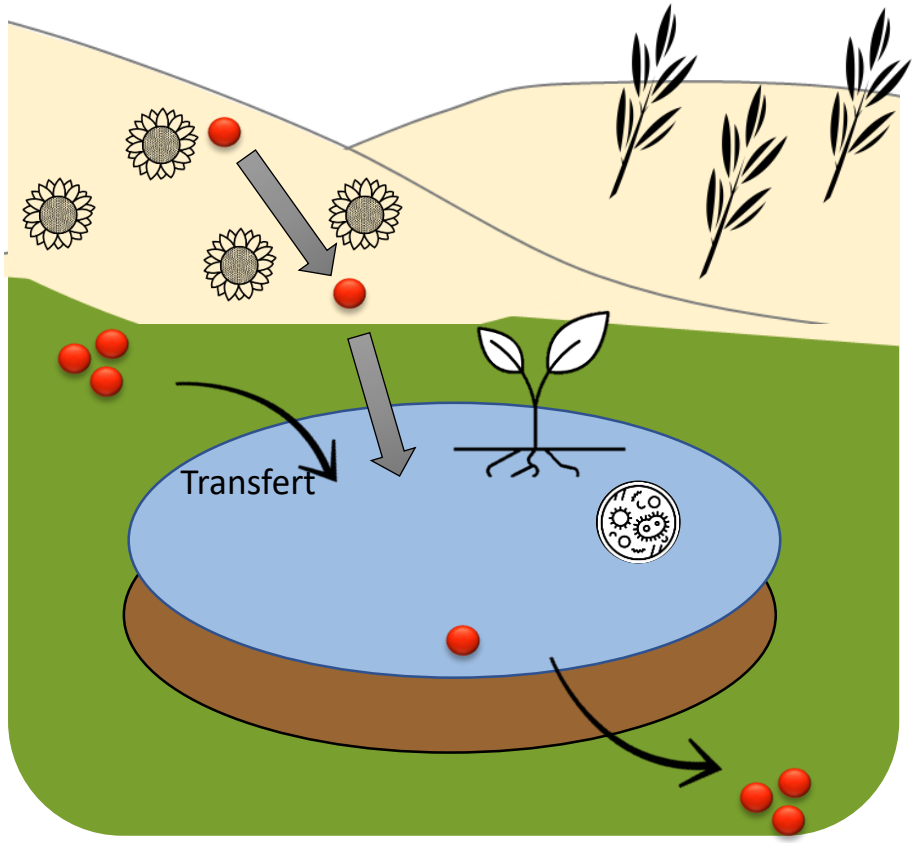
Context

- Pesticides are ubiquitous in agricultural areas
- Intensive agriculture ⟶ Soil erosion ⟶ aquatic environments : wetlands

ANR Pestipond project

Aims to characterise the role of ponds in the transfer and fate of pesticides in an agricultural context

https://pestipond.cnrs.fr/



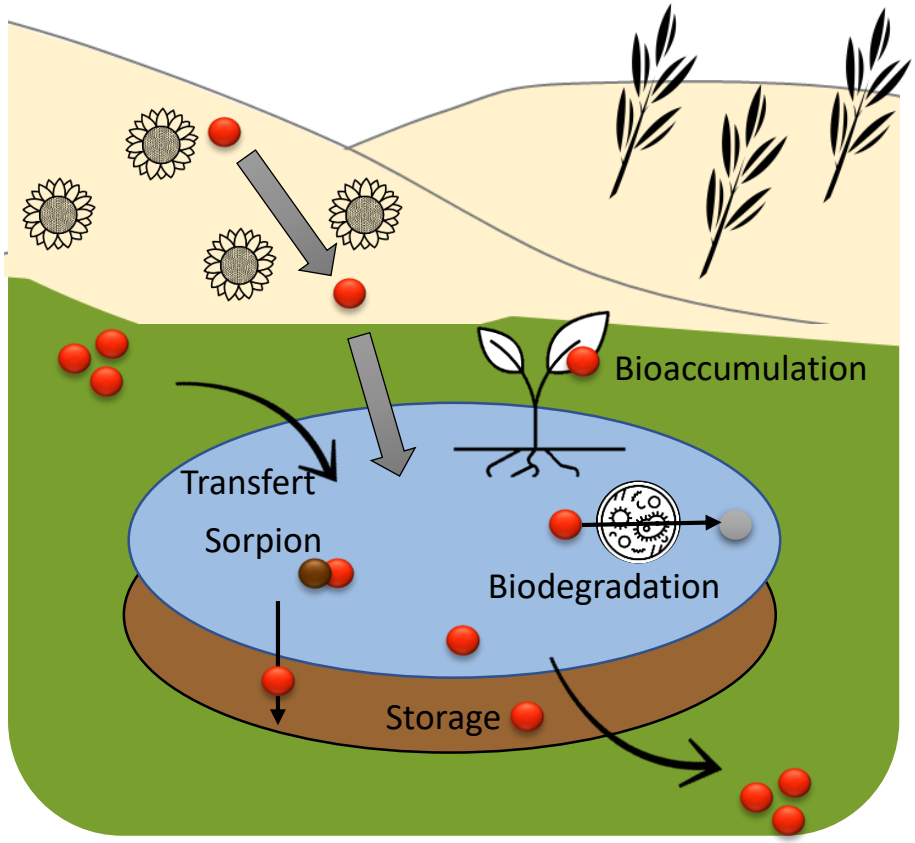
Context

- Wetlands such as pounds are composed of ⟶ Interaction with pesticides

  Water column (organic matter)

  Vegetation

  Sediments



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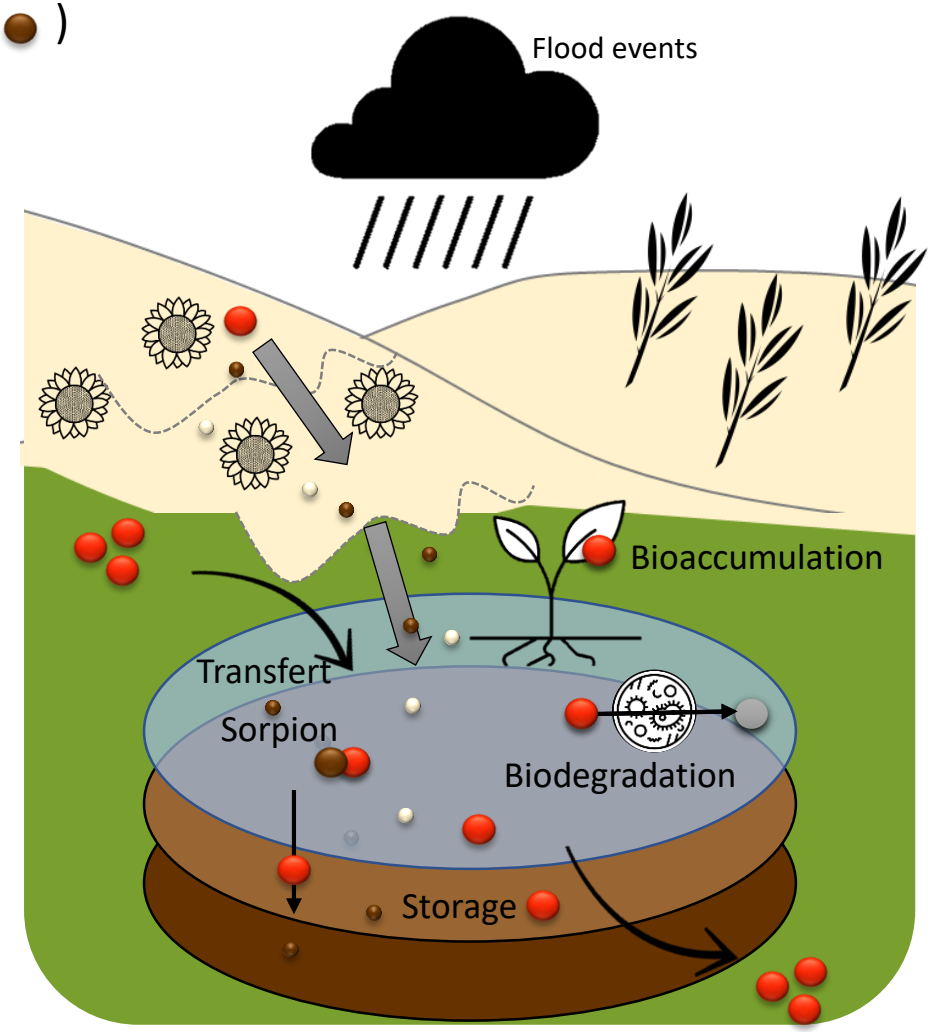
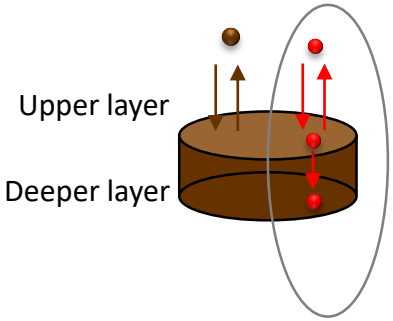


