XVIII
SYMPOSIUM ON PESTICIDE CHEMISTRY

Next generation solutions and sustainable frontiers

CREMONA, 2–4 SEPTEMBER 2026

BOOK OF ABSTRACTS

Bringing together science, innovation and collaboration to advance the safe and sustainable use of pesticides for the future.

XVIII SYMPOSIUM ON PESTICIDE CHEMISTRY

NEXT GENERATION SOLUTIONS AND SUSTAINABLE FRONTIERS

EDITORS: DIEGO VOCCIA, LEILEI ZHANG, VERONICA FERRARI

Introduction

The XVIII Symposium on Pesticide Chemistry, themed "Next Generation Solutions and Sustainable Frontiers," addresses the vital challenge of balancing global agricultural productivity with environmental protection. Rooted in a long-standing tradition established at the Università Cattolica del Sacro Cuore by Professors Attilio del Re and Paolo Fontana, alongside key international contributors, this gathering serves as a premier venue for evaluating the fate, exposure, and ecotoxicology of plant protection products. Today's landscape of pesticide science is rapidly advancing through high-resolution analytical surveillance, multi-scale environmental fate modeling, precision application technologies, and sophisticated risk assessment frameworks.

The primary aim and scope of the symposium center on creating an interdisciplinary platform where academic researchers, regulatory authorities, and industry experts can bridge the gap between scientific innovation and policy implementation. By examining chemical dynamics across air, soil, and water, assessing non-target impacts, and evaluating novel technology integration, the symposium aims to refine safety paradigms and accelerate the adoption of sustainable agricultural practices worldwide.

To achieve these goals, the scientific program is structured across four dedicated sessions that address the lifecycle and impact of plant protection products. The first session focuses on pesticide behavior and monitoring in air, soil, water, and non-target organisms, highlighting high-resolution mass spectrometry and compound-specific isotope analysis to track chemical fate and legacy pollutants. The second session advances predictive exposure and effect modeling across multi-scale scenarios, integrating mechanistic tools and dynamic models to capture landscape-level transport. The third session explores new frontiers in application technology and mitigation, evaluating precision drift control, spot-spraying, and advanced oxidation techniques to reduce environmental loads. Finally, the fourth session targets policy uptake and governance, translating empirical data into harmonized indicators, environmental monitoring networks, and adaptive regulatory frameworks for sustainable risk management. Ultimately, synthesising these four dimensions demonstrates that advancing pesticide science requires a holistic approach, where field-level observations directly inform predictive models, technological innovations reduce environmental loads, and robust evidence shapes adaptive policy. The proceedings compiled in this volume reflect this integrated trajectory, offering a comprehensive scientific foundation to guide future research, regulatory decisions, and field application strategies toward true agricultural sustainability.

Diego Voccia, Leilei Zhang, Veronica Ferrari

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PRESENTERS

SESSION I – PESTICIDES MONITORING AND BEHAVIOR IN AIR, SOIL AND WATER AND NON-TARGET ORGANISMS.

Chairs: Luigi Lucini, Dimitrios Karpouzas

This session focuses on how pesticides and their transformation products are detected, transported, transformed, and retained in environmental compartments such as air, soil, surface water, groundwater, sediments, and biota. A major theme is the improvement of monitoring strategies through advanced analytical methods, including LC-HRMS, targeted and untargeted screening, passive samplers, and compound-specific isotope analysis. Several contributions show that conventional monitoring often misses unexpected metabolites, legacy compounds, or short-term contamination peaks. Case studies from Austria, France, Norway, Belgium, North America, and other regions highlight the persistence of pesticides in soils, rainfall, groundwater, orchards, railway soils, and small agricultural water bodies. The session also emphasizes the importance of transformation products, which can be more mobile or persistent than parent compounds. Contributions on chlordecone, atrazine, toltrazuril, copper, microplastics, and dazomet/MITC show how soil properties, temperature, degradation, sorption, formulation, and co-contaminants influence environmental fate. Overall, the session argues for more harmonized, long-term, and multi-compartment monitoring systems that can better support environmental risk assessment and policy decisions.

KEYNOTE LECTURE

COMPREHENSIVE PESTICIDE MONITORING IN FOOD AND FEED: INTEGRATING TARGETED AND UNTARGETED ANALYSIS

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Presenter Ivan Aloisi

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OBJECTIVES

- Development and application of a single analytical method enabling targeted quantitative analysis and non-targeted qualitative screening of pesticides from a single data file.
- Demonstrate the advantages of LC-HRMS for simultaneous targeted quantification and non-target pesticide screening.

HIGHLIGHTS

- Description on the current state-of-the-art analytical approach for combined quantitative determination of frequently found pesticides and qualitative screening for 1000+ others in food and feed
- Detection of unexpected pesticides, other food toxicants, and metabolites beyond routine monitoring scope.
- Discussion of current challenges on implementation of LC-HRMS in routine laboratories.

INPUT OF PLANT PROTECTION PRODUCTS INTO GROUNDWATER VIA BANK FILTRATION: A REVIEW

Uta Ulrich, Lukas P. Loose, Anna Wendell, Nicola Fohrer

Presenter Uta Ulrich

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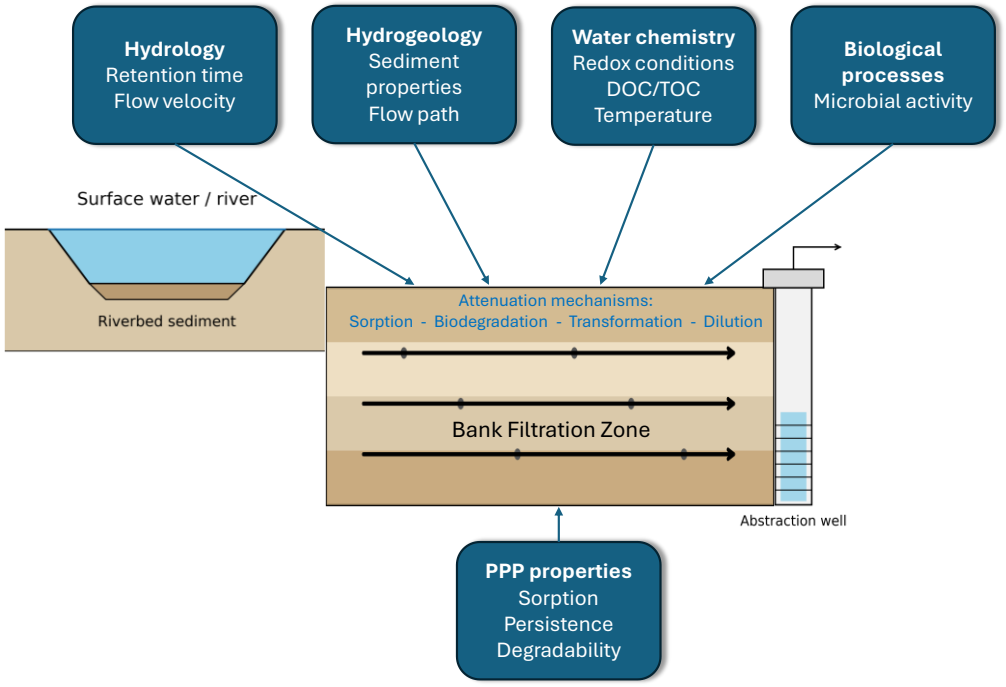
OBJECTIVES

- Review the current evidence on the transport of plant protection products (PPPs) from surface water to groundwater through bank filtration (BF).
- Compile and evaluate reported bank filtration rates (BFRs) for PPPs based on field and laboratory studies.
- Identify the main hydrogeological, hydrological, physicochemical and biological factors controlling PPP retention during BF.
- Assess the current state of knowledge and methodological limitations affecting the prediction of BF effectiveness for groundwater protection

HIGHLIGHTS

- A systematic review of 174 peer-reviewed field and laboratory studies was conducted.
- Reported retention of PPPs during BF was highly variable, with BFRs ranging from –125% (concentration increase) to +100% (complete retention) for individual active substances.
- Retention was influenced by multiple interacting factors, including retention time, flow distance, subsurface properties, flow velocity, hydrometeorological conditions, PPP properties, inflow concentrations, temperature, redox conditions, DOC/TOC, and microbial activity.
- Strong interdependencies among controlling factors hinder the identification of individual cause–effect relationships.
- Methodological heterogeneity among studies limits comparability and introduces uncertainty into groundwater risk assessments.



Conceptual Framework of Pesticide Fate during Bank Filtration

COMPOUND-SPECIFIC ISOTOPE ANALYSIS FOR ASSESSING BIODEGRADATION OF ORGANIC CONTAMINANTS IN AQUATIC ENVIRONMENTS: A LITERATURE-BASED REVIEW

Mattia Rossi, Diego Voccia, Lucrezia Lamastra, EnricoMaria Selmo, Paola Iacumin, Marco Bartoli

Presenter Mattia Rossi

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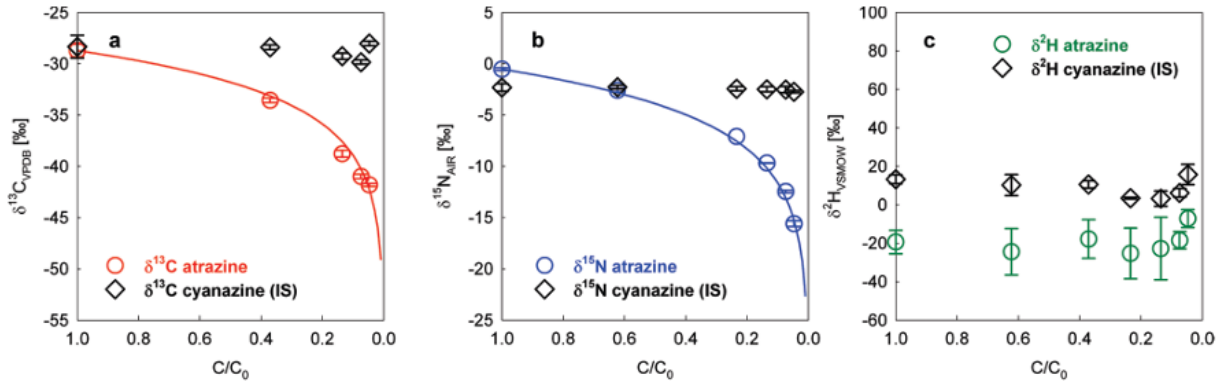
OBJECTIVES

- To compile and critically analyze published data on the biodegradation of pesticides in aquatic environments using Compound-Specific Isotope Analysis (CSIA).
- To evaluate how environmental parameters such as temperature, salinity, and pH influence isotope fractionation and biodegradation kinetics of organic contaminants.
- To develop a structured literature-derived database of isotope fractionation factors, providing a reference tool for interpreting CSIA data and improving the assessment of contaminant degradation in water systems.

HIGHLIGHTS

- Compound-Specific Isotope Analysis (CSIA) is a key tool for distinguishing biodegradation from non-degradative processes in organic contaminant fate studies [1].
- Isotope fractionation during microbial transformation of organic pollutants provides quantitative constraints on reaction mechanisms and pathways [2].
- Environmental factors such as temperature, pH, and redox conditions can significantly affect isotope fractionation and must be accounted for in data interpretation [3].
- Literature-based isotope fractionation datasets improve the reliability of CSIA applications for contaminant source identification and degradation assessment [4].
- The integration of CSIA into environmental studies improves our ability to understand contaminant behavior and assess degradation pathways in complex aquatic systems. [5].



Isotope fractionation during atrazine direct photolysis at λ 254 nm. Panels a, b, and c, show the evolution of the $\delta^{13}C$, $\delta^{2}H$, and $\delta^{15}N$ values vs the remaining fraction of atrazine (circles). Cyanazine (internal standard, IS, diamonds) [6].

REFERENCES

[1] M. Elsner, L. Zwank, D. Hunkeler, and R. P. Schwarzenbach, "A new concept linking observable stable isotope fractionation to transformation pathways of organic pollutants," Environmental Science & Technology, vol. 39, no. 18, pp. 6896–6916, 2005, doi: 10.1021/es0504587.

[2] M. Elsner, "Stable isotope fractionation to investigate natural transformation mechanisms of organic contaminants: principles, prospects and limitations," Journal of Environmental Monitoring, vol. 12, no. 11, pp. 2005–2031, 2010, doi: 10.1039/C0EM00277A.

[3] M. Elsner and G. Imfeld, "Compound-specific isotope analysis (CSIA) of micropollutants in the environment—current developments and future challenges," Current Opinion in Biotechnology, vol. 41, pp. 60–66, 2016, doi: 10.1016/j.copbio.2016.05.002.

[4] M. A. Jochmann, T. B. Hofstetter, and M. Elsner, "Current challenges in compound-specific stable isotope analysis of environmental organic contaminants," Analytical and Bioanalytical Chemistry, vol. 403, pp. 217–235, 2012.

[5] T. B. Hofstetter, R. Bakkour, D. Buchner, H. Eisenmann, A. Fischer, M. Gehre, S. B. Haderlein, P. Höhener, D. Hunkeler, G. Imfeld, M. A. Jochmann, S. Kümmel, P. R. Martin, S. G. Pati, T. C. Schmidt, C. Vogt, and M. Elsner, "Perspectives of compound-specific isotope analysis of organic contaminants for assessing environmental fate and managing chemical pollution," Nature Water, vol. 2, no. 1, pp. 14–30, Jan. 2024, doi: 10.1038/s44221-023-00176-4

[6] A. E. Hartenbach, T. B. Hofstetter, P. R. Tentscher, S. Canonica, M. Berg, and R. P. Schwarzenbach, "Carbon, Hydrogen, and Nitrogen Isotope Fractionation During Light-Induced Transformations of Atrazine," Environmental Science & Technology, vol. 42, no. 21, pp. 7751–7756, Nov. 2008, doi: 10.1021/es800356h.

PASSIVE SAMPLERS TO FACILITATE THE ASSESSMENT AND MONITORING OF CONTAMINATION IN FRESHWATER ENVIRONMENTS

Christelle Margoum, Benoit Sarrazin, Yannick Boissieux, Anae Degache, Alexandra Gruat, Céline Guillemain, Thibaud Pandelakis, Véronique Gouy-Boussada

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OBJECTIVES

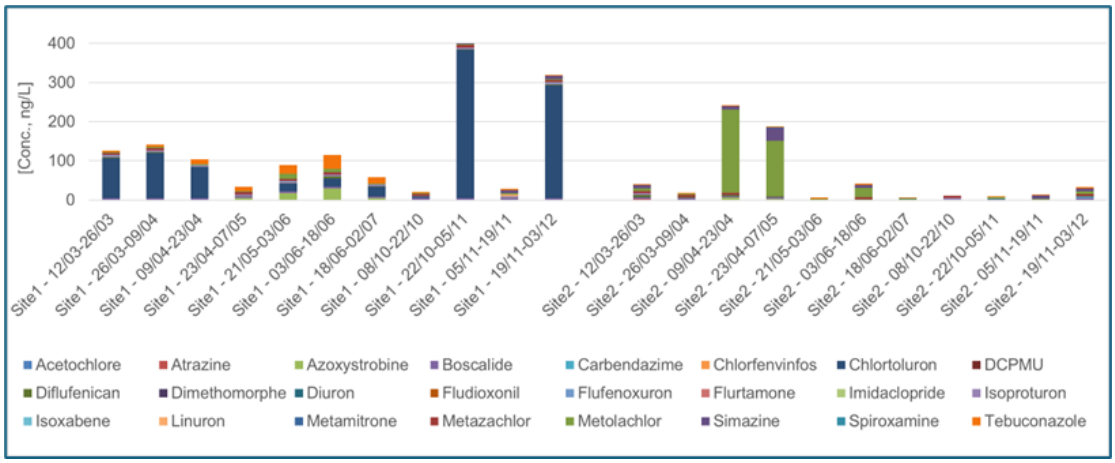
- Monitor the effects of land-use management in small agricultural watersheds and of implemented agri-environmental measures on water quality.
- Assess the relevance and feasibility of using user-friendly integrative passive samplers, such as small composite silicone rods PACSiR [1], to obtain a better integrated overview of the spatial and temporal contamination of aquatic environments by various agricultural pesticides.

HIGHLIGHTS

- PACSiR integrative samplers are particularly useful for accurately and easily assessing the average concentration of pesticides in water.
- PACSiR samplers are deployed continuously on-site, collected every two weeks, and the ones to be analyzed are selected retrospectively based on hydrological measurements and growing seasons.
- The implementation of PACSiR samplers combined with LC-MSMS analysis allowed to reach limits of quantification lower than 1 ng/L for pesticides in water.
- Compared with spot water samples, the PACSiR integrative sampler makes it possible to detect and quantify a greater number of pesticides with a wide range of physicochemical properties.
- The ability to store and to select samples for analysis retrospectively allows for more targeted analyses and reduced costs for long-term monitoring.

- A three-year monitoring program at four sites in the Dombes region (France) has revealed a relationship between the presence of pesticides and land use, as well as with the ban on the use of certain active substances.

PACSiR rod attached to its hand-made support before being placed in a ditch equipped with a flow measurement flume



Overview of spatio temporal variability of the cumulative concentrations of pesticides accumulated on PACSiR rods on two sites and over different deployment periods within a year

REFERENCES

[1] A. Martin, C. Margoum, M. Coquery, J. Randon, "Combination of sorption properties of polydimethylsiloxane and solid-phase extraction sorbents in a single composite material for the passive sampling of polar and apolar pesticides in water", J. Sep. Sci., 39, 2016,
doi: 10.1002/jssc.201600502

NOVEL HRMS APPROACHES FOR IDENTIFYING TRANSFORMATION PRODUCTS OF THE ANTIPARASITIC TOLTRAZURIL, COMBINED WITH PREDICTIVE TOOLS TO ASSESS THEIR ENVIRONMENTAL FATE

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Presenter Venetios Michelioudakis

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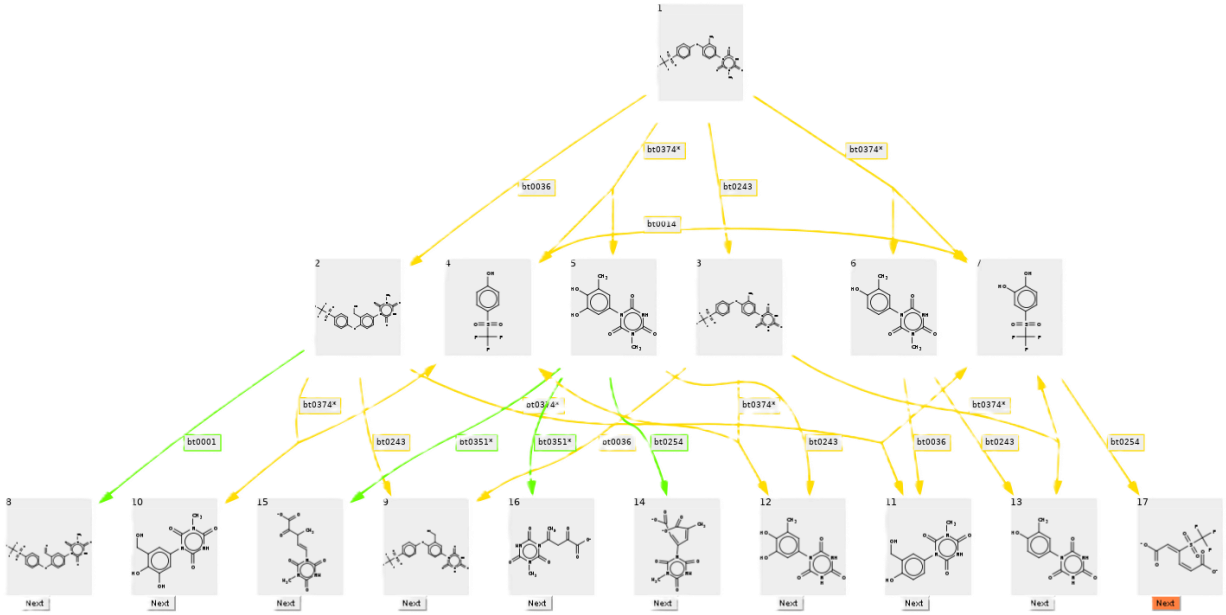
OBJECTIVES

- Identify toltrazuril transformation products (TPs) using HRMS and in silico tools.
- Assess environmental and biological impacts of toltrazuril and its TPs.

HIGHLIGHTS

- HRMS suspect & non-target screening revealed toltrazuril TPs.
- CFM-ID, SIRIUS & prediction tools supported TP identification.
- 12 novel TPs identified
- TyPol enabled TP prioritization for environmental risk.



Prediction of plausible TPs starting from toltrazuril using eawag and other software [1] to create a database based on the microbial and abiotic degradation of toltrazuril.

REFERENCES

[1] Kevin Rocco, Christelle Margoum, Loïc Richard, Marina Coquery, Enhanced database creation with in silico workflows for suspect screening of unknown tebuconazole transformation products in environmental samples by UHPLC-HRMS, Journal of Hazardous Materials, Volume 440, 2022

SMALL LENTIC WATER BODIES AS SINKS AND SOURCES OF PESTICIDES AND TRANSFORMATION PRODUCTS IN AGRICULTURAL LANDSCAPES

Lukas Paul Loose, Nicola Fohrer, Uta Ulrich

Presenter Lukas Paul Loose

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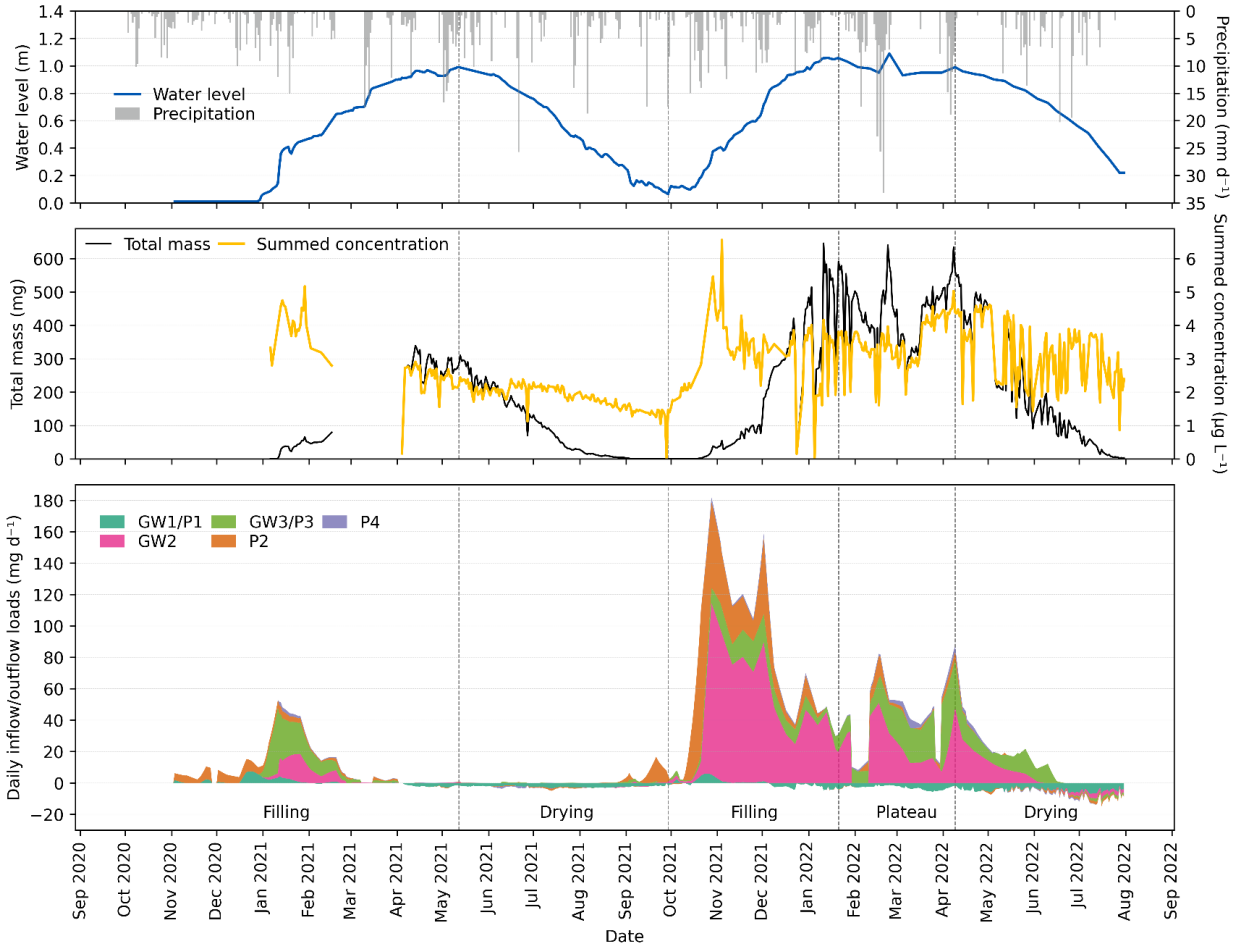
OBJECTIVES

- To characterize the temporal and spatial dynamics of pesticides and transformation products (TPs) in small lentic water bodies embedded in agricultural landscapes.
- To identify contamination patterns and transport pathways of pesticides and TPs by comparing surface water, shallow groundwater, piezometers, and drainage inflows and outflows.

HIGHLIGHTS

- Two-year monitoring revealed strong temporal and spatial variability in pesticide contamination.
- Pesticide and TP concentrations showed pronounced seasonal dynamics.
- Concentration peaks followed pesticide applications and rainfall-driven hydrological events.
- Mobile and persistent TPs, especially from metazachlor and flufenacet, dominated contamination.
- Groundwater, subsurface flow, and drainage pathways were key transport routes.
- Small lentic water bodies acted as both sinks and sources of pesticide loads.



Hydrological and pesticide mass dynamics in lentic small water body (LSWB) S across the monitoring period. The upper part of the figure shows daily precipitation and pond water level. The middle section displays total pesticide concentrations in pond water alongside the calculated total pesticide mass in the pond. The lower section illustrates daily pesticide loads entering (positive) and leaving (negative) the pond via different pathways, including groundwater pipes (GW) and piezometers (P).

PESTICIDE MONITORING IN THE EU NORTHERN ZONE – DATA GAPS AND SUGGESTIONS FOR IMPROVEMENTS

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Presenter Lotta Katia

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OBJECTIVES

- provide an overview of pesticide monitoring in the EU Northern Zone (NZ) countries
- highlight progress and remaining challenges compared with a review conducted ten years ago
- improve the comparability of information on pesticide sales, use and environmental residues
- identify data gaps affecting the assessment of the environmental risks of pesticide use

HIGHLIGHTS

- Pesticides are used less in Northern Zone (NZ) countries than in other parts of Europe. Usage levels are relatively similar across the NZ countries.
- Inconsistent monitoring of pesticide residues in the environment limits the availability of reliable and comprehensive information needed for evidence-based policymaking.
- Without consistent and harmonized monitoring of pesticide residues, early warning signs may go unnoticed, and our understanding of long-term environmental impacts remains limited.
- National project-based data cannot replace systematic monitoring for policy decision-making.
- Data gaps hinder the assessment of the risks of pesticide use across Europe.

PESTICIDES IN AIR AND SOIL IN AUSTRIA

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Presenter Wolfgang Friesl-Hanl

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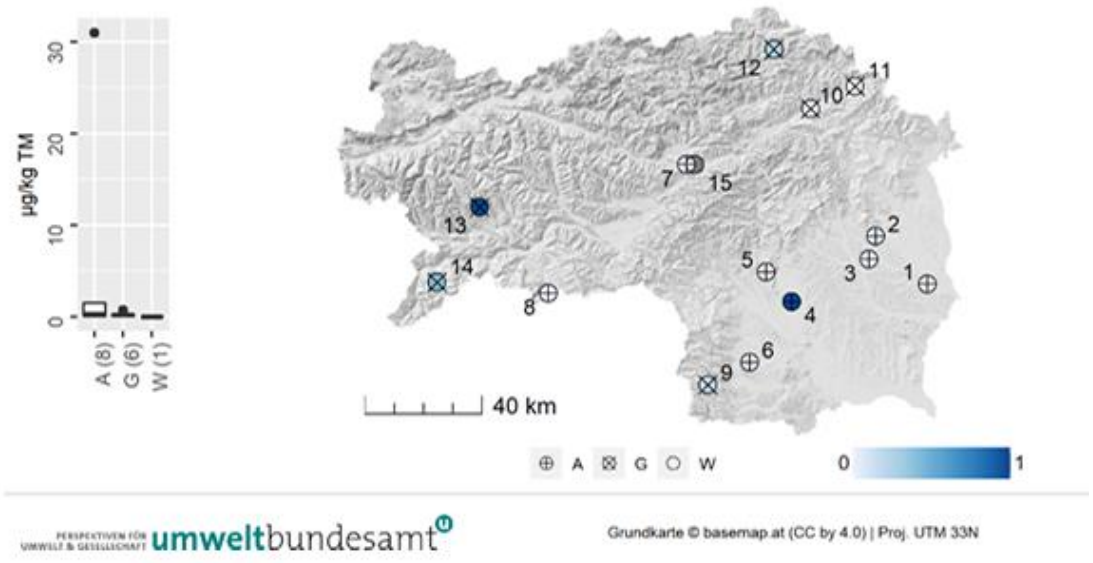
OBJECTIVES

- Providing an overview of pesticide monitoring activities in Austria and presenting results from recent investigations in AIR and SOIL.
- Demonstrating the occurrence of both currently used pesticides and legacy pollutants, such as DDT and HCB, in different environmental compartments.
- The presentation also aimed to support future monitoring strategies by identifying knowledge gaps and discussing priorities for long-term environmental surveillance.

HIGHLIGHTS

- Air monitoring in 2024 detected 47 active substances and 4 metabolites, including several pesticides that are no longer approved for use.
- The AustroPOPs project confirmed the presence of persistent organic pollutants as well as selected currently used pesticides in Austrian agricultural and forest soils.
- Comparison with MONARPOP results showed that persistent pesticides can still be detected decades after their application underlining their long-term environmental relevance.



Pendimethalin (left) and the sites investigated in Styria (right). Pendimethalin in arable soil (A), grassland (G) and forest soil (W). Pendimethalin levels on the map are displayed normalized within the land-use classes. Source: BMLRT, 2021.

REFERENCES

[1] Umweltbundesamt, 2024: Friesl-Hanl, W., Moche, W., Steinbichl, Ph., Uhl, M., "Pestizide in der Umgebungsluft – Standorte in Oberösterreich, in der Steiermark und in Salzburg". Report REP-0946.
https://www.umweltbundesamt.at/fileadmin/site/publikationen/rep0946.pdf

[2] Federal Ministry for Agriculture, Regions and Tourism – BMLRT, 2021. Tulipan, M., Friesl-Hanl, W., Offenthaler, I. and Scharf, S., "Forschungsprojekt AustroPOPs – Endbericht; Monitoring von organischen Schadstoffen in Böden Österreichs".
https://dafne.at/content/report_release/bea784df-f3d8-419a-859e-85ad1901c8cf_0.pdf

[3] Federal Ministry for Agriculture, Forestry, Environment and Water Management - BMLFUW 2008: Offenthaler, I., Moche, M., Uhl, M., Weiss, P., et al., "MONARPOP – Technical Report", ISBN 3-902338-93-8.
https://www.researchgate.net/publication/261251584_MONARPOP_Technical_Report

POSTER CONTRIBUTIONS – SESSION I

FROM NER FORMATION TO RISK ASSESSMENT: A FOUR POOL KINETIC TOOL FOR REGULATORY EVALUATION

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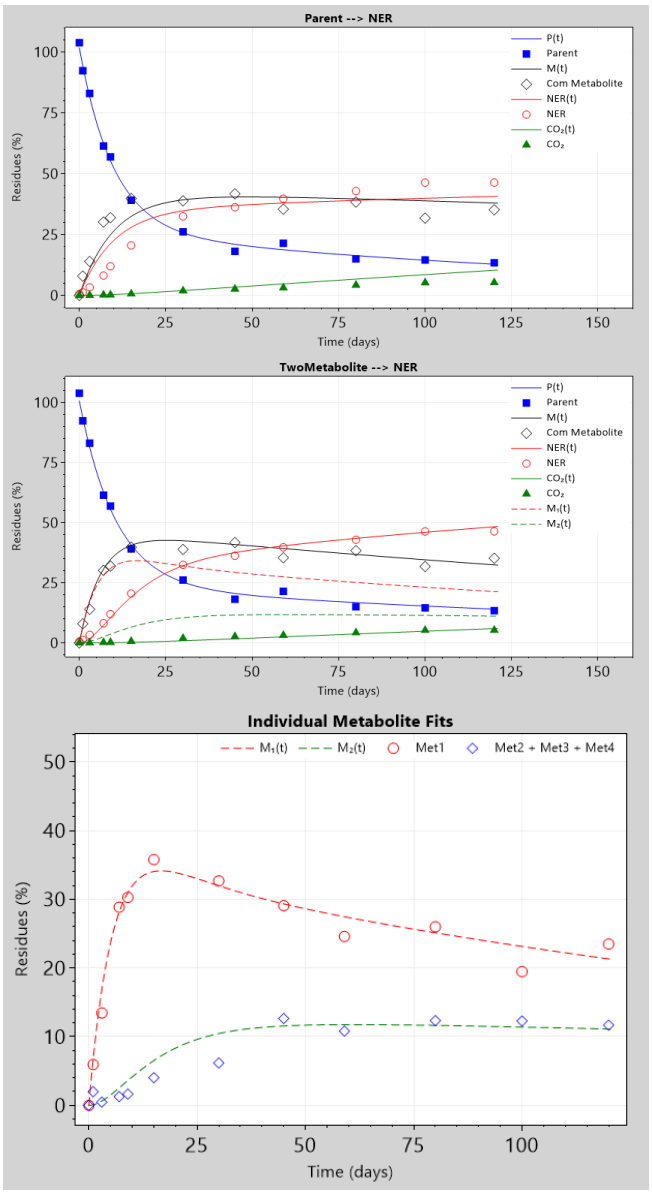
OBJECTIVES

- Develop an analysis tool based on the four-pool kinetic framework to support interpretation of NER data from OECD 307 studies.
- Identify compounds that kinetically drive NER formation.
- Support more targeted evaluation of NER relevance in environmental fate and ecotoxicological risk assessment.

HIGHLIGHTS

- A dedicated tool based on a refined four-pool kinetic framework [1] was developed for analysis of OECD 307 studies.
- Distinction between parent-driven and metabolite-driven NER enables identification of key contributors. The tool supports identification of compounds that kinetically drive NER formation.
- The approach improves interpretation of NER relevance for persistence and risk assessment using existing studies. The method is compatible with current regulatory frameworks and strengthens weight-of-evidence evaluation.



Kinetic fits illustrating parent → NER (top) and metabolite → NER (middle) pathways for an OECD 307 study. Results indicate that NER formation is not driven by the parent compound but is associated with a specific metabolite ("Met1"), as shown in the individual metabolite fit (bottom).

REFERENCES

[1] Huang, X.M., Lynn, K., Cryer, S., Wijntjes, C., 2024. Identifying bound compounds in non-extractable residues of pesticides in soil by 4-pool kinetic analysis. Sci. Total Environ. 955, 176814., doi: https://doi.org/10.1016/j.scitotenv.2024.176814

VARIATION OF CHLORDECONE SORPTION AND DESORPTION PROPERTIES FOLLOWING SOIL VARIATION IN A TROPICAL VOLCANIC ISLAND

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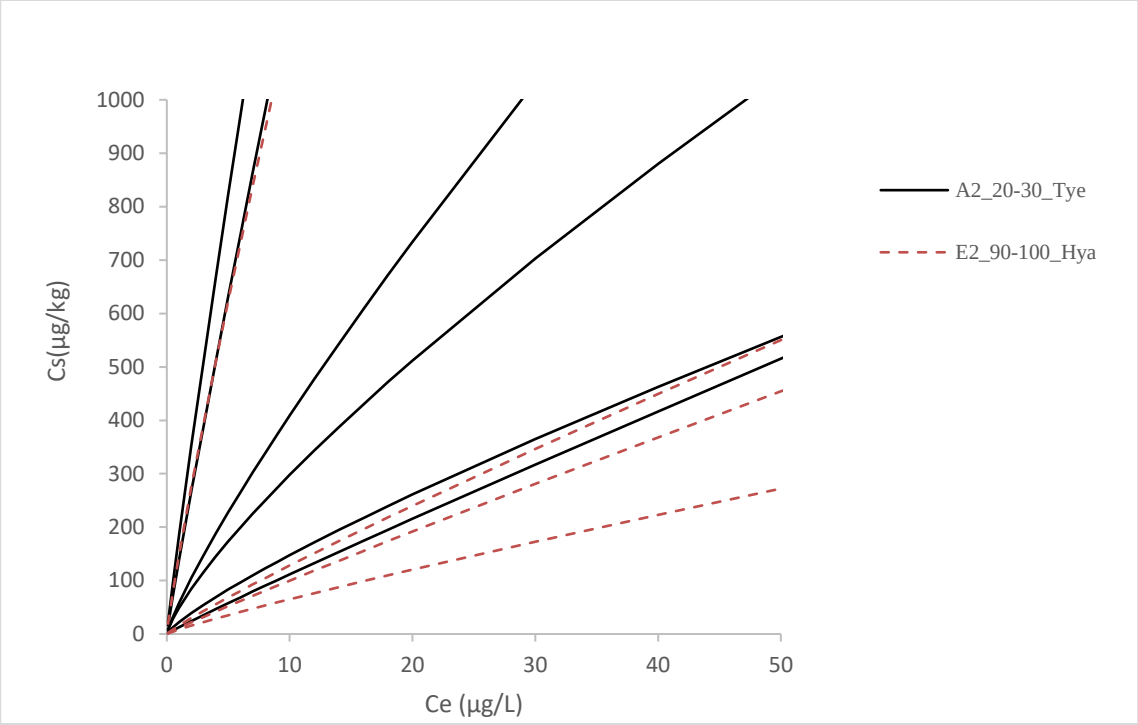
OBJECTIVES

- Learn more about the drivers of the large variability of sorption coefficients of chlordecone (CLD) in tropical volcanic soils.

HIGHLIGHTS

- Ten soils were collected along an Andosol-Nitisol toposequence in the south of the island of Basse-Terre (Guadeloupe -French West Indies), an area highly impacted by chlordecone contamination. The characterization of their pedological properties showed a high heterogeneity covering a wide range of organic matter contents, and mineralogical composition.
- The measurement of sorption kinetics of CLD revealed two categories of behaviors according to the soil properties. Fast kinetics for soils with high organic carbon content and slower ones in two steps for the others.
- Sorption coefficients measured at equilibrium varied largely between soil types (Kd from 5 to 163 $L.kg^{-1}$). The strong positive correlation with organic matter content was also confirmed. The link with soil mineralogy was furthermore investigated.
- Desorption coefficients also presented a high variability and hysteresis was observed on all samples.



