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The Swedish environmental monitoring program for pesticides & examples of monitoring data applications

Introduction

The Swedish environmental monitoring program for pesticides started in 2002.

- It includes monitoring of over 100 substances in water (stream water, groundwater and rain), air and sediments in the main agricultural areas in Sweden (Figure 1).
- Surface water samples are collected in small agricultural catchments together with information about pesticide application time, location and amount.
- The results provide comprehensive information about the environmental fate, sources and long-term trends of agricultural pesticides in the environment.
- The unique data series is available online and is frequently utilized by several stakeholders such as researchers, authorities and extension services.
- Examples of use by authorities include evaluating the transport of pesticides and organizing mitigation campaigns (Figure 2).

Two examples of results from the monitoring program are presented below.

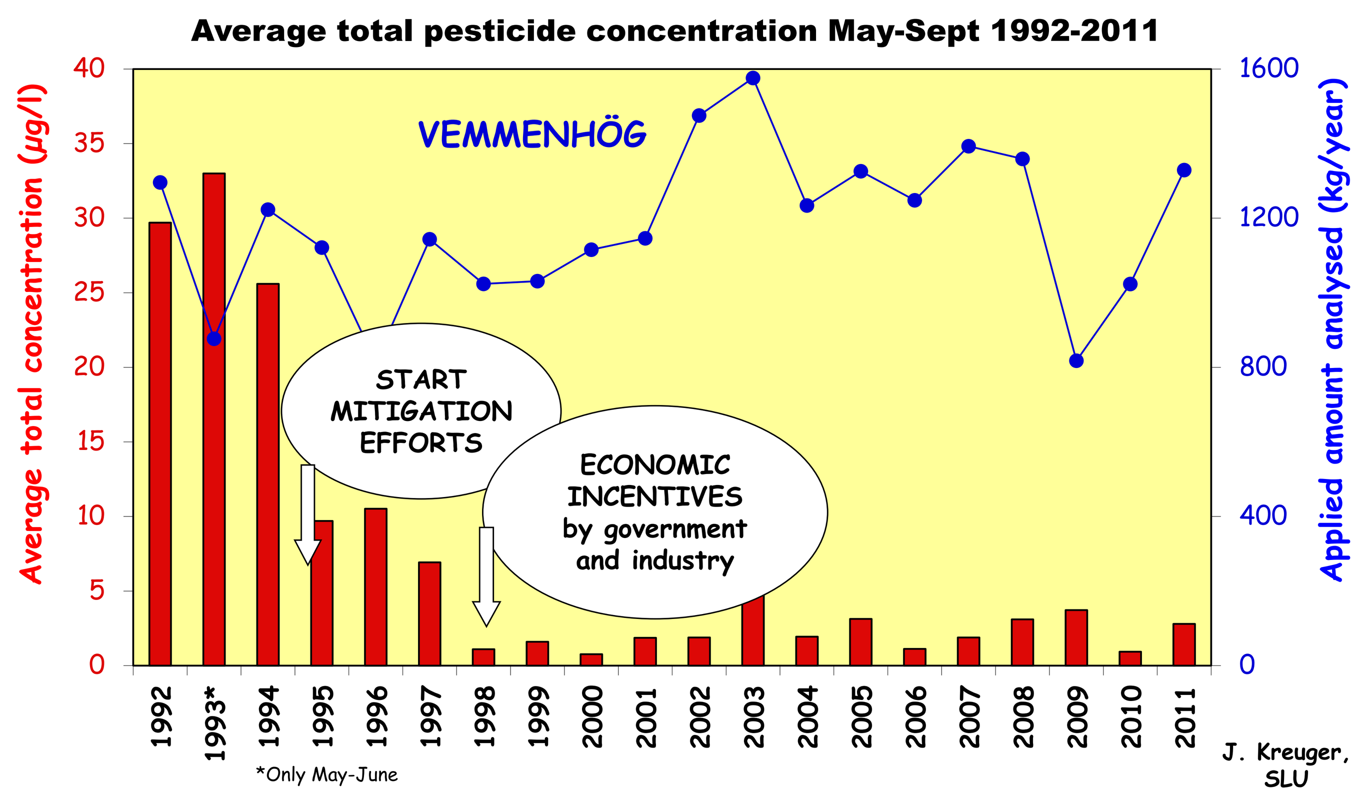


Figure 2 (above). Changes in seasonal (May-September) average total pesticide concentration in a farm creek in Skåne (Southern Sweden) over 18 years of environmental monitoring (red bars). Right axis shows the applied amount of pesticides (blue line).

