

# Towards a tool to design vegetative strips for mitigation of pesticides transfers in surface runoff. Assessment of different scenarios.

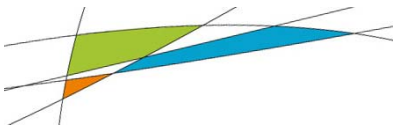
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*Non point pollutions*



## Study context

- Generalized contamination of water by pesticides in France
- Water Framework Directive
  - « Good » status for water in 2015
- « Ecophyto 2018 » plan in France
  - ✓ Diminution by one half of the applied quantities of pesticides in 10 years
  - ✓ Definition of indicators to assess evolution of water quality
- Three kinds of solutions
  1. Changes in cultivated systems. Quite long term solution
  2. Good practices, reasonable use of pesticides.
  3. Limitation of transfer from the agricultural plot to water resources



## Study context

- Vegetative strips can be useful in this context, but need to be well designed (position and size) to be efficient
    - ✓ CORPEN (French Comity to reduce agricultural water pollution by nitrogen and pesticides) : empiric rules
    - ✓ USDA : the same
- ➔ Do not take into account the local characteristics of soil and incoming runoff



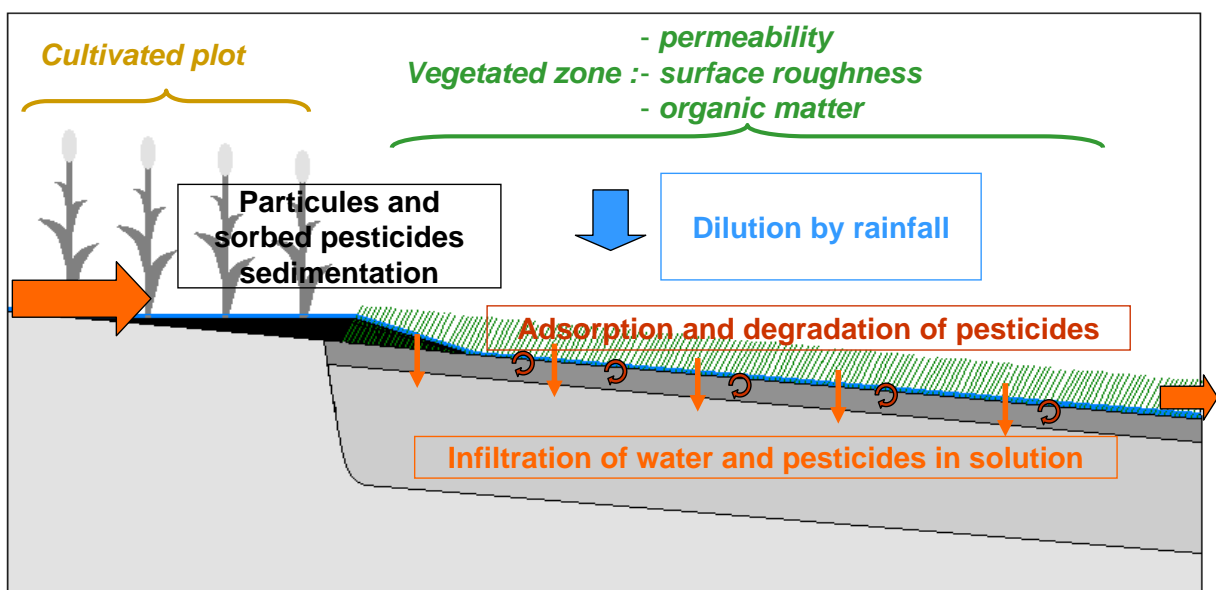
**Objective :**  
**Evaluate vegetative strips efficiency in various conditions**

3

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## Processes at work in a vegetative strip

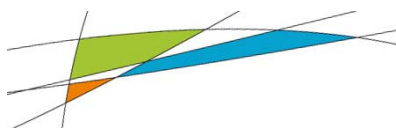


(JG. Lacas, 2005)

4

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## Material and methods

To assess overland flow retention in different areas, by building scenarios based on experimental data

- To identify dominating parameters making this retention possible



Morcille site. Lacas (2005)

- Chosen tool : Hydrus 2D  
Coupled simulation of surface and subsurface water flows

