

Environmental risk assessment of pesticide application in Southeast China

Yong-Yu Li, Luo-Ping Zhang*, Wei-Qi Chen, Xin-Hong Wang, Neng-Wang Chen, Hua-Sheng Hong

(State Key Laboratory of Marine Environmental Science, Environmental Science Research Center, Xiamen University, Xiamen, Fujian 361005, China)

Introduction

Large amount pesticide application in Chinese rural area has threatened seriously the security of local freshwater resource, habitats, and human health, and affected local sustainable development. Environmental risk assessment (ERA) provides a methodology to estimate the risk impact of pesticide use on the environment, and to preserve environmental security and sustainable development.

Methodology

In this paper Wuchuan Catchment located at the middle-stream of Jiulong River Watershed in Fujian Province, a typical agricultural area of Southeast China (Fig. 1), was selected as the study area to assess the impact of pesticide use on water resource and aquatic life.

Data on rainfall events in 2004, organophosphorus pesticides (OPPs) used in Wuchuan Catchment, and their physicochemical and eco-toxicological properties (Tab. 1) were collected. The EQC and SoilFug model (Fig. 2) were used to simulate the environmental behavior of the pesticides in relation to the load applied onto Wuchuan Catchment.

The monitoring for the pesticide concentrations in the surface runoff of the catchment's outlet in three rainfall events was done to verify the parameters of the model. Twenty large rainfall events (>20 mm) in 2004 were selected to perform ERA. The concentration curves of pesticides in the runoff were simulated, and the peak concentrations were calculated by SoilFug model. ERA was performed by the risk quotient approach, the ratio of the peak concentrations calculated to the eco-toxicological properties (LC_{50} or EC_{50}) of the pesticides.

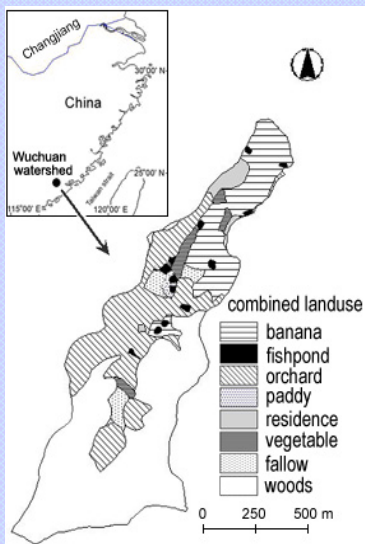


Fig. 1 Study Area

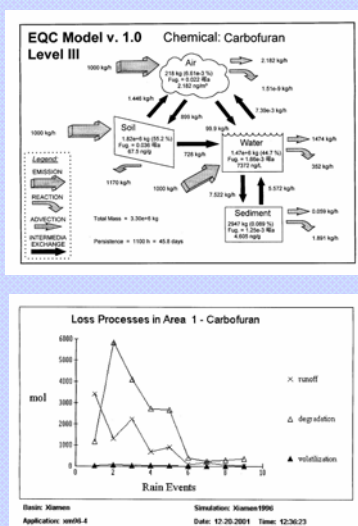


Fig. 2 EQC and SoilFug models

Results

The water samples in the runoff at the catchment outlet of Wuchuan catchment during and after rainfall in the three rain events of March 2004 were collected, and detected by GC-FPD. 15 OPPs in surface water were found with the concentrations of dichlorvos 0.26-42.1 ng/L, methamidophos 1.56-16.2 ng/L, omethoate from not detected (ND) to 35.6 ng/L, dimethoate ND-25.9 ng/L, trichlorfon ND-28.3 ng/L, disulfoton 1.98-40.8 ng/L, and methyl-parathion ND-18.2 ng/L, etc. The result showed that most highest concentrations of OPPs in surface runoff occurred after 3-4 hours rain. The characteristics of OPPs in the runoff varied with their physicochemical properties and K_{ow} of chemicals, especially with their water solubility.

Tab.1 Physicochemical and eco-toxicological properties of organophosphorus pesticide

Pesticides	Water solubility (mg/l)	Vapour pressure (mPa)	Bioaccumulation (Log K_{ow})	Soil persistence ($T_{1/2}$)	Fish LC_{50} (mg/L)	Daphnia EC_{50} (mg/L)
Methamidophos	1,000,000	4.71	-0.8	6	25	0.27
Dichlorvos	10,000	2106.5	1.9	0.5	0.45	0.00019
Dimethoate	39,800	1.10	0.704	7	6	4.7
Methyl-parathion	60	0.47	3.83	5	0.57	0.0025
Trichlorfon	120000	0.10	0.602	10	0.52	0.00096
Omethoate	23800	3.30	-0.74	6	9.1	0.022
Disulfoton	25	1.30	4.02	30	0.039	0.013

The parameters of SoilFug model were verified by the monitoring data. Twenty large rainfall events (>20 mm) in 2004 were selected to perform ERA. The concentration curves of pesticides in the runoff of rain events were simulated, and the peak concentrations were calculated by SoilFug model. ERA was performed by the risk quotient approach, the ratio of the peak concentrations calculated to the eco-toxicological properties (LC_{50} or EC_{50}) of the pesticides. The highest risks of pesticides in Wuchuan Catchment were identified by dichlorvos and trichlorfon treatment because of their high toxicities, very low EC_{50} , and some high water solubility.

Conclusion

The highest risks of pesticides in Wuchuan Catchment were identified by dichlorvos and trichlorfon treatment. The risk management measures including crop rotation, rotation of insecticide treatment and integrated pest management (IPM) were proposed to change traditional cultivation pattern and pesticide application in order to reduce the pesticide use and the risk on human health and the environment, and put forward local socio-economics towards sustainability.

*Corresponding author: Luo-Ping Zhang. Email: lpzhang@xmu.edu.cn