Assimilation of image data into a spatialized water and pesticide flux model
Claire Lauvernet, Laure-An Gatel, Claudio Paniconi, Matteo Camporese, Anna Botto, Arthur Vidard, Maëlle Nodet

To cite this version:

HAL Id: hal-02608128
https://hal.inrae.fr/hal-02608128
Submitted on 16 May 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
Assimilation of image data into a spatialized water and pesticide flux model

C. Lauvernet1, L. Gatell2, C. Paniconi2, M. Camporese3, Anna Botto3, A. Vidard4, M. Nodet5
1 INRSETE, Université du Québec, Canada – 2 Università di Padova, Italy – 3 INRA, France – 4 Univ. Grenoble Alpes & INRIA, France

Abstract: Physically-based models represent detailed surface/subsurface transfer, but the required spatial information does not allow their operational use.

In situ data on pesticides in a catchment are usually rare and not continuous in time and space.

Satellite images well describe data in space, but only water related, and at limited time frequency.

The ADIMAP project aims to exploit these 3 types of information (model, in situ data, images) with data assimilation methods adapted to image data, in order to improve pesticide fluxes simulation and estimates of hydrological parameters. This poster discusses the proposed methodology as well as the available study site data and modeling components.

CATHY-Pesticide Hydrological model

Coupled surface/subsurface flow and transport [1-7]

Richards eq. for variably saturated porous media:

\[ S_m \frac{\partial h}{\partial t} + \frac{\partial q_m}{\partial z} = \nabla \cdot (K_s \nabla h) + q_w \]

1D diffusive wave equation at surface:

\[ \frac{\partial Q}{\partial t} + a \frac{\partial Q}{\partial x} = D \frac{\partial^2 Q}{\partial x^2} + c_q(x, h, \psi) \]

Advection - dispersion equation

\[ \frac{\partial C}{\partial t} = \nabla(D \nabla c) - \nabla(\nabla c) + R \]

Linear adsorption and first order decay

\[ K_d = c \frac{\partial C}{\partial x} = -\lambda C \]

The Morcille study site (Beaujolais)

- Small watershed (8.8 km²)
- 70% of vineyard
- High risk of pesticide contamination
- Steep slopes > 25%
- Permeable sandy soils
- Continental climate with Mediterranean influence
- Research on pesticides since 1985
- River quality and flow monitored between 2006 and 2011.

Reactive solute transport on a short event

- Dynamics are reproduced, but significant delay
- Sensitivity Analysis showed high influence of hydrodynamic characteristics on solute transfer outputs [see Gatell pres. on Wednesday Session 43!]

⇒ Need to reduce uncertainty
⇒ Need to better parametrize CATHY spatialized hydrodynamic characteristics

DA for pesticide transfer modeling

Modeling pesticide transfer in a watershed is particularly complex:

- Very high heterogeneity of the system
- Many processes in interaction
- Few information on physico-chemical interactions of molecules

- Lack of data deep in the soil
- Research focuses on development of modeling in function of chosen processes to describe
- DA would improve input parameters characterisation and pesticide transfer understanding.

Hypothesis:

Assimilating hydrological variables will improve the pesticide fluxes simulations and the input parameters estimates.

⇒ Coupled Data Assimilation

Model setup on a simplified hillside

Parameter unit Zone 1 Zone 2

\( K_s \) m s⁻¹ (18.31, 0.96) (18.05±0.66)

\( n \) (0.54, 0.464) (0.42, 0.046)

\( \theta_s \) - (0.15, 0.0375)

\( \alpha \) cm⁻¹ (1.46 ± 0.0146) (1.52 ± 0.152)

\( \theta_r \) cm⁻¹ (0.032 ± 0.0096) (0.13 ± 0.03)

\( K_{D, d} \) m² g⁻¹ (27.5, 3.1) (5.1, 1.2)

\( K_{D, Tef} \) m² g⁻¹ (45.1, 30) (1.98, 1.43)

\( K_{D, soil} \) m² (30, 10)

\( F_{D, soil} \) m (0.0025, 0.0015)

Assimilation of images

- Usually, remote sensing data and sequences are under-used, though their content in information is very high (shapes evolution, correlations, ...)
- HR Images would also help to identify the landscape elements (grass strips, hedgerows, ...)
- In classical approaches: uncorrelated noise, diagonal error covariance matrices
- How to provide observation error covariance matrices adapted to spatially correlated errors? [2]
- Focusing on the observations operator description, and distances definition in the DA scheme


This study was funded by INSU LEFE/MANO in the project ADIMAP.