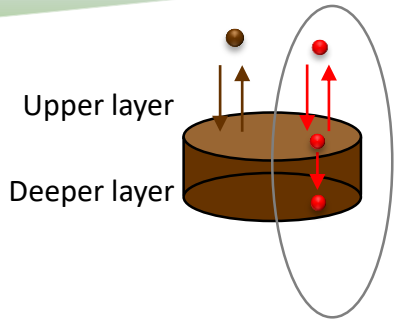
- In case of ponds
  - **sediment** → major compartment
    - agricultural erosive context



Constant interactions → reactive compartment

Storage process

Context



Constant interactions → reactive compartment

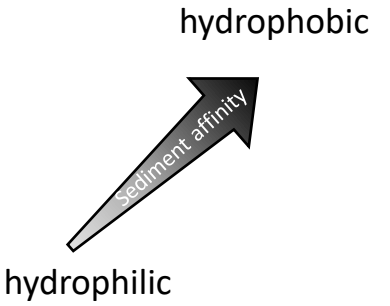
Storage process depends on

- Sediments texture:
  - Clay (0-2 µm)
  - Fine silt (2-20 µm)
  - Coarse silt (20-63 µm)
  - Sand (63 µm – 2 mm)
  - Gravel (< 2 mm)

Known for its high sorption capacity[1]

↳ larger specific surface areas

- Pesticides physicochemical properties[2,3,4]:
  - $LogK_{OW}$



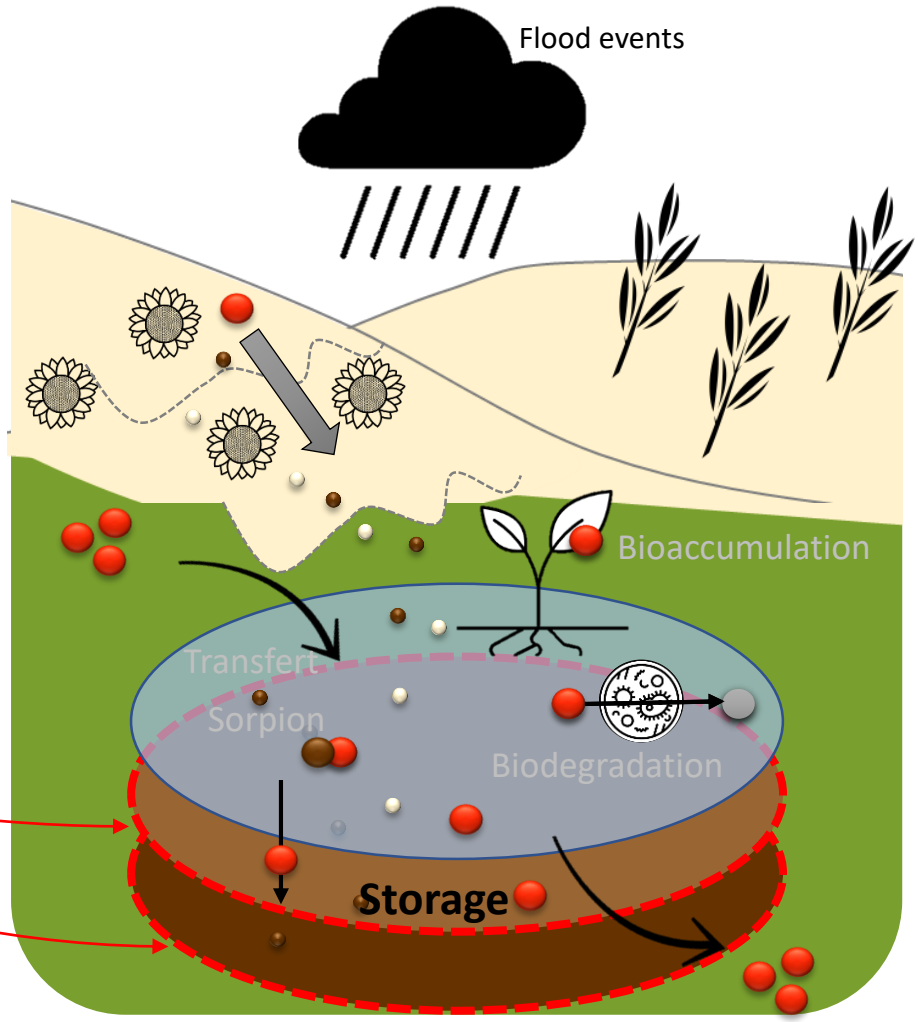
- Physicochemical conditions[5]:
  - Carbon content
  - Carbonates
  - pH
  - Redox conditions

[1] *Green, 1974*
[2] *Si et al. 2011*
[3] *Katagi, 2006*
[4] *Poissant et al. 2008*
[5] *Taghavi et al. 2010*

Objectives of this study

- Where are pesticides stored and in which quantities?
- What factors control this process?

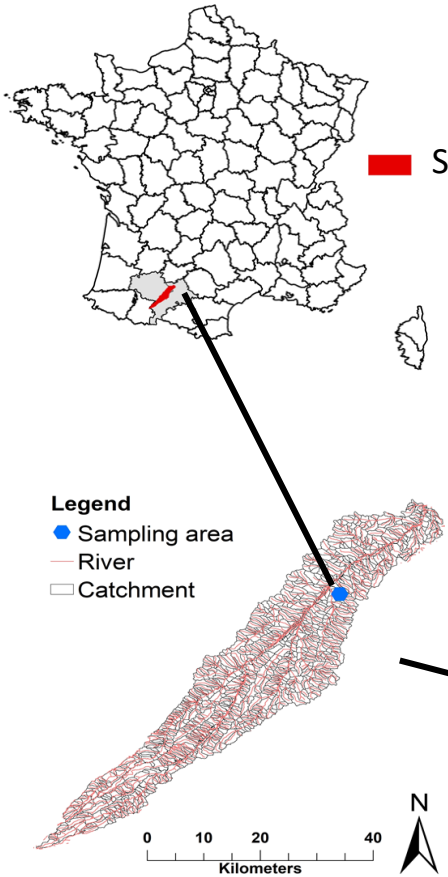
→ Spatial study on the surface and in depth

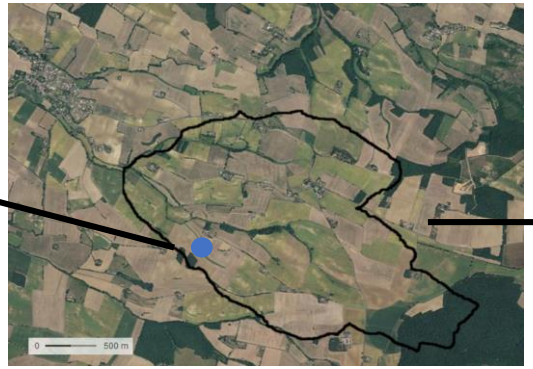


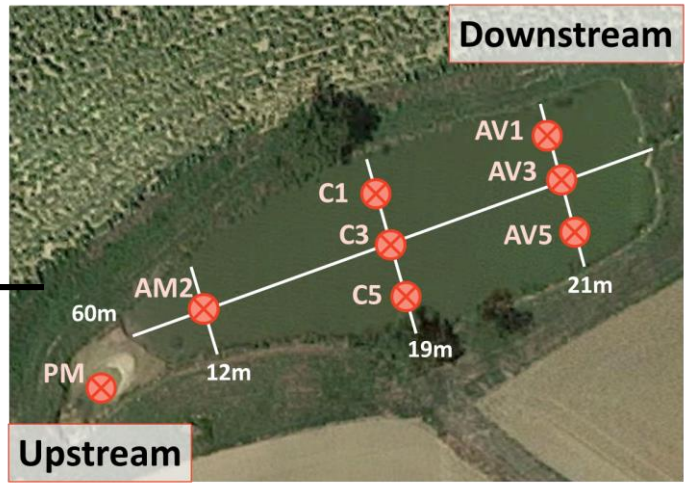
Study site

Area:
- Land cover: yearly rotation of sunflower and wheat
- Pesticides used: herbicides and fongicides
- Steep slopes → soil erosion
- High pH, carbonated soils

Pond:
- 60 m long,
- 11 to 21 m wide
- 0.5m of water column and 3 m of sediment layer depth



