

Modelling the fate of pesticides in European and French cropping systems: Integration of complex agricultural practices in risk assessment



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Introduction

- Modelling the fate of pesticides in the environment helps prevent and manage soil and water contamination
- In particular, groundwater protection is a key issue for human health and resources sustainability
- In Europe, assessment of predicted pesticides (and metabolites) concentrations in groundwater (PECgw) at 1 m depth is mandatory for their registration (European Regulation EC 1107/2009)
- Then each European country approves plant protection products (PPP) for specific agricultural uses

Objectives

- To review the models and methods used at the European and French levels to assess the PECgw
- To identify the strong and weak points of models and methods regarding cropping practices
- * At the European level, PECgw are estimated for pesticide use in crop monoculture. At the French level, refined assessment considering crop rotations can be performed
 - To achieve the sustainable use of pesticides, the European Commission promotes the introduction of new cropping systems based on integrated pest management (IPM) approaches (Directive EC 2009/128)
 - IPM is based on more complex cropping practices (cover crops, mulch...) than monoculture and rotation
- To present the recent developments that will help consider complex cropping practices in PECgw assessment



Cropping practices in the assessment of pesticides PECgw: regulatory requirements and recent developments

Regulatory risk assessment of PECgw at the European and French levels

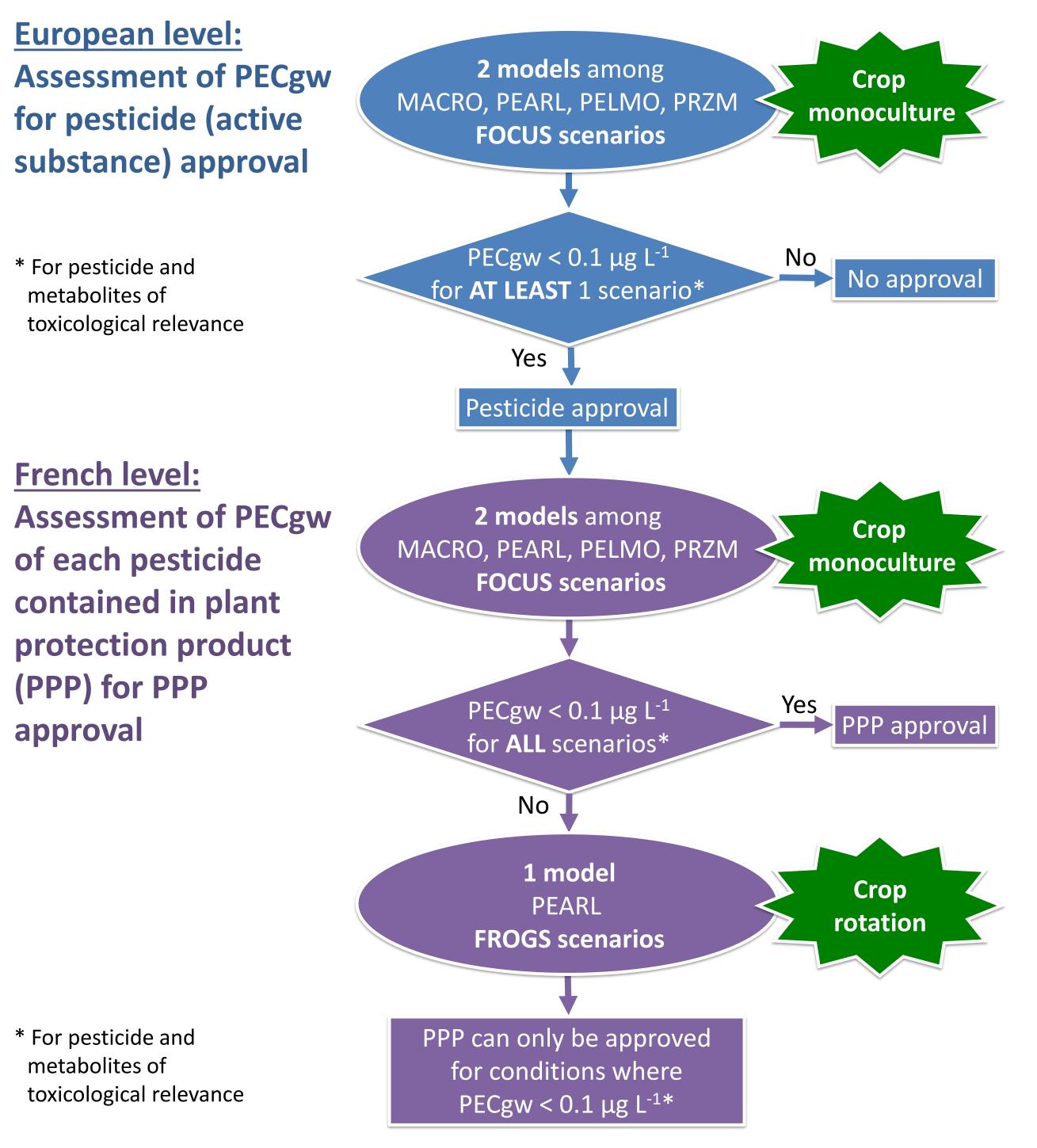
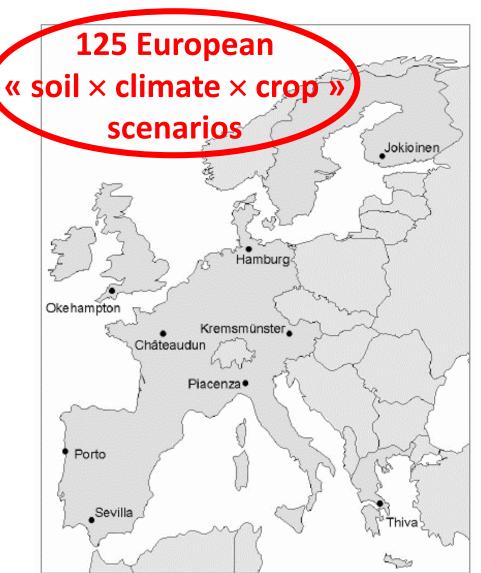


