

Pesticide exposure assessment in rice paddies under different irrigation strategies: a case study in Lomellina, Northern Italy

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INTRODUCTION

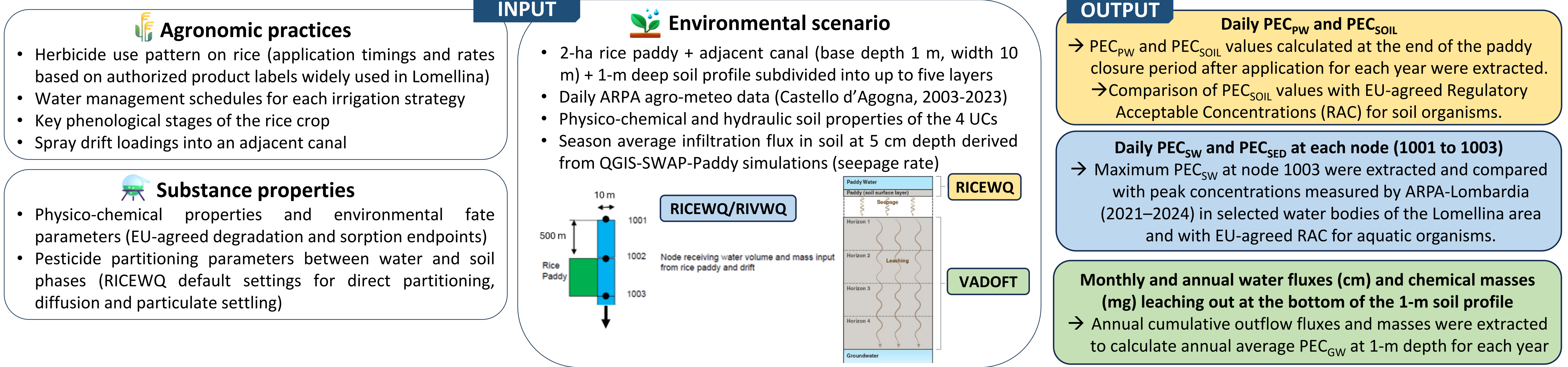
The calculation of Predicted Environmental Concentrations (PEC) of active substances of plant protection products (PPPs) is a key requirement of the EU regulatory framework (Regulation (EU) No 1107/2009) for conducting the risk assessment in soil, groundwater and surface water compartments. Current assessments rely on FOCUS models and standardized scenarios; however, these are not suitable for rice cultivation due to the complex hydrological dynamics of flooded conditions. To address this limitation, the MED-Rice guidance (SANCO/1090/2000 rev.1) provides a simplified Step 1 approach tailored to paddy fields, although it relies on simple assumptions and omits important processes, resulting in a limited realism of the exposure estimates. More advanced models are therefore needed to perform a refined and more realistic exposure assessment under rice-growing conditions. RICEWQ (RICE Water Quality) is a process-based model specifically developed to simulate pesticide fate and transport in flooded rice paddies. Coupling with the RIVWQ (RIVer Water Quality) model enables the assessment of pesticide concentrations in receiving surface waters, while linkage with the VADOFT model allows simulation of transport through the vadose zone and groundwater exposure assessment.

The aim of this study was to evaluate pesticide environmental exposure in the Lomellina rice-growing area (PV, Italy) using currently available modelling tools and to provide scientific input to ongoing regulatory discussions on pesticide environmental risk assessment in rice. This work was conducted as part of the PROMEDRICE project, funded by the Italian Ministry of University and Research (MUR) for Italian partners.

