Havs och Vatten myndigheten

This appendix contains translations to English of the Summary, Table of contents and Conclusions for the following report:

Kemiska bekämpningsmedel i grundvatten 1986-2014, Sammanställning av resultat och trender i Sverige under tre decennier samt internationella utblickar

Chemical pesticides in groundwater 1986-2014, Summary of results and trends in Sweden over three decades including an international outlook

The report has been published by
The Swedish Agency for Marine and Water Management, report 2014:15 and the Swedish University of Agricultural Sciences (SLU), CKB Report 2014:1

Summary

The purpose of this report is to compile knowledge regarding the presence of chemical pesticides in Swedish groundwater based on available data from 1986 to 2014. The report also includes a brief review of changes in agriculture in Sweden and the use of pesticides, as well as a literature review summarizing the results of studies and the general state of knowledge about pesticides in Denmark, Norway and the United Kingdom.
In order to compile data on pesticides in groundwater, results were collected from investigations conducted by many different actors: drinking water production plants (raw water och drinking water); county administrative boards; municipalities and private individuals. Additional efforts have been made to collect data for Skåne (Scania), which is the most agricultural- and pesticide-intensive region in Sweden.
One or more pesticides were found in 36% of all samples taken in groundwater throughout the study period. The most commonly detected substance was BAM (2,6-dichlorobenzamide), which was detected in 33% of tested samples, followed by atrazine together with its degradation products (5-9%). BAM is a degradation product of dichlobenil which, together with atrazine, was widely used as a herbicide against undesirable vegetation. Together they were included in the well-used product Totex, which had extensive use in a variety of sectors and areas such as park management, along railway embankments, road verges, on building sites and in industrial areas. Both dichlobenil and atrazine were banned in 1989-1990, but remain the substances most commonly found in Swedish groundwater. Of plant protection products still authorized for use in agriculture, the herbicide bentazone was found most frequently in groundwater samples over the last 10 years (about 3% of samples). Other currently approved plant protection products have been found more sporadically in groundwater surveys in recent years. In summary, results show that substances found in groundwater are predominantly those that are no longer permitted, or those whose primary use has been outside of agriculture.
These results can be explained in part by the fact that the registration process now takes environmental aspects into greater consideration, but also that improved management of plant protection products, through education and counselling to farmers, has reduced the risk of spot emissions over the years.

The quality standard concerning pesticides in drinking water is i) that the sum of all pesticides tested must not exceed 0,5 µg/l; and ii) the content of a single pesticide may not exceed 0,1 µg/l. The same levels also apply as guidelines for groundwater quality. The results of this compilation show that the occurrence of sums exceeding 0.5 µg/l in groundwater samples have decreased from about 15%, for the period 1987-1994, to just below 5% for the period 2005-2014 (excluding data from drinking water production plants). Corresponding figures for raw water samples from drinking water production plants show a decrease from about 5% to about 2%.

With the exception of samples from water treatment plants, the proportion of samples containing at least one substance with a concentration > 0.1 µg/l has varied over the years, with a maximum of 35% of samples (year 2000) exceeding this limit. The frequency of finds above 0.1 µg/l has decreased to <10% in recent years. Even samples from drinking water production plants show the same trend, with fewer samples having concentrations above 0.1 µg/l.

A compilation of pesticide levels in wells of different depths indicates that shallow wells have a higher find frequency of levels above 0.1 µg/l than deeper wells. However, the results included fewer deep than shallow wells.

A comparison of pesticide presence in drilled, as opposed to dug, wells shows that most substances have a higher >0.1 µg/l find frequency in dug wells. For atrazine, including its degradation products, there is a significant difference between dug and drilled wells, where the greater proportion of finds in dug wells is likely due to atrazine being used extensively to combat weeds in farmyards, which are often close to the farm's own private drinking water well.

Since many people get their drinking water supply from private wells and these may be more susceptible to contamination, this group of samples was evaluated separately. In private wells, the sum of contaminants exceeded 0.5 µg/l in about 10% of all samples throughout the time period, but with a decreasing trend towards the end of the period. BAM is again the most frequently encountered substance followed by atrazine and its degradation products, which have a higher occurrence in private wells compared with raw water intakes at waterworks. About 10% of water samples from private wells have at least one substance that exceeds 0.1 µg/l.

