Three years monitoring of pesticides mitigation with an artificial wetland receiving agricultural drained flow at catchment scale

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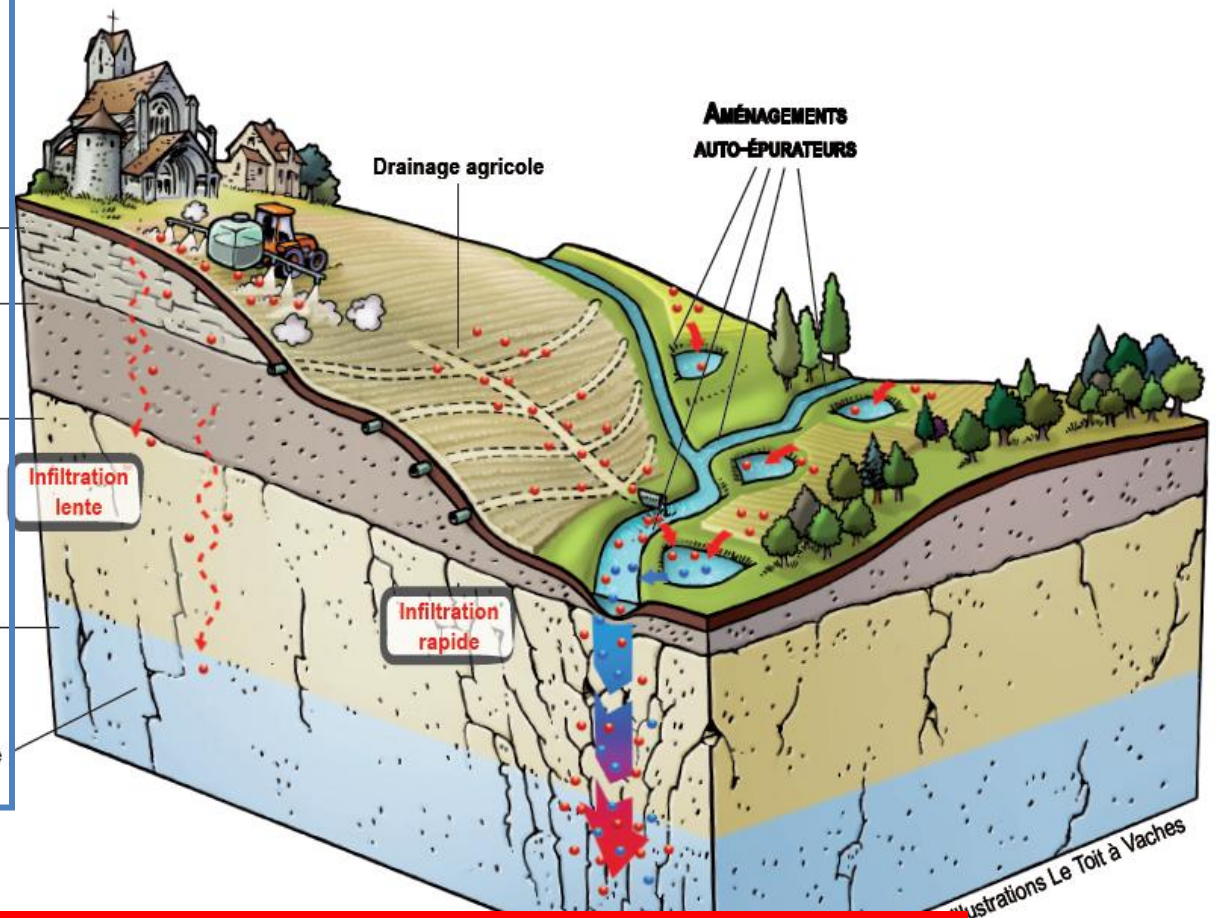
Champigny Recharge Specificity

60% OF THE RECHARGE IS DUE TO DIRECT INFILTRATION FROM SURFACE WATER TO GROUNDWATER (SINKHOLES)

One of the 42 sinkholes



→ **Vulnerability from agricultural pollution**

Objectives of the RAMPILLON project

PROTECT GROUNDWATER FROM PESTICIDE CONTAMINATION IN A TOTALLY DRAINED WATERSHED OF 400HA

Propose and test a methodology on an example to be reproduced for the whole Champigny Hydrosystem

Selected Objective: PESTICIDES MITIGATIONS from Agricultural Land by

1) Reduction of 50% of total pesticide applied amount and secondly reduction Nitrate pollution

2) Support for Implementation of Artificial WETLANDS

Involvement of all the stakeholders:

- Water Agency: Water Framework Directive
- Local authority: Drinkable water to citizens at a lowest treatment as possible
- Farmers: Food production
- And Scientists: Improve knowledge and provide solutions, tools …