Table 1. Description of FOCUS European and FROGS French scenarios for PECgw assessment: pedoclimatic and cropping practices scenarios

Pedoclimatic scenarios	Cropping practices scenarios
 9 representative European scenarios (Fig. 1): 9 climates and corresponding soil types Mean annual temperature: 4 to 18°C Precipitations: 493 to 1150 mm Soils: loam, loamy fine sand, sandy loam, silt loam, silty clay loam 	 Crop monoculture Field crops: beans, cabbage, carrots, cotton, linseed, maize, oilseed rape, onions, peas, potatoes, spring cereals, soybean, sugar beet, sunflower, tobacco, tomatoes, winter cereals Perennial: apples, bush berries, citrus, grass, strawberries, vines
 390 representative French scenarios: 31 climates (Fig. 2), 19 soil types (not all soil types in the 31 climatic zones) Mean annual temperature: 10 to 15°C Precipitations: 684 to 1018 mm 	 Crop rotation oilseed rape - winter wheat - sunflower barley - winter wheat - sunflower winter wheat - maize - barley oilseed rape - winter wheat - maize
	 9 representative European scenarios (Fig. 1): 9 climates and corresponding soil types Mean annual temperature: 4 to 18°C Precipitations: 493 to 1150 mm Soils: loam, loamy fine sand, sandy loam, silt loam, silty clay loam 390 representative French scenarios: 31 climates (Fig. 2), 19 soil types (not all soil types in the 31 climatic zones) Mean annual temperature: 10 to 15°C



MACRO (Water and solute transport in macroporous soils, Larsbo and Jarvis, 2003) PEARL (Pesticide Emission Assessment at the Regional and Local scales, Leistra et al., 2001) PELMO (Pesticide Leaching Model, Klein, 1995) PRZM (Pesticide Root Zone Model, Carsel et al., 1998) 12E

Ollseed rape - winter wheat - maize Soils: arenosol, cambisol, fluvisol, potato - winter wheat - barley gleysol, luvisol, podzoluvisol, rendzine, solonchak

FOCUS: FOrum for the Coordination of pesticide fate models and their Use (http://esdac.jrc.ec.europa.eu/projects/focus-dg-sante) FROGS: French Refinement of Groundwater Scenarios (https://frogs-outil.com/)

European level

- \succ The assessment of PECgw for pesticide use in crop monoculture can be considered as a worst case
- > FOCUS scenarios do not allow to consider diversified crop rotations
- > The representation of cropping practices in the models is incomplete: the description of the crop is only based on maximum leaf area index, root depth and height

***** French level

> FROGS scenarios allow to propose risk mitigation measures based on specific cropping practices (i.e. crop rotation) \succ However, they do not take into account cropping practices such as cover crops, mulch...

