University of Applied Sciences and Arts Northwestern Switzerland
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Investigations on environmental levels of Hexachlorocyclohexane in Basel.

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Master thesis, Molecular Technologies

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INTRODUCTION

The hexachlorocyclohexane Lindane and its wastes have spread all over the world and are the most abundant organochlorine substances in Arctic air and fresh water.[1] In the 1960s and 1970s, the pesticide Lindane has been produced in huge quantities by Ugine-Kuhlmann in Huningue near Basel. Open-air stock piling has led to distribution of the wastes throughout the city of Basel in the past. An estimated 120'000 tons of waste, consisting of different isomers of the hexachlorocyclohexane (HCH), mostly alpha- and some beta- HCH, were mixed with concrete and dumped in a huge landfill site (now ARA STEIH).

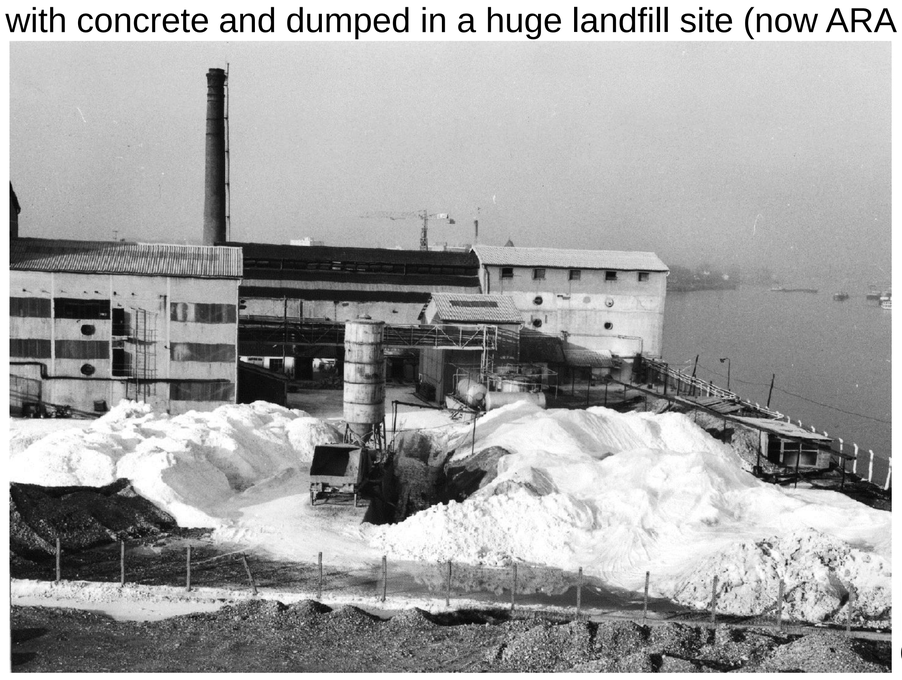

Fig. 2: Open air stock-piling of Lindane wastes on 02.11.1972 in Huningue. [2]

CONCEPT

In this study, 47 soils from various areas of Basel (21) and vicinity (26) have been analysed for HCHs, addressing several environmental questions.

Initially, three different extraction methods (accelerated solvent extraction, sonic extraction and hot Soxhlet extraction) have been evaluated for the suitability of the extraction of HCHs. 30 min hot Soxhlet extraction with hexane fulfilled the requirements best and was hence fully validated. A sampling procedure has been developed and key steps validated resulting in a robust procedure.

Investigation of the pollution of the surrounding region of Basel and Basel-city has been carried out by taking into account of the main wind directions as an influencing factor. Therefore, soils were sampled in two rough circles, with small and big radii, around the ARA STEIH. The directions of the prevailing winds from Basel were used to determine which areas have been possibly influenced by the wind and the distance from the source of the pollution taken into account.

The origins of the pollution in the surroundings of Basel and Basel city have been investigated by soil profile analysis. These profiles have been sampled to study the migration of the pollutants into the soil. Furthermore, a column test was used to simulate the migratory behaviour of HCH- isomers in natural soil in a laboratory environment.