Pesticide levels in groundwater are generally decreasing and the historically high levels of BAM, atrazine (including its degradation products) and bentazone are all coming down. Dichlobenil (with the degradation product BAM) and atrazine are banned since the early 1990s, and the effect is beginning to appear now. The usage areas for bentazon have been limited and factors such as better training and handling of pesticides in recent decades have probably contributed to the decreasing levels. To provide a good picture of groundwater quality in Sweden in the future, it would be desirable to improve data collection including both coverage and the range substances that analyzed.

Table of Contents

Conclusions and discussion

The purpose of this report is to compile knowledge regarding the presence of chemical pesticides in Swedish groundwater. Groundwater is an important resource for society, not least because approximately half of public drinking water production comes from groundwater. In addition, about two million Swedish people get their drinking water from a private well either in their permanent residence or in a holiday home.

Agriculture in Sweden has undergone certain changes over the last 30 years. Data indicate that in crop-intensive areas such as Skåne (Scania), a greater amount of pesticides per hectare is used than in less-cultivation-intensive parts of the country. The area of arable land where cereals and other pesticide-intensive crops are grown has generally decreased in Sweden, but the decrease is significantly lower in Skåne than elsewhere. In absolute numbers (kg), pesticide use has decreased over the past three decades, but at the same time, in Sweden approximately the same number of hectare doses are used as in the 1980s, which means that the lower amount sold today is sufficient to handle approximately the same area as at the beginning of the period. In comparison with other countries in Europe, Sweden uses lower doses of plant protection products. This is particularly evident in the use of fungicides and insecticides, which is partly a result of a conscious effort to reduce doses in Sweden (better adaptation) in favour of both better environment and economy. Another contributing factor is our colder climate with a generally lower infection pressure from fungi and insects compared to southern and western Europe.

This review of groundwater samples collected in 1986-2014 shows that residues were detected in 36% of samples. The results show no general decline in find frequency over time, which, to a great extent, can be explained t by lower detection limits and also more substances being included in the analyzes over the years. On the other hand, the proportion of pesticide finds decreases both when measured as the occurrence of single substance concentrations exceeding 0.1 μg/l and when measured as the percentage of samples with a total concentration exceeding 0.5 μg/l. This applies to samples derived from drinking water production plants (raw water control) as well as from other types of groundwater samples, which include individual wells and other groundwater monitoring programmes.

The results of this summary show that the pesticides most frequently found in groundwater are now prohibited. The most common substance to be detected in groundwater samples has been the BAM (2,6-dichlorobenzamide) degradation product, with an occurrence of over 35%

in the first 20 years of this compilation, followed by a certain decrease in recent years. Second most commonly found is atrazine and its degradation products atrazine-desethyl, atrazine-hydroxy and atrazine-desisopropyl. BAM is a degradation product of dichlobenil. Dichlobenil was included with atrazine in the well-known product “Totex Strö”, which was widely used for weeds on, among other things, railway embankments, gravel surfaces, industrial sites and parks. Neither atrazine nor dichlobenil has been registered for use in Sweden since 1989/1990.
The third most common substance found in groundwater samples was the herbicide bentazone, a substance approved as a plant protection product in agriculture even today. Results show that the proportion of samples with concentrations of bentazone exceeding 0.1 μg/l has, like BAM and atrazine, decreased in recent years.

For atrazine and BAM reduction is expected because use of these has ceased. There has been active work since the 1990s to reduce use of bentazon, by among other things introducing a dose limit, restriction on which crops it may be applied to and also restricting use to the spring season. Generally, work on plant protection products in agriculture has developed a lot during the period, including training for managing the substances and various protective measures to reduce spills and accidental spreading of plant protection products into the environment. Similarly, environmental aspects have been taken into consideration to a much greater extent when approving plant protection products in recent years, inter alia in order to reduce the risk of leaching to groundwater. All of these actions taken have likely contributed to the reduced levels and other findings in this compilation.

