

Metamodeling to evaluate sensitivity of operational models.

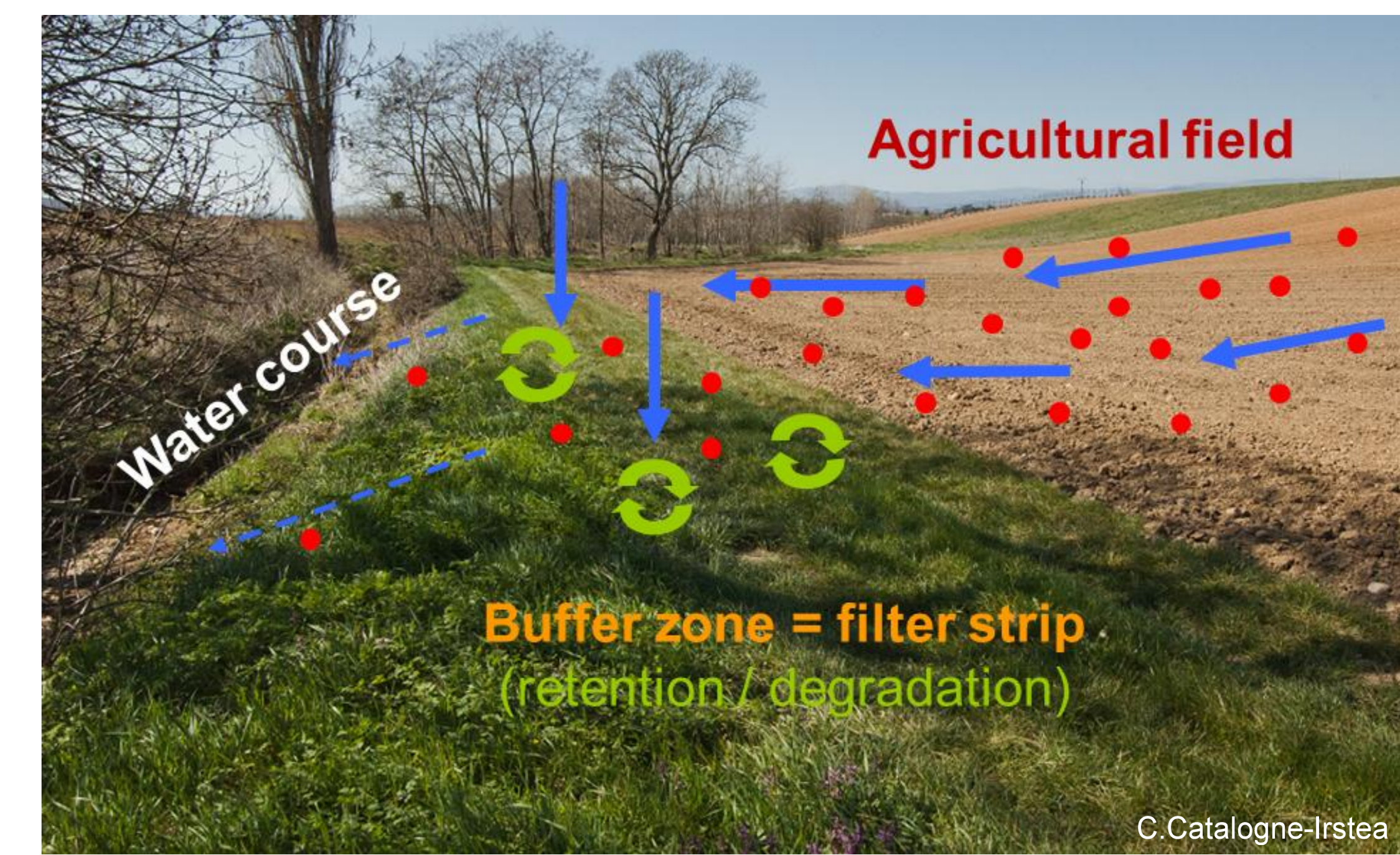
Case of a buffer strips design tool to protect water from pesticides.