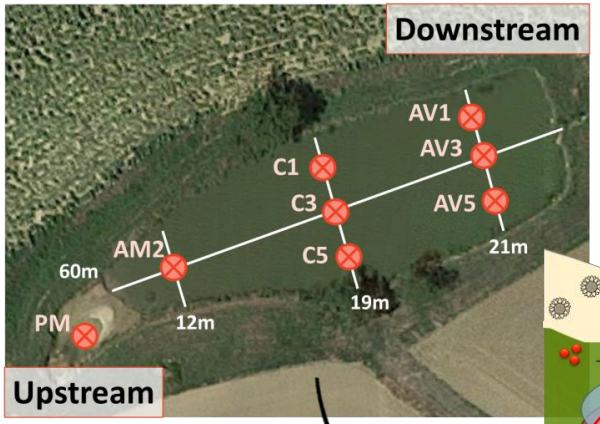


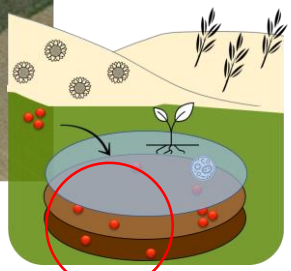


From Wu PhD, in progess

Field campaigns

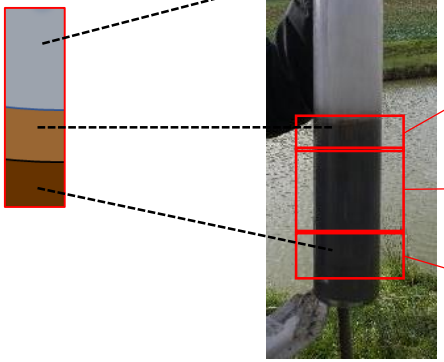
Two sampling campaigns: **autumn** (November 2019) and **summer** (July 2020)





8 cores

Sediment samples collected



Surface: 0-2 cm

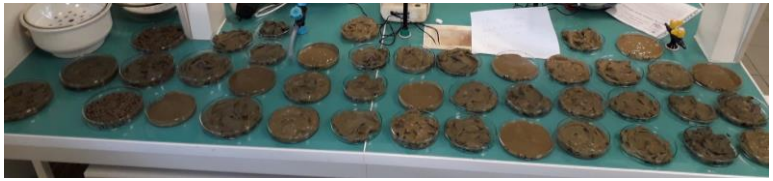
Middle: 2-12 cm
(data not shown)

Bottom: 12-17 cm

Methods

Samples preparation:

Dried at room temperature



Disintegrated smoothly using an agate mortar and pestle and quartered

Samples analysis:

- Microgranulometry: sediment texture
- Organic carbon
- Pesticides quantification

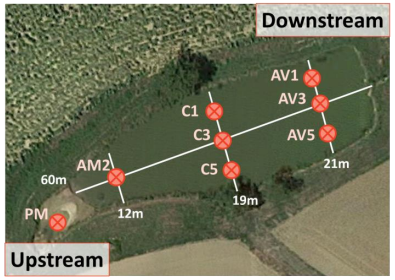
Metolachlor → $logK_{OW}$: 2.9 / herbicide

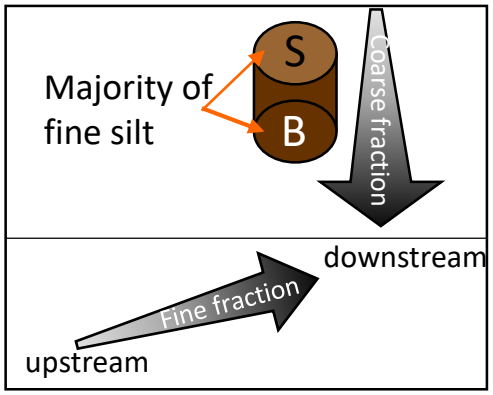
Boscalid → $logK_{OW}$: 3 / fongicide

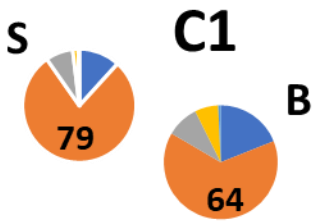
Tebuconazol → $logK_{OW}$: 3.7 / fongicide

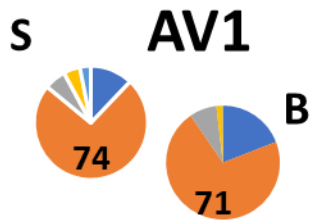
Sediment texture

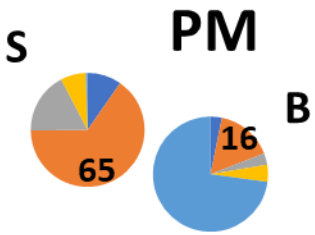
Surface vs bottom

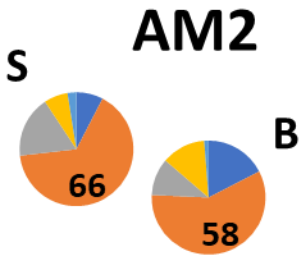


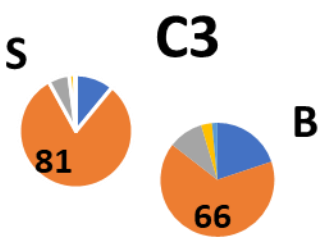


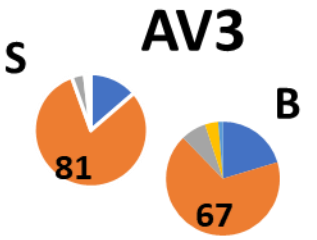










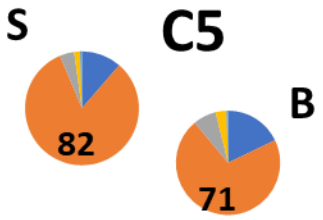


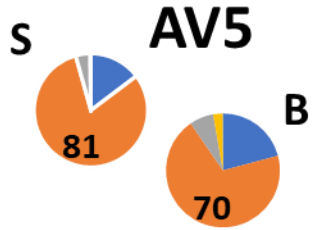
Surface

Summer

Bottom

Percentage of total





Clay
Coarse silt
Gravel
Fine silt
Sand

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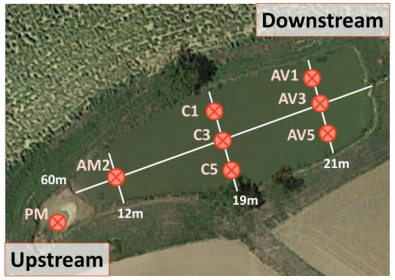
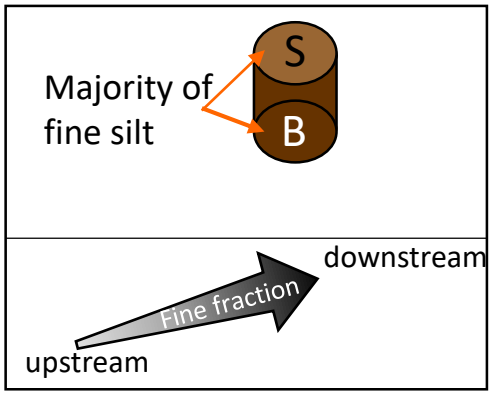
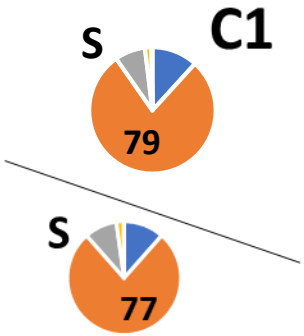
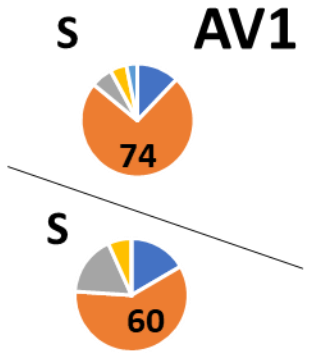
Sediment texture

