# Metamodeling to evaluate sensitivity of operationnal models. Case of a buffer strips design tool to protect water from pesticides

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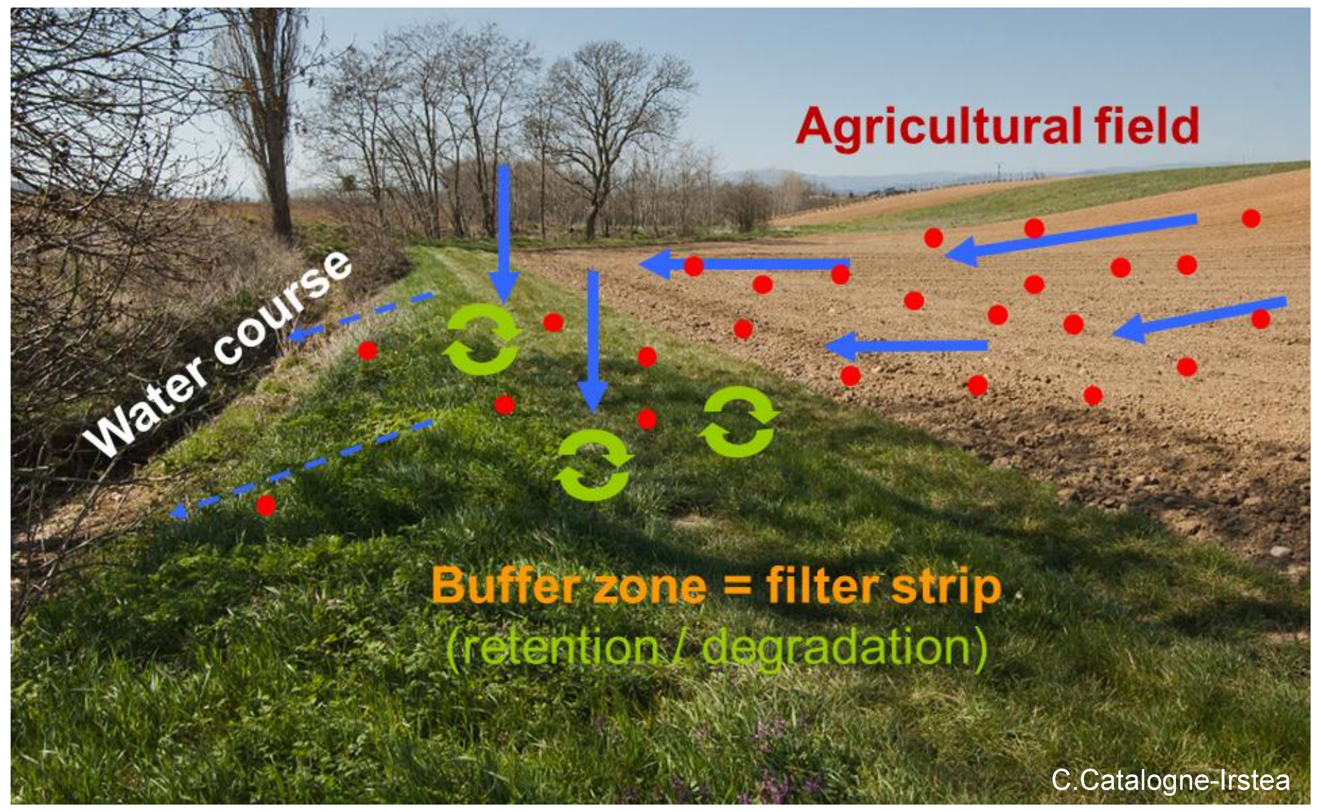



## Objectives

- Buffer strips are identified as the BMP of Choice for Runoff Mitigation to limit contamination of surface water by pesticides,
- Their efficiency strongly depends on soil, agronomic and climatic conditions and they need to be optimized by considering appropriate sizing.

➔ Irstea developed a complete toolkit to design site-specific VFS by simulating their efficiency to limit runoff transfers (Carluer et al., 2016).

➔ Need for a simpler tool to help end-users to get results based on a metamodeling, to perform easily sensitivity analysis adapted to their conditions.