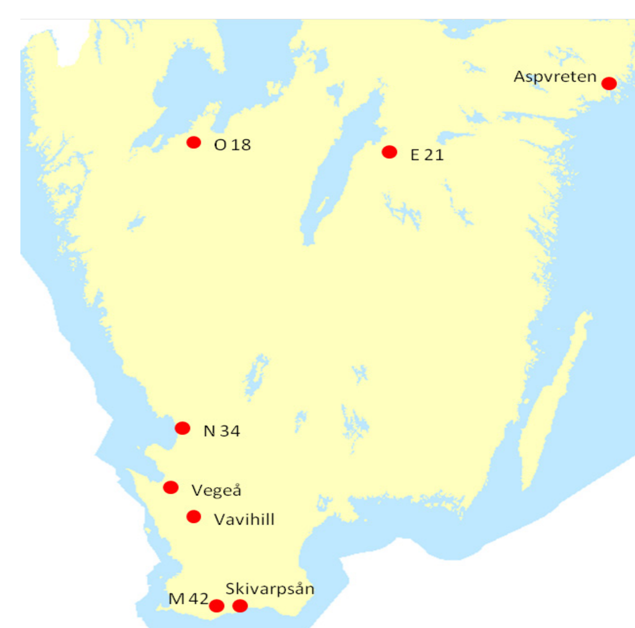


Figure 1 (right). Location of sampling sites within the Swedish environmental monitoring program (map showing the southern part of Sweden). O 18, E 21, N 34 and M 42 are the small agricultural catchments that are monitored.

Time- vs. flow-proportional sampling

In one of the small agricultural catchments flow-proportional sampling has been used in parallel with the regular time-proportional sampling. The aim was to capture the short-term variation in pesticide concentrations during the spraying season. Some pros and cons with the different methods are listed below.

Time-proportional sampling

+ Easy to maintain over the years and results in a known volume of water being collected (i.e. enough to guarantee analytical work in the lab)
+ Does not require flow measurements
+ Composite sampling gives the time-weighted average concentration during the time period (i.e. the average concentration aquatic organisms are exposed to)
- Likely to underestimate the total amount of pesticides transported from the catchment

Flow-proportional sampling

+ Individual samples collected flow-proportionally during the hydrograph will better capture peak concentrations of pesticides (i.e. the maximum pesticide concentration aquatic organisms are exposed to)
+ Allows for monitoring of the behaviour of individual pesticides throughout the flow hydrograph
+ Better estimates of the total amount of pesticides transported, if enough samples are collected
- The selection of flow criteria to trigger sampling can be complicated and results in compromises

Flow-proportional sampling demonstrates rapid variation in pesticide concentrations during the weekly time-proportional composite samples (Figure 3).

