

Passive sampling approaches used for time-integrated environmental monitoring and Risk Assessment in the tropical Río Tapezco catchment in Costa Rica

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Highest pesticide application rates and high surface runoff potentials are found in tropical countries. Global data indicate that among these countries, Costa Rica's agriculture is one of the most pesticide intensive worldwide. After use, pesticides can be transported from the fields into surface water through heavy raining events via wash-off, leaching, surface runoff and erosion processes, or direct as point source due to poor pesticide application practices and deteriorate the water quality and impair aquatic organisms.

Even if the risk of pesticide pollution is well documented in Costa Rica, comprehensive information about the diffuse and direct pesticide entry routes, their environmental behavior, and the degree of water pollution is often lacking. Generally, only grab samples are taken and time integrated methods for environmental monitoring are seldom used so far. There is a need for more time integrated data at catchment scale. Current passive sampling techniques are low-costs options that, when combined with advanced analytical screening methods, allow for a broad assessment of pesticide pollution in streams. This will lead to a better systematic understanding of the environmental fate of pesticides and to describe their impacts to non-target organisms in tropical aquatic environments in the short- and long-term.

We implemented such an approach in the tropical Río Tapezco catchment in the Zarcero canton, Costa Rica. The area covers 5112 ha, ranges between an altitude of 1100 and 2200 m above sea level and receives an average annual precipitation of 2000 - 2500 mm/yr. The catchment is intensively used for the horticultural production of vegetables, potatoes and herbs and it is specially characterized by its agricultural fields with steep slopes. The area is a hot spot of pesticide use with an average application rate of about 22 kg/ha of arable land and cropping cycle. For time-integrated monitoring, the rivers of the study area were sampled at five points in biweekly intervals between end of July and beginning of October 2015 by using three passive sampling systems (Camcather[®] with styrene-divinylbenzene reverse phase sulfonated discs, polydimethylsiloxane sheets, and a water level proportional water sampler). Additionally, pressure loggers were installed at all sites for recording water temperature and level continuously and daily precipitation data from one meteorological station (Zarcero Palmira) were available. For the quantification of about 260 substances GC-MS/MS and LC HR-MS was used.

In 2015, more than 60 pesticides were detected in the Río Tapezco catchment with biweekly time weighted average concentrations ranging from few ng/L to several $\mu\text{g/L}$. Furthermore the available European environmental quality standards for several compounds were exceeded and present a potential risk for water organisms.