## The toolkit BUVARD*

BUffer strip for runoff Attenuation and pesticides Retention Design tool

BUVARD online

Hypothesis : buffer zone efficiency = ability to retain surface runoff

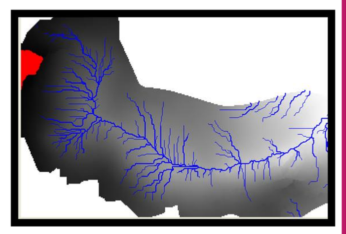
1. Definition of the surface runoff entering the buffer zone
2. Definition of buffer zone characteristics

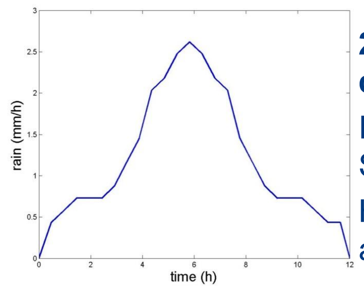
models → VFS Optimal length

## 1 Contributive Area

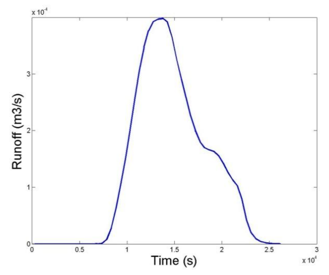
Input of →

1/ Contributive area def. (surface, length, slope) HydroDem





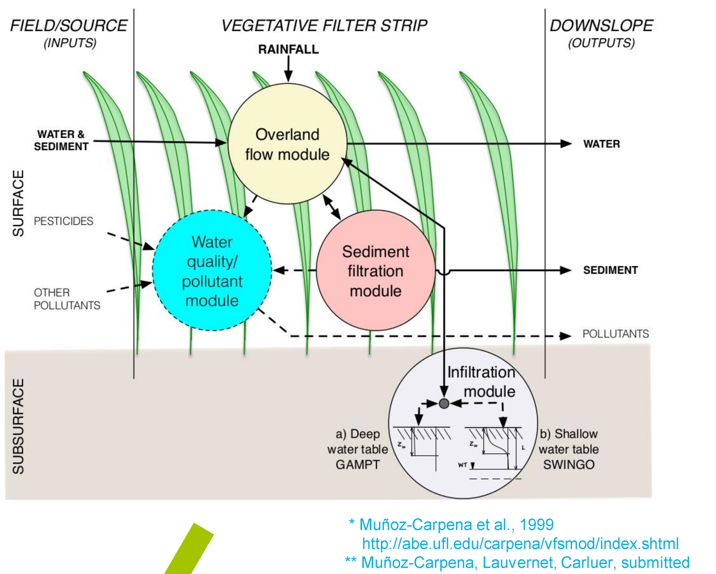
2/Precipitation event definition ⇒ HyétoHydro
Intensity – Duration – Seasonal frequency
Hyetogramm duration and season



3/ Hydrograph definition
Curve Number method
Initial soil status choice, depending on the season

## 2 Buffer Zone : VFSMOD

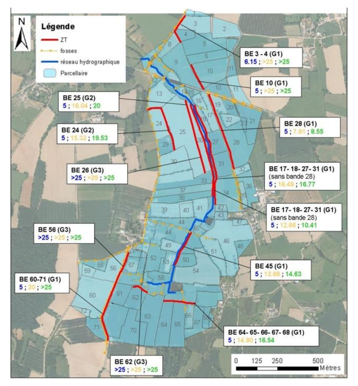
Physically based model* adapted to shallow water table**




* Muñoz-Carpena et al., 1999 http://abe.ufl.edu/carpena/vfsmod/index.shtml
** Muñoz-Carpena, Lauvernet, Carluer, submitted

