Environmental Risk Assessment of Pesticide Pollution in Rice Fields in the Mekong Delta

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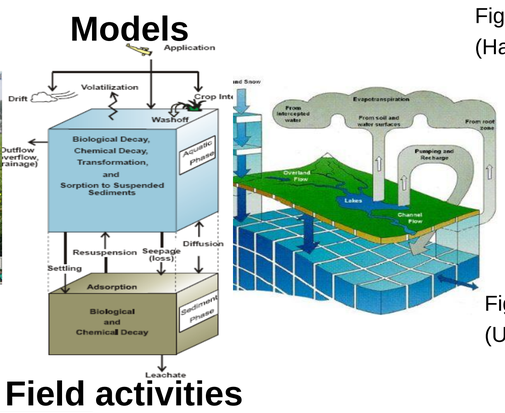
Introduction: The study aimed at main components: 10 active ingredient usage and management, concentrations in the water and soil phase, environmental risk assessment and mitigation methods, and model evaluation. Here presents the 3rd part of the research based on the comparison between the RICEWQ model results to available information on known toxic thresholds concerning health impacts, ecosystems and suggested levels of contaminants.

Material and methodology

Study area

An Long, Dong Thap

Models



Field activities

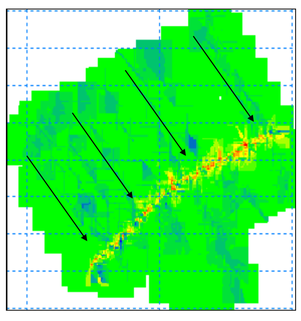


Fig. 1: Water balance

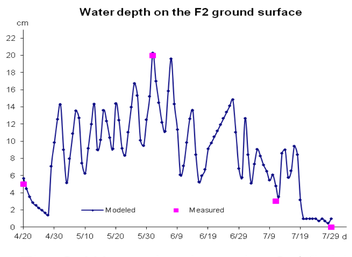


Fig. 2. Water depth on the 2nd field

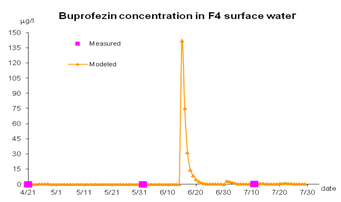


Fig. 3: Buprofezin concentrations in water

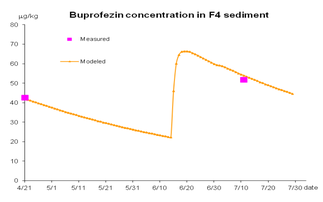


Fig. 4: Buprofezin residues in sediment

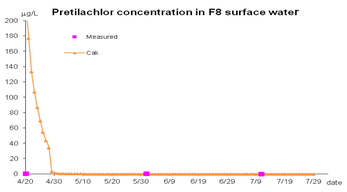


Fig. 5 : Pretilachlor concentrations in water

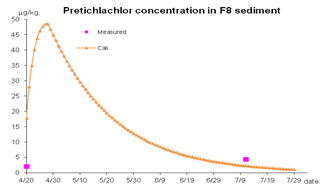


Fig. 6 : Pretilachlor concentrations in sediment

Model Outcomes

Environmental risk assessment

In water phase

Australia Guideline

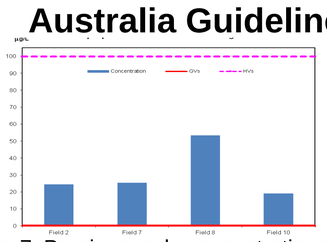


Fig. 7: Propiconazole concentrations (Hamilton et al., 2003)

Japanese standards

Pesticides	Standards (µg/L)	Maximum concentrations (µg/L) F2	F4	F7	F8	F10
Buprofezin	100		142	40.3		
Fenobucarb	200	181	120			
Fipronil	5			4.28		
Butachlor	300		891	903		360
Pretilachlor	400	919	719		220	
Isoprothiolane	400		200	280		202

Tab. 1: Water quality effluent from rice paddy discharge water in 150d (Hamilton et al., 2003)

UK Advisory

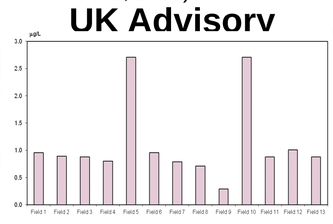


Fig. 8: cypermethrin concentrations (UK Technical Advisory Group)

Pesticides	Standards (µg/L)	Maximum concentrations (µg/L) F2	F4	F7	F8	F10
Buprofezin	10		142	40.3		
Fenobucarb	20	181	120			
Pretilachlor	40	919	719		220	
Isoprothiolane	40		200	280		202

Tab. 2: Environmental quality standards for used water (Hamilton et al., 2003)

Taiwan Limitation

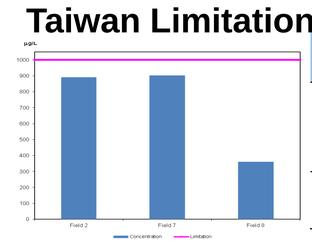


Fig. 9: Butachlor concentrations (Hamilton et al., 2003)

EPA Guidelines

Pesticides	Drinking Water Level of Concern Chronic (µg/L)	Acute (µg/L)	Maximum residues (µg/L) F2	F4	F7	F8	F10
Buprofezin[a]	73	no data		142	40.3		
Cypermethrin[b]	5600	2700	0.72	1.96	1.11	2.04	1.45
Fipronil[c]	6.67	810			4.28		
Difenoconazole[d]	350	7500	4.88	5.3	2.12	7.64	
Propiconazole[e]	129	8972	24.5	25.5	53.3	19.1	