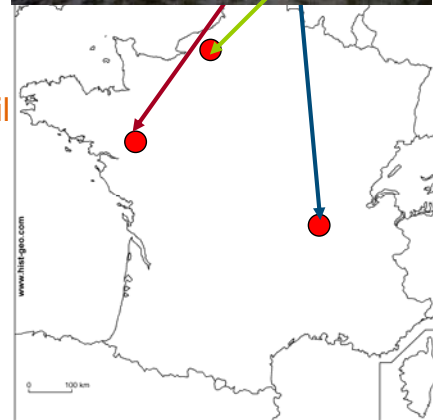
5

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## Three agro-pedo-climatic si

- Morcille site (Rhône)**
  - Very permeable clayed sand
  - Water table depth varying with the season
- Jaillière site (Loire Atlantique)**
  - Poorly permeable medium loamy over clay soil
  - Perched water table in winter, deep water table in summer
- Pays de Caux site (Normandie)**
  - Permeable silty soil
  - Highly slaked soil
  - Deep water table



6

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## Tested scenarios

- **Strip characteristics**
  - ✓ Strip width (1, 5, 10, 20 m)
  - ✓ Slope (2, 7, 15 %)
  - ✓ Surface roughness (Manning coefficient : 0.05 ; 0.1; 0.4 s.m<sup>-1/3</sup>)
- **Hydrodynamical characteristics of soil layers**
  - ✓ K-psi-theta (Van Genuchten)
  - ✓ Layer depth
- **Initial water status of soil**

*Function of the season :*

  - ✓ Water table depth ; water content
  - ✓ Successive simulations of rainfall and evaporation
- **Run-on characteristics**

*Function of the season :*

  - ✓ Overland flow discharge : duration and intensity
  - ✓ Two successive events

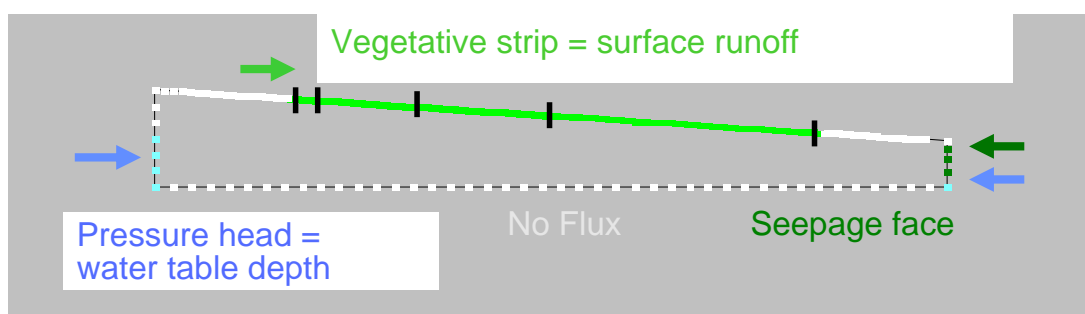
7

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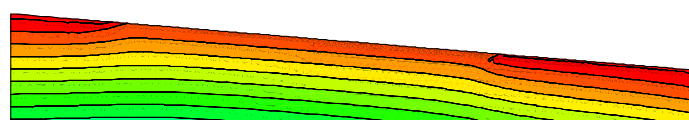