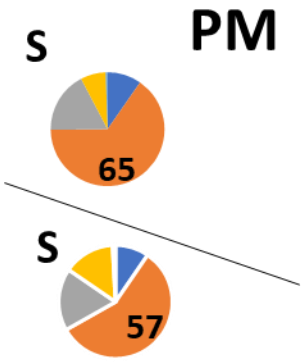
Spatial distribution

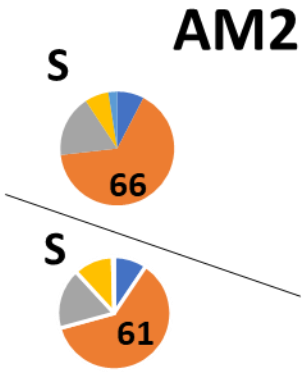


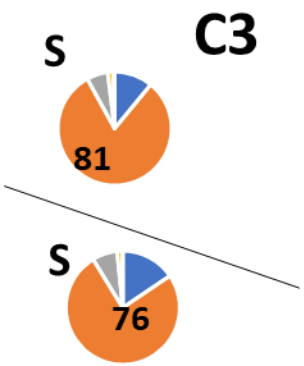


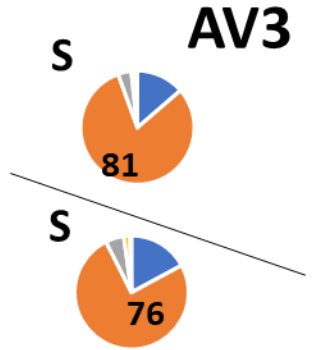


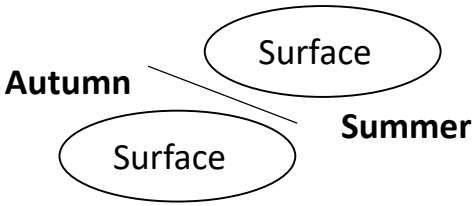




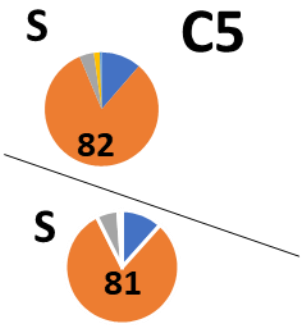


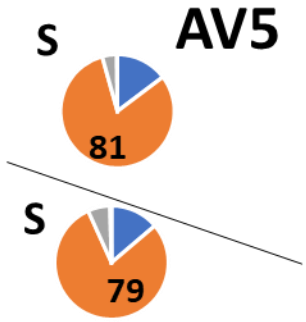






Percentage of total





- Clay
- Coarse silt
- Gravel
- Fine silt
- Sand

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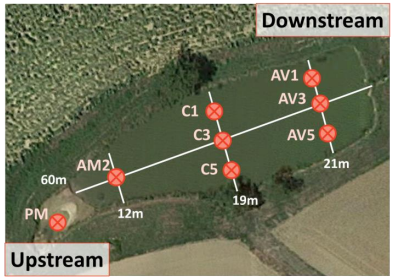
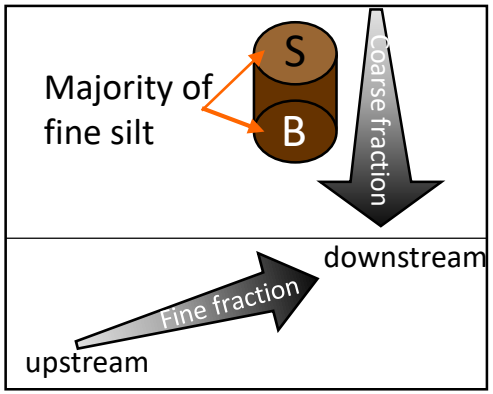
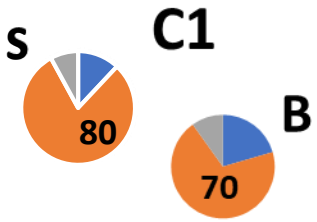
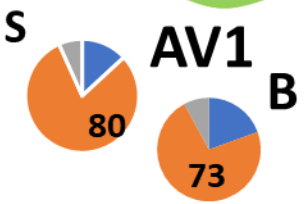
Sediment texture

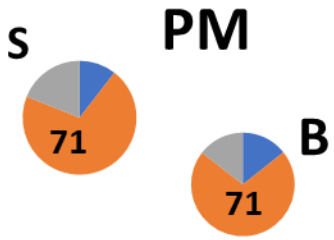
Surface vs bottom

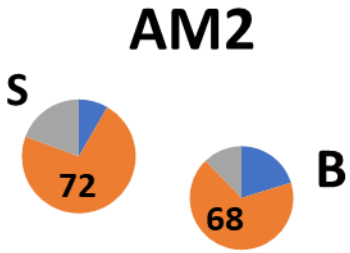


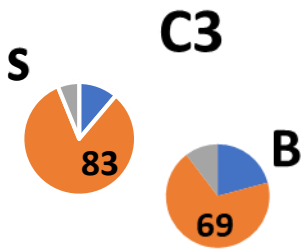


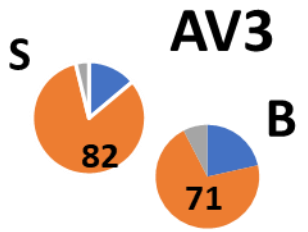


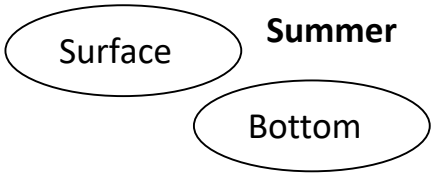


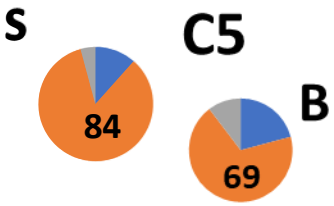


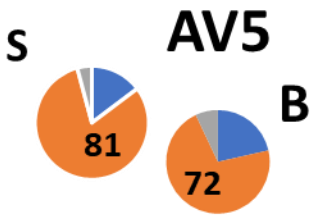












Percentage of fine fraction (<63µm)

- Clay
- Fine silt
- Coarse silt

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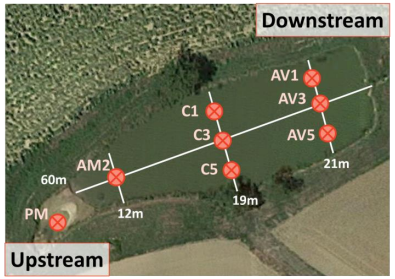
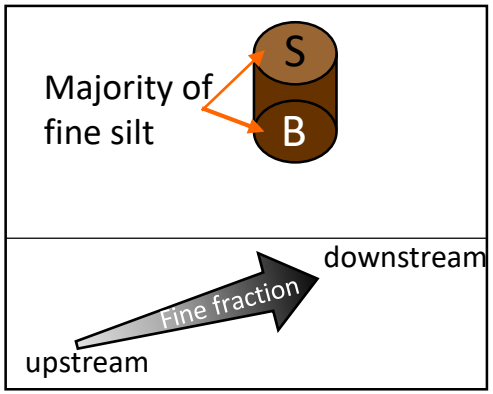
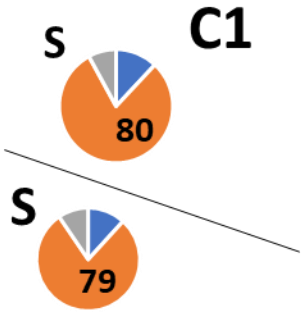
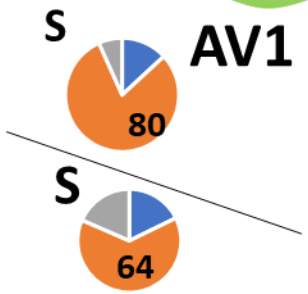
Sediment texture

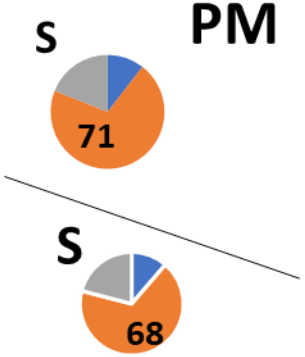
Spatial distribution

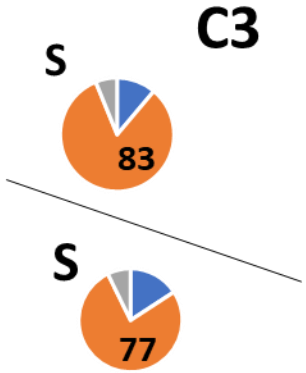


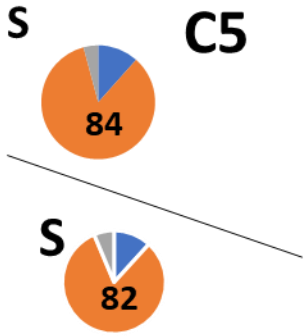


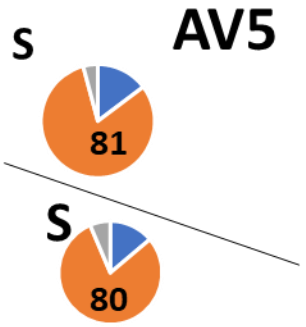


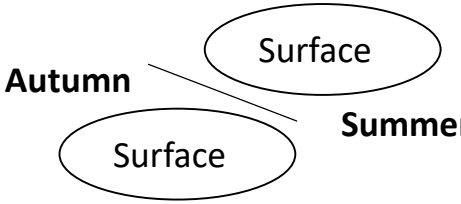












Percentage of fine fraction (<63µm)

- Clay
- Fine silt
- Coarse silt

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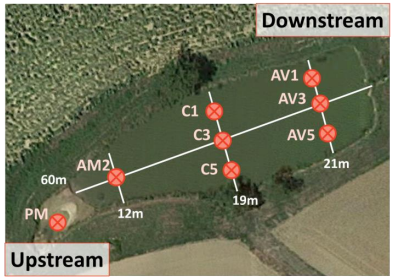
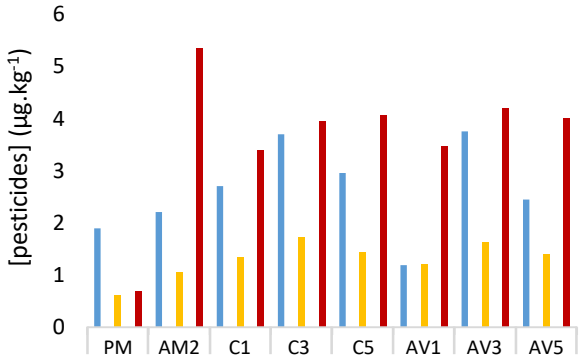
Pesticides storage