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Objectives

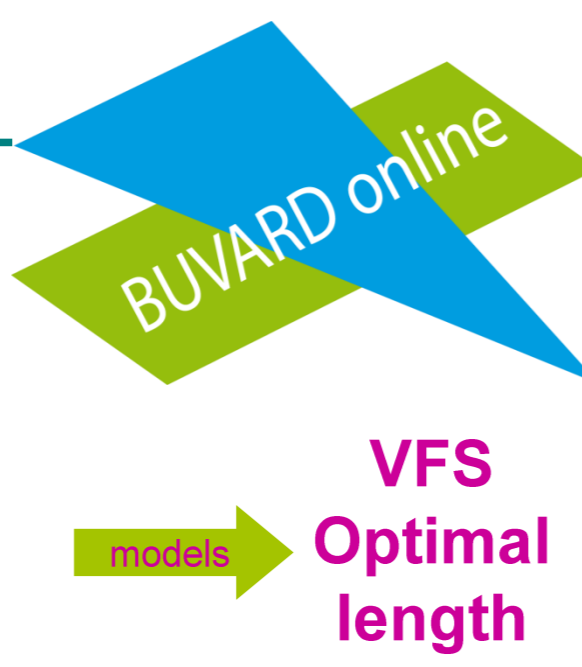
- Buffer strips are identified as the BMP of Choice for Runoff Mitigation to limit contamination of surface water by pesticides,
- Their efficiency strongly depends on soil, agronomic and climatic conditions and they need to be optimized by considering appropriate sizing.
- Irstea developed a complete toolkit to design site-specific VFS by simulating their efficiency to limit runoff transfers (Carlier 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*

BUVARD online
Buffer strip for runoff Attenuation and pesticides Retention Design tool

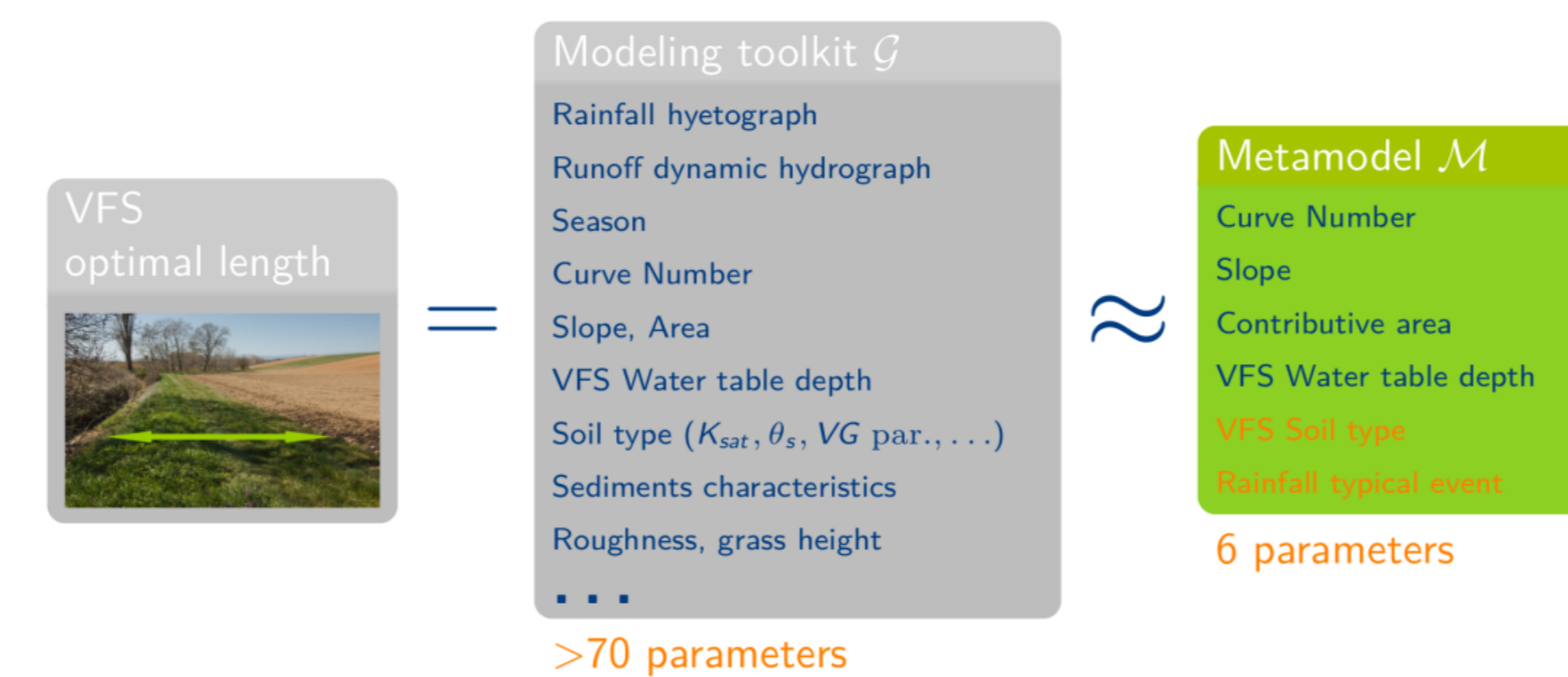
Hypothesis : buffer zone efficiency = ability to retain surface runoff

