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Comparison of different passive sampling approaches for quantifying pesticide pollution in streams of Costa Rica and Uganda

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In tropical countries, farmers must use a broad range of pesticides for crop protection year-round. After application, especially during heavy rain events, these pesticides are washed into rivers and can impair aquatic organisms or even contaminate drinking water sources.
The extent of pesticide pollution and the status of water quality in tropical regions is poorly documented. Currently, very few pesticides are analyzed from grab samples without comprehensive long-term monitoring data. There is a strong need for simple sampling strategies, which enable long-term water sampling and improved environmental pesticide monitoring.
To address this issue, we tested three easy applicable low-tech passive sampling approaches: polydimethylsiloxane (PDMS) sheets, styrene-divinylbenzene (SDB) discs, and a water level proportional (WLP) sampler. All three samplers were mounted simultaneously in streams of the Río Tapezco catchment in Zarcero, Costa Rica from July to October in 2015 and May to October in 2016. In Uganda, the samplers were installed in streams of the Mayanja catchment from mid-September to the end-November in 2017. Both regions are characterized by intensive small-holder farming. The sampling was conducted during the rainy season and the samplers were installed and replaced in biweekly intervals.
18 apolar pesticides were collected on PDMS sheets and analyzed using GC-ACPI MS/MS, 250 semi-polar and polar parent pesticides and transformation products were collected on theSDB disks and the WLP samplers and quantified using LC-HR-MS.
For detection of the spectrum of compounds presented in the streams in both catchments, the three sampling systems proved to be simple and reliable during the sampling. Using the PDMS sheets, 11 of 18 compounds were detected in Costa Rica, and 7 of 18 in Uganda.
In Costa Rica, 55 compounds were detected with both the WLP and SDB samplers. 44 additional compounds were only detected with the WLP sampler, 26 with the SDB disks; 124 substances were below limit of detection. In Uganda fewer compounds were found, 12 compounds were detected in both the WLP and SDB samples, 5 different compounds were found each with the WLP and the SDB samplers; 227 compounds were below limit of detection.
For obtaining aqueous environmental concentrations, the WLP sampler was the most suited method. SDB and PDMS samplers require compound specific sampling rates to estimate water concentrations. The three approaches were compared to determine whether their results concur. Each individual detected compound was compared to see if there is a robust linear relationship between the water concentrations from the WLP samplers and the masses from the PDMS and SDB samplers across time and sampling site. Our results show that for about 70% of the compounds there is a non-linear relationship and for many compounds there are strong spatial, but fewer temporal effects on these relationships. The spatial variation indicates that there are important local factors affecting the sampling rates with each device.
Tentatively, we explain the non-linear correlation among SDB/PDMS and WLP data, by prevalent differences in concentrations and discharge relationships for different compounds; and due to the non-ideal sampling behavior of the PDMS sheets or the SDB disks.