## Modeling with « Hydrus 2D »

### Boundary Conditions



### Simulation : Water pressure variation



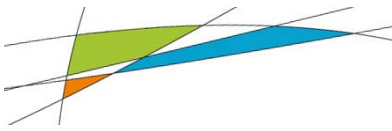
CI  
36 min  
99 min  
180 min



8

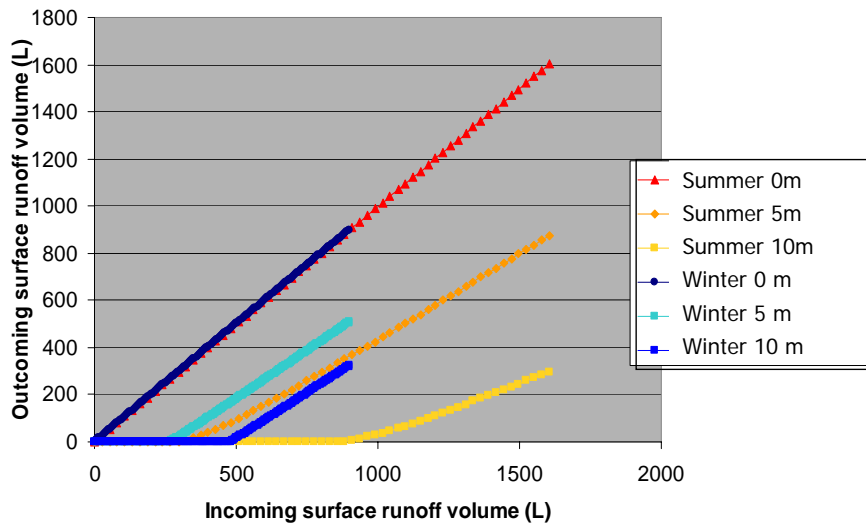
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## Morcille results

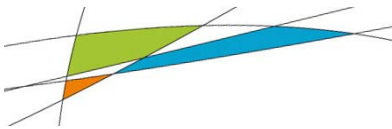
Outcoming water volume, depending on the seasons



	Incoming discharge (L/h)	Incoming volume (L/h)	Water table depth (cm)	Held back water for 5 m (%)	Held back water for 10m (%)
Summer	1600	1600	150	46	82
Winter	300	900	70	44	64

9

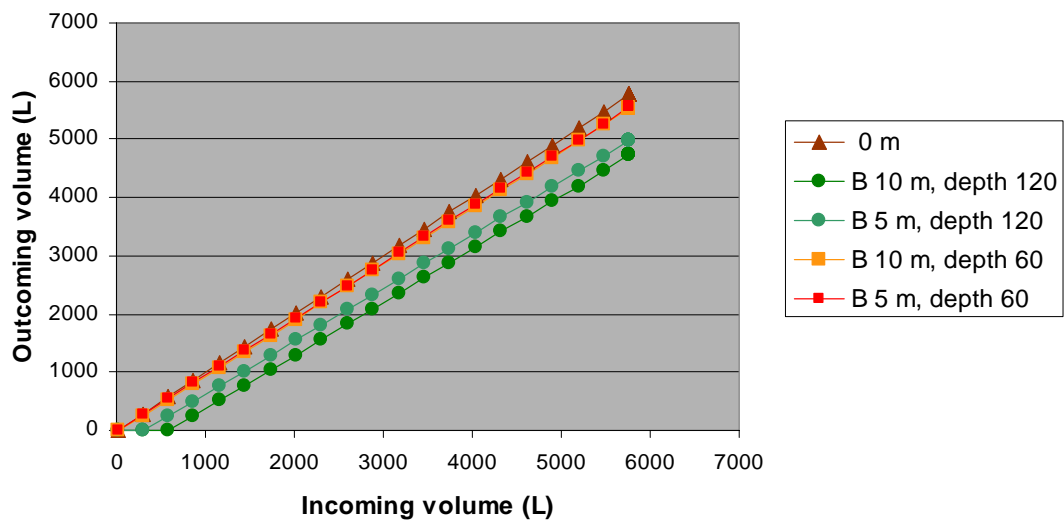
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## Jaillière results

Influence of water table depth.

Winter, discharge = 288 L/h (5760 L), slope = 2%



Water table depth (cm)	% retention for 10m	% retention for 5 m
60	4	4
120	18	14

10

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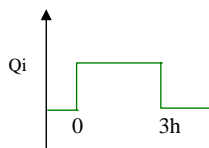
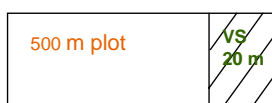




## Pays de Caux results

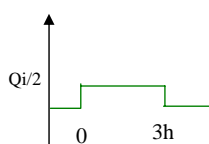
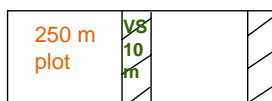
### Succession of vegetative strips :