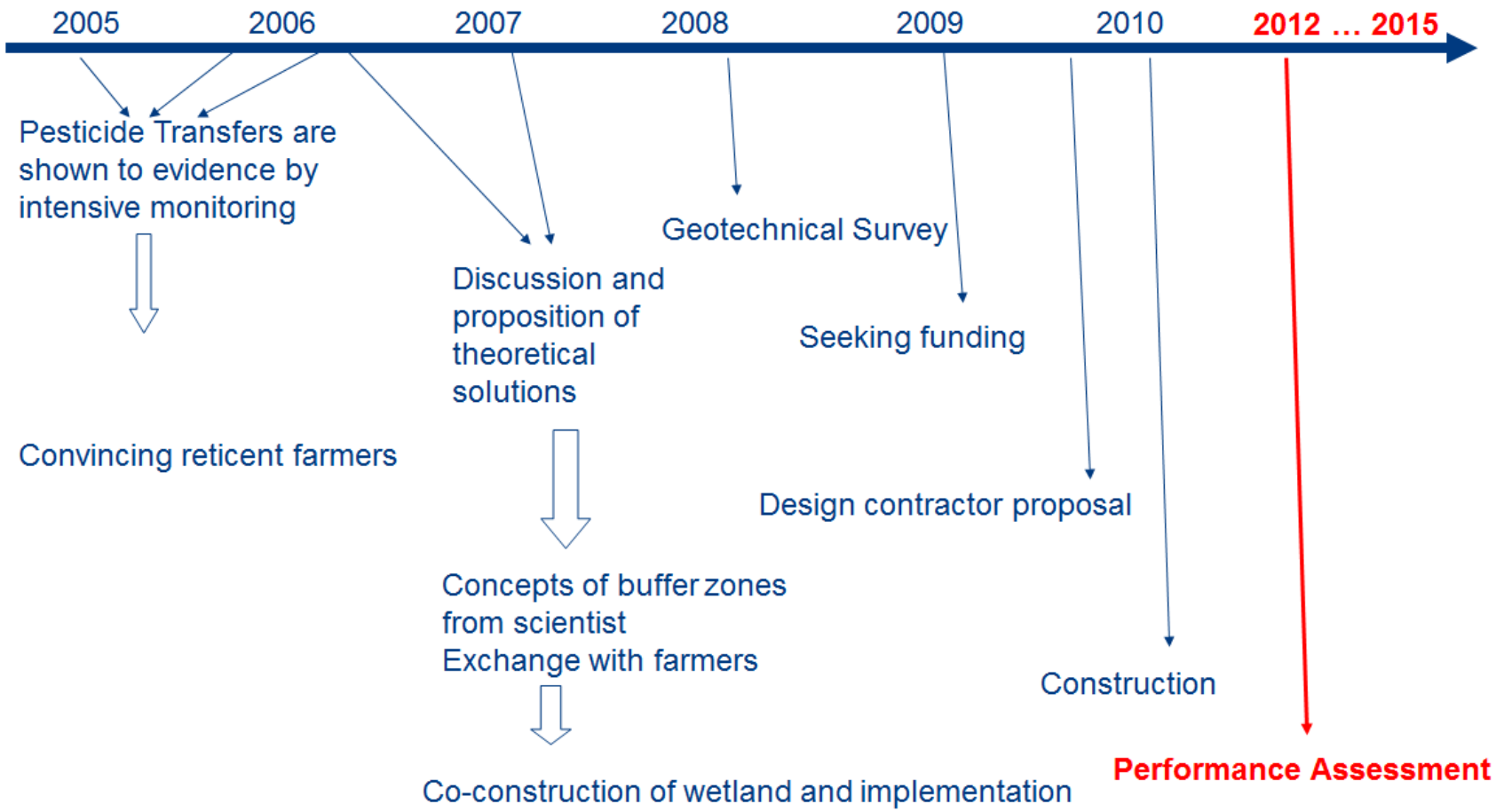
Objectives of the RAMPILLON project

PROTECT GROUNDWATER FROM PESTICIDE CONTAMINATION IN A TOTALLY DRAINED WATERSHED OF 400HA

After land reclamation, all buffering systems disappeared

Aerial Sight of the watershed

Co-construction: a step by step process



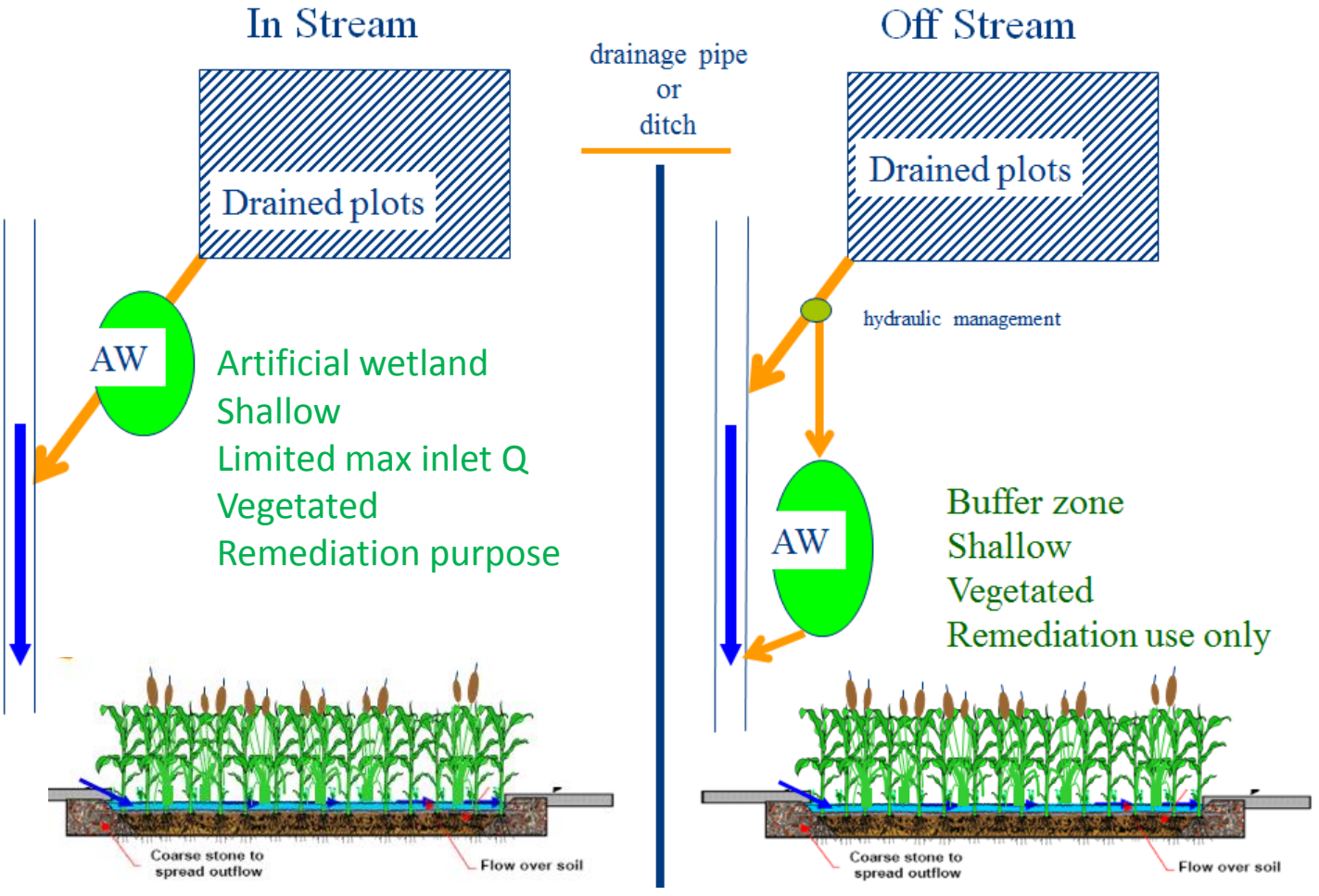
Tournebize et al., 2012

→ **When involving a group of farmers, the process takes a long time!!**

Tested water flow interception strategies

