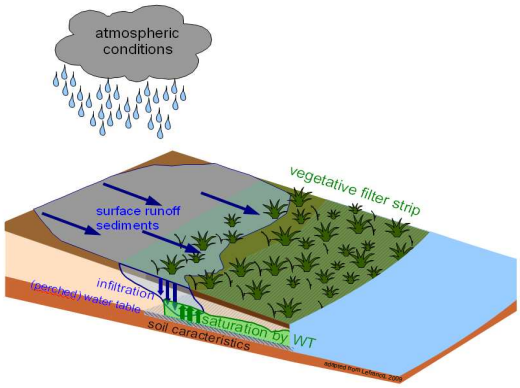
Evaluation of a mechanistic algorithm to calculate the influence of a shallow water table on hydrology sediment and pesticide transport through vegetative filter strips by sensitivity analysis

Abstract: Natural or man-introduced areas of vegetation, also known as vegetative filter strips (VFS), are a common environmental control practice to protect surface water bodies from human influence. In Europe, VFS are often set along the hydrographic network to protect it from agrochemical drift during applications and from field surface runoff. The VFS position in low lands near water bodies often implies the presence of a **seasonal shallow water table**, which may have a significant impact on buffer zone's efficiency.

Jaillière (ARVALIS–Institut du Végétal). wheat and maize crops Silty clay ; Slope = 3%.

Morcille (Cemagref), wineyard. permeable sandy-clay ; Slope = 25%.

In a platform presentation [1], the Vegetative Filter Strip numerical overland flow and transport MODel VFSMOD, has been adapted to WT with a physically-based algorithm describing ponded infiltration into soils bounded by a water table [2]. In this study, we evaluate the importance of the presence of a shallow water table on filter efficiency (reductions in runoff, sediment and pesticide transfer) by Global Sensitivity Analysis.



Objectives:

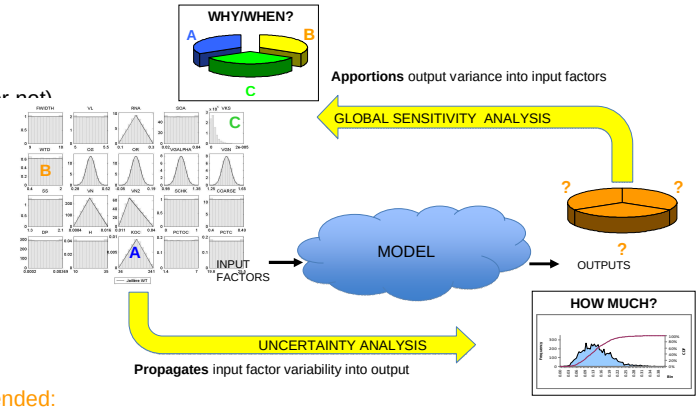
➔ **Evaluate the importance of a water table in the context of other factors/processes**

➔ **Quantify the variance that can be apportioned to each of the important factors**

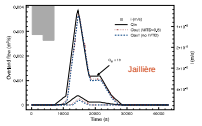
Study on 2 different agro-pedo-climatic scenarios: Jaillière and Morcille, with and without WT

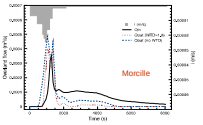
Global Sensitivity Analysis: what is it and what for?

- **prioritize** the model parameters
- identify **critical** regions in the space of the inputs (including interactions)
- support decision for research and future **experiments** (e.g. param. to be measured or not)
- gauge model adequacy and **physical relevance**
- **simplify** models (metamodeling)
- find technical **errors** in the model
- verify if **policy options** make a difference
- **anticipate** (prepare against) biased uses of the results



⚠ GSA is related to defined conditions and is not general
➔Choice of climatic events