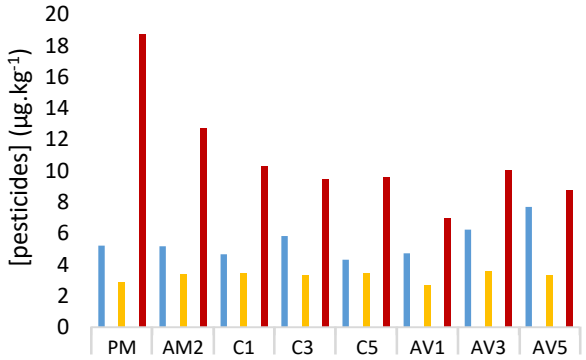


≠ pesticides accumulation

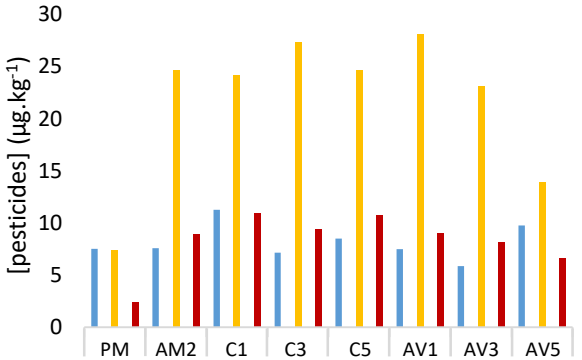
Metolachlor – $logK_{OW}$:2.9



Boscalid – $logK_{OW}$:3



Tebuconazol – $logK_{OW}$:3.7

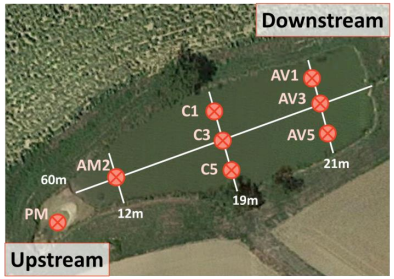


Autumn Surface

Summer Surface

Summer Bottom

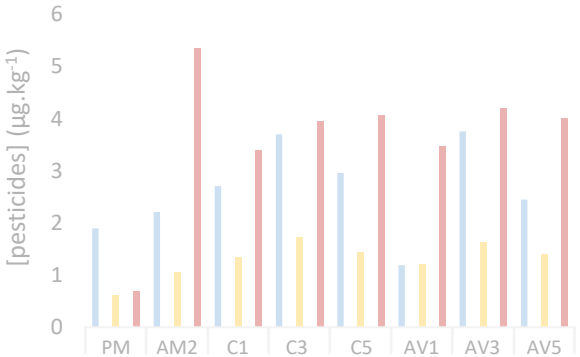
Pesticides storage



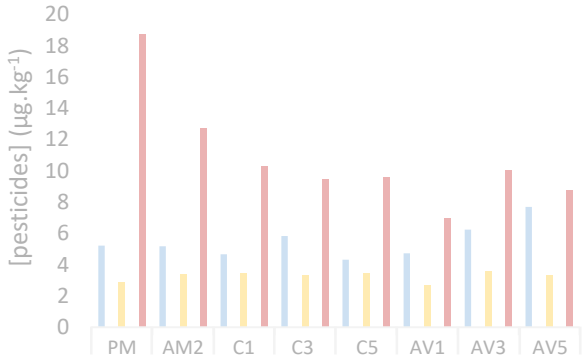
≠ pesticides accumulation :

- **Seasons: application period**

Metolachlor – $logK_{OW}$:2.9

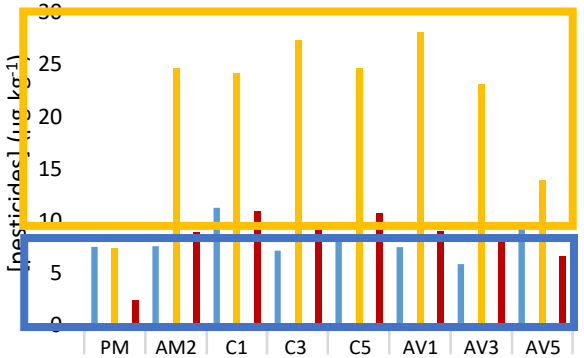


Boscalid – $logK_{OW}$:3



Summer

Tebuconazol – $logK_{OW}$:3.7



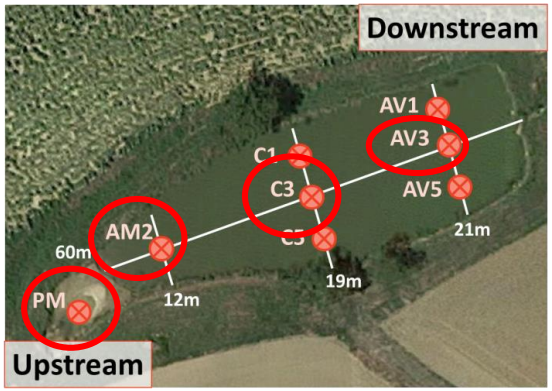
Autumn

Autumn Surface

Summer Surface

Summer Bottom

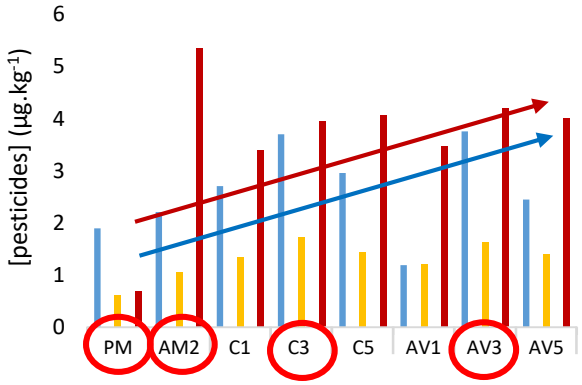
Pesticides storage



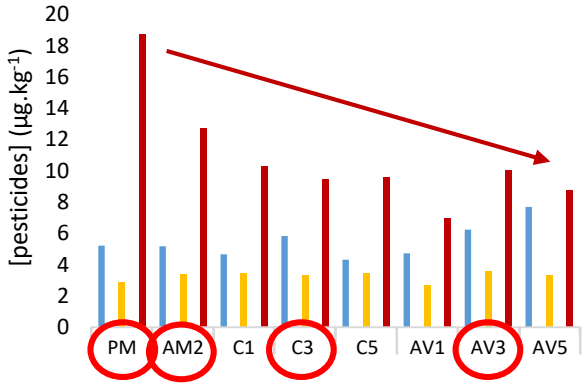
≠ pesticides accumulation :

- Seasons: application period
- **Location: upstream vs downstream**

Metolachlor – $logK_{OW}$:2.9



Boscalid – $logK_{OW}$:3



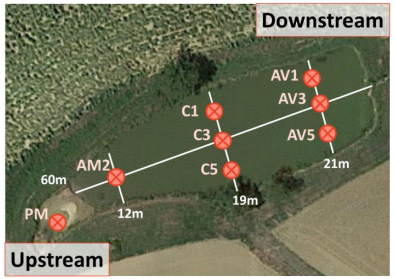
Tebuconazol – $logK_{OW}$:3.7

Autumn Surface

Summer Surface

Summer Bottom

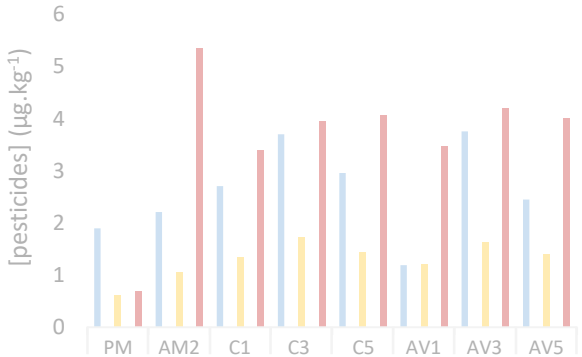
Pesticides storage



≠ pesticides accumulation :

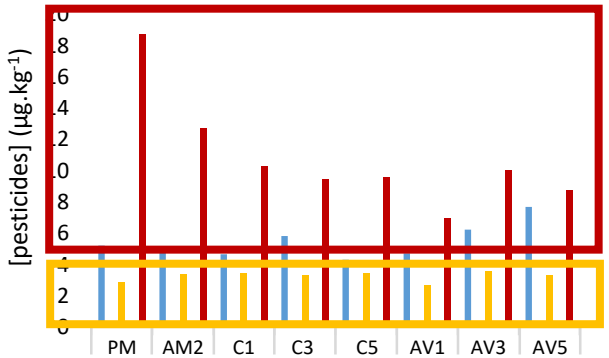
- Seasons: application period
- Location: upstream vs downstream
- **Depth: Surface vs bottom**

