

RESIDUES OF PESTICIDES IN DUTCH GROUNDWATER

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ABSTRACT

To assess the risk of groundwater pollution by pesticides in the Netherlands, occurrence of pesticides and their transformation products in groundwater is investigated. On agricultural land with potatoes, maize and flower bulbs, and also on uncropped land, filter tubes were placed for periodic sampling and analysis. In 1988 and 1989, 25 different organic compounds were found. Quality of groundwater in the Netherlands is threatened by application of pesticides. Several pesticide residues, especially decomposition products, are present at concentration levels exceeding the EC-directive for drinking water of 0.1 µg/l.

INTRODUCTION

Since 1988, systematic sampling of groundwater and analysis of residues of pesticides below agricultural land was studied. Aim of this project was to investigate if the groundwater quality is threatened by chemical compounds as a consequence of application of pesticides. In the Netherlands 35 shallow and 4 deep filter tubes are placed in parcels of agricultural land with potatoes, maize and flower bulbs and on uncropped land. This paper deals with the results of 1988 and 1989 of this project.

MATERIALS AND METHODS

Groundwater filter tubes were placed at the following locations:

- **Potato cultivation.** Potatoes are grown in rotation with crops like grain, beet, grass and maize. In this cultivation nematicides, fungicides, herbicides and insecticides are applied. Six filter tubes are placed in moderately humic sand (US soil classification: Spodic Humaquept) and 11 were placed in very humic sand (Typic Haplaquod).
- **Flower bulb cultivation.** Behind the dunes along the western coast of the Netherlands intensive flower bulb cultivation takes place on low-humic sand (Typic Psammaquept) where nematicides, herbicides and fungicides are applied.
- **Maize cultivation.** In large areas with humic-poor sandy soils in the south and the east of the Netherlands maize is grown continuously. Mainly herbicides are used. Three filters were placed on Spodic Humaquept and four on Typic Haplaquod.
- **Embankments along railroad tracks.** Four filters are placed in sandy soils (Typic Udipsamment) where herbicides are used to keep the railroad tracks free from weeds.
- **Public gardens and paths.** Two filters were placed in public gardens with a humic rich sandy soil profile (Plaggept) and one filter below a path with a sandy profile (Typic Udipsamment).

Half of the filter tubes (Stainless steel) are placed in vulnerable soils (Spodic Humaquept, Typic Psammaquept and Typic Udipsamment) and half are placed below less vulnerable soils (Typic Udipsamment and Plaggept). The users of the sites are interviewed about pesticide application in the last few years.

12 NOV. 1991

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isn=802474

uit: Proceedings of the 4th international conference environ-
mental quality, 1-4 oktober 1990, Barcelona.

RESULTS AND DISCUSSION

Results of pesticide residues found in groundwater are given by Lagas et al. (1989, 1990). Totally 25 organic compounds were found in the samples that were analysed in 1989 and 1990 (see Fig. 1). These 25 organic compounds are the result of application of 15 pesticides; 4 pesticides did not leave any detectable residue behind in groundwater. Except one compound all the maximum concentrations were higher than the EC-directive of 0.1 $\mu\text{g/l}$. The maximum concentrations of the organic compounds which were found in the Dutch groundwater are given in Fig. 1, where the concentrations are plot on a logarithmic scale. Not only the pesticides itself are found but also other chemical compounds like admixtures and decomposition products appeared to be present in the groundwater samples.