Sorption isotherm of 5 Andosols and 5 Nitisols

EXPERIMENTAL TESTING OF ADSORPTION TO VEGETATION AND PLANT UPTAKE IN DENSE VEGETATION BUFFERS

J. Adam Howe, Rafael Muñoz-Carpena, Robin Sur

Presenter Rafael Muñoz Carpena

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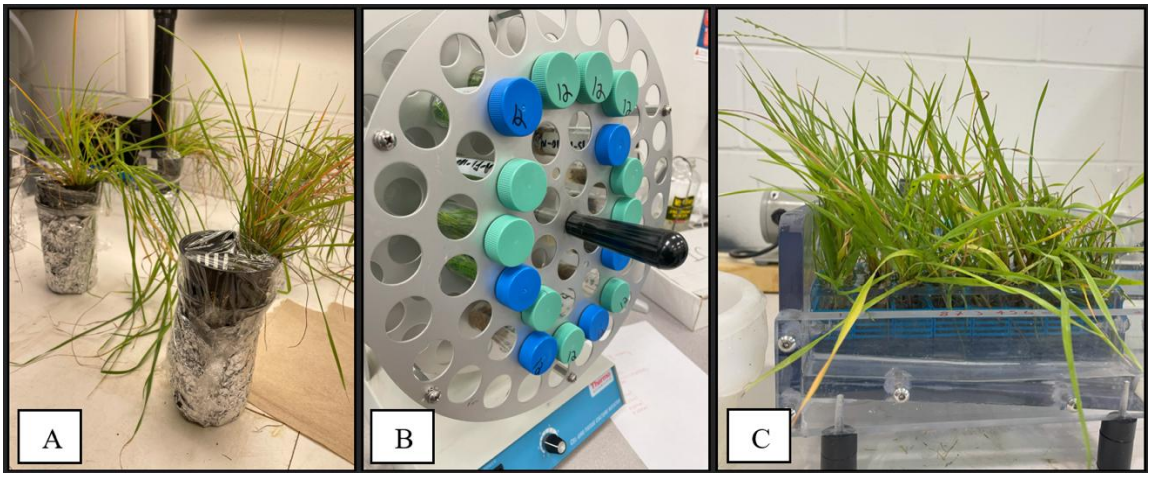
OBJECTIVES

- Test the assumption in VFSMOD that adsorption to vegetation surfaces is a negligible sink for dissolved chemicals in surface flow through a VFS[2,3].
- Test the assumption in VFSMOD that plant uptake is a negligible sink of pesticides between events.

HIGHLIGHTS

- Plant adsorption kinetics and isotherms were determined in batch reactors and flow cells, and uptake factors were determined in a hydroponic setup[1].
- Mesoscale lab-based VFS experiments were used to determine adsorption to vegetation and plant uptake under realistic, dynamic multi-event conditions.
- Batch plant sorption tests reached equilibrium quickly (~1 h) with Freundlich behavior converging to linear (n=1) indicating that instantaneous linear isotherms are sufficient.
- Neglecting adsorption to aboveground vegetation overestimated observed runoff concentrations by 0.24 -12.4%.
- Transpiration Stream Concentration Factor (TSCF) ranged from 0.30 – 1.4, which overestimated observed uptake by 2–9x.
- Adsorption to aboveground biomass and plant uptake contributed <1% of input mass to trapped residues, a total effect smaller than uncertainties in other processes, which supports their exclusion from VFSMOD.



A. Hydroponic apparatus for quantifying pesticide uptake; B. Batch reactors for quantifying equilibrium adsorption isotherms and adsorption kinetics; C. Flow cell for quantifying adsorption in a dynamic flow scenario

REFERENCES

[1] M. Lamshoeft, Z. Gao, H. Resseler, C. Schriever, R. Sur, P. Sweeney, S. Webb, B. Zillgens, and M. U. Reitz, "Evaluation of a novel test design to determine uptake of chemicals by plant roots," *Science of the Total Environment*, vols. 613–614, pp. 10–19, 2018, doi: 10.1016/j.scitotenv.2017.08.314.

[2] R. Muñoz-Carpena, A. Ritter, G. A. Fox, and O. Perez-Ovilla, "Does mechanistic modeling of filter strip pesticide mass balance and degradation processes affect environmental exposure assessments?," *Chemosphere*, vol. 139, pp. 410–421, 2015, doi: 10.1016/j.chemosphere.2015.07.010.

[3] S. Reichenberger, R. Sur, C. Kley, S. Sittig, and S. Multsch, "Recalibration and cross-validation of pesticide trapping equations for vegetative filter strips using additional experimental data," Science of the Total Environment, vol. 647, pp. 534–550, 2019, doi: 10.1016/j.scitotenv.2018.07.429.

LONG-TERM LEACHING OF ATRAZINE AND DESETHYL-ATRAZINE FROM RAILWAY TRACKS MORE THAN 30 YEARS AFTER LAST APPLICATIONS

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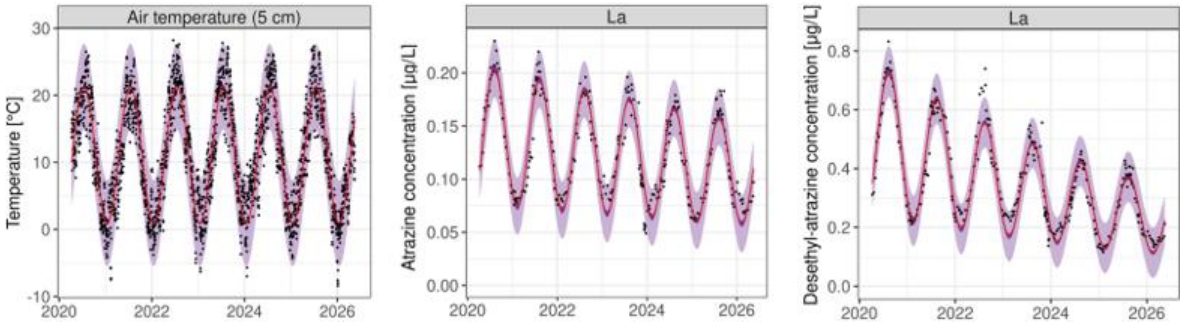
OBJECTIVES

- Investigate the leaching dynamics of aged residues of atrazine and desethyl-atrazine in railway soils using lysimeters
- Modeling of leachate concentrations and estimation of dissipation half-lives

HIGHLIGHTS

- Contaminated material was collected from two sites during railway construction work, placed in two lysimeters each, and exposed to ambient temperatures and rainfall [1]
- Atrazine and desethyl-atrazine were found in leachate at concentrations of 0.05-1.4 µg/L and 0.08-0.83 µg/L, respectively
- Concentrations varied depending on the lysimeter material and showed a pronounced seasonality with higher values in summer and lower values in winter, suggesting that desorption from soil and resulting leaching may be temperature-dependent (see also poster S1P11)
- Over the years, concentrations have been slowly decreasing
- Concentration curves could be described using a sinusoidal model to account for the seasonal variations combined with an exponential term to describe the concentration decline
- Minima and maxima of the fitted curves lag behind those of air temperature (by 26-50 d, depending on substance and the material in the lysimeters)
- Extrapolated dissipation half-lives are in the range of 8–17 years for atrazine and 5–11 years for desethyl-atrazine
- It may therefore take decades for the concentrations in the leachate to fall below the parametric limit value of 0.1 µg/L



Air temperatures (left) and concentrations of atrazine (middle) and desethyl-atrazine (right) in leachate from one of the lysimeters (La), filled with soil from a railway track that had been treated with atrazine more than 30 years ago (dimensions, 0.5 m^2 × 1.4 m). Points represent measured values, red lines simulated values, and the violet range indicates confidence intervals.

REFERENCES

[1] I.J. Buerge, R. Kasteel, and T. Poiger, "Leaching of herbicides and their metabolites in lysimeters filled with soils from railway tracks" *Sci. Total Environ.* 909, 168396, 2024, doi: 10.1016/j.scitotenv.2023.168396.

INFLUENCE OF SORPTION AND DEGRADATION ON THE ACTIVITY OF S-ABSCISIC ACID AS A SOIL-APPLIED BIOHERBICIDE

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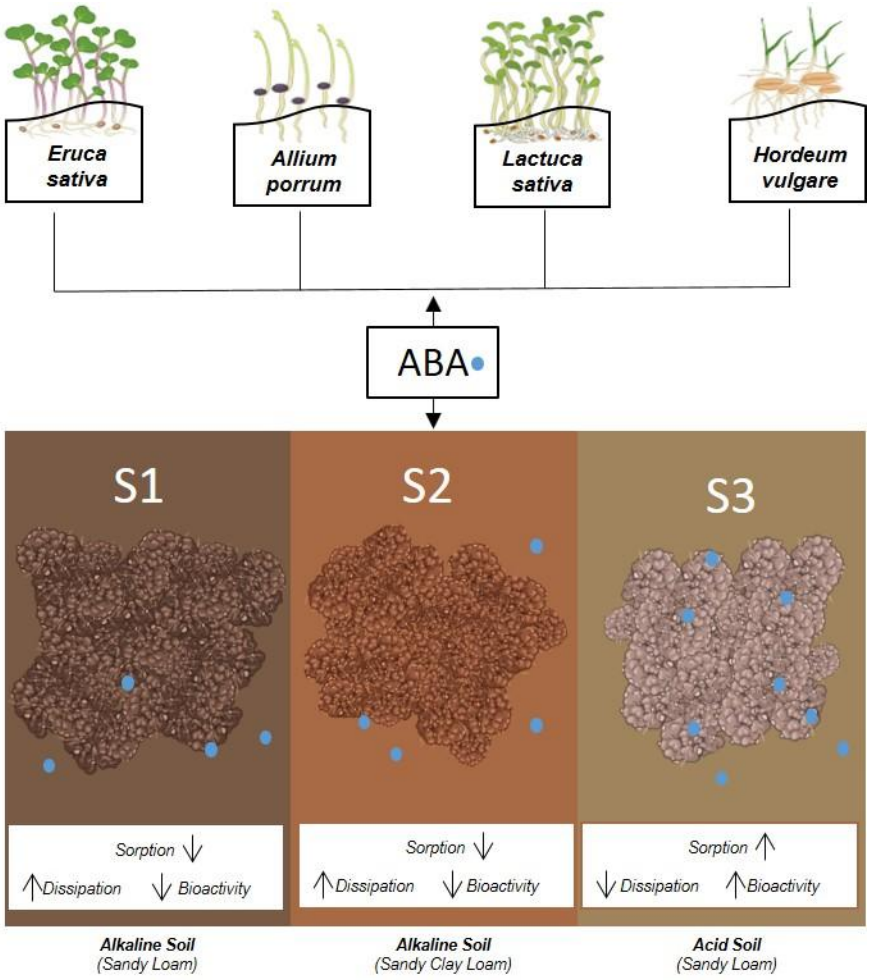
OBJECTIVES

- Assess the behavior of S-ABA in three contrasting soils (two alkaline and one acidic) through the analysis of its sorption and dissipation processes [1].
- Evaluate the germination inhibitory effects of S-ABA on sensitive plant species in relation to its availability in different soils.

HIGHLIGHTS

- Soil properties influenced the behavior and biological activity of S-ABA in three contrasting soils.
- In alkaline soils, S-ABA exhibited low sorption and persistence.
- The acidic soil promoted greater sorption and persistence of S-ABA compared with the alkaline soils.
- S-ABA inhibited the germination of the tested species, with *Eruca sativa* being the most sensitive.
- The inhibitory activity of S-ABA decreased significantly in the presence of soil, with biodegradation being the main process responsible for the loss of activity.



REFERENCES

[1] M. Elsner, L. Zwank, D. Hunkeler, and R. P. Schwarzenbach, "A new concept linking observable stable isotope fractionation to transformation pathways of organic pollutants," Environmental Science & Technology, vol. 39, no. 18, pp. 6896–6916, 2005, doi: 10.1021/es0504587.

[2] M. Elsner, "Stable isotope fractionation to investigate natural transformation mechanisms of organic contaminants: principles, prospects and limitations," Journal of Environmental Monitoring, vol. 12, no. 11, pp. 2005–2031, 2010, doi: 10.1039/C0EM00277A.

[3] M. Elsner and G. Imfeld, "Compound-specific isotope analysis (CSIA) of micropollutants in the environment—current developments and future challenges," Current Opinion in Biotechnology, vol. 41, pp. 60–66, 2016, doi: 10.1016/j.copbio.2016.05.002.

[4] M. A. Jochmann, T. B. Hofstetter, and M. Elsner, "Current challenges in compound-specific stable isotope analysis of environmental organic contaminants," Analytical and Bioanalytical Chemistry, vol. 403, pp. 217–235, 2012.

[5] T. B. Hofstetter, R. Bakkour, D. Buchner, H. Eisenmann, A. Fischer, M. Gehre, S. B. Haderlein, P. Höhener, D. Hunkeler, G. Imfeld, M. A. Jochmann, S. Kümmel, P. R. Martin, S. G. Pati, T. C. Schmidt, C. Vogt, and M. Elsner, "Perspectives of compound-specific isotope analysis of organic contaminants for assessing environmental fate and managing chemical pollution," Nature Water, vol. 2, no. 1, pp. 14–30, Jan. 2024, doi: 10.1038/s44221-023-00176-4

[6] A. E. Hartenbach, T. B. Hofstetter, P. R. Tentscher, S. Canonica, M. Berg, and R. P. Schwarzenbach, "Carbon, Hydrogen, and Nitrogen Isotope Fractionation During Light-Induced Transformations of Atrazine," Environmental Science & Technology, vol. 42, no. 21, pp. 7751–7756, Nov. 2008, doi: 10.1021/es800356h.

A PROPOSAL FOR HARMONIZED GATHERING OF EU SURFACE WATER MONITORING DATA OF PLANT PROTECTION PRODUCT ASSESSMENT

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Presenter Monika Maleri

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OBJECTIVES

Establish a baseline of quality criteria for EU surface water monitoring data on plant protection products (PPPs); addressing current deficiencies and inconsistencies and enabling their reliable use for contextualization and evaluation against environmental quality standards (EQS).

HIGHLIGHTS

- Change is needed to maximise the value of surface water (SW) monitoring data.
- Extensive chemical SW data exists across Europe.
- The WISE database [1] of the European Environment Agency is the only central register but contains only a fraction of the measurements collected by MS.
- Compliance assessment for pesticides with environmental quality standards (EQSs) remains challenging due to limited data accessibility.
- Varying data quality and heterogeneous quality standards across Member States (MS).
- Metadata (e.g., date, coordinates, crop distribution, landscape characteristics, PPP use, urban and industrial emissions) is needed to interpret emission sources and pathways to allow deriving effective risk mitigation strategies to reduce emissions in practice.
- Although EQS derivation follows CIS Guidance 27 [2], values for the same compound often vary across MS (see example in Table 1).

Table 1: EQS values for glyphosate in SW

	CZ[1]	***IE[1]***	***IT[1]***	***SE[1]***	***SI[1]***	***SK[1]***	***UK[2]***	***2026 rev of WFD[3]***
	µg/L							
AA-EQS	*36*	*60*	*0.1*	*100*	*20*	*15*	*196*	*86.7*
MAC-EQS	*--*	*--*	*--*	*--*	*20*	*--*	*398[1] 95%ile*	*398.6*

[1] Extract from EEA WISE, according to RBMP2; [2] National guidance; [3] Freshwater EQS for water not intended for abstraction as drinking water; Directive 2026/805 [3] amending Directive 2000/60/EC [4]

REFERENCES

[1] European Environment Agency, "WISE database, workbook: *WISE_SOW_SWMET_SWRBSP*," *Water Information System for Europe (WISE)*. [Online]. Available: https://water.europa.eu/. [Accessed: Jun. 8, 2026].

[2] European Commission, *Common Implementation Strategy for the Water Framework Directive (2000/60/EC), Guidance Document No. 27: Technical Guidance for Deriving Environmental Quality Standards*, updated version 2018. Luxembourg: Publications Office of the European Union, 2018. doi: 10.2875/018826. [Online]. Available: https://circabc.europa.eu/sd/a/ba6810cd-e611-4f72-9902-f0d8867a2a6b/Guidance%20No%2027%20-%20Deriving%20Environmental%20Quality%20Standards%20-%20version%202018.pdf. [Accessed: Jun. 8, 2026].

[3] European Parliament and Council of the European Union, "Directive (EU) 2026/805 of the European Parliament and of the Council of 30 March 2026 amending Directive 2000/60/EC establishing a framework for Community action in the field of water policy, Directive 2006/118/EC on the protection of groundwater against pollution and deterioration and Directive 2008/105/EC on environmental quality standards in the field of water policy (Text with EEA relevance)," *Official Journal of the European Union*, L 2026/805, Apr. 20, 2026. [Online]. Available: https://eur-lex.europa.eu/eli/dir/2026/805/oj/eng. [Accessed: Jun. 8, 2026].

[4] European Parliament and Council of the European Union, "Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy," *Official Journal of the European Union*, L 327, pp. 1–73, Dec. 22, 2000. [Online]. Available: https://eur-lex.europa.eu/eli/dir/2000/60/oj/eng. [Accessed: Jun. 8, 2026].

THE AGRICULTURAL COCKTAIL EFFECT: HOW MICROPLASTICS ALTER PESTICIDE BEHAVIOR IN SOIL

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OBJECTIVES

- Map Synergy: Evaluate the distinct physical and chemical mechanisms driving microplastic (MP) and pesticide co-contamination.
- Contrast Polymers: Compare traditional Polyethylene (PE) against biodegradable Polylactic Acid (PLA) to prove how plastic type alters environmental risk.
- Quantify Fate: Analyze how plastic aging changes the soil adsorption, leaching potential, and degradation half-lives of target pesticide classes.
- Assess Toxicity: Determine the synergistic impacts of polymer-chemical mixtures on soil health, microflora, and earthworm survival.
- Propose Frameworks: Advance agricultural risk assessment models by integrating highly specific polymer-pesticide interaction variables.

HIGHLIGHTS

- The Combo Matters: Environmental outcomes are not uniform: toxic fate depends entirely on the specific MP polymer and pesticide class pairing.
- PE as a Sponge: Traditional Polyethylene aggressively binds non-polar organophosphates, locking toxins in the soil profile and extending their chemical half-lives.
- PLA as a Disruptor: Biodegradable Polylactic Acid exhibits lower binding but drops local soil pH, completely shifting bacterial communities and accelerating antibiotic resistance.
- The Aging Trap: UV and tillage weathering turn pristine plastic fragments into rough, cracked vectors that absorb up to 2.5x higher pesticide loads.

- Magnified Bio-Toxicity: Ingested plastic particles release concentrated chemical doses inside earthworm guts, causing severe cellular inflammation and stunting crop growth.

REFERENCES

[1] Tang, K.H.D. Effects of Microplastics on Bioavailability, Persistence and Toxicity of Plant Pesticides: An Agricultural Perspective. Agriculture 2025, 15, 356. https://doi.org/10.3390/agriculture15040356
[2] Demirci, O. (2025). Interactions Between Various Classes of Pesticides and Microplastics. International Journal of Agriculture, Environment and Food Sciences, 9 (Special): 321–327. https://doi.org/10.31015/2025.si.31
[3] Qian Pang, Nuohan Xu, Bingfeng Chen, Qi Zhang, Guoyan Qin, Ziyao Zhang, Mengwei Zhang, Rongshe Zhang, Liwei Sun, Tao Lu, Ziang Yao, Haifeng Qian; Assessment of the Effects of Biodegradable and Nonbiodegradable Microplastics Combined with Pesticides on the Soil Microbiota. J. Agric. Food Chem. 12 November 2025; 73 (45): 28678–28688. https://doi.org/10.1021/acs.jafc.5c07598
[4] Peña A, Rodríguez-Liébana JA, Delgado-Moreno L. Interactions of Microplastics with Pesticides in Soils and Their Ecotoxicological Implications. Agronomy. 2023; 13(3):701. https://doi.org/10.3390/agronomy13030701
[5] I. Boughattas, F. Vaccari, L. Zhang, F. Bandini, B. Miras-Moreno, O. Missawi, S. Hattab, M. Mkhinini, L. Lucini, E. Puglisi, M. Banni, Co-exposure to environmental microplastic and the pesticide 2,4-dichlorophenoxyacetic acid (2,4-D) induce distinctive alterations in the metabolome and microbial community structure in the gut of the earthworm Eisenia andrei
Environ Pollut, 344 (2024), Article 123213
[6] Stathis Lagos, Eleni Lamprou, Hongfei Liu, Clemence Thiour-Mauprivez, Joana MacLean, Myriel Cooper, Ayme Spor, Fabrice Martin-Laurent, Matthias C Rillig, Dimitrios G Karpouzas, Interactions of microplastics with pesticides and anthelminthics mediate undesirable effects on microbial nitrogen cycling in agricultural soils, FEMS Microbiology Ecology, Volume 101, Issue 11, November 2025, fiaf104, https://doi.org/10.1093/femsec/fiaf104

STANDARDISING ENVIRONMENTAL MONITORING DATA ANALYSIS: DASHBOARD-DRIVEN APPROACHES FOR WATER QUALITY ASSESSMENT

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OBJECTIVES

Access to publicly available environmental monitoring data has expanded significantly over the past two decades, driven by open-data policies and regulatory requirements such as the Public Access to Environmental Information Directive (2003/4/EC). These datasets are generated by national and regional authorities and water utilities using differing sampling protocols, analytical methods, and reporting standards. As a result, while data availability has increased, variability in structure, scope, and accessibility continues to limit effective integration and use. A key challenge lies in the lack of consistent guidance for environmental monitoring data analysis and interpretation. Regulatory frameworks and authorities apply differing methodologies, assumptions, and thresholds, reducing comparability and reproducibility of outcomes. To address this, we synthesised guidance from multiple regulatory sources across a range of jurisdictions to define a unified framework for data analysis and interpretation. This framework has been implemented within an interactive R-Shiny environmental monitoring dashboard built on the EnviroDataMonitor vB2.0.1 database.

HIGHLIGHTS

The dashboard enables consistent analysis across heterogeneous datasets by standardising analytical workflows and outputs, while providing a range of calculation options aligned with regulatory practices, guidance and reporting in the EU [including the WFD (2000/60/EC), QA/QC Directive (EC 2009/90/EC)], UK (UKTAG, 2013), Switzerland (Schorr et al., 2025), Netherlands (IPLO, 2026), as well as the US (EPA, 2009) and internationally (ISO, 2008).

The options implemented and assessed address, amongst others:

- The calculation of standard WFD and national statistical endpoints (e.g. the UK utilises a 95th percentile for acute risk assessment);
- Utilising non-detect data with options ranging from substitution to non-parametric, semi- and parametric approaches;
- The calculation of confidence thresholds for statistical endpoints;
- The use of time- and flow-weighted data (e.g. in Switzerland);
- A range of default EU and national environmental quality standards included for consideration by users.

The dashboard and the implemented analytical approaches facilitate transparent comparison of results and supports more reproducible and robust chemical risk assessments. By improving consistency and transparency in data analysis, the approach helps reduce variability in interpretation across stakeholders, supporting more robust and defensible decision-making. This work aims to stimulate discussion on best practices for environmental monitoring data analysis and highlights the role of open-source, well-documented methods and tools in improving consistency, transparency, and regulatory applicability.

REFERENCES

[1] EPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance. EPA 530/R-09-007. 888pp.
[2] IPLO, 2026: https://iplo.nl/thema/water/oppervlaktewater/kaderrichtlijn-water/monitoring-krw/monitoringsprogramma-krw/
[3] ISO, 2008. 5667-20: Part 20: ISO 5667-20 First edition 2008-03-15 Guidance on the use of sampling data for decision making — Compliance with thresholds and classification systems. 44pp.
[4] Schorr, J., Ganz, V., Luong, K., Ceppi, E., Longree, P., Beck, B., Singer, H., Barth, S., Doppler, T., Junghans, M., & Holmes, B., 2025. Pestizideinträge in Fliessgewässer. NAWA Spez 2023: Wirkstoffe, Ökotoxikologisches Risiko, diffuse Eintragspfade vs. Einträge aus ARA. *Aqua & Gas*, *105*(10), 70-78.
[5] UKTAG (UK Technical Advisory Group), 2013. Updated recommendations on environmental standards. River basin management (2015–21). 80pp.

REGIONAL MONITORING OF SEMI-VOLATILE CROP PROTECTION PRODUCTS IN RAINFALL ACROSS NORTH AMERICAN AGRICULTURAL LANDSCAPES

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Presenter Hendrik Rathjens

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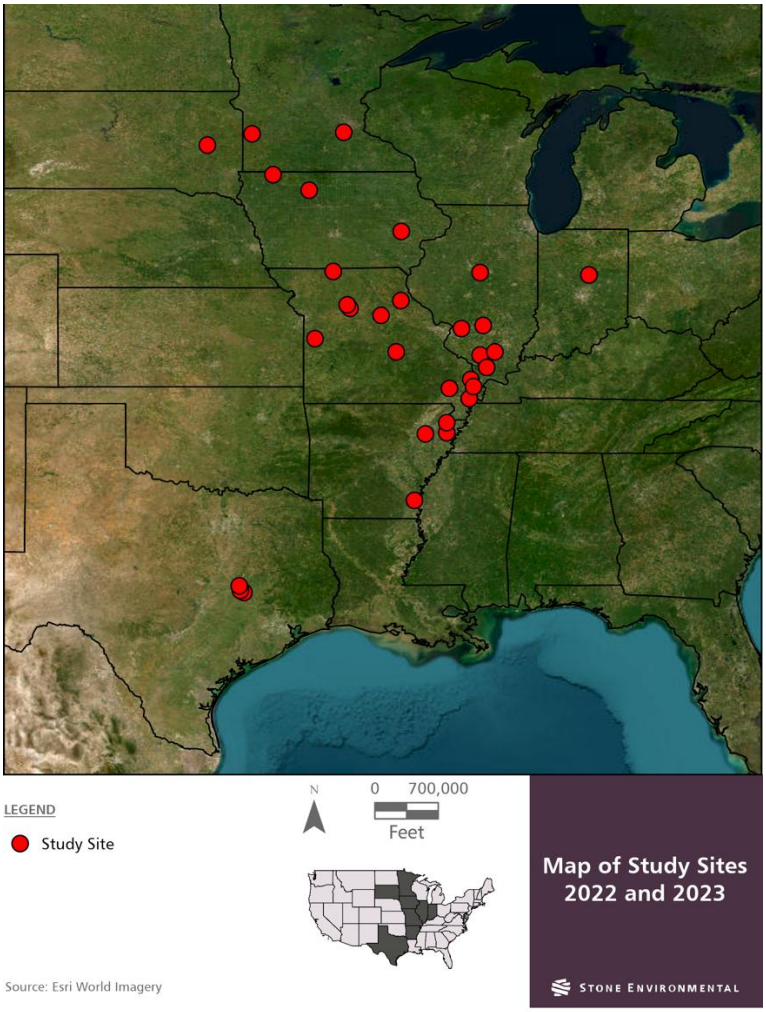
OBJECTIVES

- Deploy and operate a multi-state rainfall monitoring network across six states (Texas, Arkansas, Missouri, Illinois, Iowa, and Minnesota) in 2022 and eight states (Arkansas, Illinois, Indiana, Iowa, Minnesota, Missouri, South Dakota, and Texas) in 2023 to characterize the occurrence of dicamba and 2,4-D in precipitation across agricultural landscapes.
- Implement a combination of novel and previously tested sampling methodologies to generate a spatially and temporally resolved, high-resolution dataset of herbicide residues in rainfall.

HIGHLIGHTS

- There were 24 sites across 6 states in 2022 (12-to-17-week sampling period). 23 sites across 8 states in 2023 (14-to-21-week sampling period).
- 777 and 531 rainfall samples were collected in 2022 and 2023, respectively, using N-CON ADS 00-120 wet deposition samplers and ISCO autosamplers.
- In 2022, samples were collected on a discrete event/day basis. In 2023, this was updated to weekly composites into a single 20 L bottle.
- In 2022, 90th percentile rainwater concentrations were 0.38 µg/L and 0.19 µg/L for dicamba and 2,4-D, respectively.



Rainwater sampling locations across the central United States.

LEACHING OF LEGACY RESIDUES OF ATRAZINE FROM RAILWAY SUBSOIL STRONGLY DEPENDS ON TEMPERATURE

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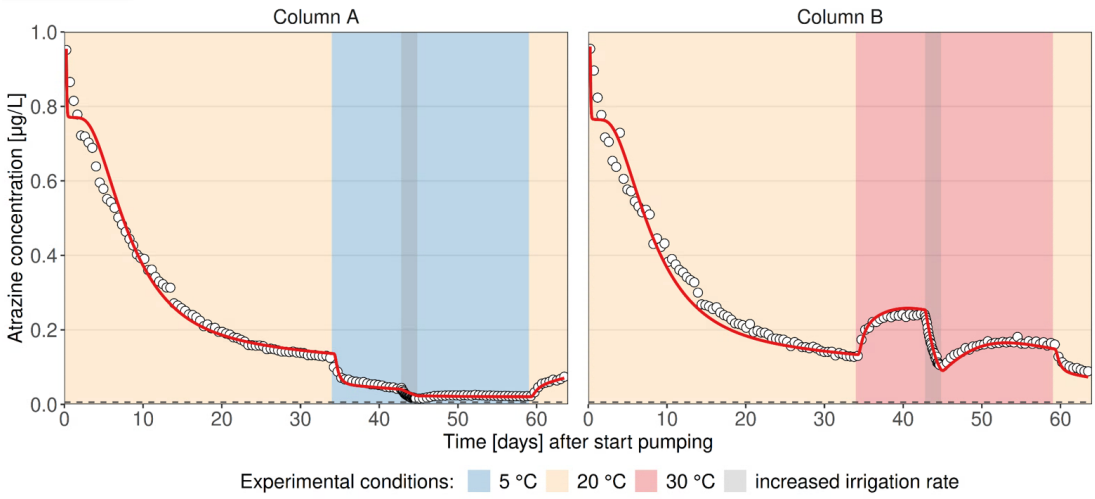
OBJECTIVES

- Understand the influence of temperature and flow rate on the leaching behavior of legacy residues of atrazine in subsoil from an old railway track last treated with atrazine at least two decades back.
- Gain insight into the long-term perspective of the residues in subsoil and their potential to contaminate groundwater.

HIGHLIGHTS

- Leaching of atrazine residues in subsoil from an old railway track was investigated in soil column experiments with two identical columns (5 x 30 cm, D x L) under saturated conditions.
- Soil columns were operated under different temperature (one column at 20 and 5°C , the other at 20 and 30°C) and flow rate (corresponding to precipitation of 37 or 183 mm/day) conditions.
- Concentrations of atrazine (and its metabolites desethyl-atrazine and deisopropyl-atrazine) in leachate were clearly temperature dependent. A change in temperature from 20° to 30°C increased leaching while a change from 20° to 5°C led to a substantial drop in leachate concentration.
- The strong temperature dependence explains the observed seasonality of atrazine concentrations in leachate of lysimeters filled with the same subsoil material [1] (see also poster S1P05).

- an increase in flow rate led to lower atrazine concentrations in leachate, indicating a strong kinetic component in the leaching behavior.
- Preliminary modelling of the leaching experiments with HYDRUS-1D indicates that the leaching behavior can be adequately described with a two-site kinetic sorption model.
- After two months of column operation (equivalent to 2.5 m of precipitation), the residual mass of atrazine and metabolites in the soil was approximately equal to the amount that had leached. This indicates that this material will be a significant source of the substances for many years (see also poster S1P05).



Elution profiles of atrazine from a railway subsoil. Two identical columns were operated under saturated conditions at different temperature and flow regimes. Points represent measured concentrations; the lines are from preliminary fitting of a two-site kinetic sorption model with HYDRUS-1D.

REFERENCES

[1] I.J. Buerge, R. Kasteel, and T. Poiger, “Leaching of herbicides and their metabolites in lysimeters filled with soils from railway tracks” *Sci. Total Environ.* 909, 168396, 2024, doi: 10.1016/j.scitotenv.2023.168396.

PESTICIDES ARE ALL AROUND US - A CASE STUDY FROM ORCHARDS IN WESTERN NORWAY

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OBJECTIVES

- Mapping pesticide exposure in different environmental compartments in orchards in Norway.
- Mapping hoverfly abundance and distribution in flowering vegetation around orchards.

HIGHLIGHTS

Environmental distribution of pesticides in orchard systems in Norway remains poorly characterized. In Norway, pesticide monitoring is conducted through the Norwegian Agricultural Environmental Monitoring Program (JOVA) but limited to five catchments, primarily representing cereals, potatoes, vegetables, and grass production, with orchard systems largely excluded. To address this gap, targeted studies have been conducted since 2019 in a major orchard area in Western Norway. Multiple environmental compartments have been sampled at several locations, included in one organic orchard and analyzed for pesticides and metabolites

Sampling was performed from multiple compartments, e.g. air, insects, water, soil and vegetation

A NATIONWIDE EXPLORATORY CAMPAIGN ON GROUNDWATER QUALITY TO SUPPORT THE REVISION OF THE NATIONAL SURVEILLANCE ORDER: THE CASE OF PESTICIDE METABOLITES (FRANCE)

Nicole Baran, Amine Boukra, Sébatien Bristeau, Charlotte Coureau, Jean-Philippe Ghestem, Clara Leroux, Anne Togola

Presenter Nicole Baran

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OBJECTIVES

- Investigate organic molecules that have been little or not studied, throughout France – with a particular focus on pesticide metabolites as these transformation products, often more mobile and persistent than the parent active substances,
- to provide new insights for the review of the national groundwater monitoring program in accordance with the WFD

HIGHLIGHTS

- At national scale, draw up a consolidated list of molecules to be analyzed (multi-criteria analysis)
- Approximately 100 targeted metabolites
- Development of new analytical methods (LC-MS/MS and IC-MS/MS) for targeted analysis
- Deployment of LC-HRMS approaches for non-targeted analysis
- Build a reusable digital sample bank

INCORPORATING REALISTIC IRRADIATION SCENARIOS INTO LIGHT-ENHANCED WATER-SEDIMENT DEGRADATION FOR REFINED ENVIRONMENTAL EXPOSURE ASSESSMENT

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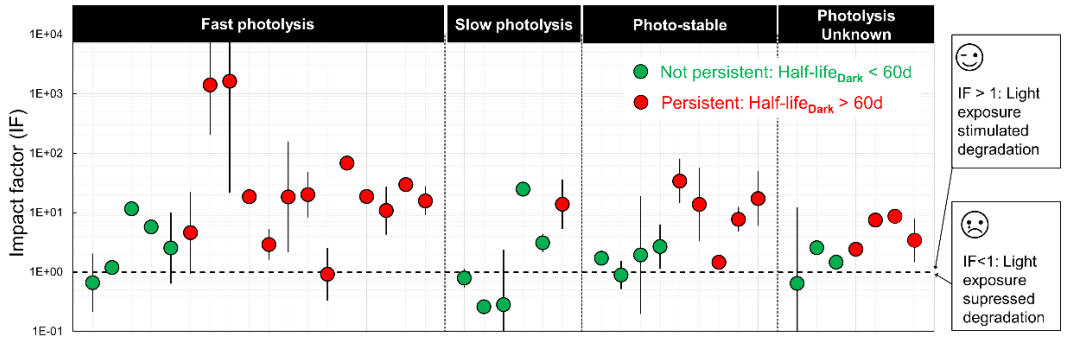
OBJECTIVES

- Leveraging comprehensive experimental efate data from plant protection product (PPP) regulated by EC 1107/2009, we systematically compared degradation half-lives derived from dark and irradiated experimental setups across substances with diverse efate profiles.
- We aim to elucidate light-enhanced degradation in W-S systems and to pave the way toward a more realistic and consistent consideration to incorporate irradiation scenarios in water–sediment studies across different chemicals and regulatory frameworks.

HIGHLIGHTS

- Most PPPs (75%) showed a 2- to >1000-fold enhancement in total system degradation, irrespective of their aqueous photodegradability. This indicates overall light-enhanced biodegradation.
- Light exposure had no impact on the overall efate metabolic profiles.
- We proposed a workflow to define realistic irradiation scenarios (e.g. for EU FOCUS water locations) to pave the way toward a more realistic and consistent consideration to incorporate irradiation scenarios into W-S studies.



Impact analysis of irradiation on total system DegT50 of active substances and metabolites with fast, slow and neglectable aquatic photolysis across all EU submitted CP active substances (AIs). Impact factor (IF)is defined as the ratio of half-lives between dark and irradiated setups.

COPPER IN SOIL AND ITS EFFECTS ON SOIL MICROBIOTA IN ORCHARDS

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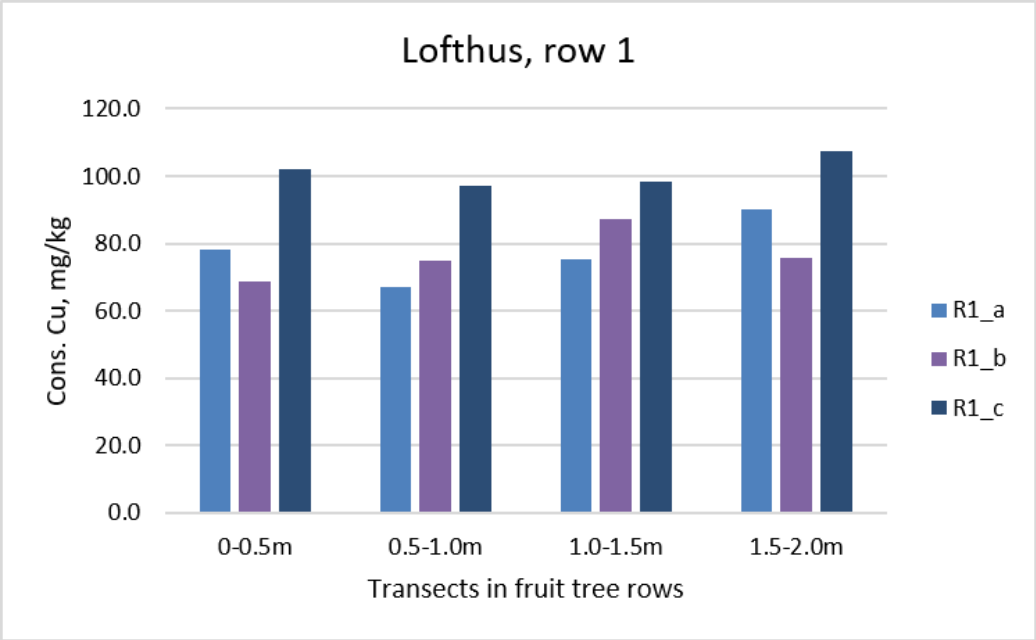
OBJECTIVES

- Mapping Copper concentrations in soil in transects through orchards with varying production intensity.
- Mapping of soil microflora
- Mapping distribution of antimicrobial resistance (AMR) and antimicrobial resistance genes (ARG).

HIGHLIGHTS

Copper is an important fungicide used in both conventional and organic fruit production in Norway and across the world. Copper can, under given conditions, pose a risk to aquatic organisms and has also been shown to be a potential driver of antimicrobial resistance in the environment. Copper is under the threat of being banned as a fungicide in EU, partly due to environmental issues, so mapping and documenting copper concentrations in the environment and possible correlations to shifts in the microbial community or AMR development is important.



Example of copper concentrations in topsoil in downhill transects between a row of apple trees. Three samples were taken 0.5 m apart from the top of the rows (a), in the middle of the rows (b), and at the bottom of the rows (c) respectively.