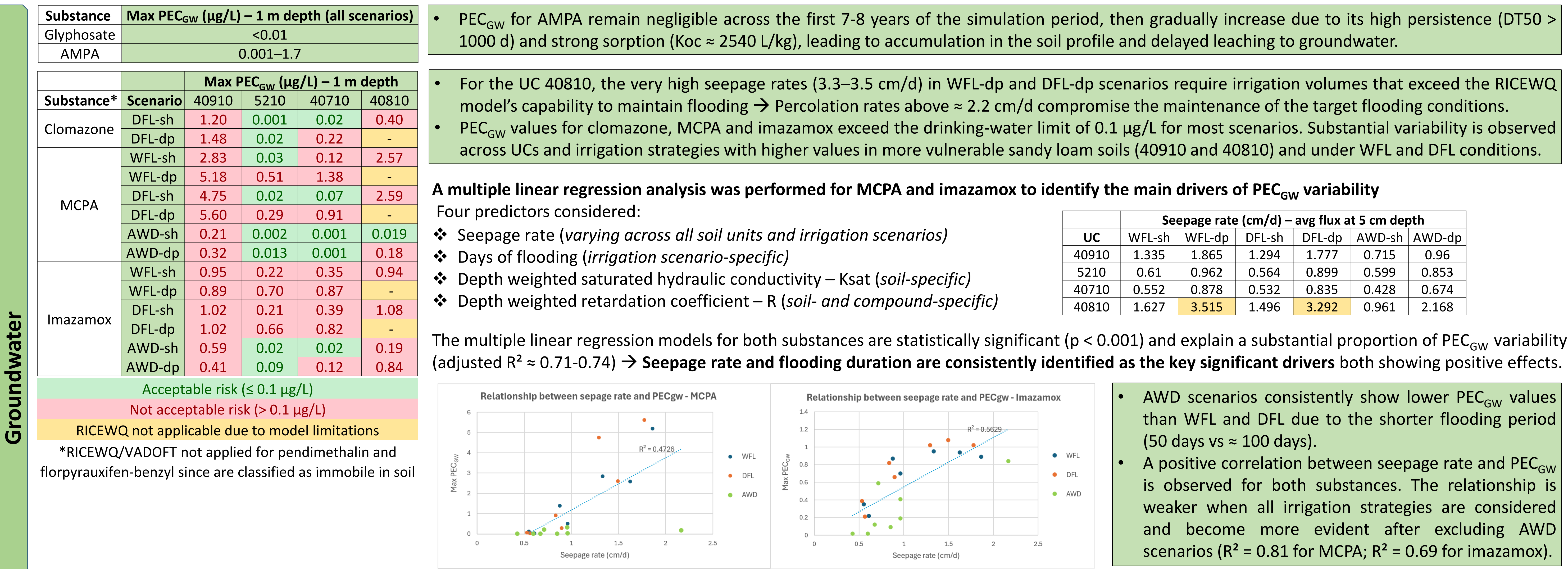
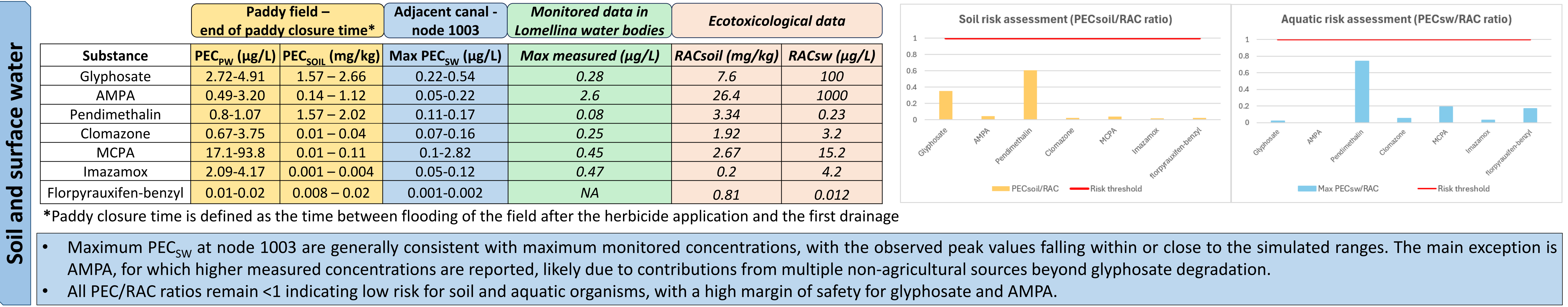
MATERIALS & METHODS

RICEWQ (1.92), RIVWQ (2.0.6) and VADOFT models were used to calculate PECs in paddy water (PEC_{PW}), paddy soil (PEC_{SOIL}), receiving canal water (PEC_{SW}) and groundwater (PEC_{GW}) considering:

- ❖ **6 herbicides:** glyphosate (plus its metabolite AMPA), pendimethalin, clomazone, MCPA, imazamox, floryprauxifen-benzyl
- ❖ **3 irrigation management strategies:** wet seeding and traditional flooding (WFL); dry seeding and delayed flooding (DFL); wet seeding and alternated wetting and drying (AWD)
- ❖ **2 groundwater levels:** shallow (sh) and deep (dp)
- ❖ **4 predominant soil cartographic units (UCs) in the Lomellina area** (1:50.000 Lombardy Region soil map): 40910 (loamy sand), 5210 (silt loam), 40710 (loamy sand), 40810 (sandy loam)



RESULTS & DISCUSSION



Cluster scenarios parametrization								
Scenario	OC (%)	Clay (%)	Silt (%)	Sand (%)	Field Capacity (m/m)	Wilting point (m/m)	Bulk density (kg/l)	Seepage rate (cm/d)
Cluster 3	1.5	20.7	38.9	40.3	0.3	0.1	1.4	0.2
Cluster 4	1.0	7.6	12.1	80.3	0.2	0.1	1.6	0.6
Cluster 5	0.7	21.1	39.2	39.7	0.3	0.1	1.4	0.2

Substance	Scenario	Max PEC _{GW} (µg/L) – 1 m depth		
		CL3	CL4	CL5
MCPA	WFL	<0.001	0.13	0.002
	DFL	<0.001	0.09	<0.001
Imazamox	WFL	<0.001	0.68	0.0016
	DFL	<0.001	0.80	0.0025

CONCLUSION

No potential risks are identified in soil and aquatic compartments for the selected herbicides and the predicted maximum surface water concentrations are generally in good alignment with ARPA monitoring data from selected Lomellina water bodies → These findings support the suitability of RICEWQ/RIVWQ modelling framework as a higher-tier tool for in-field and off-field exposure assessment in rice systems within EU pesticide regulatory context. For risk assessment purposes, the ecotoxicologically relevant concentrations and the most appropriate exposure metrics should be clearly defined. RICEWQ/VADOFT simulations show substantial differences in outcomes among different UCs and cluster scenarios with the drinking-water limit of 0.1 µg/L exceeded in many scenarios → The suitability of RICEWQ/VADOFT as a higher-tier option for groundwater exposure assessment in regulatory context requires further evaluation. Particular attention should be given to the impact of seepage rate on model predictions and to its implications on the representativeness and protectiveness of the proposed rice scenarios. Clear guidance for the regulatory application of RICEWQ/VADOFT is also warranted.