# Risk assessment studies on obsolete pesticides storage places - Hydrological and chemical methods -

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## Introduction

Sites with obsolete pesticides, so called tombs (Polish: mogilniki), have very often a detrimental impact on the environment. Their tightness cannot be guaranteed many years after they were constructed. Pesticide biologically active ingredients, as well as solvents and other chemicals stored in tombs can easily permeate into the environment. First they contaminate the soil, then the groundwater. The biggest threat is posed to groundwater and under certain hydrogeological conditions; the contaminants can spread to deeper aquifers. Nowadays, a large number of tombs are being discharged and their contents are temporarily stored at safe locations or permanently disposed of. The disposal is accompanied by a monitoring process for the adjacent soil and water and proceeds according to formal and administrative procedures established by current environmental rules and regulations.

Depending on the geological structure, i.e. lithological formations and the depth of groundwater, contaminants spread first into aeration zones of soil adjacent to a tomb and then migrated horizontally into the water-bearing layer. Sediment strata situated downstream of the groundwater flow face the biggest threat. Through filtration, pesticides and their metabolites diffused from the groundwater pose danger to local drinking water sources and eventually reach surface waters. An environmental impact assessment is intended to recognise and educate the society about the actual and potential threats to the environment. An assessment should take into account all the possible old and new recorded observations and environmental studies.

## Geological studies

Geological studies are useful to:

- Determine the geological structures and directions of groundwater flow,
- Establish a monitoring network, i.e. to install monitoring piezometers.

Hydrogeological conditions are crucial to determine the potential threats posed by contaminants to local soil and water. So often, the question is how many boreholes we should drill and how deep they should be? This process depends on the type of landfill, size of landfill, technical devices that prevent the spread of the contaminants outside the landfill.

The physiographic factors are also important including:

- complexity of geological conditions,
- distance from households, and
- distance from protected areas

For example, a common practice is to make at least three boreholes to draft geological documentation for a small tomb. If soil conditions are complex, more boreholes are necessary. The boreholes usually go about 4-5 m below the bottom of the tomb, but in order to recognise the hydrogeological conditions they should reach enough depth into the aquifer to install monitoring piezometers.

A good practice is to test the width of the water aquifer by drilling one of the holes down to the impermeable formations that contain the water-bearing layer. Also, soil and water are sampled to establish the initial or actual hydrogeological background. The scope, amount and type of studies also depend on the history of a particular area and the size and type of the landfill. Surface waters, springs, local soils and wells are sampled too.

Studies performed before disposal provide information about current conditions around the site, whereas later monitoring allows detecting further transformations of soil and Groundwater adjacent to a removed tomb. Basic information, hydrogeological parameters, physical and chemical parameters of particular chemicals let us find out and calculate how pesticides spread within the groundwater around the tomb. Also, models are available where, through input points, the spread of contaminants within a particular area can be determined.

## Chemical analyses

Analyses usually follow an established list of indicators of various biologically active ingredients, whose concentrations should be determined in soil and water samples. These are chloroorganic insecticides, ditiocarbamates, and herbicides that belong to phenoxyacids, phosphoroorganic insecticides and nitrogen derivatives.

In order to isolate the biologically active ingredients, methylene chloride and acetone were used as solvents at specific ratios to extract the ingredients from water and soil samples. Residue analyses were performed using gas chromatography (Hewlett-Packard 5890) and gas-liquid chromatography (PYE-UNICAM 104) equipped with EC and NP detectors respectively.

The biologically active ingredients analysed by the EC detector were: aldrin, DDT isomers and metabolites, HCH- isomers, metoxychlorine, chlorfenson, HCB, phenoxyacids including 2,4-D, dicamba, MCPA, and mecoprop, which determined as esters of PFB (pentafluorobenzyl). While NP detector analysed residues of dichlorfos, fenitrotion, methyloparathion, tiometon, dinoseb, DNOK, atrazine, simazine, and chlorpropham.