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



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 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

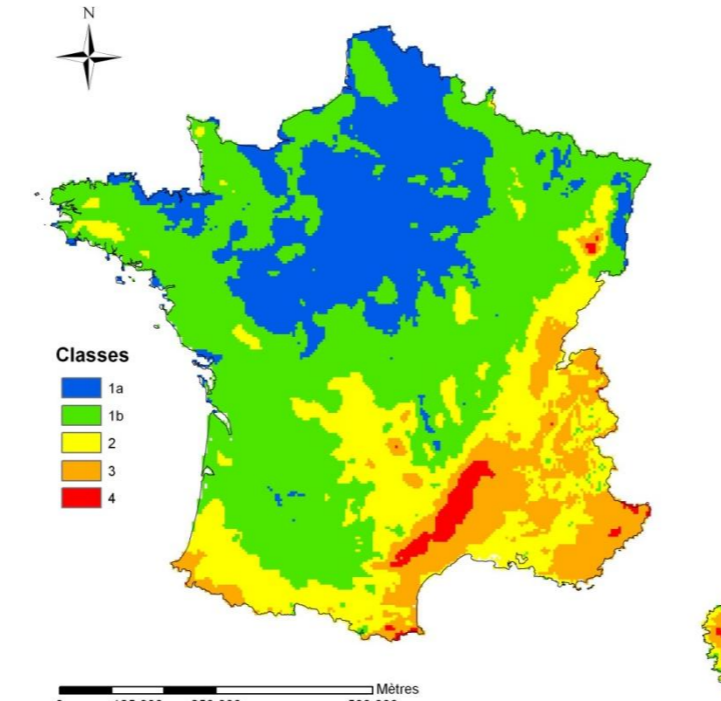
Curve Number : 63 - 99
Slope : 2% -20%
Length : 25-300m