Optimal VFS length for each scenario for several types of storms

Optimal size of each VFS on the watershed

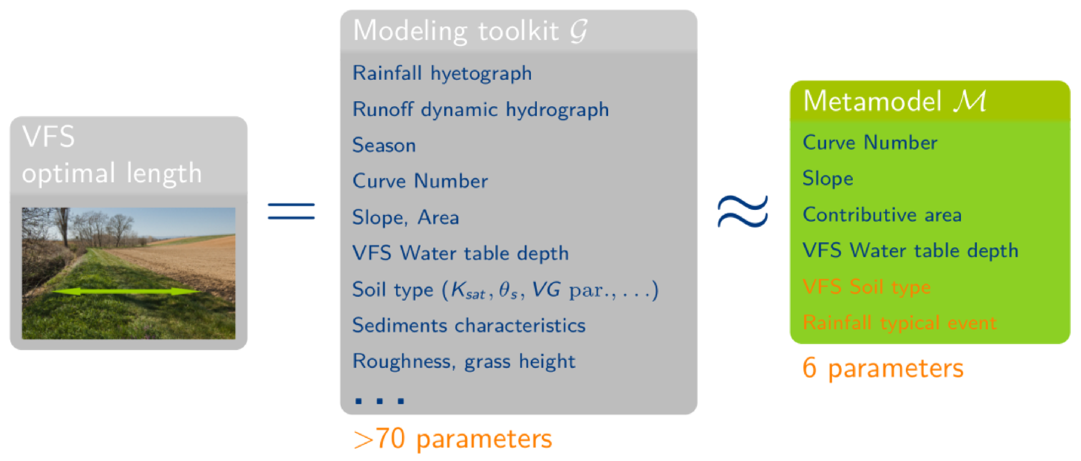


A complete tool but quite difficult to apply for non-modelers and to perform sensitivity analysis

➔ **Simulations of virtual scenarios & metamodeling**

## Metamodel vs the whole toolchain

- evaluate an output of the toolchain at any point of the domain
- evaluate sensitivity indices larger GSA at smaller numerical cost
- easier integration into other processes and simulation platforms
- easier applicability across different spatial and/or temporal scales




➔ **Which sampling strategy ?**

➔ **Which method ?**

➔ **How to to deal with qualitative variables ?**

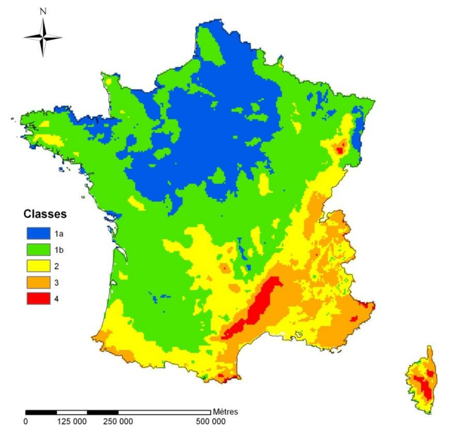
## Sampling the quantitative and qualitative variables

- Which parameters to sample? ➔ compromise between the most influent and the most accessible input parameters of the toolkit

| | | | | |
|---|---|---|---|---|
| **Curve Number** : 63 - 99<br>**Slope** : 2% -20%<br>**Length** : 25-300m | **Contributive area characteristics** | **X** | **VFS characteristics** | **Water table depth** : 0.5 m-4m<br>**Soil type** : clo, scl, SIL, CLO , SCL, SAL |

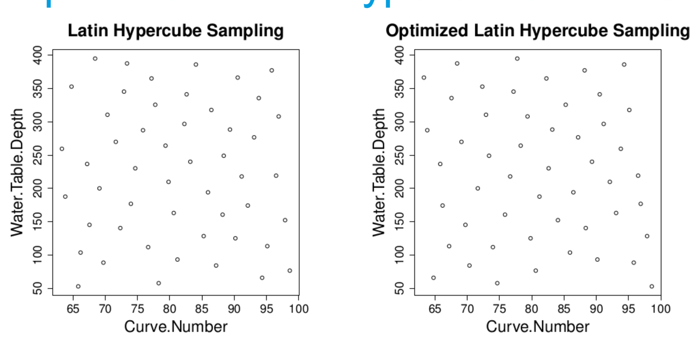
- on 4 typical rainfall events : Summer / Winter **x** short / long duration
- for 5 climatic classes in France

2 qualitative variables to deal with when developing the methods



➔ How to sample these 6 key variables?

