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Continuous pesticide screening in agricultural watersheds reveals high pesticide levels from spring to fall and strong inter-annual differences of the detected compound spectrum

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Agricultural pesticides are regularly found in many surface waters draining agricultural areas. Because of large fluctuations in concentration over time and the large number of pesticides, it is demanding to i) run monitoring programs across the entire growing season and ii) to repeat such intensive observations in different years. We present a collaborative project between research and Swiss authorities to tackle this knowledge gap. To that end, five streams (catchments sizes: 0.9 to 6.7 km2) with intensive agriculture including different types of crops (arable land, vegetables, vineyards and orchards) were studies between March and October 2017.

We collected 3.5 d composite samples continuously with automatic sampling devices. Liquid chromatography coupled to high resolution mass spectrometry was used to quantify concentrations of 217 synthetic pesticides. The measured concentrations (MECs) were compared to chronic and acute environmental quality criteria (QC). The MEC/QC ratios result in risk quotients (RQs), which should not exceed a value of one to maintain good water quality.

Overall and in all single areas, we observed a large pesticide diversity. A total of 143 pesticides was detected with the numbers per site ranging between 70 and 89 compounds. The median number of compounds per sample varied between 21 and 41 and the mean sum of pesticide concentrations per sample between 621 and 4136 ng L-1 for the different sites.

These concentrations led to frequent and long-lasting exceedances of chronic and acute QC. Critical concentrations (RQ > 1) occurred throughout the entire study period starting in March till October. Chronic QC were exceeded between 50 and 83% of the study period depending on the study area. Acute QC were exceeded between 2 weeks and 2.5 months. For 31 different pesticides, the RQ was larger than one in at least one of the 3.5d samples. For two catchments, the data from 2017 could be compared to a previous year (2015). A conspicuous findings was the change in the compounds that caused critical pesticide levels. This can be illustrated by the small number of compounds that caused QC exceedances in both years in a given area (5 and 4 pesticides, respectively) and the observation that some compounds caused exceedances in one year and were not even detectable in the other year. Despite these changes in the pesticide spectrum, the number of QC exceedances were very similar between the two years in one of the catchments. In the other one, these number dropped from 49 to 19.

In summary, these data demonstrate that pesticide pollution in small agricultural streams is not limited to a short period but extends over a large part of the year. The compounds causing critical levels differ between sites but may also vary strongly between years. This has substantial consequences for monitoring strategies.