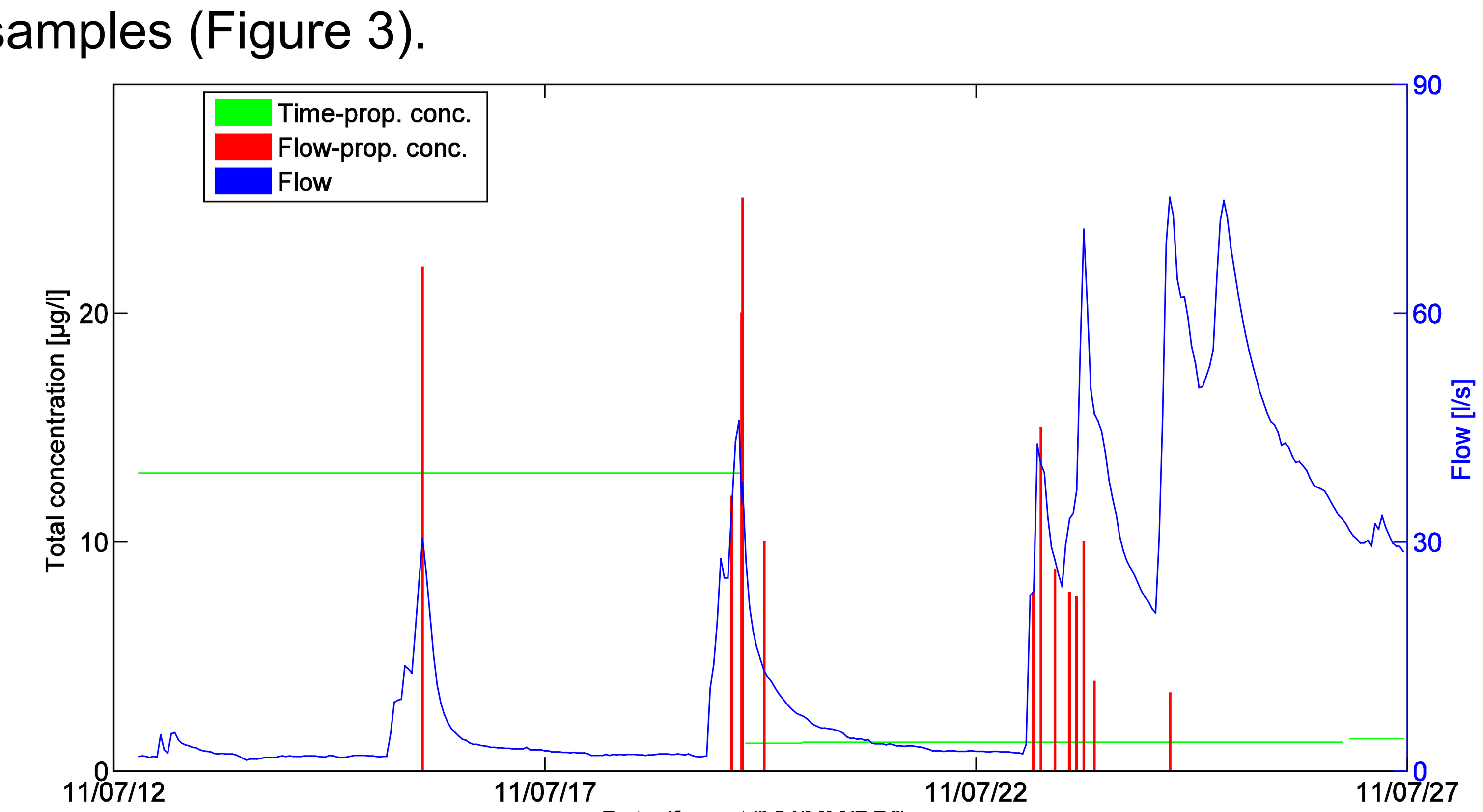


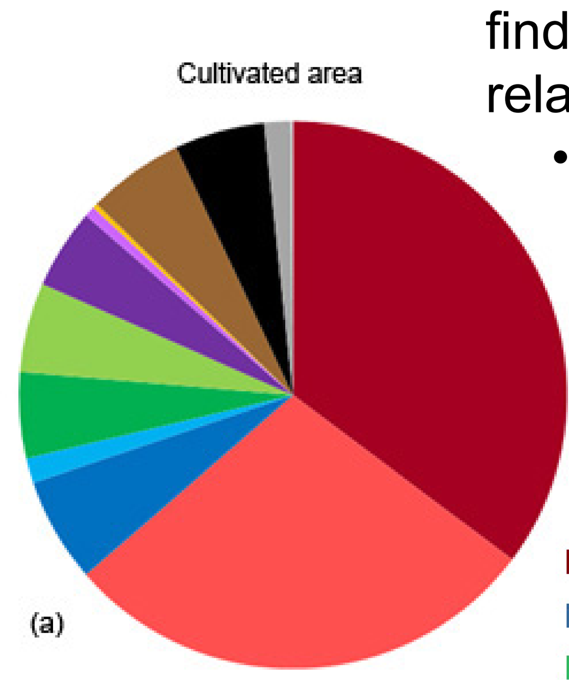
Figure 3. (Left) Comparison of time-proportional sampling to flow-proportional for a two week period in July 2011. The blue curve shows the flow rate for the time period (right axis)

Pesticide-intensive crops vs. pesticide occurrence in water

Some crops require more frequent applications of pesticides and/or larger doses. Potatoes and sugar beets are considered to be such pesticide-intensive crops. In Sweden the cultivated area for potatoes and other pesticide-intensive crops is small, especially compared to cereals. So how does the pesticide intensity relative to the cultivated area reflect in the contribution to toxic pesticide levels in streams? An investigation using the environmental monitoring data shows:

- Applications between crops (mainly application of glyphosate after harvest) contribute considerably to findings above the drinking water standard of 0.1 µg/l (figure 4b).
- Winter cereals and potatoes contribute disproportionately to findings above environmental quality standards (EQS) relative to the cultivated area (figure 4c).
- Vegetables and potatoes make up a considerably larger portion of the pesticide toxicity index (PTI) compared to the cultivated area (figure 4d).