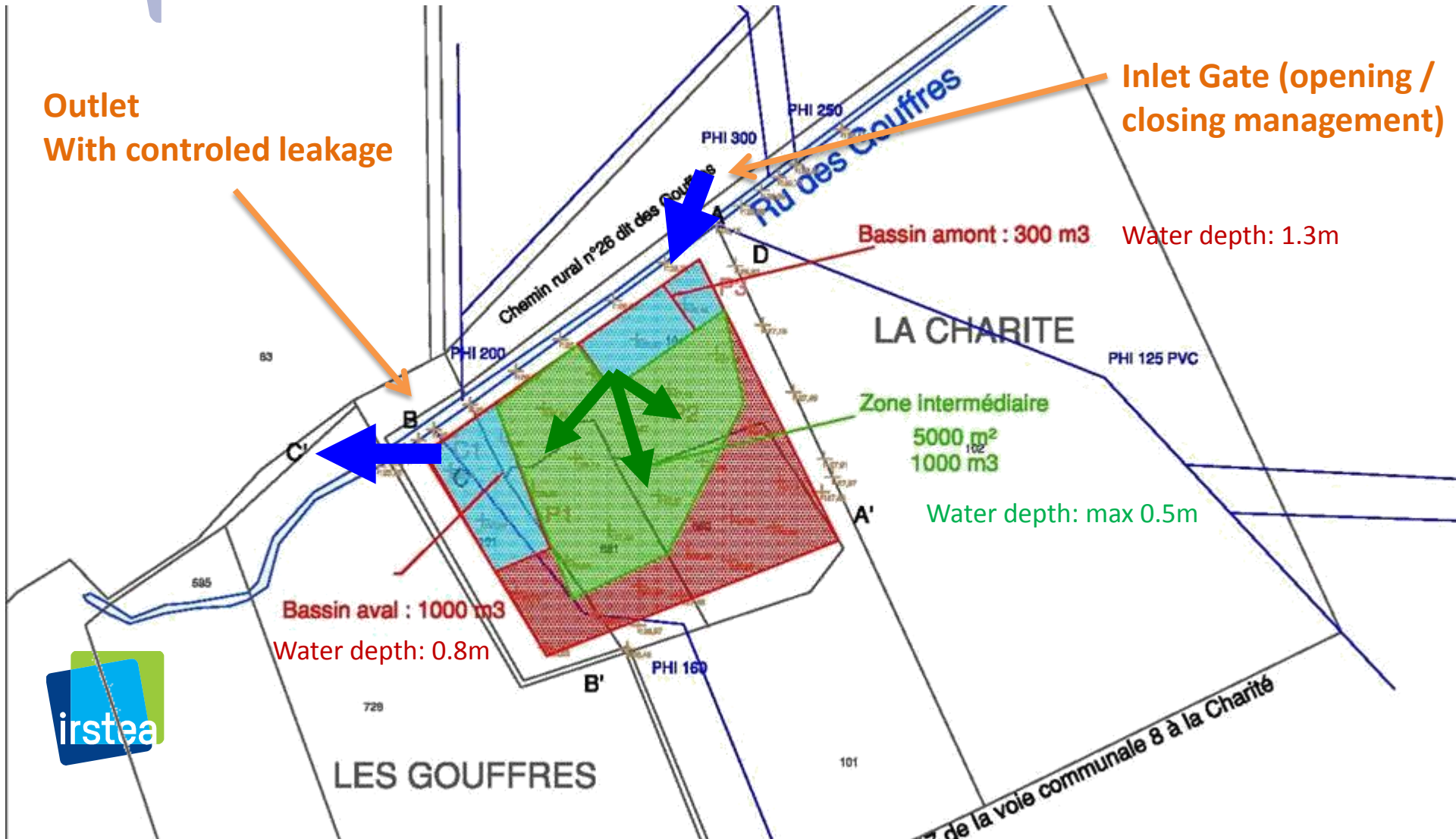
2014-2015

2012-2013
2013-2014



Main Artificial WETLAND

6300M² AND 2400M3 FOR 400HA (0.15% OF UPSTREAM WATERSHED, 6M3 PER DRAINED HA)



Ecological trajectory: Vegetation (macrophytes)

Sedge (Carex) - Reed (Phragmites australis) – Cattail (Typha latifolia) – Bulrush (Juncus) – Algae

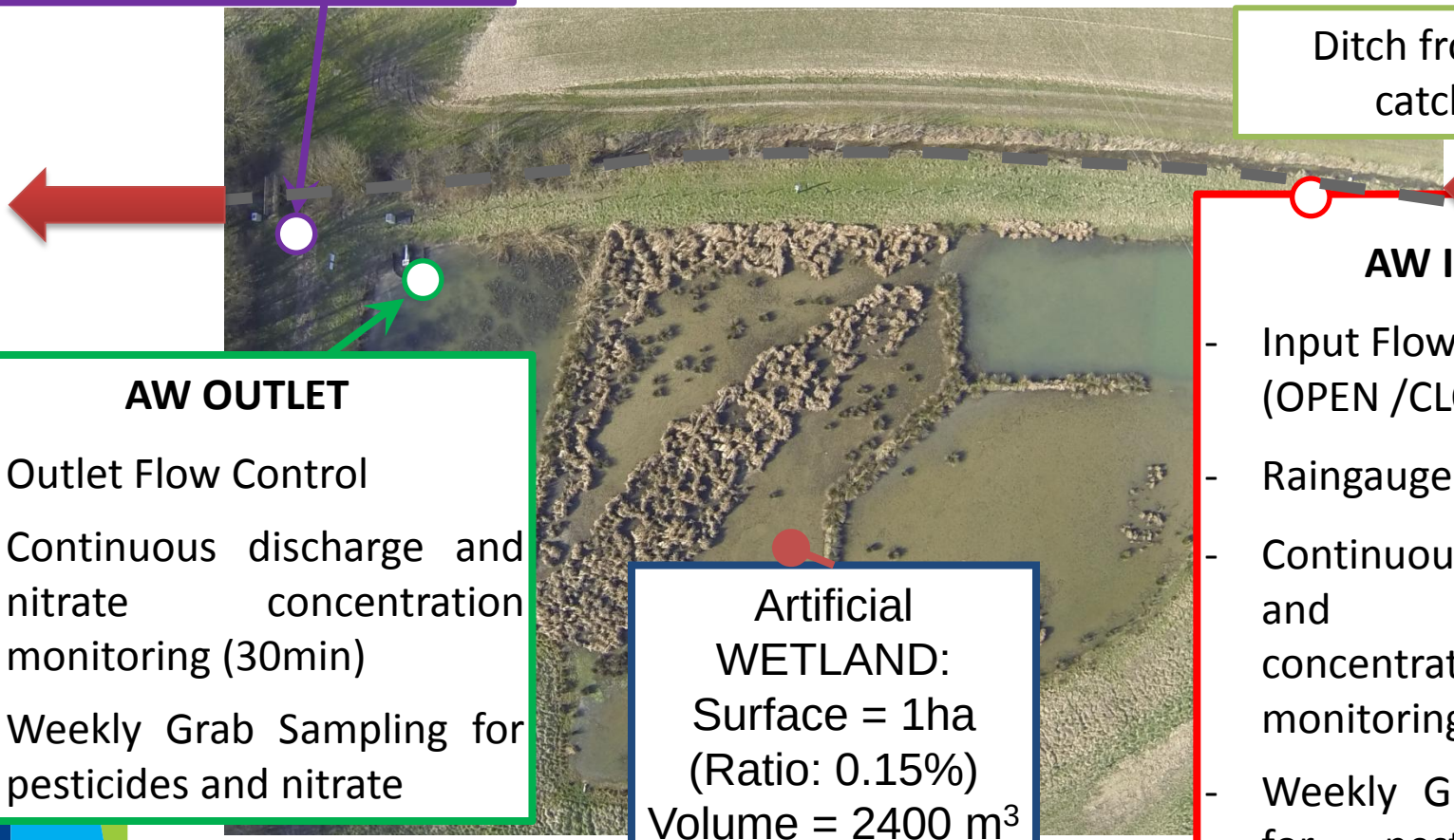
80% vegetation cover in 2012 – 20% vegetation cover in 2013 – 50% vegetation cover in 2015