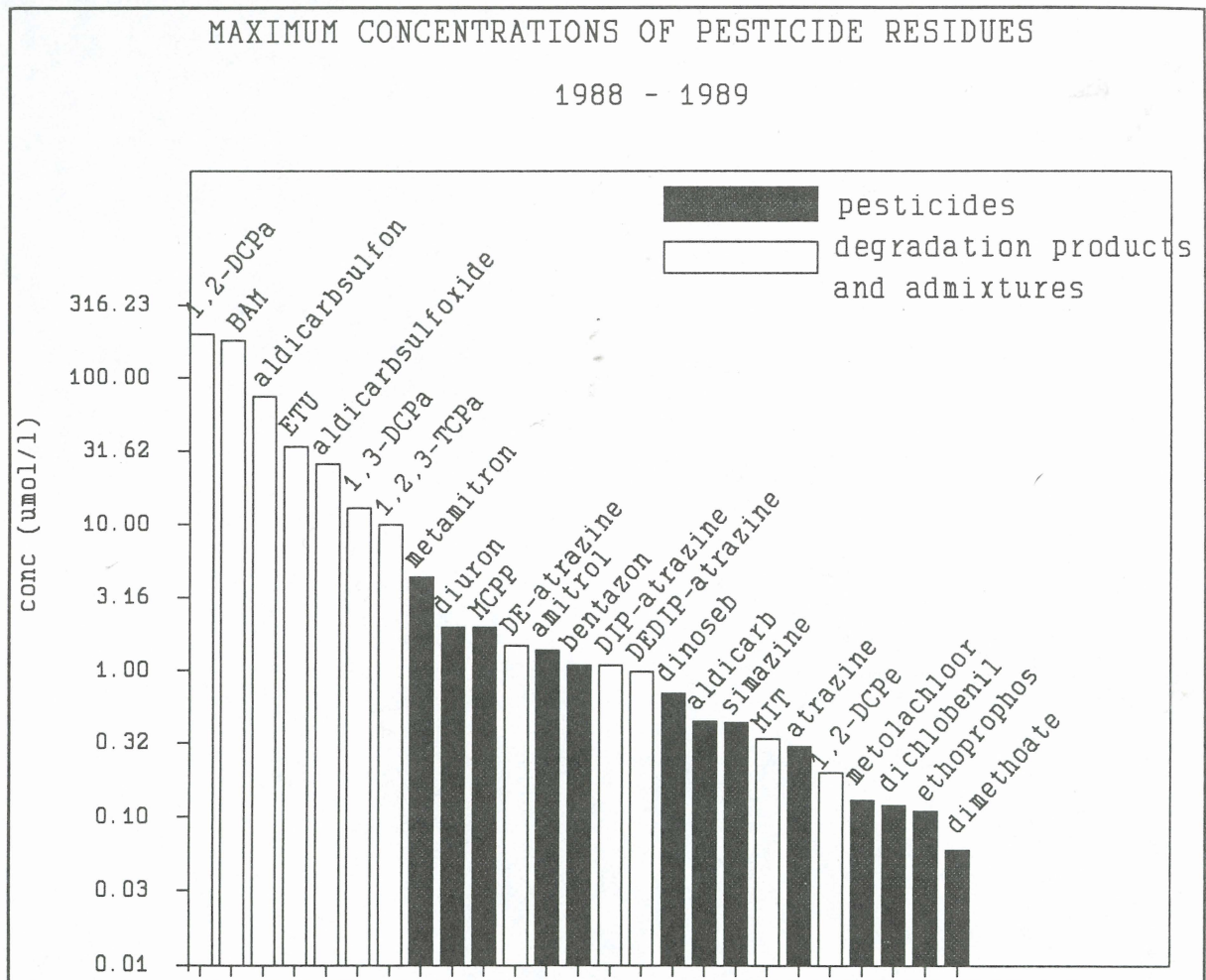


Figure 1. Maximum concentrations of pesticide residues analysed in 1989 and 1990 in Dutch groundwater filters below land where the pesticides were applied.

admixtures

The most important admixture is 1,2-DCPa (1,2-dichloropropane), while also 1,3-DCPa and 1,2,3-TCPa (1,2,3-trichloropropane) are found below agricultural land where 1,3-DCPe (1,3-dichloropropene) is applied for disinfection of the soil. Before 1984 formulations of DCPe contained up to 34% 1,2-DCPa. Although since 1984 the max. content of admixtures is 0.5% still high concentrations of up to 200 $\mu\text{g/l}$ are found in groundwater at a depth of 5 m. At higher groundwater levels lower concentrations are found.

decomposition products

Figure 1 shows that the concentration of decomposition products of pesticides are generally higher than from the mother compounds itself. From atrazine three decomposition products are found: DE-atrazine, DIP-atrazine and DEDIP-atrazine (see Fig. 2). Notice that decomposition products are more polar than the mother compound because ethyl- and isopropyl- groups are substituted by hydrogen atoms and consequently amine groups are formed.