EVALUATION OF DAZOMET AND MITC EMISSION, AND OCCUPATIONAL EXPOSURE ESTIMATION OF TWO DAZOMET FORMULATIONS DURING SOIL MECHANICAL APPLICATION COMBINED WITH SOIL MULCHING

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Presenter Federico Ferrari

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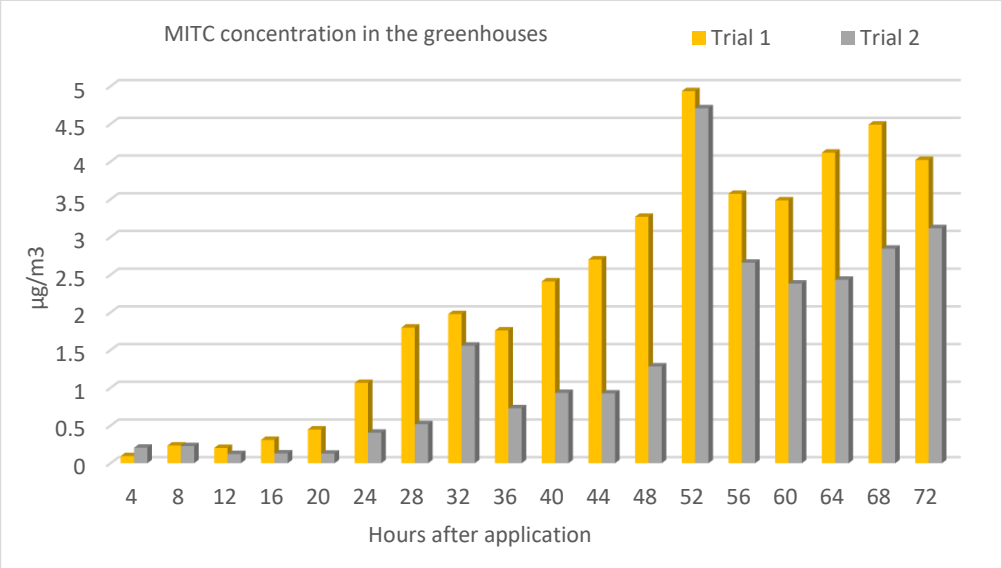
OBJECTIVES

The objective of this study was:

- to assess occupational exposure of the tractor driver and the bystanders to DAZOMET and methylisothiocyanate (MITC), during and after the application of DAZOMET GR (in the Trial 1) and of Basamid Granulat ® (in the Trial 2), both applied at 500 kg/ha through soil mix followed by mulching.
- To compare the Dazomet and MITC emission/dissipation from two formulations
- To measure Dazomet particulate emission from application machinery
- To measure Dazomet particulate emission in air during application in greenhouse and following ground deposition
- To measure MITC vapor emission in air during and after application in greenhouse

HIGHLIGHTS

- In both trials no potential exposure to MITC was measured on the operator
- In the first trial the inhalatory potential exposure to Dazomet was 170 $\mu g/m^3$ while was below LOQ (25 $\mu g/m^3$) in the second trial
- Inside the greenhouses the higher concentration of MITC has ben assessed after 52 hours after application in both trials
- From the data obtained is observed the formulation DAZOMET GR shows higher DAZOMET exposure to worker and higher MITC emission in atmosphere after soil application.



Graph: MITC air concentration in the greenhouses from application until the following 72 hours

REFERENCES

[1] EFSA Journal 2022;20(1):7032 Guidance on the assessment of exposure of operators, workers, residents and bystanders in risk assessment of plant protection products.
[2] EFSA Journal 2010;8(2):1501 Scientific opinion on Preparation of a Guidance on the assessment of exposure of operators, workers, residents and bystanders in risk assessment for plant protection products.
[3] EPA Series 875 Occupational and residential exposure Test Guidelines 875:1000; 875:1300; 875:2500.
[4] C.R. Glass *et al*., EC BCR Information. 2002. The assessment of operator, bystander and environmental exposure to pesticide. Ctr. No. SMT4-CT96-2048.

SESSION II – MODELLING PESTICIDES FATE, EXPOSURE, EFFECTS: MULTI-SCALE ENVIRONMENTAL SCENARIOS AND RECENT DEVELOPMENT

Chairs: Nicoleta Alina Suciu, Bernhard Gottesbüren

Session II is centred on the development, validation, and regulatory use of models for pesticide fate and exposure across multiple spatial scales, from field plots to landscapes and national or European scenarios. The keynote and several contributions discuss recent advances in VFSMOD, SPOTMOD, FLUXMOD, SWAT, GeoPELMO, GeoPEARL, RiceWQ/RivWQ, CATCH, and xLandscape. A recurring issue is how to make models more realistic without losing transparency or regulatory usability. Presentations address macropore flow, drainage, runoff, spray drift, volatilization, vegetated filter strips, rice paddy water management, sediment properties, groundwater vulnerability, and spatially distributed leaching. Many contributions show that exposure estimates are strongly influenced by local soil, climate, hydrology, crop management, and substance properties, and that simple linear scaling is often insufficient. Another important theme is the connection between exposure models and ecological effect models, including TKTD, population, individual-based, and landscape models. The ELINK-2 contributions are especially important because they aim to integrate exposure and effect assessment across small, field, and landscape scales. Overall, this session presents modelling as a bridge between monitoring data, mechanistic understanding, and higher-tier regulatory risk assessment.

KEYNOTE LECTURE

RECENT DEVELOPMENTS IN MEASUREMENT AND SIMULATION FOR PESTICIDE EXPOSURE AND RISK ASSESSMENT

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OBJECTIVES

Assessing pesticide runoff risk increasingly requires linking fine-scale process measurements with mechanistic simulations capable of resolving realistic risk exposure scenarios including conventional field assessments, spatially explicit approaches and new precision agriculture pesticide application conditions. Vegetative filter strips (VFS) provide a rich model system to explore complex dynamics among the soil-water-vegetation-pesticide components. From the systematic analysis of VFS processes and data, new insights into pesticide risk pathways and algorithms can be elucidated and tested that are not only specific to the buffer function but generalizable to other field conditions. This keynote summarizes recent (2025-2026) developments from our group spanning four connected efforts: (i) core numerical and process upgrades to VFSMOD, the vegetative filter strip hydrology, sediment and pesticide-transport model at the foundation of edge-of-field exposure assessment; (ii) SPOTMOD, a new 2D mechanistic framework coupling PRZM, VFSMOD and a TOXSWA metamodel to quantify runoff and predicted environmental concentrations in surface water (PEC_xw) from precision (spot) pesticide applications; (iii) targeted high-resolution mesoscale and hydroponic experiments quantifying VFS vegetation sorption, plant uptake and inter-event remobilization of trapped residues; and (iv) FLUXMOD, a new process-based framework for simulating pesticide volatilization flux from soil. Together, these developments close key gaps between measured process behavior and higher-tier regulatory exposure modeling.

HIGHLIGHTS

- Mesoscale VFS monolith and hydroponic/batch experiments (Howe et al., see other presentations in this Symposium) showed that vegetation adsorption and plant uptake contribute <1% of trapped pesticide mass, supporting their exclusion from VFSMOD [1],[2], while representing drained-to-equilibrium leaching after runoff events improved simulated remobilization of trapped residues from NSE = 0.704 to 0.994 [3],[4].
- VFSMOD core engine (4.6.2.1) incorporates new processes and refinements for realistic assessments: a Freundlich non-linear sorption/leaching solution with secant (chord) retardation, an automatic Courant-based node-selection rule, improved bivariate Petrov-Galerkin stabilization were derived from method-of-characteristics benchmarking, flexible multispecies degradation (parent and products), and sediment/pesticide mass-balance and Green-Ampt infiltration fixes now support the very small buffer segments required by SPOTMOD [5],[6].
- SPOTMOD couples PRZM (treated spots) and VFSMOD (untreated downslope sinks) with a TOXSWA metamodel to derive long-term $PEC_x w$ for precision applications; hydrology was validated against full-field PRZM across the FOCUS R1–R4 scenarios (NSE = 0.927–0.997, PBIAS < 10%) [5],[7].
- CONVISO (Olivares-Rivas et al., see other presentations in this Symposium) applies SPOTMOD to real application/weed maps — scattered thistle infestations in French arable fields, a dense soybean weed pressure map in Ohio, and standard band-application patterns — showing that mechanistic, spatially explicit reduction in runoff exposure departs substantially from a simple linear scaling by treated area.
- Resolutions from the 2024 Piacenza VFSMOD Workshop (Sur et al., see other presentations in this Symposium) have been addressed through a technical report and peer-reviewed publication, and a regulatory guidance/harmonization pathway is now being pursued to broaden VFSMOD's acceptance by EU regulatory authorities [8],[9].
- FLUXMOD (Hong et al., see other presentations in this Symposium), a new mechanistic volatilization framework coupling an application soil leaching component, hourly FAO-56 soil-water dynamics with a resistance-based soil–atmosphere pesticide exchange formulation, reproduced soil moisture (NSE ≤ 0.946) and dicamba volatilization flux (KGE ≤ 0.916) across 23 field trials; global sensitivity analysis identified field capacity, Henry's constant and organic carbon as the dominant controls [10].
- Collectively, these advances demonstrate a validated, measurement-constrained modeling chain — from soil- and plant-scale process data through field-scale runoff and volatilization simulation — that is directly applicable

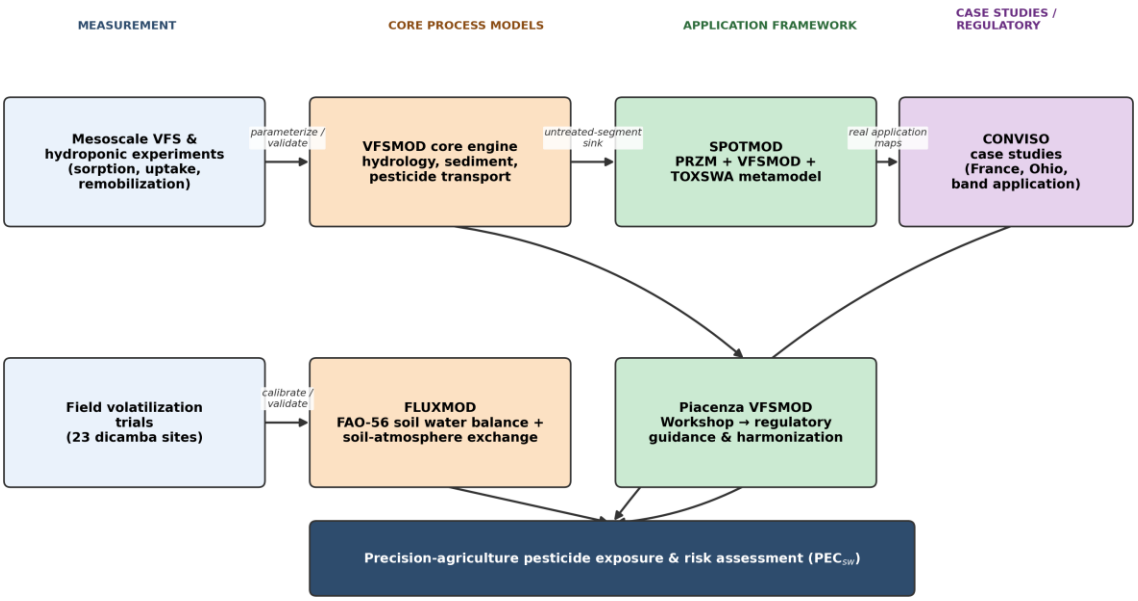

Figure 1. Conceptual linkage of the four efforts summarized in this keynote: mesoscale/hydroponic measurements and field volatilization trials parameterize and validate the VFSMOD core engine and FLUXMOD; VFSMOD underpins SPOTMOD, which is applied to real-world fields through CONVISO; VFSMOD advances also feed the Piacenza Workshop regulatory pathway. All four strands converge on precision-agriculture pesticide exposure and risk assessment (PEC$_x$w).

REFERENCES

[1] M. Lamshoeft, Z. Gao, H. Resseler, C. Schriever, R. Sur, P. Sweeney, S. Webb, B. Zillgens, and M. U. Reitz, "Evaluation of a novel test design to determine uptake of chemicals by plant roots," Science of the Total Environment, vols. 613–614, pp. 10–19, 2018, doi: 10.1016/j.scitotenv.2017.08.314.
[2] S. Reichenberger, R. Sur, C. Kley, S. Sittig, and S. Multsch, "Recalibration and cross-validation of pesticide trapping equations for vegetative filter strips using additional experimental data," Science of the Total Environment, vol. 647, pp. 534–550, 2019, doi: 10.1016/j.scitotenv.2018.07.429.
[3] R. Muñoz-Carpena, A. Ritter, G. A. Fox, and O. Perez-Ovilla, "Does mechanistic modeling of filter strip pesticide mass balance and degradation processes affect environmental exposure assessments?," Chemosphere, vol. 139, pp. 410–421, 2015, doi: 10.1016/j.chemosphere.2015.07.010.
[4] R. Muñoz-Carpena, S. Reichenberger, R. Sur, and S. Sittig, "Complex runoff remobilization of residues trapped in vegetative buffers during long-term exposure assessments: VFSMOD development and analysis," presented at the Pesticide Behaviour in Soils, Water and Air, York, U.K., 2022.
[5] A. Ritter, R. Muñoz-Carpena et al., "VFSMOD Input Definitions, Literature References and Sensitivity Analyses for Evaluating Vegetative Filter Strips in Pesticide Risk Assessment," NC State Center of Excellence for Regulatory Science in Agriculture (CERSA), 2023, doi: 10.5281/zenodo.7789811.
[6] R. Muñoz-Carpena, J. E. Parsons, and J. W. Gilliam, "Modeling hydrology and sediment transport in vegetative filter strips," J. Hydrol., vol. 214, no. 1–4, pp. 111–129, 1999, doi: 10.1016/S0022-1694(98)00272-8.
[7] FOCUS, "FOCUS Surface Water Scenarios in the EU Evaluation Process under 91/414/EEC," EC Document Reference SANCO/4802/2001-rev.2, 245 pp., 2001.
[8] R. Muñoz-Carpena et al., Resolutions from the VFSMOD Workshop, Piacenza, Italy, September 2024, https://zenodo.org/records/17942850.
[9] S. Reichenberger et al., "Update of vegetative filter strip scenarios for pesticide risk assessment in Europe," Science of The Total Environment, vol. 1039, 10 July 2026, 181906, doi: 10.1016/j.scitotenv.2026.181906.
[10] E. D. Sall, K. Huang, N. Pai, A. W. Schapaugh, J. L. Honegger, T. B. Orr, and L. S. Riter, "Quantifying dicamba volatility under field conditions: Part II, comparative analysis of 23 dicamba volatility field trials," J. Agric. Food Chem., vol. 68, no. 8, pp. 2286–2296, 2020, doi: 10.1021/acs.jafc.9b06452.

CRITICAL REVIEW OF CONCEPTUAL APPROACHES TO MACROPORE FLOW IN LEACHING AND DRAINAGE MODELS

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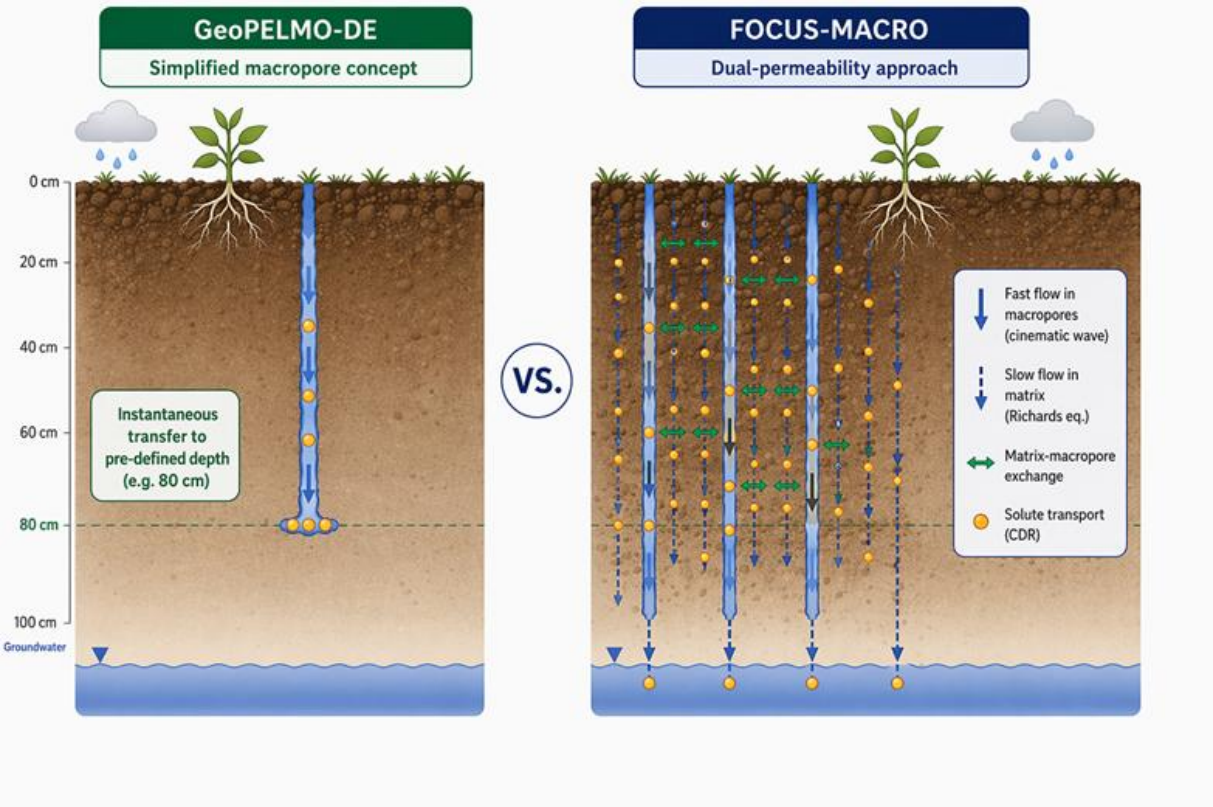
OBJECTIVES

- Description of differences of macropore approaches flow in regulatory models
- Critical evaluation of the different macropore concepts
- Comparison of simulations with the different concepts in GeoPELMO-DE with macropores and FOCUS-MACRO

HIGHLIGHTS

The macropore version of PELMO [1] in the spatially distributed leaching model GeoPELMO DE [2] uses a simplified conceptual macropore approach enabling large-scale assessments with much shorter calculation times compared to FOCUS-MACRO [3]. Key processes (e.g. matrix exchange, degradation in macropores) are not explicitly represented in PELMO. First comparison with MACRO for 9 dummy compounds and 6 regulatory scenarios shows systematic differences in water fluxes and substance concentrations [4]. Largest deviations occur in drainage-driven scenarios. Due to the significant impact on PECgw further testing and validation of macropore flow in PELMO should be carried out before using GeoPELMO-DE for regulatory purposes.



Graphical representation of the macropore flow concepts in GeoPELMO-DE and FOCUS-MACRO.

REFERENCES

[1] M. Klein, PELMO (Pesticide Leaching Model), Version 5.00 – User Manual, Fraunhofer Institute for Molecular Biology and Applied Ecology, Schmallenberg, Germany, Feb. 2020.

[2] M. Klein et al., "Protect groundwater from plant protection products – Spatial distributed leaching modelling to identify agricultural areas with high risk for leaching," Umweltbundesamt, TEXTE 33/2026, Dessau-Roßlau, Germany, 2026. [Online]. Available: https://doi.org/10.60810/openumwelt-8431

[3] M. Larsbo and N. Jarvis, MACRO 5.0 – A model of water flow and solute transport in macroporous soil: Technical description, Swedish University of Agricultural Sciences (SLU), Department of Soil Sciences, Division of Environmental Physics, Uppsala, Sweden, Emergo 2003:6, 2003.

[4] S. Reichenberger, J. Olivares-Rivas, "Preferential Flow in Leaching Models – A Comparative Analysis of the Models PELMO and MACRO," knoell Germany GmbH, Mannheim, Germany, Rep. No. 122289-1, Feb. 2025. [Online]. Available: Zenodo. doi: 10.5281/zenodo. 20693360.

BRINGING RICE CULTIVATION PRACTICES INTO ENVIRONMENTAL RISK ASSESSMENT

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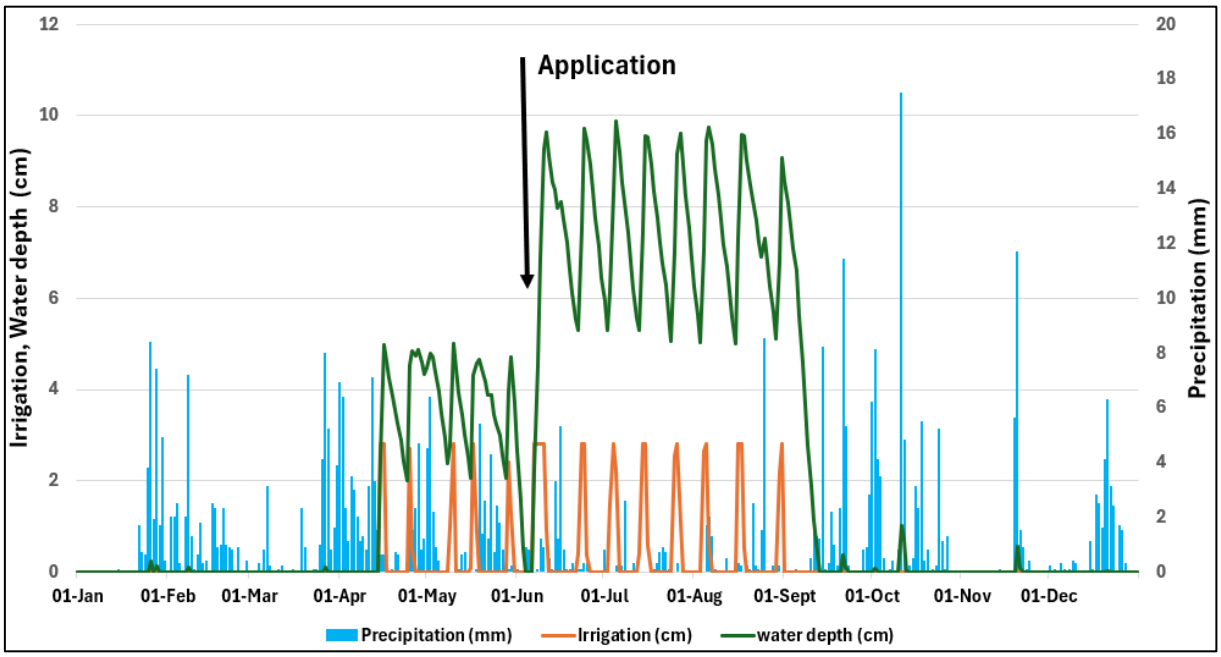
OBJECTIVES

- Evaluate the relevance of current SANCO and draft MedRice scenarios against actual European rice cultivation practices.
- Assess the impact of water management and application timing on exposure estimates.
- Compare exposure estimates derived using MedRice and the coupled RiceWQ/RivWQ modelling approach.

HIGHLIGHTS

- European rice cultivation involves dynamic flooding–drying cycles that are not represented in the static MedRice framework.
- RiceWQ/RivWQ simulations explicitly capture hydrological dynamics, paddy–canal interactions, and metabolite formation and degradation processes.
- PECsw values differ substantially between RiceWQ/RivWQ and MedRice, with larger differences for metabolites than for parent compounds.
- Incorporating regionally representative, dynamic modelling improves the scientific robustness and regulatory relevance of rice ERA.



Precipitation and water-management dynamics for wet-seeded rice under the ICPS cluster 1 scenario for Spain, simulated with RiceWQ (application date: 5 June).

Outcome of the FOCUS SW Repair Stage 2 Testing

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OBJECTIVES

- Perform a systematic evaluation of the FOCUS SW Repair framework across a representative set of substances, crops and application patterns.
- Document exposure outputs under revised modelling concepts and compare them transparently with the legacy FOCUS SW framework.
- Assess differences using percentile-based comparison metrics (52.5^{th}, 77.5^{th}, 87.5^{th} percentiles) of annual maximum PEC_{SW} over 20 years, consistent with the percentile range in the EFSA Scientific Report on FOCUS SW Repair [1].

HIGHLIGHTS

- FOCUS SW Repair generally produced higher PECSW values than the legacy framework across most scenarios, with differences increasing at higher percentiles.
- The magnitude of differences was strongly scenario-, crop- and percentile-dependent, spanning several orders of magnitude, and no uniform scaling factor could be identified.
- Variability between crop groups was observed, with particularly high variability in arable crops, while drift-dominated crops showed comparatively lower variability.
- Inclusion of metabolites substantially increased computational demand and resulted in an approximate fivefold increase in calculation time compared to the legacy framework.
- Project sizes and data handling requirements increased considerably, creating practical constraints for storage, transfer and processing.

- A limited number of unresolved software issues were identified, and additional follow-up work is required prior to confirmatory reruns.

The figure below illustrates the variability and magnitude of differences between FOCUS SW Repair and the legacy framework across scenarios and percentiles.

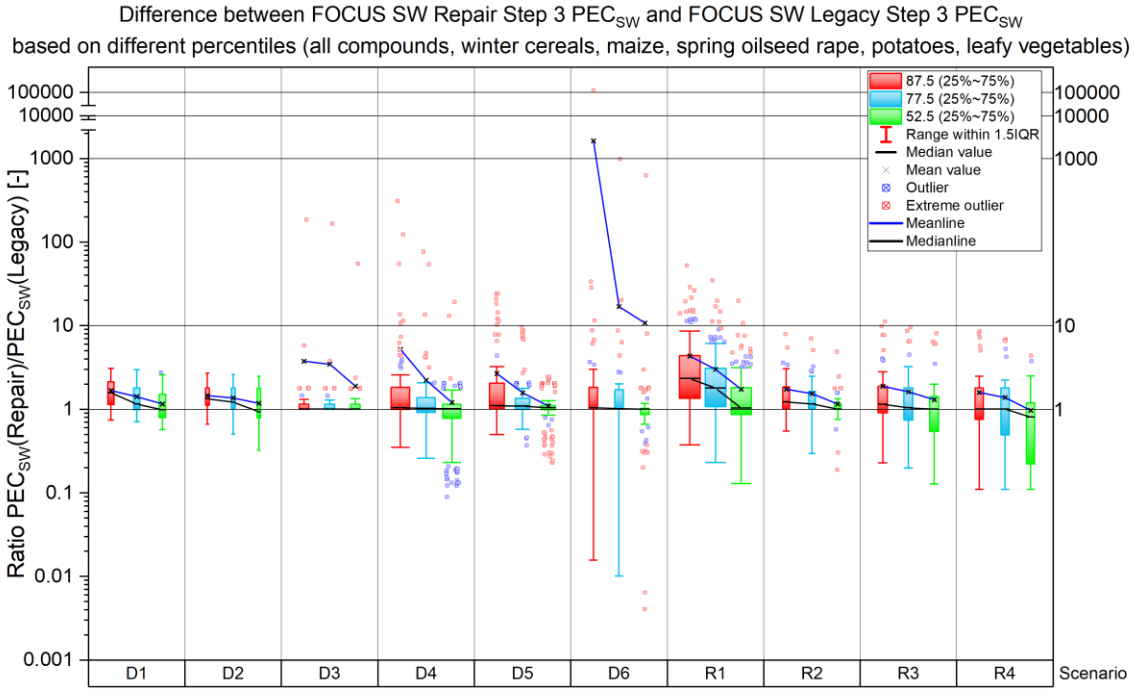

Figure: Ratio of PECSW (FOCUS SW Repair / Legacy) across FOCUS SW scenarios (D1–D6, R1–R4), shown for selected percentiles of annual maximum PECSW.

REFERENCES

[1] EFSA (2020): Scientific report of EFSA on the 'repair action' of the FOCUS surface water scenarios. EFSA Journal 2020;18(6):6119, 301 pp.

RETENTION OF A MAJOR METABOLITE IN VEGETATED FILTER STRIPS UNDER CONTROLLED RUN ON CONDITIONS

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OBJECTIVES

To compare measured vegetative filter strip efficiencies from a controlled, realistic field experiment with predicted VFS efficiencies from regulatory and site-specific modelling

HIGHLIGHTS

Vegetated filter strips (VFS) are routinely applied as a regulatory mitigation measure in European surface water risk assessment for plant protection products, using either fixed reduction efficiencies according to FOCUS Landscape [1] or scenario-specific modelling approaches such as SWAN-VFSMOD (recently updated to become more realistic [2]). This study compares experimentally observed VFS efficiencies under controlled conditions with mitigation assumptions applied in regulatory exposure assessment frameworks.

A controlled GLP run-on study was conducted to assess retention of an active substance, its major metabolite and a tracer, complemented by VFSMOD simulations under regulatory and site-specific conditions. Experimental conditions were derived from FOCUS surface water scenarios [3] to represent realistic high-end runoff and erosion boundary conditions.

VFSMOD [4] was applied both under regulatory configurations, i.e. SWAN-VFSMOD scenarios as 20-year simulations in analogy to FOCUS surface water repair [5] and site-specific conditions. While runoff volumes and dissolved loads of tracer and parent substance in VFS outflow were adequately captured by the site-specific simulations, the dissolved load of the metabolite was consistently overestimated, indicating additional dissipation processes not represented in the model.

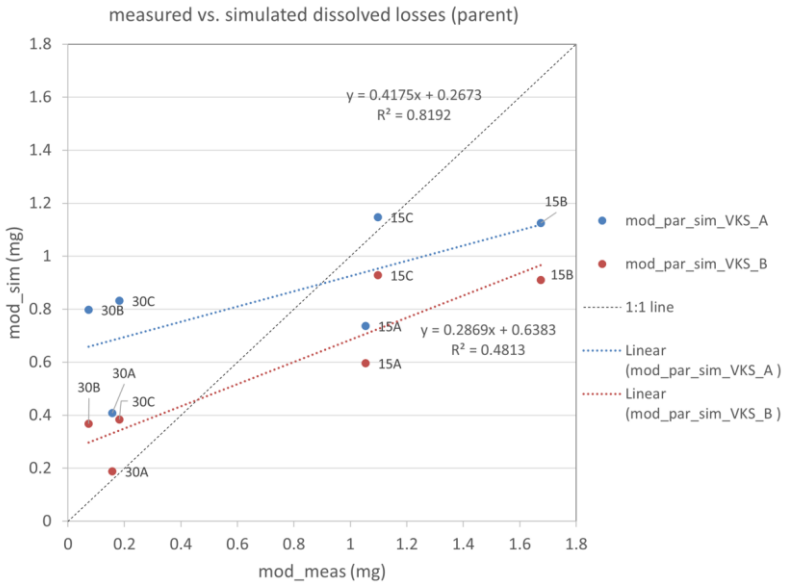

Figure 1: Measured vs. simulqted dissolved losses of the parent molecule in VFS outflow. 30/15: VFS lengths in flow direction (ft). A, B, C: replicates. VKS_A and VKS_B: different parameterizations of vertical saturated conductivity

A direct comparison of exported (mod_meas) and simulated (mod_sim) dissolved losses for the parent molecule (Figure 1) highlights a systematic pattern across VFS lengths (approx. 4.6 and 9.1 m). However, it has to be noted that the simulations were uncalibrated and did not account for the natural in-field variation of soil hydraulic properties.

Overall, the findings support a more nuanced interpretation of observed and predicted runoff mitigation by VFS, showing that model performance depends on system conditions. While the predictive capability of VFSMOD remains robust, additional processes such as abiotic degradation during runoff may contribute to dissipation and thereby lead to a conservative representation of metabolite transport.

REFERENCES

[[1] FOCUS (2007). “Landscape and Mitigation Factors In Aquatic Risk Assessment”. Volume 1. Extended Summary and Recommendations. SANCO/10422/2005 v2.0, p. 169.

[2] Reichenberger et al. (2026). “Update of vegetative filter strip scenarios for pesticide risk assessment in Europe”. STOTEN 1039: 181906. DOI: 10.1016/j.scitotenv.2026.181906.

[3] FOCUS (2001). “FOCUS Surface Water Scenarios in the EU Evaluation Process under 91/414/EEC”. Report of the FOCUS Working Group on Surface Water Scenarios, EC Document Reference SANCO/4802/2001-rev.2. 245 pp

[4] Muñoz-Carpena, R., Parsons, J.E. (2022). “VFSMOD: Vegetative Filter Strip Modeling System”, v. 4.5.0. Model Documentation & User Manual. University of Florida, Gainesville. https://abe.ufl.edu/faculty/carpena/vfsmod/index.shtml.

[5] EFSA (2020). “Scientific report of EFSA on the ‘repair action’ of the FOCUS surface water scenarios”. EFSA Journal 2020;18(6):6119, 301 pp. https://doi.org/10.2903/j.efsa.2020.6119

EVALUATING MITIGATION STRATEGIES FOR PESTICIDE TRANSPORT IN DRAINED AGRICULTURAL LOWLANDS USING SWAT

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OBJECTIVES

Mobile and persistent pesticides and their transformation products pose a risk to water quality in artificially drained agricultural lowlands. Subsurface drainage systems provide rapid transport pathways from agricultural fields to surface waters, thereby reducing the residence time available for retention and degradation processes [1], [2]. However, existing recommendations for reducing pesticide losses predominantly address surface runoff, whereas targeted mitigation strategies for drained agricultural land remain scarce [3].

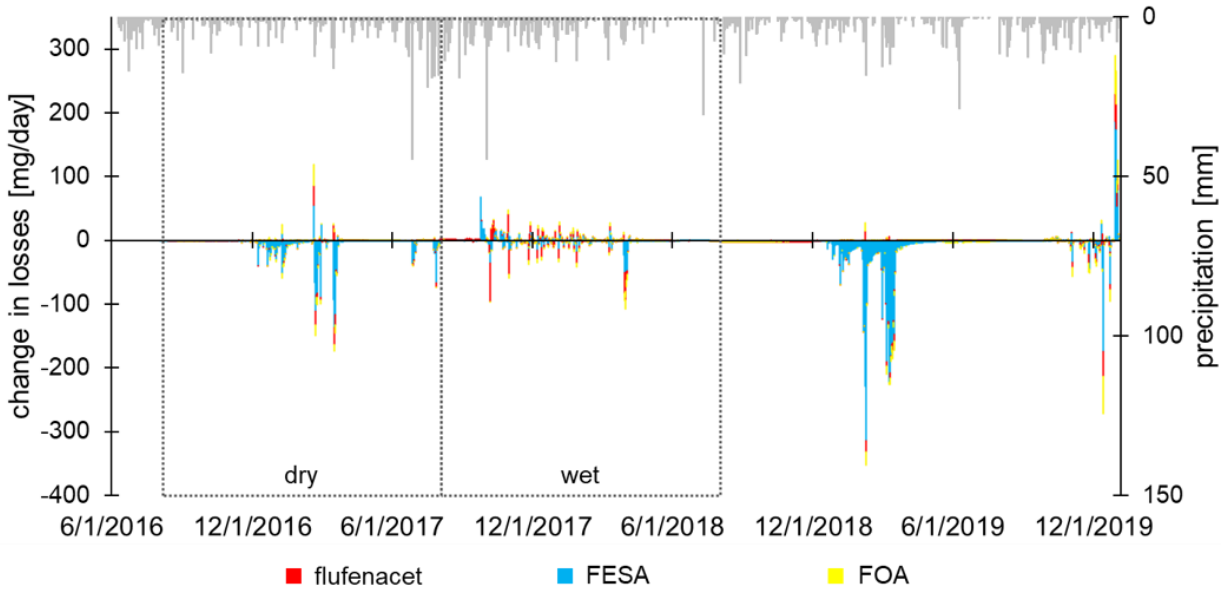
The objective of this study was therefore to assess the effectiveness of field-based measures and drainage control in reducing pesticide losses under different hydrological conditions. For this purpose, the ecohydrological model SWAT+ was applied to a 100-ha agricultural farm under realistic environmental and management conditions. The analysis addressed three main objectives:

- First, the potential of adapted field management to reduce losses of flufenacet and its transformation products was assessed.
- Second, the contribution of subsurface drainage control to surface-water protection was evaluated.
- Third, the effectiveness of combined mitigation measures was compared with that of individual measures.

HIGHLIGHTS

- Pesticide losses and mitigation effectiveness varied spatially and temporally.

- Drainage control was more effective than field-based measures in reducing pesticide losses.
- Field-specific and weather-adapted drainage control increased the reduction in pesticide transport.
- Mitigation effectiveness depended on compound-specific properties and field-scale hydrological conditions.
- Combining mitigation measures enhanced the net reduction in pesticide transport.



Daily pesticide losses from the drainage network at the study area outlet under the combined management scenario; Dashed lines indicate the wet and dry application periods

REFERENCES

[[1] S. Willkommen at al., "How weather conditions and physico-chemical properties control the leaching of flufenacet, diflufenican, and pendimethalin in a tile-drained landscape," Agriculture, Ecosystems & Environment 278, 2019, doi: 10.1016/j.agee.2019.03.017.

[2] A.-K. Wendell et al., "A spatio-temporal analysis of environmental fate and transport processes of pesticides and their transformation products in agricultural landscapes dominated by subsurface drainage with SWAT+," Science of The Total Environment 945, doi: 10.1016/j.scitotenv.2024.173629.

[3] S. Reichenberger et al., "Mitigation strategies to reduce pesticide inputs into ground- and surface water and their effectiveness; A review," Science of The Total Environment 384, doi: 10.1016/j.scitotenv.2007.04.046.

CALCULATION OF PESTICIDE CONCENTRATIONS IN WFD WATERBODIES IN THE NETHERLANDS

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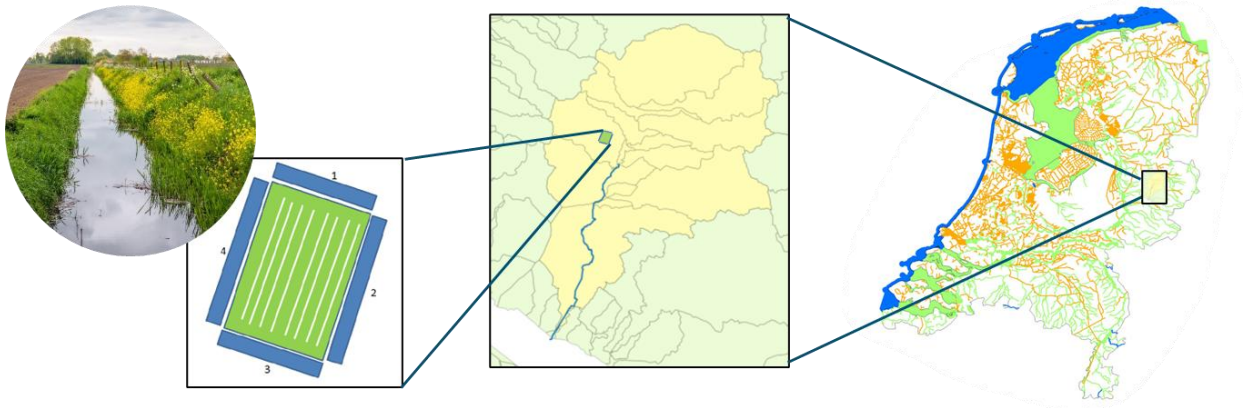
OBJECTIVES

The development of a methodology is presented, accompanied by the simulation tool (CATCH 1.0), designed to assess whether authorised uses of pesticides in agriculture could lead to exceedances of Water Framework Directive (WFD) environmental quality standards in Dutch surface waters.

HIGHLIGHTS

- Recent monitoring shows several pesticides exceed WFD standards even when products are used according to existing authorisations.
- The gap arises because authorisation procedures assess risks at the edge-of-field scale, whereas WFD compliance is evaluated at the larger waterbody scale, often with stricter environmental quality standards.
- CATCH 1.0 links emissions from agricultural fields to concentrations in waterbodies by integrating emission modelling with hydrological transport modelling.
- Simulations were carried out for 735 WFD waterbodies, using three illustrative substances.
- Results highlight differences arising from application practices, spatial distribution, and substance properties.
- The tool functions as a screening instrument and has limitations, including a focus on agricultural sources (other emission sources excluded).

- CATCH 1.0 is an initial step towards aligning authorisations with WFD objectives, supporting informed decision-making, the reassessment of substances, and the reduction of exceedances in WFD waterbodies.