Monitoring Strategy

Coupling high frequency monitoring (Q, R, ET, SM, NO^3)
Weekly flow weighted sampling

Catchment OUTLET

- Continuous discharge monitoring (30min)
- Weekly Grab Sampling for pesticides and nitrate



Ditch from 400ha catchment

AW INLET

- Input Flow Control (OPEN /CLOSE Strategy)
- Raingauge
- Continuous discharge and nitrate concentration monitoring (30min)
- Weekly Grab Sampling for pesticides and nitrate

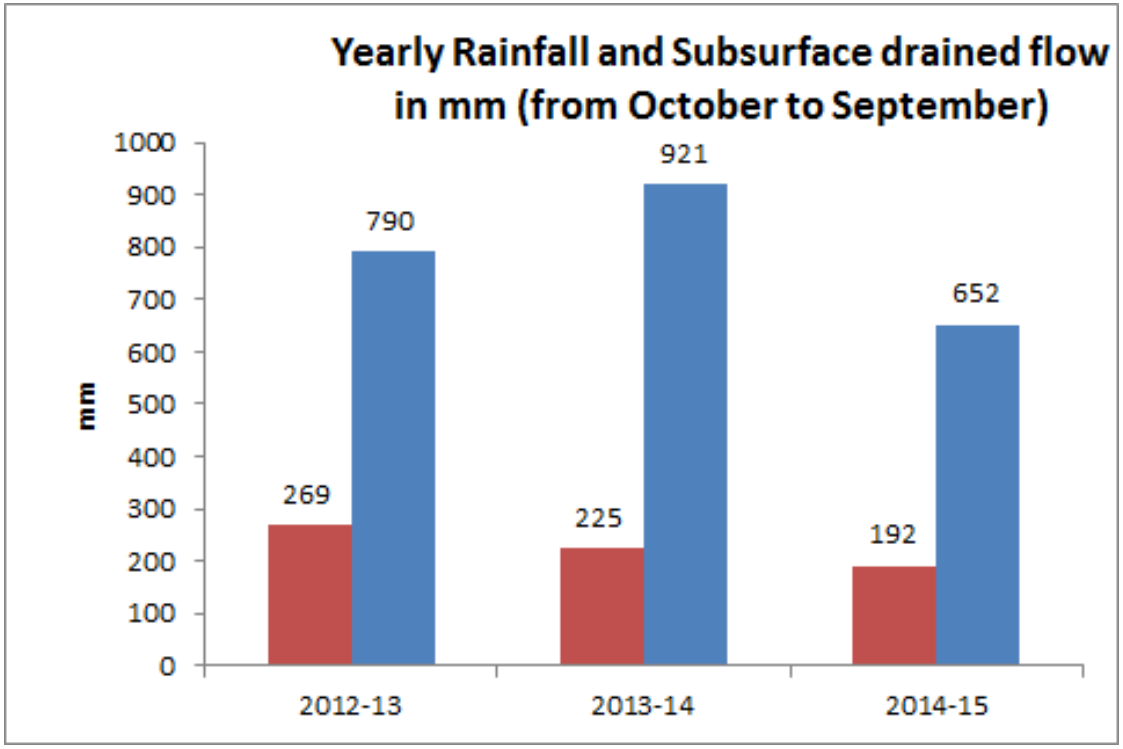
AW OUTLET

- Outlet Flow Control
- Continuous discharge and nitrate concentration monitoring (30min)
- Weekly Grab Sampling for pesticides and nitrate

