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Sources and Input Pathways of Glyphosate and its Degradation Product AMPA

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Despite being the pesticide used in the largest quantities worldwide, the environmental relevance of glyphosate has been considered low for many years. Reasons for this assessment were the observations that glyphosate degrades quickly into its degradation product AMPA and that it sorbs strongly to soil particles. Hence, little losses to water bodies had been expected. Research during the last few years however contradicts this expectation.
Although glyphosate is a dominant pesticide used in agriculture, recent studies on other pesticides revealed that urban sources may play a significant role for water quality. Therefore this study compares glyphosate input into streams from agricultural and urban sources. For that purpose, a catchment of an area of 25 km2 was selected. It has by about 12'000 inhabitants and about 15 % of the area is used as arable land. Four sampling sites were selected in the river system in order to reflect different urban and agricultural sources. Additionally, we sampled a combined sewer overflow, a rain sewer and the outflow of a waste water treatment plant. At each site discharge was measured continuously from March to November 2007. During 16 rain events samples were taken by automatic devices at a high temporal resolution.
To analyze the concentration of glyphosate and its degradation product AMPA, the samples were derivatized with FMOC-Cl at low pH conditions and then filtrated. The solid phase extraction was conducted with Strata-X sorbent cartridge. Glyphosate and AMPA were detected with API 4000 after the chromatography with X bridge column C18. To assure the data quality, interne standards of Glyphosate and AMPA were added to every sample. The limit of detection and quantification for glyphosate and AMPA are bellow 1ng/l.
We analyzed two rain events at a high resolution for all stations and several events at the outlet of the catchment. We measured high glyphosate concentration in urban and agriculture dominated catchments with up to 3'600ng/l in the rainwater sewer and 2'500ng/l from agricultural origin. The highest glyphosate concentrations were detected during peak flow. The input of the waste water treatment plant (WWTP) was up to 500ng/l. We detected glyphosate above the detection limit in all samples throughout the sampling period. Even after the vegetation period in November, glyphosate peak flow concentration in the outlet of the entire catchment was 137 ng/l exceeding the Swiss water quality criteria for single pesticides. The AMPA concentrations were generally lower than those of Glyphosate except for the WWTP. Generally, AMPA concentrations varied less during a rain event than glyphosate concentrations.
Despite the strong sorption to soil particles and short half-life, glyphosate occurs in high concentrations in surface waters affected by urban and agricultural sources. Concentrations were even higher than those of other widely used herbicides like atrazine and mecoprop.