Results

Investigations of the sampling procedure have proven its robustness and ensures that sampling at any chosen location yields truly representative results.

The evaluation of the extraction method has shown, that 30 min hot Soxhlet suffices to extract all HCHs from soil and thus the extraction method was fully validated.

Further region of Basel:
Interpretation of the data has shown that the main winds do not have an influence on the pollution concentration on the surroundings of Basel. In general, the results of the surroundings of Basel show low pollution, mostly gamma- HCH (Lindane) in the top 20 cm of soil. It is therefore proposed, that this pollution originates mostly from the use of Lindane in the past.

Basel-city:
An influence of the main wind on pollution has been found for the city of Basel. This influence has shown to be strongly dependant on the distance to the ARA STEIH.

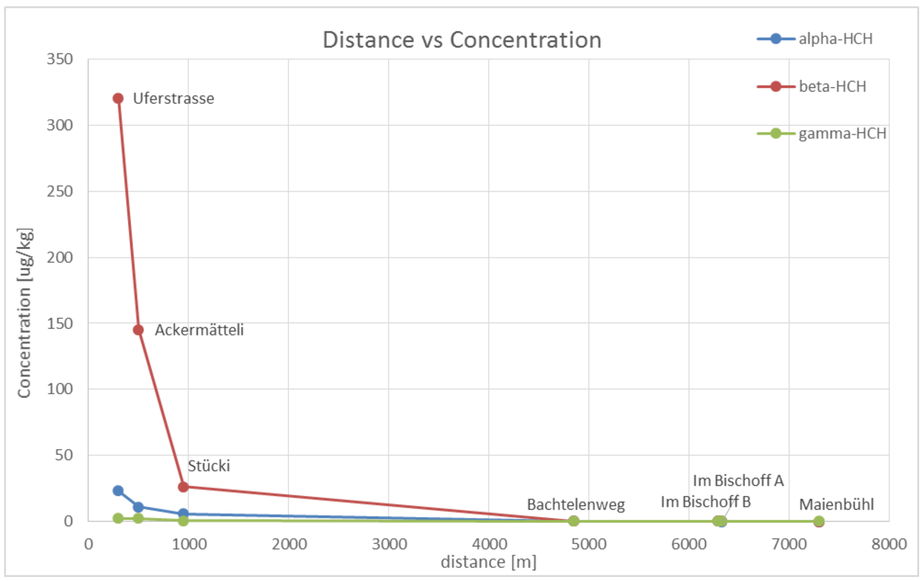

Fig. 2: Samples in the main wind direction showing the influence of the distance to the ARA STEIH.

In general, most areas in Basel show low contamination, mostly beta- and alpha-HCH. However, some areas show a significant pollution of beta- HCH, albeit below the legal limit. The high abundance of beta- HCH shows, that the isomeric ratio has changed since the production of time. This is tentatively explained by the high stability of this isomer and also different migration properties in soil.