**Table 1. Residue levels of biodegradable pesticides in the water and soil samples**

| Sample | Biodegradable ingredients | Determination method | Concentration | |
|---|---|---|---|---|
| | | | Soil mg/kg | Water µg/l |
| **Chloroorganic insecticides** | | | | |
| 1. | aldrin | GLC - EC | 0.005 | 0.10 |
| 2. | pp'DDD | GLC - EC | 0.005 | 0.10 |
| 3. | pp'DDE | GLC - EC | 0.005 | 0.05 |
| 4. | op'DDT | GLC - EC | 0.005 | 0.10 |
| 5. | pp'DDT<br>Σ DDT | GLC - EC<br>GLC - EC | 0.005<br>0.005 - 0.020 | 0.10<br>0.05 - 0.35 |
| 6. | alpha-HCH | GLC - EC | 0.001 | 0.05 |
| 7. | beta-HCH | GLC - EC | 0.005 | 0.05 |
| 8. | gamma-HCH | GLC - EC | 0.001 | 0.05 |
| 9. | HCB | GLC - EC | 0.001 | 0.05 |
| 10. | Methoxychlor (DMDT) | GLC - EC | 0.020 | 0.50 |
| 11. | Chlorphenson | GLC - EC | 0.005 | 0.10 |
| **Phosphoroorganic insecticides** | | | | |
| 12. | Fenitrothion | GLC - NP | 0.02 | 0.50 |
| 13. | Tiometon | GLC - NP | 0.01 | 0.50 |
| 14. | Metyloparathion | GLC - NP | 0.02 | 0.50 |
| **Nitrophenols** | | | | |
| 15. | DNOK | GLC-NP | 0.05 | 1.0 |
| 16. | Dinoseb | GLC-NP | 0.05 | 1.0 |
| **Herbicides** | | | | |
| 17. | 2,4-D | GLC - EC | 0.10 | 1.0 |
| 18. | MCPA | GLC - EC | 0.10 | 1.0 |
| 19. | Dicamba | GLC - EC | 0.10 | 1.0 |
| 20. | Mecoprop | GLC - EC | 0.10 | 1.0 |
| 21. | Atrazine | GLC - NP | 0.01 | 0.50 |
| 22. | Simazine | GLC - NP | 0.01 | 0.50 |
| 23. | Chlorpropham | GLC - NP | 0.02 | 0.50 |

