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Lindane & other Pesticides in the North Sea: Reasons for concern

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Interim Report

There are now many different types of biocides in the North Sea, with poorly understood individual properties and virtually unknown synergistic effects. Being dispersed deliberately on land, these toxic substances are migrating into all compartments of the ecosystem, finally being transported by water and air into the North Sea. Their appearance in the sea is not restricted to coastal regions – instead, they are widely distributed by currents. The pesticides and their metabolites are accumulated by organisms, weakening their immune system and making them more susceptible to various diseases.

This paper illustrates that these problems have been created as the inevitable consequence of the past application of a permissive approach. Lindane and other pesticides are used as case examples to illustrate these problems.

LINDANE

Lindane is chosen as the key example because it is the one pesticide still in Europe for which a lot of

analytical data in different ecosystem compartments are available today. This was not always the case: While the first synthesis of hexachlorocyclohexane (HCH) was performed in 1825, the toxicity of the HCH isomers was discovered in 1912, and commercial production of lindane as an insecticide was taken up in 1945, it was not before 1981 that the first systematic sampling and analysis of North Sea water for HCH isomers was carried out (GAUL, 1983). Before that time, analytical methods simply had not been developed that were capable of tracing lindane throughout the North Sea into the polar regions of the North Eastern atlantic Ocean.

Since GAUL's publication, the sampling campaign has been repeated several times by GAUL himself (DHI, 1987 & 1988) and by another group of scientists (ZISCH, 1988), with the disquieting result that lindane concentrations in North Sea water have increased approximately by a factor of 4 between 1981 and 1986/87. This increase has been documented in the German contribution to the "2nd International Conference for the Protection of the North Sea", London 1987.

Recent investigations on sediments have shown that elevated lindane concentrations are not restricted to coastal areas: local maxima are found in all regions of the North Sea (LOHSE, 1988a; KNICKMEYER 7 STEINHART, 1988). The sedimentary record of the deposition area of the Skagerrak shows an increase of lindane concentrations even in the youngest top layer (LOHSE, 1988b)

In contrast to certain statements made by lindane producers (BIEGEL, 1988) the lipophilic insecticide is enriched by many organisms, mainly accumulating in fatty tissues of different organs (e.g. BUTHER, 1988; ZISCH, 1989). Bioaccumulation factors between lindane concentrations in water and in liver fat of fish range between 10,000 and 100,000, that is only about one order of magnitude lower than for PCB.

The reasons for the increasing lindane concentrations in North Sea Water are not known. Most European producers have stopped lindane production, but two companies still continue, and there is a huge variety of lindane formulations commercially available in the North Sea states. Actual figures of lindane use in

agriculture and forestry are difficult to obtain and, so far, not known to us.

The largest lindane inputs occur via rivers and the atmosphere riverine inputs are about 3,2 tons per year (QS, 1987), with a constant flux from the Elbe river (ARGE ELBE, annual reports) and a basically falling trend for the river Rhine between the early 1970ies and today (RIJKWATERSTAAT, 1980 & 1988; RIWA, 1986-87; LWA-NRW 1989a). In parallel to this, lindane concentrations in groundwater and drinking water are decreasing in such a way that they are not considered to be a major problem any longer (LWA-NRW, 1989b).

At the same time, the atmosphere appears to play an increasing role in lindane transportation. Estimates of atmospheric lindane deposition over the North Sea have increased from 1.5 t/a (HOLDEN, 1979) to 6 - 60 t/a (QS, 1986).

In contrast to the decreasing lindane concentrations in rivers, constantly high or even increasing levels are found in continental rainwater (Ministry of the Environment, The Netherlands, 1988; BAYERISCHE LANDESANSTALT FUR WASSERFORSCHUNG, 1987). In an estimation of lindane fluxes for Bavaria, THE BAYERISCHE LANDESANSTALT (ibd.) has come to the Conclusion that by far more lindane is moved via the atmosphere (6.8 t/a annual deposition) than via rivers (0.5 t/a input to Bavaria, 1 t/a runoff from Bavaria).

OTHER PESTICIDES

While data on lindane concentrations in the environment have been routinely collected in the past decade during DDT and PCB monitoring, the analytical methods for monitoring other pesticides on triazine, organophosphorous, phenyl urea etc. basis have only recently been developed. Even today, the sensitivity of these methods for sea water analysis does not reach the sensitivity of methods for lindane analysis.

However; wherever analysts begin to look into North Sea water and sediments more closely, they find an enormous variety of "new" pesticides:

- dichlobenil, parathion-methyl, PCP (WEBER & ERNST, 1983)

- dichlobenil (EDER, 1984)
- atrazine and other triazines (ERNST et al., 1988)
- chlorophenols (EDER, 1980; ERNST & weber, 1980)
- parathion-methyl, -ethyl, propethamphos, etrimphos,
- fenitrothion (DHI, 1988)

In European rivers and groundwater, the pesticides now causing the main concern for public water supply and environmental authorities are the triazines, mainly atrazine and simazine, the phenyl urea derivatives chlortoluron, diuron, metoxuron and linuron, in some cases the chlorophenoxy carboxylic acid derivatives, and various products like bentazon, metazachlor, and metabenzthiazuron (see e.g. RIWA 86/87; LWA-NRW 1989b; STOCK, 1988; FoE, 1988).

All these compounds are regularly found above the new EC limit of 0.1 µg/l water. It is only a question of time when these new products, or their metabolites, will be found in significant amounts also in the North Sea.

It has been observed that manufacturers are apparently able to shift from one active ingredient to another one very rapidly whenever a build-up of higher concentrations in groundwater is observed (LWA-NRW, 1989b). Thus they possibly try to avoid a ban of individual active ingredients, while the sum of pesticides in the environment is actually increasing, and nothing is known about synergistic effects between the different pesticide ingredients.

SUMMARY AND CONCLUSIONS

Even at the end of the 1980s, it takes years, if not decades between the beginning of large-scale production and use of ever new pesticides, promised by the manufacturers to be environmentally harmless, and the finding that these substances are environmentally harmful, persistent, bioaccumulative and dangerous to marine and terrestrial life including man.

The long-term effects of these dangerous substances continue for decades, even after production and use are on the decline: While, in the case of lindane, public water suppliers are glad that it is slowly disappearing from their raw water, scientists find increasing amounts of the insecticide floating about in the atmosphere, moving over large distances, and finally accumulating in the North Sea.

For other pesticides, we are just at the point where concentrations in groundwater and rivers reach some peak maximum, water suppliers call alarm, and marine chemists are only beginning to develop methods for the analysis of these substances in the sea.

At the same time, manufacturers are increasing the speed of pesticide rotation, thus causing new problems by reducing the concentrations of individual compounds, making analytical work more difficult, while the number of active ingredients and the overall amount of pesticides in the environment is increasing.

The only way out of this cycle is the strict application of the precautionary principle, that means that the use of pesticides has to be reduced to an absolute minimum. An important first step would be a total end to the production and use of organochlorine, persistent, bioaccumulati;- or biotoxic pesticides.