Studies in Denmark show, as in Sweden, that BAM is the most common substance in groundwater, but even atrazine and bentazone are among those most commonly detected. In Norway, bentazon is the most commonly detected substance in groundwater. In the UK, results from their groundwater studies show that it is primarily atrazine and simazine that are found. Dichlobenil has been approved for use up until 2010 in the UK, but its degradation product BAM has not been analyzed regularly, so it is not possible to make any definite conclusions about its presence in groundwater.
Pesticide residues have been found in the groundwater in all parts of Sweden, even in counties with small agricultural areas. This is largely due to pesticides historically having been used in many sectors of society, including on soils other than arable land, such as along roads, industrial sites and courtyards. This type of soil is usually heavily drained, which increases the risk of leaching to groundwater. In addition, it was common for these applications to use high doses (overdose) due to ignorance of the risks, which also increased leaching to groundwater.

A compilation of pesticide levels in wells of different depths shows a tendency for shallow wells to have a higher occurrence of samples exceeding 0.1 µg/l than deeper wells. A study conducted in Denmark showed similar results as in Sweden, but with a clearer decline in the levels in deep wells. However, a comparison between dug and drilled wells does not show any clear differences between these different types of wells.

Drinking water from private wells is an important resource supplying about 15% of Sweden's population. Our study shows that it is more common with pesticide residues in private wells compared to in raw water for drinking water production plants, except with regard to BAM, where the detection frequency between the water types is similar. Even aggregated levels for private wells are higher than in raw water for public water production plants. Approximately 8% of all samples from private wells in 2005-2014 had a total concentration exceeding 0.5 µg/l. The corresponding figure for the drinking water production plants was approximately 2%. The results also show that the aggregated (sum of pesticide) concentrations in water samples from both private wells and from raw water to waterworks are lower overall in the last ten years (2005-2014) compared with the period 1987-2004.

The results in this report show that pesticides have been detected in groundwater from all regions, as well as in urban areas, in agricultural areas and in forest land. It is also clear that substances that have been used almost exclusively outside agriculture have a generally higher find rate than substances used in agriculture, regardless of the main land use in the vicinity of the test area. There is a tendency for occurrences exceeding 0.1 µg/l to be higher in private wells than in raw water for drinking water production plants and in water from shallower premises. Individual wells may be more exposed to risks such as penetration of runoff water due to construction defects or poor maintenance when the owner of a private well usually has less opportunity, knowledge and money for well maintenance. Even rock wells can be poorly sealed against penetration of runoff water, although the situation has been improved through training and certification well borers.

A large part of the information in this report comes from samples tested by drinking water production plants. According to the Swedish Food Administration (Statute SLVFS 2001: 30), water production plants should analyze pesticides (in the treated drinking water) in both normal control and increased control. However, this law does not specify exactly which substances should be tested. To a large extent, the choice of analysis parameters has been based on the Swedish Environmental Protection Agency report “Assessment criteria for environmental quality –

groundwater" with a list of 26 pesticides and degradation products listed (Appendix 5). In practice, these 26 subjects have become a standard package that has been applied in analyses of water from both private wells and from drinking water production plants. A new proposal for pesticide analyses has been developed by SGU (2013b), which may be relevant to what substances are included in the analysis chain in future and will probably cause other substances to be detected. It is important that the analyses include relevant substances and that the scope of analysis parameters is regularly updated in dialogue with the relevant authorities so that the results generated provide the best possible basis for decision making.

In summary, this report shows that there is a large variation data availability in terms of the surface coverage, how often samples were collected and which substances were analyzed. To provide a good picture of the groundwater quality in Sweden, data collection should be improved. Plant protection products are now almost exclusively used in arable land, while today's environmental monitoring of groundwater, to a limited extent, occurs within the agriculturally dominated parts of Sweden. This should be considered in future discussions on the design of groundwater monitoring. Results also show that private wells are more susceptible to contamination, which means that more targeted studies of private wells in agricultural areas should be considered in order to better monitor the effectiveness of the work on preventive measures.