Conceptual diagram of the modelled route by which pesticides move from treated fields, through edge-of-field ditches and the sub-catchment, and ultimately into WFD waterbodies.

COLLECTION OF SEDIMENT DATA IN SMALL EDGE-OF-FIELD WATERCOURSES AND PONDS FOR USE IN THE EU-FOCUS SURFACE WATER SCENARIOS

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OBJECTIVES

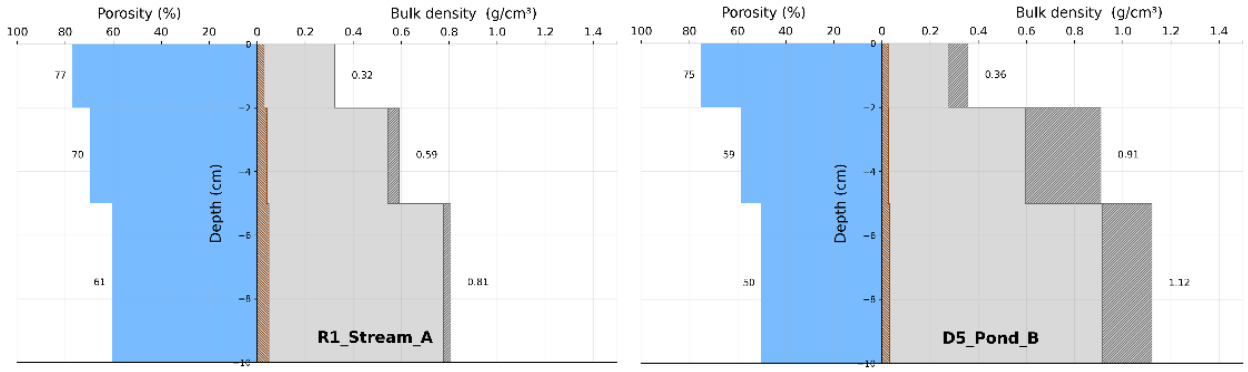
- Obtain data to define more realistic sediment properties in freshwater small bodies located edge-of-field. Key elements are: (i) depth dependent properties of bulk density, porosity, and organic matter content; (ii) differentiated for type of waterbody: ditch, stream and pond; and (iii) characterize the sediment in the same major agricultural areas as the ten current scenarios represent.
- To improve the sediment descriptions of the EU-FOCUS surface water scenarios [1] [2] to improve the quality of the aquatic risk assessment.

HIGHLIGHTS

- The targeted literature review showed a lack of a standardized methodology, for depth discretization of the samples and often missing combination of organic matter and bulk density measurement, critically restricting the usability of the data.
- Water bodies were selected in the vicinity (i.e., 30 km) of the existing scenario location coordinates. The sediment of 30 water bodies; 8 ditches, 16 streams and 6 ponds, was sampled. 20 Cores were taken in a stretch of 100 m for ditches and streams and scaled to size

for the ponds. From each core 0-2, 2-5 and 5-10-cm layers were sampled. Determined was bulk density, porosity and organic matter content.

- Recommendations are given on how the data can be used to enable a more realistic (and/or conservative) risk assessment for benthic organisms and rooted water plants in the registration procedure at EU level.



Example of sediment property profiles for a stream and for a pond. Sediment properties of the three layers, 0-2 cm, 2-5 cm and 5-10 cm depth. The left part of each graph shows: porosity (in volume %, blue). The right part of each graph shows: sediment bulk density (in g/cm3). The values of porosity and bulk density of the three layers are indicated. The bulk density is discriminated in (i) bulk OM density (brown), (ii) together with the granular fraction < 2mm defined as fine sediment material (sum of brown and grey), and (iii) bulk stone density (dark grey).

REFERENCES

[1] EFSA (European Food Safety Authority), Adriaanse P, Boivin A, Klein M, Jarvis N, Stemmer M, Fait G and Egsmose M, 2020. Scientific report of EFSA on the 'repair action' of the FOCUS surface water scenarios. EFSA Journal 2020;18(6):6119, 301 pp. https://doi.org/10.2903/j.efsa.2010.1637.

[2] FOCUS (Forum for the Co-ordination of Pesticide Fate Models and their Use), 2001. FOCUS surface water scenarios in the EU evaluation process under 91/414/EEC. Report of the FOCUS Working Group on Surface Water Scenarios. EC Document Reference SANCO/4802/2001-rev. 2, 245 pp., as updated by Generic guidance for FOCUS surface water scenarios, v. 1.4, May 2015.

ASSESSMENT OF PEC_{air} FOR VOLATILE SOIL METABOLITE USING FLUX RATES FROM AEROBIC SOIL AND FIELD VOLATILITY STUDIES

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Presenter Shiran Qiu

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OBJECTIVES

- To develop and apply a tiered approach to estimate PECair for a volatile soil metabolite
- To compare flux rates derived from aerobic soil studies and field volatility studies

HIGHLIGHTS

- PECair of a soil metabolite was estimated using a tiered approach combining aerobic laboratory (Tier 1) and field volatility (Tier 2) data
- In Tier 1, PECair was estimated using volatilization rates from aerobic soil studies within a box model incorporating adjusted soil loading and key environmental parameters.
- In Tier 2, PECair was derived from a field volatility study using continuous air monitoring and meteorological data to quantify post-application emissions via the IHF method.

A single on-field air sampling station located near the center of each plot ran continuously. Flux monitoring (field volatility) was conducted using a single in-field air profile monitoring station (center mast) with duplicate collectors at five heights (0.15, 0.33, 0.55, 0.9, and 1.5 m above the soil surface). Each collector contained a single XAD-2 OVS sorbent tube connected with Tygon tubing and attached to an air sampling pump (1 L/min).

IMPORTANCE OF AGED SORPTION PROCESSES IN THE EXPOSURE ASSESSMENT OF PESTICIDES

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Presenter Bernhard Jene

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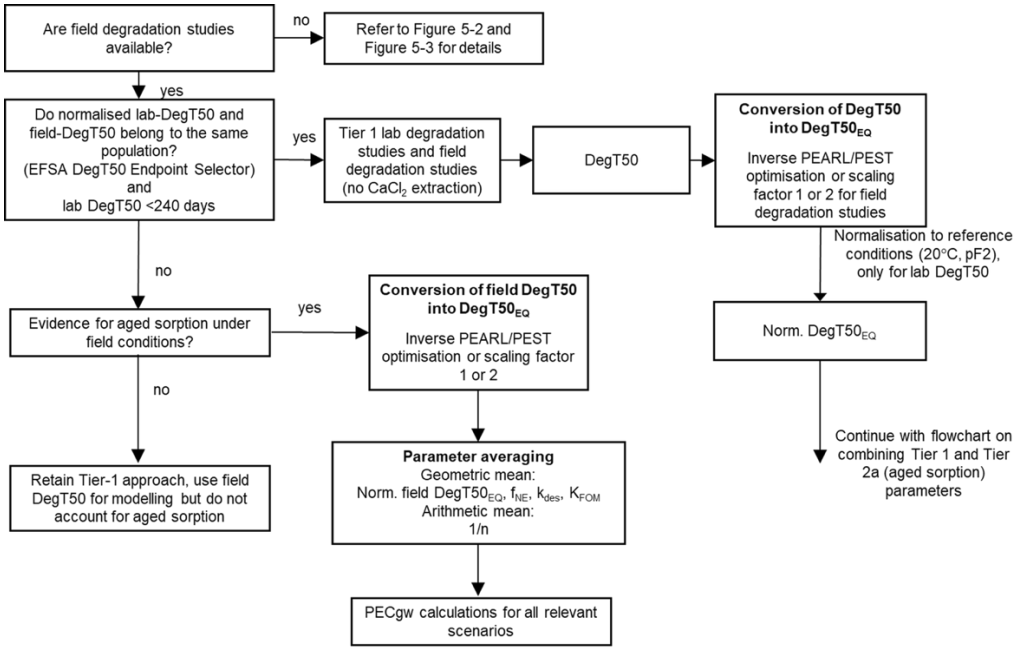
OBJECTIVES

- Explaining practical limitation of current version of the aged sorption guidance
- Demonstrating evidence of aged sorption processes under field conditions
- Introducing the P5 metric to check available field studies for the relevance of aged sorption
- Proposing changes to the current guidance to allow for the combination of aged sorption and field DegT50 values

HIGHLIGHTS

Aged sorption reduces the downward transport of organic substances in soil over time and is a key process for pesticide exposure. Its regulatory relevance was established through EU guidance [1], [2]. However, in most cases the guidance restricts the combination with field DegT50 values, strongly limiting practicasl application. Recent scientific evidence confirms the validity of applying aged sorption under field conditions [3]. No conceptual conflict or double counting occurs. An updated regulatory guidance enabling combined use of aged sorption with field DegT50 values has therefore been proposed. Further progress now requires regulatory action to translate these scientific findings into practice.



Proposed flowchart to consider aged sorption in combination with field DegT50 values

REFERENCES

[1] European Commission, Directorate-General for Health and Food Safety, "Guidance on how aged sorption studies for pesticides should be conducted, analysed and used in regulatory assessments," SANTE/12586/2020 Rev. 1, Oct. 22, 2021. [Online]. Available: https://food.ec.europa.eu/document/download/3c4f864c-c475-4bd7-a162-2971a6930f6a_en?filename=pesticides_ppp_app-proc_guide_fate_aged-sorption_0.pdf

[2] EFSA Panel on Plant Protection Products and their Residues (PPR), Ockleford C, Hernandez-Jerez AF, et al. Scientific Opinion about the Guidance of the Chemical Regulation Directorate (UK) on how aged sorption studies for pesticides should be conducted, analysed and used in regulatory assessments. EFSA J. 2018;16(8):e05382. Published 2018 Aug 27. doi:10.2903/j.efsa.2018.5382

[3] W. van Beinum, S. Beulke, and I. Hardy, Evidence for Aged Sorption in Field Studies and the Use of Field DegT50 in Combination with Aged Sorption, Oct. 2025. Enviresearch Ltd. and Battelle UK Ltd.

TRACING SOURCES OF 1,2,4-TRIAZOLE IN FLEMISH DRINKING WATER USING A COMBINED MONITORING-MODELLING APPROACH

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OBJECTIVES

Elevated concentrations of 1,2,4-triazole, a metabolite formed from various antifungal compounds, have been detected in surface-water-based drinking water production facilities in West-Flanders (Belgium). Due to the reliance on large, cross-boundary catchments, these systems are particularly vulnerable to complex contamination patterns [1]. This study aims to identify the sources, transport routes, and transformation processes of 1,2,4-triazole to support effective mitigation strategies. A comprehensive multi-method approach was applied, integrating literature review, GIS-based spatial modelling, targeted monitoring, and advanced analytical techniques including non-target analysis, to disentangle diffuse and point source contributions and identify transformation products contributing to observed concentrations. Diffuse agricultural pressure was assessed using a GIS-based theoretical spatial model building on FOCUS Step 1 principles, incorporating crop distribution, authorized pesticide use, and relevant substance properties.

HIGHLIGHTS

- Elevated 1,2,4-triazole concentrations detected in drinking water production systems in West Flanders.
- Point sources (industry and wastewater treatment plants) linked to highest observed concentrations.
- Diffuse agricultural inputs cause minor exceedances in absence of point sources.

- Spatial modelling identified highest upstream pressure from cereals, potatoes, and vegetables (Figure 1).
- Concentrations of 1,2,4-triazole increase during drinking water treatment, especially in summer.
- Non-target analysis revealed unknown intermediates degrading into 1,2,4-triazole.
- Approach supports identification and management of emerging contaminants in drinking water.

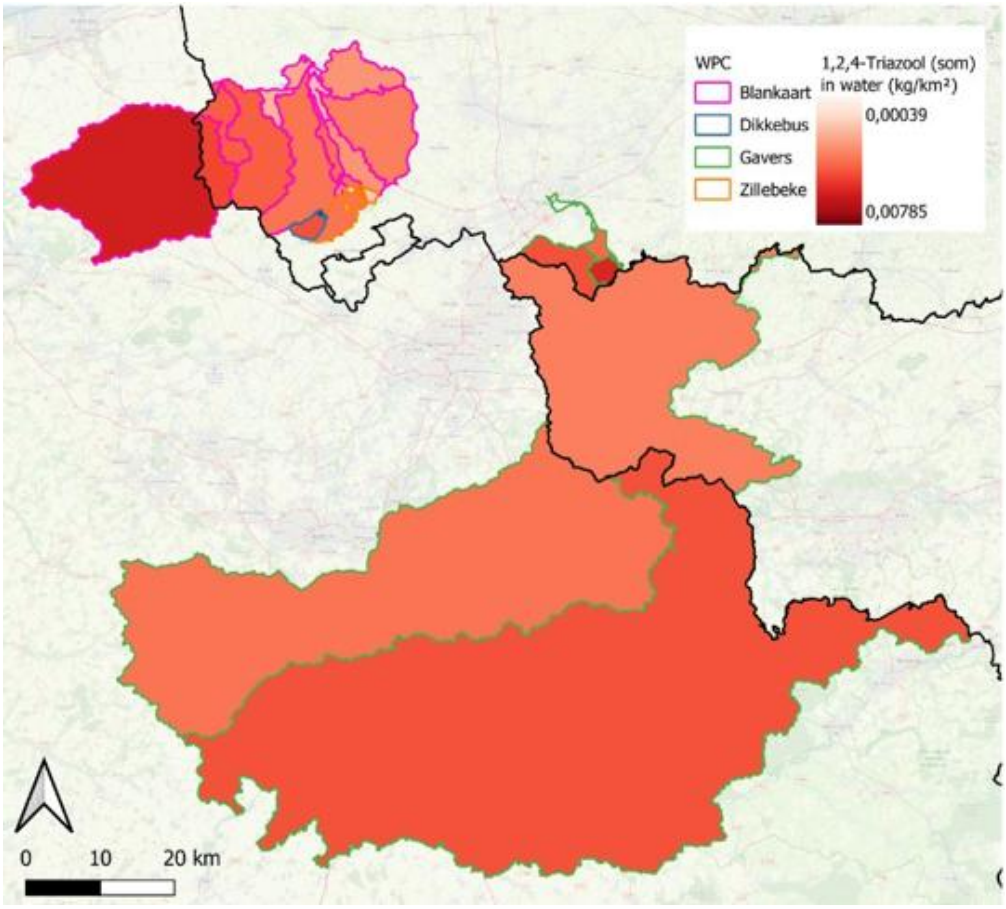

Figure 1: Theoretical spatial pressure patterns for the total 1,2,4-triazole in surface water from plant protection products for the different Water Production Centers (WPC) in West-Flanders, Belgium.

REFERENCES

[1] K. Nödler et al., Substances from Multiple Sources (SMS): The Presence of Multiple Primary and Secondary Sources of Persistent and Mobile Organic Contaminants Is an Upcoming Challenge for the Drinking Water Sector and Regulatory Frameworks, Environmental Science and Technology, Vol 53, September 2019, doi: https://doi.org/10.1021/acs.est.9b05168

ASSESSMENT OF GROUNDWATER VULNERABILITY TO PESTICIDES IN GERMANY – FINDINGS FROM HARMONISED MONITORING DATA AND MACHINE LEARNING

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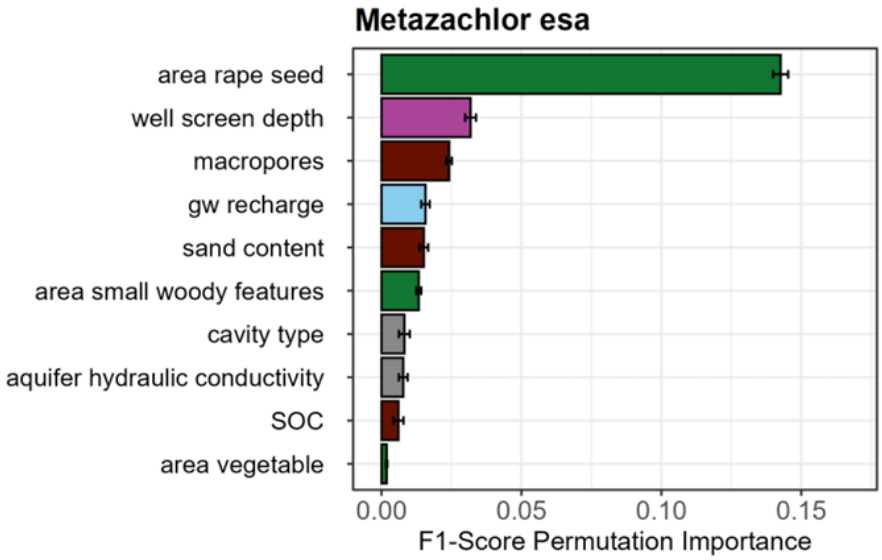
OBJECTIVES

- Assess which site characteristics control the occurrence of pesticide active substances and metabolites in groundwater across Germany.
- Develop machine-learning models to quantify and spatially predict groundwater vulnerability based on harmonised monitoring data from more than 26,000 wells.
- Evaluate whether monitoring data can support the development of a nationwide groundwater vulnerability index for plant protection products (PPPs).
- Derive recommendations for the selection of monitoring sites in targeted post-registration groundwater monitoring studies.

HIGHLIGHTS

- A harmonised national database comprising >26,000 monitoring wells and >500 active substances and metabolites was established.
- More than 95% of all measurements were below the limit of quantification, requiring a classification approach based on concentration classes.
- Robust random forest and neural network classification models were developed for eight mobile and persistent pesticide metabolites, while comparable models for active substances and substance groups could not be established due to the high proportion of censored measurements

- Agricultural land use, particularly the area of the main crop associated with the respective parent compound, was identified as the most important predictor of metabolite occurrence.
- Filter depth, sand content and groundwater recharge showed secondary importance, while hydrogeological properties such as aquifer type and hydraulic conductivity had comparatively low influence.
- Vulnerability could not be reliably separated from actual pesticide use patterns and only a limited number of compounds provided a sufficient basis for robust model development, preventing the derivation of a robust nationwide groundwater vulnerability index
- Comparisons with existing vulnerability assessment approaches and process-based leaching models showed limited correspondence with monitoring observations. The high mobility of the investigated compounds is discussed as one possible explanation.
- For future targeted monitoring studies and site selection, site-specific information and local expert knowledge remain essential.
- Harmonisation of monitoring programmes and laboratory analytics (LOQ/LOD) would substantially improve future vulnerability assessments.



Example of permutation feature importances derived from the Random Forest model for metazachlor ESA. Features are ordered by decreasing importance. Error bars represent the standard deviation across ten model training seeds and colours indicate the feature category.

REFERENCES

[1] Cooke, A.-K., Dorau, K., Erkens, E., Joger, F., Willkommen, S., Broda, S. (2026), Grundwasservulnerabilitätsbewertung im Zulassungsverfahren von Pflanzenschutzmitteln (FARM), In: Schriftenreihe Umweltbundesamt TEXTE 88/2026, https://doi.org/10.60810/openumwelt-8222

[2] Cooke, A.-K.; Willkommen, S.; Broda, S. (2024), Analysing agricultural plant protection product concentrations in groundwater in Germany: Nationwide database with site and compound insights, Environmental Research, 248, 118231. https://doi.org/10.1016/j.envres.2024.118231.

[3] Cooke, A.-K.; Mohanty, S.; Joger, F.; Erkens, E.; Broda, S. (2026), Concentrations of Plant Protection Product Metabolites in Groundwater in Germany: Assessing the Influence of Site Characteristics using Random Forests and Feedforward Neural Networks, Environmental Data Science, EDS-2026-0053, in review.

HARMONISED FRAMEWORK FOR THE SETAC SPATIALLY DISTRIBUTED LEACHING MODELLING OF PESTICIDES INITIATIVE

Aaldrik Tiktak, Anton Poot, Bernhard Jene, Gerco Hoogeweg, Pavan Cornelissen, Dimitrios Skodras, Maarten Braakhekke, Louise Wipfler, Judith Klein, Michael Stemmer, Amy Ritter, Robin Sur, Gregor Spickermann, Gerard Heuvelink, Greg Hughes, Stephan Marahrens, Stefan Reichenberger, Nicoleta Suciu & Michelle Morris

Presenter Aaldrik Tiktak

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INTRODUCTION

Spatially distributed leaching modelling (SDLM) of pesticides is a methodology to estimate the leaching potential over large spatial extents such as the national or European scale. SDLM is described in the FOCUS groundwater report [1] as a higher tier of the leaching risk assessment and is already used in the national authorization procedure of some EU-countries. Additionally, SDLM can help put groundwater monitoring programs into context [2].

OBJECTIVES

A SETAC working group was formed in 2020 with the main objective to deliver a harmonised modelling framework including the data needed to run the model, and documents describing the use of the framework in regulatory assessments. The framework will serve Tier-3B and Tier-4 of the groundwater risk assessment scheme [3]. At Tier 3B, the framework delivers the same exposure assessment goal as currently used in Tier 1 and 2 of the FOCUS groundwater report (i.e., the overall 90th-percentile of the leaching concentration at 1-m depth).

HIGHLIGHTS

Two spatially distributed leaching models have been developed within the working group, namely GeoPEARL-EU and GeoPELMO-EU. These models have been used to compute the 90th-percentile

overall leaching concentration by running approximately 10,000 scenarios consisting of unique combinations of land-cover, climate and soil data. The models were used at both Tier-3B, and Tier-4. The Tier-3B results have been aggregated on the FOCUS zone level to compare them to Tier 1. The Tier 1 simulations were computed with FOCUSPEARL and FOCUSPELMO. Results show that the leaching concentration simulated at Tier-3B is generally lower than the leaching concentration simulated at Tier-1 (Figure 1). This means that the FOCUS scenarios are sufficiently conservative and that an update of these scenarios is not necessary.

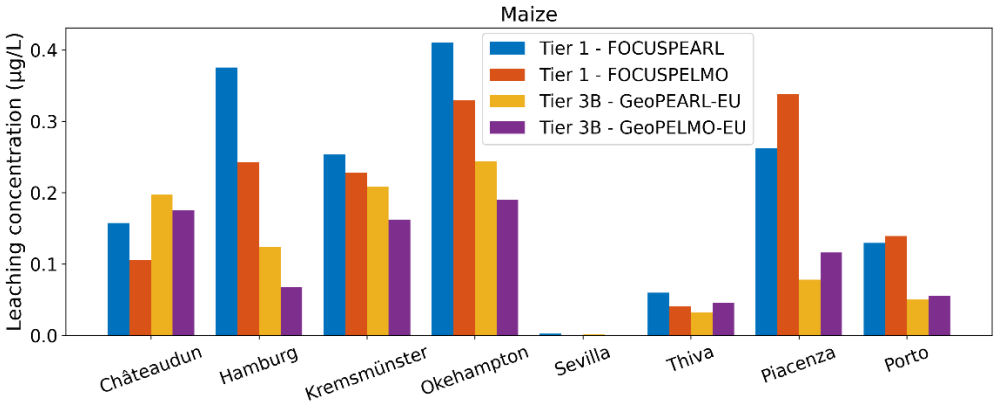

Figure 1 - Target percentile of the leaching concentration of an example substance at 1-m depth. For Tier 1, this is the 80th-percentile in time and space, while for Tier 3B this is the overall 90th-percentile

Another aim of SDLM is to put groundwater monitoring sites into context (Tier-4 of the FOCUS groundwater leaching assessment) [3]. For this purpose, simulations have been carried out for a set of theoretical monitoring sites. In these simulations, site-specific soil, crop and climate data are used. The simulated leaching concentration are then plotted on the cumulative frequency distribution of the leached mass flux simulated with SDLM to show whether the selected monitoring sites represent vulnerable locations. Preliminary results show that GeoPELMO-EU and GeoPEARL-EU deliver approximately the same results.

REFERENCES

[1] European Commission (2014) "Assessing Potential for Movement of Active Substances and their Metabolites to Ground Water in the EU" Report of the FOCUS Ground Water Work Group, EC Document Reference Sanco/13144/2010 version 3.
[2] EFSA PPR Panel (2023). "Statement of the Scientific Panel on Plant Protection Products and their Residues (PPR Panel) on the design and conduct of groundwater monitoring studies supporting groundwater exposure assessments of pesticides." EFSA Journal 2023;21(5):7990.
[3] Tiktak A et al. (2020) "Spatially Distributed Leaching Modelling of Pesticides in the context of Regulation (EC) 1107/2009, Problem definition document." Available at https://esdac.jrc.ec.europa.eu/projects/sdlm.

FINDINGS FROM SPATIALLY DISTRIBUTED LEACHING MODELLING OF PESTICIDES IN GERMANY WITH GEOPELMO DE

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Presenter Judith Klein

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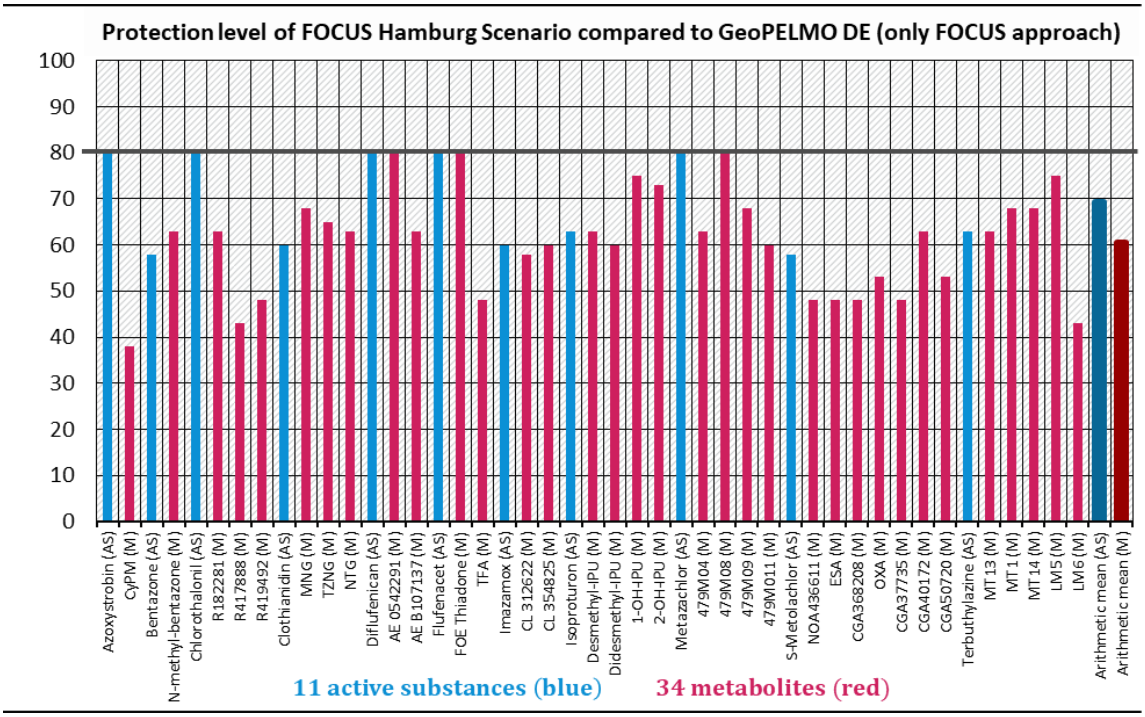
OBJECTIVES

This work investigated which adjustments are required to apply spatially distributed leaching modelling (SDLM) for a robust and reliable groundwater assessment of pesticides across the agricultural area of Germany [1]. A new version of GeoPELMO DE was developed and evaluated to account for surface runoff, preferential (macropore) flow and drainage in addition to chromatographic (matrix) flow, with the aim of improving the prediction of leaching for active substances and metabolites under German conditions (see also S2P01).

HIGHLIGHTS

- A new version of GeoPELMO DE was developed to additionally account for runoff, macropore flow and drainage
- Nationwide climate, soil and groundwater datasets were reviewed and adapted
- Lysimeter results and Danish PLAP monitoring data supported calibration of macropore flow in PELMO
- Runoff & drainage had the strongest influence on water balance, while macropore flow and parametrization of OC-contents in subsoils most strongly affected percolate concentrations
- Nationwide predicted leachate concentrations were often more conservative than the FOCUS Hamburg scenario



The predicted environmental concentrations (PECs) from the FOCUS Hamburg scenario are compared with the 80th spatial percentile concentration from GeoPELMO DE (version FOCUS matrix flow). Evaluation of a large number of active substances and metabolites using GeoPELMO DE L shows that the protection level of the FOCUS Hamburg scenario varies strongly between the compounds.

REFERENCES

[1] M. Klein, J. Klein, S. Hannappel, K. Thomas, S. Seifert, M. Trapp, "Protect groundwater from plant protection products. – Spatial distributed leaching modelling to identify agricultural areas with high risk for leaching," TEXTE 33/2026, 290pp. Apr. 2026, https://doi.org/10.60810/openumwelt-8431

SPRAY DRIFT AS A CRITICAL DRIVER OF LANDSCAPE-SCALE PESTICIDE EXPOSURE: COUPLING DAD-DRIFT WITH SWAT

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Presenter Mike Fuchs

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OBJECTIVES

Reliable pesticide exposure assessments require models that capture all major transport pathways. While the Soil and Water Assessment Tool (SWAT+) is widely used for landscape-scale pesticide modeling, it lacks a process-based representation of spray drift — a pathway that can contribute substantially to surface water contamination. Empirical drift approaches previously coupled with SWAT oversimplify spatial relationships between application and non-target areas and have been shown to introduce large uncertainties.

We present the first integration of the mechanistic Droplet and Atmospheric Dispersion drift (DAD-drift) model into a high-resolution SWAT+ model, applied to the upper Funne catchment, an agriculture-dominated lowland basin in North Rhine-Westphalia, Germany. A realistic 5-year crop rotation with seven active ingredients (two fungicides, five herbicides) was simulated using publicly available data. An ensemble of 20 hydrological parameterizations was used to quantify uncertainty in predicted environmental concentrations.

HIGHLIGHTS

Results show that including spray drift markedly increases predicted pesticide concentrations in surface waters. The effect is strongest for immobile, strongly sorbing substances, where spray drift became the dominant transport pathway and increased maximum concentrations by several orders of magnitude. For mobile substances, hydrological pathways such as tile drainage and interflow governed transport dynamics, but spray drift still produced additional concentration peaks immediately after application.

Ensemble simulations revealed that hydrological parameterization uncertainty propagates directly into exposure predictions, underscoring the need for multi-realization approaches when quantifying the contribution of individual transport pathways.

This study demonstrates that spray drift must be explicitly represented in landscape-scale exposure assessments. The combined SWAT+–DAD-drift framework provides a transferable tool for linking agricultural practices with water quality and for evaluating the effectiveness of mitigation measures such as no-spray buffer strips and drift-reducing nozzles at the catchment scale.

BEST PRACTICES FOR GIS DATASETS – ORGANIZATION AND VERSION CONTROL FOR USE IN RISK ASSESSMENT

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Presenter Gregor Spickermann

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OBJECTIVES

The objective of this work is to define and promote best practices for the management, organization, and version control of Geographic Information System (GIS) datasets used in environmental and regulatory risk assessment.

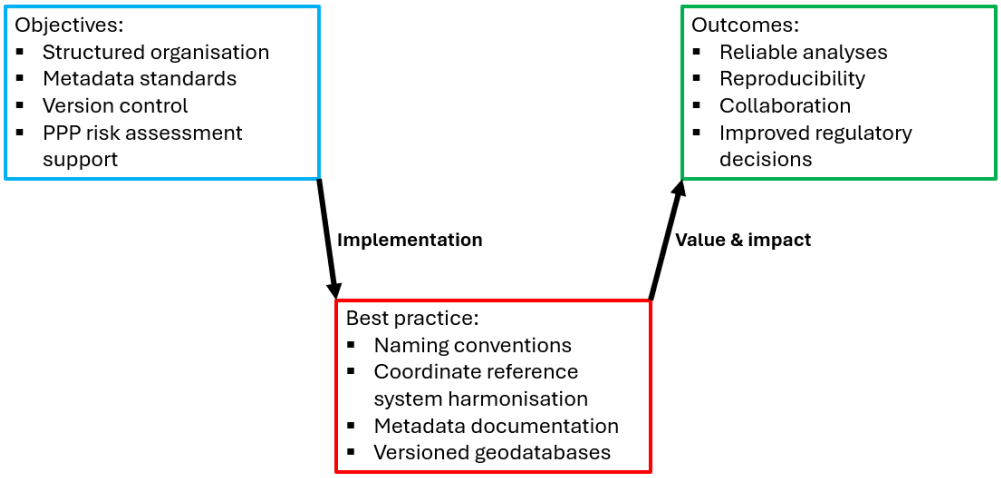
Specifically, this contribution aims to:

- Establish structured approaches for organizing GIS datasets to ensure consistency and usability
- Highlight the importance of metadata in improving transparency and reproducibility
- Describe effective version control strategies for multi-user environments
- Emphasize the need for full documentation of data processing workflows, including software tools and versions used
- Data creation, storage and distribution should follow best practices and standards to ensure consistency and reliability
- Demonstrate how robust GIS data management supports high-quality risk assessments, particularly for Plant Protection Products (PPPs)

HIGHLIGHTS

- Structured GIS data organization improves reliability and reduces analytical errors
- Standardized naming conventions and coordinate systems ensure consistency across datasets

- Metadata is essential for transparency, traceability, and reproducibility
- Version control mechanisms enable secure collaboration and change tracking
- Full documentation of data processing workflows, including software and versions, is critical for reproducibility
- High-quality GIS data management directly supports robust environmental risk assessments and regulatory decision-making



Conceptual framework for GIS data management in environmental risk assessment.

REFERENCES

[1] Geospatial One Stop Best Practices White Paper. Source: https://www.fgdc.gov/organization/coordination-group/meeting-minutes/2002%20meeting%20minutes/may/5-01-02_reformat_ver11.pdf.
[2] Overview of Best Practices for Management of Environmental Geospatial Data. Source: https://edm-1.itrcweb.org/overview-of-best-practices-for-management-of-environmental-geospatial-data/.
[3] Versioning Data Is About More than Revisions: A Conceptual Framework and Proposed Principles. Source: https://datascience.codata.org/articles/dsj-2021-012.
[4] Environmental Data Management (EDM) Best Practices. Source: https://edm-1.itrcweb.org/environmental-data-management-systems/.
[5] Versioning 101: Essential information about ArcSDE geodatabases. Source: https://www.esri.com/news/arcuser/0110/versioning101.html.
[6] 5 best practices for utilizing GIS data. Source: https://www.gov1.com/product-news/articles/5-best-practices-for-utilizing-gis-data-white-paper-80pgrprMRvoW5bos/.

DEVELOPING A DEB-ABM FOR A TERRESTRIAL ARTHROPOD TO BRIDGE THE GAP BETWEEN FATE MODELLING RESULTS AND EFFECT MODEL APPROACHES ON A LANDSCAPE SCALE

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Presenter Leonhard Bürger

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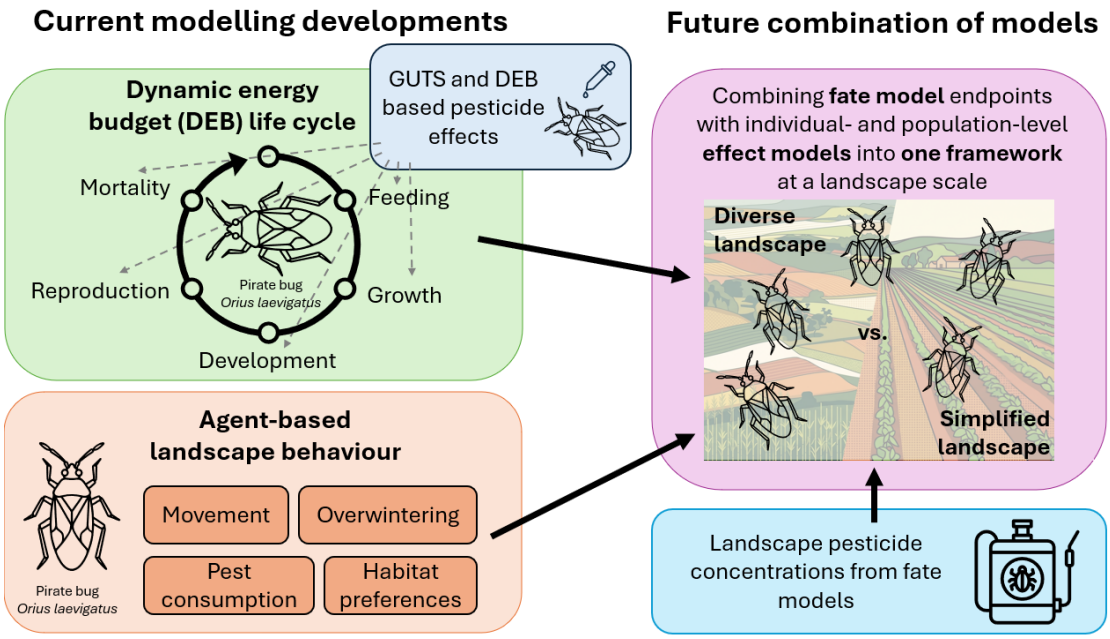
OBJECTIVES

- Implementation of existing pesticide effect modelling approaches for one terrestrial arthropod species, from the individual up to the population level in a landscape
- Combination of different submodules into one landscape model using fate model endpoints as input

HIGHLIGHTS

- Development of an individual based dynamic energy budget (DEB [1]) model for the terrestrial leaf-dwelling pirate bug Orius laevigatus based on openly available Add-my-pet data and parameters [2]
- Integration of a toxicokinetic-toxicodynamic (TKTD) based pesticide effect module based on BufferGUTS [3] and calibration with laboratory data
- Definition and implementation of an agent-based landscape ecological model for the same Orius species based on literature sources
- Developed models can be used in isolation or as submodules in other (landscape) modelling frameworks
- Assessment of the potential of combining these model approaches into the xLandscape landscape modelling framework to be used together with fate modelling endpoints



Graphical abstract of the current and future modelling frameworks to assess landscape scale pesticide risks of terrestrial arthropod species.

REFERENCES

[1] B. Kooijman, Dynamic Energy Budget Theory for Metabolic Organisation, 3rd ed. Cambridge University Press, 2009. doi: 10.1017/CBO9780511805400.

[2] A. Huang and D. Bashkir, Orius laevigatus, Add-my-pet database, 2025, version 2025/06/19

[3] L. U. Bürger and A. Focks, "From water to land—Usage of Generalized Unified Threshold models of Survival (GUTS) in an above-ground terrestrial context exemplified by honeybee survival data," Environmental Toxicology and Chemistry, vol. 44, no. 2, pp. 589–598, 2025, doi: 10.1093/etojnl/vgae058.

LANDSCAPE SCALE AQUATIC EXPOSURE AND EFFECT MODELLING CONSIDERING SPOT APPLICATION

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Presenter Sebastian Multsch

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OBJECTIVES

- Introduction of a scenario based landscape modelling approach designed to evaluate how precision spot application strategies [1, 2] influence aquatic risk under realistic environmental conditions. The approach combines process based simulation of spray drift and hydrological transport with mechanistic effect modelling across spatial scales using xLandscape [3, 4].
- Local meteorology, crop management and application parameters are explicitly represented, while heterogeneous spot spray patterns are derived from infestation intensity and patch size distributions [5]. Time resolved exposure profiles in surface waters are subsequently translated into effects using a toxicokinetic–toxicodynamic model for Lemna sp. [6].

HIGHLIGHTS

- The methodology was applied to early season herbicide use in oilseed rape within a 54 km² agricultural catchment in North Rhine Westphalia, Germany. Precision spot application reduced aquatic exposure by an additional factor of approximately 3.5.
- The results illustrate how linking application technology with fate, exposure and effect modelling enables integrated risk assessment at the landscape scale. Such approaches provide a transparent basis for incorporating precision agriculture into pesticide risk assessment and support science based decision making for sustainable pesticide management.