Tab. 3: Maximum concentrations vs. DWLOC (a: EPA, 2001; b: EPA, 2002; c: EPA,1998; d: EPA, 1999; e: EPA; 2004)

European Food Safety Authority

Bioaccumulation Pesticides	a log K_{ow}	Evaluation
Buprofezin	4.93	High
Cypermethrin	5.30	High
Fenobucarb	2.78	Moderate
Fipronil	3.75	High
Butachlor	4.50	High
Pretilachlor	4.08	High
Isoprothiolane	3.30	High
Difenoconazole	4.36	High
Hexaconazole	3.90	High
Propiconazole	3.72	High

Acceptable daily intake (µg/kg body weight/day) and potential risk locations						
Pesticide	Buprofezin	Fenobucarb[1]	Fipronil	Pretilachlor	Hexaconazole	Propiconazole[2]
ADI	10	40	0.2	18	5	70
Fields	2	2	1	3	1	1

Tab. 4: ADI and potential risk locations ([1:] Kawata and Yasuhara, 1992, [2:] WHO, 2009, http://sitem.herts.ac.uk/aeru/iupac/index.htm.

Tab. 5: Potential bioaccumulation of pesticides http://sitem.herts.ac.uk/aeru/iupac/index.htm.

In sediment phase

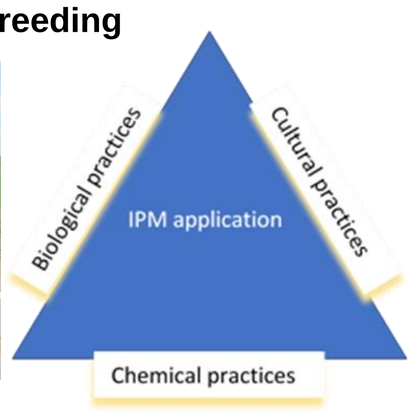
Maximum concentrations in sediment and critical values	(µg/kg)	Critical values (µg/kg)	Notes
Buprofezin		**170**	Chronic 28d NOEC
Field 4	66.4		
Field 7	190		
Cypermethrin		**16000**	EC_{50}
Field 2	26.1		
Field 4	43.5		
Field 7	28.7		
Field 8	40.2		
Field 10	112		
Fipronil		**0.2**	Chronic 28d NOEC
Field 7	7.38		
Pretilachlor		**686000[a]**	14d LC_{50}
Field 2	183		
Field 4	152		
Field 8	48.5		
Isoprothiolane		**440000[a]**	14 d LC_{50}
Field 4	122		
Field 7	220		
Field 10	77.5		
Difenoconazole		**10000**	Chronic 28d NOEC
Field 2	33.2		
Field 7	76		
Field 8	17.1		
Field 10	63.2		
Propiconazole		**25000**	Chronic 28d NOEC
Field 2	26		
Field 7	47.2		
Field 8	34		
Field 10	17.9		

Tab. 6: Guidelines and concentrations in sediment.(http://sitem.herts.ac.uk/aeru/iupac/index.htm,[a:] Bläsing, 2010)

Mitigation methods

IPM method

Aquaculture, livestock breeding



Living along the channel

Irrigation practices

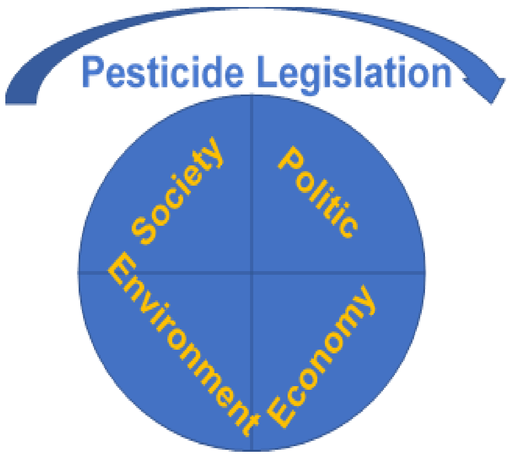
Pesticide quality-quantity

Weather conditions

Pesticide use safety

Pesticide spraying

Local and national levels



Conclusions:

- ❑ The pesticide application posed a low to high risk for water contamination.
- ❑ High predicted herbicide concentrations exceeded both the Japanese and Taiwanese standards.
- ❑ Four insecticides might have negative impacts on water bodies.
- ❑ Pesticide monitoring and modeling in farms and regional/catchment scales is further needed
- ❑ Pesticide concentrations exceeded the guidelines at 24 times.
- ❑ Three fungicide concentrations were higher than the expected values
- ❑ The attention is required to protect the soil organisms which act as natural form of pest control.
- ❑ The Vietnamese community needs to carefully establish their own legislation

References

1. Bläsing, M., 2010. Master thesis of “Pesticide residues in the Mekong Delta, Vietnam: Soil and sediment analyses and methodical constraints”. University of Bonn, Germany
2. Hamilton, D.J., Ambrus, Á., Dieterle, R.M., Felsot, A.S., Harris, C.A., Holland, P.T., Katayama, A., Kurihara, N., Linders, J., Unsworth, J., Wong, S.S., 2003. Regulatory limits for pesticide residues in water. Pure Appl. Chem. 75, 1123 – 1155.
3. Environmental Protection Agency, 2001, 2002, 2004.
4. European Food Safety Authority, 2010. Conclusion on the peer review of the pesticide risk assessment of the active substance buprofezin. EFSA Journal; 8(6): 1624.
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5. (http://sitem.herts.ac.uk/aeru/iupac/index.htm
6. Toan, P.V., 2011. Doctor thesis of “Pesticide use and management in the Mekong Delta and their residues in surface and Drinking water “. University of Bonn, Germany.

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