Artificial WETLAND:
Surface = 1ha
(Ratio: 0.15%)
Volume = 2400 m^3
Eddy tower

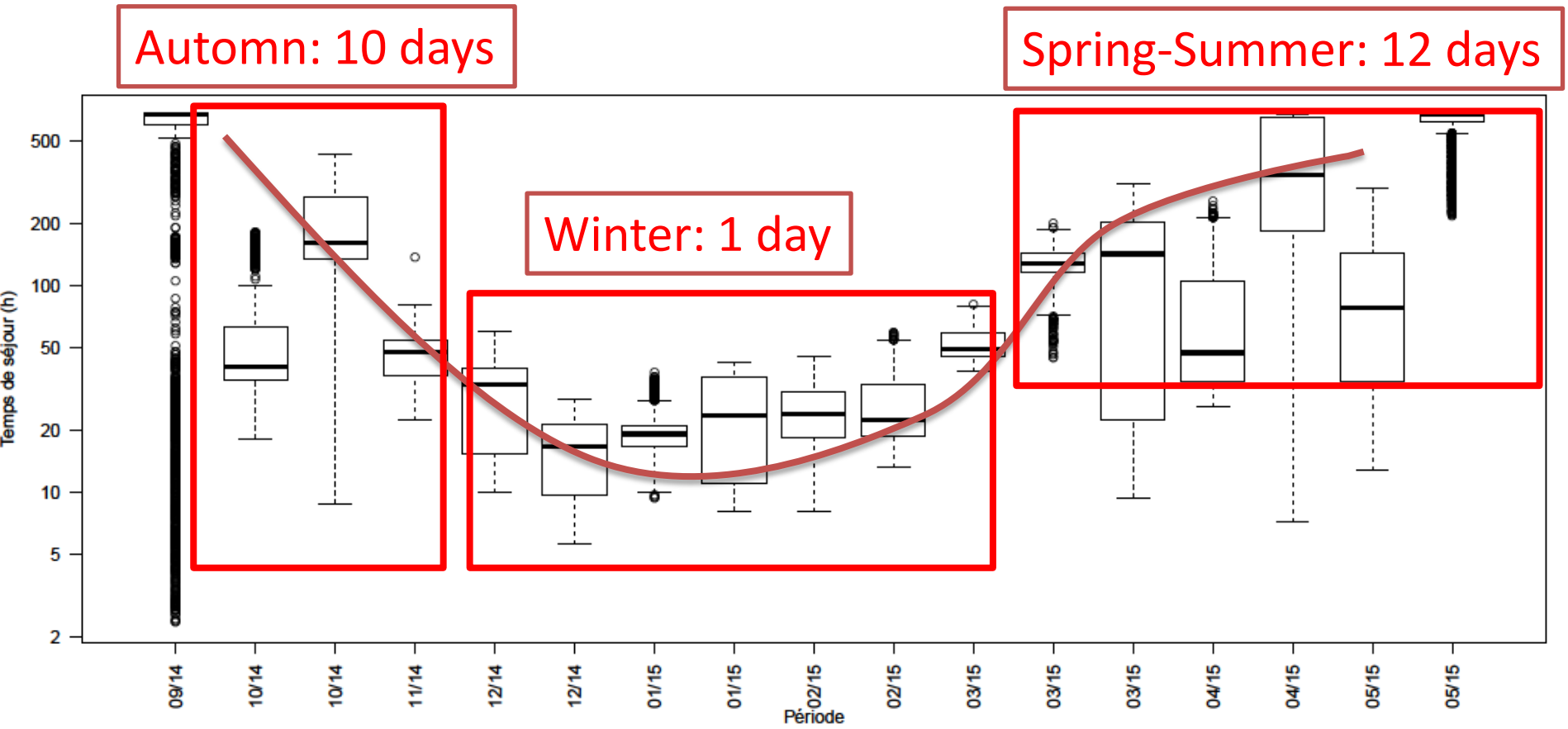
irstea

Hydrological Results



Hydrological Description	2012/13 & 2013/14	2014/2015
Proportion Winter / Other seasons	85/15%	80/20%
Opening days of inlet gate	235 days	365 days
Intercepted volume	11%	67%
Water losses	4%	6%
Representativity of sampling strategy	80%	94%

Distribution of hydraulic residential time



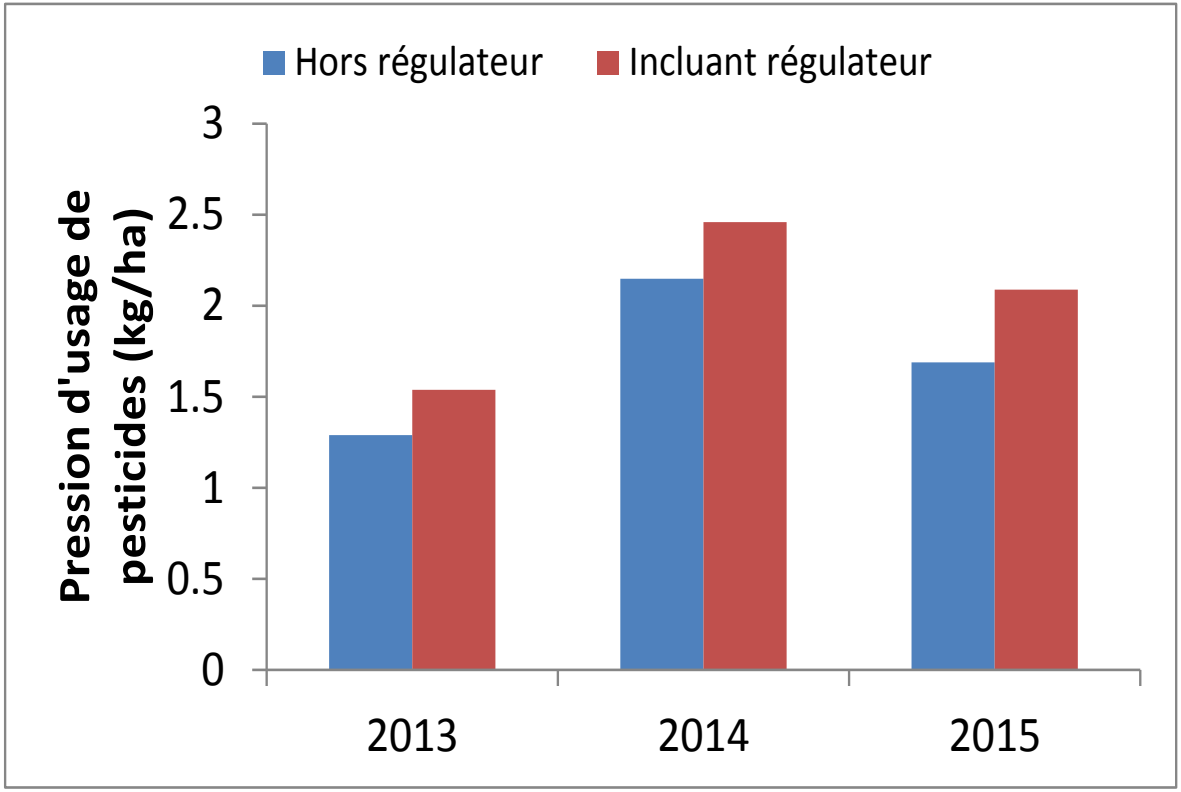
Hydraulic Residential Time strongly depends on watershed hydrological response:

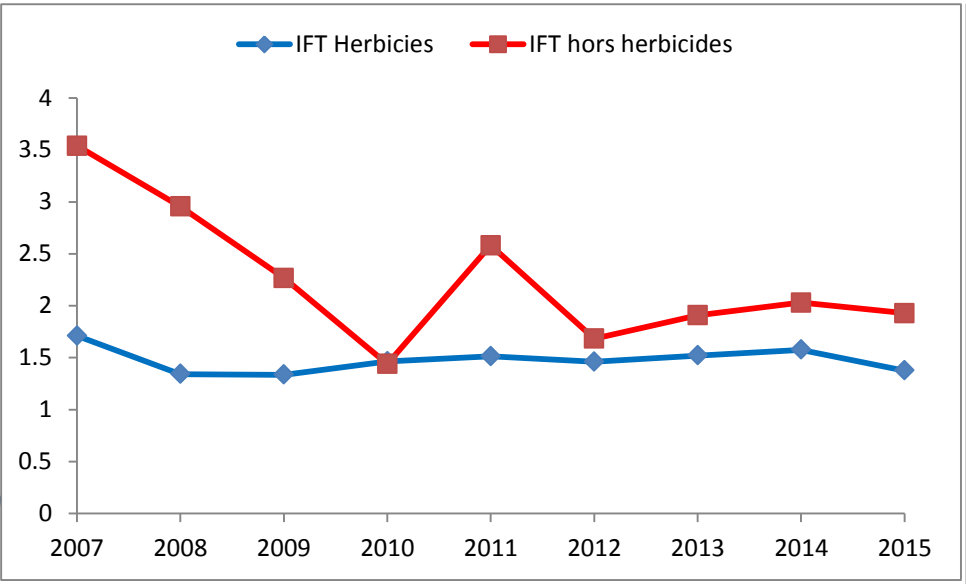
- short in winter (less than 1 day)