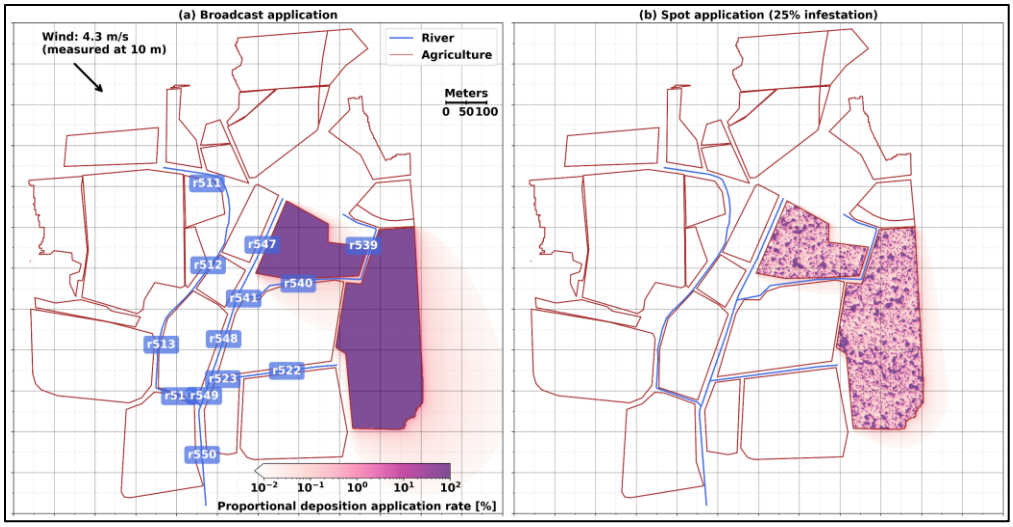

Illustration of drift deposition simulated with a physical based drift model for (a) broadcast (left) and (b) spot (right) application across a ~100 ha study site (North Rhine-Westphalia, Germany), considering a northwest wind direction at 4.3 m/s. Note: physical barriers such as hedges and trees are not considered in drift simulations.

REFERENCES

[1] EUPAF - European Precision Application Task Force [url: BVL - EUPAF].
[2] European Commission, Compendium of conditions of use to reduce exposure and risk from plant protection products: PAFF-PPL-March 2024-Doc.A.07.02 23 May 2024. [url: cdd9b6c4-29dc-4077-a118-3e51c0abeb80_en].
[3] S. Bub. https://github.com/xlandscape/, 2026.
[4] B. Buddendorf et al., Aquatic risks at the landscape scale: a case study for pyrethroid use in pome fruit orchards in Belgium. Environmental Science & Technology. 5;57(41):15608-16, 2023.
[5] M. Fuchs et al., The droplet and atmospheric dispersion drift (DAD-drift) model – A modular approach for estimating spray drift at the landscape scale. Environmental Research, Volume 271, 121104, 2025.
[6] W. Schmitt et al., Mechanistic TKTD-model simulating Lemna populations.,Ecol Model 255:1– 10, 2013.

ELINK-2: INTEGRATED EXPOSURE AND EFFECT MODELLING AT DIFFERENT SPATIAL SCALES

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Presenter Dirk Nickisch

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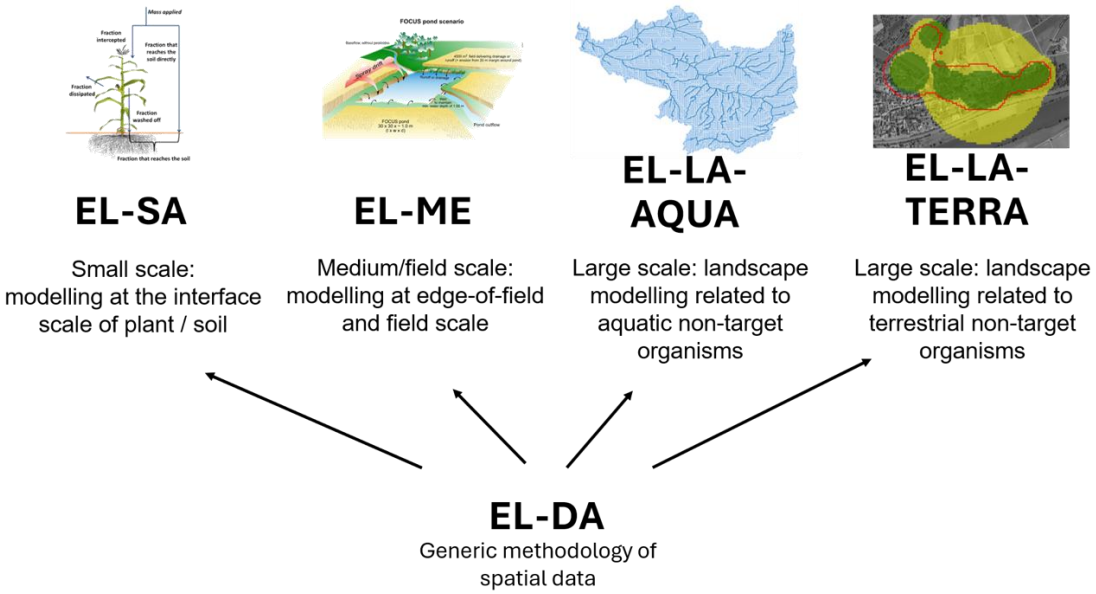
OBJECTIVES

- Advance the integration of exposure and effect modelling across spatial scales to improve environmental risk assessment of agrochemicals.
- Develop and test scenario-based approaches that incorporate spatial heterogeneity in aquatic and terrestrial ecosystems.

HIGHLIGHTS

- Multi-scale approach covering small (EL-SA), field (EL-ME), and landscape scales (EL-LA_terra and EL-LA_aqua).
- Terrestrial focus on the arthropod Bembidion across all terrestrial working groups to ensure consistency and comparability.
- Inclusion of additional soil organisms (earthworms and springtails) in the small-scale group (EL-SA).
- Emphasis on precision application farming scenarios in EL-SA and EL-ME to reflect realistic and emerging agricultural practices.
- Aquatic landscape-scale assessment includes species with differing mobility: Lemna, Asellus, and stickleback.
- Use of the xLandscape modelling environment to support spatially explicit landscape-level analyses.

- Strong coordination via the EL-DA group providing standardised test datasets and methodological support.
- Observers and other interested parties can keep up to date with progress on the official website [1].



Aims and Scope of ELINK-2 working group. The SETAC endorsed workshop started in March 2026 with a first face to face meeting where the different working groups discussed case studies. It is envisaged to present results in 2027. Picture EL-SA: PEC soil guidance (EFSA 2017), Picture EL-ME: https://www.pesticidemodels.eu/toxswa

REFERENCES

[1] SETAC endorsed ELINK-2 workshop. (2026). ELINK-2: Linking exposure and effect modelling. https://www.setac.org/elink2.

POSTER CONTRIBUTIONS – SESSION II

SCENARIO SELECTION BASED ON SPATIALLY DISTRIBUTED LEACHING MODELLING OF PESTICIDES IN GERMANY WITH GEOPELMO DE

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Presenter Wolfram König

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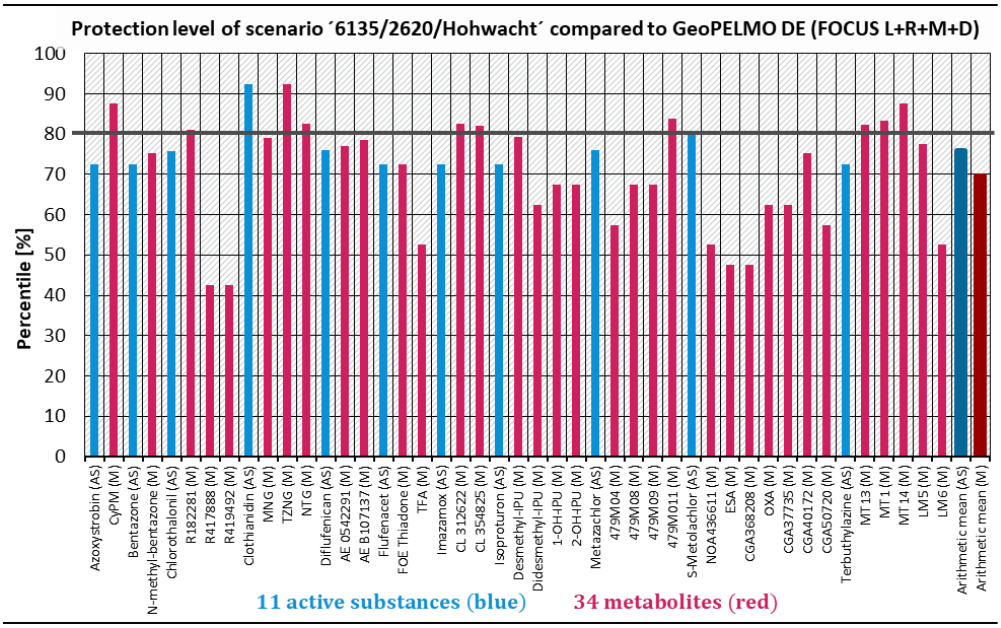
OBJECTIVES

This work was conducted to identify agricultural areas in Germany with high risk for leaching by using the method of spatially distributed leaching modelling (SDLM) [1]. A new version of GeoPELMO DE was developed that considers surface runoff, preferential (macropore) flow and drainage beside chromatographic (matrix) flow. Nationwide predicted leachate concentrations are often more conservative than the currently used national approach based on the FOCUS Hamburg scenario (S2O13). This finding is consequently observed across the tested modelling approaches, FOCUS leaching approach based on matrix flow or an extended approach including runoff, macropore flow and drainage is used.

HIGHLIGHTS

- National scenarios, for example also the Hohwacht scenario, were selected and tested on several pesticides to analyse whether they represent a targeted 80th spatial percentiles.
- Some scenarios represent a rather narrow percentile range around the 80th percentile, while others represent a very broad range of percentiles. Differences were identified for active substances and metabolites.
- The results were more heterogeneous when additional processes were included in the modelling.

- This raises the question whether only spatial models are able to equally predict an accurate temporal and spatial percentile for pesticides. Individual climate-soil-combinations can serve as an approximation, but it must be expected that there may be deviations from the results of a geo-version of the model.



As an example, the predicted environmental concentrations (PECs) from the new scenario Hohwacht are compared with the 80th spatial percentile concentration from GeoPELMO DE (version FOCUS Leaching+Runoff+Macropore flow+Drainage). The evaluation of several active substances and their main metabolites shows that a single scenario like Hohwacht does not represent a stable targeted spatial percentile for the different investigated compounds.

REFERENCES

[1] M. Klein, J. Klein, S. Hannappel, K. Thomas, S. Seifert, M. Trapp, “Protect groundwater from plant protection products. – Spatial distributed leaching modelling to identify agricultural areas with high risk for leaching,” *TEXTE 33/2026*, 290pp. Apr. 2026, https://doi.org/10.60810/openumwelt-8431.

A MECHANISTIC-AI HYBRID APPROACH TO META-MODEL PESTICIDE TRANSPORT IN LANDSCAPES

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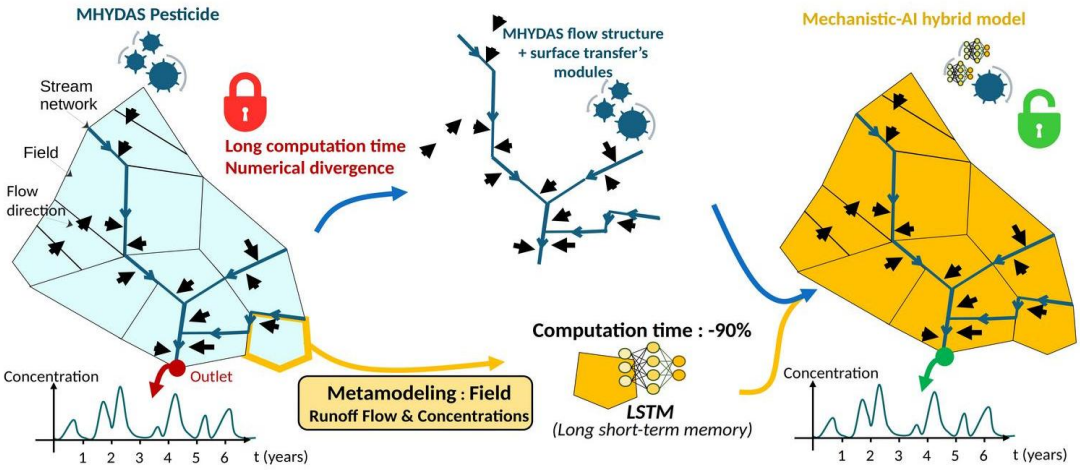
OBJECTIVES

The poster presents a hybrid solution to model pesticide transport in landscapes that combines an AI meta-model with a mechanistic model to simulate pesticide concentrations in runoff water at the catchment scale. This low-CPU-time approach enables intensive numerical simulations, supporting the design of sustainable landscape-diversification strategies.

HIGHLIGHTS

- The approach couples in the OpenFLUID modeling platform[1]: i) a field scale metamodel that simulates the dynamics runoff and its pesticide concentrations, with ii) a mechanistic surface transfer modele and the MHYDAS[2] flow structure
- The field scale metamodel was constructed by linking two LSTM neural networks trained on pesticide transport simulations runed with MHYDAS[4].
- At the field scale, the overall performance in reproducing multi-year records of herbicide flows is excellent, but zero flow periods are underestimated.
- CPU times are reduced by ~90 % (field[4]) and ~76 % (catchment[5]) respectively.



Flowchart of the mechanistic-AI hybrid approach. Metamodeling of the field modules of MHYDAS-Pesticides was carried out following a thorough validation of its ability to reproduce 20 years of field diuron and glyphosate export in runoff in that context.[3]

REFERENCES

[1] Fabre J.-C., Louchart X., Colin F., Dagès C., Moussa R., Rabotin M., Raclot D., Lagacherie P., Voltz M. (2010). *OpenFLUID : a software environment for modelling fluxes in landscapes.* International Conference on Integrative Landscape Modelling, Montpellier, France, https://hal.inrae.fr/hal-02752603 (https://www.openfluid-project.org/)

[2] Crevoisier D., Dagès C., Fabre J.-C., Roman-Villafane S., Voltz M. (2021). Modélisation Hydrologique Distribuée des AgroSystèmes - Eau et Pesticides. (INRAE Montpellier - UMR LISAH), 148p., https://hal.inrae.fr/hal-04090048

[3] Métayer G., Dagès C., Crevoisier D., Bailly J.-S., Voltz M. (2024). Performance of a pesticide fate model for predicting multi-year surface runoff contamination in a Mediterranean vineyard. Science of the Total Environment, 906, 167357, https://dx.doi.org/10.1016/j.scitotenv.2023.1673577

[4] Métayer G., Dagès C., Voltz M., Bailly J.-S. (2025) Metamodeling of a physically based pesticide runoff model with a long short-term memory approach. Journal of Hydrology, 2025, 662 https://dx.doi.org/10.1016/j.jhydrol.2025.133800

[5] Guillaume Metayer. Simulation par approche mixte mécaniste-statistique du devenir des pesticides dans l'environnement pour le diagnostic de la contamination des sols et des eaux. Sciences de l'environnement. Institut national d'enseignement supérieur pour l'agriculture, l'alimentation et l'environnement, 2024. Français. https://hal.inrae.fr/tel-04972030v2.

FIT-FOR-PURPOSE RISK ASSESSMENT OF LOW-CONCERN ACTIVE SUBSTANCES (LCASS) – A STARTING POINT FOR A TAILORED GROUNDWATER RISK ASSESSMENT OF BIOPESTICIDES AND INORGANICS?

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OBJECTIVES

- Identify key challenges in groundwater (GW) risk assessment under Reg. (EC) No 1107/2009 for biopesticides and inorganic substances;
- Evaluate limitations of current modelling approaches (e.g., FOCUS) when applied to non-conventional substances;
- Examine the applicability of the fit-for-purpose LCAS framework [1] to address data gaps and modelling constraints;
- Demonstrate how tailored approaches improve realism, consistency, and proportionality in GW risk assessment.

HIGHLIGHTS

- Current GW modelling approaches are not fit-for-purpose for biopesticides and inorganic active substances under Regulation (EC) No 1107/2009, particularly the 0.1 µg/L GW limit, challenging due to data gaps and unrealistic worst-case assumptions;
- Botanical mixtures, microbial metabolites, and inorganic compounds present specific assessment limitations not captured by FOCUS models;
- The LCAS framework integrates non-standard approaches (e.g. data waivers) to assess the likelihood of breaching the protection goal already at early stages (see table below);

- Fit-for-purpose approaches can improve realism, consistency, and proportionality of GW risk assessments for low-risk substances.

Pathways to Harm – Regulation (EC) No 1107/2009 vs LCAS methodology following [1] (orange = similar, green = additional approach).

Event (=Step)	**LCAS methodology**
1: Use of PPP containing active substance	similar approach to EC Regulation 1107/2009:
Assess likelihood of exposure to soil	nature and manner of use of plant protection products containing the active substance determines soil contamination
2: Soil is exposed to active substance	additional approaches to EC Regulation 1107/2009:
Determine if assessment for degradation products is needed	absence of hazard due to degradation products is justified based on the combination of natural occurrence in soil or history of use (of the active substance or the degradation products) and absence of indications for adverse effects
Assess likelihood of mobility of the substance in soil	additional approaches to EC Regulation 1107/2009:
	assess likelihood of mobility of the substance in soil, e.g., based on Koc value, see Assessing soil contamination: A reference manual (fao.org) [2]
3.a/b: Substance is mobile in soil	additional approaches to EC Regulation 1107/2009:
Determine PECgroundwater	- using either endpoints derived from guideline studies, or where appropriate from alternative methods (e.g., QSAR, read across) or default values (e.g., based on ready biodegradability) - adequate justification that the parametric value is not breached (e.g., combining natural occurrence data in soil, history of use and absence of groundwater concentrations > 0.1µg/L)
4.a/b/c: Harm	similar triggers to EC Regulation 1107/2009:
	parametric drinking water limit for organic pesticides (0.1 µg/L or 0.5 µg/L, resp.) or > 1/10 ADI or max concentration for inorganic pesticides

Aims and Scope of ELINK-2 working group. The SETAC endorsed workshop started in March 2026 with a first face to face meeting where the different working groups discussed case studies. It is envisaged to present results in 2027. Picture EL-SA: PEC soil guidance (EFSA 2017), Picture EL-ME: https://www.pesticidemodels.eu/toxswa

REFERENCES

[1] Z. Vryzas *et al.* (2025), "Fit-for-purpose risk assessment for low-concern active substances and uses," *EFSA Supporting publication 2026:EN-9791. 42 pp., doi:10.2903/sp.efsa.2026.EN-9791*
[2] FAO (2000), "FAO Pesticide Disposal Series 8, Assessing soil contamination, A reference manual, Appendix 2: Parameters of pesticides that influence processes in the soil", *https://www.fao.org/4/X2570E/X2570E06.htm*.

REVISITING MACRO 5.2 PARAMETERIZATION FOR EU & UK DRAINAGE SCENARIOS

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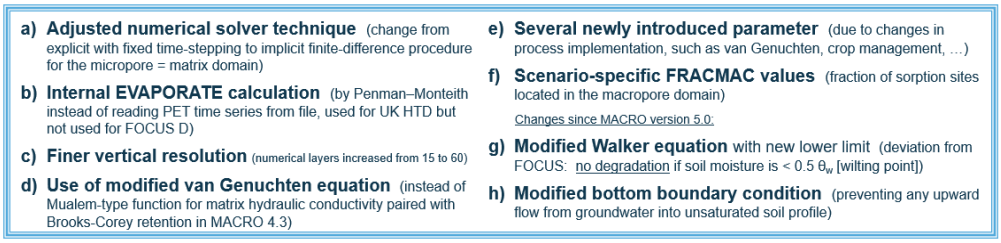
OBJECTIVES

The MACRO model is a cornerstone of regulatory pesticide fate assessment within the FOCUS Surface Water (SW) framework, providing a physically based simulation of macropore flow and solute transport in structured soils. The MACRO model is also employed in the UK higher tier drainflow assessment. The original drainflow scenarios were parameterized using MACRO 4.3b, calibrated and validated against field data to ensure realistic hydrological behaviour.

With the release of MACRO 5.2, several technical updates were implemented. While these updates improve model flexibility and performance, early comparisons indicated that outputs for standard scenarios may deviate from those generated with the earlier model version, potentially affecting regulatory consistency.

HIGHLIGHTS

A detailed comparison of process implementation and parameterization between the MACRO versions has been conducted based on the technical manuals of MACRO 4.3b and MACRO 5.0, the change document of MACRO 5.2 and model input-output files. The evaluation identified eight categories of changes.



Systematic simulations with MACRO 5.2 have been started in order to identify a suitable re-parameterization to restore better agreement with 4.3b reference loads while maintaining physical plausibility.

SIMULATION OF MICROTOPOGRAPHY AND PRECISION APPLICATION TO MITIGATE TRANSPORT OF PLANT PROTECTION PRODUCTS VIA RUNOFF AND EROSION USING A FULLY INTEGRATED SURFACE WATER-GROUNDWATER MODEL

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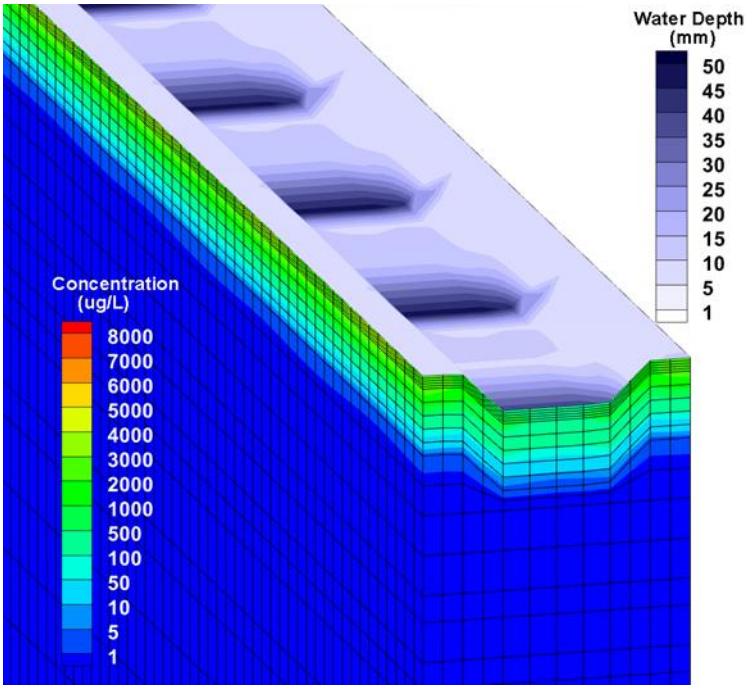
OBJECTIVES

- To extend the capability of the physics-based, fully integrated, 3D hydrological fate and transport model HydroGeoSphere (HGS) for simulation of transport of plant protection products (PPPs) via runoff and erosion;
- To verify HGS runoff generation, PPP concentrations dissolved in runoff and adhered to eroded sediment against the PRZM model; and,
- To demonstrate the effects of reduced PPP application through banded application to potato ridges and to simulate reduced runoff and PPP transport through the use of microdams.

HIGHLIGHTS

- Banded PPP application to potato ridges resulted in lower simulated PPP mass transport via runoff and erosion compared to broadcast application; and,
- Use of microdams in the furrows between potato ridges reduced total runoff and increased infiltration, thereby reducing PPP transport via runoff and erosion.



Simulated 3D PPP concentrations in soil (dissolved phase) and ponded surface water behind microdams three days after banded PPP application to potato ridges, for the spring 1993 PPP application in the FOCUS R3 (Bologna) runoff scenario HGS model with a potato crop and low sorbing Test Substance 1 (FOCUS, 2001).

REFERENCES

[1] FOCUS (2001). FOCUS surface water scenarios in the EU evaluation process under 91/414/EEC. Report of the FOCUS working group on surface water scenarios. EC Doc. Ref. SANCO/4802/2001-rev.2 Version 1.4 (May 2015).

ADDRESSING PH-DEPENDENT LEACHING OF AGROCHEMICALS IN THE EU THROUGH ADVANCED SPATIAL ANALYSIS AND GROUNDWATER MONITORING DATA

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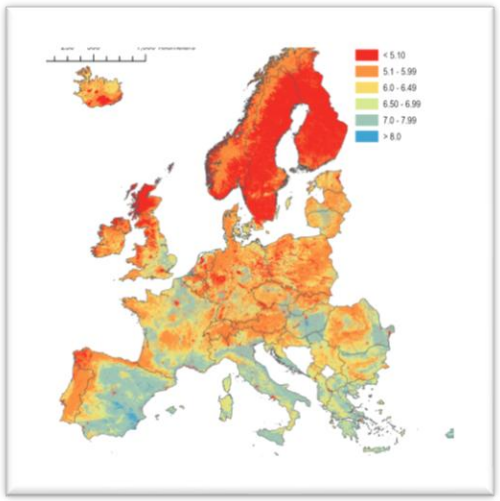
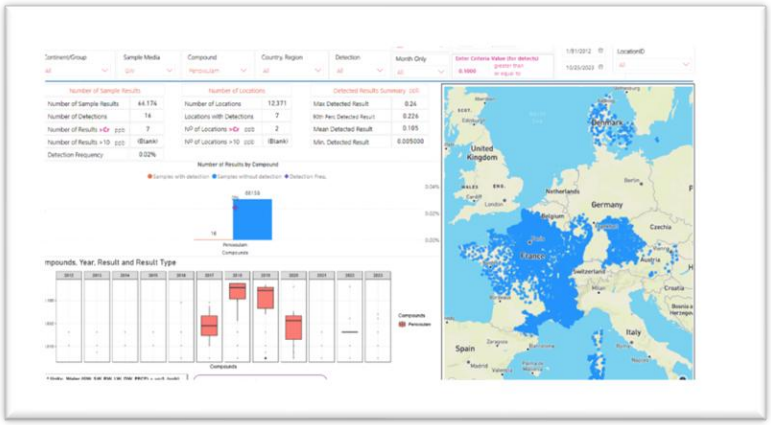
OBJECTIVES

- The leaching potential of agrochemicals with pH-dependent sorption and degradation in the EU was evaluated.
- Spatial soil pH mapping and long-term groundwater monitoring data were used to assess and support leaching risk mitigation.

HIGHLIGHTS

- Spatial mapping identified EU agricultural areas vulnerable to pH-dependent leaching across crop types, supporting appropriate label restrictions. Crop production areas in Europe were identified using multiple datasets, including CORINE 2018, EUCropMap 2018, Eurostat Agricultural Census data, and the RapeSeedMap 10 database. Soil pH(H_2O) data was obtained from the SoilGridTM database.
- We utilized a platform to collect and analyze long-term public groundwater monitoring data, demonstrating low leaching risk.





Spatial analysis of Soil pH across EU Crop Product Areas and Decade of Public Groundwater Monitoring Across Key EU Regions

PESTICIDE EXPOSURE ASSESSMENT IN RICE PADDIES UNDER DIFFERENT IRRIGATION STRATEGIES: A CASE STUDY IN LOMELLINA, NORTHERN ITALY

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OBJECTIVES

- Calculation of Predicted Environmental Concentrations in paddy water (PEC_{PW}), soil (PEC_{SOIL}), surface water (PEC_{SW}) and groundwater (PEC_{GW}) for six herbicides commonly used in Italian rice cultivation using the higher-tier models RICEWQ (v1.92), RIVWQ (v2.0.6), and VADOFT [1] across representative pedoclimatic units of the Lomellina area (Lombardy Region, Northern Italy) under three irrigation strategies (wet seeding and traditional flooding - WFL; dry seeding and delayed flooding - DFL; wet seeding and alternated wetting and drying - AWD).
- Comparison of maximum PEC_{SW} values with recent publicly available monitoring data from surface water bodies in Lomellina and with the EU-agreed Regulatory Acceptable Concentrations (RAC) for aquatic organisms.
- Identification of key drivers affecting PEC_{GW} variability and comparison with outcomes derived from the soil cluster scenarios currently proposed in the pesticide regulatory context.

HIGHLIGHTS

- Maximum PEC_{SW} values are generally consistent with maximum monitored concentrations, with the exception of AMPA which shows higher monitored values likely due to contributions from multiple non-agricultural sources.
- All the substances and scenarios under assessment show an acceptable risk for aquatic organisms, with a high margin of safety for glyphosate and AMPA.

- Seepage rate and flooding duration are consistently identified as the main drivers of PEC_{GW} variability, with seepage rate emerging as a key factor controlling groundwater contamination risk.

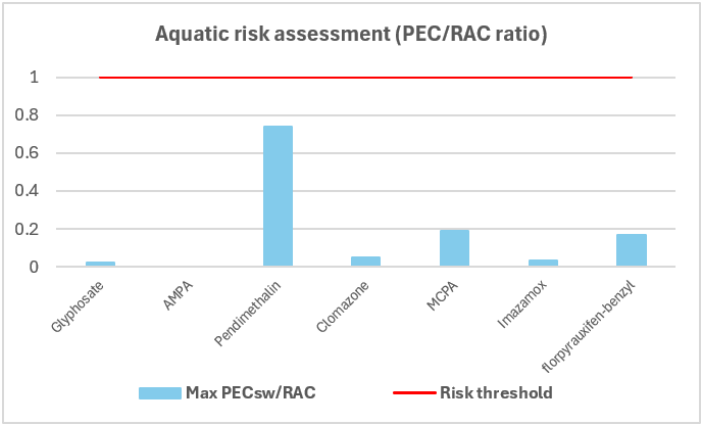

Figure 1. Aquatic risk assessment based on maximum PEC_{SW}/RAC ratios for the selected compounds

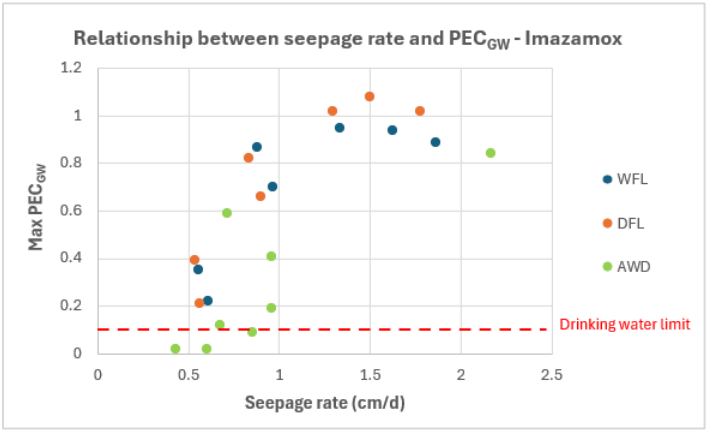

Figure 2. Maximum PEC_{GW} as a function of seepage rate for imazamox under three irrigation strategies

REFERENCES

[1] F. Casallanovo *et al.*, "Comparative assessment of exposure tools to estimate pesticide concentrations in rice paddies: a discussion of the Brazilian context" *Integrated Environmental Assessment and Management,* 21(4), 751–760, 2025, doi: https://doi.org/10.1093/inteam/vjaf015.

EXPERIMENTAL TESTING OF VFSMOD REMOBILIZATION ASSUMPTIONS WITH HIGH-RESOLUTION MESOSCALE MONOLITH DATA

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Presenter Rafael Muñoz Carpena

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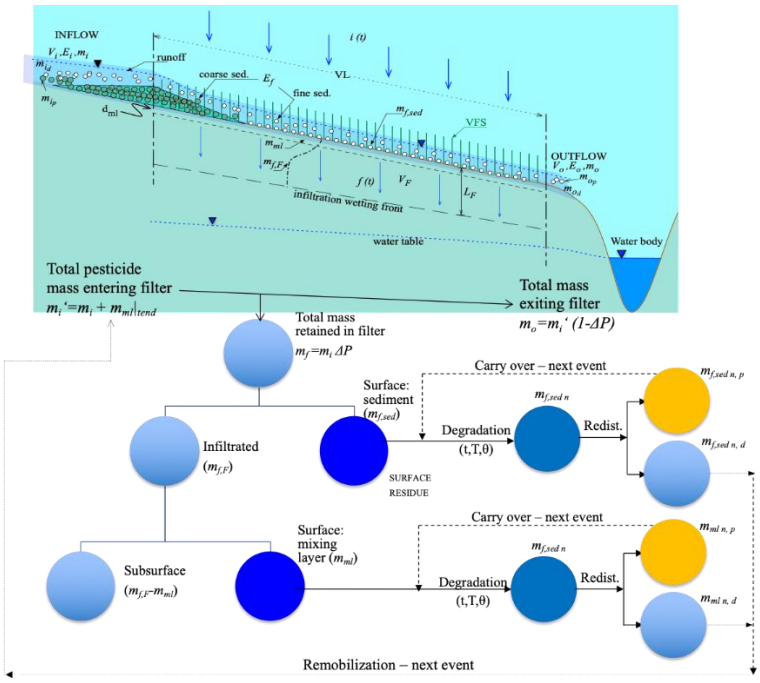
OBJECTIVES

- Evaluate the performance of the recently updated remobilization process in VFSMOD[1,2]
- Improve the process description by allowing the soil surface mixing layer to drain to field capacity after the rainfall event and leaching of associated dissolved mass before quantifying degradation between events.

HIGHLIGHTS

- High resolution experimental data was collected using a rain simulator (3m x 3m x 3m) and VFS monolith (1.2m x 1.2m x 0.4m) instrumented to record inputs, outputs, and in-soil measurements.
- Three pesticides (Mesosulfuron, Fluopyram, Diflufenican) with a wide range of sorption characteristics were monitored over three consecutive rainfall–runoff events separated by one-week dry periods.
- Laboratory experiments were simulated with two VFSMOD versions: the recently updated full porewater remobilization, and with the proposed drained to equilibrium leaching
- With full porewater remobilization, VFSMOD predictions of pesticide remobilization had a mean Nash-Sutcliffe Efficiency (NSE)($\approx R^2$) of 0.704, while incorporating drained to equilibrium leaching markedly improved performance to NSE= 0.994.

- Representing drained to equilibrium leaching after runoff events substantially improves prediction of remobilization of pesticide residues trapped in VFS.
- This work directly quantifies VFS pesticide remobilization in experimental settings for the first time.



Diagrammatic representation of the different components of the remobilization algorithm in VFSMOD[1],[2]

REFERENCES

[1] R. Muñoz-Carpena, A. Ritter, G. A. Fox, and O. Perez-Ovilla, "Does mechanistic modeling of filter strip pesticide mass balance and degradation processes affect environmental exposure assessments," Chemosphere, vol. 139, pp. 410–421, 2015, doi: 10.1016/j.chemosphere.2015.07.010.

[2] Muñoz-Carpena, S. Reichenberger, R. Sur, and S. Sittig, "Complex runoff remobilization of residues trapped in vegetative buffers during long-term exposure assessments: VFSMOD development and analysis," presented at the Pesticide Behaviour in Soils, Water and Air, York, U.K., 2022.

FLUXMOD: A PROCESS-BASED FRAMEWORK FOR QUANTIFYING PESTICIDE VOLATILIZATION FROM SOILS

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OBJECTIVES

Pesticide volatilization from soil can be an important off-target exposure pathway following agricultural application, yet current regulatory approaches often rely on simplified, time-invariant physicochemical indicators or fixed emission fractions [1]. This study developed and evaluated FLUXMOD, a mechanistic, process-based modeling framework that explicitly couples initial pesticide leaching during the initial pesticide application, hourly soil moisture dynamics (FAO-56 water balance with Penman-Monteith evapotranspiration), liquid-phase pesticide mass balance in a near-surface mixing layer, and a resistance-based soil–atmosphere exchange formulation to simulate time-resolved volatilization fluxes under field conditions. The framework was calibrated and validated against multi-site field measurements and subjected to Global Sensitivity Analysis (GSA) to identify key controls on emission dynamics.

HIGHLIGHTS

- FLUXMOD integrates four coupled process modules: (i) infiltration and leaching during the initial pesticide application; (ii) hourly FAO-56 soil water balance; (iii) liquid-phase pesticide mass balance with Koc-based sorption equilibrium in a near-surface mixing layer; and (iv) resistance-based soil–atmosphere exchange flux using Henry's law gas–liquid partitioning [1].
- The model was calibrated and validated against multi-site field datasets including time-resolved dicamba volatilization flux measurements from 23 field trials across six geographic locations [2] and concurrent soil moisture observations.

- Soil moisture simulations showed strong agreement with field observations (NSE ≤ 0.946), consistent with the established role of soil water content in controlling near-surface pesticide phase partitioning [3].
- Simulated volatilization fluxes reproduced observed complex temporal dynamics and emission magnitudes across study sites (KGE ≤ 0.916), capturing diurnal emission peaks characteristic of the early post-application period.
- Global Sensitivity Analysis using Sobol indices [4] identified field capacity (θ^{fc}) as the dominant control on soil moisture, while Henry's constant (H) and organic carbon content (OC) were the primary drivers of volatilization flux variability.
- Cumulative first-order sensitivity indices (ΣS_i = 0.58–0.79) reveal strong parameter interactions, confirming that volatilization dynamics are governed by coupled physicochemical, soil, and environmental processes—not by any single indicator [5].
- Simulated high-percentile (P90) emission levels were consistent with field-observed flux distributions, supporting FLUXMOD's suitability for conservative pesticide exposure assessments in regulatory risk evaluation [6].
- Future work will couple FLUXMOD with atmospheric dispersion models (e.g., AERMOD) to enable regional-scale evaluation of downwind pesticide concentrations and human/ecological exposure.

REFERENCES

[1] C. Bedos, P. Cellier, R. Calvet, E. Barriuso, and B. Gabrielle, "Mass transfer of pesticides into the atmosphere by volatilization from soils and plants: overview," Agronomie, vol. 22, no. 1, pp. 21–33, 2002.
[2] E. D. Sall, K. Huang, N. Pai, A. W. Schapaugh, J. L. Honegger, T. B. Orr, and L. S. Riter, "Quantifying dicamba volatility under field conditions: Part II, comparative analysis of 23 dicamba volatility field trials," J. Agric. Food Chem., vol. 68, no. 8, pp. 2286–2296, Jan. 2020, doi: 10.1021/acs.jafc.9b06452.
[3] R. Reichman, D. E. Rolston, S. R. Yates, and T. H. Skaggs, "Diurnal variation of diazinon volatilization: soil moisture effects," Environ. Sci. Technol., vol. 45, no. 6, pp. 2144–2149, 2011, doi: 10.1021/es102905b.
[4] Y. Khare, C. J. Martinez, R. Muñoz-Carpena, A. Bottcher, and A. James, "Effective global sensitivity analysis for high-dimensional hydrologic and water quality models," J. Hydrol. Eng., vol. 24, no. 1, p. 04018057, Jan. 2019, doi: 10.1061/(ASCE)HE.1943-5584.0001755.
[5] C. Bedos et al., "Modelling pesticide volatilization after soil application using the mechanistic model Volt'Air," Atmos. Environ., vol. 43, no. 22–23, pp. 3630–3639, 2009, doi: 10.1016/j.atmosenv.2009.03.026.
[6] K. Guillaume, O. Cesbron, N. Bonvallot, and O. Le Bihan, "From application in the fields to dispersion in the atmosphere: A narrative review on airborne pesticides and their monitoring in France," Atmos. Pollut. Res., p. 102820, 2025, doi: 10.1016/j.apr.2024.102820.