#### Usual simulation

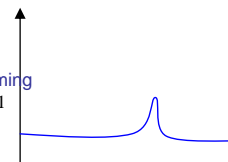


$Q_i$  = incoming discharge = 1800L/h

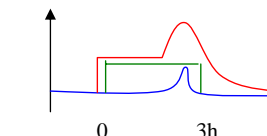
#### First strip simulation



$Q$  outgoing strip n° 1



#### Second strip simulation



$Q_i$  2<sup>nd</sup> strip =  $Q_i/2 + Q$  outgoing strip n° 1

Strip	20 m	Succ. 10m	10 m	Succ. 5m
Outcoming volume (L)	1431	1366	3277	3147

11

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## Overall results

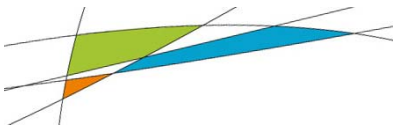
Soil	Slope (%)	Season	Water table Depth (cm)	Ks deep layer (mm/h)	Incoming discharge (L/h)	Held back Volume (L)	Reduction (%)
<b>Morcille</b>							
Sandy	7	Summer	150		1600 (1h)	1244	78
		Success summer	150		1600 (1h)	1024	64
		Winter	70		300 (3h)	636	69
		Success winter	70		300 (3h)	361	40
<b>Jaillière</b>							
Clayed-loamy	2	Summer	190		144 (2h)	288	100
		Winter	60		288 (20h)	242	4
		Winter	120		288 (20h)	1037	18
		Winter	120		1440 (2h)	607	21
		Winter	120		120 (18h)	939	44
<b>Pays de Caux</b>							
Silty	2	Sum/wint	No water table	5	180 (10h)	1800	100
		Winter	/	5	720 (10)	2556	36
		Winter	/	1	720 (10)	1852	26
		Success winter	/	5	720 (10)	1401	19
		Summer	/	1 et 5	1800 (3h)	2131	40
		Success summer	/	5	1800 (3h)	1018	19

10 m width strip.

12

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## Discussion

### Vegetative strip efficiency :

Depends strongly on the first layers permeability and available porosity

#### → Process triggering surface runoff

- ✓ Water table rising
- ✓ Overtaking soil infiltration capacity

### Towards a dimension rule

#### Multiple regression

Linear equation

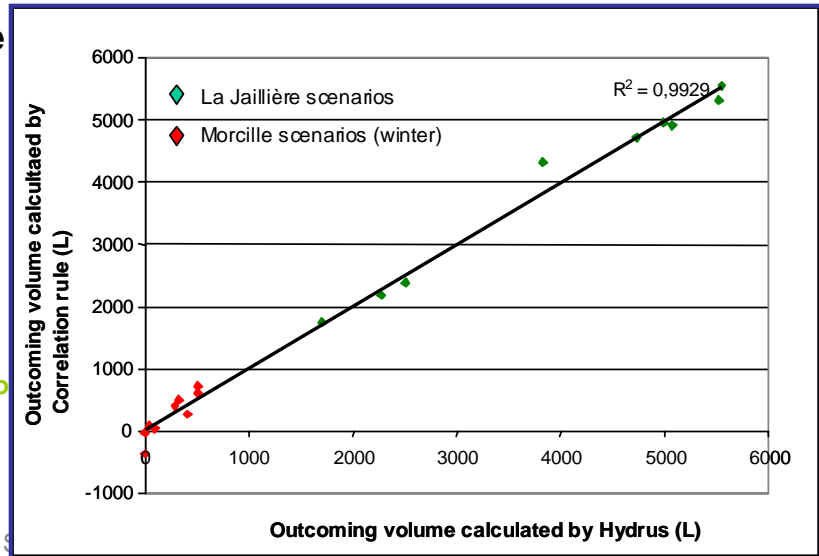
$$X_1 = a_2X_2 + a_3X_3 + \dots + b$$

#### Water table rising:

Incoming volume, strip width  
Soil available porosity

#### Overtaking infiltration capacity (horto)

Incoming discharge, strip width,  
Soil layer permeability  
Soil available porosity



13

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## Conclusion

- Strong contrast between strip efficiencies depending on the area :  
Morcille : 60%, Jaillière : 20%, Pays de Caux : between 20 and 40%
- Multiple regressions lead to satisfying results but problems remain to link used parameters with data easily accessible on the field
- A simulation model seems necessary, particularly for the «overtaking infiltration capacity » situation
- Dimensionning must also take into account the pesticides concentrations dynamics (intra-event, inter-season)
- Design of vegetative strip must be thought at the hillslope scale

14

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Thank you for your attention !!