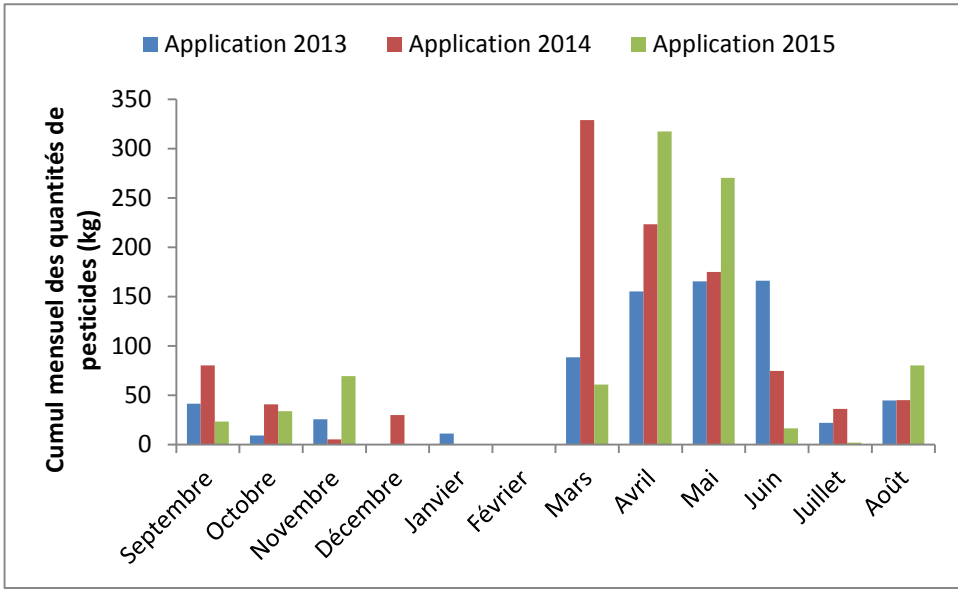
- longer during other seasons (between 2 and 100 days)

Pesticides Pressure

No decrease of pesticides application during the monitoring periods







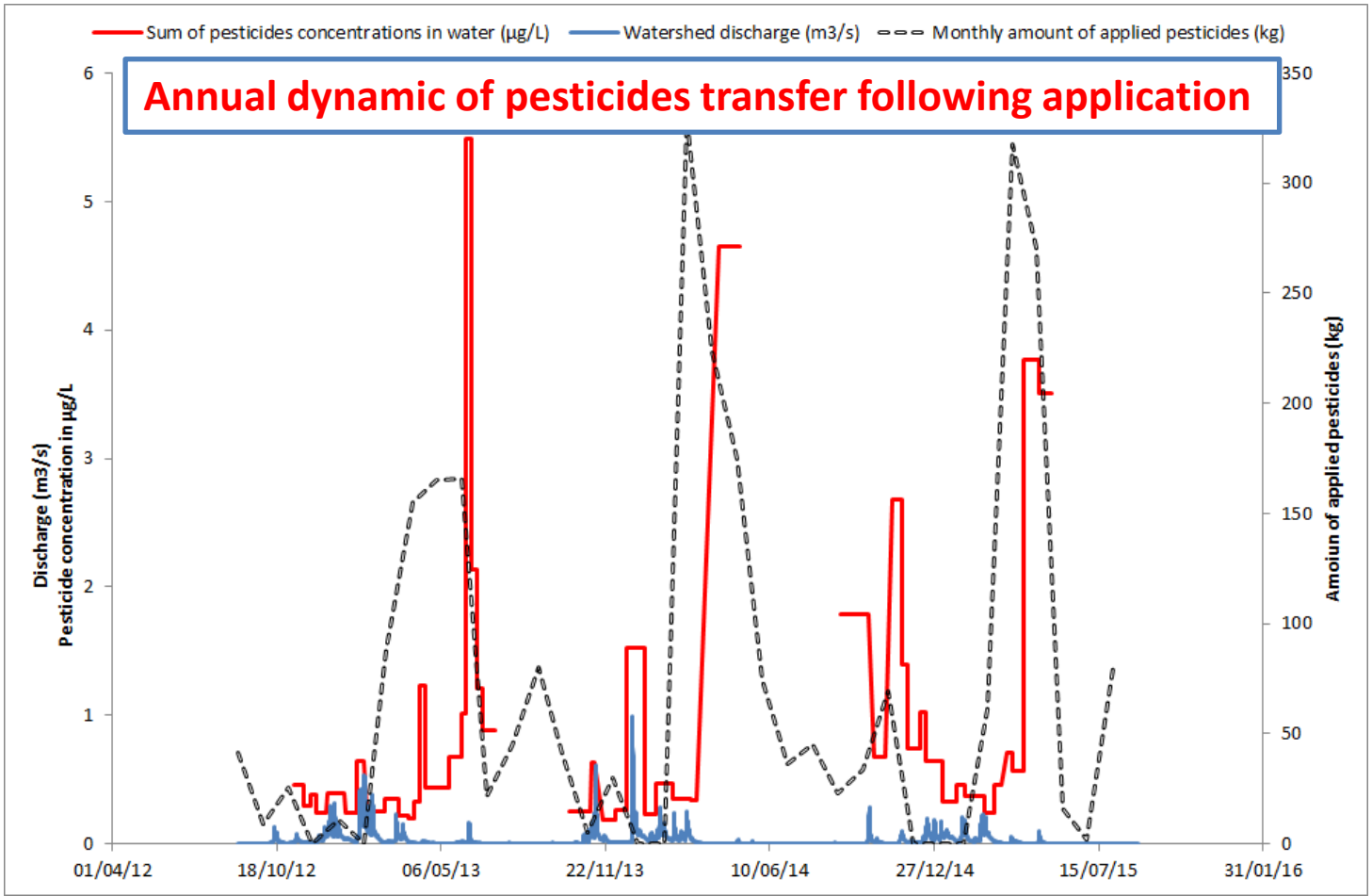
Pesticides results

76 molecules applied every year (1.71kg of active molecules per ha)

→ About 64 analysed (84%) :

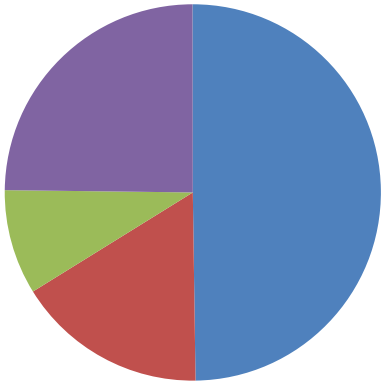
→ **27 non detected ; 38 molecules detected > LQ**