Sorption of this more polar compounds is less strong than for atrazine and consequently higher concentrations are found in groundwater. Because of the same theory ETU which is a rather polar decomposition product of the fungicides maneb, zineb and mancozeb is found in the upper groundwater below flower bulb cultured land where average concentrations of 6 $\mu\text{g/l}$ are measured. BAM is a decomposition product of dichlobenil, a herbicide which is applied in public gardens and that was found in groundwater with a max. concentration of 180 $\mu\text{g/l}$.

Aldicarb-sulfon and aldicarb-sulfoxide are decomposition products of the nematicide aldicarb which was applied on potato cultured land. These compounds were found up to a depth of 5 m below soil surface.

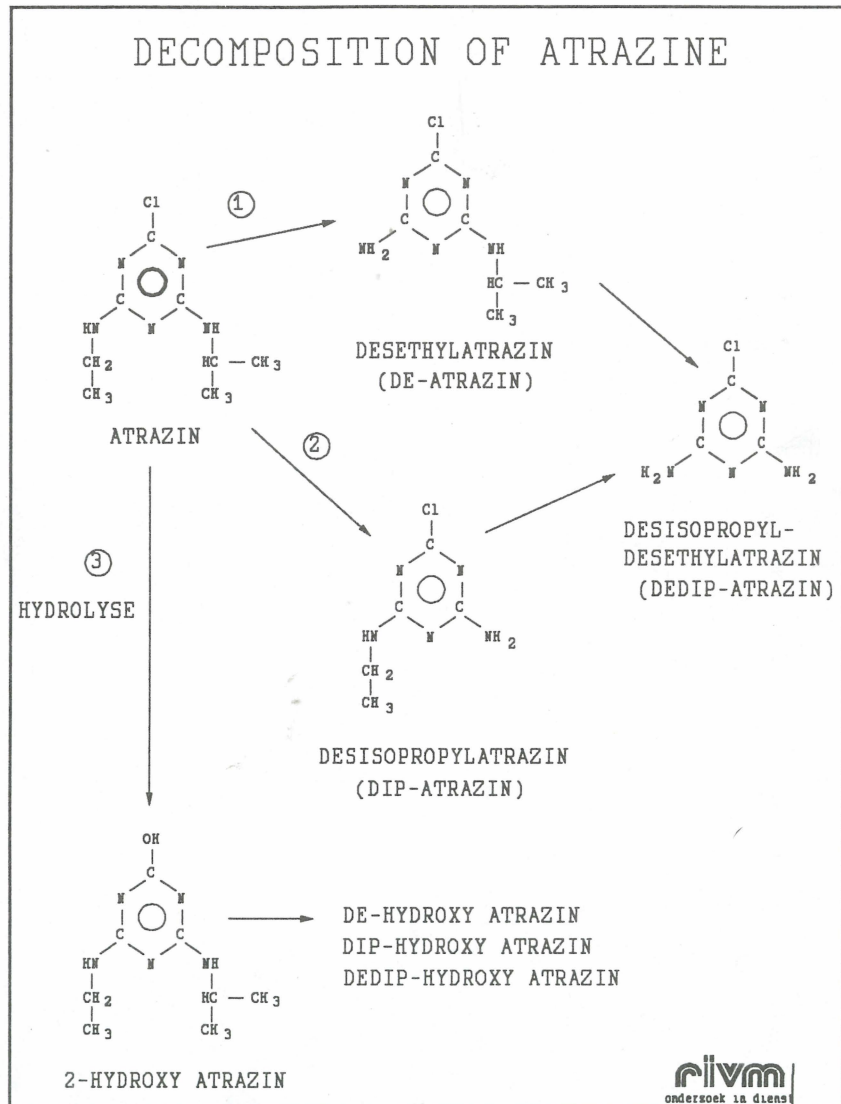


Figure 2. Scheme of decomposition routes of atrazine in groundwater. Route 1 and 2 are dealkylation reactions and route 3 is a hydrolysis reaction.

CONCLUSIONS

Quality of groundwater in the Netherlands is threatened by application of pesticides. Several pesticide residues are found at concentration levels exceeding the EC-directive for drinking water of 0.1 $\mu\text{g/l}$. Quality of groundwater is particularly threatened by decomposition products of pesticides. These compounds are generally more polar than the mother compound and are consequently more mobile in soil and groundwater.

REFERENCES

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