Contributive area characteristics

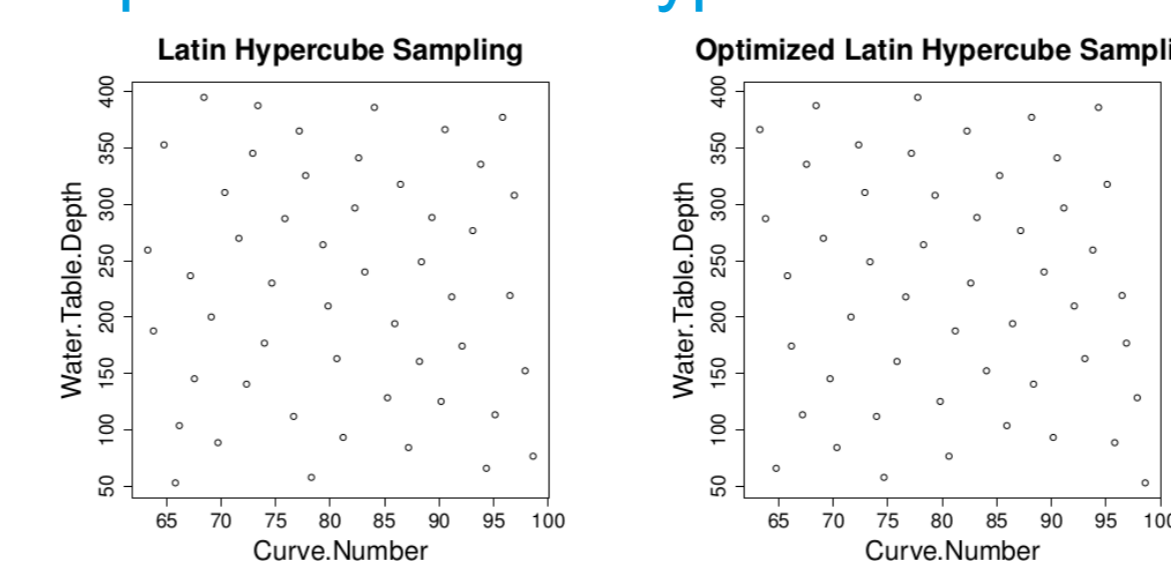
VFS characteristics

Water table depth : 0.5 m-4m
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



→ How to sample these 6 key variables?
Optimized Latin Hypercube method



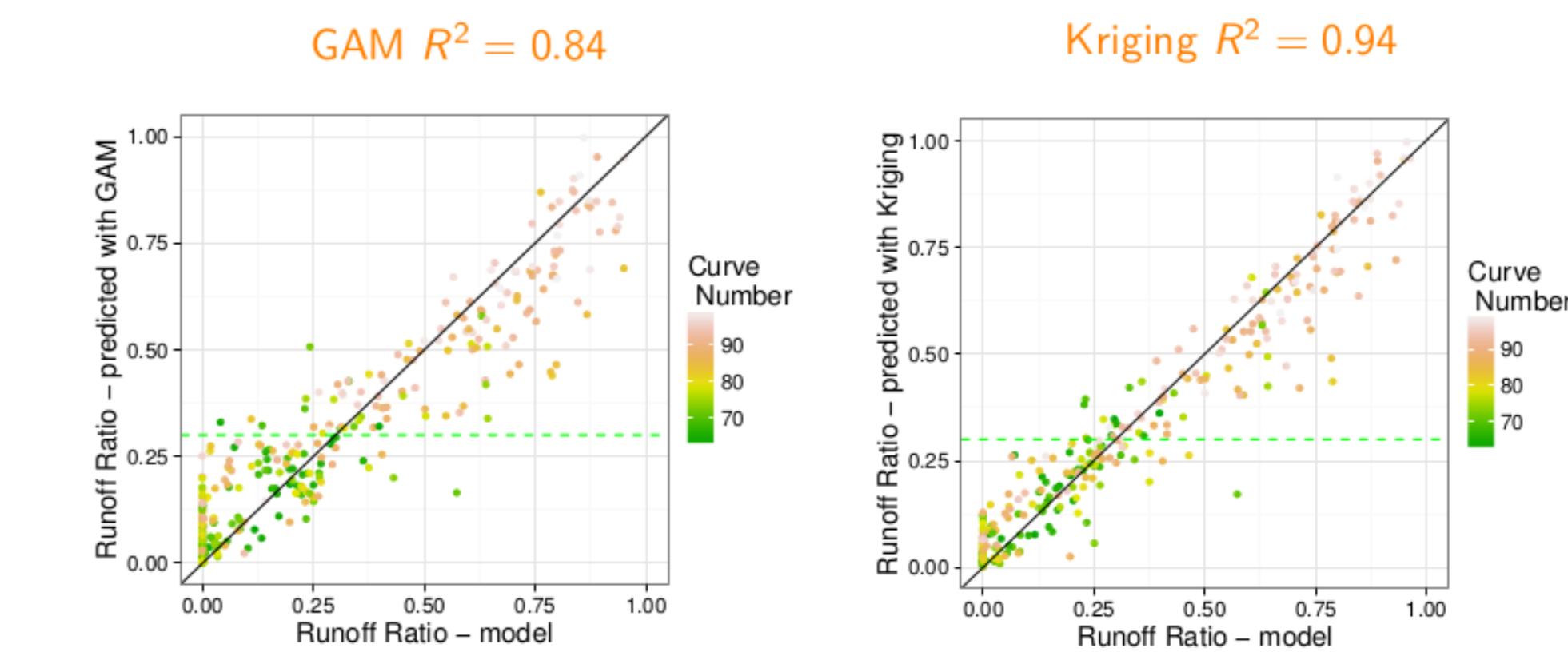
The LHS was optimized via distance (maximin) criteria
dist. = 0.137 → 0.345