Optimized Latin Hypercube method



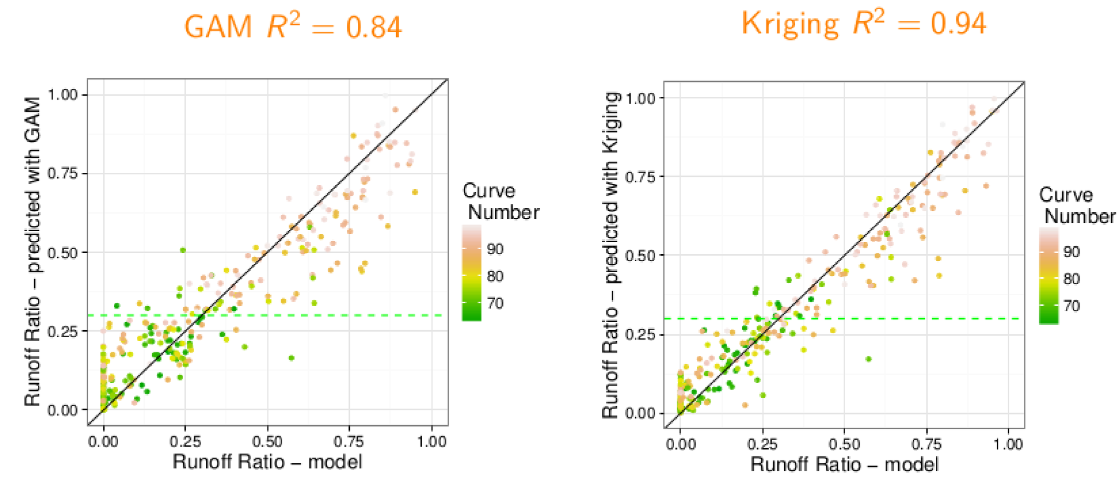

The LHS was optimized via distance (maximin) criteria
dist. = 0.137 → 0.345

→ only 960 runs of the toolkit to perform one metamodel per climatic class

## Results

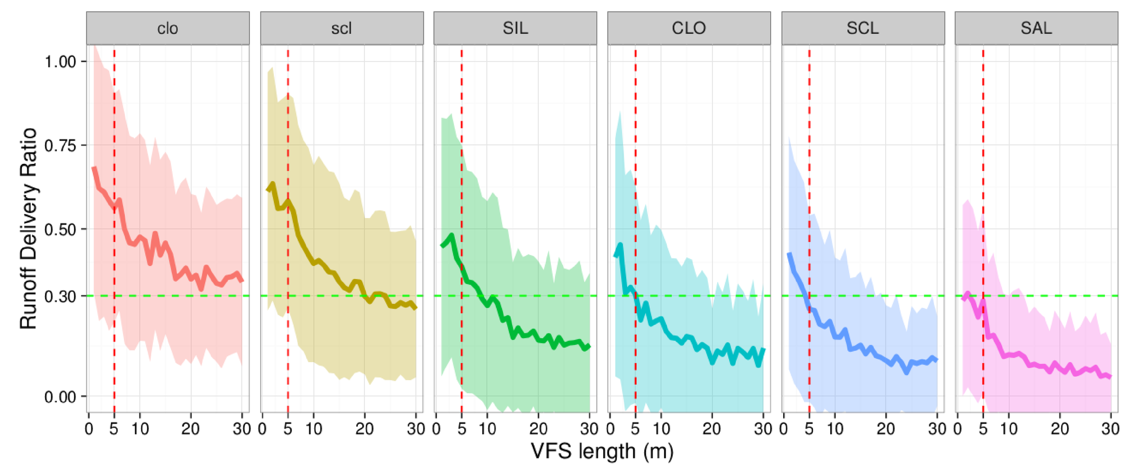
- Comparison of two methods : Kriging & Generalized Additive Model
- Kriging was adapted to qualitative variables with particular covariance model

Output variable is the Runoff Delivery Ratio = Runout/Runin :
RDR = 0 ⇔ efficiency = 100%; RDR = 1 ⇔ efficiency = 0%




➢ Kriging is very efficient with qualitative variables
➢ High sensitivity of RDR to the Curve Number

- Uncertainty analysis : Average efficiency and uncertainty on large sample simulations (24 000)




➢ a very large variability of optimal length / type of soil
➢ possibility to quantify uncertainty of the results

## Conclusion :

- Qualitative variables (rain type, soil type) were properly taken into account by the kriging adaptation
- Good quality of prediction (94 % of variance) but large uncertainty
- The optimal VFS length is very sensitive to the Curve Number
- MM is a promising tool to test the toolkit to perform UA and GSA at low cost
- BUVARD-MM is now integrated in webtool (R/Shiny) → a real way to use the toolkit operationnaly

**Limitations and perspectives:**

- On larger ranges (Curve Number in p.), the current metamodel is not satisfying (due to a large plateau of a null values of the output variable)
- Continue testing and compare methods on :
  - prediction uncertainty
  - sensitivity of prediction quality to the sampling size
  - global sensitivity analysis (Sobol)

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