→ **6 non applied but detected such as atrazine**

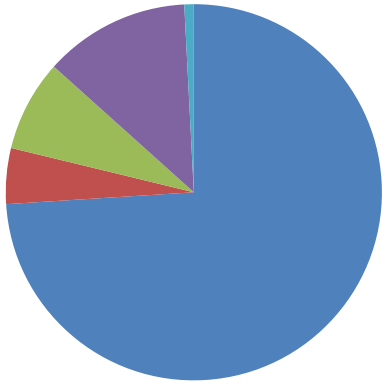


Pesticides exportation from drained area

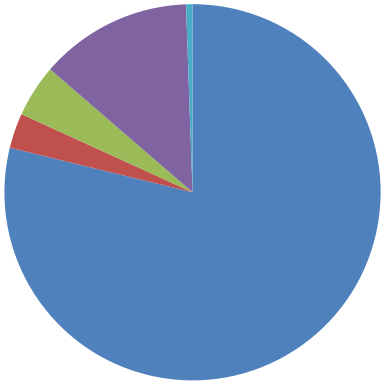
Année 2012-13
Flux total : 415g

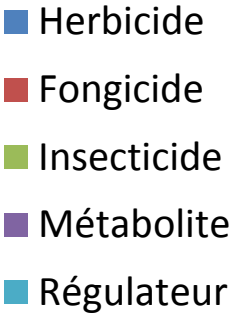


Année 2013-14
Flux total : 535g



Année 2014-15
Flux total : 579g





In average, about 1,5g of exported pesticides per hectare, corresponding to less than 0,1% of applied amount at crop field in subsurface drainage context

Distributed as more thant 70% for herbicides (including some metabolites), end secondly fungicides

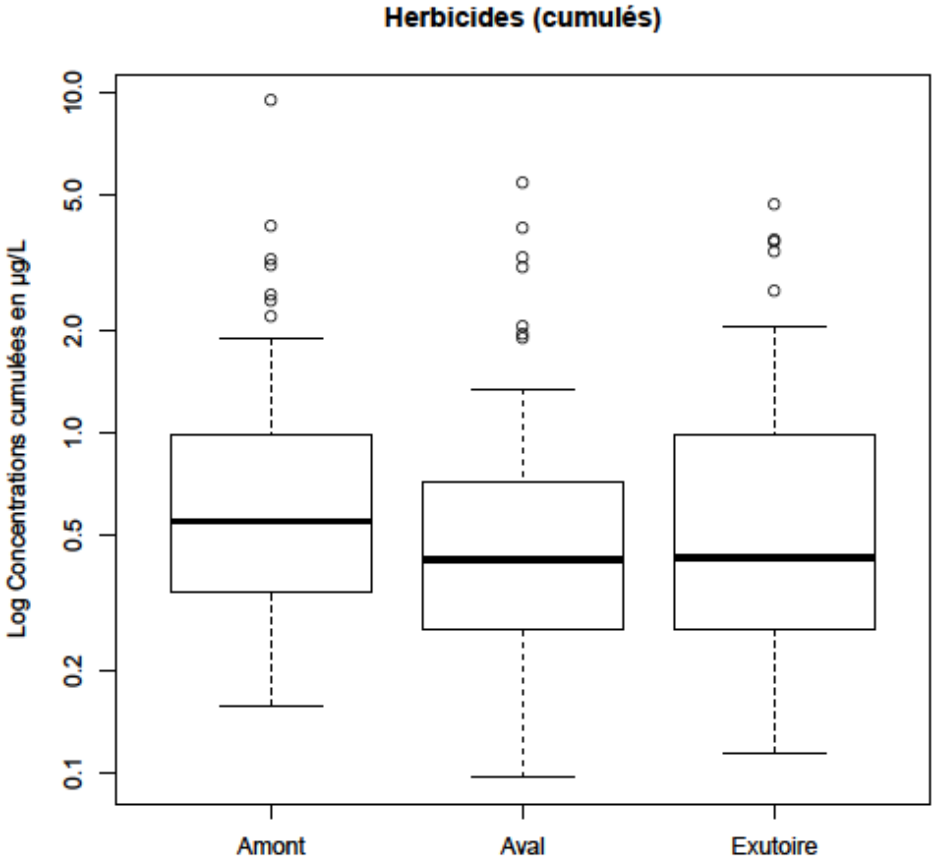
Pesticides removal efficiency within the artificial wetland

Concentration

Reduction of peaks, and concentrations thank to the wetland (Sum<0.5µg/L)

Fluxes

-118g/year



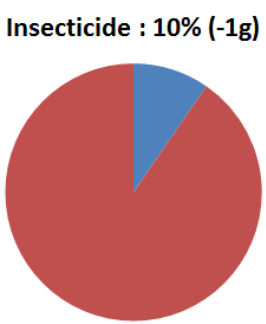
Internal efficiency

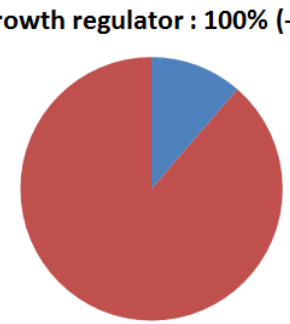
35% in average

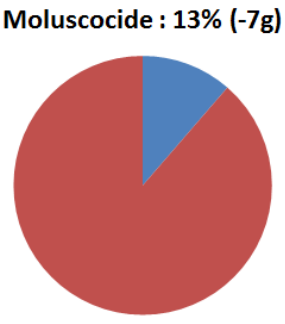
Global efficiency

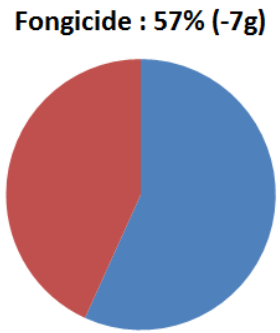
22% in average

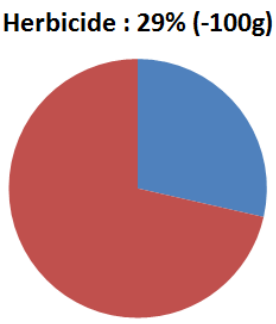
Depending on water interception strategy











Driven factors for pesticides removal efficiency?