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

Results

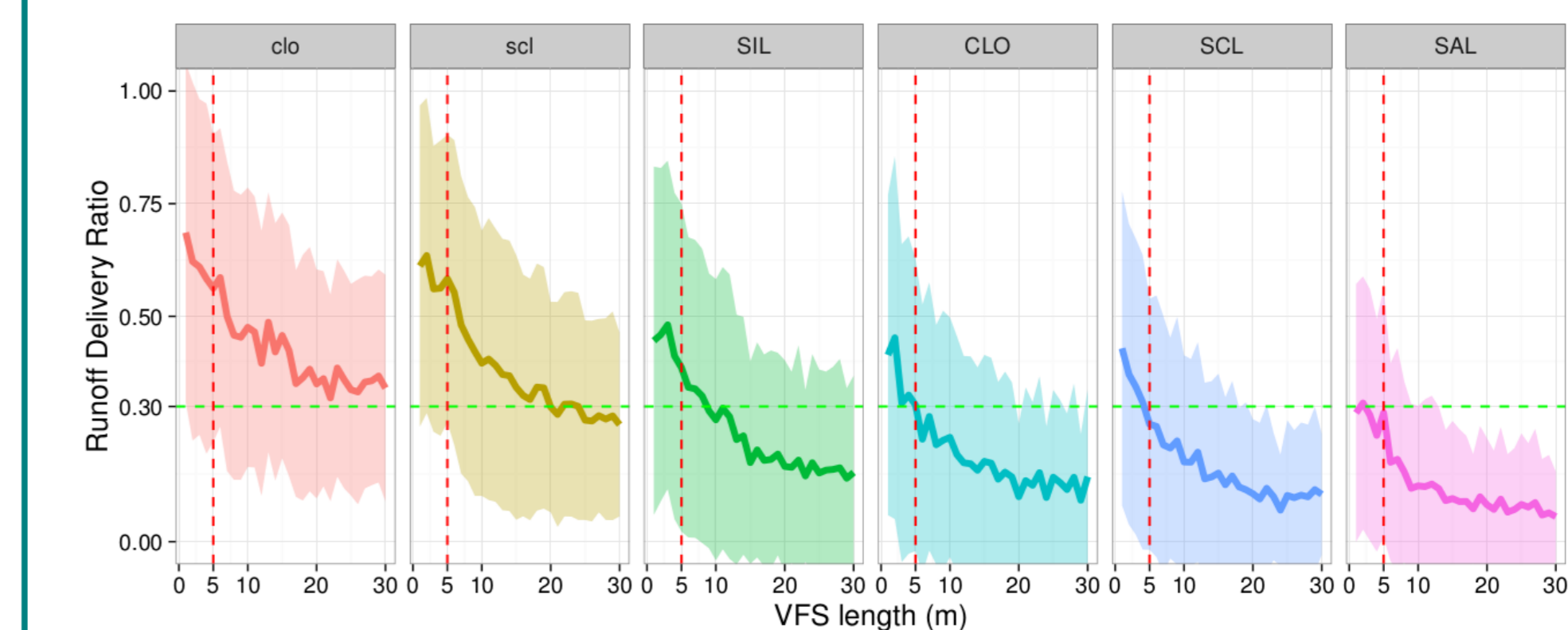
- Comparison of two methods : Kriging & Generalized Additive Model
- Kriging was adapted to qualitative variables with particular covariance model