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Fig. 1. Location of the 9 FOCUS European scenarios for PECgw assessment (FOCUS, 2000)

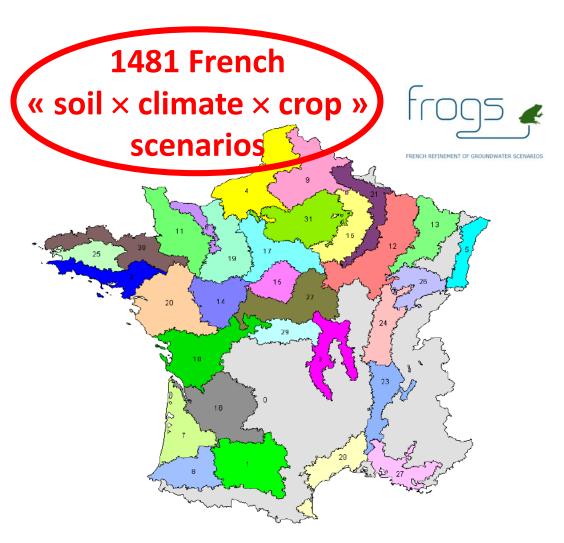
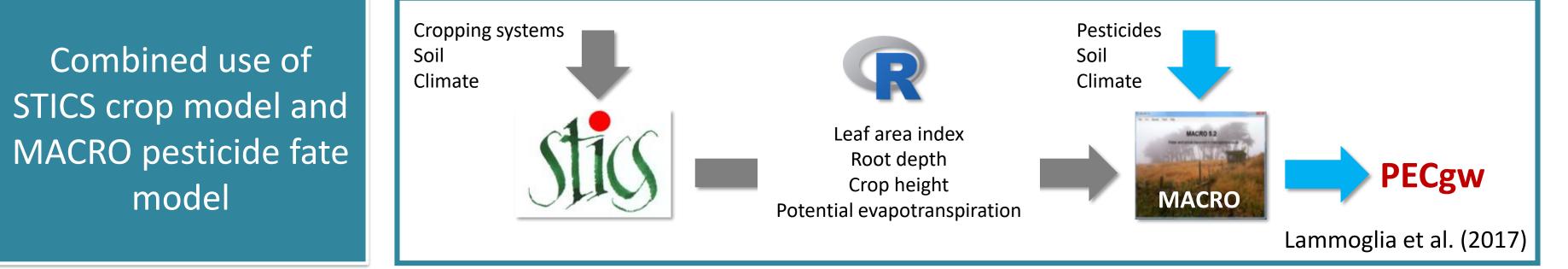


Fig. 2. Location of the 31 FROGS French agronomic scenarios for PECgw assessment (homogeneous geographic entities which show common agricultural and physical conditions for the growing of arable crops) (FROGS, 2013)

Recent developments to assess the PECgw of pesticides used in complex cropping systems

Need of new modelling tools to assess the PECgw of pesticides used in complex cropping systems:

Crop models are able to simulate refined crop development and



- various cropping practices (cover crops, mulch, fertilization...)
- > STICS crop model (Brisson et al., 2003) has been widely tested and its performance was shown to be good
- MACRO is known to be efficient to simulate the fate of pesticides
- ➡ STICS-MACRO is a new promising tool to assess the PECgw of pesticides used in various cropping systems (Lammoglia et al., 2017)

Conclusion and perspectives

Diversified cropping practices are increasingly adopted for a sustainable use of pesticides

Current assessment of PECgw for pesticide approval is done for crop monoculture at the European level, and can take into account crop rotations at the French level In the future, the diversity of cropping practices might be considered in modelling for pesticide regulatory risk assessment



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