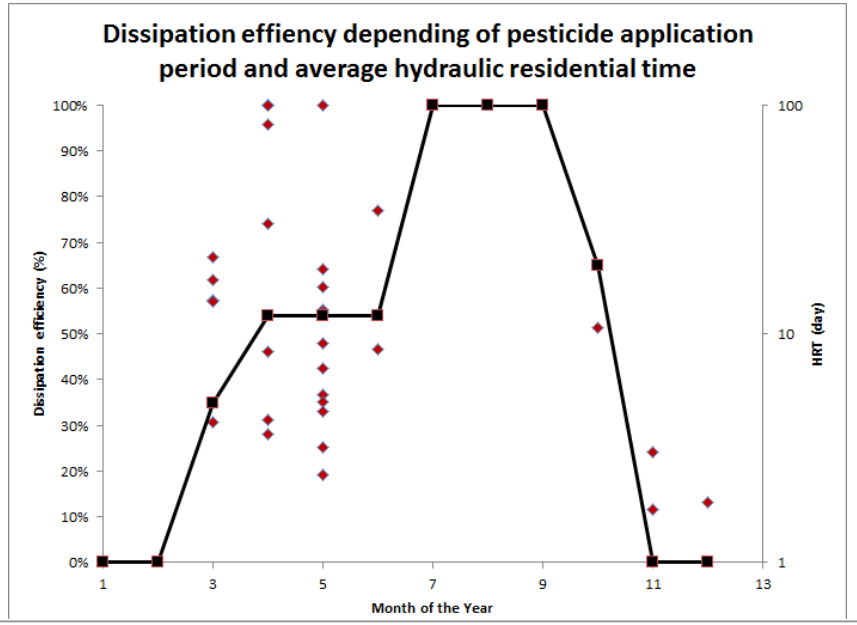
HIGH VARIABILITY ACCORDING TO MOLECULES

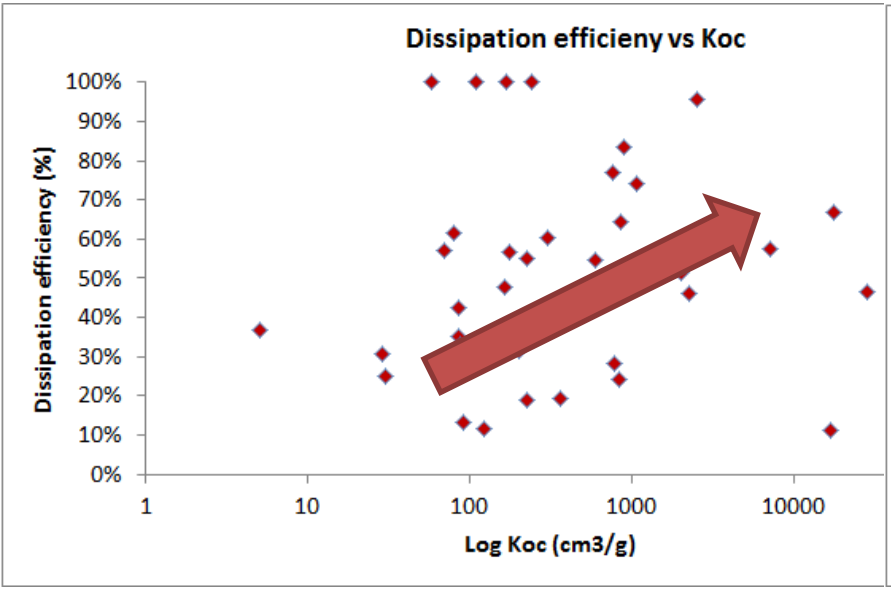
Any clear evidence of efficiency depending on pesticides properties

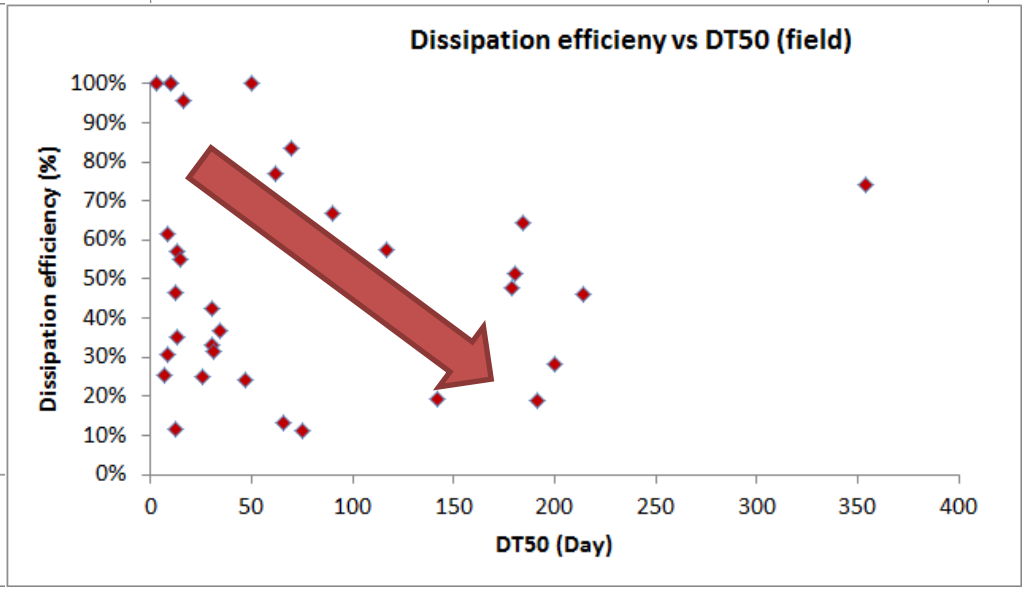
Strong sorption, low DT50 seem to increase efficiency

BUT

Season (temperature), pH and HRT should also have a real influence







Pesticides removal efficiency ranking

Inefficient	10 → 20%	20 → 40%	40 → 60%	60 → 100%
Mesotrione	Cyproconazole	Clopyralid	Clomazone	2,4-D
Imazamox	Imidaclopride	Bentazone	Aclonifen	Benoxacor
Chlortoluron	Atrazine déséthyl	Metamitrone	Dimethenamide	Chlorméquat
Ethofumesate	Mesosulfuron mtl	Chloridazone	Atrazine	Triflusulfuron mtl
Fluroxypyr	Isoproturon	Florasulam	S-metolachlor	Ethephon
2,4-MCPA	AMPA	Boscalid	Azoxystrobine	Napropamide
		Dimetachlore	Diflufenican	Tebuconazole
		Nicosulfuron	Lenacile	Epoxyconazole
		Propyzamide	Glyphosate	Pendimethaline
			Propiconazole	Fluoxastrobine
			Quinmerac	Métazachlor

Should these results influencing farmers' pesticides choices and practices?

Take Home Message

The 3 years monitoring of artificial wetland showed

1) High potentiel for Pesticides removal
2) High variability of removal efficiency according to pesticides

→**It is not a 100% warranty solution, important to accept variability**

3) The crucial knwoledge of pollutant water dynamic upstream (hydrological diagnosis)
4) Water and Hydraulic residential time management influence deeply the removal efficiency: IN STREAM strategy should be recommended
5) Still question about pesticide accumulations and metabolites???

The monitoring provides a set of data, useful for designing the future artificial wetland according to the water quality objective

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Thank you for your attention