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Spatial and temporal patterns of pesticide losses in a small Swedish agricultural catchment

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Research at catchment and regional scales shows that losses of pesticides to surface water often originate from a relatively small fraction of the agricultural landscape. These 'hydrologic source areas' represent areas of land that are highly susceptible to fast transport processes, primarily surface runoff or rapid subsurface flows through soil macropores, either to subsurface field drainage systems or as shallow interflow on more strongly sloping land. A good understanding of the nature of transport pathways for pesticides to surface water in agricultural landscapes is essential for cost-effective identification and implementation of mitigation measures. However, the relative importance of surface and subsurface flows for transport of pesticides to surface waters in Sweden remains largely unknown, since very few studies have been performed under Swedish agro-environmental conditions.

We conducted a monitoring study in a small sub-surface drained agricultural catchment in one of the main crop production regions in Sweden. Three small sub-catchments were selected for water sampling based on a high-resolution soil map developed from proximal sensing data; one sub-catchment was dominated by clay soils, another by coarse sandy soils while the third comprised a mix of soil types. Samples were collected from the stream, from field drains discharging into the stream and from within-field surface runoff during spring and early summer in three consecutive years. LC-MS/MS analyses of more than 100 compounds, covering the majority of the polar and semi-polar pesticides most frequently used in Swedish agriculture, were performed on all samples using accredited methods. Information on pesticide applications (products, doses and timing) was obtained from annual interviews with the farmers.

There were clear and consistent differences in pesticide losses between the three sub-catchments, with the largest losses occurring in the area with clay soils, and negligible losses from the sandy sub-catchment. This suggests that transport of pesticides to the stream is almost entirely occurring along fast flow paths such as macropore flow to drains or surface runoff. Only a very small proportion of fields are directly connected to the stream by overland pathways, which suggests that macropore flow to drains was the dominant loss pathway in the studied area. Data on pesticide use patterns revealed that compounds were detected in drainage and stream water samples that had not been applied for several years. This suggests that despite the predominant role of fast flow paths in determining losses to the stream, long-term storage along the transport pathways also occurs, presumably in subsoil where degradation is slow.