ELINK-2: LINKING EXPOSURE AND EFFECT MODELS ACROSS SCALES FOR PESTICIDE RISK ASSESSMENT: CONCEPTS, CASE STUDIES AND DATA GAPS FOR SMALL-SCALE CONSIDERATIONS FROM ELINK-2

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Presenter Bernhard Gottesbüren

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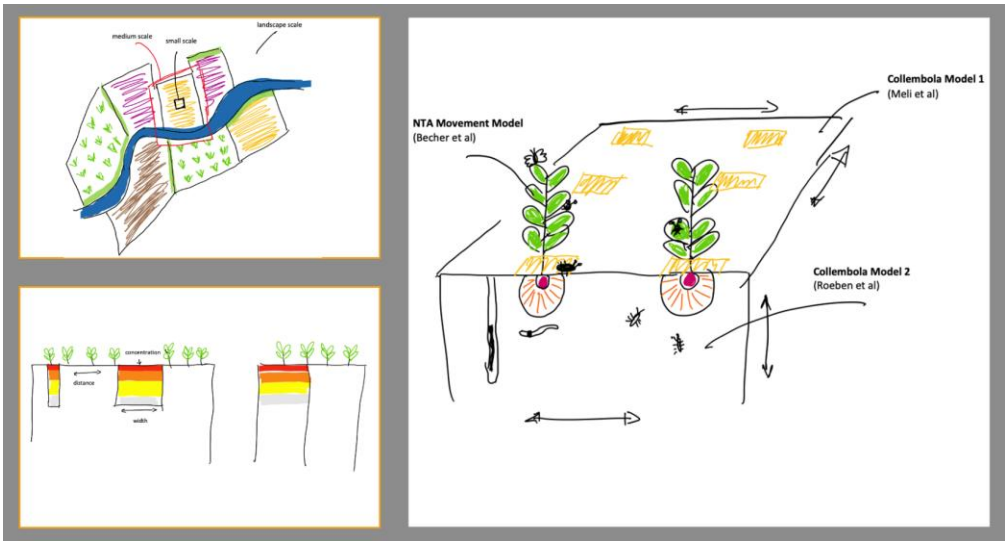
OBJECTIVES

- Development and demonstration of concepts for linking mechanistic exposure and effect models at the small spatial scale, with a focus on soil organisms and non-target arthropods.
- Exploration of how small-scale exposure–effect relationships inform and improve consistency with medium- and landscape-scale modelling approaches within ELINK-2.
- Evaluation of the coupling between mechanistic soil exposure models (including adaptations of regulatory tools) and effect models, such as individual-based population models and TKTD approaches.
- Assessment of the relevance of spatial heterogeneity, arising from precision application techniques (e.g. patch, band, and spot applications) and organism movement, for exposure and risk characterization.
- Contribution to harmonized cross-scale case studies within ELINK-2, enabling comparison of exposure–effect linkages and supporting integrated assessment frameworks.

HIGHLIGHTS

- Small-scale modelling demonstrates that spatial heterogeneity and organism movement can critically influence exposure–effect relationships and may require spatially explicit approaches.

- Coupling of exposure and effect models at the small scale enables process-based understanding that supports interpretation and extrapolation to higher-tier assessments.
- Harmonized case studies across ELINK-2 can reveal temporal and spatial mismatches between exposure profiles and effect model requirements.
- Integration across scales highlights methodological limitations and key data gaps, supporting prioritization of future model development.
- The EL-SA work contributes to a coherent, scale-explicit risk assessment framework, improving ecological realism while maintaining regulatory relevance; see [1].



From landscape to small scale. Within the EL-SA group we will look at different models and their scales: The NTA model will look at the movement of NTA within a plant, which can lead to very different exposure pattern [2]. The Collembola Model 1 will look at a field from a horizontal perspective, with a focus on precision application pattern [3]. The Collembola Model 2 will take a horizontal view [4].

REFERENCES

[1] https://elink2.info/
[2] Becher, M., Chapple, A., Fremdt, H., Isemer, R., Jakoby, O., Plling, E., Schmolke, A., Schriever, C., Thorbek, P., Preuss, T.G.. Effects of Drift Exposure on Non-Target Arthropods: Insights from a Small-Scale Movement Model [Poster presentation]. 35th SETAC Europe Annual Meeting, LOCATION. https://setac.secure-platform.com/vienna2025/solicitations/102006/sessiongallery/94169/application/6325
[3] Meli, M., Auclerc, A., Palmqvist, A., Forbes, V. E., & Grimm, V. (2013). Population-Level Consequences of Spatially Heterogeneous Exposure to Heavy Metals in Soil: An Individual-Based Model of Springtails. Ecological Modelling, 250, 338–351. https://doi.org/10.1016/j.ecolmodel.2012.11.010
[4] Roeben, V. (2023). The life-history and vertical distribution of a soil organism (Folsomia candida) as basis for an ecological relevant population model for the risk assessment of pesticides [RWTH Aachen University]. In Dissertation: RWTH Aachen University (p. pages 1 Online-Ressource : Illustrationen). https://doi.org/10.18154/RWTH-2024-00429.

MODELLING OF EXPOSURE AND EFFECTS AT THE MEDIUM EDGE-OF-FIELD AND FIELD SCALE (EL-ME)

Bas Buddendorf, Dieter Schäfer, Andreas Focks, Birgit Zillgens, Devdutt Kulkarni, Judith Klein, Stefan Reichenberger

Presenter Dieter Schäfer

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OBJECTIVES

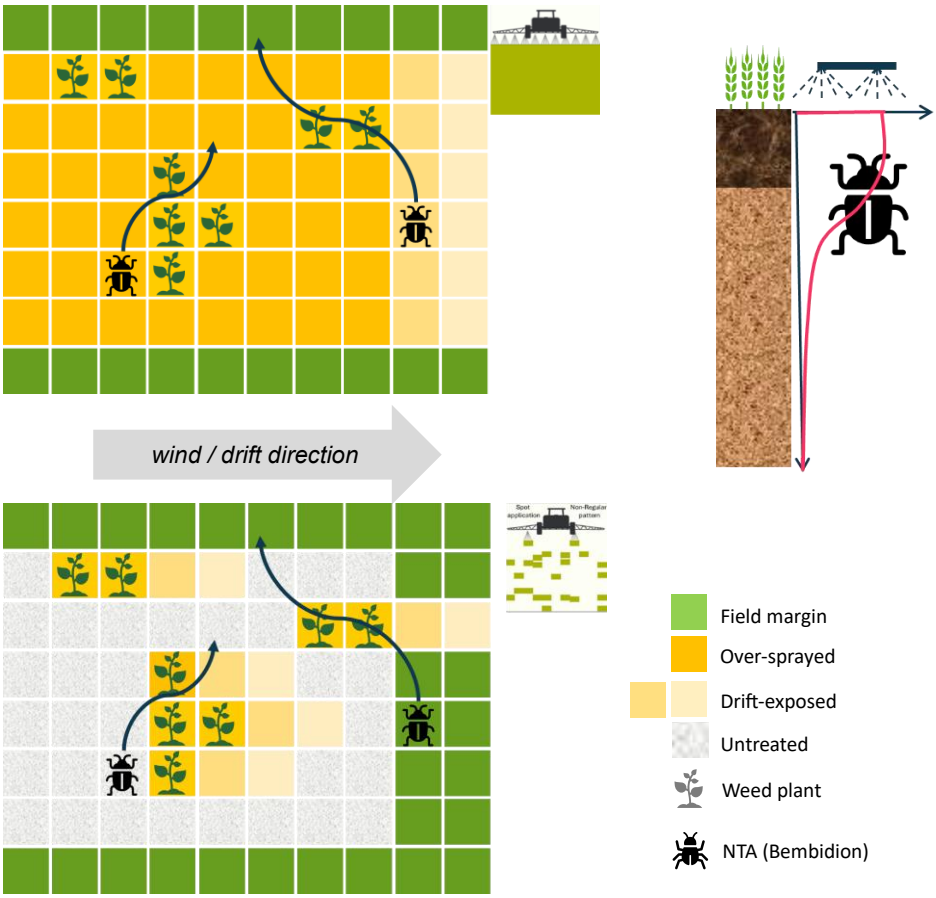
The medium scale in ELINK-2 is the scale of a single agricultural field and its imme-diate surroundings (field margins), thus covering the basic spatial unit for regulatory risk assessment of pesticides. The EL-ME medium-scale modelling is fully aligned with the large-scale (EL-LA_Terra) and small-scale (EL-SA) modelling, applying the same basic parameterization regarding environmental (weather, soil, topography etc.) and agronomic (crop, pesticide treatments, crop rotation etc.) aspects. The same expo-sure models (even the same exposure concentrations, where applicable) are used to address the medium-scale exposure routes relevant for the investigated species, the ground beetle Bembidion: in-field soil deposition from direct application and spray drift, as well as off-field soil deposition from spray drift; in addition, temporal and spatial variation of substance concentrations in soil will be calculated. To predict the effects of applied pesticides, similar effect models are used across spatial scales, with aligned parameterization.

special aspect of EL-ME will be the explicit consideration of precision application: various patch application patterns based on real-world application maps will be used to represent realistic in-field heterogeneity of exposure. Standard broadcast applica-tions will be modelled to represent homogeneous baseline exposure for comparison. Each exposure scenario will be combined with a simple (fixed effect threshold, eco-logy not considered) and with a more ecologically realistic (population modelling, ecology explicitly considered) effect modelling scenario.

This approach allows a robust analysis of the feasibility and plausibility of combined ecological modelling at the highly relevant field scale, under heterogeneous exposure situations. It will also reveal gaps and deficiencies that require further work.
The poster explains the medium-scale modelling concept of ELINK-2 and presents the selected exposure and effect models (including necessary adaptations) with their full parameterization.

HIGHLIGHTS

- Predicting the effects of pesticides on a non-target arthropod at field-scale
- Linking exposure and effect modelling in a common data framework across scales
- Heterogeneity of exposure based on realistic precision application patterns
- Impact of exposure heterogeneity and level of ecological detail on modelling results.



Conceptual approach of EL-ME modelling: Exposure on and in soil predicted with standard regulatory exposure models considering direct overspray and spray drift (top right), effects on non-target arthropods predicted with the Bembidion model in a broadcast application scenario (top left) and a precision application scenario (bottom left); both scenarios modelled with simple and complex ecology.

ELINK-2 TERRESTRIAL LANDSCAPE: MODELLING EXPOSURE AND EFFECTS ACROSS TERRESTRIAL LANDSCAPES – A CASE STUDY OF A NON-TARGET ARTHROPOD

Nika Galic, Fabian Gruber, Philip Branford, Sascha Bub, Oliver Jakoby, Jorge Olivares, Melissa Reed, Edna Roedig, Thomas Sinclair, Marie Trijau, Sanne van den Berg, Dirk Nickisch

Presenter Philip Branford

Adama Agricultural Solutions
Arlington Business Park, Reading
UK

OBJECTIVES

- Develop and apply a spatially explicit modelling framework linking pesticide exposure and effects on a non-target arthropod (*Bembidion lampros*) across terrestrial landscapes.
- Evaluate the influence of spatial heterogeneity — including crop diversity and proportion of natural habitat — on species abundance and population resilience under realistic agricultural scenarios
- Evaluate the level of effects at landscape level when allowing for level of effects in-field

HIGHLIGHTS

- Focus on *Bembidion lampros*, a ground-dwelling predator central to European agricultural ecosystems, as the focal species for the terrestrial landscape working group.
- Further development of an existing population model to evaluate abundance and persistence across spatial units: in-field, off-field, and landscape-wide.
- Simulation of multiple applications of a single compound under realistic Good Agricultural Practice (GAP) and multi-year crop rotations.
- Scenario design ranges from low to high crop diversity and from no natural habitat to 80% natural habitat, ensuring representativeness and regulatory relevance.
- Builds on the legacy of the 2007 ELink workshop and responds to the 2025 EU Modelling Workshop call for frameworks addressing spatial heterogeneity.

- Part of the broader ELink2 initiative leveraging existing modelling tools to explore pesticide exposure and effects within realistic agricultural environments.
- Aims to provide mechanistic understanding of how landscape structure influences species resilience, informing science-based risk assessments across spatial scales.

REFERENCES

[1] SETAC endorsed ELINK-2 workshop. (2026). ELINK-2: Linking exposure and effect modelling. https://www.setac.org/elink2

ELINK-2: MODELLING AQUATIC EXPOSURE AND EFFECTS ON CATCHMENT SCALE

Sebastian Multsch, Charles Hazlerigg, Eric Bruns, Mike Fuchs, Elena Alonso Garcia, Wenkui He, Udo Hommen, Dirk Nickisch, Andreu Rico, Mascha Rubach, Nicoleta Suciu, Robin Sur

Presenter Sebastian Multsch

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OBJECTIVES

- Aquatic risk assessment of plant protection products within the European regulatory framework follows a tiered approach, where lower tiers apply conservative edge of field scenarios, while higher tiers allow refinement through increased ecological and spatial realism where scientifically justified. Landscape scale modelling provides a means to explore this additional realism in higher tier assessments.
- Although a wide range of tools and models for PPP exposure and effects is available, their combined and consistent application across spatial scales has not yet been corroborated for regulatory risk assessment. In parallel, interest is increasing in approaches that support catchment scale risk management and stewardship in line with wider EU water protection objectives.

HIGHLIGHTS

- Model applications were implemented within the xLandscape framework [1], integrating established regulatory exposure models for spray drift, runoff, drainage, and aquatic fate with mechanistic effect models.
- This poster presents discussion points and planned work from the aquatic landscape working group (EL-LA-AQUA) of the ELINK-2 initiative [https://elink2.info/], reflecting exchanges during the first face-to-face workshop held in March 2026. The workshop explored the applicability, transparency, and regulatory relevance of landscape-scale aquatic risk

assessment using linked exposure and effect models, building on established regulatory concepts and tiered risk assessment principles.

- Ongoing work within ELINK-2 aims to provide a proof of concept for technical implementation and to identify key challenges for future work, including mixture toxicity, data availability, validation strategies, transparent uncertainty communication, and pragmatic pathways for regulatory consideration.

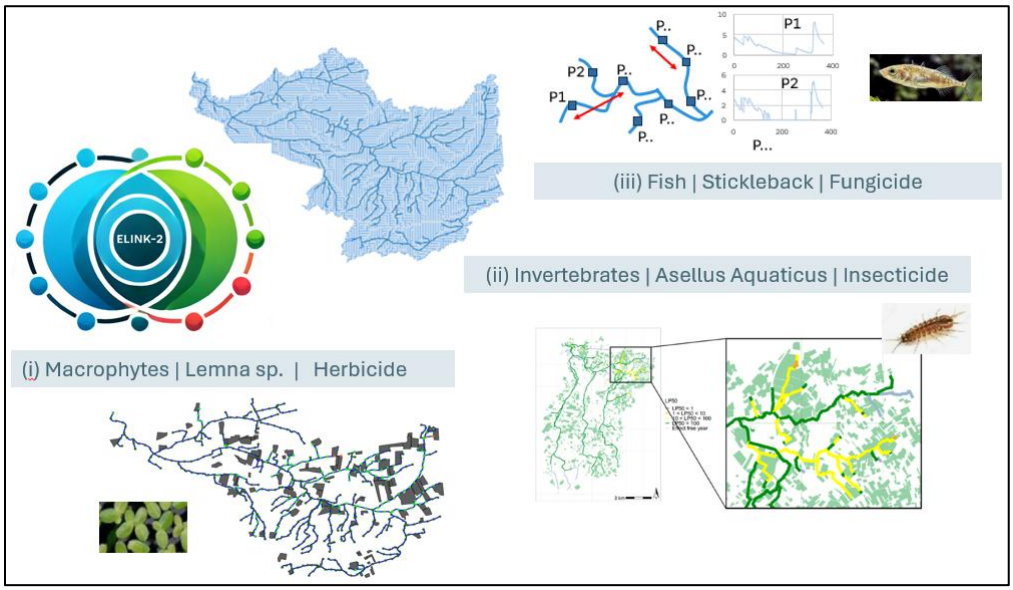

Figure of three illustrative case studies defined for agricultural catchments: (i) macrophytes exposed to a herbicide using a toxicokinetic–toxicodynamic model for Lemna spp. [2]; (ii) aquatic invertebrates exposed to an insecticide using an individual based model for Asellus aquaticus [3]; and (iii) fish exposed to a fungicide using an individual based stickleback model [4] incorporating habitat structure and organism mobility.

REFERENCES

[1] S. Bub. https://github.com/xlandscape/, 2026.
[2] Multsch *et al.*, XVII Symposium on Pesticide Chemistry, Piacenza, 2024.
[3] B. Buddendorf *et a*l.,. Environ. Sci. Technol. 5;57(41):15608-16, 2023.
[4] K. S. Mintram *et al*., Aquatic Toxicology 224 (2020): 105483, 2020.

ELINK-2 DATA - EXPOSURE MODELS FOR PESTICIDE RISK ASSESSMENT ACROSS SCALES: AVAILABILITY, LIMITATIONS, AND DATA GAPS

Edna Roedig, Dirk Nickisch, Yi Chen, Frederico Ferrari, Wenkui He, Gregory Hughes, Jorge Rivas Olivares, Hedrik Rathjens, Franziska Taubert

Presenter Dirk Nickisch

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OBJECTIVES

- Identify the challenges of linking spatially and temporally explicit exposure models to effects models as a key goal of the ELINK-2 project [1]
- Establish what existing exposure models at the plant, field, and landscape-scale can and cannot deliver in terms of data quality, spatial and temporal resolution, and represented processes
- Evaluate the suitability of regulatory tools (e.g., PERSAM, PEARL, PELMO) and the modular landscape modeling framework xLandscape for coupled risk assessment
- Assess model compatibility with crop-specific application scenarios, crop rotations, drift inputs, and linkage to effects models, including TKTD-based approaches

HIGHLIGHTS

- Field-scale assessments rely on 1D model outputs; a gap remains for 2D approaches that simulate horizontal soil concentration gradients
- Landscape-scale parameterisation challenges are illustrated using the Funne catchment, Germany
- Temporal mismatches between exposure and TKTD-based effects models are identified
- Data gaps are mapped across scales, establishing a framework for prioritising model development and linkages within ELINK-2

REFERENCES

[1] SETAC endorsed ELINK-2 workshop. (2026). ELINK-2: Linking exposure and effect modelling. https://www.setac.org/elink2

IMPACT ASSESSMENT OF SELECTED INPUT PARAMETERS ON THE PREDICTING ENVIRONMENTAL CONCENTRATION OF PLANT PROTECTION PRODUCTS IN SOIL CALCULATED ACCORDING TO EFSA GUIDANCE (2017)

Boulai Ysé, Conrad Arnaud, Sromova Katerina, Tourret Martin, Vuillemard Pascaline, Farama Emilie and Mazerolles Vanessa

Presenter Yse Boulai

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OBJECTIVES & HIGHLIGHTS

The European Food Safety Authority (EFSA) has released a guidance (EFSA, 2017[a]) providing the methodology for calculating the predicted environmental concentrations of active substances and transformation products in soil (PECsoil) which can be used to conduct terrestrial risk assessments in the context of the Regulation (EC) No 1107/2009. This guidance on PECsoil calculations aims to ensure a more robust estimation of the exposure levels for soil organisms following application of Plant Protection Product (PPP). The methodology relies on specific soil scenarios taking into account knowledge on soil, weather and crop. The PECsoil calculations for the active substance and/or its metabolite(s) require only a few input parameters mainly related to (a) the application conditions of PPP (*e.g.*, crop, application rate, crop growth stage, application method) and (b) the properties of the active substance/metabolite(s) (*e.g.*, soil degradation and soil mobility). To facilitate the calculations, the analytical PERSAM tool has been released in addition to updated versions of the existing FOCUS numerical tools.

This work focuses on how variations in several input parameters related to (a) the assessed compound (especially soil degradation half-life, DT_{50} and soil mobility, Koc) and (b) the type of annual crops and application periods, affect PECsoil estimates under the EFSA methodology (2017). The PECsoil were calculated based on the recommendations of this guidance for several combinations of input parameters (DT_{50}/Koc), and different types of annual crops. Additionally, a statistical analysis was also conducted

on some of these crops to characterise in detail the impact of the selected input parameters on the PECsoil results.
This poster presents an analysis of sensitivity of the PERSAM model against the selected input parameters in order to better anticipate its use in risk assessment for annual crops.

REFERENCES

[1] [a)] EFSA Journal 2017;15(10):4982

SESSION III - NEW FRONTIERS IN PESTICIDE SCIENCE: LINKING APPLICATION TECHNOLOGY, EXPOSURE AND EFFECT RISK ASSESSMENT

Chairs: Lucrezia Lamastra, Marc Voltz

his session explores how new pesticide application technologies can be incorporated into exposure and effect risk assessment. The dominant theme is precision application, including banded spraying, spot spraying, patch application, variable-rate application, UAV spraying, and 3D canopy-targeted application in vineyards and orchards. Several contributions argue that precision technologies can reduce total pesticide use and off-target exposure, but that their environmental benefit depends strongly on spatial patterns, proximity to water bodies or field margins, crop structure, equipment type, and meteorological conditions. SPOTMOD and related case studies show how real application maps can be used to simulate runoff from treated and untreated field areas, while drift models estimate off-field deposition. EUPAF contributions propose tiered frameworks for integrating precision application into EU regulatory assessment, from simple conversion factors to advanced spatially explicit modelling. GIS data, LiDAR, remote sensing, machinery records, drone imagery, and local weather data are presented as key inputs for future field-specific exposure assessment. The session also discusses the need to link application technology with ecological effect assessment, rather than treating exposure reduction as a purely technical matter. Overall, Session III frames precision agriculture as a promising but complex frontier that requires harmonized terminology, better data, technology-specific validation, and regulatory adaptation.

KEYNOTE LECTURE

KEY CHALLENGES IN LINKING PESTICIDE APPLICATION AND MITIGATION TECHNIQUES TO EFFECT RISK ASSESSMENT: A FOCUS ON ATMOSPHERIC PROCESSES CONTRIBUTION

Carole Bedos

Presenter Carole Bedos

Université Paris-Saclay, INRAE, AgroParisTech, UMR ECOSYS 22, place de l'Agronomie 91120 Palaiseau France

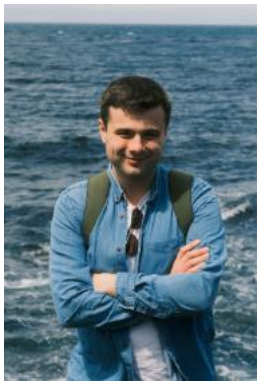
The use of pesticides to protect crops from various pests leads to contamination of all environmental compartments, thereby exposing ecosystems and populations. This issue arises in the food system and One Health contexts. Different exposure pathways of ecosytems and human population are involved: by hydrological and atmospheric transfers for the former and by ingestion, cutaneous and inhalation for the latter. Effects on organisms may be at the individual and populational scales. Currently, risk assessment is essentially done per active substance and per treated field and there are several limits in current regulatory risk assessment regarding the "air chapter".

With a focus on atmospheric compartment, this presentation will highlight some recent developments such as modelling approaches based on process-based modelling at different scales (local, landscape, regional/national) to answer to different questions on environmental dissipation of pesticides, machine learning approaches to predict pesticide concentrations in the air or in silico approaches to explore environmental behaviour and health effects. This overview will be completed by epidemiologic approaches carried out to identify potential links between exposure and childhood asthma. Regarding experimental approaches, new data on degradation in the atmosphere allowing the identification of transformation products will be presented as well as protocols set up in vitro to identify toxicological effects on pulmonary cells. This overview will be completed by management practices identified to limit pesticide dissipation through the atmosphere and thus exposure. The need for interdisciplinary approaches will be emphasized.

Remaining challenges will be identified, such as the assessment of the contribution of each pathway of exposure or the estimation of the different uncertainties in the chain Agricultural practices – effects, including the required knowledge on agricultural practices to spatialize pesticide dissipation in the environment. We will also identify the need for further developments regarding mixture of active ingredients or transformation products, the description within the model of new agricultural or the identification of agricultural pesticide management practices reducing exposure and effects in a One Health approach.

SPRAY DRIFT FROM BANDED AND REGULAR SPOT APPLICATIONS

Michael Bird, David Patterson



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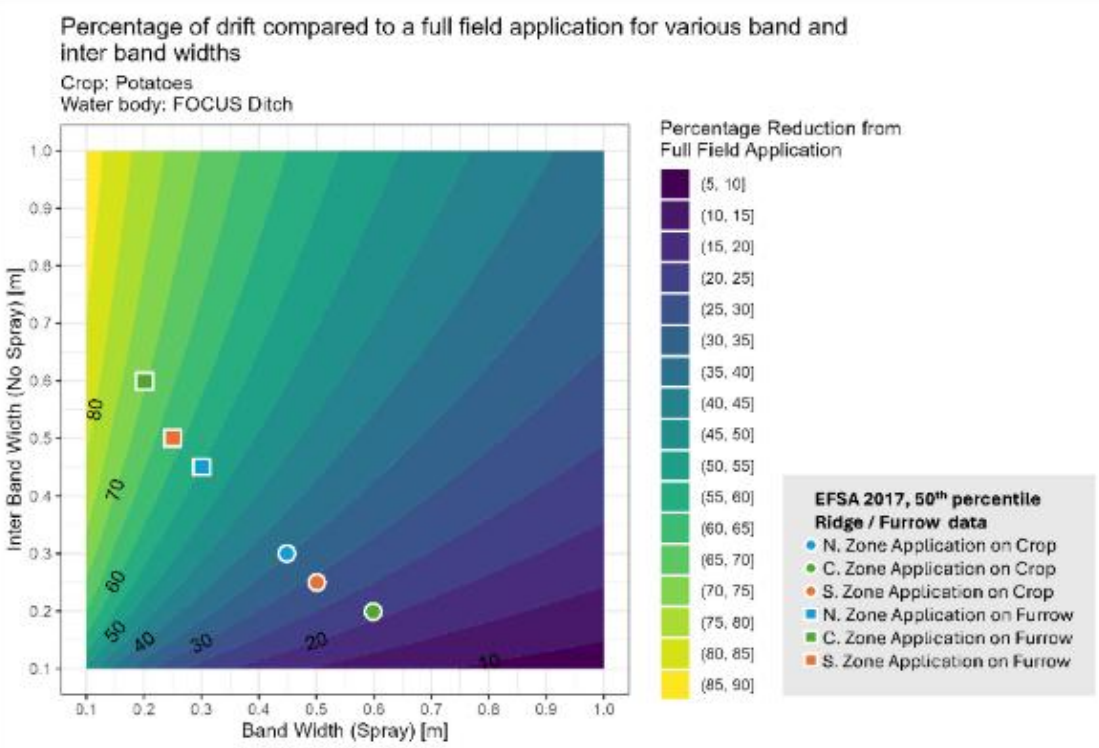
OBJECTIVES

As European agriculture embraces precision agriculture (PA), environmental risk assessment (ERA) of plant protection products (PPPs) must advance to reflect the reduced enviornmental exposure from non-full field applications. Two common forms of precision agriculture are banded and regular spot applications, where PPPs are applied in bands, or in a regularly spaced spot pattern. Here we present a mathematical method for deriving off field spray deposition from banded or spot application from a full field spray drift curve for the surface water ERA. This method is drift curve agnostic and can be applied to any band and spot geometries as the crop agronomy requires. This methodology could be applied in ERAs by adapting regulatory accepted full field drift curves without the need for additional experimental data specific to PA spray equipment.

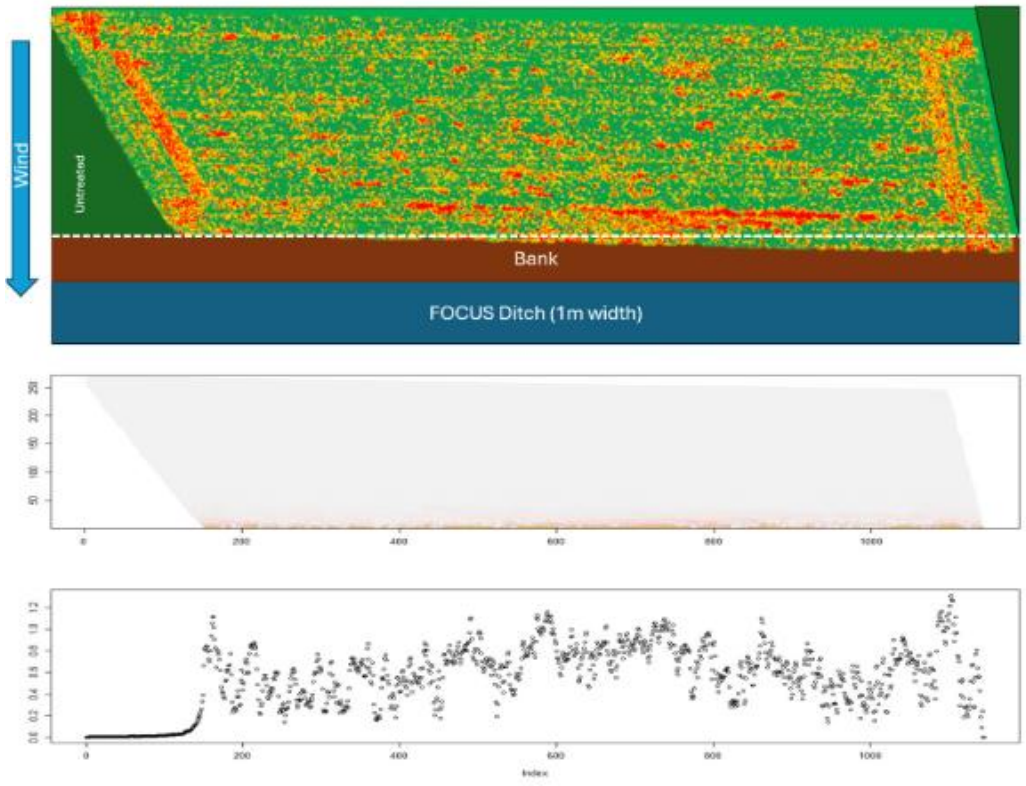
We also debut the new BRASS method (Buffers for the Risk Assessment of Spot Spraying) for estimating spray drift and calculating "on the fly" minimum buffer zones for pre-defined spray maps.

HIGHLIGHTS

- A derivation of the method for estimating banded application drift.
- A demonstrative analysis of the potential reduction when applied to the EU risk assessment, FOCUS Surface Water [1]
- A demonstration of the BRASS method to estimate spray deposition from a spray map and calculate a real time minimum buffer.



Potential reductions in spray drift for banded applications for various row widths when using the FOCUS SW drift assessment



A demonstration of the BRASS methodology where a pre-defined spray map (top, red = spray) is converted into a per-pixel spray deposition (middle) and then can be summed into a per column drift deposition (bottom)

REFERENCES

[1] FOCUS (2001). "FOCUS Surface Water Scenarios in the EU Evaluation Process under 91/414/EEC". Report of the FOCUS Working Group on Surface Water Scenarios, EC Document Reference SANCO/4802/2001-rev.2. 245 pp.

ESTIMATING GROUNDWATER EXPOSURE CONCENTRATIONS FOR PRECISION AGRICULTURE IN EUROPE: A ROBUST METHODOLOGY

Shanghua Li, David Patterson

Presenter Shanghua Li

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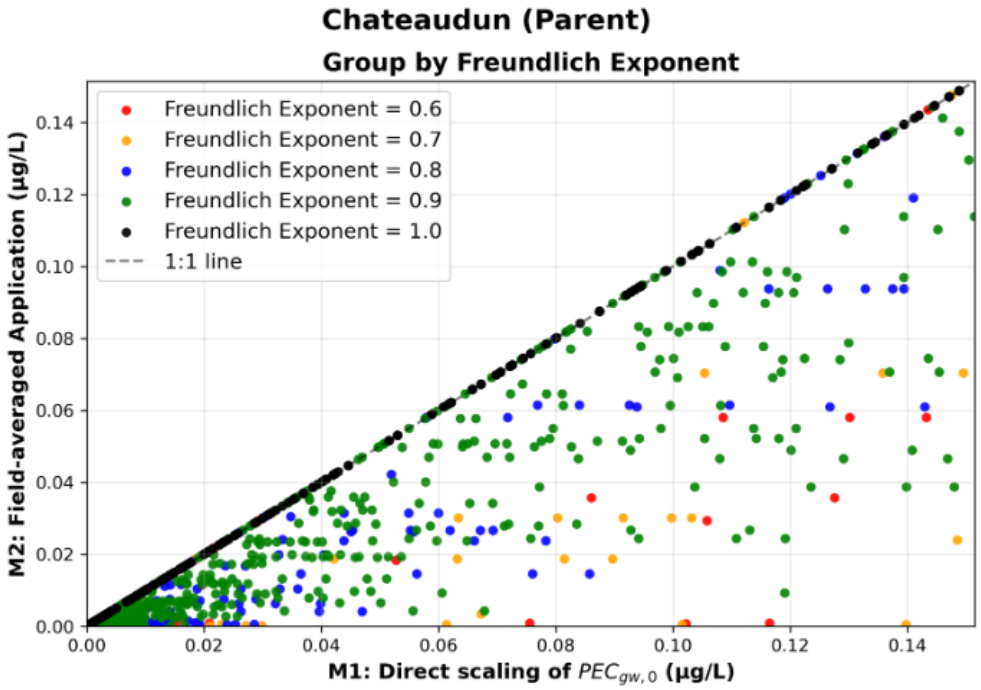
OBJECTIVES

Evaluate the most appropriate approach to estimate groundwater concentration for precision application technology.

- Evaluate the recommendation from the European Precision Application Task Force (EUPAF) that directly scaling broadcast PEC_{gw} [1] values by the treated field fraction is protective for parent and metabolite substances for the groundwater exposure assessment.

HIGHLIGHTS

- The non-linearity of Freundlich sorption [2] is the key driver for the substance partitioning between the solid and liquid phases.
- Directly scaling the broadcast PECgw by the fraction of the field treated is a scientifically defensible and conservative approach to evaluate groundwater concentration for parent substances for Precision Application.
- For parent substances where strong non-linear sorption behavior is present, directly scaling PECgw results in higher predicted groundwater concentration than using a reduced rate [3] for precision application evaluation.



Comparison of two methods to evaluate groundwater concentration for precision application. Method 1 (M1) is the direct scaling of PECgw from broadcast rate by the treated field fraction, and method 2 (M2) is the concentration derived from scaling the broadcast rate by the treated field fraction.

REFERENCES

[1] EUPAF, "Risk assessment and management for precision application," EUPAF Task Group 3&4 Document, version 1.2, Dec. 2025. Available: BVL - EUPAF - Risk Assessment and Management for Precision Application

[2] M. Leistra, A. M. A. van der Linden, J. J. T. I. Boesten, A. Tiktak, and F. van den Berg, "PEARL model for pesticide behaviour and emissions in soil-plant systems; Descriptions of the processes in FOCUS PEARL v1.1.1," Bilthoven, National Institute of Public Health and the Environment. Wageningen, Alterra, Green World Research. RIVM report 711401009/Alterra-rapport 013.2001

[3] M. M. S. Ter Horst, E. L. Wipfler, K. van Boheemen, and J. F. M. Huijsmans, "Impact of precision application of herbicides on leaching to groundwater," Wageningen Environmental Research, Wageningen, The Netherlands, Report 3293, 2023.

SPOTMOD: THEORETICAL BACKGROUND AND HYDROLOGY CALIBRATION

Rafael Muñoz-Carpena, Jorge Olivares-Rivas, Robin Sur, Stefan Reichenberger and T.J. Schultz

Presenter Rafael Muñoz Carpena

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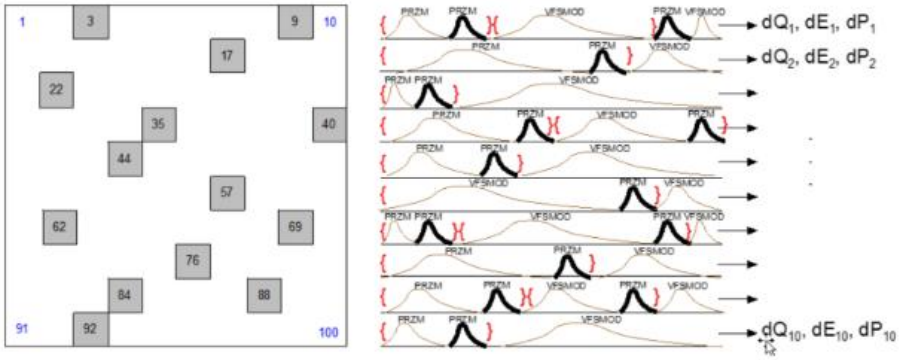
OBJECTIVES

Field "spot treatments" of agrochemicals based on proximal or remote sensing weed or plant infestation maps and high-precision application technology can significantly reduce chemical input and the associated economic cost to the farmer, while also lowering off-field drift and surface runoff to adjacent water bodies and terrestrial habitats relative to conventional broadcast applications. While the quantification of drift reduction with spot applications is advancing, very limited work exists on the quantification of potential pesticide runoff reduction. The objectives of this work are: (i) to present the theoretical background of SPOTMOD, a new 2D mechanistic exposure-modelling framework coupling PRZM, VFSMOD and TOXSWA to quantify pesticide runoff from precision (spot) applications and derive long-term predicted environmental concentrations in surface water (PEC_{sw}); and (ii) to validate the consistency of SPOTMOD hydrology against full-field PRZM runoff across the FOCUS R1–R4 surface-water scenarios.

HIGHLIGHTS

- POTMOD represents sources (runoff generated on treated spots) and sinks (infiltration, sedimentation and pesticide trapping on downslope untreated segments), including the effect of variable crop vegetation conditions on infiltration and sedimentation over the cropping season.
- It accommodates variable spot size and treated-area fraction, and variable spatial application patterns ((quasi-)random and observed weed maps), enabling realistic worst-case exposure assessment.

- Hydrology consistency was validated against full-field PRZM for two representative crops (potatoes and maize) across the FOCUS R1–R4 scenarios [4], using 11 storms spanning the 1st–99th percentiles of the storm-magnitude distribution.
- If in PRZM a snowmelt event generates surface runoff, this is passed on to VFSMOD, but these correspond to small, low-risk events.
- Full-field SPOTMOD (VFSMOD) and PRZM runoff agreed very closely (NSE = 0.927–0.997, RMSE = 0.251–0.397 m³, PBIAS < 10%), ensuring hydrological consistency of both models within SPOTMOD.



SPOTMOD model design. The field is divided into slope-direction strips the width of the treated spots; treated spots (sources) are simulated with PRZM and the downslope untreated segments (sinks) with VFSMOD. Edge-of-field runoff (dQ), erosion (dE) and pesticide (dP) contributions of each strip are summed over the field and fed to a TOXSWA metamodel to compute PEC_{sw}.

REFERENCES

[1] A. Ritter, R. Muñoz-Carpena *et al.*, "VFSMOD Input Definitions, Literature References and Sensitivity Analyses for Evaluating Vegetative Filter Strips in Pesticide Risk Assessment," NC State Center of Excellence for Regulatory Science in Agriculture (CERSA), 2023, doi: 10.5281/zenodo.7789811.

[2] R. F. Carsel, J. C. Imhoff, P. R. Hummel, J. M. Cheplick, and A. S. Donigian Jr., *PRZM-3, A Model for Predicting Pesticide and Nitrogen Fate in the Crop Root and Unsaturated Soil Zones: User's Manual for Release 3.12.* Athens, GA, USA: Center for Exposure Assessment Modeling (CEAM), US EPA, 2003.