Metolachlor – $logK_{OW}$:2.9



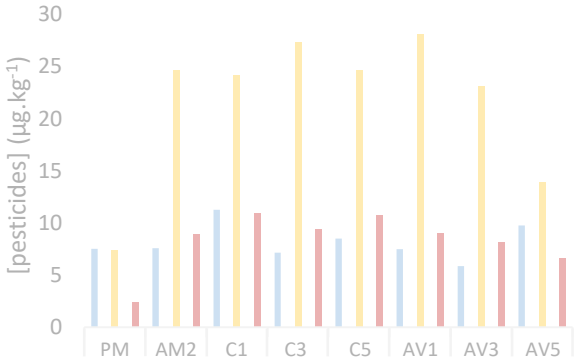
Boscalid – $logK_{OW}$:3

Bottom



Surface

Tebuconazol – $logK_{OW}$:3.7

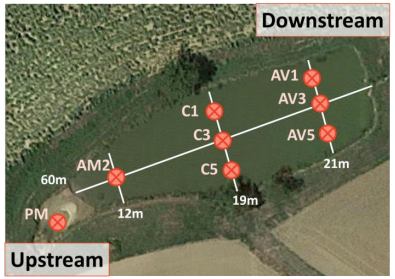


Autumn Surface

Summer Surface

Summer Bottom

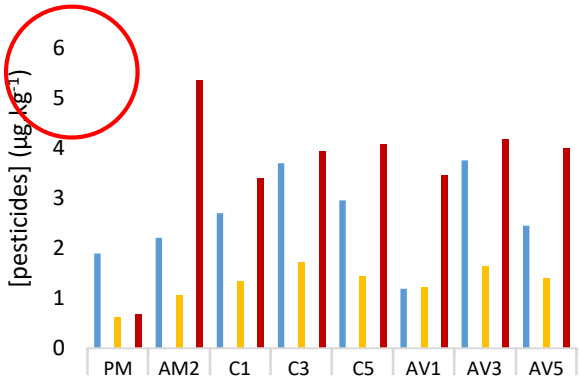
Pesticides storage



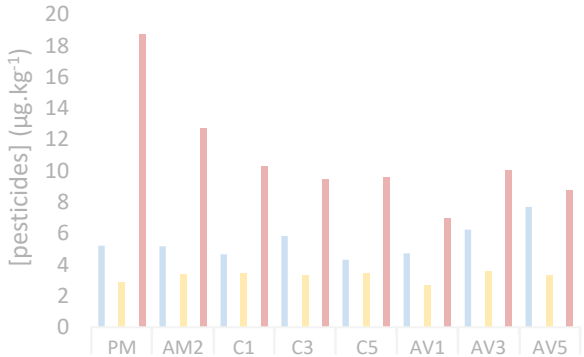
≠ pesticides accumulation :

- Seasons: application period
- Location: upstream vs downstream
- Depth: Surface vs bottom
- **Physicochemical properties: $logK_{OW}$**

