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A three-year monitoring of pesticide transfer through a tile-drained catchment.

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To comply with current regulations like the European Water Framework Directive (2000/60/EC), buffer zones can be used to reduce water bodies' pesticide pollution. As part of the ArtWET LIFE Environment project (06/ENV/F/000133), an artificial wetland and a forest buffer, located at Bray (France), were set up to intercept and treat flows coming from a 46-ha tile-drained catchment. The two buffer zones were located at the catchment outlet, in parallel to the agricultural ditch and upstream a natural creek. Because of limited land-availability, the buffer zones were not large enough to accommodate all catchment drainage water volumes. Consequently, only a portion of water volumes was selected to be intercepted by the buffer zones. To ensure a significant positive effect on downstream water quality, it is important to primarily intercept catchment flows presenting the highest concentrations into the minimum water volumes. Which flows are those?

To answer this question, the Bray catchment was continuously monitored for three years (2007 – 2010). The present paper focuses on the characterization of catchment outlet flow rates and pesticide concentrations from weekly collected flow-weighted composite samples. Water samples underwent a Solid-Phase Micro-Extraction (SPME) procedure and a Gas-Chromatography Mass-Spectrometry (GC – MS) analysis developed for the screening of sixteen pesticides presenting different physico-chemical properties. The whole analytical method was validated and detailed uncertainty calculations were made (Passeport et al., 2010). The sampling strategy allowed for mass balance calculations over the three years.

Approximately, pesticide applications account for 2043 g/ha/yr of herbicides and 283 g/ha/yr of fungicides. Herbicides applications mainly consisted of fall herbicides applied from the end of August to December, whereas fungicides were spread out in April and May. Between 150 and 250 mm of tile-drained water are generated each year at the catchment outlet. Their distribution is typical of tile-drained catchment from North-western Europe, namely including three distinct hydrological regimes: a fall "drainage initiation" and spring "end of drainage" seasons surrounding a winter "intense drainage season". The latter is characterized by large discharges and water volumes following rainfall events.

Pesticides presenting the highest application rates and lowest adsorption coefficients (isoproturon, chlorotoluron, metazachlor) were associated with the highest frequencies of quantification (> 68 %), concentrations and loads. Conversely, epoxiconazole and diflufenican (low application doses and high adsorption coefficients) were quantified in 20 % of the samples and associated to lower concentrations.

The results showed that pesticide dynamics through the catchment is dependent on applications and rainfalls. Flows following applications were associated with high concentrations. This occurred after fall and spring applications associated with low water volumes. However, unexpectedly, flows resuming after a period of low (or no) flows could also present high concentrations. For instance, epoxiconazole showed high concentrations in February 2009 whereas the previous application dated from Spring 2008. Several transfer pathways therefore contributed to pesticide transfer through tile-drained watersheds. As proposed by (Paris, 2004) and (Branger et al., 2009), pesticide applied above the drains may transfer more quickly than those applied at the inter-drain region where they may slowly transferred down to the 1-m deep drain. Moderately mobile pesticide may be more prone to quick and "typical" transfer than sorbing molecules.

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