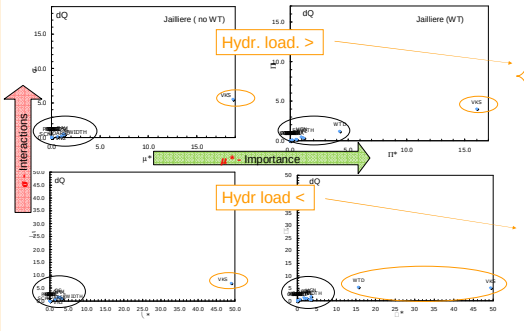


⚠ For model with large number of factors ➔ a **two-step global process** is recommended:

1 Qualitative Screening with limited number of simulations (Morris Method) ➔ Ranking and selection of important factors (μ*), interactions (σ)

2 Quantitative Variance-based method: (Ext.FAST, Sobol) ➔ First order indexes (Si, direct effects), Total order (STi, interactions), Uncertainty analysis

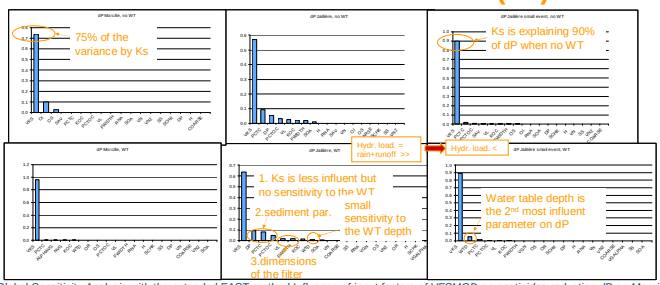
1 Qualitative Sensitivity Analysis (Morris method) of VFSMOD on infiltration (dQ) & hydraulic loading



With a high hydraulic loading (=rainfall+runoff)
- Ks is the most influent parameter on dQ
- Water Table depth (WTD) does not play a key role since infiltration is limited anyway

With a lower hydraulic loading:
- Ks explains most of dQ when no WT
- WT can have an impact on infiltration ➔ on dP as well

2 Quantitative Sensitivity Analysis (Ext.Fast) of VFSMOD Pesticide reduction (dP)



Global Sensitivity Analysis with the extended FAST method Influence of input factors of VFSMOD on pesticides reduction dP on Morcille, Jaillière, and Jaillière with a smaller event. Pesticide=Isoproturon.
18(20) param 3 pesticides * 2 sites (Jaillière and Morcille) *5000 = 1 140 000 simulations performed on HPC of University of Florida*

➔The quantitative confirm the qualitative method : same hierarchy and physical coherence

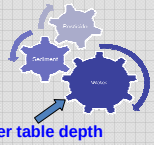
Depending on the agro-pedo-climatic conditions, the water table can play a key role

Conclusion : has the water table a (bad) effect on pesticide trapping by VFS?

✓ It depends! sometimes (soil, rainfall, incoming runoff) sensitive to the presence of WT

✓ **Infiltration** is the main process, and it is driven by Ks

Complexity of pesticides transport and trapping in buffers does not warrant simple empirical relationships based on field characteristics of the filters (length, slope)



We need to :

✓ **study locally** the conditions to assess the efficiency of a VFS and to optimize it

✓ pay particular attention to soils that contain a **seasonal shallow water table** and/or that are potentially hydromorphic

LAUVERNET C.[1], MUÑOZ-CARPENA R. [2], CARLUER N.[1]
1 Irstea/CEMAGREF, UR MALY, 3 bis quai Chauveau - CP 220, F-69336 Lyon, France. e-mail. claire.lauvernet@irstea.fr
2 Agricultural and Biological Engineering. University of Florida. 287 Frazier Rogers Hall, PO Box 110570 Gainesville, FL 32611-0570 (EEUU).

[1] Muñoz-Carpena R, Lauvernet C., Carluer, N. Development and testing of a mechanistic algorithm to calculate the influence of a shallow water table on flow dynamics through vegetative filter strips (*MODELLING session 1*).
[2] Muñoz-Carpena R, Parsons JE, Gilliam JW, 1999. Modeling hydrology and sediment transport in vegetative filter strips. J. Hyd. 214:111-129.
http://abe.ufl.edu/carpena/vfsmod/

www.irstea.fr