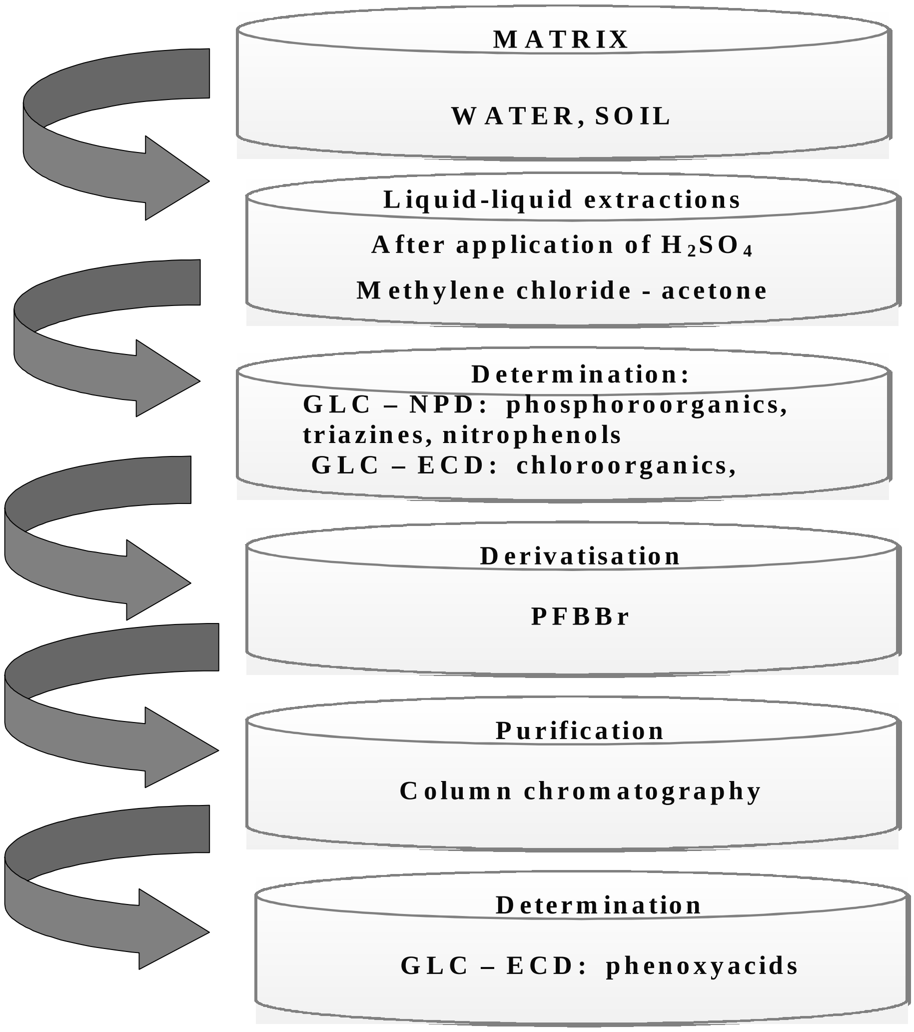


**Figure 1. Analytical procedure of the biodegradable ingredients in water and soil samples**

An example of a chemical study is an evaluation of contaminants in closed model retention tanks of interim landfills. The tanks contain effluents drained from highly contaminated soil excavated from around tombs in the towns of Niedźwiady and Sośnicowice. Figure 2 shows the example.

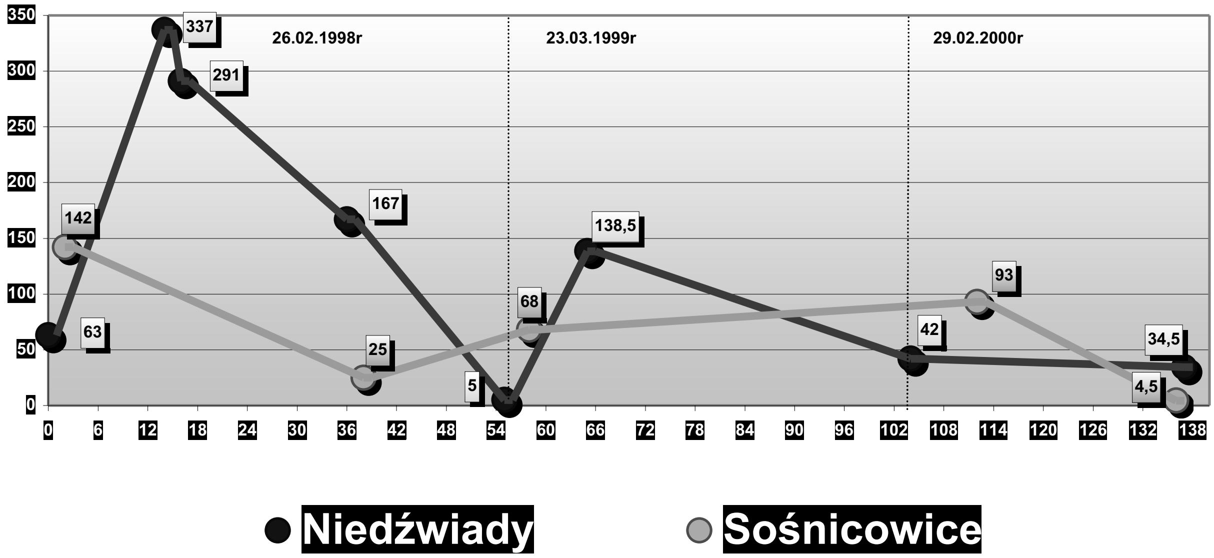


**Figure 2. Changes in the indicative biodegradable ingredients determined during the period 1998-2000 in the effluents of closed tanks at landfills in Niedźwiady and Sośnicowice**

## Conclusions

1. Hydrogeological and chemical studies are crucial for the disposal of old tombs containing obsolete pesticides as shown in Figure 3.