Mitigation measures directed towards pesticide use in vegetable and potato crops may be effective to increase the ecological status of the stream.



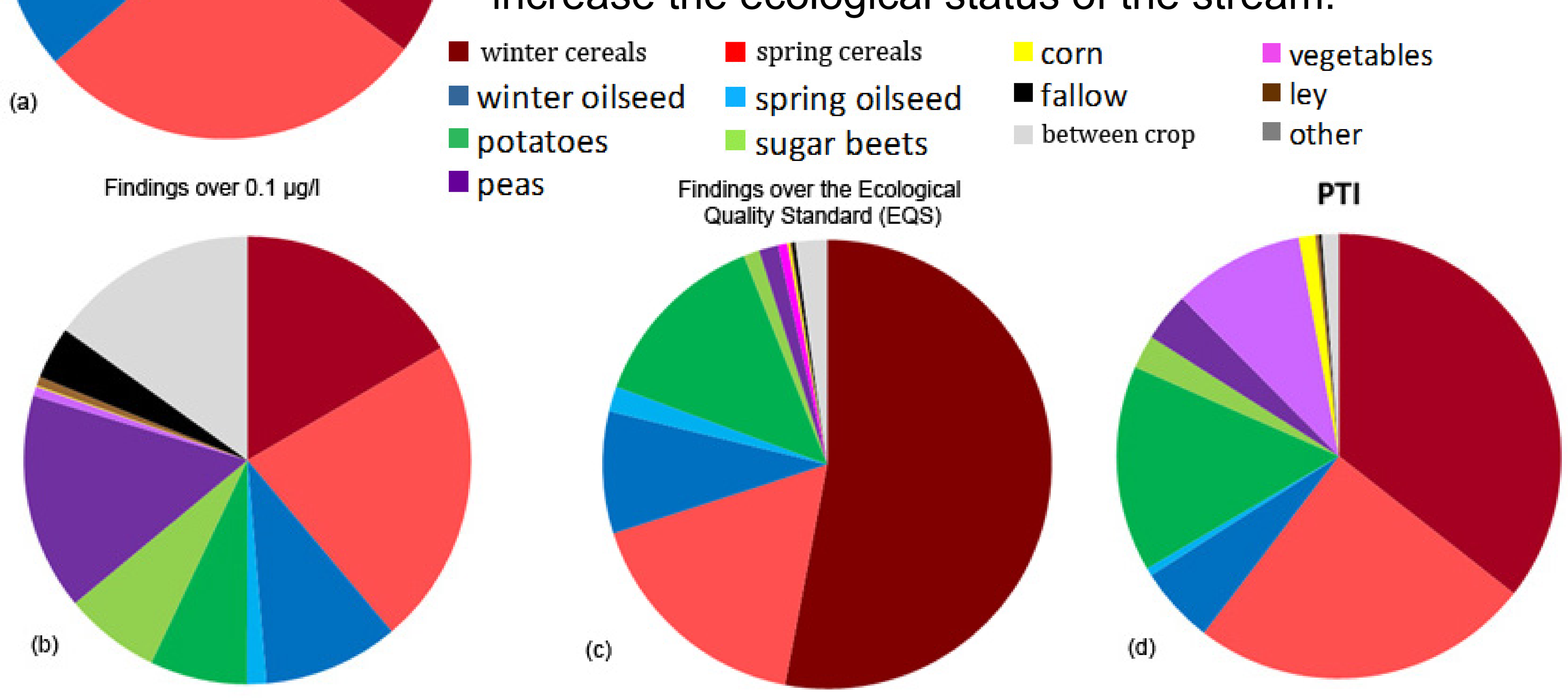


Figure 4. Relative contribution from different crops to (a) cultivated area, (b) total number of findings over the drinking water standard (0.1 µg/l), (c) total number of findings over the environmental quality standard (EQS) , and (d) the pesticide toxicity index (PTI), as calculated from data on stream water, pesticide use and cropping within all four monitoring catchments during the period 2002-2011.