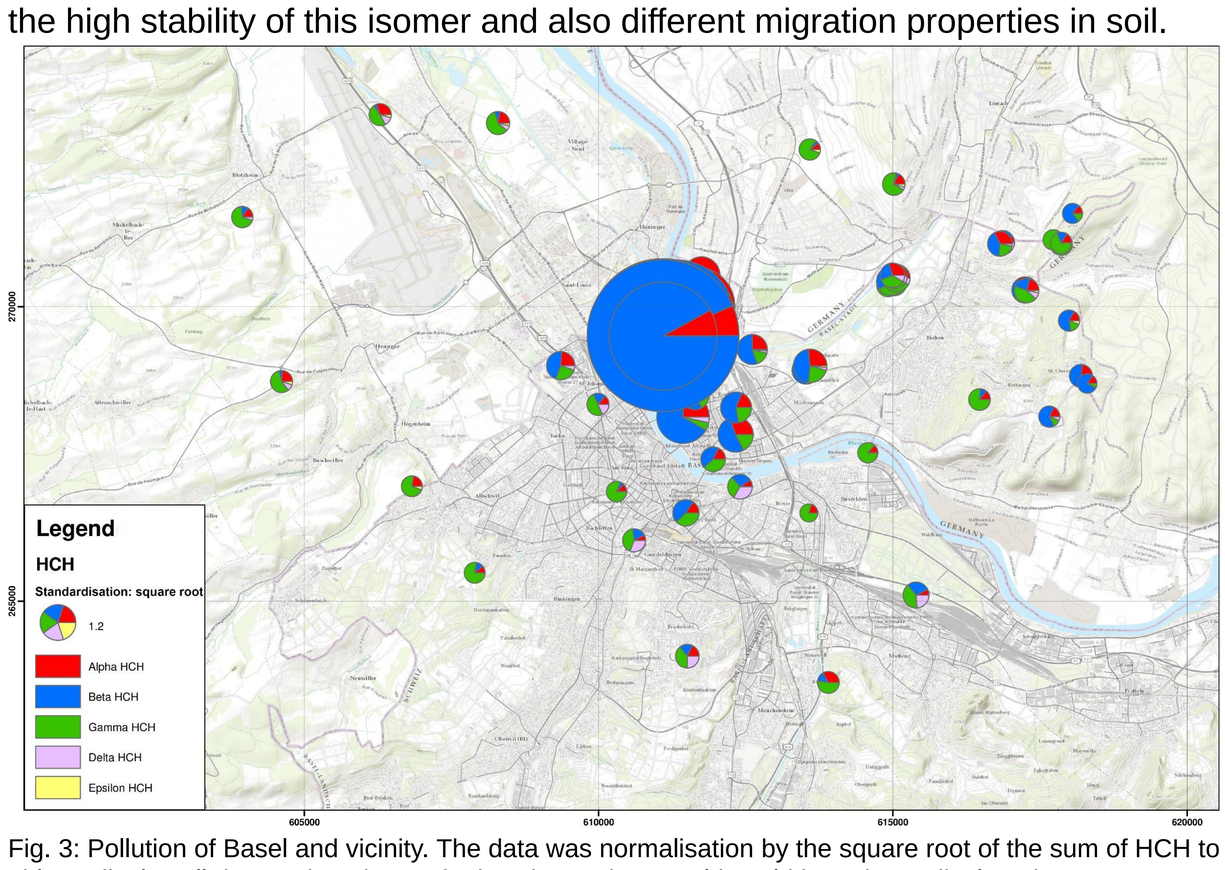

Fig. 3: Pollution of Basel and vicinity. The data was normalisation by the square root of the sum of HCH to be able to display all data. Otherwise no further data points would could have been displayed.

Soil profiles have been taken to investigate the origin of the pollution. The distribution of the HCHs have shown to be even throughout the sampled depth of 20 cm. The natural bioturbation over time is an explanation for this observation. Thus the pollution must originate from former open air stock-piling more than 40 years ago. In a laboratory experiment, the migration of the HCHs have been investigated in detail and a slight migration with water has been shown for all isomers. However, beta- HCH was retained more than the other isomers. This difference in migration also explains the high abundance of beta- HCH.

CONCLUSION

A robust sampling and extraction method has been established for the purpose of extracting HCHs from soils. In the surroundings of Basel low pollution, mostly Lindane, has been detected originating from use in the past. A strong wind and distance dependency of the pollution has been found in the city. The pollution consists predominantly of beta- HCH originating from the time of production. Profile analyses show an even distribution of the pollutants throughout the soil. A laboratory experiment confirms that migration of all isomers with water can take place. Natural processes, such as bioturbation, can explain these findings.

REFERENCES

[1] Li, Y. F., Bidleman, T. F., Barrie, L. A. & McConnell, L. L. Global hexachlorocyclohexane use trends and their impact on the arctic atmospheric environment. *Geophys. Res. Lett.* **25,** 39–41 (1998).
[2] Weil am Rhein: Langwieriger Kampf gegen die Giftberge - badische-zeitung.de. (2013).