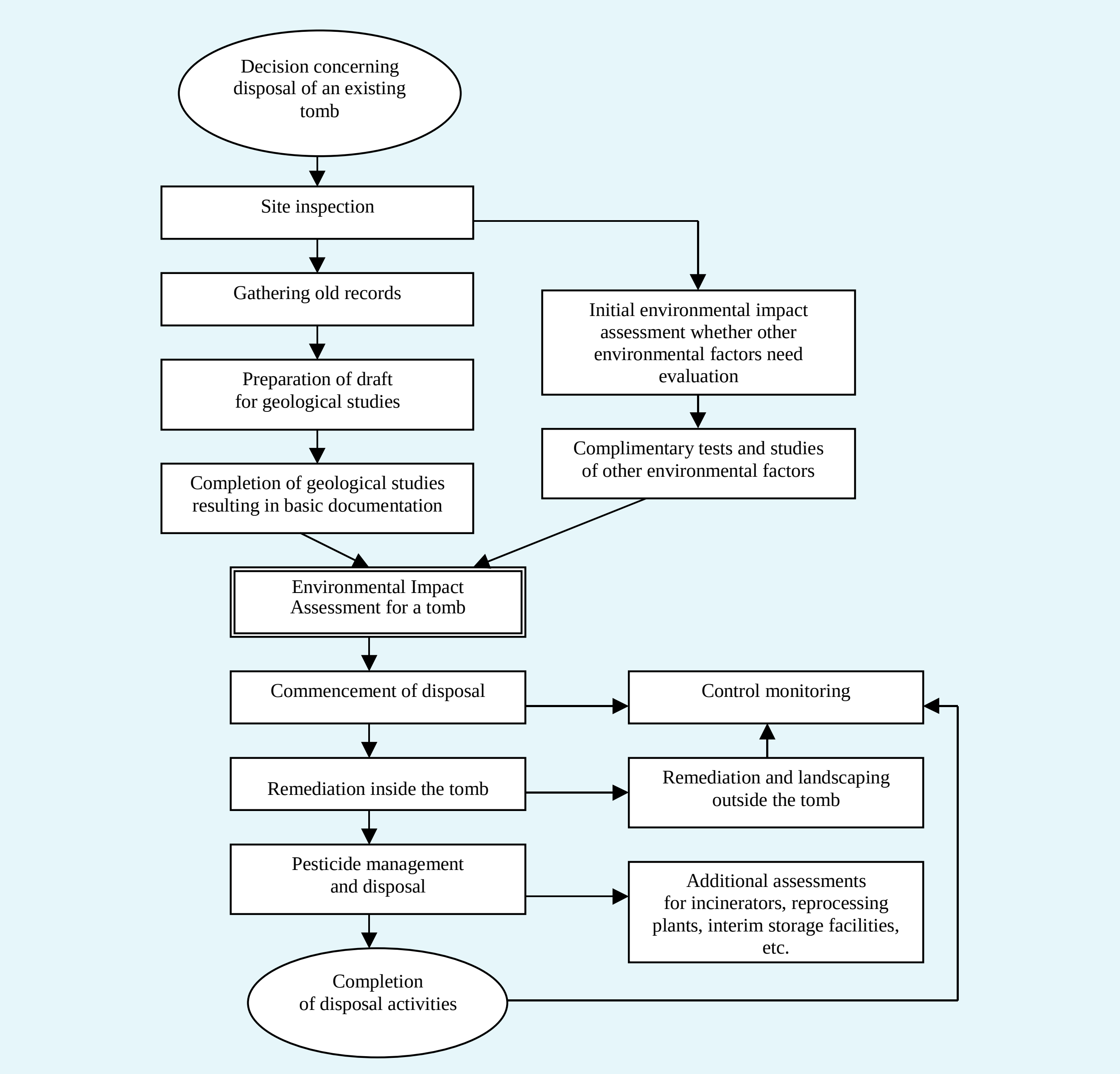


**Figure 3. Environmental activities accompanying tomb disposal**

2. A properly performed assessment of environmental threats results in recording of facts and setting disposal priorities. Some emergency cases require immediate remediation.

## References


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