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Measuring pesticides in surface waters – continuous versus event-based sampling design

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Monitoring pesticides in surface waters is still a work- and cost-intensive procedure. Therefore, studies are normally carried out with a low monitoring frequency or with only a small selection of substances to be analyzed. In this case, it is not possible to picture the high temporal variability of pesticide concentrations, depending on application dates, weather conditions, cropping seasons and other factors.

In 2007 the Institute of Landscape Ecology and Resource Management at Giessen University implemented a monitoring program during two pesticide application periods aiming to produce a detailed dataset of pesticide concentration for a wide range of substances, and which would also be suitable for the evaluation of catchment-scale pesticide exposure models. The Weida catchment in Thuringia (Eastern Germany) was selected as study area due to the availability of detailed pesticide application data for this region. The samples were taken from the river Weida at the gauge Zeulenroda, where it flows into a drinking water reservoir. The catchment area is 102 km^2. 67% of the area are in agricultural use, the main crops being winter wheat, maize, winter barley and winter rape. Dominant soil texture classes are loamy sand and loamy silt. About one third of the agricultural area is drained. The sampling was carried out in cooperation with the water supply agency of Thuringia (Fernwasserversorgung Thueringen). The sample analysis was done by the Institute of Environmental Research at Dortmund University.

Two sampling schemes were carried out using two automatic samplers: continuous sampling with composite samples bottled two times per week and event-based sampling triggered by a discharge threshold. 53 samples from continuous sampling were collected. 19 discharge events were sampled with 45 individual samples (one to six per event). 34 pesticides and two metabolites were analyzed. 21 compounds were detected, nine of which having concentrations above the drinking water limit (0.1 μg/l).

Pesticide loads were calculated separately from continuous and event-based samples. Only three pesticides dominated the total load. These were the herbicides metazachlor, terbuthylazine and quinmerac amounting to 75 % of the total load. This result seems to be plausible considering the fact that these three substances are the pesticides with the highest applied amounts in the Weida catchment. The highest pesticide loads of single pesticides were observed during or shortly after their application period, mostly accompanied by larger discharge events. They can be explained as surface runoff and drainage inputs from treated fields, since spray-drift inputs would be detected during the application periods without dependency on discharge events, and inputs from point-sources are usually independent of discharge as well.

Annual loads calculated from continuous samples were mainly higher than those of event-based samples due to the fact that they represent a much longer time period. On the other hand, the highest concentrations were found in the event-based samples; in many cases they double the maximum concentrations of continuous samples.

The monitoring study presented shows that different sampling strategies lead to different results and can answer different questions. If the intention is to detect maximum concentrations caused by surface runoff or drainage inputs, e.g. to assess the resulting risk to the aquatic community, the event based sampling method can be recommended. If one is rather interested in calculating annual pesticide loads and assessing which fractions of applied amounts finally enter the surface water network, continuous sampling is advisable.

The dataset of continuous and event-based pesticide concentrations offers the possibility to evaluate and improve pesticide exposure models at the catchment scale. Further work is scheduled on this issue.