European Commission

Science for Environment Policy

Banned pesticides continue to affect toxicity in streams

12 January 2017
Issue 480

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Many toxic pesticides have been banned by the EU, however some can remain in the environment for many decades. Aquatic invertebrates are particularly vulnerable to pesticides, which can alter their feeding behaviour, growth and mobility. New research has found that persistent pesticides can increase toxicity in streams by up to 10 000 times compared to the residues of currently used pesticides. The researchers recommend these be taken into account when calculating overall toxicity.

The green revolution in the 1940s produced many effective and apparently safe pesticides, including synthetic insecticides such as DDT. Many of these chemicals were later discovered to have toxic effects, such as carcinogenicity, and subsequently banned from use. Another important issue is persistence; their long lifetimes mean some of these so-called 'legacy' pesticides can persist in the environment several decades after their use is prohibited.

Researchers examined the presence of both contemporary and legacy pesticides in 14 streams in Denmark, and used their results to predict the overall toxicity of the streams. They looked at both the influence of surface run-off and groundwater on concentrations in streams by taking samples in the streams shortly after periods of high precipitation, when surface runoff is high, and during a period of low precipitation, when groundwater was expected to be the largest source of inflow to the streams. Twelve of the streams were located in catchments where agriculture represents 80% or more of land use.

Water samples were collected from 2010 to 2012 mostly during May and June, the main periods when pesticides are applied to crops. The researchers used two methods to sample sediment: direct sampling of bed sediment using a core sampler, to give a snapshot for a specific moment in time; and time-integrated sampling for particulates (suspended sediment flowing in the stream), to which pesticides washed from agricultural fields can bind. They say this helped them to capture the pesticides which are expected to attach preferentially to (fine) particle surfaces.

The total toxicity was assumed to be the sum of the individual toxicities of all pesticides detected, neglecting any enhanced or reduced toxicity which may occur when different pesticides interact. The toxicity measure used was the LC_{50} — the concentration of the chemicals leading to 50% mortality for the test animals during an observation period of 48 hours — for the benchmark organism *Daphnia magna*. The study only provides an estimation of toxicity, by measuring the concentration of substances of *known* toxicity (the researchers did not assess the direct effect of the pesticides on aquatic organisms).

A total of 32 pesticides were detected. Two of the four most commonly detected were dinitro-ortho-cresol and trichloroacetic acid, both last sold in Denmark in the 1980s. The researchers believe these pesticides were generated in and transported from the atmosphere, rather than being present in surface runoff or groundwater. Three commonly detected pesticides in groundwater were mecoprop, dichlorprop, and dichlobenil. All of these chemicals were banned in Denmark in the late 1990s.

The estimated aquatic ecotoxicity increased by up to 10 000 times when legacy pesticides were included. Insecticides bound to sediments were found to be the largest source for the predicted ecotoxicity.

Continued on next page.

Source: McKnight, U.S., Rasmussen, J.J., Kronvang, B. *et al.* (2015). Sources, occurrence and predicted aquatic impact of legacy and contemporary pesticides in streams. *Environmental Pollution* 200 (64–76): 0269-7491. DOI: 0.1016/j.envpol.2015.02.015.

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In this study, eight of the nine pesticides included on the Water Framework Directive's[1] list of 33 Priority Substances[2] at the time of the study — shown to be of major concern for European Waters — were detected. For two of these, diuron and isoproturon, some detected concentrations were above or close to the EU aquatic Predicted No Effect Concentrations (PNECs)[3] — below which no adverse ecosystem effects can be measured. Meanwhile the fungicide hexachlorobenzene — never authorised for use in Denmark — and the insecticide lindane were detected in the sediment at concentrations well above the sediment PNEC values used in the context of the selection of the 33 priority substances listed in Directive 2008/105/EC[4].

Since the study looked at only selected areas of Denmark, it is possible that similar results would not be found elsewhere. However, the researchers note that most of the maximum concentrations measured are similar to the reported median values of concentrations for European streams.

The study indicates that, alongside contemporary pesticides, legacy pesticides, and the compounds produced as they break down, remain a hazard to aquatic environments. The researchers recommend that monitoring programmes which estimate the ecotoxicity of streams be adjusted to reflect this. Furthermore, they advise that a greater research emphasis be put on the analysis of groundwater, often presumed to contain low levels of pollution. They also highlight that pesticides bound in particular to suspended sediments were a major source of predicted toxicity and need to be further studied.

1. http://ec.europa.eu/environment/water/water-framework/info/intro_en.htm

2. Since amended by Directive 2013/39/EU. See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:226:0001:0017:EN:PDF.

3. Revised Proposal for a List of Priority Substances in the Context of the Water Framework Directive (COMMPS Procedure)

4. Ibid. For updated environmental quality standard dossiers for the priority substances, see : https://circabc.europa.eu/w/browse/2266abad-7e2f-4380-83b8-623c5526d3f6 and https://circabc.europa.eu/w/browse/8d2c7c28-358e-4ddf-8a0e-149f6667c19f