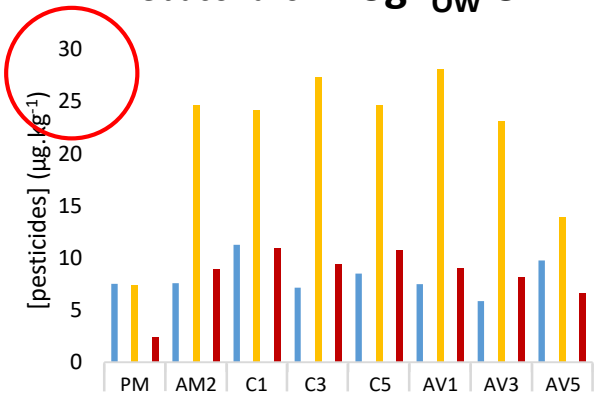
Metolachlor – **$logK_{OW}$:2.9**



Boscalid – $logK_{OW}$:3



Tebuconazol – **$logK_{OW}$:3.7**

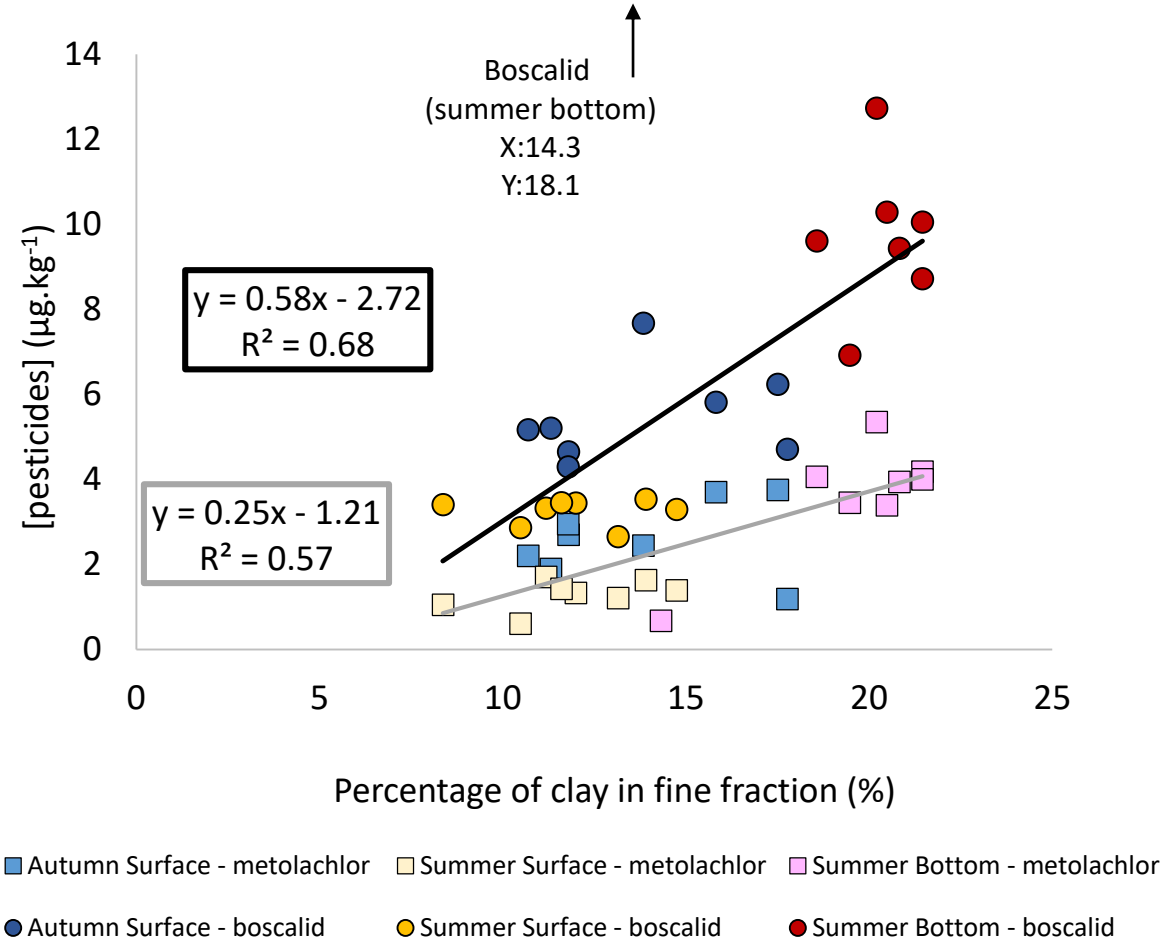


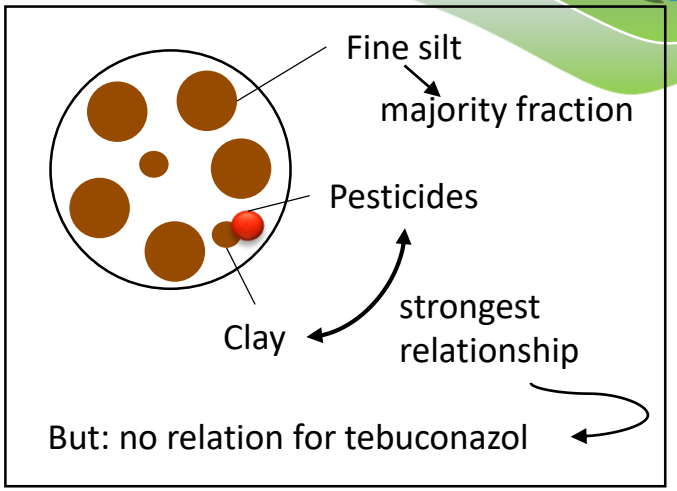
Autumn Surface

Summer Surface

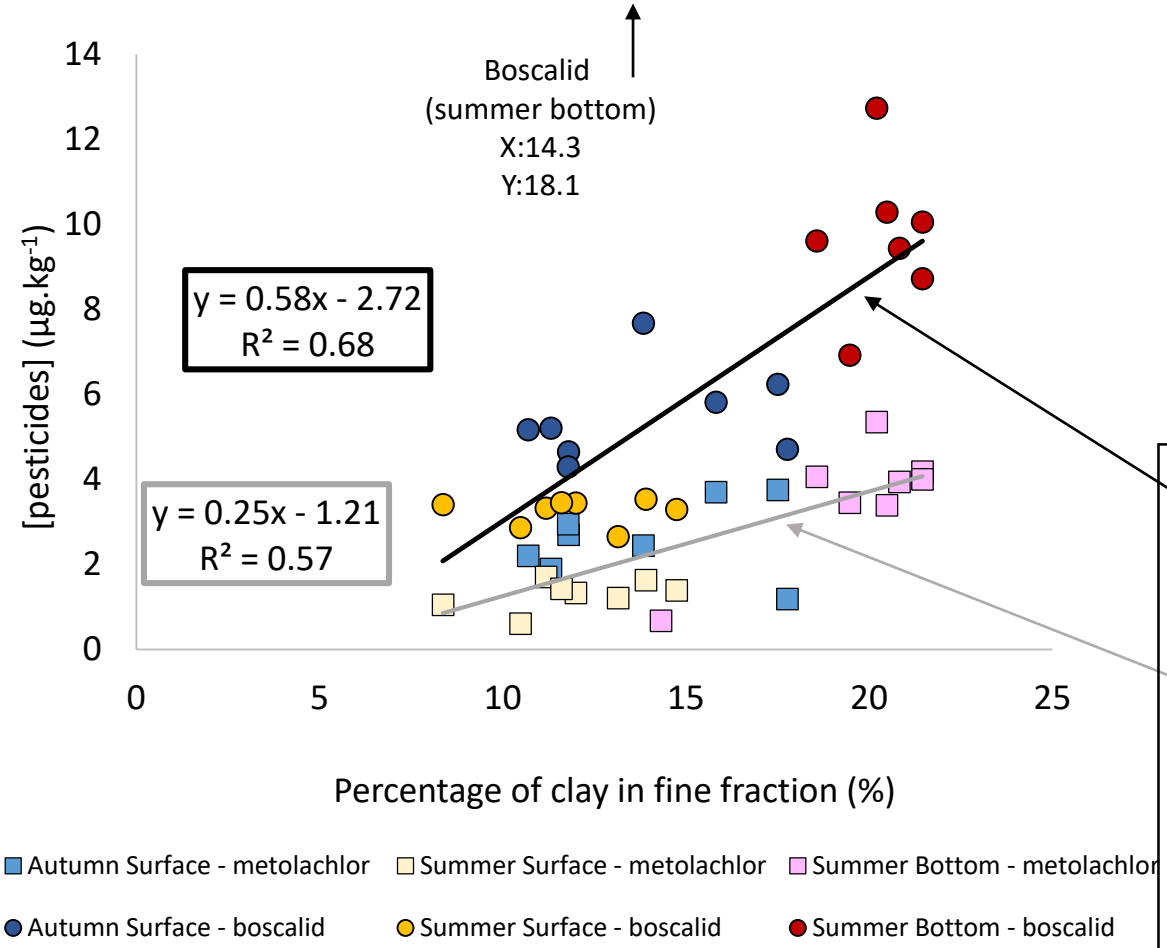
Summer Bottom

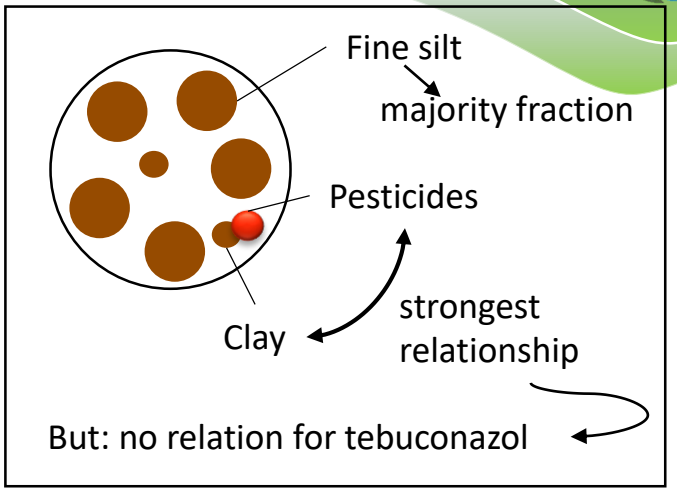
Role of sediment texture





Role of sediment texture





Boscalid - $logK_{OW}$:3

Better controlled by clays

Very similar physicochemical properties

Metolachlor - $logK_{OW}$:2.9

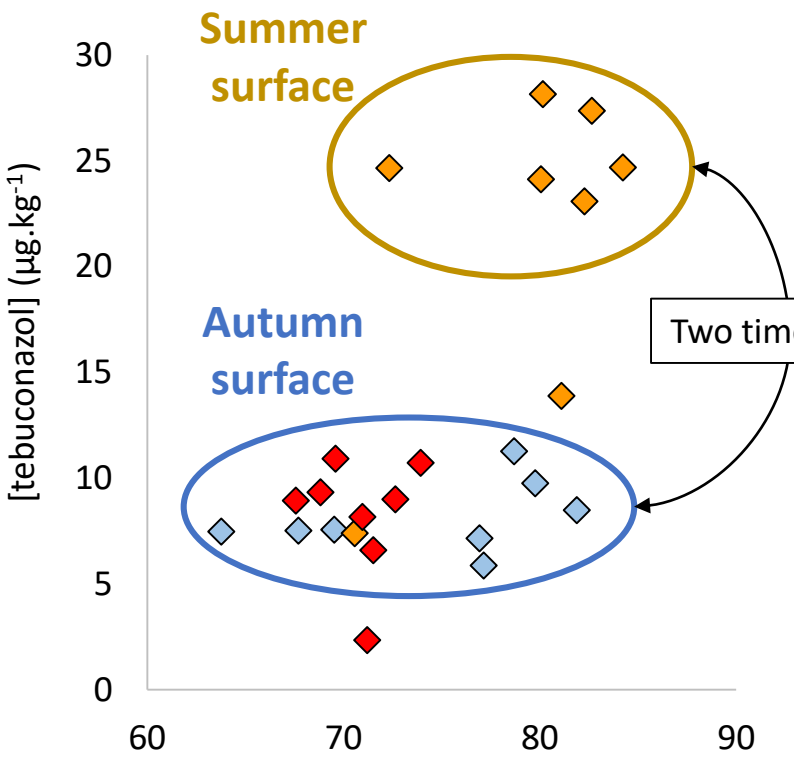
Clays: strong exchange capacity

- Other influencing factors in this high pH environment?
- Competition phenomenon?

→ Controlling factor: clay fraction[1,2]

[1] *Weber et al. 2004*
[2] *Maillard and Imfeld, 2014*

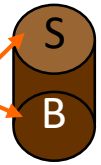
Seasonality effect



Two times higher

Reminder

Majority of fine silt



Tebuconazol → not controlled by fine silt

Tebuconazol mostly used in spring

→ Period of flood events

→ In erosive area

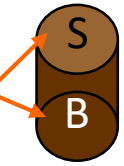
→ Dillution with stream flow?
Degradation : autumn conditions?

◇ Autumn Surface - tebuconazol
◇ Summer Surface - tebuconazol
◆ Summer Bottom - tebuconazol