[3] R. Muñoz-Carpena, J. E. Parsons, and J. W. Gilliam, "Modeling hydrology and sediment transport in vegetative filter strips," *J. Hydrol.*, vol. 214, no. 1–4, pp. 111–129, 1999, doi: 10.1016/S0022-1694(98)00272-8.

[4] FOCUS, "FOCUS Surface Water Scenarios in the EU Evaluation Process under 91/414/EEC," EC Document Reference SANCO/4802/2001-rev.2, 245 pp., 2001.

SPOTMOD: CASE STUDIES FOR REFINING EDGE-OF-FIELD EXPOSURE FOLLOWING PRECISION APPLICATION USING REAL APPLICATION MAPS

Olivares-Rivas, J.; Muñoz-Carpena, R.; Sur, R.; Schultz, T. J.; Reichenberger, S.

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OBJECTIVES

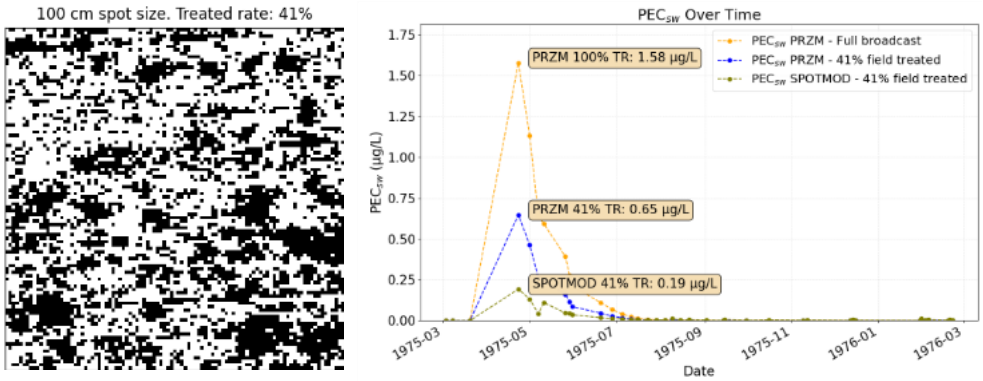
A new model, SPOTMOD, simulates spatially explicit pesticide runoff following precision applications. It combines treated spot areas (simulated with PRZM [1]) and untreated downslope areas (simulated with VFSMOD [2]) along the main flow direction to the field edge. Runoff at the field edge is routed to adjacent waterbodies to estimate predicted environmental concentrations in surface water (PEC_{SW}) using a TOXSWA metamodel [3]. Our objective is to conduct a series of case studies to quantify pesticide inputs to field-adjacent waterbodies following precision application in arable fields:

1. Thistles in arable fields in France (scattered distribution, with treatment maps refined to 1-hectare resolution in line with current European regulatory frameworks).
2. Weeds in a soybean field in Ohio (high density near the field edges and adjacent waterbody, using the full ~12-hectare field map).
3. Standard band application (using a pattern currently applied in a regulatory context).

In addition to SPOTMOD-simulated runoff, drift inputs are simulated with SiMoD [4] on the same treatment maps to provide a more complete assessment of potential pesticide entries. Results are compared with PEC_{SW} from standard FOCUS calculations using PRZM, assuming a broadcast application and an application rate scaled to the treated proportion of the field.

HIGHLIGHTS

- SPOTMOD simulates spatially explicit, two-dimensional pesticide runoff across various map types (square, non-square, and repeating band patterns), using either predefined or user-defined treatment maps.
- SPOTMOD's built-in weather, crop, and soil parametrizations are based on existing FOCUS scenarios, but they can be easily adapted to other conditions.
- As a mechanistic model, VFSMOD captures pesticide retention in untreated field areas, reducing runoff entries to waterbodies beyond those predicted by a simple linear reduction in application rate.
- The spatial distribution of spot applications to match field infestations patterns strongly affects the reduction in pesticide runoff from the field.
- Drift and runoff can be quantified with separate models, and the combined outputs can feed regulatory tools (e.g., FOCUS TOXSWA) for higher-tier simulations.
- SPOTMOD was conceived to align with existing regulatory frameworks and tools, so its implementation as a higher-tier software should be straightforward.



TR: treated rate. Left: simulated application pattern; black spots represent treated areas and white spots untreated ones; runoff flows from left to right. Right: PEC_{SW} for an herbicide applied to thistles in French fields, showing standard broadcast application (PRZM), linear reduction based on the proportion of treated area (PRZM), and mechanistic reduction calculated with SPOTMOD. The herbicide has a K_{FOC} of 1000 L/kg and a DT_{50} of 100 days. Weather and soil conditions correspond to the FOCUS R4 scenario. Maize was selected as a crop for this simulation.

REFERENCES

[1] Suárez, L. A. (2005). PRZM -3, A Model for Predicting Pesticide and Nitrogen Fate in the Crop Root and Unsaturated Soil Zones: Users Manual for Release 3.12.2

[2] Muñoz-Carpena, R. & Parsons, J. E. (2020). VFSMOD-W. Vegetative Filter Strips Modelling System. Model Documentation & User Manual. Version 6.x.

[3] Adriaanse, P. I., Van Leerdam, R. C., & Boesten, J. J. (2017). The effect of the runoff size on the pesticide concentration in runoff water and in FOCUS streams simulated by PRZM and TOXSWA. *Science of the Total Environment*, *584*, 268-281.

[4] Butler Ellis, M. C., & Miller, P. C. H. (2010). The Silsoe spray drift model: A model of spray drift for the assessment of non-target exposures to pesticides. Biosystems Engineering, 107, 169e177.

ADVANCES IN RISK ASSESSMENT AND MANAGEMENT OPTIONS BY THE EUROPEAN PRECISION APPLICATION TASK FORCE (EUPAF)

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Presenter Bernhard Gottesbüren

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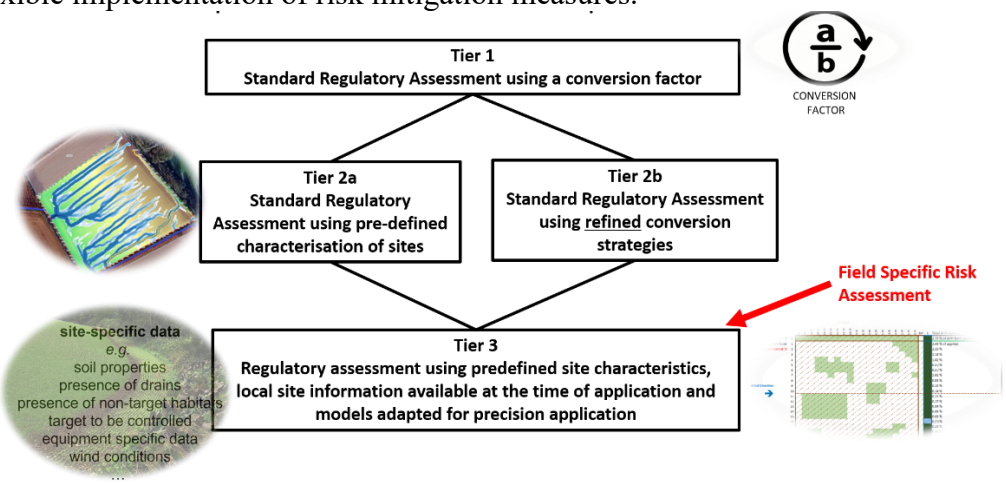
OBJECTIVES

- Create a scientific platform for connecting expertise in precision applications and risk assessment and management [1].
- Identify use categories for precision applications and develop terminology to reflect these categories in regulatory dossiers
- Propose options for reflections of precision application use categories in risk management and risk assessment scenarios

HIGHLIGHTS

- Tiered assessment schemes and criteria are developed, if, when and how
    1) existing regulatory models and scenarios together with conversion factors could be utilized to consider altered application rates for risk assessment
    2) a) new predefined scenarios to reflect local conditions could be derived
    b) new exposure figures (e.g. drift curves) could be derived for new techniques/technologies for environmental exposure assessment and
    3) new models, scenarios, and methodologies could be developed for comprehensive risk assessments, *e.g.* web services, meta models under consideration of site-specific environmental data at the time of application.

- A concept of Flexible Risk Mitigation is developed proposing regulatory-approved algorithms that integrate predefined site characteristics e.g. soil type, and local site information e.g. wind speed to support a flexible implementation of risk mitigation measures.



Conceptual Tiered Assessment Framework for environmental exposure assessment considering predefined characteristics of sites assessed for risk and local site information available at the time of application

REFERENCES

[1] BVL - EUPAF www.bvl.bund.de/SharedDocs/Downloads/04_Pflanzenschutzmittel/01_EUPAF_Information/Task_Group_3_4_results.html?nn=694878.

POSTER CONTRIBUTIONS – SESSION III

IMPACT OF INORGANIC ANIONS ON THE PHOTODEGRADATION OF HERBICIDE RESIDUES IN WATER BY UV/PERSULFATE-BASED ADVANCED OXIDATION

Gabriel Pérez-Lucas, Marina Aliste, Aitor Campillo and Simón Navarro

Presenter Gabriel Pérez Lucas

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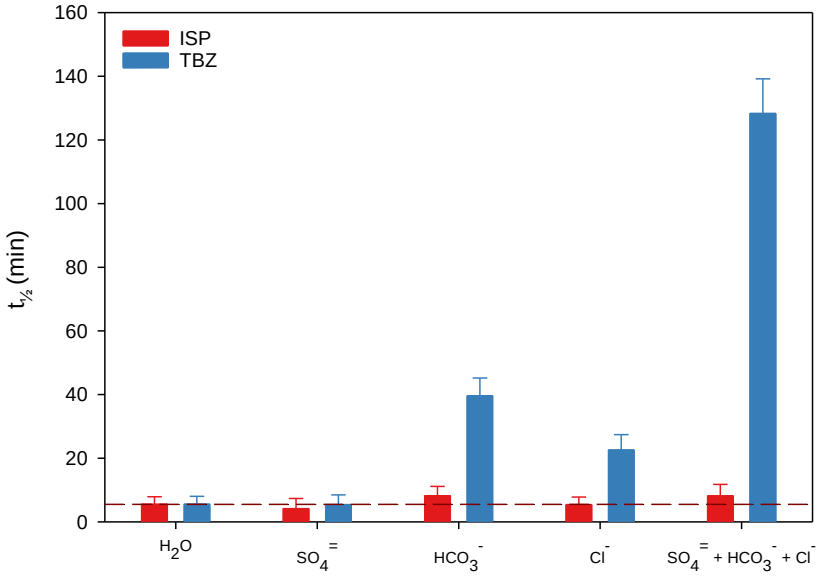
OBJECTIVES

- Evaluate the efficiency of the UV/persulfate advanced oxidation process in degrading two widely used herbicides (terbuthylazine and isoproturon) in aqueous solutions.
- Investigate the influence of UV irradiation wavelength (254 vs. 365 nm) on the degradation kinetics of these herbicides.
- Assess the effect of common inorganic anions (SO_4^{2-}, HCO_3^- and Cl^-) on the performance of the AOP system, both individually and in combination.
- Identify the main degradation intermediates and propose plausible reaction pathways involved in the photodegradation process.

HIGHLIGHTS

- The UV/$S_2O_8^{2-}$ process was highly efficient at degrading herbicides, achieving complete removal (0.2 mg L^{-1}) within 30 minutes under UV (365) nm with a persulfate dose of 250 mg L^{-1}.
- Faster degradation rates were observed at 254 nm than at 365 nm, although both wavelengths enabled effective removal under optimised conditions.
- Sulfate ions (SO_4^{2-}) had little effect on degradation efficiency, but the combined presence of bicarbonate (HCO_3^-) and chloride (Cl^-) significantly reduced removal performance.
- The inhibitory effect of (HCO_3^-) and (Cl^-) is attributed to their interaction with reactive radicals (HO• and $SO_4^{\bullet-}$), forming less reactive species with lower redox potential.

- The identified transformation pathways include dealkylation, dechlorination and hydroxylation, which provide insight into the mechanistic aspects of herbicide photodegradation.



Half-lives (t½) obtained for the degradation of herbicides in saline water. ISP (isoproturon), TBZ (terbuthylazine).

REFERENCES

[1] M. Aliste, I. Garrido, G. Pérez-Lucas, P. Flores, P. Hellín, S. Navarro, and J. Fenoll, "Appraisal of water matrix on the removal of fungicide residues by heterogeneous photocatalytic treatment using UV-LED lamp as light source," *Environ. Sci. Pollut. Res*., vol. 28, no. 19, pp. 23849–23858, May 2021, doi:10.1007/s11356-020-11560-y

[2] G. Luna-Sanguino, A. Ruíz-Delgado, C. J. Duran-Valle, S. Malato, M. Faraldos, and A. Bahamonde, "Impact of water matrix and oxidant agent on the solar assisted photodegradation of a complex mix of pesticides over titania-reduced graphene oxide nanocomposites," *Catal. Today*, vol. 380, pp. 114–124, Nov. 2021, doi: 10.1016/j.cattod.2021.03.022.

[3] M. Gambín, G. Pérez-Lucas, and S. Navarro, "Removal kinetics of four leacher herbicides through solar heterogeneous photocatalysis as influenced by water matrix components," *Bull. Environ. Contam. Toxicol*., vol. 106, no. 6, pp. 989–995, Jun. 2021, doi:10.1007/s00128-021-03158-y

[4] M. Aliste, I. Garrido, G. Pérez-Lucas, S. Navarro, and J. Fenoll, "Photocatalytic oxidation of chlorantraniliprole, imidacloprid, pirimicarb, thiamethoxam and their main photoreaction intermediates as impacted by water matrix composition under UVA-LED exposure," *Catalysts*, vol. 11, no. 5, Art. no. 609, May 2021, doi: 10.3390/catal11050609.

VALORIZATION OF AGRO-INDUSTRIAL WASTES AS ORGANIC AMENDMENTS TO REDUCE HERBICIDE LEACHING INTO THE SOIL

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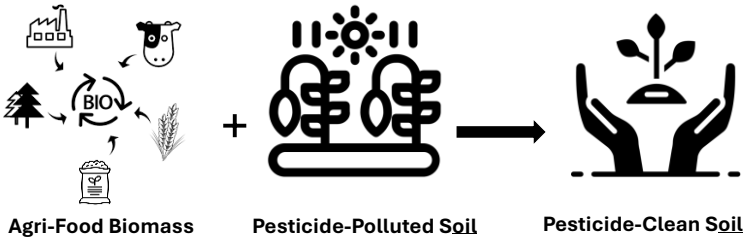
OBJECTIVES

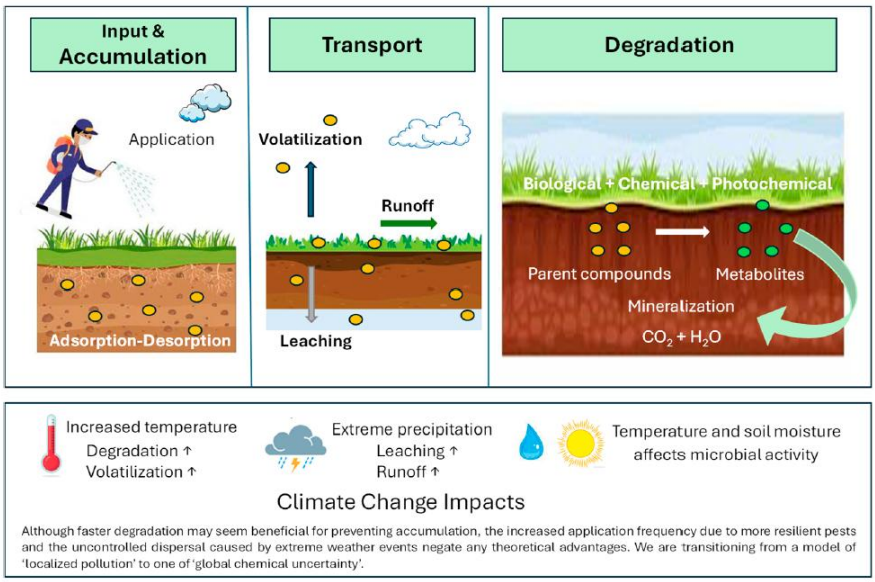
Highlight the impact of agricultural waste and agro-industrial by-products on the behaviour of pesticides, as a strategy for avoiding soil pollution from these xenobiotic compounds.



HIGHLIGHTS

- Population growth directly correlates with increased food demand. This increasing demand is revolutionizing the food, agricultural, and industrial sectors.
- Excessive and sometimes uncontrolled application of pesticides frequently results in pollution of environmental compartments. In soil, pesticides undergo a complex process involving adsorption (binding), degradation (microbial, chemical, and photochemical), and transport.
- Current models for managing agricultural residue and waste emphasize sustainability, profitability, technical feasibility, and potential for adoption. Using waste from agricultural crops and agri-food products as organic amendments is an effective method for retaining and degrading the residues of pesticides in the soil environment.

- Organic waste can be used fresh after a drying and shredding process or composted to stabilize their organic matter content. converting plant-based biomass into biochar and incorporating it into biobeds is an effective way to reduce pesticide pollution in soil.
- The choice of the most appropriate method will depend, in each case, on the available waste, the necessary infrastructure for obtaining biochar or composted materials, the type of soil, climatic conditions, and the physicochemical characteristics of each pesticide.



Behavior and fate of pesticides in the soil under climate change.

REFERENCES

[1] J. Fenoll, E. Ruiz, P. Flores, N. Vela, P. Hellín, and S. Navarro, "Use of farming and agro-industrial wastes as versatile barriers in reducing pesticide leaching through soil columns," *J. Hazard. Mater.*, vol. 187, no. 1–3, pp. 206–212, Mar. 2011, doi: 10.1016/j.jhazmat.2011.01.012

[2] G. Pérez-Lucas, N. Vela, J. A. Escudero, G. Navarro, and S. Navarro, "Valorization of organic wastes to reduce the movement of priority substances through a semiarid soil," *Water Air Soil Pollut.*, vol. 228, no. 3, Art. no. 119, Mar. 2017, doi: 10.1007/s11270-017-3305-9

[3] G. Pérez-Lucas, A. El Aatik, N. Vela, J. Fenoll, and S. Navarro, "Exogenous organic matter as strategy to reduce pesticide leaching through the soil," *Arch. Agron. Soil Sci.*, vol. 67, no. 7, pp. 934–945, Jun. 2021, doi: 10.1080/03650340.2020.1768531.

[4] K. Sridhar, M. Sharma, and B. S. Inbaraj, "Valorization of food and agro-industrial waste: novel approaches and their applications," *Front. Nutr.*, vol. 10, Art. no. 1250816, Aug. 2023, doi:10.3389/fnut.2023.1250816

[6] D. Kumar, J. Rani, and K. K. Selwal, "Low-cost adsorbents: A sustainable strategy for emerging contaminant mitigation," *Water, Air, & Soil Pollution*, vol. 236, no. 14, p. 947, 2025, doi: 10.1007/s11270-025-08573-z.

EUPAF: RECOMMENDATIONS FOR LINKING OF EXPOSURE AND EFFECT RISK ASSESSMENTS

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Presenter Dirk Nickisch

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OBJECTIVES

- To harmonise between exposure and effect modelling in environmental risk assessment by introducing and evaluating common conceptual frameworks across varying spatial and application scenarios.
- To assess and compare the applicability and limitations of Representative Elementary Area/Volume (REA/REV) concepts and probabilistic approaches for improving risk assessment under spatially heterogeneous and non-standard pesticide application patterns.

HIGHLIGHTS

- Identification of REA/REV as a promising concept for simplifying and harmonising modelling under regular and homogeneous exposure conditions.
- Recognition of significant limitations of REA/REV when applied to spatially heterogeneous practices such as precision or spot spraying.
- Demonstration that proportional reductions in treated area (e.g. 10%) do not necessarily translate into proportional reductions in biological effects or population impacts.
- Emphasis on key ecological uncertainties, including individual exposure variability and population-level responses under heterogeneous exposure conditions.
- Introduction of probabilistic risk assessment as a robust complementary approach capable of explicitly addressing spatial variability and biological diversity.

- Highlighting the importance of species traits (e.g. mobility) in determining exposure–effect relationships in complex landscapes.
- Acknowledgement of increasing data availability and computational advances enabling wider adoption of probabilistic approaches.

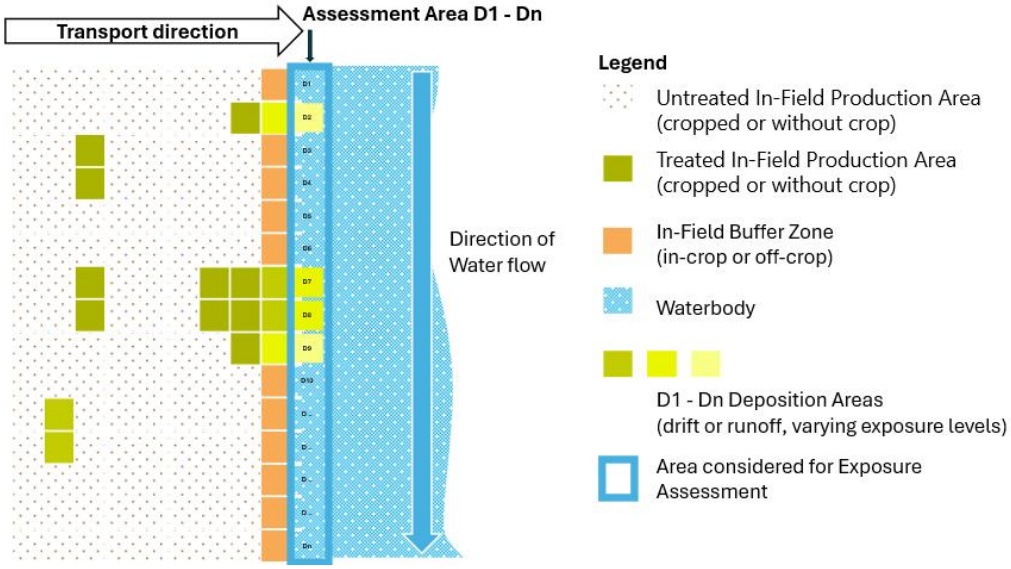

Illustration of in-field components and relation to off-field (non-target) aquatic landscape features supporting probabilistic exposure assessment

EUPAF - PROCESS MODELS FOR ENVIRONMENTAL EXPOSURE ASSESSMENT OF PRECISION APPLICATION: A TIERED INVENTORY FROM THE EUPAF WORKING GROUP

Sebastian Multsch, David Patterson, Stephen Brignall, Jörn Strassemeyer, Robin Sur, Olivier de Cirugeda Helle, Bernhard Gottesbüren

Presenter Sebastian Multsch

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OBJECTIVES

- Precision application (PA) technologies (e.g. band, spot, patch and variable rate spraying) modify the spatial and temporal distribution of pesticide emissions after spraying compared with broadcast applications.
- Within the European Precision Application Task Force (EUPAF) [1], an inventory of process-based exposure models was compiled and organised within a proposal for tiered exposure assessment framework (PA-EXP-TIER-1 to PA-EXP-TIER-3) to clarify regulatory applicability and identify priorities for further development.

HIGHLIGHTS

- PA-EXP-TIER-1: Standard regulatory exposure models are applied unchanged, representing PA via average-rate conversion across groundwater, surface water, and soil exposure pathways (FOCUS/EFSA framework).
- PA-EXP-TIER-2: Standard models are extended through site-specific risk characterisation (Tier2a, harmonised geodata/software) and/or refined PA-specific conversion strategies (Tier2b, e.g. drift curves).

- PA-EXP-TIER-3: Advanced process-based models explicitly capture spatial heterogeneity and local conditions, supported by metamodels and web services for scalable, efficient landscape-scale exposure–effect assessment.
- Further development is needed for pragmatic lower tier tools and online assessments, cloud-based delivery, coupled exposure–effects modelling, and implementation of digital innovations (e.g. digital labels), supported by targeted proof-of-concept case studies.

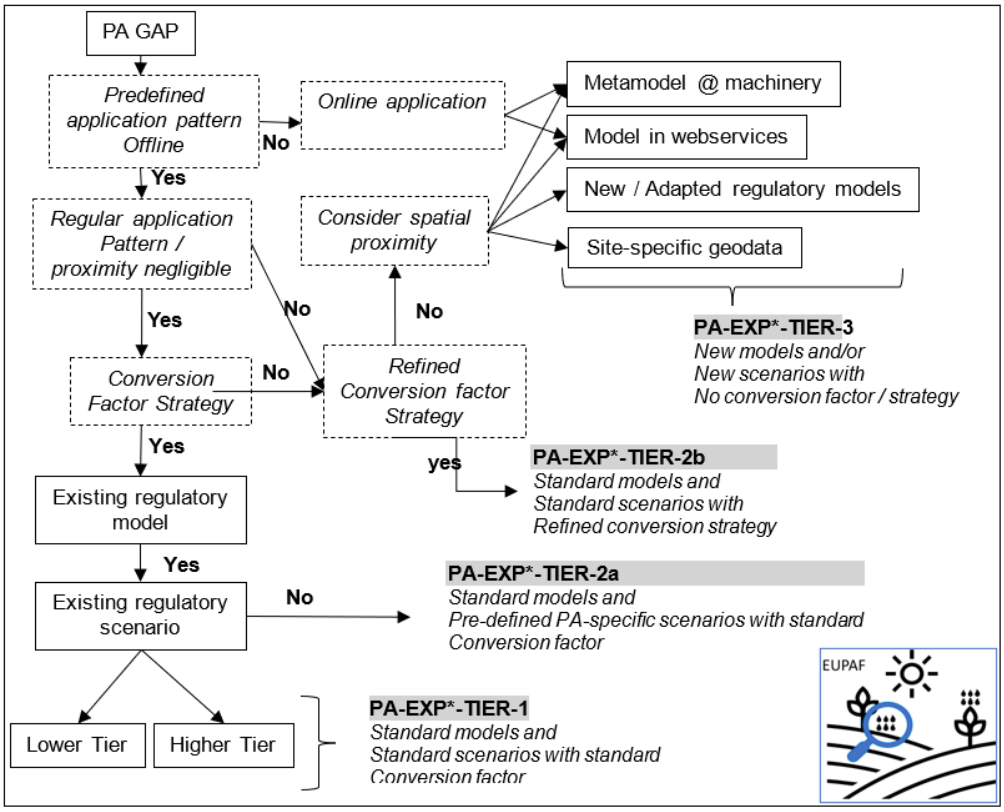

*Figure of the Environmental exposure decision flow for process model and scenario selection (*EXP – exposure).*

REFERENCES

[1] EUPAF - European Precision Application Task Force, url: https://www.bvl.bund.de/SharedDocs/Downloads/04_Pflanzenschutzmittel/01_EUPAF_Information/Task_Group_3_4_results.html?nn=694878, June 2026.

EUPAF - GENERAL CONSIDERATIONS ON ENVIRONMENTAL RISK ASSESSMENT OF 3-D (CANOPY) PRECISION APPLICATION OF PLANT PROTECTION PRODUCTS IN ORCHARDS AND VINEYARDS

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OBJECTIVES

To evaluate how 3-D precision application (PA) technologies in structurally complex crops – orchards, vineyards and bush crops – may affect the environmental risk assessment (ERA) of plant protection products (PPPs). Unlike conventional broadcast applications, which assume a uniform 2-D distribution, 3-D PA aims to deliver product within the canopy volume and should, where it performs as intended, reduce off-target exposure. However, PPP distribution in 3-D canopies is far more variable than in 2-D crops, and achievable precision is strongly sprayer-dependent – air-assisted axial-fan sprayers being less accurate than face-to-face (F2F) or directed low-drift systems. The aim is to assess whether current ERA approaches capture these technology-specific exposure patterns, identify where adaptation is needed, and outline a tiered, mass-balance-based framework that is scientifically sound, transparent and regulatory-compatible – while being explicit about its limitations.

HIGHLIGHTS

- **Precision Application of PPP to 3D Crops:** GPS-guided sprayers, LiDAR canopy mapping and remote sensing enable site-specific dosing matched to canopy density, leaf area and fruit distribution. The realized benefit is technology-dependent and not yet proven across the full range of crops, canopies and sprayer configurations.
- **Demonstrated savings (Xun *et al.* 2023):** In an apple orchard, a precision sprayer achieved > 60% less ground drift (BBCH-72), 57.3% less at BBCH-99, and 43% lower pesticide use (*vs.* 12%

optimized). Comparable or larger savings exist for other technologies (*e.g.* F2F and CDA/rotary-atomizer systems, up to ~75% seasonal), so drift-mitigation and use-saving potential must be classified by spraying technology and canopy structure, not as a generic PA attribute.

- **The critical role of airborne drift:** PA is not equivalent to a drift-reduction technology (DRT). Airborne drift in 3-D crops can be an order of magnitude higher than in arable spraying – higher still in sparse or leafless canopies — affecting bystanders, residents, operators, workers and pollinators, plus long-range off-site transport. Robust ERA therefore requires that airborne drift be measured, not inferred.
- **Limitations of the current framework:** FOCUS and EFSA models assume uniform, field-wide application and treat 3-D crops only via generic in-row/inter-row "band" assumptions, missing the patchy, phenology-, weather- and technology-dependent exposure of true 3-D PA. The band logic already accepted for 2-D crops should extend to 3-D crops, and refinements must distinguish wall/hedgerow versus globular (individual-tree) systems and address both horizontally and vertically differentiated applications.
- **Proposed tiered assessment framework:** Tier 1 (standard scenarios with conversion for treated proportion and canopy interception); Tier 2a (refined site/drift-interface characterization); Tier 2b (technology-specific source refinement); Tier 3 (site-specific, spatially explicit 3-D modelling).
- **Mass-balance representation – and its caveats:** Realistic refinement partitions applied mass across target row, in-field inter-row and off-field domains (f_{row}, $f_{inter\text{-}row,}$ $f_{off\text{-}field}$) with interception and drift terms summing to unity to avoid compounded worst cases. However, mass-balance closure for 3-D crops is not yet established (historical recoveries ~ 50-150%) and credible partitioning depends on measured airborne drift and resolving high canopy-capture heterogeneity.
- **Practical paths forward:** 1) A Deposition Pathway Profiling Database (starting with experimental deposition data from different contributors Performance Pulve, FR, Wageningen University Research (WUR), NL and Julius-Kühn-Institut (JKI) DE and 2) a "Target Application Equivalence" concept (Ctgb/Dutch working group)/framework. If a PA technique results in the same or lower average application rate per area compared to conventional methods, it can be considered equivalent and with a better targeted technique the same (or approximately so) target canopy exposure can be achieved with a lower overall application rate. The notifier then has the benefit of the lower application rate in modelling with (theoretically) the same coverage and efficacy. This allows existing risk assessments to remain valid, avoiding the need for new authorization.
- Both routes should allow to integrate PA into existing frameworks, pending field experimentation to characterize partitioning across crops, growth stages and technologies.

EUPAF – RECOMMENDATIONS FOR DEVELOPMENT OF ENVIRONMENTAL EXPOSURE SCENARIOS FOR PRECISION PESTICIDE APPLICATIONS

Hendrik Rathjens, Olivier de Cirugeda Helle, Sebastian Multsch, Dirk Nickisch, David Patterson, Jörn Strassemeyer, Robin Sur, Bernhard Gottesbüren

Presenter Hendrik Rathjens

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OBJECTIVES

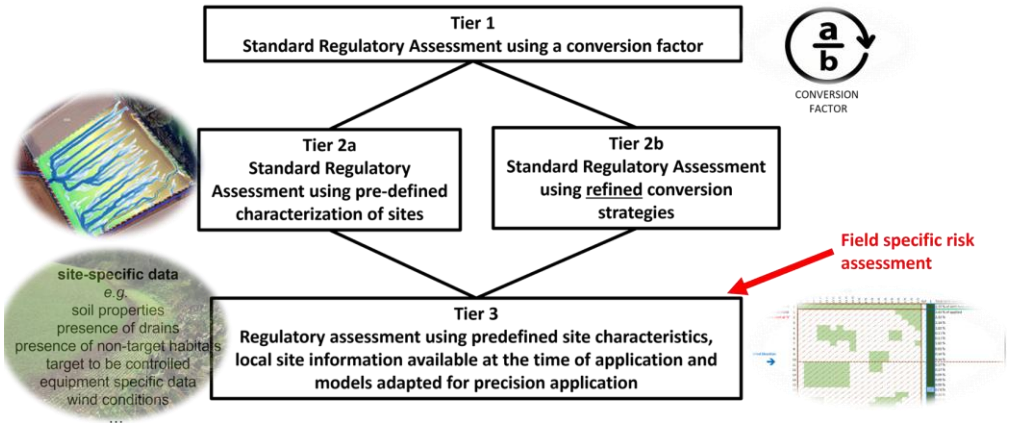
Integrating precision application (PA) into EU exposure assessment requires concepts that extend the established FOCUS-based framework [1] without disrupting its consistency and harmonization. This contribution sets out the conceptual building blocks and a tiered pathway for that integration. Before finalized scenarios can be developed, the structure for characterizing PA-specific exposure patterns must be described. Specifically, this work aims to:

- Establish a tiered structure that progressively refines exposure assessment for PA from simple conversion and reduction factors at Tier 1, through GIS-based regional scenarios and technology-specific refinements at Tier 2, to field-specific assessment at Tier 3.
- Provide concepts for translating real-world precision spray patterns into regulatory scenarios.
- Outline a development pathway that accommodates the diversity of PA technologies and remains applicable across European regulatory zones, as a concrete step toward recognizing the exposure-reducing potential of precision application within a harmonized, regulatory-accepted framework.

HIGHLIGHTS

- Precision application can be integrated into EU risk assessment as an extension of the existing FOCUS-based framework, preserving regulatory consistency.

- At lower tiers, reduced field-scale application rates of PA can be captured through conversion or reduction factors applied within standard FOCUS models, maintaining backward compatibility with established registration procedures.
- Conversion factors are not universally applicable. Their validity depends on the exposure pathway, holding where exposure is driven by the average field rate (e.g., groundwater exposure) but breaking down where it depends on the spatial pattern and proximity to treated areas (e.g., runoff, drift).
- The Representative Elementary Area (REA) concept defines the minimum spatial scale at which exposure is relevant for effect assessment, providing a basis for accounting for organism mobility when linking exposure and effects.
- Four statistical components: (1) field coverage ratio, (2) application zone characterization, (3) spatial distribution analysis, and (4) edge analysis are proposed to characterize real-world spray patterns and map them to idealized regulatory scenarios.
- Technology-specific drift reduction can replace standard regulatory assumptions where supported by ISO 22866-compliant trial data, as illustrated by drift reduction potentials recognized for advanced precision sprayers.
- Harmonized European and national GIS datasets enable the derivation of regionally representative, predefined scenarios for relevant exposure pathways, supported by web services that deliver site- and field-specific data.
- At the highest tier, field-specific inputs (e.g., as-applied maps, drone imagery, LiDAR-derived vegetation structure, and local meteorology) can support exposure estimates reflecting actual conditions at the time of application.



Conceptual tiered framework for environmental exposure assessment of precision application.

REFERENCES

[1] FOCUS, "FOCUS Surface Water Scenarios in the EU Evaluation Process under 91/414/EEC," Report of the FOCUS Working Group on Surface Water Scenarios, EC Document Reference SANCO/4802/2001-rev.2, 245 pp., 2001.

GIS DATA AS A BASIS FOR EXPOSURE MODELLING IN PRECISION PLANT PROTECTION APPLICATIONS

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Presenter Sebastian Multsch

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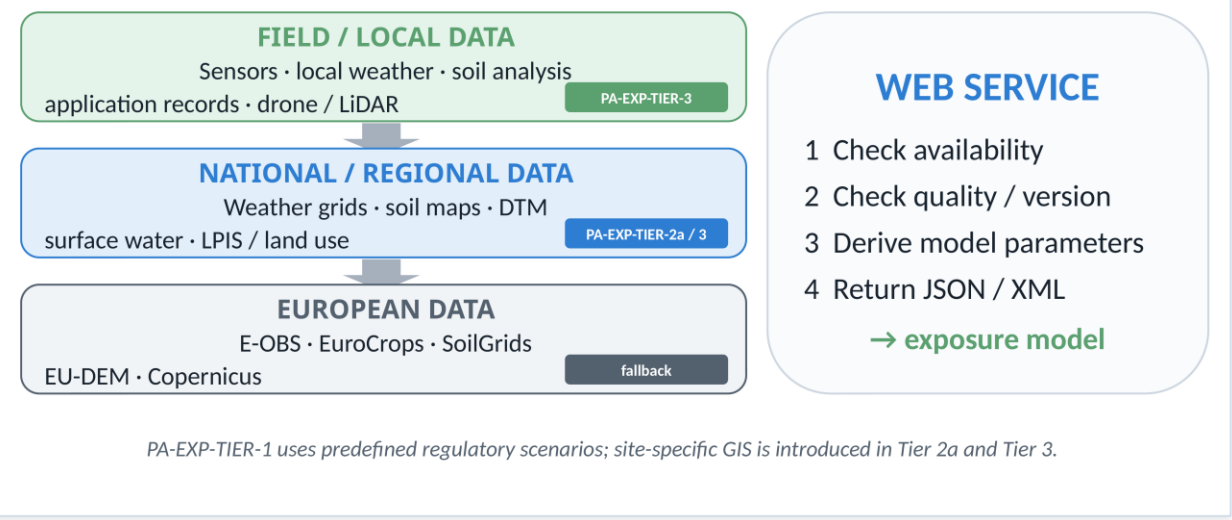
OBJECTIVES

- Inventory suitable georeferenced environmental data sources at field/local, national/regional and European/global scale for the main input domains required in plot-specific pesticide exposure modelling, and assess how they can support the EUPAF PA-EXP tiers.
- Develop a tiered GIS-data provision concept that prioritises the best available source, applies explicit quality and version control, and delivers model-ready parameters through interoperable web services for PA-EXP-TIER-2a and PA-EXP-TIER-3 assessments.

HIGHLIGHTS

- Candidate data sources were identified for all major environmental input domains: weather, field geometry/land use, surface water, soil, topography, remote sensing/LiDAR and landscape structure, and crop phenology.
- A tiered “best available data” hierarchy is proposed: field/local data first, national/regional data second, and European/global datasets as fallback where resolution and quality are sufficient.
- PA-EXP-TIER-2a can be supported by harmonised predefined geodata, whereas PA-EXP-TIER-3 can additionally use field-specific and application-time information from sensors, machinery records, drones or LiDAR.
- The main implementation challenge is harmonisation of spatial/temporal resolution, access, provenance, quality and version control - not a general lack of potentially useful GIS data.

- Interoperable web services can check data availability and quality, select the best source, derive exposure-relevant parameters and return standardised model-ready inputs.
- SYNOPS-WEB demonstrates automated derivation of plot-specific distance to surface water, terrain/flow accumulation, erosion potential and weather data [1].
- LiDAR-based services can characterise field margins, riparian vegetation and adjacent non-target structures, providing high-resolution inputs for off-field exposure assessment.



Tiered GIS-data provision for precision-application exposure modelling: field/local data are prioritised, with national/regional and European sources used as fallback; interoperable web services check availability and quality and derive model-ready parameters.

REFERENCES

[1] J. Strassemeyer et al., "SYNOPS-WEB, an online tool for environmental risk assessment to evaluate pesticide strategies on field level," Crop Protection, 97, 28-44, 2017.

DO DISTINCT VERMICOMPOST FRACTIONS DIFFER IN THEIR POTENTIAL TO IMPROVE SALT STRESS TOLERANCE IN ARABIDOPSIS?

