

# Glyphosate herbicides in surface waters

**Glyphosate is by far the most commonly used herbicide – worldwide and also in Switzerland. Given its importance, however, relatively little data is available on its occurrence in the aquatic environment since the substance is difficult to detect analytically. A reliable method for the determination of glyphosate and its degradation product AMPA in water has now been developed by Eawag and applied to environmental samples.** Irene Hanke and Heinz Singer

Glyphosate is a broad-spectrum herbicide with low toxicity to humans and the environment. Worldwide and in Switzerland, it is among the most widely used pesticides. In recent years, use of the agent has risen sharply around the world as a result of the increased cultivation of crops such as maize and soya that are genetically modified to be resistant to

this herbicide. Sales of glyphosate in Switzerland currently amount to approx. 190 t per year, which is equivalent to about 14 % of the total quantity of pesticides used. The bulk of this product is applied as a non-selective herbicide in the agricultural sector. Around 4 t is used

by Swiss Federal Railways (SBB) for vegetation control on the rail network (see the article on p. 14). Use of glyphosate as a weedkiller by public institutions, industry and private individuals accounts for an unknown proportion of the total. Because glyphosate is strongly adsorbed to soil minerals and readily biodegradable, it is assumed that – even though the substance is highly soluble in

water – only a small fraction enters surface or groundwaters.

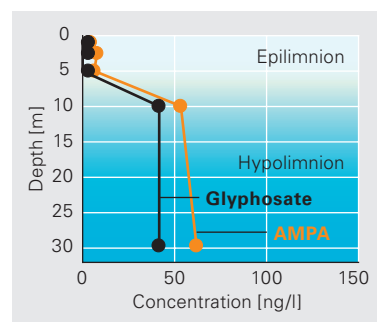
## Difficult to detect

The properties of glyphosate – a small, polar, zwitterionic and strongly sorbing compound with a propensity for complexation – and its major metabolite aminomethylphosphonic acid (AMPA) make reliable detection of trace levels difficult with the analytical methods currently available. At Eawag, therefore, we have chosen a method in which the analytes are first converted in an aqueous solution with the aid of the derivatization reagent FMOC-Cl to a product which permits efficient enrichment from the water sample, unproblematic liquid chromatographic separation and highly sensitive detection by mass spectrometry. Although the method was essentially already known, certain refinements were required; in particular, these related to optimization of the yield and speed of derivatization, the removal of undesirable by-products and the inhibition of metal complexes.

## Environmental measurements

The analysis of samples from various lakes, rivers and groundwaters demonstrated the robustness of the method and revealed interesting initial environmental data. None of the groundwater samples analysed contained detectable concentrations of glyphosate or AMPA (<10 ng/l). In contrast, glyphosate and AMPA were detected in all the lakes and rivers investigated. In the samples withdrawn from the tributaries of Lake Greifen, up to 390 ng/l glyphosate and 180 ng/l AMPA were de-

**Although the mobility of glyphosate is expected to be low, we measured concentrations similar to those of atrazine.**



Concentration/depth profiles of glyphosate and AMPA in Lake Greifen in August 2006. Glyphosate and AMPA are detectable in the lower layer of the lake (hypolimnion).

ected. The Rhine at Weil contained about 30 ng/l glyphosate and 50 ng/l AMPA. These concentrations of glyphosate – a substance considered to be of low mobility – are thus in a range similar to that observed for the widely used and more mobile compound atrazine. The depth profile of the concentration for Lake Greifen shows that glyphosate and AMPA appear to be degraded in the uppermost water layer (epilimnion). Using the newly developed analytical method, possible sources, input pathways and the degradation of glyphosate are now to be studied in more detail. ○ ○ ○



Analysis of enriched water samples by mass spectrometry.

Hanke I., Singer H., Hollender J. (2006): Quantification of Glyphosate and Aminomethylphosphonic Acid in Water using Solid Phase Extraction-Liquid Chromatography-Tandem Mass Spectrometry. Proceedings of the IAEAC European Conference on Pesticides, November 26–29, Almeria, Spain.