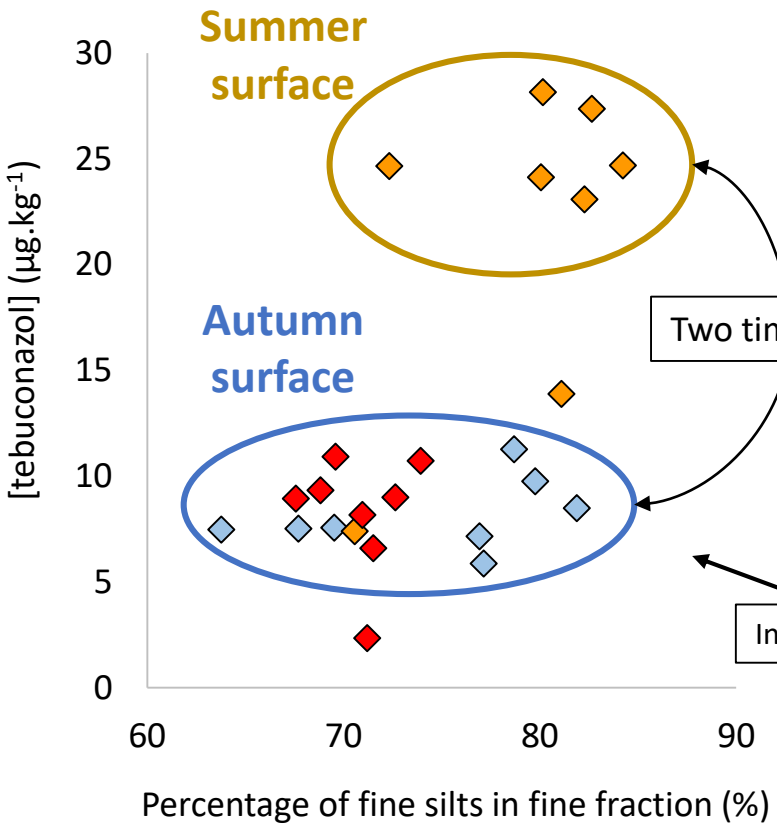
Seasonality effect

Reminder

Majority of fine silt



Tebuconazol → not controlled by fine silt

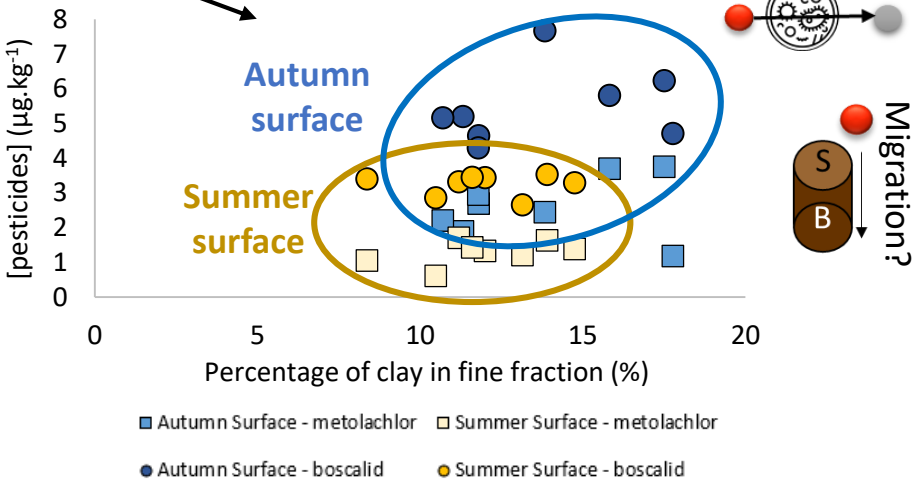


Two times higher

- Tebuconazol mostly used in spring
  - Period of flood events
  - In erosive area
- Dillution with stream flow?
  Degradation : autumn conditions?

Inverse observations

Summer degradation phenomena → Greater activity?



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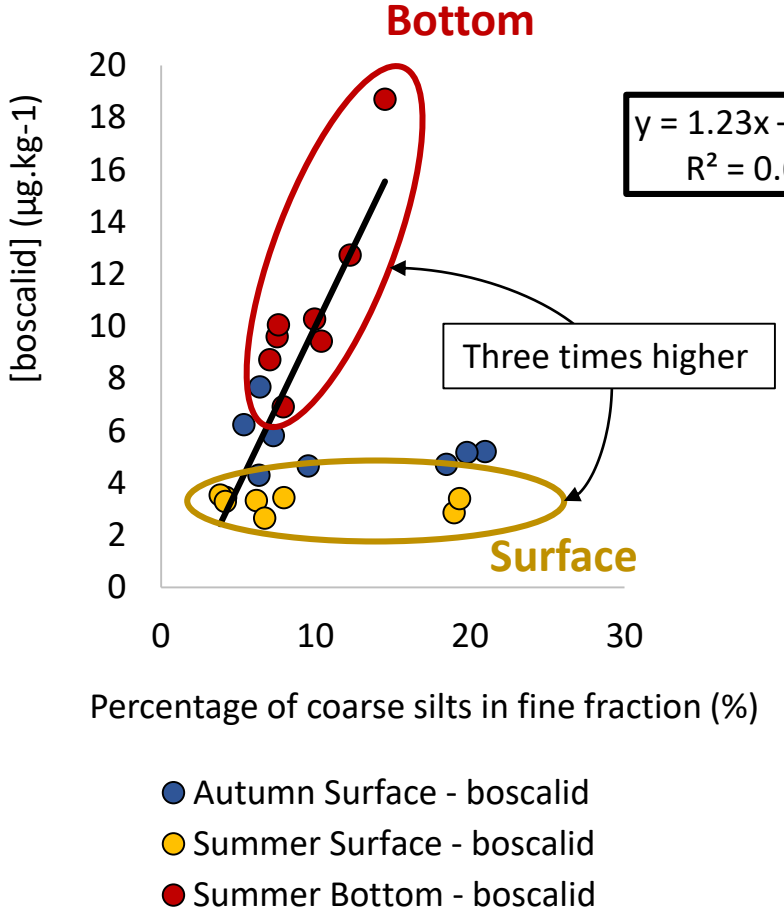
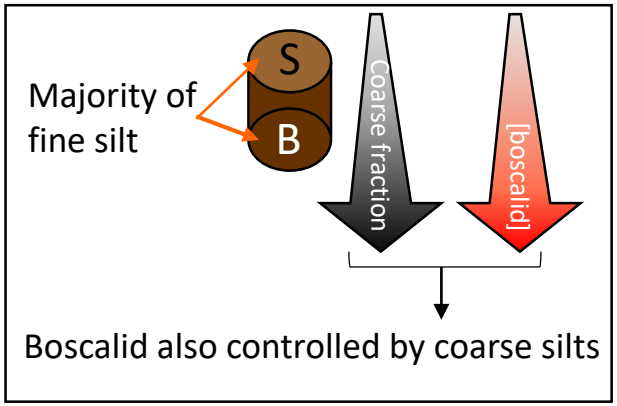
Depth storage process



$y = 1.23x - 2.29$
$R^2 = 0.67$



Controlling factors [1,2,3,4]?

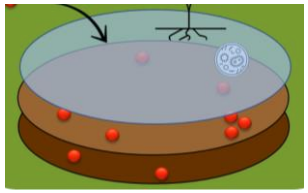
- Degradation: Greater activity?

- pH?
- Redox potential?
- Organic carbon?
- Carbonates?
- Oxydes?

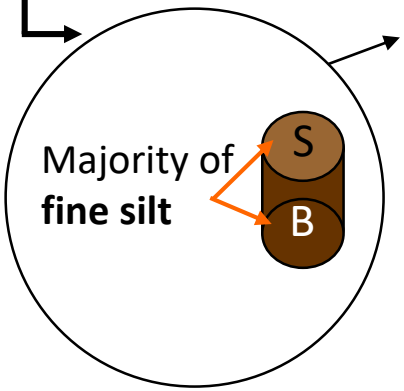
[1] *Farenhorst et al. 2009*
[2] *Bur et al. 2009*
[3] *Taghavi et al. 2010*
[4] *Katagi, 2006*

Conclusion

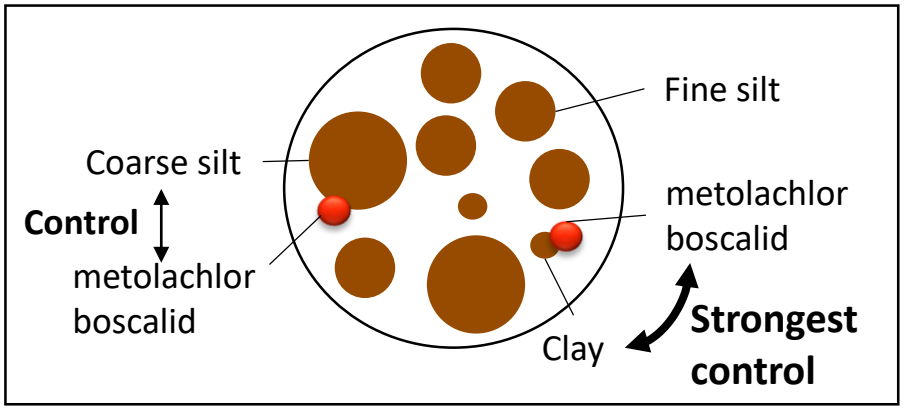
Characterisation of the spatial distribution of sediment texture and pesticides storage: determination of controlling factors



Majority of **fine silt**

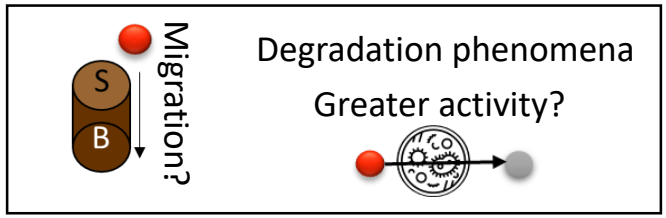


Pesticide storage not controlled by this fraction



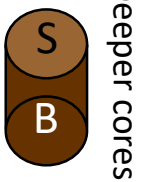
Seasonality related to pesticide application period → tebuconazol

In depth: pesticide enrichment → different processes



To go further

- Study processes in greater depth
- Carbonates and organic carbon analyses



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