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 :

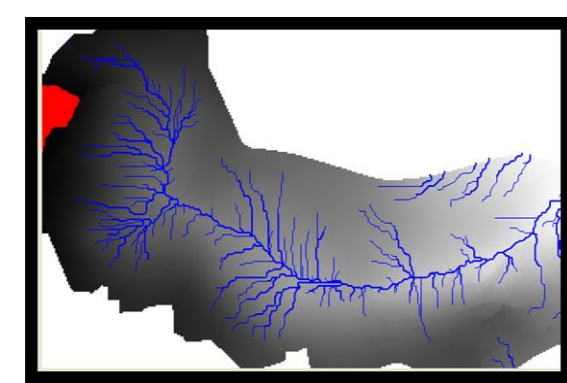
- Qualitative variables (rain type, soil type) were properly taken into account by the kriging adaptation
- Good quality of prediction (94 % of variance) but large uncertainty
- The optimal VFS length is very sensitive to the Curve Number
- MM is a promising tool to test the toolkit to perform UA and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

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)

1 Contributive Area

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

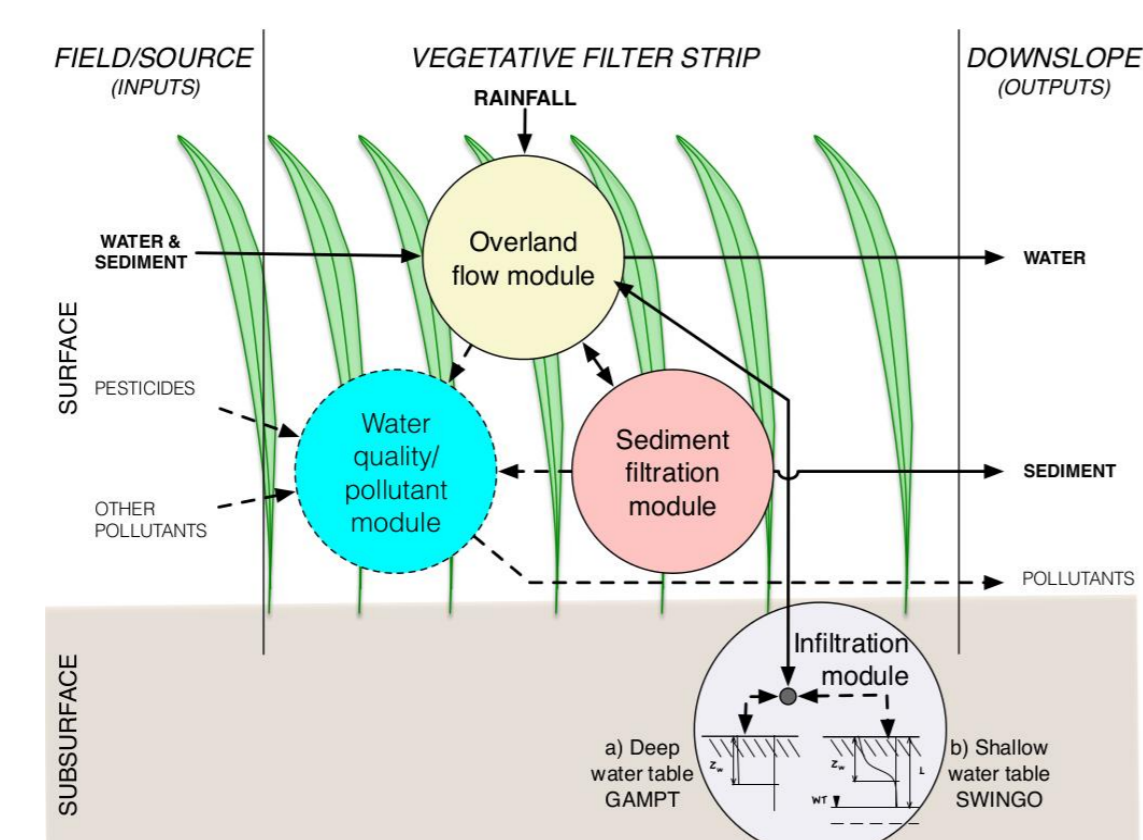


2/Precipitation event definition ⇒ HyetoHydro
Intensity – Duration – Seasonal frequency
Hyetogramm duration and season

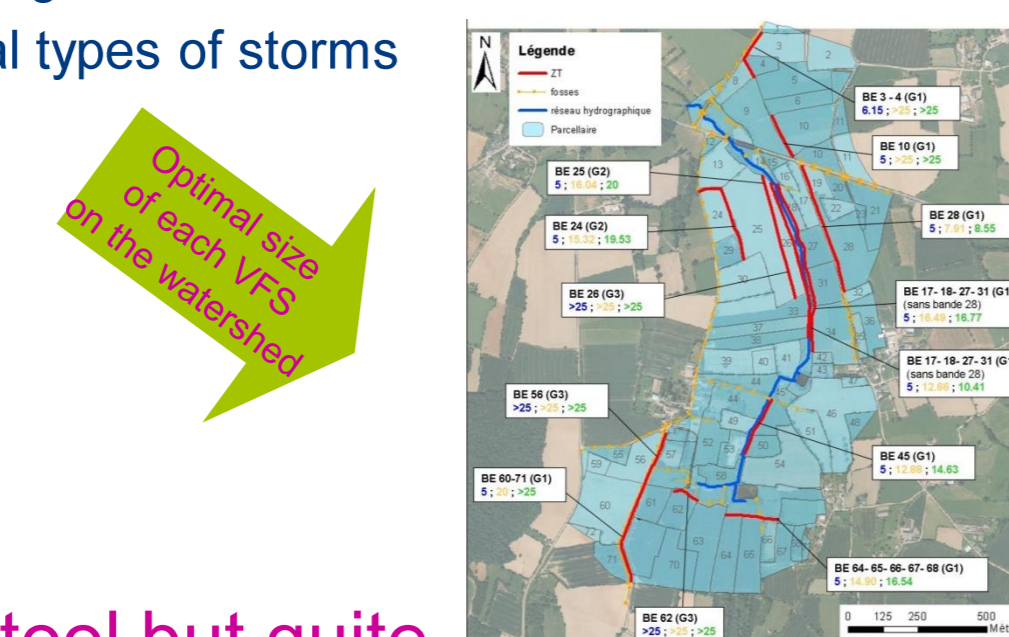
3/ Hydrograph definition
Curve Number method
Initial soil status choice, depending on the season

2 Buffer Zone : VFSMOD

Physically based model* adapted to shallow water table**



Optimal VFS length for each scenario for several types of storms



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

→ Simulations of virtual scenarios & metamodeling

