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Monitoring and modeling the fate of commonly used pesticides in surface water of the Lower Mekong Delta

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Introduction: The Lower Mekong Delta, one of the largest agricultural areas in Southeast Asia, has been reported to be increasingly polluted by agrochemicals since the beginning of the transformation processes in Vietnamese economy and specifically in the agricultural sector in 1986 (MRCS, 2007; Dasgupta et al., 2005; Dung, 2003; Phuong, 2003). Although pesticides have contributed significantly to enhancing agricultural productivity, these agrochemicals also have created risks to human health and environment (Margni, 2001; Phuong, 2003; Dasgupta et al., 2005) and lead to value loss of water resources (Phuong, 2003). While prohibited persistent organic pollutants such as HCHs and DDTs, were monitored and still detected in the Lower Mekong Delta in recent studies (Minh et al., 2007, Carvalho et al., 2008) little data exist on water pollution by recently used pesticides in the Delta.

Aiming to fill this information gap, a study comprising three components was set up at two study sites of the Delta. Pesticide use and management was investigated through surveys and participatory rural appraisals with farmers; pesticide residue concentrations were determined in field outflows, connected irrigation canals and in drinking water and finally pesticide fate was predicted by using a coupled MIKE 11/ MIKE SHE model. This abstract focuses on the work done in the field of pesticide monitoring.

The western study site (An Long Commune, Dong Thap province) represented an agricultural pattern with two intensive paddy rice crops per year and was heavily affected by flood in the rainy season. The second site located in the central part of the Delta (Ba Lang ward, Can Tho City) was characterized by a mix of paddy rice, vegetables and fruit trees. Fifteen pesticide compounds (buprofezin, butachlor, cypermethrin, difenozonazol, α-endosulfan, β-endosulfan, endosulfan-sulfate, fenobucarb, fipronil, hexaconazol, isoprothiolane, pretilachlor, profenofos, propanil, and propiconazol) were monitored systematically from August 2008 to August 2009.

Methods: Water samples (0.5 L) were collected in borosilicate bottles with Teflon caps, pre-filtered with glass wool (Roth, Germany) and glass fibre filter (Millipore, USA), solid-phase extracted (Phenomenex, C18-E) and quantified using GC-MS (Agilent 6890). For quality assurance samples and blanks were spiked with a surrogate standard (d-HCH). The recovery of the surrogate standard was used to monitor for matrix effects and sample processing errors. Surrogate recovery was evaluated by a recovery standard (Fluoren-d10) spiked to the sample after the extraction.

Results: A total of 434 samples (253 samples in Ba Lang, 119 samples in An Long and 62 drinking water samples) were collected from August 2008 to August 2009. In An Long 13 of the 15 target compounds were detected in water samples. Average residue concentrations ranged from 0.01 to 3.96 μg/l. The fungicide isoprothiolane and the insecticide buprofezin occurred with the highest concentrations (up to 20.77 and 16.53 μg/l, respectively). In Ba Lang, 12 of the 15 monitored pesticides were detected with an average concentration from 0.01 to 0.30 μg/l. The fungicide isoprothiolane was detected with highest (up to 12.86 μg/l). In 70% of all samples more than four different pesticides were detected. Their effect may add up and pose risk to humans and aquatic organisms.

In rural areas surface water is frequently used as drinking water source. First results from a sampling program of drinking water indicate that locally used water treatment methods (precipitation with aluminium sulfate followed by boiling) were not appropriate to reduce the pesticide exposure of the consumer. Through evaporation, boiling of drinking water even increased the concentrations of some non-volatile pesticides.

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