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OBJECTIVES

- To evaluate whether distinct vermicompost-derived fractions (DOM1, DOM2, and percolate V) differentially enhance salt stress tolerance in *Arabidopsis thaliana*.
- To elucidate the physiological and biochemical mechanisms underlying vermicompost fraction-mediated salt stress alleviation, with particular emphasis on photosynthetic performance, oxidative stress regulation, and antioxidant defense responses.
- To characterize metabolic reprogramming induced by different vermicompost fractions under salinity stress and identify metabolic pathways associated with improved stress resilience.

HIGHLIGHTS

- Distinct vermicompost fractions differently modulate salt stress tolerance in Arabidopsis.
- Vermicompost fractions improve plant performance under salinity by enhancing photosynthetic efficiency and reducing oxidative damage.
- Untargeted metabolomics reveals extensive metabolic reprogramming associated with vermicompost-mediated stress adaptation.
- Vermicompost-derived organic fractions represent promising sustainable tools for improving plant tolerance to abiotic stress.

SPRAYER *VS* UAV FOR VINEYARDS PROTECTION: PPPS DISTRIBUTION, EFFICACY AND LOSSES

Nicoleta Alina Suciu, Tito Caffi, Margherita Furiosi, Ghada Arbi, Gian Maria Beone, Eric Mozzanini, Marco Grella

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OBJECTIVES

- Development of an innovative spraying system for the targeted application of plant protection products (PPPs) via an unmanned aerial vehicle (UAV);
- Field tests to determine optimal operating parameters (L/ha, flight altitude, flight speed, canopy growth stage, etc.) for the targeted application of PPPs via UAV;
- Comparison of the performance of the UAV and a conventional sprayer in terms of spray distribution, application efficacy, and off-target losses.

HIGHLIGHTS

- Preliminary semi-field and field results indicate that the UAV spray system developed, together with the distribution protocol implemented, can effectively control grapevine downy mildew (though further confirmation is required), even when spray deposition within the canopy is less uniform than that achieved with conventional application technologies [1];
- The study demonstrated that optimized UAV configurations can increase application efficiency, approaching the performance of the tested air-blast sprayer when air inclusion nozzles are used (in terms of the balance between canopy deposition and off-target losses) (Fig.1) [2];

- However, the development of dedicated UAV technology for the targeted application of PPPs in vineyards demands further investigations, together with the development of dedicated commercial solutions and PPP formulations suitable for UAV application;
- In summary, UAV spray systems represent a highly promising tool for applying PPPs in challenging environments but the scientific evidence regarding sustainability, efficacy, and efficiency must be consolidated before authorizations for their use can be widely expanded.

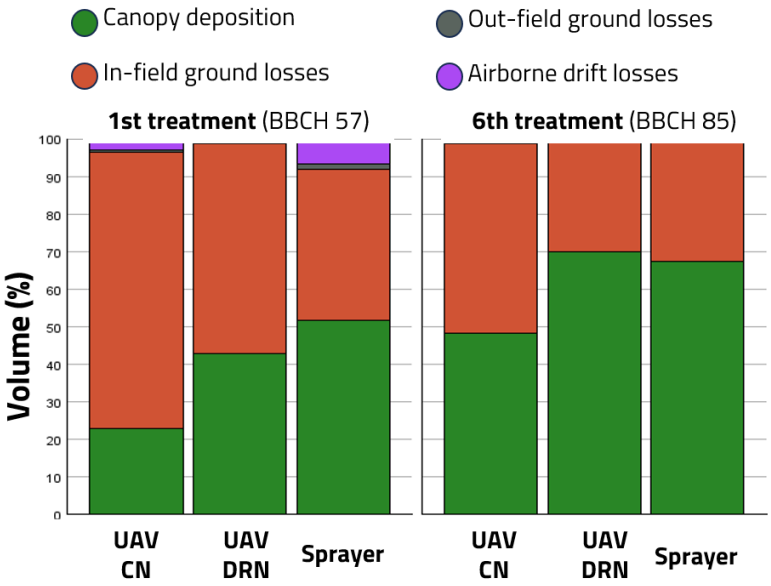

Figure 1. Mass balance of plant protection product (PPP) distribution of the UAV spray system, equipped with conventional "UAV CN" and air inclusion nozzles "UAV DRN", and the conventional air-blast sprayer "Sprayer" application at grapevine growth stages BBCH 57 and BBCH 85.

REFERENCES

[1] Furiosi M., Triachini S., Beone G.M., Fontanella M.C., Gaaied S., Arbi G., Lomadze A., Grella M., Mozzanini E., Dicembrini E., Languasco L., Fittipaldi Broussard M., Nassi L., Caffi T., Suciu N.A (2025) "Aerial Spray Application of Plant Protection Products for Grapevine Downy Mildew Control: Efficacy and Canopy Deposit Evaluation in Semi-Field Trials", *Agronomy*, 15 (12), art. no. 2703, DOI: 10.3390/agronomy15122703

[2] Biglia A., Mozzanini E., Gioelli F., Sopegno A., Alcatrão L.E., Suciu N.A., Furiosi M., Caffi T., Gay P., Grella M. (2025) "Assessing the potential efficacy and efficiency of UASS vine-targeted spray application across growth stages", *Smart Agricultural Technology,* 12, 101532. DOI: 10.1016/j.atech.2025.101532.

SESSION IV - ENHANCING POLICY UPTAKE THROUGH NEW OPTIONS FOR PESTICIDES RISK ASSESSMENT AND MANAGEMENT

Chairs: Ettore Capri, Richard Maycock

Session IV shifts from scientific development to implementation, asking how new knowledge, tools, and monitoring evidence can be translated into pesticide policy and risk management. A central contribution proposes an adaptive pesticide authorization framework, arguing that current systems are often too slow to incorporate monitoring data, new scientific findings, or emerging environmental concerns. Several presentations focus on making existing tools more acceptable and useful for regulators, including the wider regulatory uptake of VFSMOD and the use of catchment vulnerability mapping to contextualize surface water monitoring. Other contributions explore more participatory and digital approaches: serious games and stakeholder processes are presented as ways to support collective action in catchments, while farm management information systems and field-specific digital risk management are proposed as future pathways for tailored mitigation measures. The session also addresses regulatory challenges linked to encapsulated slow-release formulations, aged sorption, rice guidance, and pesticide risk indicators. The critique of HRI-1 highlights the need for indicators that better reflect ecotoxicity, effective dose, and real risk reduction rather than relying mainly on quantity-based metrics. Overall, this session emphasizes that better science alone is not enough: effective pesticide management requires adaptive regulation, transparent communication, stakeholder involvement, harmonized indicators, and digital tools that connect risk assessment to real agricultural practice.

KEYNOTE LECTURE

AN ADAPTIVE FRAMEWORK FOR PESTICIDE AUTHORISATION

Aaldrik Tiktak & Mascha Rubach

Presenter Aaldrik Tiktak

PBL Netherlands Environmental Assessment Agency

INTRODUCTION

There is considerable concern in society and the scientific community about the use of pesticides. An important reason is that new scientific insights into the effects of pesticide use on, for example, biodiversity and groundwater are difficult to incorporate into the authorisation process. The Netherlands has extensive monitoring data for groundwater and surface water [1], yet these data are barely used in authorisation decisions. Moreover, there is limited policy urgency to improve the authorisation system. While certain elements of the regulatory framework are revised and adapted, the system as a whole remains inert and proved partly ineffective to prevent unacceptable pollution [1]. In this contribution, we argue that not only the substances themselves, but also the authorisation framework should be regularly evaluated utilising the available monitoring data and, where necessary, adapted.

INSUFFICIENT CAPACITY FOR LEARNING AND ADAPTATION

The current authorisation framework is based on models and guidelines developed in the period 1990-2010. Although improvements have been made since then, progress has been slow. In addition, the extensive groundwater and surface water monitoring networks are not being used sufficiently to improve guidelines and models. While the Dutch Board for the Authorisation of Plant Protection Products and Biocides (Ctgb) does reassess products when environmental standards are regularly exceeded, these reassessments are largely based on the existing models and guidelines. As a result, they generate only limited new insights [3]. This results in a lock-in: we know that there may be errors in the core assumptions of the underlying legislation and it’s guidelines and models, but it is hardly possible to improve the legal framework.

AN ADAPTIVE AUTHORISATION FRAMEWORK

This shows that it necessary to move towards an adaptive authorisation framework in which monitoring and evaluation are systematically used to improve the framework over time [3]. This means that when environmental standards are exceeded on a structural basis, there must be a willingness to revise the legal framework, if necessary. Under the current authorisation system, the primary focus is on operating within the existing legal framework, which allows structural problems to persist. To achieve this, we argue that a standing work group consisting of policy makers, risk assessors, and independent scientists is needed. Such a group could help ensure that new scientific insights, monitoring data, and practical experiences are systematically incorporated into regulatory frameworks. This would strengthen the framework's capacity to adapt to emerging knowledge and also societal concerns, while maintaining a transparent and scientifically robust authorisation proces.

OMNIBUS PROPOSAL MAKES PERIODIC AND INDEPENDENT EVALUATION EVEN MORE URGENT

The European Commission (EC) states that the administrative burden of the current authorisation procedure is too large [4]. For this reason, the EC has proposed replacing the mandatory periodic reassessment of active substances with a "risk-based system" that would no longer include a fixed approval period. Under such a system, substances would only be reassessed if they are considered to pose a risk to human health or the environment.

A scientific review of this proposed reform indicates that many aspects of the plan remain unclear [5]. In particular, there is uncertainty about the criteria that would trigger a reassessment and about which authority would have the mandate to decide whether a reassessment is required. Also, no mechanism is in place to evaluate approved substances against updated guidance or legislation. As a result, there is a risk that the burden of proving the safety of plant protection products shifts from manufacturers to other actors, such as regulators, researchers, or civil society organisations. If mandatory periodic reassessment is indeed replaced by a risk-based system, regular evaluation of the authorisation framework and signaling by an independent working group will become even more urgent.

REFERENCES

[1] See for example The pesticides Atlas.

[2] Duquesne *et al.* (2026). "*Advancing environmental risk assessment (ERA) of plant protection products through a systems-based approach to strengthen biodiversity protection*". Environment International

[3] See Reassessment of substances has been finalised

[4] See for example Topping CJ *et al.* (2026). "*Escaping the Reductionistic Trap: A Systems-Based Approach to Environmental Risk Assessment*". Environmental Science & Technology

[5] See the Food and Feed Safety Simplification Omnibus of 16 December 2025.

[6] Backhaus T. *et al.* (2026). "*Periodic Reassessment or Permanent Approval? A Critical Analysis of the EU Commission's Proposal to Reform Pesticide and Biocide Authorisation in Europe*". ChemRxiv.

VFSMOD –JOINING THE PATH FORWARD?

Robin Sur, Rafael Muñoz-Carpena, Stefan Reichenberger, Bernhard Jene, Nicoleta Alina Suciu, Igor Kondzielski, Elena Alonso-Prados, Roger Holten, Andrew Bailey, Peter Rainbird, Horatio Meyer, Amy Ritter

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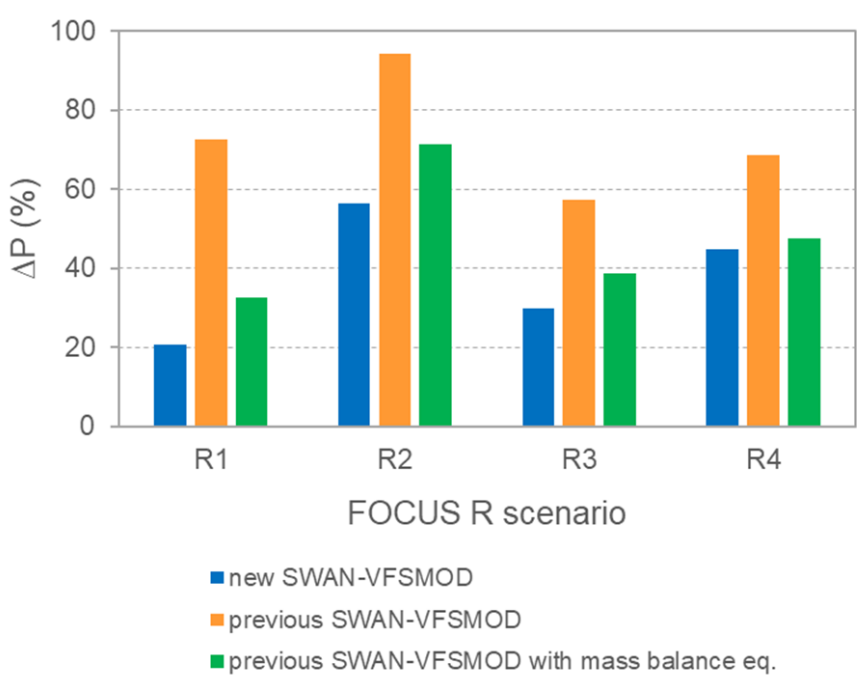
OBJECTIVES

- Summary of the findings from the 2024 Piacenza VFSMOD Workshop and the final resolutions document
- Present state of science regarding the recent version of VFSMOD and SWAN
- Discuss options on how a wider acceptance of VFSMOD by regulatory authorities can be accomplished

HIGHLIGHTS

The final resolutions of the 2024 Piacenza VFSMOD Workshop [1] contain actions and answers to questions and comments from different EU regulators. We will present the state of science and stakeholder discussions on the regulatory acceptance of VFSMOD. All major issues presented in the resolution's comments have been resolved through a technical report and a follow-up peer-reviewed publication [2,3].

Now, a wider regulatory acceptance of VFSMOD needs to be achieved. We propose that a regulatory guidance document be prepared and weigh options whether either by a mandate from COM to EFSA or as a member state driven initiative in collaboration with different stakeholders and final note taking by SCoPAFF.



Comparison of predicted pesticide load reduction efficiency ΔP between new and previous SWAN-VFSMOD for Koc = 100 L/kg, 30 mm rainfall, event duration = 8 h, and VL = 10 m [3].

REFERENCES

[1] R. Muñoz-Carpena *et al.*, Resolutions from the VFSMOD Workshop, Piacenza, Italy, September 2024, https://zenodo.org/records/17942850

[2] S. Reichenberger *et al.*, Update of the definition of vegetative filter strip scenarios for Europe, report no. 122333-1, 19 March 2025, https://zenodo.org/records/17400444

[3] S. Reichenberger *et al.*, Update of vegetative filter strip scenarios for pesticide risk assessment in Europe, Science of The Total Environment, vol. 1039, 10 July 2026, 181906, https://doi.org/10.1016/j.scitotenv.2026.181906

CONTEXTUALIZING SURFACE WATER MONITORING USING CATCHMENT-BASED PESTICIDE VULNERABILITY MAPPING WITH TWO COMPLEMENTARY METHODS IN FLANDERS (BELGIUM)

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OBJECTIVES

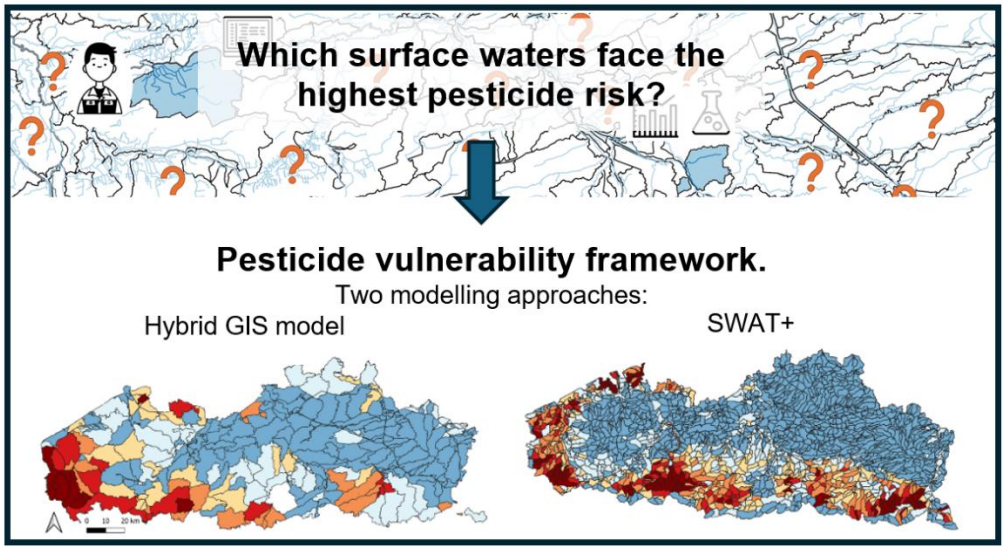
Pesticide concentrations in European surface waters can exceed environmental quality standards, yet monitoring networks cover only a fraction of agricultural catchments and capture peak exposures only sporadically. Interpreting such data requires spatial context on how susceptible each catchment is to pesticide transport (i.e., its catchment vulnerability). Such frameworks are well established for groundwater [1] but lacking for surface water. This work develops and tests a framework for pesticides in surface water, aiming to:

- Develop and compare two modelling approaches of fundamentally different complexity for ranking catchment vulnerability.
- Validate both methods against surface water monitoring data and map vulnerability for three herbicides across Flanders (Belgium).
- Demonstrate how vulnerability rankings contextualize monitoring data, guide cost-effective monitoring, and target mitigation.

HIGHLIGHTS

- A newly developed hybrid GIS-based model and the process-based SWAT+ model [2] converge on consistent catchment vulnerability rankings.
- Both models were validated against monitoring data from 237 catchments (2017–2021) plus daily time series at intensively monitored sites.

- Correlations with observed loads and concentrations were moderate-to-strong for flufenacet (0.51-0.70) and ethofumesate (0.42-0.84), weaker for metribuzin (0.14–0.49) due to its spatial and temporal application pattern [3].
- Highest vulnerability occurs in southwestern West Flanders and the southern hilly belt, driven by topography, soil type, connectivity, and crop distribution.
- Across the seven monitored catchments, the two approaches gave identical vulnerability ranks for 48% of catchment–substance combinations and agreed within two ranks for 91%, demonstrating a robust framework.
- The models are complementary: the hybrid GIS model is efficient for screening and monitoring prioritization, while SWAT+ adds mechanistic insight and concentrations comparable to regulatory thresholds.
- Relying only on routinely available spatial data, the framework is transferable to data-limited regions.
- The maps support risk assessment, monitoring-network design, and mitigation prioritization under the WFD and Drinking Water Directive [4].



Catchment pesticide vulnerability framework applied to Flanders (Belgium), mapped with the hybrid GIS model and SWAT+.

REFERENCES

[1] A. L. Gimsing et al., "Conducting Groundwater Monitoring Studies in Europe for Pesticide Active Substances and Their Metabolites in the Context of Regulation (EC) 1107/2009," *J. Consum. Prot. Food Saf.*, vol. 14, no. S1, pp. 1-93, 2019, doi: 10.1007/s00003-019-01211-x.

[2] K. Bieger et al., "Introduction to SWAT+, A Completely Restructured Version of the Soil and Water Assessment Tool," *J. Am. Water Resour. Assoc.*, vol. 53, no. 1, pp. 115-130, 2017, doi: 10.1111/1752-1688.12482.

[3] EFSA, "Peer Review of the Pesticide Risk Assessment of the Active Substance Metribuzin," *EFSA Journal*, vol. 21, no. 8, Aug. 2023, doi: 10.2903/j.efsa.2023.8140.

[4] European Parliament and Council, "Directive 2000/60/EC of 23 October 2000 Establishing a Framework for Community Action in the Field of Water Policy," *Official Journal L 327*, pp. 1-73, 2000.

IMPORTANCE OF AGED SORPTION PROCESSES IN THE EXPOSURE ASSESSMENT OF PESTICIDES

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OBJECTIVES

Current pesticide risk assessment for rice in the European Union relies on the outdated MedRice guidance (SANCO/1090/2000[1]). While the recent proposal by the International Centre for Pesticides and Health Risk Prevention (ICPS[2]) is appreciated, it aims to harmonize assessment criteria and improve environmental fate equations, it also requires technical refinements to reflect actual agricultural practices. Notably, CropLife Europe has informally reviewed the draft and proactively collected technical comments that are aligned among industry end users to ensure the new guidance would be scientifically robust and operationally realistic.

HIGHLIGHTS

Protection Goals for Aquatic Organisms**:** A primary concern in the new draft is the proposal of a novel in-field protection goal for aquatic organisms. The draft suggests protecting in-paddy aquatic invertebrates and macrophytes to preserve the food supply for birds and mammals. However, this is unrealistic because:

- Artificial Habitat: Rice paddies are secondary, non-permanent, and artificial ecosystems managed primarily for rice production.
- Agronomic Practice: Aquatic and semi-aquatic macrophytes are considered pest species that compete with rice; they are targets for herbicidal weeding, not subjects for protection.
- Water Management: Paddies are regularly drained for agronomic operations, preventing the establishment of permanent aquatic communities. Consequently, the protection goal should be

updated to align with existing EFSA aquatic guidance, focusing on edge-of-field water bodies rather than in-field environments.

Technical Areas for Improvement: To enhance the scientific robustness of the guidance, technical comments can be clustered into three key areas:

- Environmental Fate and Behavior:
  - Soil Characteristics: The draft proposes a drastic reduction of soil organic carbon (OC) content (from 1.8% to 0.9% for clayey scenarios) based on outdated datasets from 1990. This does not reflect typical rice paddy soils, which are known to be significant carbon stores.
  - Model Refinement: There is a need for more versatility in modeling wet/dry periods and providing better descriptions for calculating metabolite concentrations. Inconsistent approaches to infiltration rates between sandy and clayey scenarios must also be addressed.
- Ecotoxicology (Birds and Mammals):
  - Regional Representativeness: Focal species and feeding guilds are currently based largely on data from a single region (Lombardy, Italy), failing to represent the wider southern European rice-growing region.
  - Guidance Alignment: Some elements, such as the introduction of bats (which lack an agreed risk assessment scheme) deviate from EFSA 2009 and 2023 standards.
  - Data Gaps: Residue values for macrophytes are based on theoretical calculations rather than empirical data.
- Non-Dietary Exposure (Professional and Incidental):
  - Outdated Models: The draft references superseded models like UK POEM and German BBA instead of the current EFSA guidance calculator.
  - Unrealistic Exposure Scenarios: Proposed Transfer Coefficient (TC) values are based on crops like sweetcorn and peas, which do not reflect the height or density of rice, leading to a gross overestimation of worker exposure.

Conclusion: For a new rice guidance document to be successfully implemented, it should move beyond theoretical conservatism and embrace agronomic realism. Integrating stakeholder feedback and reflecting the diverse practices across all rice-producing Member States is essential for creating a policy framework that is both protective and practical.

REFERENCES

[1] MED-Rice (2003). Guidance Document for Environmental Risk Assessments of Active Substances used on Rice in the EU for Annex I Inclusion. Document prepared by Working Group on MED-Rice, EU Document Reference SANCO/1090/2000 – rev.1, Brussels, June 2003, 108 pp

[2] ICPS 2020: Update and harmonization of rice pesticide risk assessment and revision of European guidelines: A proposal

FEEDBACK ON THE IMPLEMENTATION OF A PARTICIPATORY APPROACH TO ENCOURAGE COLLECTIVE ACTION WITHIN CATCHMENT AREAS TO LIMIT PESTICIDE CONTAMINATION OF WATERCOURSES

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OBJECTIVES

- Investigate the capacity of a landscape and participatory approach to foster the emergence of levers for collective action aimed at reconciling agriculture with the quality of watercourses.
- Assess the contribution of a serious game to 1) facilitate coordination and consultation at the catchment area level to develop farming systems and promote buffer agro-ecological infrastructure and 2) explore future scenarios with stakeholders.

HIGHLIGHTS

- The study relied on interdisciplinary approaches (hydrology, agronomy, sociology, the science of stakeholder engagement) and a transdisciplinary approach, involving a range of stakeholders (farmers, the agricultural sector, water authorities, local authorities, environmental organisations and the education sector).
- The commitment to more sustainable practices is the result of ongoing negotiations between conflicting individual and collective values.
- Although the players' attitudes may limit collective action during the participatory simulation, the game provides an informal and interactive framework that can facilitate dialogue, mutual learning and co-construction, with a motivating effect of the geospatial model GeoMelba.
- To take action, farmers are calling for the development of viable transition pathways – tailored to the diversity of farming situations and including a cost-benefit analysis.

- Other issues – such as erosion, soil fertility, crop water requirements or the farm's energy strategy – are more likely to encourage farmers to adopt new cropping systems and agricultural practices that may also help to reduce pesticide use and run-off [1].

*Top: Serious Games *Causerie* Kit (left side) and a view of a group simulation session (right side). Bottom: User interface of the GeoMelba model for use by the game facilitator. Causerie is freely available here: https://polldiff.lyon-grenoble.hub.inrae.fr/recherche/gestion-integree-du-bassin-versant/ jeu-serieux-causerie*

REFERENCES

[1] V. Gouy Boussada, L. Seguin, S. Malingrey, G. Armani, O. Barreteau, et al., " Can a serious hybrid game centred on the landscape encourage the emergence of levers for collective action to reconcile agriculture and water quality*?"* *Innovations Agronomiques,* 96, 2024, ⟨10.17180/ciag-2024-Vol96-art02-GB⟩. ⟨hal-04811551⟩.

TOWARDS INCLUSIVE AND INFORMED POLICY-MAKING

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Presenter Kevin Bosc

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OBJECTIVES & HIGHLIGHTS

Decision-making processes on pesticides policy and approval should remain informed by the latest risk assessment and management considerations, embracing emerging methodologies, with a transparent involvement of relevant stakeholders.

As industry, we rely on predictable and proportionate regulatory frameworks when we make decisions on developing new solutions to address farmers needs. Bringing a new crop protection active ingredient to market requires on average over $300m and 11 years from discovery to sale.

As applicants, we are seeking fair opportunities to update our dossiers to meet the latest data requirements, and we encourage regulators to take decisions based on the latest scientific expertise.

Having a strong dialogue and feedback mechanism between applicants, risk assessors and risk managers is critical.

Ensuring transparency in these processes is also a must, particularly for agri-food chain stakeholders due to their key role as primary users of solutions. They are able to convey insightful information to risk managers on their needs and gaps in the toolbox, as well as practical information on how they apply products. Having a holistic picture, taking into account socio-economic considerations, is essential for policymakers to make informed decisions.

Finally, there are still opportunities to improve risk communication, both within the policy making process, and towards the general public. Such initiatives are needed to improve the public trust in the robust regulatory frameworks around the world and tackling the potential for misinformation.

POSTER CONTRIBUTIONS – SESSION IV

INTEGRATING SLOW-RELEASE BEHAVIOUR OF ENCAPSULATED PLANT PROTECTION PRODUCTS INTO EU REGULATORY LEACHING ASSESSMENT: CURRENT KNOWLEDGE AND REGULATORY CHALLENGES

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OBJECTIVES

- We conducted a comprehensive review of peer-reviewed literature and EU regulatory dossiers to evaluate how capsule (CS) formulation properties affect leaching potential of PPPs compared to other formulations.
- We aimed to synthesize knowledge on the impact of slow-release behaviour of CS formulations for groundwater exposure and raise regulatory awareness that current leaching assessments may overestimate groundwater risk of CS-formulated PPPs.

HIGHLIGHTS

- No single PPP submission has covered all CS-specific studies. Yet collectively, most key studies were covered in the current EU framework.
- In an OECD 307 study comparing EC and CS (Fig.a), apparent half-lives of CS were 10-times higher than EC.
- In EU TFD studies, CS showed release-limited dissipation in long-term (Fig. b-d). Metabolites were at trace levels, less frequently detected in CS than SC
- Leaching assessment should allow the consideration of (CS) slow release in a tiered approach

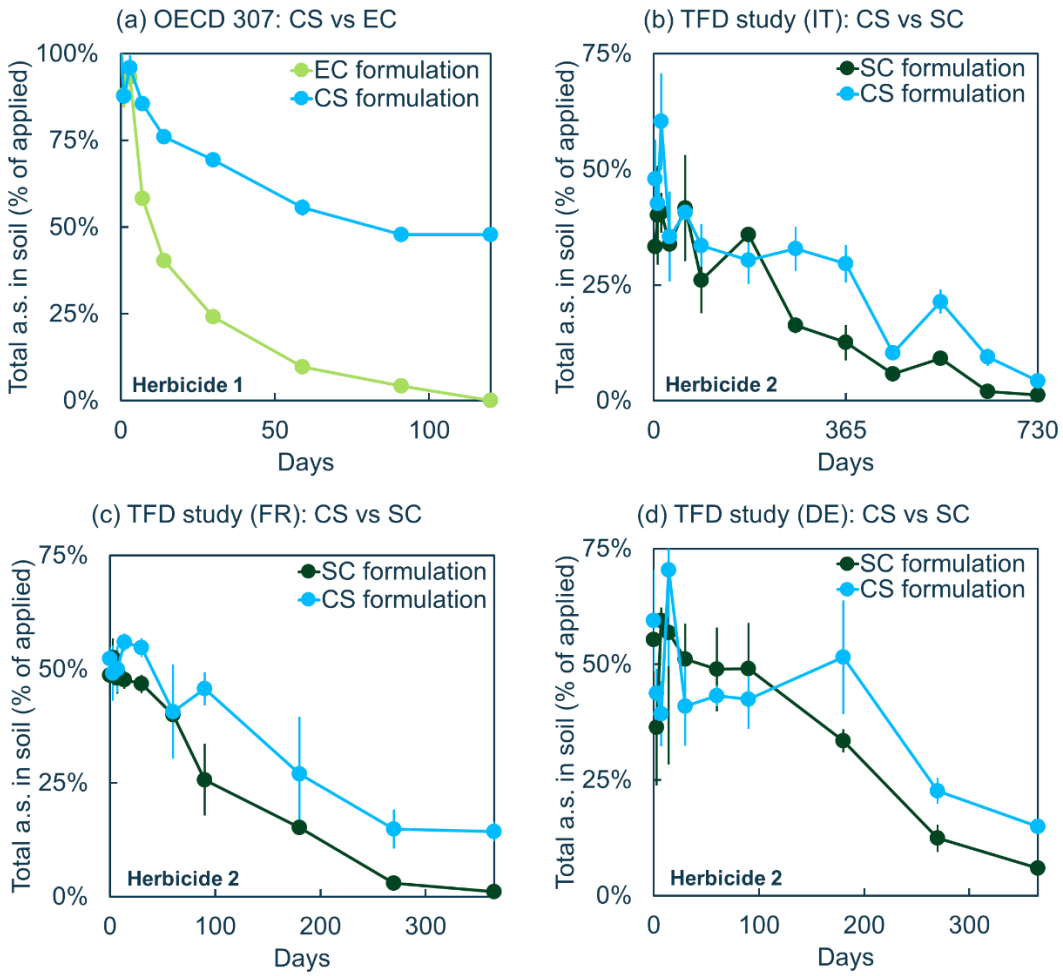

Fig a-d. Consistent with slow release, higher percentages of applied a.s. in soil over time were observed for CS compared with SC/EC in regulatory lab (a) and field studies (b-d).

A DIGITALIZED WAY FORWARD TO FIELD SPECIFIC RISK MANAGEMENT

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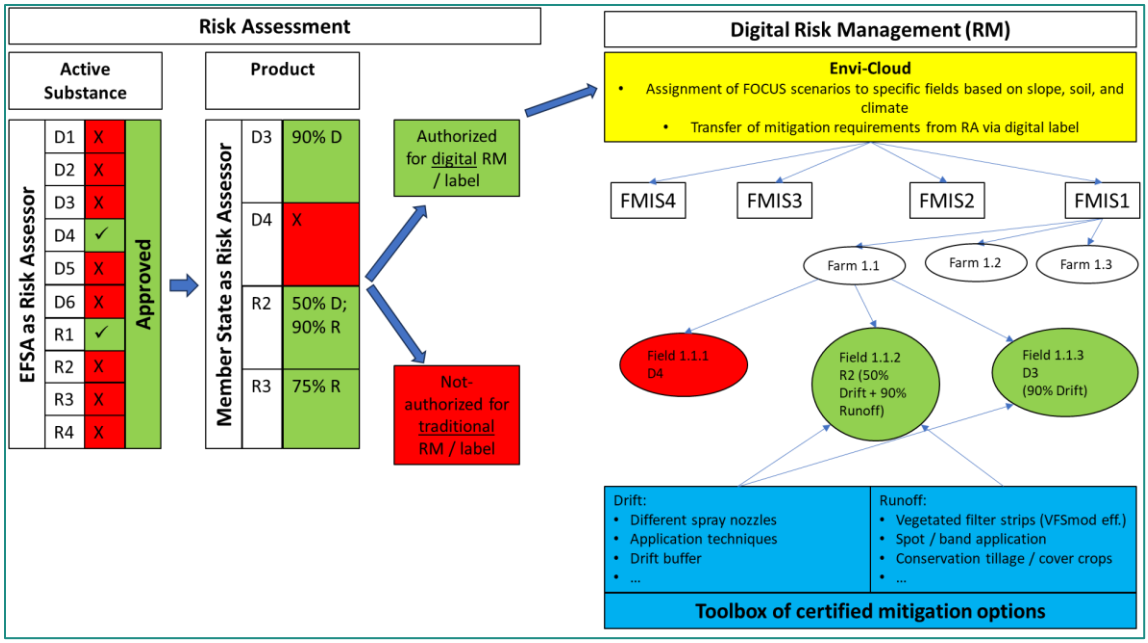
OBJECTIVES

Usage of farm management information systems (FMIS) implementing detailed geospatial data are used increasingly in agriculture, but often not yet in the authorization process of plant protection products. A transformation towards a digital driven field specific risk management for plant protection products is proposed in three phases. The work was published in a peer-reviewed journal [1].

HIGHLIGHTS

The risk assessment procedure on EU and member state level would remain in large parts as it is. The proposed process makes use of FMIS to distribute field specific restrictions and mitigation requirements. In phase 1 the mitigation requirements, based on standard regulatory scenarios (e.g. FOCUS), would be transferred to the specific fields which present the closest similarities to the given scenario with respect to soil and climate conditions. In phase 2 and phase 3, field specific modelling or modelling with geospatial data would be performed where the parameterization can be adapted to local conditions. Most of the relevant processes and parts are already available but would need to be connected in a new secure execution space to integrate risk assessment results, risk management decisions and farm management software (Envi-Cloud).



Flowchart of phase 1. Risk assessment (RA) on active substance and product level is done "as usual" by the European Food Safety Authority (EFSA) and EU Member States (MS), but approval with ONE passing relevant scenario. Member States decide about mitigation requirements (D = drift; R = runoff) for each FOCUS (Forum for Co-ordination of Pesticide Fate Models and Their Use) scenario based on the products intended uses. For the risk management (RM) in the online platform Envi-cloud and farm management information systems (FMISs), each field is assigned a FOCUS scenario and with it the required mitigation requirements. Farmers can select for each field-specific mitigation options which are in their "toolbox" for the specific field.

REFERENCES

[1] Kahl et al. (2025): Field specific risk management for plant protection products: a "digitalized" way forward. Integrated Environmental Assessment and Management, 2025, 1–11. https://doi.org/10.1093/inteam/vjaf165

TOWARDS A MORE RELIABLE PESTICIDE RISK INDICATOR TO MONITOR THE IMPLEMENTATION OF NATIONAL ACTION PLANS: THE LIMITATIONS OF HRI-1 AND ALTERNATIVES BASED ON ECOTOXICITY

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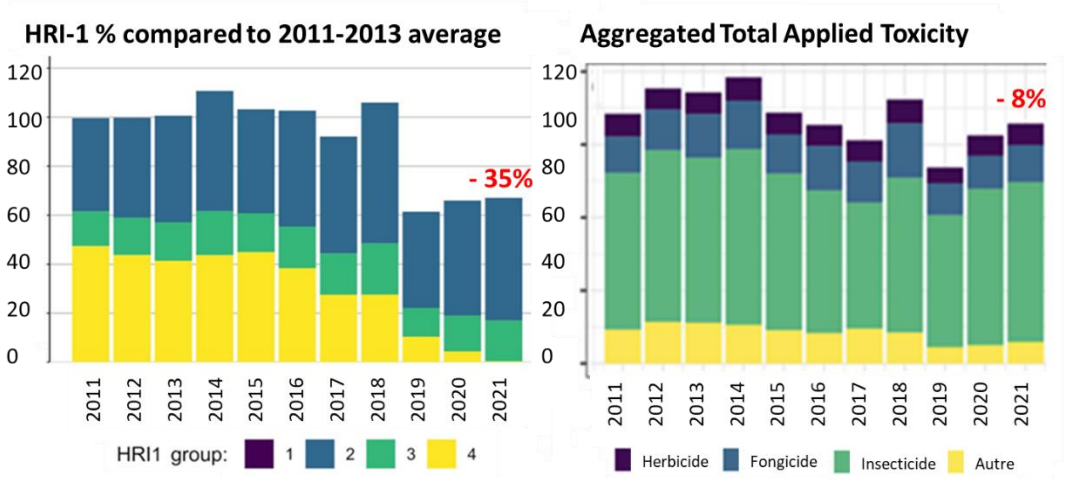
OBJECTIVES

- Assess the advantages and limitations of the HRI-1[1] in relation to the objective of evaluating a national action plan aimed at limiting plant protection product use and risk.
- Propose avenues for improvement and discuss the merits of an alternative indicator that takes into account the toxicity levels of the active substances.
- Conduct a European consultation – via online survey and targeted video interviews - on the current position of scientists and stakeholders on HRI-1 and its possible improvement.

HIGHLIGHTS

- This study confirms the shortcomings of the HRI-1, which have already been highlighted by scientists and environmental organisations:
- Low discriminatory power of the four proposed risk groups (particularly group 2, which accounts for more than 70% of authorised substances),
- Direct sum of quantities without taking effective doses into account,
- Weights assigned to each group are arbitrary,
- Retroactive application of category changes,
- Standardisation based on a single reference period, despite the fact that progress levels at this reference point vary across Europe.

- The global value of HRI-1 shows a 38% decrease in 2021, although its score for Group 2 remains high (see the graph).
- A good indicator must meet criteria relating to scientific basis, relevance, legitimacy and feasibility. It must be easy to implement at the European level.
- Two indicators based on toxicity data appear to be suitable alternatives: the ATAT [1], [2] (see the graph) and Pesticide Load [3].
- European databases should be improved in order to make more data available for a range of relevant taxa, long-term toxicity, and co-formulants.
- From a policy perspective, it seems difficult to reach a consensus at European level in the short term. European projects are essential to test the new indicator's ability to meet the above-mentioned criteria and to promote a harmonised methodology ensuring its better application at European level.
- The risk indicator should be accompanied with a set of complementary indicators in order to better inform public policy on in-depth practice changes.



Trends in the HRI-1 (left) and ATAT (right) indicators for France over the period 2011–2021 and their respective decreases in 2021 compared with the average for 2011–2013 (% shown in red).

REFERENCES

[1] J.-N. Aubertot, M. Garnault, V. Boussada, X. Reboud, C. Lannou, et al., "Vers un indicateur harmonisé pour quantifier l'utilisation des produits phytopharmaceutiques et les risques associés". INRAE, 2025, 136p. ⟨hal-04956205⟩.
[2] Bub S., Wolfram J., Petschick L.L., Stehle S., Schulz R. 2023. Trends of total applied pesticide toxicity in German agriculture. Environmental science & technology 57(1): 852-861. https://doi.org/10.1021/acs.est.2c07251
[3] Kudsk P., Jørgensen L. N. et Ørum J. E. 2018. Pesticide Load - A new Danish pesticide risk indicator with multiple applications. Land Use Policy 70: 384-393. https://doi.org/10.1016/j.landusepol.2017.11.010.

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